Appendix 7

Optimum Shelter Belts

How to Guide

Monitoring the biodiversity benefits of your Optimum Shelter Belt

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Introduction

Shelterbelts are rows of trees or shrubs that reduce the force of the wind. They can reduce soil erosion, increase crop yields and protect livestock from heat and cold stress. They beautify the landscape and also support biodiversity. They offer sources of feed, nesting and shelter for insects, birds and mammals, and provide habitats and corridors for wildlife that are becoming the theme of many national biodiversity strategies. This *How to* guide supports the standardised monitoring of the biodiversity benefits of establishing OSBs at 20 sites. It is hoped that the results, quantifying any changes attributable to the presence of the OSB, will be of great interest to landowners and many categories of professionals.

General approach

Biodiversity is a measure of variation at the genetic, species, and ecosystem level. Its measurement therefore needs to encompass different scales, but clearly not everything can be recorded. For this reason the biodiversity monitoring protocols focus on a complementary set of proxies and taxonomic groups that, together, are indicative of overall biodiversity value and provide a meaningful narrative about the food web. They are therefore also referred to as 'indicators', which must be practicable to measure, robust, and sensitive enough to pick up realistic changes over relatively short timespans (several years).

There are many different biodiversity monitoring schemes and methods in existence and this current set of protocols is aligned to some of the most relevant. Of particular note are:

- the biodiversity indicators being developed as part of the Global Farm Metrics initiative. These are still being finalised but include areas of habitats, connection to off-farm habitats, and birds as an indicator species for habitat quality;
- the Hedgerow Biodiversity Protocol developed by ORC in 2105 under the TWECOM project;
- work by Centre for Ecology and Hydrology (CEH) in defining hedgerow Favourable Conservation Status (FCS);
- the AGROMIX project (Horizon 2020) biodiversity sampling protocols.

Eleven indicators have been selected, comprising six indicators that describe the habitat and its value for wildlife, and six indicators focussing on important groups of species. The habitat indicators are habitat structure and connectivity, vegetation composition (of both the woody species in the shelter belt as well as the ground flora at its base), dead wood, and berries and flowers (as food sources). The species group indicators are breeding birds, small mammals, butterflies, bumblebees, soil fauna, and pests and invasive species.

The protocols also recognise the varying level of interest and knowledge of those undertaking the monitoring, addressing this by providing, for each biodiversity attribute, a two-tiered approach. Tier

1 represents a basic measurement providing the minimum level of detail needed to track change over time. It is divided into Tier 1a and 1b with the latter reflecting the scope to record additional, valuable detail. Tier 2 represents a more advanced measurement and therefore methodology, sometimes requiring additional equipment. The tiers of measurement for the 12 indicators are summarised in Table 1.

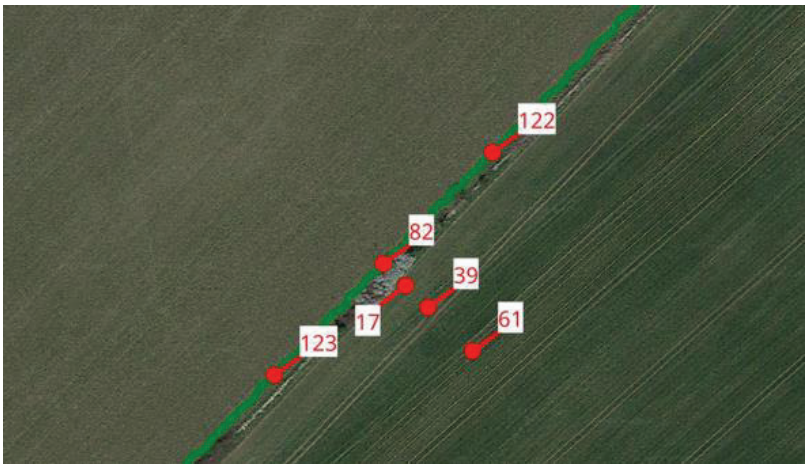
Table 1: Biodiversity monitoring indicators and tiers of measurement.

Indicator	**Measurement level**		
	Tier 1a	**Tier 1b**	**Tier 2**
Habitat and food			
Habitat structure	Presence of standard trees, shrubs and other structural components	Quantification of structural components along the OSB, with height information	Calculation of foliage height diversity
Habitat connectivity	Presence of large gaps and connections between OSB & other semi-natural features	Continuity of canopy along hedgerow (% gaps)	Connectivity modelling using LandApp Wild Edge and Guidos toolkit
Vegetation composition – woody plants	Variety of woody plants	Species richness and abundance of woody plants	Species diversity of woody species per 30 m
Vegetation composition – ground flora	Cover/abundance of main plant types at centre and edge of OSB	Cover/abundance of plant species at centre and edge of OSB	Comparison of OSB plant communities with other on-farm habitats: NVC, ordination and similarity
Dead wood	*Dead good Deadwood* survey of quantity of deadwood	*Dead good Deadwood* survey of quantity and age of deadwood	*Dead good Deadwood* survey of quantity and age of deadwood with additional volume calculation
Food supply	Abundance of berries, nuts and flowers	Species diversity and abundance of berries, nuts and flowers	[No Tier 2 protocol]
Indicator groups:			
Birds	Abundance of birds using the OSB & adjacent field	Abundance of different species of birds using the OSB & adjacent field	Breeding Bird Survey counts
Small mammals	Density of runways and burrows made by small mammals	Additional search for dormice evidence (OSBs with hazel only)	Species identification using footprint tunnels
Butterflies	Abundance of butterflies using the OSB & adjacent field	Abundance of different species of butterflies using the OSB & adjacent field	UK Butterfly monitoring Scheme transect
Bumblebees	Abundance of bees using the OSB & adjacent field	Abundance of different species of bees using	BeeWalk monitoring

		the OSB & adjacent field	
Soil fauna	Abundance of earthworms	Abundance and weight of the three main different types of earthworm	Soil Biological Quality Index (QBS)
Pest and invasive species	Levels of tree leaf browning and yellowing along the OSB as well as presence of grey squirrel and muntjac deer	Pests and diseases of specific tree species identified	Woodland herbivore impact assessment

Sampling design

Where relevant to the indicator concerned, sampling for each OSB should follow the T-shaped design shown below. This is further described in the introductory material for the the OSB monitoring protocols.



Protocols

Habitat structure

Rationale

More structural complexity results in a greater range of habitat niches, a pattern observed for many different taxonomic groups (Simonson et al 201). For hedgerows, structural complexity is known to be a key attribute for invertebrates, birds, mammals and plants, with the multiple structural components (including associated banks, ditches and other features) allowing more species to complete their life cycles. For example, the majority of invertebrates benefit from denser, more complex hedgerow structures (e.g. Maudsley, Seeley and Lewis 2002).

Trees in shelterbelts and hedgerows add to this important habitat heterogeneity and Merckx et al. (2009) found that the presence of hedgerow trees resulted in a substantially higher abundance

(+60%) and species richness (+38%) of larger moths in the immediate landscape compared to similar landscapes without hedgerow trees. Slade et al. (2013) showed that trees outside woodlands – especially when part of a hedgerow network - act as “stepping stones” for macro-moths moving across an agricultural landscape. For this reason trees have been described as ecological keystone structures with a disproportionate effect on ecosystem functioning. Trees provide habitat for lichens, are a rich source of seed, fruit and invertebrate food, and provide song posts and cavity nesting sites for birds.

The Tier 1 protocols are adapted from the PTES Great British Hedgerow Survey guidelines and draws from the Definition of Favourable Conservation Status of Hedgerows (Staley et al 2020). The Tier 2 protocol is based on the method of calculating Foliage Height Diversity (FHD) described by Simonson et al (2012) *Conservation Biology*.

Tier 1a protocol

For a typical 40 m stretch of the OSB, walk down its length and record which of the following structural components are present (noting definitions):

1. Ditch;
2. Bank;
3. Marginal vegetation: a strip of developed perennial ground vegetation to the side of the OSB, differing from the vegetation of the adjacent field. It may include brambles, grass or other perennial herbs;
4. Basal vegetation: a developed ground layer of vegetation at the bottom of the OSB;
5. Shrub layer: woody plants and small trees in the height range 0.5-4 m;
6. Standard trees: trees > 4 m high and emerging from the canopy of the shrub layer.

The resulting score will be in the range 0-6. For hedgerows, three criteria for the achievement of Favourable Conservation Status are the presence of one standard tree per 40 m length, and the presence of at least three of the structural components. Additionally, a gap between the ground and the base of the shrubland canopy should be < 0.5m. Note down if this is the case for the OSB.

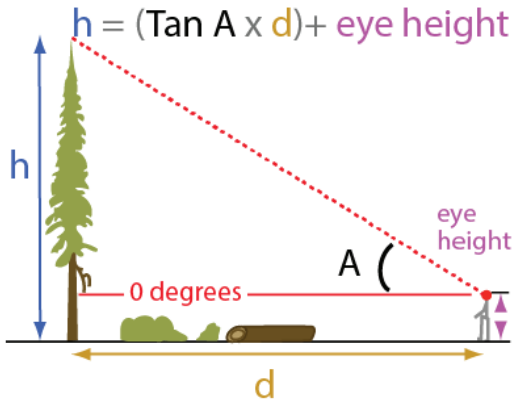
Equipment/resources: Data entry sheet.

Tier 1b protocol

In this version of the Tier 1 protocol the presence of the six different structural components is quantified over the length of the whole OSB, and some height information is also recorded.

Walking along the OSB and every 10 paces (equating approximately to 10 m) record which of the structural components are present. Also count the number of standard trees.

Within each 10 m section, also estimate the average top height of any tree canopy and the top and bottom height of the shrub canopy. The latter can be measured with the help of a 2 m pole marked in 10 cm intervals. Top heights above 2 m can be estimated by eye to the nearest m. For the tree height, first select a tree that appears to represent the average tree height within the 10 m section. The easiest way to then measure the height is with a clinometer or inclinometer, following the maker's instructions.



Credit: University of British Columbia

In the absence of this equipment, the following method using a ruler is an alternative method. Stand far enough away from the tree where you can see the entire tree in your field of view. Hold the ruler upright in your hand with your arm extended out fully. Line the ruler up with the tree so the top of the ruler aligns with the highest point of the tree; mark on the ruler with your thumb the tree base. Keeping your arm extended, turn the ruler 90 degrees. Either have your measuring assistant stand at the point on the ground out from the tree where you see the ruler end or note the point where the ruler ends. Measure the distance from either the person or the spot to the tree base, this distance is equivalent to the tree's total height.

Tip: It would be efficient to combine this survey with that for habitat connectivity.

Equipment/resources: Data entry sheet, in(clinometer) or ruler, long measuring tape, 2 m pole.

Tier 2 protocol

This protocol is for the calculation of a metric used to describe the distribution of canopy cover across different height strata: Foliage Height Diversity (FHD). The diversity index is calculated by the Shannon Diversity Index equation used for species diversity.

At the three sampling points along the OSB (see sampling strategy), three replicates of the following method are to be undertaken, at 10 randomly chosen spots, each at least 1 m apart. See Equipment (below) for a description of the pole and disk needed for this method. Stand the pole vertically and pass the disk up it noting if it makes contact with vegetation (branches, twigs and leaves) as it passes up through each height interval of: 0–25 cm, 25–50 cm, 50–100 cm, 1–2 m and 2–4 m. Then looking up the pole, estimate if the disk would make contact with vegetation higher than 4 m.

Sum the number of vegetation contacts in each height interval for the 3 x 10 sampling points in the OSB and then calculate the Shannon diversity index using the formula:

$$\sum_{i=1}^{S}(pi\ln pi)$$

where p is the proportion of contacts with the sampling disk for a given height interval to the total number of contacts for all height intervals. The Excel data sheet makes this calculation for you once the data is entered.

Equipment/resources: Data entry sheet. A 4 m pole made of bamboo or similar, marked off in the height intervals 25 cm, 50cm, 1 m, 2 m and 4 m. A plastic disk of approximately 20-25 cm diameter with a hole cut in the middle so that it can pass up and down the pole.

Habitat connectivity

Rationale

Optimum Shelter Belts, as part of a wider network of hedgerows and other linear semi-natural features, represents an important ecological infrastructure allowing movement of species across the landscape. This may be for daily foraging, as in the case of mobile species such as bumblebees, bats and small mammals. But there is also (more limited) evidence of migration and population dispersal using these woody ecological corridors, for example in response to climate change.

For OSBs to function well in allowing species movement, good connectedness is important. For example, some species of bats and small mammals avoid hedgerows with gaps (Feber et al. 2019).

It is worth noting that there can be a downside to connectivity to the extent that it may allow the spread of pests, diseases and even (e.g. for linnets) predation (e.g. by corvids).

The Tier 1a and 1b protocols are based on connectivity criteria for the Favourable Conservation Status of hedgerows; no gaps > 5m and horizontal gappiness < 10% of total length. The Tier 1b protocol is based on the Hedgerow Survey Handbook (Defra).

Tier 1a protocol

Walk the whole length of the OSB and note down the presence and length of any gaps in the woody cover of greater than 5 m, estimated by one pace = 1 m. At each end of the OSB, also note whether it connects (i.e. there is a gap of no more than 5 m) to a hedgerow, woodland, or other wooded habitat feature.

Tip: Access points are not included as gaps for the purposes of condition assessment for this attribute, because 5m is about the standard gate width in some areas

Equipment/resources: Data entry sheet.

Tier 1b protocol

As per Tier 1a, but in this case record gaps of greater than 1 m. From knowledge of the total length of the OSB, on the recording form use your data to calculate the total horizontal gappiness in % (total length of gaps/total length of OSB x 100).

Tip: Gaps must be complete breaks in the canopy; overlapping canopies (trees, shrubs) are not considered as gaps.

Equipment/resources: Data entry sheet, calculator for calculation of horizontal gappiness.

Tier 2 protocol

In this researcher led protocol, Land App Wild Edge, Guidos toolkit and Condatis (circuit theory based) connectivity modelling approaches will be used to study the increase in landscape

connectivity on the farm resulting from the establishment of the OSB. The four measures of semi-natural habitat developed by Wild Edge are: connectedness (%), unconnected components (total number), core to edge (%, and indication of proportion of farmland close to semi-natural habitat and benefiting from their beneficials) and semi-natural habitat amount (%).

Vegetation composition – woody species in the shelter belt

Rationale

A high diversity of animal species is often associated with the richness of the flora. For an Optimum Shelter Belt, the flora consists of the woody species (trees and shrubs) and the ground flora of herbaceous species. These two components are largely independent, and the latter are the focus of the separate protocol below.

A good mix of woody species provides a range of resources and has been shown to benefit bird species richness (Arnold 1983), pollinating invertebrates (Staley et al. 2018) and invertebrate numbers in general (Garratt et al. 2017). Dormouse population density in hedgerows is strongly influenced by shrub diversity.

For this reason one of the measures of the Countryside Survey for the quality of hedgerows is the mean number of native species per 30 m length. The average for England is 3.7 (Carey et al 2008), and this is an attribute included in the Hedgerow Survey Handbook (Defra 2007). Research in Devon, Lincolnshire, Cambridgeshire, Huntingdonshire and Northants, has found that hedgerows, on average, gain one woody species roughly every 100 years, per 30 metre length (Pollard et al, 1974).

Tier 1a protocol

The woody species survey can be undertaken at any time of year but will be easiest when the deciduous shrubs and trees are in leaf.

Walk 30 m along one side of the OSB and, looking across its width, note down how many different kinds of woody species you see. For this purpose, a woody species will be at least 0.5 m high (seedlings are to be excluded).

Tip: Include ramblers and climbers such as bramble, honeysuckle and ivy, even though they are ubiquitous and not an indicator of shelterbelt quality.

Equipment/resources: Data entry sheet. A list of woody species native to England (and Wales) can be found in the Hedgerows Regulations 1997 (Schedule 3). This information can also be found in the Hedgerow Survey Handbook (Defra 2007, Appendix 11).

Tier 1b protocol

As for Tier 1a, walk a 30 m length along one side of the OSB, but this time record which woody species you see and how many there are of each. For trees/shrubs which are not immediately recognisable, give them a descriptive short name, take a leaf/flower/fruit sample in a bag, and try to ID the sample on return from the survey.

On the recording form and with recourse to a guide or online source, note which species are not native. (A quality indicator for hedgerows is that non-native species make up <10% of the total.)

Tip: You may find it easiest to demarcate short sections of the OSB with long tapes that you peg across its width as you go along, to aid counting.

Equipment/resources. As per Tier 1a, plus an identification guide for shrubs and trees such as the Collins Tree Guide by Owen Johnson, or a plant identification app.

Tier 2 protocol

The difference between species richness and species diversity is that the latter takes into account not only how many species are present but also how evenly distributed the numbers of each species are. This Tier 2 protocol collects the same information as Tier 1b, but calculates the Shannon Diversity Index, a commonly used index in ecology.

To calculate the index for your shelterbelt either enter your Tier 1b data into the online Shannon Diversity Index Calculator (see link below) or else into the Excel spreadsheet calculator tool provided with this protocol.

Tip: With this index, 1 represents infinite diversity and 0, no diversity. Don't expect high numbers!

Equipment/resources: as per Tier 1b, plus the online calculator (https://www.omnicalculator.com/ecology/shannon-index) or OSB Excel calculator.

Vegetation composition – herbaceous species in the bottom

Rationale

High animal species richness is linked to high plant species richness, both of woody species (trees and shrubs) and of herbaceous plants.

The ground flora is an important component of OSBs and can contribute significantly to species diversity. Ground flora also provides an important food resource to a wide range of wildlife such as butterflies and bees. The centre of a mature OSB may develop a ground flora (for example of some shade-tolerating species) that is distinct from that at the outside edge, and this is reflected in the sampling design.

For example, those next to ungrazed grasslands or arable fields may be dominated by tussocky grasses, while those next to fields that receive high levels of fertilizer input are often dominated by nettles (Urtica dioica) or goosegrass (Galium aparine). Occasionally, hedge bottom floras are remnants of former species-rich grassland (Wilson 2019). In other instances, the flora is rich in herbs that include ancient woodland indicators (Garbutt and Sparks 2002), as with many lane-side ancient Devon banked hedges (Devon County Council and The Devon Hedge Group 1997). There is evidence the number of woodland indicator species in some hedgerows is reducing (Smart et al. 2001, Garbutt and Sparks 2002).

Protocols Tier 1a and 1b are adapted from the TWECOM Hedgerow Biodiversity Protocol 2015 and the AGROMIX biodiversity protocols.

Tier 1a protocol

The survey should ideally be carried out between May and June.

Identify a representative section of the OSB and place two 2m x 1m quadrats 10 m apart at the edge. Aim to survey the ground flora influenced by the OSB rather than by the adjoining land use, by placing the quadrats as close to the woody stems as possible.

For each quadrat, use the DOMIN scale (Table 2) to record the cover/abundance of each main type of ground flora: grass-like plants (grasses/sedges/rushes), forbs (broadleaved herbaceous plants), woody perennials (e.g. tree seedlings), mosses/lichens, as well as the cover of bare ground.

Table 2: DOMIN scale.

Value	Visual estimate of cover
+	1 individual, with no measurable cover
1	<4% cover with few individuals
2	<4% cover with several individuals
3	<4% cover with many individuals
4	4-10% cover
5	11-25% cover
6	26-33% cover
7	34-50% cover
8	51-75% cover
9	76-90% cover
10	91-100% cover

Repeat the method for a further two quadrats located as close as possible to the centre line of the OSB, parallel to the original two quadrats. For these quadrats, continue to focus on the ground vegetation and not the shrub/tree layer.

Alternatively (from FCS report): Critchley et al. (2013), using more recent Countryside Survey data, developed an alternative, functional, classification of herbaceous hedgerow flora, to guide restoration work. Thirteen different vegetation types in six broad groups were identified. The broad groups were woodland herbs, species-rich or semi-improved grassland, rank grassy vegetation, species-poor pasture, disturbed arable and sparse vegetation.

Equipment/resources: Data entry sheet, 2 m x 1 m quadrat.

Tier 1b protocol

As per Tier 1a, but for each quadrat, use the DOMIN scale to record the cover/abundance of plant species present with a cross or tick mark on the ground flora data entry sheet. The species list on the ground flora data entry sheet is not exclusive. The list may need to be adapted to include frequently occurring species in your locality. Space has been left to record other species present. From the list and supplementary information, note down which species are non-native. The threshold for Favourable Conservation Status of hedgerows is <10% non-native. Additionally, what is the combined cover within the quadrats of nettles, cleavers and docks? The FCS threshold is < 20% for nutrient enrichment.

Tips: If the species cannot be identified, either note the genus or family or give the plant a name/short descriptor. Specimens can be collected for identification if that is a possibility later.

Equipment/resources: Data entry sheet, quadrat, Plant identification guide (e.g. The Wild Flower Key: How to identify Wild Flowers, Trees and Shrubs in Britain and Ireland by Francis Rose, 2006, and

Grasses, Sedges, Rushes and Ferns of Britain and Norther Europe – a Collins Picket Guide by Richard Fitter and Alastair Fitter, 1984), Plant ID apps (e.g. Seek).

Tier 2 protocol

In this researcher led protocol, quadrat-based surveys will be undertaken of the flora of the OSB and comparison habitats (hedgerows, field margins, meadows) and the results studied through National Vegetation Classification (NVC) communities, ordination analysis and similarity indices.

Dead wood

Rationale

Decaying wood originating from shelter belt shrubs and trees is important for saproxylic fungi, invertebrates and other species including threatened and scarce species. Its quality and abundance are heavily influenced by shelterbelt management. Retention of any veteran trees in the line of the shelterbelt is obviously critical, but other dead wood associated with snags, windblown trees, stumps and fallen branches also provides valuable habitat.

Tier 1a, 1b and 2 protocols are all based on The Conservation Volunteers *Dead good Deadwood* survey and UK Forestry Standard for deadwood.

Tier 1a protocol

Walk 100 m or 100 paces of the shelterbelt and look across its width mapping on a data sheet the locations of large pieces of deadwood. Large pieces are defined as being more than 20 cm in diameter and 2 m long. Each piece should be recorded as one of five categories: veteran tree, tree stump, snag, windthrown tree or fallen log. See the survey booklet (link below) for further information.

Equipment/resources: Data entry sheet, Deadwood survey booklet, field guide, tape measure.

https://www.tcv.org.uk/scotland/dead-good-deadwood-survey/

Tier 1b protocol

For this protocol, the Tier 1a survey is carried out but with the recording of additional information (Form B of the Deadwood survey protocol) that helps estimate the age of each piece of deadwood. This involves measuring the piece of deadwood, looking at the surface of the deadwood and inside the deadwood. See the survey booklet (link below) for further information.

Equipment/resources: Data entry sheet, Deadwood survey booklet and field guide, tape measure.

Tier 2 protocol

Carry out the survey as per Tier 1b. Additionally, using the measurements of the pieces of deadwood, calculate the volume of each by assuming cylinder shape and applying the equation Volume = length x $(\text{diameter}/2)^2$ x 3.14. Estimate the total deadwood volume per hectare (10,000 m^2) by summing the volumes of the pieces and multiplying the total by 20. This assumes a 100 m transect and that the OSB is at the specified 5 m width. For comparison, Scottish Forestry advises a threshold of 20 cubic metres of deadwood (excluding stumps) per hectare for woodland.

Equipment/resources: Data entry sheet, Deadwood survey booklet, field guide, tape measure.

Food supply: berries, nuts and flowers

Rationale

A plentiful supply of nectar and pollen, provided by diverse species of woody and herbaceous plants from early spring to late summer, is desirable. So too, is a plentiful winter supply of berries from multiple woody species.

Hedgerow flowers are used by a wide range of invertebrate species, feeding on pollen, nectar and the petals. The quantity of hedgerow flowers was included in a recent assessment of farmland floral resources needed to support six focal pollinator species (Dicks et al. 2015), demonstrating their role in supporting pollinator populations. Also, the length of season that flowers are available is important, e.g. willow catkins and blackthorn flower early in the season, through to late-flowering ivy (Staley et al. 2018). Pollinators emerging in early spring (e.g. queen bumblebees) may be particularly dependent on early hedgerow floral resources, due to the shortage of other flowering resources at this time in the wider agricultural landscape (Dicks et al. 2015). Hedgerow berries provide a food resource for overwintering bird, mammal and invertebrate species, with hawthorn berries favoured by thrushes species (Sparks and Martin 1999). Many invertebrate species feed on the fleshy fruits of woody hedgerow species, around a quarter of which are classified as rare or scarce (Jefferson 2004). Ten of the 18 most threatened mammals in Britain rely on the fruits and berries of hedgerows (OPAL Biodiversity Survey Guide).

Tier 1a protocol

Carry out the following survey twice in the year: in the late Spring/Summer to capture flowering plants in the margin of the shelterbelt and autumn to capture nuts and fruit (hazelnuts, rose hips, etc.)

Following the OPAL Citizen Science Biodiversity Survey guide, estimate the number of berries, nuts and flowers in a 3 m stretch of OSB according to the following ranges: 0, 1-10, 10-100, 100-1000, > 1000. Repeat for two more 3 m stretches. Record the results separately for the basal/marginal ground vegetation and the woody vegetation of the shelterbelt.

Tip: Placing two poles at either end of the 3 m section and then standing back to study the vertical profile of the OSB, can help the count estimation. Count inforescences of small flowers and fruits (e.g. elder flowers and berries) as one unit.

Equipment/resources: Data entry sheet, OPAL Citizen Science Biodiversity Survey guide, measuring tape and poles

Tier 1b protocol

In this version of the Tier 1 protocol, note down the different species of berry, nut and flower as well as the abundance score for each separately for the OSB and its base/margin (as per 1a). Shannon diversity index using the formula:

$$\sum_{i=1}^{S}(pi\ln pi)$$

where p_i is the proportion of the entire number of food items made up of species i. For the purposes of this calculation the media value of each abundance range should be used (i.e. 5, 55 and 550; above 100 try to arrive at a visual estimate to nearest 500). The Excel data sheet makes this calculation for you once the data is entered.

Equipment/resources: As per Tier 1a. Standard field guides are the best means of identifying plant species from the leaf if not flower and fruit.

INDICATOR GROUPS

Breeding birds

Rationale

Hedgerows are one of the most important surviving semi-natural landscape features for birds. They provide nesting, foraging and roosting sites and provide cover and facilitate movement across the landscape. Birds can be used as bioindicators due to their ecology being well understood and the existence of links between bird community, vegetation associations and territories. Birds are also easily detected giving not only presence but also abundance. One area of interest is the presence of nesting birds and to assess whether the sloping profile of the OSB attracts different species of nesting birds associated with both tree canopies and hedgerows.

As many as 16 out of the 19 birds used by Government to assess the state of farmland wildlife are associated with hedgerows, with 10 using them as a primary habitat (Staley et al 2020).

Protocols Tier 1a and 1b are adapted from the Game and Wildlife Conservation Trust (GWCT) Big Farmland Bird Count and the TWECOM Hedgerow Biodiversity Protocol 2015.

Tier 1a protocol

The survey should be undertaken once in April/May and once in May/June, preferably on a sunny day. If possible, the survey should take place between 6 and 9 am as this is when birds are most active. If at another time, try to make this consistent across years/counts.

Spend 30 minutes walking down one side of the total length of the OSB recording the number of birds seen (a) in the OSB and its immediate environs, and (b) in the open field on your other side. Enter the data as you go using the bird data entry sheet. In the case of (a), the data entry sheet will prompt you to distinguish the birds observed in the marginal/basal ground vegetation, the shrubby layer, and (if relevant) the taller tree canopy. Note the start and finish time of the survey and make additional notes where indicated in the data entry sheet on observations of interest, such as nests observed, any dead birds or signs of a bird kill.

Tip: Walk the length of the OSB at a slow, methodical pace, not lingering in hotspots to improve your count. Some birds may be flushed from their resting places and move along the OSB ahead of you. As far as possible, try not to repeat count these birds. For the OSB count, don't record birds flying overhead (i.e. birds not obviously using the OSB) although do note them under additional observations (see above).

Equipment/resources: Data entry sheet, Binoculars.

Tier 1b protocol

As per the Tier 1a protocol, but in this case record both the species and number of birds seen.

Equipment/Resources: Data entry sheet, Binoculars, Bird survey sheet listing common farmland bird species and Biodiversity Action Plan (BAP) species, Bird identification guide (e.g. RSPB Birds of Britain

and Europe by Rob Hume (2014) or Collins Bird Guide by Lars Svensson and Killian Mullarney (2010), Bird identification app (e.g. Merlin).

Tier 2 protocol

BTO Breeding Bird Survey: BBS monitors the population changes of 118 breeding bird species across the UK, involving almost 3,000 volunteers who survey their randomly selected 1-km square each spring[26]. The survey involves two early-morning spring visits to a local 1-km square, to count all the birds you see or hear while walking two 1-km lines across the square. Further instructions and a recording form can be found here. Opportunities should be sought to integrate data from relevant BBS survey squares with the Tier 1a and 1b OSB bird monitoring results.

Small mammals

Rationale

Shelterbelts and hedgerows are important habitat and transport corridors for small mammals including wood mouse, yellow-necked mouse, bank vole and common shrew. Species such as harvest mice, field voles, pygmy shrews and water shrews may also venture into these areas. Dormouse, a Biodiversity Action Plan species, is associated with good quality hedgerows in southern Britain, while the group as a whole is of conservation importance due to recent declines. The amount of ground cover, and hedgerow condition (lack of gaps) has been found to be important for some small mammal species (Kotsageorgis and Mason, 1997).

The Tier 1b protocol is based on the PTES Dormouse Nut Hunt. The footprint tunnel (Tier 2 Protocol) is based on the survey of urban hedgerow mammals by Atkins et al (2008).

Tier 1a protocol

Typical habitat for small mammals is a matrix of interconnecting runways through grass and leaf litter that they use in both the day and night (Barnett & Dutton 1995). In this Tier 1a protocol, the idea is to assess the density of runways within quadrats, comparing the centre of the OSB with the grassy margin at its edge and the crop or pasture field to its side.

Using the sampling scheme shown in Figure 1, at each of the three positions along the OSB, mark out a 2 x 2 m quadrat using pegs and measuring tape. Within the quadrat, look for the presence of runways. What do they look like? For voles they are usually 40-50 mm wide and typically lie slightly below the surface of the ground, as voles keep runways clear by clipping vegetation and create small ruts through repeated use (Cook et al 2004). Runways of other small mammals will be similar.

Having identified any runways, estimate their total length using a tape measure or by visual comparison with the 2 m side of the quadrat.

Also note down the number of any active small mammal burrows that you find within the quadrat.

Having undertaken the six quadrats along the OSB, carry out three more in the field at increasing distance from the OSB as shown in Figure 1.

Tip: To assess if a burrow is being actively used, peer into its entrance and see if there is an accumulation of detritus in it or if it is covered with a spiderweb or other tell-tale signs of disuse.

[26] https://www.bto.org/our-science/projects/breeding-bird-survey/taking-part

Equipment/resources: Data entry sheet, long tape measure, pegs (e.g. tent pegs).

Tier 1b protocol

Carry out the Tier 1a method but for the three quadrats in the centre of the OSB, make a careful search for hazelnuts that have been gnawed by mice and voles, noting the different characteristics of nuts gnawed by dormice in comparison to those gnawed by the other small mammals (see figure below).

The best time to carry out the survey is during the autumn and winter when there are no leaves on the trees and the discarded nut shells are easiest to find on the woodland floor.

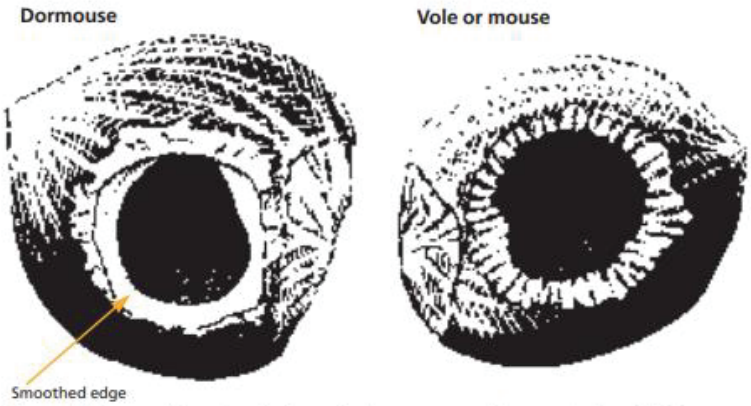


Figure 5 Gnawed hazel nuts. Dormice leave a smooth round hole with few toothmarks on the surface. Mice and voles may also leave a round hole, but with transverse toothmarks on the cut edge.

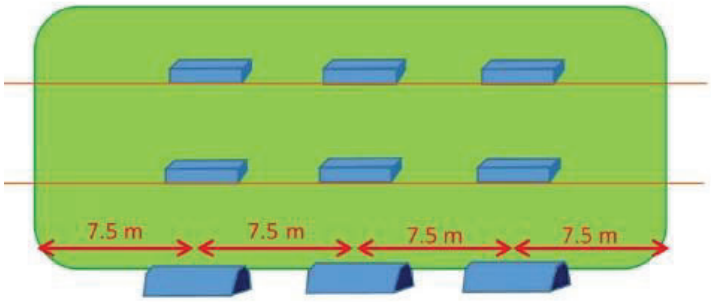
Tip: You may find it easier to take the hazel nuts home and use a magnifying glass to identify what has been nibbling them.

Equipment/resources: As per Tier 1a, magnifying glass.

Tier 2 protocol

Small mammals not only use runways on the ground, but also “arboreal” runways along the branches of a shelterbelt or hedgerow. The following method samples mammals moving through the canopy of the shelterbelt as well as on the ground using footprint tunnels, a low invasive survey method.

Bait and prepare the tracking plate of each footprint tunnel as per the maker’s instructions (see also Equipment/resources below). Nine footprint tunnels are required for each OSB and sampling session. Taking a 15 m length of the OSB, place three tunnels 7.5 m apart at ground level as well as at heights 1 m and 2 m (see figure below). Secure those on the ground with metal pegs and those at height to a branch using cable ties. Leave all tubes in the OSB for four nights before removing. Try to identify any footprints on the paper using a guide and record the species.



Tip: It can be difficult to distinguish between some species of smaller mammals. Atkins et al (2008) note: *During pilot studies, tracing paper was found to be less palatable to slugs and snails, and the ability to overlay this on example footprints made identification more accurate.*

Equipment/resources: Footprint tunnels and Identification Guide. We recommend the footprint tunnel (dimensions c. 120 cm x 71 cm) available from NHBS which come with charcoal powder and metal fixing but require additional purchase of masking tape, vegetable oil, bait (e.g. dog/cat food) and cable ties. Also available at NHBS is the FSC *A Guide to British Mammal Tracks and Signs* (included with a set of footprint tunnels).

Butterflies

Rationale

Shelter belts and hedges are an important nectar source for a number of butterfly species. Butterflies also react very quickly to change in their environment which makes them good biodiversity indicators. Pressures such as agricultural intensification and loss of habitat have resulted in many common butterfly species having undergone serious declines.

Protocols Tier 1a and 1b are adapted from the TWECOM Hedgerow Biodiversity Protocol 2015.

Tier 1a protocol

The survey should ideally be carried out once in July and once in August (with at least 10 days between the two visits) and between 11am and 5pm on a still, sunny day.

Walk one side of the length of one side of the OSB at a slow, methodical pace noting down the numbers of butterflies you see in and around the OSB. Return along a transect through the adjacent field at a distance of 20 m from the OSB, and within 2.5m either side of the survey line, 5m ahead and 5 m from ground level up, again noting down the numbers of butterflies seen. Record the start and finish time for each survey. This data should then be entered into the butterfly data entry sheet.

Tip: Try to avoid double counting where possible, for example when an individual butterfly repeatedly flies in and out of your recording area. Do not linger in hotspots to improve your count, as this will bias results, and do not count butterflies behind you.

Equipment/resources: Data entry sheet.

Tier 1b protocol

As per the Tier 1a protocol, but in this case record both the species and number of butterflies seen.

Tips: A butterfly net may prove useful to capture and then ID species that are unfamiliar.

Equipment/resources: Data entry sheet, Binoculars, Butterfly identification guide (e.g. Guide to the Butterflies of Britain by John Bebbington or Collins Butterfly Guide by Tom Tolman and Richard Lewington (2008)), Butterfly net.

Tier 2 protocol

UK Butterfly Monitoring Scheme: A new transect encompassing the OSB can be set up as a contribution to this nationwide monitoring scheme. This involves selecting the site, designing the route, filling in and submitting a UKBMS F1 Site details form, and recording data on a UKBMS F2 Weekly recording form. However, this is a regular and long-term commitment, requiring that there are only a very few missed weeks each year, and that the transect is continued for at least 5 consecutive years. Further instructions and a recording form can be found here.

Bumble bees

Rationale

Although bumblebees contribute over £400 million a year to the British economy through pollinating crops, they are facing large declines across the country. Hedgerows are particularly important in providing forage plants for bumblebees at the start and end of the nesting season, when flower-rich grassland areas are being grazed or cut.

Protocols Tier 1a and 1b are adapted from the TWECOM Hedgerow Biodiversity Protocol 2015 and mirror the methodology for butterflies.

Tier 1a protocol

The survey should ideally be carried out once in July and once in August (with at least 10 days between the two visits) and between 11am and 5pm on a still sunny day.

Walk one side of the length of one side of the OSB at a slow, methodical pace noting down the numbers of bumblebees you see in and around the OSB. Honeybees should also be noted if possible. Return along a transect through the adjacent field at a distance of 20 m from the OSB, and within 2.5 m either side of the survey line, 5 m ahead and 5 m from ground level up, again note down the numbers of bumblebees (and honeybees) seen. Record the start and finish time for each survey. This data should then be entered into the butterfly data entry sheet.

Tip: Try to avoid double counting where possible, for example when an individual bee repeatedly flies in and out of your recording area. Do not linger in hotspots to improve your count, as this will bias results and do not count bees behind you.

Equipment/resources: Data entry sheet, Pen or pencil.

Tier 1b protocol

As per the Tier 1a protocol, but in this case record both the species and number of bees seen.

Tip: Although the bumblebee survey sheet includes illustrations of a number of common bumblebees you may wish to take an additional field guide with you (see below).

Equipment/resources: Data entry sheet, Pen or pencil, Bee identification guide (e.g. Field Guide to the Bumblebees of Great Britain and Ireland by Mike Edwards and Martin Jenner, 2009, A Pocket

Guide to the Bumblebees of Britain and Ireland by Pinchen, 2006; What's that Bumblebee by the Bumblebee Conservation Trust, 2010.

Tier 2 protocol

BeeWalk monitoring for the Bumblebee Conservation Trust: This is the national recording scheme to monitor the abundance of bumblebees across Britain. It involves volunteers identifying and counting bumblebees seen on a fixed route walked each month from March to October inclusive. Specialist knowledge is not required but a training session is organised. The fixed route is required to be 1 to 2 km in length and the records are submitted through the BeeWalk website. Further instructions and a recording form can be found here.

Soil fauna

Rationale

Earthworms are an important indicator group for soil health and biodiversity. Hedgerows are known to improve soil conditions, including earthworm diversity, an effect that can extend into the field. Many other organisms inhabit a healthy soil and contribute to its health the Tier 2 protocol is designed to capture this wider faunal diversity.

Tier 1a, 1b and 2 protocols are based on those used in the Horizon Europe project ReForest.

Tier 1a protocol

For this methodology, samples should be taken at six stations according to the T-shape arrangement of sampling (see Sampling design, above). Two surveys should be undertaken per year, in autumn and spring.

Dig a soil pit measuring 25 x 25 x 25 cm and place the soil on a mat. Hand-sort the soil, separating whole earthworms. Count and record the total number of whole earthworms and enter the data into the earthwork data entry sheet. Return all earthworms and back-fill the soil pit.

Equipment/resources: Data entry sheet, Spade, Plastic mat (approx. 1 x 1 m).

Tier 1b protocol

As per Tier 1a, samples should be taken at six stations according to the T-shape arrangement of sampling (see Sampling design) and two surveys undertaken per year, in autumn and spring.

Dig a soil pit measuring 25 x 25 x 25 cm and place the soil on a mat. Hand-sort the soil, placing each whole earthworm into a pot. Count and record the total number of whole earthworms. Separate adult and juvenile earthworms (see survey sheet for identification), returning juvenile earthworms to the soil pit. Separate adult earthworms according to three types: epigeic (litter-dwelling), endogeic (topsoil-dwelling) and anecis (deep burrowing) (see survey sheet). Count the number of adult earthworms of each of the three types and record in the survey sheet the overall weight of each type. Return all earthworms and back-fill the soil pit.

Equipment/resources: Data entry sheet, Spade, Holding pot, Rinsing bottle (water), Plastic mat (approx. 1 x 1 m), Weighing scale.

Tier 2 protocol

As per Tiers 1a and 1b, samples should be taken at six stations according to the T-shape arrangement of sampling (see Samping design). Two surveys should be undertaken per year, in autumn and spring.

At each sample location, dig a soil sample of 10 x 10 x 10 cm using a spade or a square corer. Seal the sample in a ziplock plastic bag. Within 48 hours, the samples should be put into a Berlese-Tullgren extractor (see image below). This involves putting the soil into a funnel fitted with a 2mm mesh. The collection jar below should contain a liquid preservative of 2/3 alcohol and 1/3 glycerol. The extraction process should continue for at least 7 days, depending on soil moisture. After extraction, an optical microscope should be used to record presence of each order/class within each collection jar (note: abundance / counts within each class are not needed). Based on the presence of each order/class, the Ecological-Morphological Index (EMI) can be calculated (see survey sheet).

Equipment/resources: Spade; Trowel; Ziplock bags; Funnels and collection vessels; 2mm mesh; Alcohol and glycerol solution; Optical microscope. See for more information: https://doi.org/10.1016/j.apsoil.2017.05.020).

Example of a Berlese-Tullgren extractor (light bulbs are not required).

Invasive pests and diseases

Rationale

Invasive plants can out compete or smother low-growing herbs, reducing species richness, while invasive pests like grey squirrels and muntjac deer can have adverse impacts such as harming tree regeneration. Pathogens like ash dieback disease can have serious deleterious consequences. Increasing landscape connectivity provided by OSBs may potentially have undesirable consequences for the spread of tree pests and diseases as well as pests and diseases that attack crops.

The following protocols focus on tree pests and disease as wel as the presence of grey squirrels and muntjac deer. Crop pests and disease are covered in the crop production protocols.

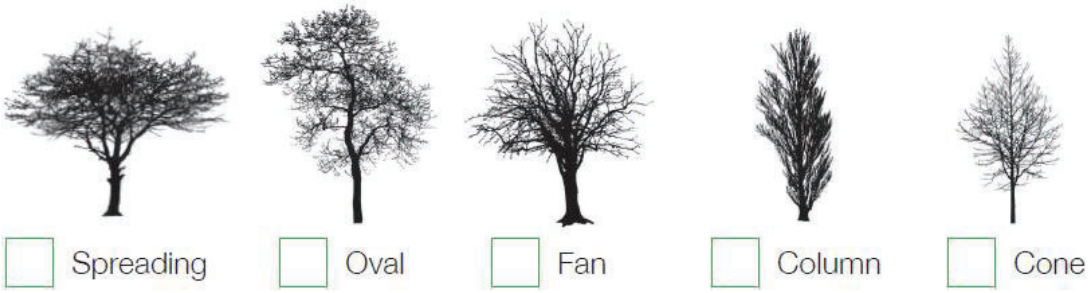
The Tier 1a protocol is based on Activity 1 of the OPAL Tree Health survey and Tier 1b is based on Activity 2 of the OPAL survey.

Tier 1a Protocol

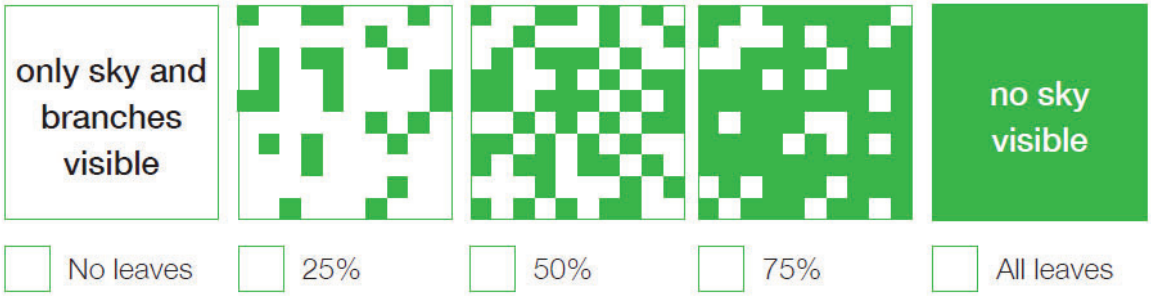
From your knowledge of visits to the OSB, note down if grey squirrel and muntjac deer have been seen, and what was the highest number of individuals seen of each as well as the approximate greatest distance observed from one end of the OSB (or 'throughout' if that is the case).

Complete the tree health survey between May and September when the trees are in full leaf. For each of the distances 10, 20, 30, 40 and 50 m from one end of the OSB, take the nearest standard tree and undertake the following assessment, recording the data on the form provided.

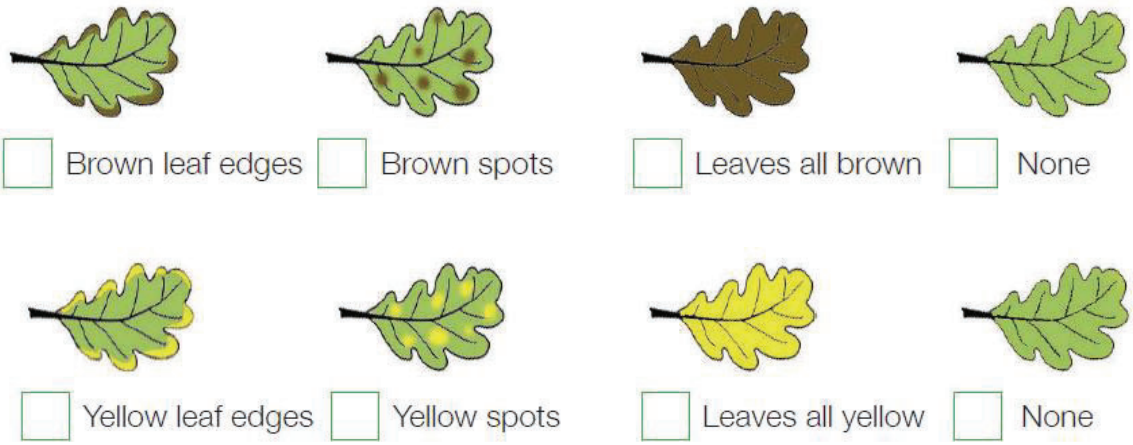
Firstly, note the species of tree, girth (measured with a tape measure) and approximate height to the nearest 1 m. Describe the shape of the crown as one of the following:



Stand under the tree next to the trunk and look up to estimate how much of the view is made up of leaves, to the nearest value in this key below.



Look to see which types of leaf browning and leaf yellowing are visible and record the presence (yes/no) of each.



For each of browning and yellowing, estimate the proportion of affected leaves as one of: less that a

quarter of the tree, between one quarter and one half, between one half and three quarters, and more than three quarters.

Additionally, note any signs of insect damage such as: leaf holes (holes all the way through the leaf), leaf mining (green tissue inside the leaf has turned brown or disappeared) and lead galls (bumps and growths on the leaves).



Tip: For a more robust measure of tree height see the method described in the Tier 1b Habitat structure protocol.

Equipment/resources: Data entry sheet, OPAL Tree Health Survey Booklet and Pests and Diseases Identification Guide.

Tier 1b Protocol

Carry out the Tier 1a survey but for any trees that are oak, ash or horse chestnut, additionally record the presence of the diseases and pests below. If these trees are present in the OSB but missing from the surveyed sample, select at least one tree of each species present to undertake this search.

Oak:




☐ Oak mildew ☐ Knopper gall ☐ Tortrix roller moth ☐ Oak decline

Ash:




☐ Ash bud moth ☐ Ash key gall ☐ Nectria canker ☐ Ash decline

Horse chestnut:

☐ Horse Chestnut leaf blotch

☐ Horse Chestnut leaf-miner

☐ Bleeding canker of Horse Chestnut

☐ Horse Chestnut scale

Tip: The Most Unwanted pests are covered by plant health legislation which means that if you find them you must notify Forest Commission officials so that they can take any necessary action to control them. The easiest way to do this is through the TreeAlert App: www.forestry.gov.uk/treealert.

Equipment/resources: Data entry sheet, OPAL Tree Health Survey Booklet and Pests and Diseases Identification Guide, pen and paper.

Tier 2 Protocol

Woodland herbivore assessment method: As part of the Woodland Grazing toolbox of Scottish Forestry, the Woodland herbivore assessment method has been devised to assess and monitor the impact of large herbivores on woodlands. It is a relevant method for understanding the level of deer use of the OSB and impact on its vegetation, alongside livestock interactions where they are present, but is proposed to be trialled by a researcher. Further instructions and a recording form can be found here.