Boppard lecture notes - **Sampling strategies for forest areas**

Peter Buckley & Radim Hédl

VEGETATION

Use of existing classifications

In the UK, sample units in woodland of 50x50m have been used to construct the National Vegetation Classification NVC), which recognises 25 main semi-natural woodland and scrub communities, each of which has two or more sub-communities. The NVC is based on certain combinations of trees, shrubs, ground vegetation, bryophytes and lichens. Theoretically, an experienced ecologist should be able to identify a particular type of forest without the need for quadrats, although this of course gives no information about the relative abundance of species, canopy structure, cover, density or basal area.

Vegetation is often used as a proxy to explain the biodiversity of a habitat. Apart from vegetation classifications, lists of the typical 'indicator' species present (mostly plants, but also bryophytes, wood-decaying fungi, epiphytic lichens, saproxylic beetles and land snails) can be used to recognise woodland types and those that have had centuries of continuous cover (ancient woodlands) – woods that are likely to have the highest biodiversity value. In Germany and France, 70-80 forest indicator plants are diagnostic.

Sampling strategies

Stratify the woodland into visually different types, and select homogeneous areas within each type for survey and sample within each, OR carry out more rigorous sampling strategies.

a) *Random*: Sample at random, superimposing a grid on the forest area and choosing <u>random</u> points. In both cases avoid the forest edges where the vegetation may be atypical. Random samples can be allocated and 'found' using GPS, or by approximate pacing using large-scale maps. Populations within a sampling unit have an equal chance of being selected, but coverage of the area tends to be inefficient, within clustering and undersampled areas common.

b) *Systematic*: samples are arranged at fixed intervals, for example along a transect. Problems can arise if the interval between samples coincides with a regularity with the species or habitats being measured. May undersample some smaller habitat types, but gives the most efficient coverage of the area.

c) *Stratified sampling*: Areas can be stratified by judgement initially: by recognising beforehand different soil types or vegetation types, divide these into sub-groups before sampling within each type. This is faster than random sampling, but requires some subjectivity on the part of the surveyor.

d) *Stratified systematic unaligned*: this method combines the advantages of random and systematic sampling. Stratify the area first into equal-sized blocks, then place the samples using the same x-coordinate within columns but a different y-coordinate position.

e) *Permanent plots*: For long-term planning purposes – changes over time. Records of natural processes (canopy dynamics) include changes in canopy structure, death of canopy trees, fallen dead wood, presence of regeneration and promotion of saplings, incidence of disturbances – frost, animal damage, windthrow, disease, etc. Transect sections of 20x30m typical; belt/strip transects, e.g. Lady Park Wood

Sampling time of year

In woodlands, it is important to sample early enough to record the vernal flora, particularly in April and May. It may be too late to find *Anenome nemorosa* or *Ranunculus ficaria* in July; mid-June is a good compromise. For historical artefacts such as boundary banks, ditches, sawpits, etc., winter is best when the vegetation has died down and features are more side-lit.

Sampling vegetation structure

Because of complex layering ion a forest environment, it is necessary to record the different layers separately. Record visual percentage cover of the different layers – adding together the percentage cover of all layers above field layer together to form an index. Use the height intervals prescribed for shrub, sub-canopy and canopy. Bovey et al (2016) used 2–8 m, 8–16 m and above 16 m categories. They found total birds and bat richness, richness for forest and threatened birds and edge-specialized bats significantly increased with total deadwood quantities.

Sample plots and quadrats

Size of sample plot: trees and shrubs in the canopy are recorded in large sample plots: the UK recording scheme uses 50x50 m plots, but smaller 20x20 m or 30x30 m plots may also be sufficient. Other surveys have used 14.1x14.1m = 200m^2 units, but these may be too small to provide an accurate record of the tree and shrub layers. Plots can also be circular (see exercise) around a central point. Record the species, percentage cover and stem diameter of all live trees and shrubs >5-7cm dbh. For multi-stemmed trees, calculate the basal area for each stem separately and sum.

Within each plot, a number of smaller quadrats are usually set up to record understorey vegetation layers. The cover abundance of each species present is recorded by eye, using either a scale of abundance or directly as percentage cover. The 5-point Braun-Blanquet scale, the 10-point Domin scale, or the DAFOR scale (dominant, abundant, frequent, occasional and rare) can be used. Size of the quadrat depends on the scale of the vegn. Small, 2x2m, 4x4 m or 10x10 m quadrats could be employed, ranging from 1-5.

Plotless sampling

Alternatively, systematic sampling of the canopy can be done using plotless methods (such as the point-centred quarter method) – this could be done in parallel with conventional frame quadrats and the results compared.

Point-centred quarter method

This is one of several distance measures which can be used to measure density, basal area and canopy cover. At each sampling point along a transect, recognise four quadrants at the cardinal points of the compass (NW,NE, SW, SE). Make sure that these sampling points are not so close together that any individual trees recorded do not overlap between sample points; the distance between samples should be at least 20-30m.

Measure the distance (m) to the nearest tree or coppice stool (>7cm dbh) in each quadrant per sampling point – NW, NE, SW and SE. Note the tree species and its dbh (cm). The mean area occupied by a tree is then calculated from the average of the four distances for a number of points:

Density = $1/d^2$ where d is the average mean distance per sampling point.

A minimum of 20-50 points is usually recommended. Three measures can be derived from the method:

1. Species density (from the mean distance)
2. Basal area and dominance (from diameter measures)
3. Frequency of each species

Dead wood assessments

Kirby et al. (1988) found virtually no dead wood in recently cut coppice, but 60-140m^3/ha in a survey of woodlands in the UK. In unmanaged stands, accumulation of fallen wood is often associated with exceptional events, e.g. Great Storm of 1987. Dead wood is a proxy measure for groups of saproxylic species – flies, beetles, fungi, lichens, bryophytes, etc. that all utilise dead and dying wood, but may be scarce or absent in coppice.

For **fallen dead wood**, use the *line transect method*: up to 10, 25m transects, randomly located. Measure diameter of all pieces intersected by the tape. Stumps and snags assessed by measuring height and diameter of those falling within 2m either side of the transect line.

Total length (in metres/ha) of fallen timber/unit area (L) = $\pi\ 10^4\ N/\ 2t$

Where N = no. of intersections, and t is the transect length. For the following diameter classes (5-10, 11-20, 21-30 cm etc.), the length for each class is calculated separately and then converted to a volume, and the volumes for each diameter class summed to give the total.

Add to this the **standing dead wood**: categories are ‘‘high stumps’’ for 0.5-1.5 m; ‘‘snags’’ >1.5m. Measure diameter at the cut level for high stumps, in middle of snags <4m, and at breast height for snags >4 m. Assign to 10cm diameter classes. Decay classes can be assigned to both standing and dead wood, e.g. 1= recently fallen, bark on; 2 = bark loose, wood sound; 3 = rot starting; 4 = well-rotted.

Diversity measures

Species density is the number of species present in a given area. Species density (often termed species richness) is frequently confused with true diversity although of course it is related. More properly, species diversity (strictly richness or evenness) is a measure of both the number of species and the spread of abundance between them, expressed as an index.

One the most widely used index is the Shannon-Weiner index (H):

H = $\sum p_i \ln p_i$, where p_i is the proportion of the *i*th species and ln is the natural logarithm.

FAUNA

Bird sampling

Birds depend more on vertical vegetation structure than on tree composition – history is of also of less significance than for (indicator) plants and invertebrates that require continuity – birds are extremely mobile. Many bird species forage and nest in the shrub layer, say 4-5m – heavily grazed woods are poor habitats (deer grazing). Migrant songbirds from Africa, such as the nightingale and blackcap. The density of birds is usually greater in the outer 50m of the wood where the shrub layer is better developed. Several spp. prefer woods dominated by mature trees (hole-nesting birds and woodpeckers).

Breeding Bird Surveys (Territory Mapping): Long-term studies of bird communities in relation to habitat management. Labour intensive, requiring up to 10 visits between early April and early July. Visits may be later further north in the country. Surveys should start early in the morning, when bird activity is at its height, avoiding the period immediately after dawn when the intensity of the dawn chorus makes recording more difficult. Follow a predetermined route through the woodland, recording all birds within 25 m, and those between 25–100 m, either side of the path. Expect it will take 1.5 -2 hrs to cover 10 ha.

Point counts: Aim is to make comparisons of relative abundance of species in a wood: undertaken from a fixed point for a fixed time. Points laid out at random on a grid system, minimum 100 - 200m between points. More than 20 counts are needed per station; record all birds seen and heard for 5-10 minutes, differentiating 'near' and 'far' birds at a threshold distance of 25m. Two visits at each station, one mid-April – early May and mid-May – early June. Can be used to compare habitat requirements of birds in combination with vegetation structure.

Butterfly sampling

Plan a route or transect through the most promising habitat (e.g. forest rides, woodland edges), and walk this on four, evenly-spaced occasions during the flight season noting species and numbers; typically early to mid-May; the first two weeks of June; mid to late July; and mid-August. If any habitat specialists are known to be present, then visits should be more frequent during their flight season. Surveys are usually carried out between 11.00 and 16.00 hrs, ideally in dry and sunny (at least 60% sunshine) weather with no more than a moderate breeze; at least 13^{o}C in sunny conditions or 17^{o}C if overcast. Strictly, only butterflies occurring within a 5 m wide line transect are recorded, up to 5 m ahead of the recorder. This will allow data to be compared with other years if so desired.

Other invertebrates

Pitfall traps effective for large, nocturnal beetles, spiders and ants. Straight-sided containers sunk flush to ground level, e.g. 8cm diameter, 10cm deep, preservative of ethylene glycol, empty fortnightly, 5-10 traps per station.

Sweep netting – passing a sweep net backwards and forwards through the vegetation (10-20 sweeps standard); effective for flies on vegn but less for Lepidoptera and sawflies

Vacuum sampling usually battery or petrol-operated machines- provide relatively quantitative estimates of invertebrate numbers over a defined area of vegn. No good on flattened or wet vegetation. Lepidoptera and sawflies cling tenaciously and are less sampled.

Beating: Sharply tapping or vigorously shaking branches with a stick above a 1m^2 beating tray. Easily dislodged species are beetles, bugs, spiders and Lepidoptera larvae.

Fogging: for invertebrates in the tree canopy – non-persistent, knock-down insecticide, collected in trays on the ground. Collects large and representative samples of resident spp.

Malaise traps: tent-shaped traps to catch flying insects, about 2x2m. Can be located at ground level or can be hoisted into the canopy – alcohol preservative, weekly intervals.

Window or Interception traps: netting, glass or plastic screens over collecting troughs.

Water traps: for flying insects, e.g. flies, bees & wasps. Containers 10cm deep, yellow or white. Clear daily or use preservative such as ethylene glycol.

Light traps: lights attract moths (MV or actinic)

Emergence traps: for adult insects emerging from pupae in soil and dead wood: traps flies and beetles and their parasitoids. Erect over dead wood and rot holes for dead-wood invertebrates.

Mammal surveys

For small mammals, use of simple box traps (Longworth, Sherman), set out on a grid; mark-recapture. Dormouse nest boxes, and use of hair tubes. Dung counts can be used for larger mammals.

Ultrasonic calls made by bats recorded by bat sound detectors that can recognise the frequencies of different species; more detailed studies use mist-netting. .

Epiphytes (mosses and lichens)

Large old trees, old coppice stools and pollards – lichens more able than bryophytes to tolerate fluctuating light and humidity in coppice and pollards. High humidity produces the richest epiphytic floras (oceanic Britain).

Soils

Mull: Thin (few cm) of purely organic layer, little distinction between L, F and H. A layer well developed.

Mor: well-developed organic layer – sharp divisions between layers. Mixed organic/mineral soil (A) layer thin or absent.

Moder: Intermediate; upper organic layers well developed, but greater mixing of organic/mineral layer.

Peat: organic layer well-developed; virtually no mixing with mineral soil; wet.