BSBI Recording the British and Irish flora 2010-2020

Annex 1: *Guidance on sampling approaches*

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1 Background

As stated in *Recording the British and Irish flora 2010-2020* the BSBI aims to undertake a comprehensive update of hectads in the period 2000-2019, in preparation for a third atlas of the British and Irish flora planned for around 2024. This is one of a number of aims. Others include completing the Threatened Plant Project and a repeat of the Monitoring Scheme. It is recognised that many Vice-county Recorders (VCR) have their own botanical interests and projects which will also need to be accommodated (such as County Rare Plant Registers, county flora projects, site floras, etc.). There is so much one could possibly do and so many ways one could do it, that some guidance and advice is appropriate.

While the sampling approach for the Threatened Plant Project and the Monitoring Scheme is well described, that for general recording in the Vice-county (VC), such as that required to update our records for a new atlas is not.

This guidance is intended to describe possible sampling approaches and their effects. The guidance will focus on approaches to:

- Sampling within hectads, using tetrads or monads, including systematic or random selection or through prioritisation of the richest squares
- Sampling within hectads using sites, habitats and species
- *Ad hoc* recording in each hectad to maximise coverage - in addition to sampling approaches

2 Essential requirements of any sampling approach

There are a number of important criteria any sampling approach must fulfil. It must be enjoyable, sustainable, repeatable and achievable.

An ambitious approach is fine providing you and local members/botanists can rise to meet that challenge and enjoy it! Enjoyment is key. We want Recorders to enjoy their fieldwork and not feel overburdened by it. So careful choice of a sampling approach is required that can be sustained over a period and will achieve good geographic and taxonomic coverage.

3 Resolution of recording

A key decision is what general recording resolution to adopt. A compromise needs to be reached between achieving recording accurate, useful data and the practical difficulties of surveying. As a general rule the data will be more sensitive to change and more accurately quantified if there are a large number of small survey sites. However, issues of land access and transport to each survey site mean that it may be easier to survey fewer larger sites. Fortunately, computerisation has reduced the difficulties of handling large numbers of records from numerous sites.

The BSBI's minimum survey unit is the tetrad, which will be the choice of many recorders. The availability of cheap hand-held GPS systems makes almost any resolution of recording possible but in reality high resolution records (i.e. down to less than a 100 m) is only really feasible for rare or other interesting taxa. For general recording of widespread species the only other popular choice is the monad (1 x 1km). It is not necessarily true that if you have a big county you should opt for the largest grid square. Given that you only have a finite amount of time for recording you are not going to cover much more ground if you choose tetrads over monads. More importantly you should decide if the advantages of using monads outweigh the additional work in data entry.

Table 1: A list of the comparative advantages of monad and tetrad recording:

Advantages of monads	Advantages of tetrads
• Relatively higher resolution. • Quicker to record thoroughly. • Generally closer to the size of habitats and other landscape features. • The boundaries are clearly marked on OS maps i.e. less ambiguous. • The grid reference is simple to define. • Widely used by other recording schemes. • For the same recording effort the surveys are more evenly spread across the area.	• There is usually public access to a good proportion of a tetrad. • Less driving between sites. • Less paperwork. • Less data entry.

Recording presence at the 5 × 5 km squares (pentads or quadrants) and at hectad resolution is not recommended, although both could be used for designing sampling approaches to collect information at finer resolution ('stratification').

While grid square recording should be used for most species it is BSBI policy that all nationally and county rare and scarce and all UK priority species (e.g. UKBAP, Red List) should be undertaken *at least at* 100 m resolution - i.e. using a six figure grid reference (or better). A full list of UK Priority Species is currently available on the BSBI website. Similarly we strongly recommend that scarcer axiophytes, new county and/or hectad records, and re-discoveries of species thought to be extinct within VCs be recorded at least at 100m resolution

4 Sampling

It is generally better to have comprehensive surveys of a few tetrads or monads within hectads, rather than partial surveys from everywhere. The reason is that comprehensive surveys of smaller areas can be used for many purposes, whereas less focused surveying is only useful for hectad mapping. By formalising the methods of the survey, recording effort can be quantified and defined. This means that future surveys can be compared with the first without worrying that differences are only the results of differences in recorder effort.

A predefined list of sample sites means that the work can be easily divided between the available surveyors. This avoids duplication of work; spreads recording effort evenly and lets individual surveyors see their contribution. It may also reduce the pressure on recorders who might otherwise feel obliged to try and reach every corner of their VC.

Another advantage is that results can be quantified. If recording is not systematic it can't be quantified because the recording effort is not controlled, many surveys can only report relative changes in abundance of species rather than absolute changes. Though it is not easy, good sampling can provide results in absolute terms.

Complete coverage of monads is not feasible in all but the smallest of VCs, neither is full tetrad coverage in large, sparsely populated and remote VCs. For these areas a sampling approach within hectads is more suitable. So the question arises of how to select squares for survey and how many squares should be sampled.

Ecologists have invented a bewildering array of survey methods, applicable to all sorts of organisms and landscapes. The methods you will find most applicable will depend on the landscape in your VC and what you want to achieve from the survey.

One approach is to use unbiased sampling of grid-squares across the whole VC. It is not a strategy that is intended to be the only recording that is conducted, but a way of efficiently surveying a VC, particularly for commoner plants. This kind of sub-sampling can be used by any VCR, however, it might be particularly attractive to recorders in remote areas; large VCs; or to recorders with large areas of agricultural land with few interesting species.

This is not an approach for monitoring rare species, which requires more targeted surveying of suitable habitat. Nevertheless, unbiased surveys frequently result in the discovery of new sites for species, because it forces surveyors to go to places they would not ordinarily visit. Locations of good habitat are not always obvious from maps.

4.1.1 What is a sampling strategy aiming to measure?

A core capability of the BSBI is to give expert knowledge on the distribution of wild plants and it is important that we continue to collect data for this purpose. However, this leads to many other questions for which our data can be used. For example, it is interesting to understand the factors that determine distribution; the environmental drivers of change; the rates of change in the distribution and abundance of individual species and their rates of dispersal. Yet, we can only answer these questions if we collect the right sort of data.

4.2 Unbiased Sampling

4.2.1 Completely random

Random surveying selects grid squares with the fewest preconceptions about the nature of the VC and its landscape. It is in the nature of randomness, that there will be clusters of sites that occur next to each other and some large gaps between sites. Nevertheless, the sampling of each habitat type in the county will be roughly proportional to the area covered by that habitat type in the county.

This approach needs the honesty to accept the sites where they fall. However, if there are inaccessible sites, it is valid to move a sampling site to a randomly chosen neighbouring grid square.

If your only goal is get the maximum number of species for each hectad then this is not the approach for you. As a rule of thumb you will find about 50% of all the species in a hectad, by surveying three random tetrads (Fig. 1).

You can get a list of the hectads, tetrads and monads in your VC from the resources page Biological Record Centre's website (http://www.brc.ac.uk/resources.htm). The easiest way to pick random squares is to paste the list of squares into a spreadsheet and use the random function to create random numbers in the adjacent column (=rand() in Excel). You can then sort both columns by the random number column. With the squares in random order you can just pick the number you want to survey from the top of the list.

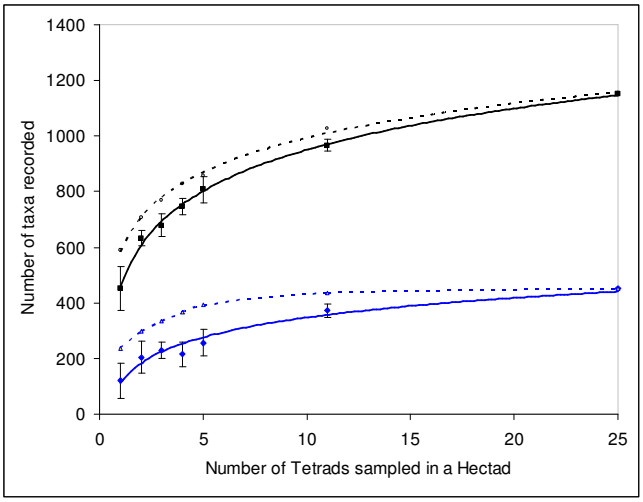

Figure 1. The number of species found using a completely random sample of tetrads (solid) or by selectively sampling the most biodiverse tetrads in order (dashed). Calculated for two hectads, NG52 in north-west Scotland (lower) and SO51 on the Welsh-English border (upper).

4.2.2 A regular pattern

This method is used to ensure that there are no large gaps in the distribution of sampling sites. The same grid squares are sampled in each of the hectads in the VC (Figure 2, top right). This may be suitable for a VC with a diverse landscape, with many habitats roughly in equal proportions. A uniform grid may give a more uniform selection of grid squares for each habitat than a completely random selection. However, it can sometimes cause problems where landscape features such as rivers, mountains, towns etc occur synchronously with the pattern of your grid. For example if parallel river valleys occur roughly every 10km in your county, then sampling the same tetrad in every 10km square may either always contain a river or never.

The squares you choose for your regular grid are not that important. If you choose the A, J and W tetrads you can coincide with the Local Change squares and this would reduce the work required.

4.2.3 A combined approach

It is also valid to combine the two approaches above. You might decide that you want equal recording effort in each of the hectads in your VC. You could then randomly choose an equal number of sample sites in each hectad (Figure 2, bottom left). For those hectads that are not completely within the VC you can reduce the number of random grid squares by the proportion of the hectad within the county.

4.2.4 Partitioning or Stratification

You might consider that some parts of you VC are more interesting than others. You might want to survey these interesting areas more intensively, yet you want to design a survey that will cover the whole VC. In this case you can divide the area up in to sectors (stratify) and randomly select more grid squares from the interesting areas (Figure 2, bottom right). While this technique allows you to study more botanically interesting areas, the survey as a whole is biased. So to get quantitative results you need to separate the data into its separate partitions before doing the analysis.

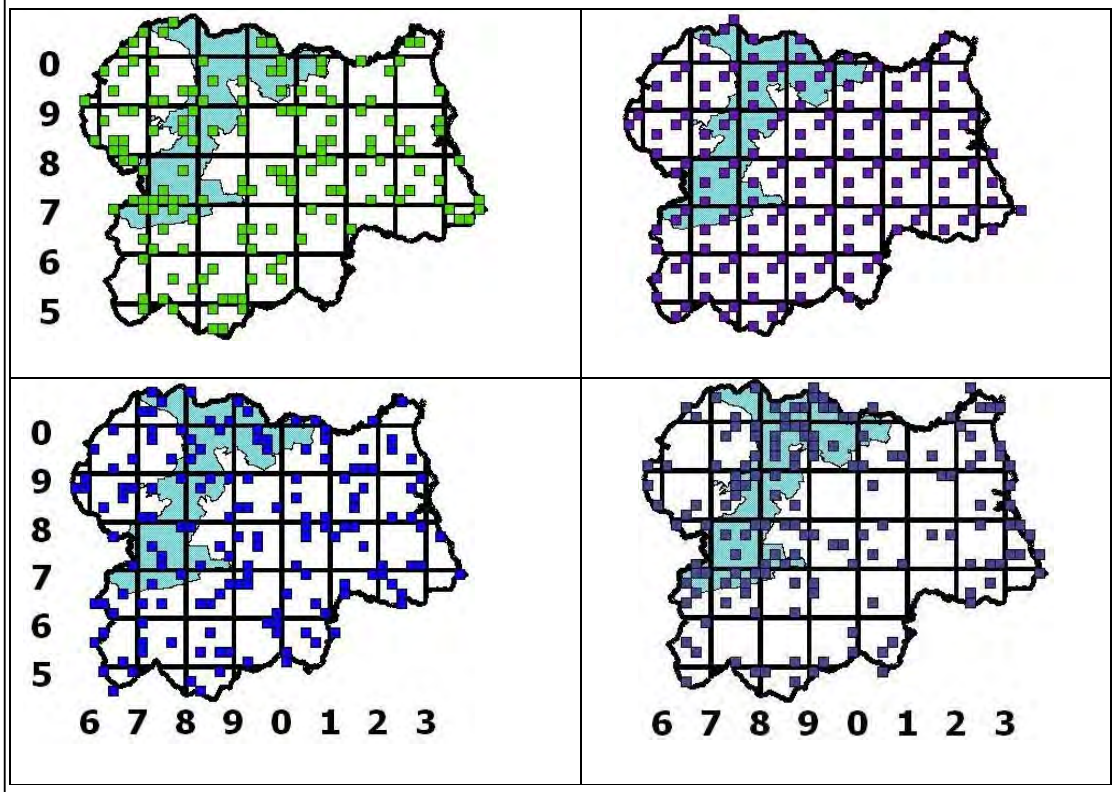

Figure 2. Four different strategies for choosing 150 unbiased grid squares to sample about 12% of the tetrads in South Northumberland. **Top left:** Completely randomly chosen tetrads. **Top right:** A regular pattern of grid squares. **Bottom left:** An equal number of random tetrads in each hectad. **Bottom right:** Partitioning: The area was split into three parts; the coast (eastern border of the map); Northumberland National Park (shaded area) and the rest of the county. Tetrads where randomly selected from these three partitions, but two thirds of the tetrads were picked from the national park and coast and the remaining tetrads are used sample the remaining "less interesting" area.

4.2.5 What are the advantages of an unbiased survey?

1. The results will reflect the true status and abundance of plants in the county at any one time, rather than being biased towards popular areas for surveying.
2. An unbiased survey can give a snapshot of the situation during a well defined time period. Such a survey can provide a baseline with which other surveys can be compared.
3. It is a method of covering the whole VC in a relatively short period. Surveying the whole county can take many years, by which time some species may have spread and other have become extinct. It is better to use several shorter periods of surveying so that changes of distribution can be monitored.

4.3 Targeted Sampling

If you survey the most biodiverse grid squares in a hectad, starting with the most biodiverse and working downwards, you will find more of the species in a hectad with fewer surveys than using an unbiased survey (Fig. 1). If your primary goal is to put dots on a hectad map then this is a better method to use. Still, this presupposes that you know which squares are the most biodiverse. Furthermore, the most biodiverse are not always the most enjoyable to survey. For example, in most counties urban areas are the most biodiverse. Potentially biodiverse grid squares can be identified by analysing databases; from old habitat surveys or from an educated guess using Google Earth and OS maps. Both targeted and unbiased sampling have their advantages, for many recorders it will make sense to do a bit of each. However, this will depend on what the Recorder wants to achieve.

4.4 Sample Size

How many sites should I survey? As a rule of thumb, a random survey of three well surveyed tetrads per hectad will find 50% of the species. For targeted surveys the value is 70% (Fig. 1). However, the difference between these methods diminishes the more squares you survey in a hectad. Obviously, more surveys are preferable, but it is a false economy to survey many squares at the expense of inadequate surveying. It is better to have a few well surveyed sites than many poorly surveyed. Again a compromise should be made, but it is probably best not to be too ambitious. Normally, it is best if the sites are chosen at the beginning of the survey based on the number of sites you think can be covered in the period of the survey. That way they can be divided up between recorders and progress can be tracked.

4.5 How should each square be surveyed?

Ideally a site should be surveyed so that if someone followed your same method they would get the same result. In reality this is not so simple. Difference can come about due to the dates of the surveys, the knowledge of the people doing the surveys and the routes and time taken. To reduce the impact of these inconsistencies it is best to survey a site more than once and at different times of year and preferably by different people. Nevertheless, this isn't always possible and some sites will benefit from more surveying than others. Using monads also reduces the variability caused by different route surveyors take, just because monads limit the number of possible routes. Some diverse sites will need more time to survey than others. So there is no point trying to equalize the time spent surveying each site, however it is still worth recording the amount of time spent recording and noting your route. This can be a simple sketched route map. Alternatively GPS techniques can be used to record your route and display it against an OS background. You never know when these will come in handy.

If the site can only be visited once, then this is best done in June or July. If it can be visited twice, then visits at least two months apart between April and August, will record the most species.

It is rarely possible to find every species at a site and there is little point trying. You should only survey to the point where the return in recorded species, doesn't warrant the effort of recording them. In the final analysis you can then assume that any species not found is either absent or rare within the site.

4.5.1 Habitat sampling

One of the disadvantages of grid square sampling is that it is based on artificial boundaries, rather than real boundaries in the landscape. So, if you want to study the woodland plants of your county you would prefer to have species lists from the woodlands, rather than the grid squares that contain woodland.

Although, it requires more effort, particularly in paper work and data entry, there is considerable advantage in creating separate species lists for the major habitats in a grid square. In the database the sites can still use the same grid reference; however the site name and habitat can be different. For example, for tetrad NY89A you might have three sites called *Highgreen Manor area, roadsides*; *Highgreen Manor area, streamsides* and *Highgreen Manor area, Black Crag*.

The extra effort required is not insignificant; however it does give more value to the records. Again the Recorder has to judge if this extra effort is worth it.

4.6 Measuring abundance

Almost all VC surveys only note the presence of each species within a site. While this is useful, there is no distinction between plants that are present as single individuals and those that are abundant. To illustrate the issue further, if the average oak tree occupies 10 m^2 there could be from 1 to 10,000 trees within a monad. Such a big difference means that some measure of abundance is preferable to none. Having said that, the reason people only record the presence of

plants is that quantifying plants is hard work and time-consuming. Indeed, exact measures of abundance are practically impossible when surveying plants in large areas. However, there are some simple methods to indicate abundance that recorders might like to experiment with.

- The DAFOR scale: This is the easiest assessment of abundance. The surveyor assigns one of the following categories to the abundance of the species; **D**ominant, **A**bundant, **F**requent, **O**ccasional or **R**are. In addition to its simplicity. One of the advantages of this system is that it is supported in the "Quantity" field of MapMate which makes data entry simple. However, this is a very subjective system open to different interpretations and quantifiable only in a rudimentary way. Various other abundance scales have been used, such as the Domin Scale and extensions of the DAFOR scale; however, these are difficult to apply across large areas and the advantage of the DAFOR system is its simplicity and more categories increase the complexity without reducing the subjectivity.
- Nested plots: a measure of abundance can be achieved by surveying several subplots within the larger grid square. Abundance is then assumed to be proportional to the number of subplots occupied. This is a time consuming method and requires an unbiased selection of subplots. It is also only applicable to common plants. In practise it would be difficult to implement throughout a VC and few volunteer surveyors would have enthusiasm for it.
- Counting plants: This is a simple, unambiguous method for some species that can be combined with all other approaches. It is also much easier to analyse total plant counts than any other estimate of abundance. Plant counts are invaluable for the assessment of change and of conservation status and should be collected wherever possible. However, it is only applicable to rare, easily seen and easily identifiable species.
- Estimating population size: We would recommend it the use of the 'broken-log' scale where counts are made of populations smaller than 100 individuals. Larger population sizes are then estimated to within the following size classes (101-300; 301-1,000; 1,001-3,000; 3001-10,000, >10,000. Estimates for large populations can also be extrapolated from sub-samples (e.g. quadrats) although the margins of error, even for relatively easy-to-census species such as *Scorzonera humilis*, can be quite large, and so results need to be treated with caution (Gurney, 2008). Alternatively presence/absence can be counted in larger grid-squares (e.g. 100 x 100 m). However, such an approach may not be applicable to all species as many the life-forms, in particular clonal species, do not produce distinct individuals. For these it is only feasible to count the number of patches or flower stems and provide an estimate of the extent of the population.
- Coverage: Where plant counts are impractical it might be possible to measure or estimate the area covered by a plant. Again this is only applicable to certain rare species. (Aerial) photographs can sometimes be used to estimate land coverage for some common species.

4.7 *Ad hoc* recording

Additional records can be made – preferably on separate recording cards for the adopted recording unit en route to (or from) selected or randomly chosen squares, or to threatened plant populations or just travelling about the VC. These could be complete lists if concentration and time permits; or perhaps just additional records to those already been recorded in the hectad. Certainly if your destination is remote or montane you should take advantage of that by doing some ad-hoc recording in those remote places. Some rich habitats such as weedy fields or species-rich road verge grasslands can be easy to spot from a car (preferable as a passenger!) and ad-hoc records can be made during a quick stop. These can be thought of as map fillers, they are not very repeatable, but they get dots on maps with minimal effort. If you are only surveying biodiverse natural habitat, then they are a good way to gather dots on maps for common species from "boring" habitats.

5 Conclusion

The BSBI wishes to provide enjoyable opportunities for members to put their botanical recording expertise to good use to help inform plant conservation, research and promote further recording. More specifically we would like good geographic and taxonomic recording coverage of all hectads at least by sampling tetrads in the run up to the publication of the next Atlas in just over ten years time.

We would like Recorders to carefully consider (or reconsider) adopting a recording strategy based on a sampling approach. The strategy should take into account the size, geography, location of the Vice-county and the availability of recording effort and personal interests. Critically it should be sustainable over the period.

Sampling strategies are many and varied. Each has its advantages and disadvantages. Unbiased surveys are fantastic for common plants, but they miss rarer species. On the other hand, targeted surveys find rare species, but are unsuitable for obtaining quantitative results and for the analysis of change. Each Recorder should decide on which mix of strategies is suitable for their own county.

A clear strategy or plan of action will help to encourage and focus effort by vice-county recorders and contributing botanists. Importantly it also provides a means of measuring progress.

6 References

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