

## ***Interactive comment on “Woodland survey of Great Britain 1971–2001” by C. M. Wood et al.***

**C. M. Wood et al.**

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- Response: Many thanks for all the constructive comments regarding our manuscript which we have endeavoured to address as follows:

Response to K. Boggs

Comment: This paper is essentially the methods used to monitor woodland vegetation change in Great Britain over a 30 year time-span. There are many methods used to monitor vegetation at regional and National scales across the world. In this paper their approach was somewhat rigorous by attempting to place sample sites in all woodland vegetation types in Great Britain, sound statistical placement of plots within each site, and a comprehensive sampling of vegetation and environmental variables within each site. The major shortfall is not using a systematic grid or random placement of the plots

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across Great Britain. Even with this shortfall, it is still a large and valuable dataset that encompasses most if not all vegetation communities in Great Britain. There are many individual monitoring efforts developed at different times for varied purposes that use different methods. As a result, the monitoring effort may fulfill a local land management objective, but the information cannot typically be combined with other monitoring data to answer larger scale management objectives. Having a single approach to monitoring is, thus, extremely valuable. Serving all of the data online also allows managers and researchers to rapidly search and analyze this data for a variety of purposes.

- Response: Although it is perhaps a shortfall of the sampling strategy that sites were not located using a systematic grid or random placement, it must be noted that the initial selection of sites was undertaken at a time when computing facilities for processing data, particularly spatial data, were limited. Neither was GPS technology available to facilitate the location of random points in the field. The strategy taken used the best information available at the time to ensure the sites were representative of a range of woodland vegetation types and environmental factors (see below). Additionally, the Association Analysis (Williams and Lambert, 1959) used to achieve this was very novel for the time, and contributed to further development of the technique. Further discussion on the representativeness of the sites may be found in Kirby et al. (2005), and see comment further down.

Response to Anonymous Referee #1

Comment: Well-presented original dataset, definitely worthy of publication. Speculation on climate change effects levelling out flaws in the data collection in the last sentence of section 4 (p. 267, lines 12-14) doesn't seem to be justified and is suggested for deletion.

- Response: We accept that the comment is speculative and have deleted the sentence from the revised MS.

Response to Anonymous Referee #2

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Comment: Dear Colleagues, Editors, I appreciate having the opportunity to review the manuscript (MS) ESSD 2015-6 by Wood et al. titled 'Woodland survey of Great Britain 1971–2001'. Right from the title over the abstract to the text, I found this MS impressive and extremely well suited for this journal. I only have smaller comments for this nice MS: Page 3 Line 18: please explain what foot and mouth outbreak have to do with the forest survey, or lack thereof.

- Response: There was a serious outbreak of Foot and Mouth disease amongst livestock in Britain in 2001. Being an extremely contagious disease, access to many parts of the British countryside was severely restricted in an attempt to constrain the spread of the disease. For this reason, fieldwork in the countryside, including the woodlands in question, was not possible during that summer. We have updated the MS to explain this.

Comment: What I like to add is the suggestion to calibrate surveyors throughout the entire project, not just 2 days prior (and without a test or certification even).

- Response: In 1971, all survey teams were initially accompanied by a supervisor and regular visits into the field were made by the project leader (Bunce) to ensure consistency and quality in data recording. It must be remembered that at that time, studies of this nature were ground-breaking, and concepts of quality assurance and quality control procedures for ecological surveys were not mainstream. The project leader ensured data were being recorded to a satisfactory standard throughout the field season according to the criteria laid out in the field handbook, a measure that at that time was in itself a novel concept. In the 2001 survey, more rigorous quality control procedures were in place. We were satisfied that the field surveyors were experienced in this field and that the 2 day course was sufficient. Additionally, experienced survey staff were available in the office to answer queries from the field throughout the survey via telephone. We accept that this could have been taken further with perhaps a mid-season refresher training course or similar. In terms of quality assurance, 6 of the sites were visited again by a different set of surveyors within two weeks of the initial

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site survey. A mixed model ANOVA showed no overall difference in species richness between the different surveyors. This is described in more detail in (Kirby et al., 2005) We have amended the text to reflect these points.

Comment: Page 4 line 11: It's a claim that the survey is representative, please elaborate more later in the text, and present the evidence, quantitatively ideally.

- Response: In addition to being geographically spread across the country (as shown in figure 1) and proportionally well spread across zones with higher woodland cover in comparison to another national survey, the Countryside Survey, as described, we can demonstrate the site representativeness in relation to other factors. Firstly, we can compare the number of plots allocated to each National Vegetation Classification (NVC) group (Rodwell, 1992) with the estimated total area of NVC types in ancient semi-natural woodland across Britain (Cooke and Kirby, 1994). The 1971 survey data span the broad range of types in roughly the proportions that might be expected from the Cooke and Kirby data. Secondly, a comparison was made with the sample of woody vegetation from the GB Countryside Survey from 2000 (Haines-Young et al., 2000). The 1971 plots were grouped by Countryside Vegetation System classes (Bunce et al., 1999) and their frequency was compared to the estimated national area of each class. The two data sets are generally well-correlated. The largest deviations from the line of best fit are also consistent with the differences in sampling strategy between the surveys.

We have updated the MS with this information including full references and additional tabular data to illustrate.

Comment: Page 5 line 13 what does mean "relocation error was not significant", was that ever tested, and if so, where and how done? Can we express that error in meter, and with an error ellipse?

- Response: Statistical analyses of temporal vegetation change are more powerful when based on records from plots located in the same place rather than randomised

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to new locations at each survey. This follows from the general principle that locations near to each other tend to be more similar. Therefore, the principle of autocorrelation between near points was used to address the problem of quantifying the error involved in attempting to relocate the same vegetation monitoring plots. In the repeat survey, the field botanist relied only on a marked point on a map as the sole aid to relocating the 1971 plot location. Consequently, considerable relocation error could potentially arise. The hope is that having made an effort to move near to the mapped point, the plot records from 2001 will, on average, be more similar to the respective 1971 plot record than if a completely new, random set of locations were chosen. Even if vegetation change occurs, species compositional data recorded from the same point at times 1 and 2, will tend to be more similar than data recorded from two random points at times 1 and 2. In attempting to measure the amount of relocation error, one cannot of course exploit a 'true' set of temporal pairs known to have been recorded in exactly the same position. What can be done is to compare the average species compositional similarity between the ostensibly true temporal pairs with the average similarity for a random pairing of the 1971 data with the 2001 data. If, on average, attempts to relocate the true 1971 position had been successful then the similarity between the true pairs should be greater than the random pairs. Overall at 97 sites (out of 103) mean similarity was greater between 'relocated' plot pairs compared to random-pair comparison; for 59 sites the difference was significantly greater, therefore we were satisfied that the relocation error was not significant when interpreting any results. A full account of this is given in Appendix 3 of Kirby et al. (2005).

We have updated the MS with a description of the above.

Comment: Sticking to a protocol that is 30 years old is not so good and for progress. We understand why it was done, but please elaborate more on the shortcomings, and how to update with keeping the comparability intact. Issues for assessment, update and justification are for instance square plots vs circular ones, plot radii, autocorrelation, and plot less methods etc.

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- Response: It is often an insoluble problem that in order to extend an older time series without breaking consistency with its established methods, those methods have to be repeated despite a more modern design perhaps being preferable if we were to start again. However, although the protocols are old, that does not necessarily mean they are outdated. This survey was the first time at a national level that samples were being used to obtain an integrated assessment of the response of vegetation to the environment across a defined population. The structure of the project provided the basis for the further development of strategic survey methods. A subsequent survey based on these (Bunce and Shaw, 1973) methods, the Classification of the Native Pinewoods of Scotland set the conservation agenda for this scarce resource (Bunce and Jeffers, 1977). In later work, the concept of a woodland site, and subsequently a 1km square sampled a random, with random plots sampled within, became a standard sampling strategy used as the basis of surveys such as the Cumbria Survey (Bunce and Smith, 1978) and the Terrestrial Survey of Shetland (Milner, 1975). Variations of this method are currently used very successfully in several other large ecological surveys in Britain, such as the Countryside Survey (Carey et al., 2008), and the Glastir Monitoring and Evaluation Programme (Emmett et al., 2014). Within the European Biodiversity Observation Network (EBONE), methods adapted from the basic principles in this Woodland Survey have been developed to roll out across the whole of Europe (Bunce et al., 2008; Bunce et al., 2011). During the EBONE project, the methods were widely tested across 12 European countries, and also Israel, Australia and South Africa. The methods were proven to be robust, reliable and repeatable at a continental, landscape scale (Roche and Geijzendorffer, 2013). A key aim of the sampling design was that the methods chosen should be standardized, therefore highly repeatable. The size of the plot was chosen with reference to continental phytosociologists who at the time most widely used plots of between 100 and 200m<sup>2</sup>. After preliminary field tests, it was found that the number of species recorded usually stabilised at this size. The area of 200m<sup>2</sup> was thus adopted for this survey, with 4 nests within. As the focus of the survey is on ground flora as well as tree and shrub information, the square plot with inner nests aids a sys-

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tematic search of the vegetation within the plot. It is also straightforward to layout in the field, and ensures a standard sized plot is laid out every time. For these reasons, we consider the square plot as more advantageous than a circular plot. Plotless sampling of tree density has been dismissed, as it is not considered to sample randomly. Random sampling was preferred to systematic sampling in this case to avoid the possibility of resonance with environmental features, for example a grid line following the course of a stream. Restricted random sampling may have had a slight advantage ensuring more even coverage of the area. Random sampling also has practical advantages over systematic sampling, which requires continuous scale adjustment in order to obtain a constant sample from variable sized areas (Bunce and Shaw, 1973). We have updated the text to reflect these comments, along with full references.

Comment: Secondly, this dataset suffers dramatically from old frequency statistics approaches. May I suggest to consider new analysis methods, such as Bayesian statistics and machine learning predictions (entropy, trees, carts, boosting bagging, ensembles etc.). It will affect the design and some numbers and conclusions.

- Response: The data have been used for a wide range of analyses including Bayesian methods (see further comment below). Additionally, the plot species data have contributed to Great Britain niche models such as MutiMOVE (Henrys et al., 2013). We have updated the MS to describe these, including the relevant references.

Comment: Re. soil samples, were there any controls done, and parallel measures taken for quality control? This applies not only to the labs and lab outcome, but also to the actual interpretation. Double-blind assessments would be ideal.

- Response: Quality control measures were followed as outlined in (Allen, 1989). These included the analyses of certified standard reference samples within batches. In terms of the interpretative data recorded in 1971, control methods had not been considered at the time of recording. This is a shortcoming that could perhaps be rectified in a future repeat of the survey.

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Comment: Page 8: Juniper to me is a tree, in the original state they grow high and very old! It's not just a shrub.

-Response: We accept that junipers can grow very high and old, however, in Britain, junipers most often grow in a shrub-like form. Therefore the arbitrary decision was made to assign it to the shrub category back in 1971, on the basis that the stems rarely reach a diameter of greater than 5cm (in Britain).

Comment: In the MS, please mention at least once Metadata, and the ISO format styles. It's a UK requirement too.

- Response: We have updated the manuscript to reflect that the metadata is stored in the ISO 19115 (2003) schema ([http://www.iso.org/iso/catalogue\\_detail.htm?csnumber=26020](http://www.iso.org/iso/catalogue_detail.htm?csnumber=26020)), in a UK Gemini 2.1 profile (<http://www.agi.org.uk/join-us/agi-groups/standards-committee/uk-gemini>).

Comment: The literature reference list is almost shorter than the number of people mentioned in the acknowledgements. Please put more context into the literature section.

- Response: We have added a new section to the MS regarding data analysis, which includes more context and content. We have included a description of some examples of analyses undertaken using the dataset such as the impact of a severe storm on species diversity in British woodland (Smart et al., 2014), an investigation into invasive species (Marrs et al., 2013) and the application of multivariate techniques to assess the effects of landscape scale environmental drivers on the vegetation composition of British woodlands (Corney et al., 2004). Although there are many schemes across the world that monitor trees and forestry, there are few programmes that take an integrated approach such as the project in question, including trees, but also vegetation and soil information. Many national forest and woodland monitoring schemes were initially set up with an emphasis on monitoring timber production, commonly in the 1920s, when timber supplies were low following the First World War. For example,

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in Britain, the Forestry Commission was set up in 1919, and since then has undertaken national forestry inventory surveys which concentrate on the size, distribution, composition and condition of all forests in Britain but do not focus on sampling ground flora or soils (Forestry Commission, 1952, 1970, 1984, 2003, 2013). This is a similar situation in the heavily forested countries of northern Europe such as Sweden, Denmark and Finland where National Forest Inventories are also carried out (Groom and Reed, 2001), and also in the United States of America where the US Forest Service has had a monitoring programme in place since the 1920s (United States Forest Service, 2015a;Smith, 2002). In tropical regions there is a general shortage of biodiversity data (Balmford et al., 2005), which is largely due to the geographical inaccessibility of many of the areas, and lack of local resource. Many studies regarding forestry and woodland in these regions rely heavily on remotely sensed information which concentrate on extent, biomass and carbon stocks (Asner, 2015;DeVries et al., 2015;Sousa et al., 2015;Wani et al., 2015), rather than ground-level biodiversity at a national level. Efforts are being made in many countries to intensify soil and ground vegetation sampling, as in the USA (Smith, 2002;United States Forest Service, 2015b), however, it is important to remember that the focus of this Woodland Survey is on the semi-natural woodland ecosystem (not only trees and shrubs, but also soils and ground flora). Taking this into account, there is relatively little literature regarding comparable national long-term monitoring schemes across the world, particularly those dating back as far as 1971. A discussion regarding the above has been inserted in to the MS.

Comment: Finally, I think this manuscript can benefit from more content, data analysis and context. I wonder for instance how this (national) data set fits with the EU efforts, and how it compares with US Forest Service sampling plots, and when compared to tropical survey work?

- Response: See response above.

Comment: Overall, as a reviewer, I am in big favor of the publication and wide use of these data! Thanks, this is an anonymous review.

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