Right tree, right place: using botanical heat-maps to inform tree planting

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In 2021, the UK government published its ambitious plan to achieve 'Net Zero' decarbonisation by 2050 (UK Government, 2021a). In England, this includes planting around 30,000 hectares of trees every year (equivalent to around 74,000 football pitches) to sequester carbon and produce environmental benefits, such as nature recovery, flood alleviation and improvements to water and air quality (UK Government, 2021b). This is an unprecedented scale of tree planting and will largely be achieved by encouraging private and public landowners to plant trees on their land, often as part of government schemes, e.g. the Forestry Commission's new England Woodland Creation Offer (EWCO) or Community Forests that provide financial incentives.

Whilst tree planting will help to reduce our net carbon emissions, it could be disastrous for nature recovery ambitions if trees are planted on areas of existing wildlife value. The starkest recent example of such inappropriate planting was the conversion of large parts of the Flow Country in Scotland to commercial forestry in the 1980s, which had far-reaching and long-lasting repercussions for both forestry and conservation (Warren, 2000). Since 2020, we have seen inappropriate planting of trees on several species rich grasslands and blanket bogs of high wildlife value in England (Figure 1). Frequently such areas have low agricultural value, so the income provided by trees, through comparatively generous incentive schemes and woodland carbon and timber incomes is attractive. For this reason, it is vital that those administering tree planting schemes are able to access high quality environmental information to help screen sites prior to planting. In response to this need, BSBI has been working with Natural England, Woodland Trust and Forestry Commission, to provide 'heat-maps' that help identify the most important areas for plants, so that trees are not established in the wrong place. In this note we describe the development and use of these heat-maps.

Figure 1. Example of inappropriate tree planting near to Greystoke, Cumbria, where planting was due to take place on deep peat supporting bog species such as Cranberry *Vaccinium oxycoccos*, sundews *Drosera* spp. and Creeping Forget-me-not *Myosotis stolonifera*. *Keith Watson*

Development

Following some high-profile cases of inappropriate tree planting in Cumbria (Figure 1), it became obvious that BSBI data could have been used to screen woodland creation proposals, so ruling sites out for planting. To avoid further damage and losses BSBI, Woodland Trust, Forestry Commission and Natural England explored how these data could be used to screen planting proposals. Part of this 'brief' was that any resultant product would provide a remote and easily interpretable assessment of botanical interest that could be used by decision-makers to inform next steps (ideally on a geo-spatial web-based portal).

The first stage of this work was to identify the species likely to be indicative of areas of high botanical quality. For this we used two groups of species:

Species of conservation priority – comprising the rarest and most threatened plant species in Great Britain, i.e. Nationally Rare (Wigginton, 1999), Nationally Scarce (Stewart et al., 2004) and GB threatened species (Critically Endangered, Endangered, Vulnerable, Near Threatened; Cheffings & Farrell, 2005).

Positive habitat indicators – comprising species most likely to indicate the presence of high-quality habitat, including species used for site condition monitoring of UK Priority Habitats (JNCC, 2004), BSBI axiophytes (Walker, 2018) and ancient woodland indicators (Glaves et al., 2009).

These species were assigned to 10 broad habitat types using Hill et al. (2004) (Table 1). Crucially, this gave us the flexibility to produce heat-maps for individual habitats, as well as for all priority or indicator species combined.

Heat-maps

Over the last six months Natural England, working closely with BSBI staff, have been further developing the heat-maps as part of the Natural Capital Ecosystem Assessment (NCEA) programme. They have used BSBI records of the priority and habitat indicator species (collected between 1970–2021) to produce the following heat-maps that can be used to support woodland creation proposals on geo-spatial web-based portals.

Priority species heat-map – this provides a map of the number of priority species present at 100 m (hectare) grid square resolution and is intended to be used as an initial screen to see if a proposed planting site is known to support any species of national importance (Figure 2), which could be deleteriously impacted by woodland establishment.

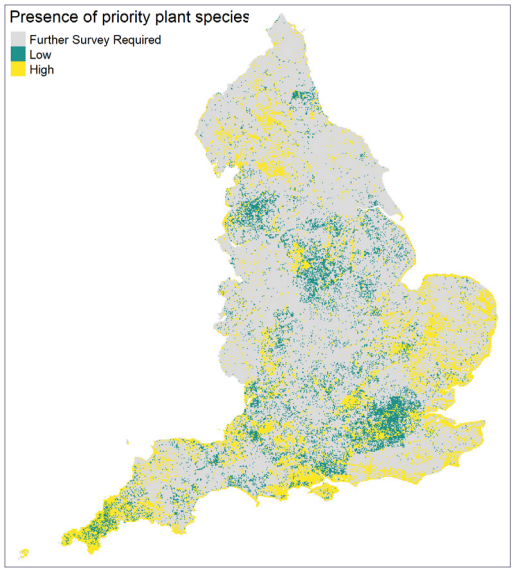
Botanical indicator heat-map – this provides a heat-map of the number of positive habitat indicator species present within each 1 × 1 km grid square. This aims to support landscape scale decisions on land management decisions and can be used to help identify likely presence of high-quality habitats where tree planting should be avoided. An example indicator heat-map is shown for Bog and Heath in Figure 3.

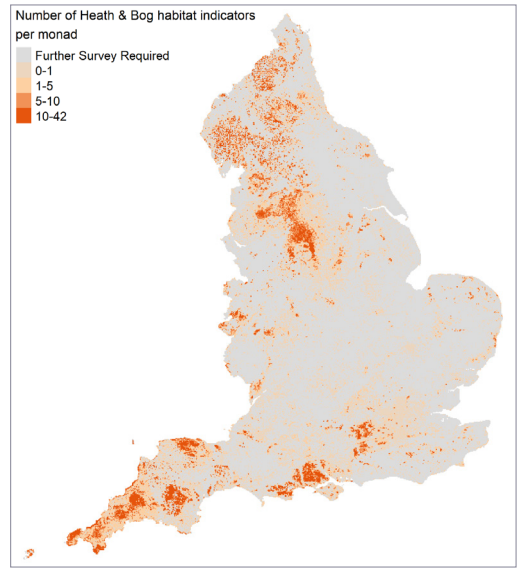
Ancient woodland indicator heat-map – this provides a heat-map of the number of ancient woodland indicators within each 1 × 1 km grid square. This was developed specifically to support the update of the ancient woodland inventory and to identify areas most suitable for native wooded habitat creation.

To ensure ease of use for decision-makers, a simple 'traffic light' scale of botanical value (low, medium, high) was developed based the number of indicators present signalling a habitat of high quality. To account for spatial (latitudinal) bias in the distribution of indicators in England, habitat quality was assessed by comparison to the proportion of indicators found in the surrounding regional species-pool (here defined as a 'moving window' of monads within 25 km of the focal monad). A critical

Table 1. Broad habitats used for heat-maps with number of positive indicators selected.

Broad habitat	Indicators	Plantatt Broad habitats (after Hill et al., 2004)
Woodland	223	Broadleaved, mixed, yew & coniferous woodland
Arable	80	Arable and horticultural (includes orchards, excludes domestic gardens)
Boundary & linear	189	Boundary and linear features
Grassland	352	Neutral, calcareous & acid grassland, bracken, improved grassland
Fen, marsh, swamp	217	Fen, marsh and swamp
Heath & bog	95	Dwarf shrub heath, bog
Montane	98	Montane habitats (acid grassland and heath with montane species)
Inland rock	248	Inland rock
Water	185	Standing water, canals, rivers and streams
Coast	162	Supralittoral rock and sediment, littoral sediment (saltmarsh), inshore sublittoral sediment





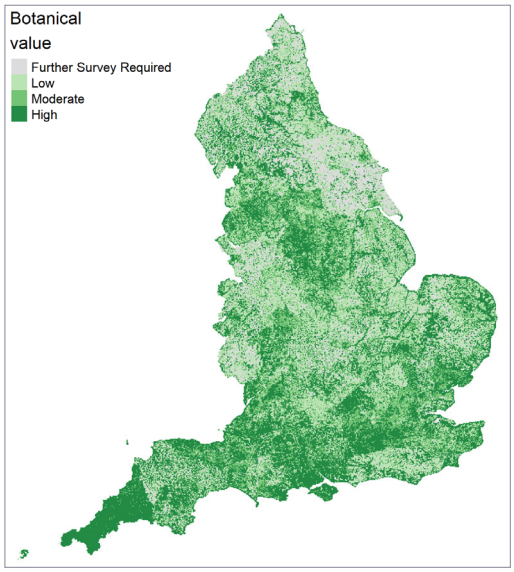


Figure 2 *(top left).* Heat-map of priority plant species at the monad scale. The yellow areas indicate the most important areas for these species in England.
Figure 3 *(top right).* Heat-map of positive habitat indicators for Heath and Bog at the monad scale.
Figure 4 *(bottom left).* Map of botanical value at the monad scale. This map combines the priority species and habitat indicators.
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assessment was carried out of a range of thresholds to use for the boundaries between the categories.

Finally, an overall 'botanical value map' was produced to provide a high-level strategic overview that combines information in the priority species and habitat indicator maps described above (Figure 4). This took the highest broad habitat 'traffic light' value (low, medium, high) for each monad and the presence of priority species. If priority species were present then the monad is automatically flagged as of high value. This approach ensures that the overall botanical interest at the monad scale is easily understood as well as highlighting the need to drill down into the more detailed heat-map spatial layers for high and medium value maps.

Survey coverage

The absence of records of priority species or habitat indicators for a given hectare or monad in the BSBI database is not conclusive proof of absence, as sites

or squares may not have been visited or if they have, then they may not have been well recorded. The reasons for poor survey coverage at the monad level are likely to be varied, including the accessibility and remoteness of the square, its terrain, and the numbers of botanical recorders in the vicinity. To account for this variation, we produced a measure of recording coverage for each monad, the number of 'recording days', with a recording day defined as a day when 40 or more species had been recorded during a single visit. An analysis of recording days compared with all taxa recorded within a monad showed that it usually took three recording days to achieve a reasonable list of 200 or more taxa for a monad. We therefore categorised monads with three or more recording days as well recorded and those with less as requiring further survey. This is very important when assessing tree planting proposals as it indicates when additional information, including field survey, will be needed to confidently establish whether sites proposed for tree planting support habitats of high wildlife value.

How will the maps be used?

The heat-maps will be provided, under licence, to a range of land management organisations involved in tree planting decision-making in England. These will be supplied as geopackages containing attribute tables with species lists for each hectare or monad and the year the species were last recorded. It is envisaged that these organisations will load the data onto their own (or possibly shared), geo-spatial web interfaces, so that staff can access them when advising on, or screening, tree planting proposals. Specific operational guidance will be developed to inform use of the heat-maps by staff with Natural England, the Woodland Trust and Forestry Commission working to agree a consistent approach. In June of this year, for example, they will be made available to all Natural England staff on an internal web interface.

In terms of assessing tree planting proposals, the priority species map (at 100 m resolution) is the most important, as it will indicate whether any national rarities or threatened species occur on or close to the proposed planting site. Clearly, if any of these species are present a detailed field survey and impact assessment must take place to identify the key areas of wildlife value and how the impacts of any tree planting on these can be mitigated. Clearly in some situations tree planting will be incompatible with the conservation and restoration of rare, scare and threatened plants or habitats.

Where the priority heat-map layer suggests an absence of priority species, the second habitat indicator heat-map should provide some indication of whether the proposed woodland establishment site occurs within a monad with significant interest from a botanical perspective. This may flag where the establishment of trees and woodland is likely to be inappropriate or at least suggest that a site survey is required before the proposed tree planting can go ahead. Where both maps suggest that there is little botanical interest in the monad **and** the survey coverage is good (i.e. if it has had more than three 'recording days'), then the proposed site is unlikely to be of botanical interest and in all likelihood tree planting will go ahead, although local knowledge of the site, assessment of aerial photographs, field survey and discussions with the owners is always advisable when changes in land use are planned.

The botanical value map will be shared openly on an Open Government Licence (OGL) via the MAGIC website, which provides the general public with free access to a wide range of spatial datasets relating to conservation and land management (*magic.defra.gov.uk*). Unlike the heat-maps this will be shared as a simple visualised layer with no associated geodatabase information, such as species or the year of last record. It is hoped that this heat-map will be widely used for strategic conservation and land management spatial planning.

Although these heat-map layers have been developed in response to the threat posed by inappropriate afforestation, they clearly have much wider applications for conservation land management and achievement of nature recovery ambitions in the future. An obvious example is the new Environmental Land Management Scheme (ELMS) due to be introduced over the coming years, where the heat-maps could be used to target or

inform advice on land management options at the farm-scale. The heat-maps could also inform the development of Local Nature Recovery Strategies and a desk based assessment of the notified vascular plant interest on protected sites.

Next steps

Currently the botanical heat-maps are only available to BSBI and Natural England, but we hope to make them more widely available to other organisations in the future, as well as explore their potential for other land management activities. The initial work has also raised many questions, for example, how the maps could be improved by incorporating tetrad records in areas where very little monad data are available (e.g. Devon, Sussex, Herefordshire, North-east Yorkshire). We would also like to see a similar approach extended to Wales and Scotland, where pressures on wildlife-rich sites from afforestation are arguably greater.

The BSBI has always been a strong advocate for plant conservation; so it is great to see its data being used in partnership with a range of conservation bodies to influence land management policies and to safeguard our most valued wildlife habitats – put simply, helping to ensure that the new trees and woodlands are planted in the right place.

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References

Cheffings, C.M. & Farrell, L. (eds) 2005. The Vascular Plant Red Data List for Great Britain. *Species Status*, 7: 1–116. Joint Nature Conservation Committee: Peterborough.

Glaves, P., Rotherham, I.D., Wright, B., Handley, C. & Birkbeck, J. 2009. *A survey of the coverage, use and application of ancient woodland indicator lists in the UK*. Hallam Environmental Consultants Ltd., Biodiversity and Landscape History Research Institute and the Geography, Tourism and Environment Change Research Unit, Sheffield Hallam University: Sheffield.

Hill, M.O., Preston C.D. & Roy D.B. 2004. *PLANTATT. Attributes of British and Irish Plants: Status, Size, Life history, Geography and Habitats*. NERC Centre for Ecology and Hydrology: Huntingdon.

JNCC 2004. *Common Standards Monitoring guidance*. Available from: *jncc.gov.uk/our-work/common-standards-monitoring-guidance* [Accessed 10/01/2021].

Stewart, A., Pearman, D.A. & Preston, C.D. (eds) 2004. *Scarce Plants in Britain*. Joint Nature Conservation Committee: Peterborough.

UK Government, 2021a. *Net Zero Strategy: Build Back Greener*. Her Majesty's Stationery Office: London.

UK Government, 2021b. *The England Trees Action Plan 2021–2024*. Her Majesty's Stationery Office: London.

Walker, K.J. 2018. *Vascular plant 'axiophyte' scores for Great Britain, derived from the assessments of the vice-county recorders of the Botanical Society of Britain and Ireland (May 2016)*. NERC Environmental Information Data Centre. (Dataset). *doi.org/10.5285/af2ac4af-12c6-4152-8ed7-e886ed19622b*

Warren, C. 2000. Birds, bogs and forestry revisited: The significance of the Flow Country controversy. *Scottish Geographical Journal*, 116: 315–337.

Wigginton M.J. (ed.) 1999. *British Red Data Books. Volume 1. Vascular Plants*. Third edition. Joint Nature Conservation Committee: Peterborough.

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