England Biodiversity Indicators 2023

This document supports
5b. Abundance of farmland plant species
6b. Abundance of woodland plant species
7b. Abundance of wetlands plant species

Technical background document

Abundance of farmland, woodland and wetlands plant species – technical document – August 2020

The creation of the National Plant Monitoring Scheme (NPMS) https://www.npms.org.uk/ has allowed for the creation of annual trends in the abundance of plants in habitats of conservation importance. Following 5 years of development, the scheme was launched by a partnership consisting of the Botanical Society of Britain and Ireland (BSBI), the Joint Nature Conservation Committee, Plantlife, and the UK Centre for Ecology & Hydrology (UKCEH) in 2015.

The design of the NPMS included the definition of a set of 11 broad UK habitat types, within which 28 finer habitat types are nested (Pescott et al., 2019a). These fine-scale habitats are linked to existing classifications such as the British National Vegetation Classification. Surveyors can choose, based on their knowledge of a habitat, whether to record a plot at the broader or finer level.

Since 2018, UKCEH, with input from all partners, have been developing a method of using NPMS data to indicate annual changes in habitat condition. The method is based on a hierarchical model, formulated in a Bayesian framework, that integrates information on a species' abundance and occupancy; the occupancy estimates also take advantage of the fact that most plots are surveyed twice a year, allowing adjustments for false negatives (i.e. species that are overlooked during surveys). Simulation tests and applications to real data suggest that the method produces ecologically sensible metrics.
Much of the work undertaken to develop the indicator published in October 2020 is documented in a report published by UKCEH:

> Pescott, O.L, Powney, G.P. and Walker, K.J. (2019b). *Developing a Bayesian species occupancy/abundance indicator for the UK National Plant Monitoring Scheme*. Wallingford, NERC/Centre for Ecology & Hydrology and BSBI, 29pp. DOI:10.13140/RG.2.2.23795.48161

The simulation tests and applications to real data explored in this report indicate that the model performs well in ideal scenarios; biases in less data-rich scenarios could largely be explained by simulated relationships between abundance and detectability. These are likely to be less clear-cut in real datasets. Subsequent to the publication of that report, further work by UKCEH, BSBI, Defra and JNCC explored how additional covariates describing a species' detectability could be incorporated. The model was also extended to create annual indices, and these have also now been combined into composite species indicators (see below).

The underlying models for each species summarise that species' percentage cover (i.e. abundance) data at the broad habitat level. This is done using a model that is able to account for both the range of percentage covers that a species may exhibit in a habitat when present, and the fact that a species may often be absent from any given plot (Pescott *et al.*, 2019b). Such data are often described as "zero-inflated". For each NPMS indicator plant species/broad habitat combination then, the abundance data for a given year are used to estimate the parameters of an underlying zero-inflated Beta distribution. The mean of this zero-inflated distribution is the annual indicator estimated for a single species within a broad habitat, thus taking into account the frequency with which a species is present across plots and its local abundance when present. This process is repeated across years for each species/habitat combination, creating an annual trend for this metric.

Subsequently, these individual species/broad habitat trends are combined into a multi species indicator (MSI) as follows:

1. Within a broad habitat, simulate 1000 values per species, per year, from the distribution estimated for the mean of the zero-inflated Beta distribution from the appropriate Bayesian model;

2. within species, standardise all values to the mean of 2015 (and rescale so that the 2015 mean = 100);
3. per year, for each simulation, take the geometric mean of the logged index across species (thus creating 1000 samples of the MSI);
4. exponentiate, and calculate the mean and standard deviation across these MSI samples (this yields the indicators presented).

This follows the logic of the method presented by Soldaat *et al.* (2017). The 4 broad UK habitat indicators presented are those for which the largest numbers of NPMS plots currently exist: arable field margins; broadleaved woodland and hedges; bog and wet heath; and lowland grassland. Maps of the locations of the monads contributing plot data to the current indicators by UK NPMS broad habitat are provided in Annex 1; lists of species included within each UK broad habitat are provided in Annex 2.

The work undertaken was presented to the UK Biodiversity Indicators Steering Group in April 2020. The minutes of that part of the meeting state:

> *The Steering Group were very supportive of the work which had gone into producing this indicator.*

Accordingly, the indicator is published as an Experimental Statistic – to involve users and stakeholders in assessment of suitability and quality. Any feedback on the novel methods used in the development of this indicator should be submitted to the UK biodiversity indicators project team.

References:

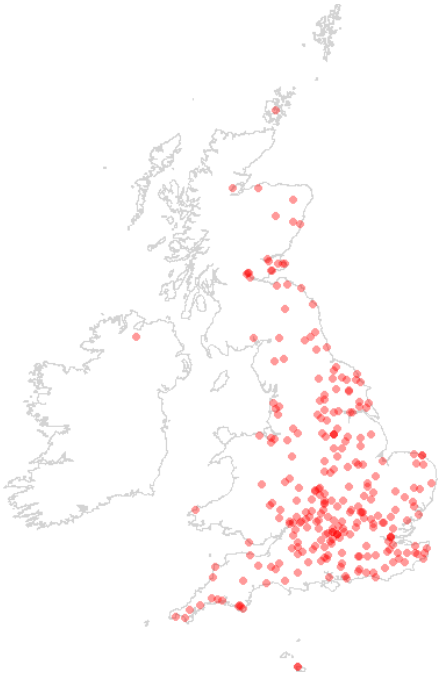
Pescott, O.L., Walker, K.J., Harris, F., New, H., Cheffings, C.M., Newton, N., Jitlal, M., Redhead, J., Smart, S.M. and Roy, D.B. (2019a). The design, launch and assessment of a new volunteer-based plant monitoring scheme for the United Kingdom. *PLoS ONE* 14(4): e0215891. https://doi.org/10.1371/journal.pone.0215891

Pescott, O.L, Powney, G.P. and Walker, K.J. (2019b). *Developing a Bayesian species occupancy/abundance indicator for the UK National Plant Monitoring Scheme*. Wallingford, NERC/Centre for Ecology & Hydrology and BSBI, 29pp. DOI:10.13140/RG.2.2.23795.48161

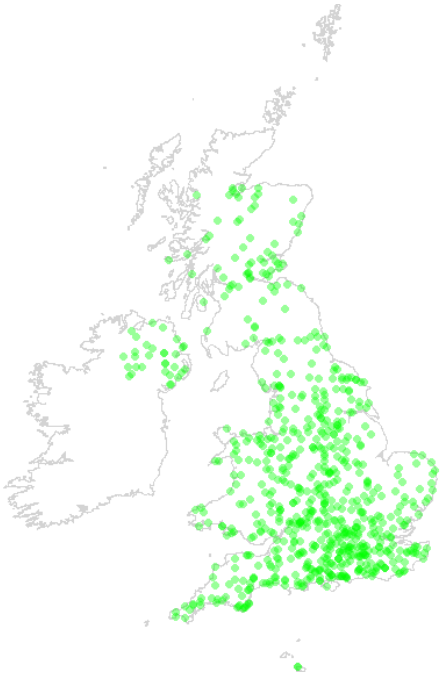
Soldaat, L.L., Pannekoek J., Verweij, R.J.T., Van Turnhout, C.A.M. and Van Strien, A.J. (2017). A Monte Carlo method to account for sampling error in multi-species indicators. *Ecological Indicators* 81: 340–347 DOI:10.1016/j.ecolind.2017.05.033

Annex 1. The maps below show the distribution of monads with NPMS samples 2015-2022 for each named NPMS broad habitat in the UK

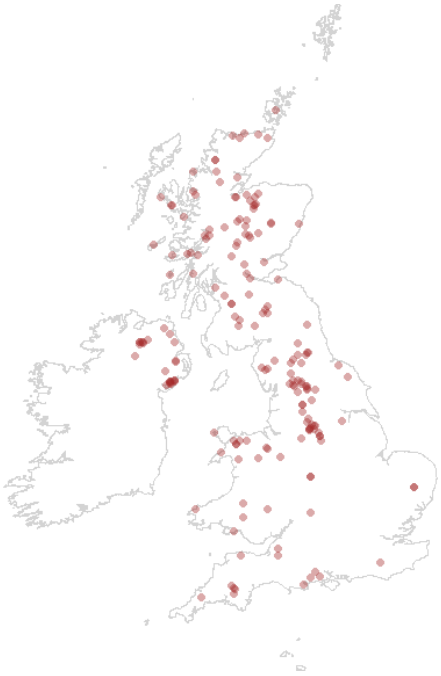
Arable field margins



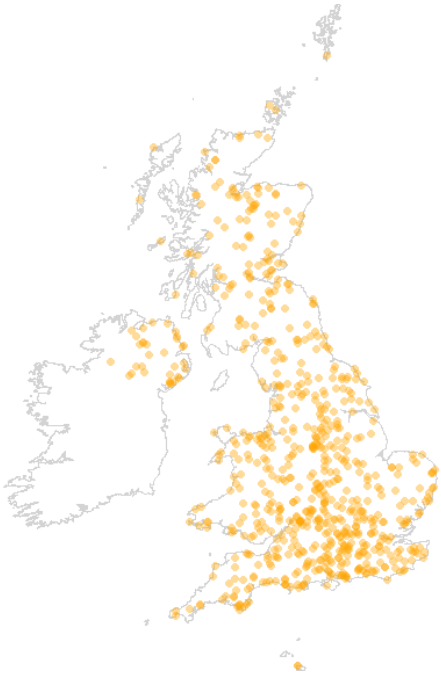
Broadleaved woodland and hedges



Bog and wet heath



Lowland grassland



Annex 2. Species included within each of the 4 UK broad habitat types in this indicator

Arable field margins (25 species)

Common name	Species
Fool's Parsley	*Aethusa cynapium*
Scarlet Pimpernel	*Anagallis arvensis*
Stinking Chamomile	*Anthemis cotula*
Shepherd's-purse	*Capsella bursa-pastoris*
Sticky Mouse-ear	*Cerastium glomeratum*
Small Toadflax	*Chaenorhinum minus*
Fat-hen	*Chenopodium album*
Dwarf Spurge	*Euphorbia exigua*
Sun Spurge	*Euphorbia helioscopia*
Fumitories	*Fumaria* spp.
Corn Marigold	*Glebionis segetum*
Sharp-leaved Fluellen	*Kickxia elatine*
Round-leaved Fluellen	*Kickxia spuria*
Henbit Dead-nettle	*Lamium amplexicaule*
Scented Mayweed	*Matricaria recutita*
Black Medick	*Medicago lupulina*
Pale Persicaria	*Persicaria lapathifolia*
Wild Mignonette	*Reseda lutea*
Field Madder	*Sherardia arvensis*
White Campion	*Silene latifolia*
Perennial Sow-thistle	*Sonchus arvensis*
Smooth Sow-thistle	*Sonchus oleraceus*
Scentless Mayweed	*Tripleurospermum inodorum*
Hairy Tare	*Vicia hirsuta*
Field Pansy	*Viola arvensis*

Lowland grassland (86 species)

Common name	Species
Yarrow	*Achillea millefolium*
Agrimony	*Agrimonia eupatoria*
Marsh Foxtail	*Alopecurus geniculatus*
Sweet Vernal-grass	*Anthoxanthum odoratum*
Kidney Vetch	*Anthyllis vulneraria*
Daisy	*Bellis perennis*
Yellow-wort	*Blackstonia perfoliata*
Hard-fern	*Blechnum spicant*
Quaking-grass	*Briza media*
Upright Brome	*Bromopsis erecta*
Heather	*Calluna vulgaris*
Marsh-marigold	*Caltha palustris*
Clustered Bellflower	*Campanula glomerata*
Harebell	*Campanula rotundifolia*

Cuckooflower	*Cardamine pratensis*
Musk Thistle	*Carduus nutans*
Field Mouse-ear	*Cerastium arvense*
Common Mouse-ear	*Cerastium fontanum*
Dwarf Thistle	*Cirsium acaule*
Pignut	*Conopodium majus*
Crosswort	*Cruciata laevipes*
Common Spotted-orchid	*Dactylorhiza fuchsii*
Carrot	*Daucus carota*
Tufted Hair-grass	*Deschampsia cespitosa*
Bell Heather	*Erica cinerea*
Small Cudweed	*Filago minima*
Dropwort	*Filipendula vulgaris*
Hedge Bedstraw	*Galium mollugo*
Marsh-bedstraw	*Galium palustre*
Heath Bedstraw	*Galium saxatile*
Wood Crane's-bill	*Geranium sylvaticum*
Chalk Fragrant-orchid	*Gymnadenia conopsea*
Meadow Oat-grass	*Helictotrichon pratense*
Horseshoe Vetch	*Hippocrepis comosa*
Yorkshire-fog	*Holcus lanatus*
Meadow Barley	*Hordeum secalinum*
Cat's-ear	*Hypochaeris radicata*
Ploughman's-spikenard	*Inula conyzae*
Yellow Iris	*Iris pseudacorus*
Heath Rush	*Juncus squarrosus*
Field Scabious	*Knautia arvensis*
Oxeye Daisy	*Leucanthemum vulgare*
Fairy Flax	*Linum catharticum*
Mat-grass	*Nardus stricta*
Adder's-tongue	*Ophioglossum vulgatum*
Wild Marjoram	*Origanum vulgare*
Bird's-foot	*Ornithopus perpusillus*
Wood-sorrel	*Oxalis acetosella*
Wild Parsnip	*Pastinaca sativa*
Reed Canary-grass	*Phalaris arundinacea*
Mouse-ear-hawkweed	*Pilosella officinarum*
Greater Burnet-saxifrage	*Pimpinella major*
Buck's-horn Plantain	*Plantago coronopus*
Hoary Plantain	*Plantago media*
Silverweed	*Potentilla anserina*
Cowslip	*Primula veris*
Bulbous Buttercup	*Ranunculus bulbosus*
Creeping Buttercup	*Ranunculus repens*
Weld	*Reseda luteola*
Yellow-rattle	*Rhinanthus minor*

Common Sorrel	*Rumex acetosa*
Sheep's Sorrel	*Rumex acetosella*
Great Burnet	*Sanguisorba officinalis*
Meadow Saxifrage	*Saxifraga granulata*
Small Scabious	*Scabiosa columbaria*
English Stonecrop	*Sedum anglicum*
Pepper-saxifrage	*Silaum silaus*
Ragged Robin	*Silene flos-cuculi*
Perennial Sow-thistle	*Sonchus arvensis*
Sand Spurrey	*Spergularia rubra*
Betony	*Stachys officinalis*
Lesser Stitchwort	*Stellaria graminea*
Greater Stitchwort	*Stellaria holostea*
Devil's-bit Scabious	*Succisa pratensis*
Common Comfrey	*Symphytum officinale*
Thyme	*Thymus polytrichus/pulegioides*
Hop Trefoil	*Trifolium campestre*
Lesser Trefoil	*Trifolium dubium*
Red Clover	*Trifolium pratense*
Marsh Arrowgrass	*Triglochin palustris*
Gorse	*Ulex gallii/minor*
Marsh Valerian	*Valeriana dioica*
Common Valerian	*Valeriana officinalis*
Wall Speedwell	*Veronica arvensis*
Heath Speedwell	*Veronica officinalis*
Tufted Vetch	*Vicia cracca*

Broadleaved woodlands and hedges (65 species)

Common name	**Species**
Bugle	*Ajuga reptans*
Ramsons	*Allium ursinum*
Lesser Burdock	*Arctium minus/nemorosum*
Lords-and-Ladies	*Arum maculatum*
Marsh-marigold	*Caltha palustris*
Giant Bellflower	*Campanula latifolia*
Nettle-leaved Bellflower	*Campanula trachelium*
Pendulous Sedge	*Carex pendula*
Remote Sedge	*Carex remota*
Wood-sedge	*Carex sylvatica*
Climbing Corydalis	*Ceratocapnos claviculata*
Rough Chervil	*Chaerophyllum temulum*
Enchanter's-nightshade	*Circaea lutetiana*
Traveller's-joy	*Clematis vitalba*
Dogwood	*Cornus sanguinea*
Hazel	*Corylus avellana*
Hawthorn	*Crataegus monogyna*

Marsh Hawk's-beard	*Crepis paludosa*
Hound's-tongue	*Cynoglossum officinale*
Broom	*Cytisus scoparius*
Spurge-laurel	*Daphne laureola*
Foxglove	*Digitalis purpurea*
Spindle	*Euonymus europaeus*
Wood Spurge	*Euphorbia amygdaloides*
Woodruff	*Galium odoratum*
Wood Avens	*Geum urbanum*
Ground-ivy	*Glechoma hederacea*
Common Ivy	*Hedera helix*
Hogweed	*Heracleum sphondylium*
Bluebell	*Hyacinthoides non-scripta*
Marsh Pennywort	*Hydrocotyle vulgaris*
Square-stalked St John's-wort	*Hypericum tetrapterum*
Holly	*Ilex aquifolium*
Sheep's-bit	*Jasione montana*
Yellow Archangel	*Lamiastrum galeobdolon*
Honeysuckle	*Lonicera periclymenum*
Gypsywort	*Lycopus europaeus*
Yellow Pimpernel	*Lysimachia nemorum*
Purple-loosestrife	*Lythrum salicaria*
Wood Melick	*Melica uniflora*
Dog's Mercury	*Mercurialis perennis*
Wood Millet	*Milium effusum*
Three-nerved Sandwort	*Moehringia trinervia*
Wall Lettuce	*Mycelis muralis*
Common Twayblade	*Neottia ovata*
Royal Fern	*Osmunda regalis*
Butterbur	*Petasites hybridus*
Hart's-tongue	*Phyllitis scolopendrium*
Barren Strawberry	*Potentilla sterilis*
Blackthorn	*Prunus spinosa*
Buckthorn	*Rhamnus cathartica*
Butcher's-broom	*Ruscus aculeatus*
Sanicle	*Sanicula europaea*
Wood Club-rush	*Scirpus sylvaticus*
Skullcap	*Scutellaria galericulata*
Red Campion	*Silene dioica*
Goldenrod	*Solidago virgaurea*
Lesser Stitchwort	*Stellaria graminea*
Greater Stitchwort	*Stellaria holostea*
Black Bryony	*Tamus communis*
Wood Sage	*Teucrium scorodonia*
Upright Hedge-parsley	*Torilis japonica*
Marsh Valerian	*Valeriana dioica*

Wood Speedwell	*Veronica montana*
Dog-violet	*Viola reichenbachiana/riviniana*

Bog and wet heath (43 species)

Common name	**Species**
Hard-fern	*Blechnum spicant*
Heather	*Calluna vulgaris*
Star Sedge	*Carex echinata*
Bog Sedge	*Carex limosa*
Common Sedge	*Carex nigra*
Carnation Sedge	*Carex panicea*
Bottle Sedge	*Carex rostrata*
Meadow Thistle	*Cirsium dissectum*
Heath Spotted-orchid	*Dactylorhiza maculata*
Wavy Hair-grass	*Deschampsia flexuosa*
Great Sundew	*Drosera anglica*
Oblong-leaved Sundew	*Drosera intermedia*
Round-leaved Sundew	*Drosera rotundifolia*
Many-stalked Spike-rush	*Eleocharis multicaulis*
Crowberry	*Empetrum nigrum*
Bell Heather	*Erica cinerea*
Cross-leaved Heath	*Erica tetralix*
Common Cottongrass	*Eriophorum angustifolium*
Hare's-tail Cottongrass	*Eriophorum vaginatum*
Fir Clubmoss	*Huperzia selago*
Heath Rush	*Juncus squarrosus*
Lesser Twayblade	*Listera cordata*
Heath Wood-rush	*Luzula multiflora*
Bogbean	*Menyanthes trifoliata*
Purple Moor-grass	*Molinia caerulea*
Bog-myrtle	*Myrica gale*
Mat-grass	*Nardus stricta*
Bog Asphodel	*Narthecium ossifragum*
Lousewort	*Pedicularis sylvatica*
Common Butterwort	*Pinguicula vulgaris*
Bog Pondweed	*Potamogeton polygonifolius*
Tormentil	*Potentilla erecta*
White Beak-sedge	*Rhynchospora alba*
Cloudberry	*Rubus chamaemorus*
Black Bog-rush	*Schoenus nigricans*
Lesser Skullcap	*Scutellaria minor*
Devil's-bit Scabious	*Succisa pratensis*
Deergrass	*Trichophorum caespitosum s.lat.*
Gorse	*Ulex gallii/minor*
Bilberry	*Vaccinium myrtillus*
Cranberry	*Vaccinium oxycoccos*

Cowberry	*Vaccinium vitis-idaea*
Marsh Violet	*Viola palustris*