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## Data Article

## OakEcol: A database of Oak-associated biodiversity within the UK



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## ABSTRACT

Globally there is increasing concern about the decline in the health of oak *Quercus* trees. The impact of a decline in oak trees on associated biodiversity, species that utilize oak trees, is unknown. Here we collate a database of all known birds, bryophytes, fungi, invertebrates, lichens and mammals that use oak (*Quercus petraea* and *Q. robur*) in the UK. In total 2300 species are listed in the database. For each species we provide a level of association with oak, ranging from obligate (only found on oak) to cosmopolitan (found on a wide range of other tree species). Data on the ecology of each oak associated species was collated: part of tree used, use made of tree (feeding, roosting, breeding), age of tree, woodland type, tree form (coppice, pollarded, or natural growth form) and season when the tree was used. Data on use or otherwise by each of the 2300 species of 30 other tree species was also collated. A complete list of data sources is provided. For further insights into how this data can be used see Collapsing foundations: The ecology of the British oak, implications of its decline and mitigation

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options [1]. Data can be found at EIDC <https://doi.org/10.5285/22b3d41e-7c35-4c51-9e55-0f47bb845202>.

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#### Specifications table

Subject area	Ecology
More specific subject area	Species level ecology
Type of data	Database (Microsoft Office Access Database) but held in EIDC as CSV files with details as to how to reconstruct as a relational database.
How data was acquired	Collation of data across literature and databases
Data format	Collated in standardized format from many data sources
Experimental factors	The species included in the database were known to occur in the UK and with evidence that the species uses oak. The quality of the data used was categorised as peer-reviewed (which included quality-controlled databases) or non-peer-reviewed and if the data came from a UK source or a non-UK source.
Experimental features	The data was collected under a common, predefined template, to ensure the same data was collected across taxon groups. A literature review, that including searching relevant databases of species records, was conducted to identify which species used oak trees and if they used any of 30 other tree species.
Data source location	UK
Data accessibility	Mitchell, R.J.; Bellamy, P.E.; Ellis, C.J.; Hewison, R.L.; Hodgetts, N.G.; Iason, G.R.; Littlewood, N.A.; Newey, S.; Stockan, J.A.; Taylor, A.F.S. (2019). Oak-associated biodiversity in the UK (OakEcol). NERC Environmental Information Data Centre. <a href="https://doi.org/10.5285/22b3d41e-7c35-4c51-9e55-0f47bb845202">https://doi.org/10.5285/22b3d41e-7c35-4c51-9e55-0f47bb845202</a>
Related research article	Mitchell R, Bellamy PE, Ellis CJ, Hewison RL, Hodgetts NG, Iason GR, Littlewood NA, Newey S, Stockan JA, Taylor AFS. (2019) Collapsing foundations: the ecology of the British oak, implications of its decline and mitigation options. Biological Conservation <a href="https://doi.org/10.1016/j.biocon.2019.03.040">https://doi.org/10.1016/j.biocon.2019.03.040</a>

#### Value of the data

- The most complete list of biodiversity associated with oaks (*Quercus*) in the UK.
- The data can be used to identify which species are most at risk of declining, if oak declines.
- The information could be used to prioritize conservation of species at a range of scales.
- The database can be used to identify other tree species that oak-associated species would use instead of oak. Such information may be used in management plans of woods and forests.

## 1. Data

There are 24 tables in a relational database (Fig. 1, Table 1) containing information about species that use oak (*Quercus petraea* and *Q. robur*) in the UK. The primary table (Species) lists all the oak associated species and information on their conservation status. A secondary table “Only oak associated species” is a subset of this table excluding the species that use the oak woodland habitat but not specifically the oak tree. There are tables detailing the age of tree used, the tree form used (coppiced, pollard, natural), the part of the tree used, and the season when the tree is used. Information on how the species uses the tree (for feeding directly or indirectly or as a habitat for living or nesting/roosting) is collated in the “Use” table. Information was also collected on the type of oak woodland the species uses, specific relationships between invertebrates and fungi and other ecological notes. The “Alternative Tree” table provides information on if the oak associated species are known to use any of 30 other alternative tree species, with a related table giving the tree species names in both English and Latin. There are also 10 definition tables providing definitions for the terms used in the other tables. The final table is a list of references used in collating the database, these references can be linked to the data in the other tables.

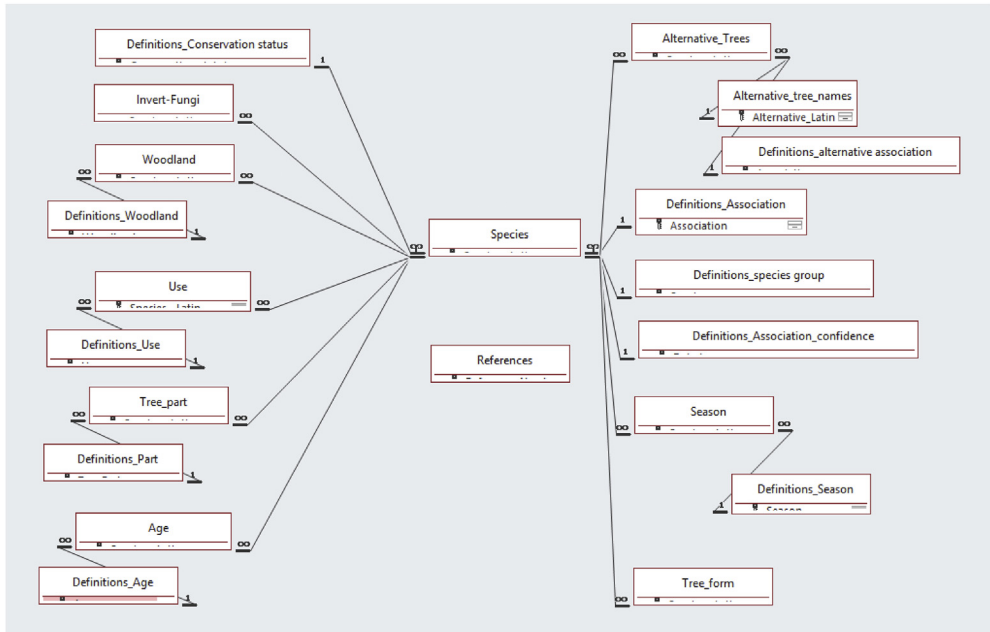


Fig. 1. Diagram of the relationships between the different tables within the database OakEcol.

All the data sources are classified as peer-reviewed (or quality-controlled database) or non-peer-reviewed and either from the UK or not.

## 2. Experimental design, materials, and methods

A literature review was conducted in 2016/17 using an extensive search of both published and grey literature, together with unpublished information, in order to identify as comprehensively as possible those species that use *Q. petraea/robur* (oak-associated species) and the nature of this association in the UK. We confined ourselves to six taxon groups: birds, bryophytes, invertebrates, fungi, lichens and mammals, and did not attempt to include algae, bacteria or other micro-organisms. All data were collected under a pre-defined common structure and collated into a relational database (OakEcol).

The level of association of each species with *Q. petraea/robur* within the UK was recorded as ‘obligate’, ‘high’, ‘partial’, ‘cosmopolitan’ or ‘uses’ (Table 2). For some guilds it was possible to define these categories based on the number of records of a species occurring on *Q. petraea/robur* as opposed to other tree species. For other guilds a more subjective assessment was made based on the available literature (Table 3).

Information on the conservation status of associated species was recorded (Table 4); this was broadly grouped as to whether the species was known to have some form of conservation protection, as different taxon groups have different measures of conservation protection. Where relevant, according to taxon group, additional information was collated on the IUCN status of the species, if the species was on a UK Red Data book list, a Biodiversity Action Plan species or on the priority species list of any of the four countries within the UK. Birds species were also recorded as red, amber or green on the UK Birds of Conservation Concern list. The conservation status of the species and its level of association with oak were combined to provide an “at risk to oak decline” category for each species ranging from RED-coded which was high risk to GREEN-coded, no risk [1].

**Table 1**

List of Tables in the OakEcol database and a description of the data they contain.

Table name	Description of data
Species	The main data table in the database to which most other tables are related. A list of all oak-associated species, Latin and English names, their level of association with oak, their conservation status, if the species is native to the UK. Information on if the species is a priority species in any of the four countries within the UK, a red data book species, a BAP species or an IUCN species. A reference number, related to the reference table is included. This table includes some mammal species that are found in oak woods but don't directly use the oak tree.
Only oak tree species	As per the species table but only includes those species that use oak trees, not just the woodland habitat. Also those fungi that are only recorded once, and then on oak are removed as there is no reliable way of knowing their level of association with oak.
Age	The ages of the oak tree that the oak associated species uses
Alternative_tree_names	A list of Latin and English tree names for species that could replace oak and for which an assessment as to whether the oak associated species do or not use them, was made.
Alternative_Trees	Information on if the oak associated species will or will not use 30 other tree species
Definitions_Age	Definitions of the age classes used in the Age table
Definitions_alternative association	Definitions of the level of association classes used when assessing how the oak associated species uses the 30 alternative tree species
Definitions_Association	Definitions of the classes of association that the oak associated species have with oak.
Definitions_Association_confidence	Definitions of the classes of data describing the data used to assess the level of association of the oak associated species with oak and the alternative tree species. These classes were based on if the data was peer-reviewed or not and if it came from the UK or not
Definitions_Conservation status	Definitions of the conservation status of a species used in the Species table.
Definitions_Part	Definitions of the tree parts used in the Tree_parts table
Definitions_Season	Definitions of the seasons used in the Seasons table
Definitions_species group	Definitions of the species groups used in the species table
Definitions_Use	Definitions of how the oak associated species use the oak tree, as used in the Use table.
Definitions_Woodland	Definitions of woodland types as used in the Woodlands table.
Ecology_notes	Notes on the ecology of the oak associated species.
Invert-fungi	Information on if the oak associated invertebrate eats fungi or carries a fungus and aids its spread.
Only_Woodland	A list of those species (mammals) which are associated with oak woodlands but do not directly use the oak trees.
References	Full details of all references used.
Season	The season when the oak associated species uses the oak tree.
Tree_form	The tree form (pollard, coppice and/or natural growth form) that the oak associated species uses.
Tree_part	The part of the tree that the oak associated species uses.
Use	How the oak associated species uses the oak tree e.g. feeding, roosting, nesting.
Woodland	The type of woodland in which the oak associated species uses oak trees.

**Table 2**Criteria used to assess the use of *Quercus robur/petraea* in the UK. This includes species dependent on other species that use *Q. robur/petraea*, such as parasites and some of the predatory insects.

Association with oak in UK	Definition
Obligate	Unknown from other tree species. NOTE: when dealing with parasites the following criteria were used: obligate host + obligate parasite = obligate; obligate host + parasite with multiple hosts = uses; highly associated host + obligate parasite = highly associated; highly associated host + parasite with multiple hosts = uses
High	Rarely uses other tree species
Partial	Uses oak more frequently than its availability
Cosmopolitan	Uses oak as frequently or lower than availability
Uses	Uses oak but the importance of oak for this species is unknown

**Table 3**

Methods used to assess level of species associated with *Q. robur/petraea*. For each species the reference used is listed in the OakEcol database.

Species group	Data sources and criteria used to assess association
Lichens	For all lichen species which had been confirmed as recorded on <i>Q. robur/petraea</i> within the British Lichen Society database (1960–2017), the number of times that each species had been recorded on <i>Q. robur/petraea</i> as a proportion of the total number of all records across all substrata (including corticolous, terricolous and saxicolous records, etc) was calculated. The ‘level of association’ for a species was considered <i>obligate</i> if 100% of records were from <i>Q. robur/petraea</i> , <i>high</i> if >75% of records were from <i>Q. robur/petraea</i> , <i>partial</i> if >50% of records are from <i>Q. robur/petraea</i> , and <i>cosmopolitan</i> if the number of records from <i>F. excelsior</i> trees <50%.
Bryophytes	The British Bryological Society (BBS) records and the following references [2–8], were the primary sources used. Additional literature was used for specific species (see OakEcol database)
Fungi	The species assessed was limited to the fungal taxa reported in The Fungal Records Database of Britain and Ireland (FRDBI) <a href="http://www.fieldmycology.net/FRDBI/FRDBI.asp">http://www.fieldmycology.net/FRDBI/FRDBI.asp</a> which contains a total of 51914 post-1960 records where the associated organism was <i>Quercus</i> or Oak. Many of these were erroneously included within the field of fungi – with many being lichens. Detailed assessments of fungi were limited to those with 98–100% of records with <i>Quercus</i> and which were considered to be obligate associates and those with 80–97% of records with <i>Quercus</i> and which were considered to be highly associated with <i>Quercus</i> . Entries with a species epithet suggesting a strong affinity with <i>Quercus</i> were also assessed.
Invertebrates	The principal data sources used were [9–20]. Additional literature searches were carried out for specific species (see OakEcol for details).
Mammals	The handbook of British Mammals [21] retrieved from <a href="http://books.google.co.uk/books?id=w_UJNAAACAAJ">http://books.google.co.uk/books?id=w_UJNAAACAAJ</a> was used as the main information supplemented with additional literature searches for specific species (see OakEcol for details).
Birds	The assessment of birds associated with <i>Q. robur/petraea</i> trees was primarily based on online searches of peer reviewed literature. Further information was sought from unpublished reviews on the habitat associations and requirements for woodland birds. See OakEcol for complete list of references.

**Table 4**

Definitions of criteria used to record the conservation status of the oak-associated species within the OakEcol database.

Measure	Category	Definition
Conservation concern	Conservation concern-protected.	Species is listed as being of some conservation concern in one of BAP, Red data, IUCN, Birds of conservation concern
	Conservation concern-unprotected.	Known by experts to be of conservation concern but it is currently not protected i.e. it is not listed in one of BAP, Red data book, IUCN, birds of conservation concern
	Not of Conservation Concern.	There is enough data to know that the species is of no conservation concern
	Unknown	The distribution/population of the species is unknown and it is not known whether this species should be of conservation concern
IUCN	Endangered	A taxon is Endangered when the best available evidence indicates that it meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild. <a href="http://www.iucnredlist.org/static/categories_criteria_3_1">http://www.iucnredlist.org/static/categories_criteria_3_1</a>
	Vulnerable	A taxon is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable (see Section V), and it is therefore considered to be facing a high risk of extinction in the wild. <a href="http://www.iucnredlist.org/static/categories_criteria_3_1">http://www.iucnredlist.org/static/categories_criteria_3_1</a>
	Near Threatened	A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future. <a href="http://www.iucnredlist.org/static/categories_criteria_3_1">http://www.iucnredlist.org/static/categories_criteria_3_1</a>
	Least concern	A taxon is Least Concern when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant taxa are included in this category. <a href="http://www.iucnredlist.org/static/categories_criteria_3_1">http://www.iucnredlist.org/static/categories_criteria_3_1</a>

(continued on next page)

**Table 4** (continued)

Measure	Category	Definition
	Data deficient	A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. <a href="http://www.iucnredlist.org/static/categories_criteria_3_1">http://www.iucnredlist.org/static/categories_criteria_3_1</a>
BoCC4	Red	Birds of conservation concern - red listed
	Amber	Birds of conservation concern - amber listed
	Green	Birds of conservation concern - green listed
Priority sp_England	Yes	Listed as a Priority species in England (species of principal importance) <a href="http://webarchive.nationalarchives.gov.uk/20140711133551/http://www.naturalengland.org.uk/ourwork/conservation/biodiversity/protectandmanage/habsandspeciesimportance.aspx">http://webarchive.nationalarchives.gov.uk/20140711133551/http://www.naturalengland.org.uk/ourwork/conservation/biodiversity/protectandmanage/habsandspeciesimportance.aspx</a>
	No	Not listed as a Priority species in England
Priority sp_Wales	Yes	Listed as a Priority species in Wales (Section 7 List) <a href="http://www.biodiversitywales.org.uk/Environment-Wales-Bill">http://www.biodiversitywales.org.uk/Environment-Wales-Bill</a>
	No	Not listed as a Priority species in Wales
Priority sp_NI	Yes	Listed as a Priority species in Northern Ireland <a href="https://www.daera-ni.gov.uk/articles/northern-ireland-priority-species">https://www.daera-ni.gov.uk/articles/northern-ireland-priority-species</a>
	No	Not listed as a Priority species in Northern Ireland
Priority sp_Scotland	Yes	Listed as a Priority species in Scotland (Scottish Biodiversity List) <a href="http://www.gov.scot/Topics/Environment/Wildlife-Habitats/16118/Biodiversitylist/SBL">http://www.gov.scot/Topics/Environment/Wildlife-Habitats/16118/Biodiversitylist/SBL</a>
	No	Not listed as a Priority species in Scotland

**Table 5**

Definitions of criteria used to record the ecology of the oak-associated species within the OakEcol database.

Measure	Category	Definition
Age of tree used	Seed	Species uses acorns
	Seedling	Species uses the oak trees 1 year old or less
	Sapling	Species uses the oak trees under 2 m in height
	Pole	species uses the pole stage oak trees which are defined as >2 m height, younger than 50 years
	Mature	Species uses mature oak trees which are defined as more than 2 m in height and under 3 m in girth, don't have lots of holes, rotten wood etc - characteristics which are veteran tree characters
	Veteran	Species uses Veteran oak trees which includes Veteran, Ancient and Notable trees: defined as large girth (usually over 3 m, taking into consideration environmental conditions) with at least 3 veteran attributes (e.g. important habitats visible such as dead wood in the trunk, contain standing dead wood, have fallen wood around base, rot holes, water pockets, seepage lines, hollows in trunk or major limbs etc.)
Use of tree	Dead	Species uses dead oak trees
	Seed	Species uses acorns
	Feeding - direct	Species eats part of the oak (e.g. acorns, leaves, wood, bark)
	Feeding - indirect	Species eats another organism found on the oak
	Habitat - living space	Species uses the oak as a habitat in which to live (e.g. epiphytes, bird nest holes etc.)
Part of tree used	Bark	If the species grows/lives/eats/otherwise uses the bark of oak trees (used for lichens/bryophytes that grow on the bark of the tree and birds that hunt for insects on the bark of the tree. For species that nest in holes trunk was used.
	Canopy	The species grows/lives/eats/otherwise uses the canopy of oak trees
	Dead wood	The species grows/lives/eats/otherwise uses the dead wood of oak trees
	Flowers	The species grows/lives/eats/otherwise uses the flowers of oak trees
	Leaves	The species grows/lives/eats/otherwise uses the leaves of oak trees
	Limbs/branches/twigs	The species grows/lives/eats/otherwise uses the limbs/branches/twigs of oak trees
	Roots	The species grows/lives/eats/otherwise uses the roots of oak trees
	Seeds	The species grows/lives/eats/otherwise uses the seeds of oak trees
	Shoots	The species grows/lives/eats/otherwise uses the shoots of oak trees
	Trunk	The species grows/lives/eats/otherwise uses the trunk of oak trees (used for birds/mammals/inverts that live/breed inside holes in trees, but bark was used for lichens/bryophytes that grow on the bark of the tree.

**Table 5** (continued)

Measure	Category	Definition
Woodland type	Woodland habitat not tree	The species uses the oak woodland habitat but is not specifically associated with oak trees (many mammals)
	Ancient woodland	Species uses oak trees in Ancient Woodland sites – any site that has always been wooded since at least 1600AD (in England and Wales) when the first maps appeared. Definition taken from Royal forestry society 2008 A glossary of tree terms <a href="http://www.rfs.org.uk/files/TreeTerms_RFS_17102011.pdf">http://www.rfs.org.uk/files/TreeTerms_RFS_17102011.pdf</a>
	Recent woodland	Species uses oak trees in Recent woodland sites. Includes Woodland established since AD1600 that have regenerated and planted native woodland. Definition taken from Royal forestry society 2008 A glossary of tree terms <a href="http://www.rfs.org.uk/files/TreeTerms_RFS_17102011.pdf">http://www.rfs.org.uk/files/TreeTerms_RFS_17102011.pdf</a>
	Wood pasture	Species uses oak trees in Wood pasture systems. An ancient system of land-use in which domestic animals were grazed within woodland or under widely scattered trees. The trees were often pollarded. Definition taken from Royal forestry society 2008 A glossary of tree terms <a href="http://www.rfs.org.uk/files/TreeTerms_RFS_17102011.pdf">http://www.rfs.org.uk/files/TreeTerms_RFS_17102011.pdf</a>
	Plantation Non-woodland	Species uses oak trees in non-woodland situations e.g. single trees, trees in gardens, parks, hedges

**Table 6**

The 30 tree species for which information was collated for whether the 2300 oak-associated species will or will not use these trees in addition to oak.

Latin	English
<i>Acer campestre</i>	Field Maple
<i>Acer pseudoplatanus</i>	Sycamore
<i>Alnus glutinosa</i>	Alder
<i>Betula pendula</i>	Silver Birch
<i>Betula pubescens</i>	Downy Birch
<i>Carpinus betulus</i>	Hornbeam
<i>Castanea sativa</i>	Sweet Chestnut
<i>Fagus sylvatica</i>	Beech
<i>Fraxinus excelsior</i>	Common Ash
<i>Ilex aquifolium</i>	Holly
<i>Larix spp</i>	Larch
<i>Malus sylvestris</i>	Crab Apple
<i>Picea abies</i>	Norway Spruce
<i>Pinus nigra ssp. laricio</i>	Corsican Pine
<i>Pinus sylvestris</i>	Scots Pine
<i>Populus tremula</i>	Aspen
<i>Prunus avium</i>	Wild Cherry
<i>Pseudotsuga menziesii</i>	Douglas fir
<i>Quercus cerris</i>	Turkey oak
<i>Quercus robur</i>	Red Oak
<i>Sorbus aria</i>	Whitebeam
<i>Sorbus aucuparia</i>	Rowan
<i>Sorbus torminalis</i>	Wild service tree
<i>Taxus baccata</i>	Yew
<i>Thuja plicata</i>	Western red cedar
<i>Tilia cordata</i>	Small leaved lime
<i>Tilia platyphyllos</i>	Large leaved lime
<i>Tilia vulgaris</i>	Hybrid T. cordata × T. platyphyllos
<i>Tsuga heterophylla</i>	Western hemlock
<i>Ulmus glabra</i>	Wych elm

**Table 7**

Definitions of criteria used to assess association of oak-associated species with 30 alternative tree species.

Association	Definition
No	Known not to use this tree species.
Parasite	Species is a parasite, so no assessment of alternative tree species made
Probable	Based on ecological knowledge of the species the oak-associated species is thought likely or probable to use this tree species but there are no records of the species using this particular tree species. For example, the species is known to use a wide range of deciduous tree species, thus it is probable that it will also occur on other deciduous tree species, even if no records of its occurrence on this tree species exist.
Rarely_Gen	The oak-associated species has very occasionally been recorded on this genus but there is no information on if it will occasionally use this species. Unlikely to be a good alternative tree species
Rarely_Sp	The oak-associated species has very occasionally been recorded on this tree species but very rarely, so unlikely to be a good alternative tree species
Unknown	The use (or otherwise) of this tree is unknown
Yes_Gen	Known to use this genus but no information on if it will use this species
Yes_Sp	Known to use this tree species. Note there are a few obligate species in the data base, which although only recorded on native oak in the UK have some evidence from outside the UK that they will use other tree species (often another species of oak). Hence occasionally an obligate species may have "Yes_Sp" recorded against it for an alternative tree species. Looking at the related data under the column "Association-confidence" (Table 7) where the data is shown as coming from a non-UK source explains this seeming contradiction.

**Table 8**

Definitions of criteria used to record the quality of the data used to make assessments of the level of association of species with either oak or any of the alternative tree species.

Data type	Definition
Anecdotal	Information on the use the species makes of oak is predominantly based on anecdotal evidence
Not reviewed-Non UK	Information on the use the species makes of oak is predominantly based on literature that has an unknown review process and uses data from outside the UK
Not reviewed-UK	Information on the use the species makes of oak is predominantly based on literature that has an unknown review process but is based on UK data
Peer reviewed-Non UK	The species is known to occur in the UK, but the information used to assess the level of association of the species with oak is predominantly based on peer reviewed literature from outside the UK
Peer reviewed-UK	Information on the use the species makes of oak is predominantly based on peer reviewed literature using data from the UK. This includes published books and quality-controlled databases.

Information on the ecology of the oak-associated species was collated. This information covered how the species used the tree (feeding directly/feeding indirectly/living space/nesting/roosting), the part of the tree used, the age of tree used, the tree form used and the woodland type used (Table 5).

The literature was searched in the same manner as that used to identify oak-associated species (Table 3) to collate evidence of whether the oak-associated species did or did not use 30 alternative tree species (see list of tree species in Table 6). The level of use of the alternative tree species was categorised according to whether the species was known to use that particular tree species, or just that genus of tree and if the species regularly used the tree species or only rarely (Table 7).

The quality of the data used to make the assessment of the level of association of the species with oak and with the 30 alternative tree species was recorded with the categories based on whether the literature was peer reviewed/the database quality controlled and if the data were from the UK or not (Table 8). In addition, all the data sources for assessments were recorded.

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## Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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