Data Flow of UK Fungal Records

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Foreword

Fungus conservation has lagged behind the other macroscopic kingdoms of life. Nonetheless they face the same threats and pressures faced by other taxa like climate change, eutrophication, habitat loss and fragmentation. The UK supports globally threatened species and internationally important assemblages of fungi. In a 2010 report on England's lost and threatened species, five broad assemblages were considered internationally important: two of these are fungi (thermophilous boletes and grassland fungi), or fungi are a significant component (lichen, bryophytes and ferns of temperate rainforest) (Natural England, 2010). Since then, comparative data from across Europe has identified new fungal assemblages of international importance: Saprotrophic communities of beech and oak; Montane heath mycorrhizal fungi; and Fungi of Atlantic hazel and Atlantic oak woodland (Bosanquet, 2018). Furthermore, progress in global red-listing of fungi over the past 10 years is showing an increasing proportion of the UK's threatened taxa, with the number expected to grow with the increased global effort on new assessments.

The Government has set statutory targets for nature recovery in the Environment Act 2021 including one to reduce extinction risk by 2042. Meeting this target and others in the legislation must be evidence-led to best meet the scale of the Government's ambition. Like other taxa, conservation planning and action for fungi is dependent on high-quality biological records that help to inform species autecology, distribution, population changes, important sites and responses to changing environments. However, the recording landscape is complex with two national recording schemes as well as an increasing number of online recording platforms. Flows of data from recorder to repository appear to be becoming increasingly complicated. This presents significant obstacles to using the data: the scale of duplication across platforms, gaps in the data, varying data licences and confidence in records with no observable standard for verification. Very little fungi data is making its way to National Biodiversity Network (NBN) Atlas and as a result, the Global Biodiversity Information Facility (GBIF), and so broader access is limited and restricting its application to decision making in areas like land-use and management, but also ecological research.

Recording fungi does not happen without purpose so it is important to understand the motivations behind fungus recording and how those influence decisions around data management and access. Fundamentally those motivations need to be reflected in the work of data users like Natural England.

The purpose of this report is to better understand the flow of fungi data: who collects it, with whom do they share it, how is it accessed and importantly what do they want from it. By mapping the topography of the fungi data landscape Natural England and its partners can have a better understanding of where to source data from, its limitations and ultimately how to drive better conservation decision making for the fungal kingdom. It is also hoped that the recording community can reflect on its findings to improve the experience of recorders.

Natural England commission a range of reports from external contractors to provide evidence and advice to assist us in delivering our duties. The views in this report are those of the authors and do not necessarily represent those of Natural England.

Executive summary

This report explores the current state of fungus recording in the UK, focusing on data collection, verification, and sharing processes.

- **Importance of fungi conservation**: Fungi are essential components of ecosystems, and the UK supports globally threatened species and internationally important assemblages of fungi. However, their conservation is hindered by incomplete, inaccessible, and inconsistently verified data.
- **Data complexity and challenges**: The recording landscape includes multiple national recording schemes, local groups and online platforms. Issues such as data duplication, inconsistent verification, and restricted data sharing hinder conservation efforts such as Red List assessments and Local Nature Recovery Strategies.
- **Key data sources** are summarised:
    - **British Mycological Society (BMS)** maintains the **Fungal Records Database of Britain and Ireland (FRDBI)**, a major repository.
    - **Fungus Conservation Trust (FCT)** manages **CATE2**, a significant but less accessible database.
    - **National Biodiversity Network (NBN) Atlas** and **Global Biodiversity Information Facility (GBIF)** provide broader access to biodiversity data.
    - **Online platforms** (including iRecord, iNaturalist, and Observation.org) facilitate data collection but raise concerns over taxonomy, identification and verification.
    - At county or other local level, **Local Fungus Recording Groups** play an important role in recording and checking records, while **Local Environmental Records Centres** also play a role in supporting recording and curating data for their regions.
- **Verification issues**: Ensuring accuracy in fungus identification is challenging due to taxonomic complexities. Different platforms use varied verification standards, creating inconsistencies in data quality.
- **Data sharing barriers**: Some repositories restrict access, limiting the use of data for conservation planning, including Red List assessments.
- **Stakeholder perspectives**: A survey of fungus recorders and database managers revealed concerns about data fragmentation, complex submission processes, and the balance between data accessibility and conservation needs.
- **Recommendations**: The following steps could address the barriers that have been identified:
    - Aligning fungi data with FAIR data principles
    - Improving and standardising verification
    - Enhancing data accessibility
    - Improving data interoperability and integration
    - Promoting data use in conservation planning and research
    - Support for fungus recording at national and local level

Addressing these challenges can improve the use of fungi data for conservation planning, habitat management, and policy decision-making, ensuring fungi receive the attention necessary for their long-term protection.

Contents

Version	Authors	Notes
DRAFT 1.0	Sam Amy, Martha Henson, Martin Harvey	Initial draft for discussion with NE
DRAFT 1.1	Further edits by the authors and incorporating comments from Matt Wainhouse	
DRAFT 1.2	Further edits (including revised graphics) by Martin Harvey	
DRAFT 1.3	Further edits to incorporate comments from consultees by Matt Wainhouse and Martin Harvey	Stakeholders from British Mycological Society (BMS), Fungus Conservation Trust and Royal Botanic Gardens, Kew were invited to comment on a draft manuscript. We are grateful for comments from Martyn Ainsworth, Clare Blencowe, Stuart Skeates and Marcus Yeo.

1 Introduction

1.1 Purpose of this report

This report describes work carried out by the UKCEH Biological Records Centre to investigate the status of fungus recording, and how biological records of fungi are stored, verified and shared. The work was commissioned by Natural England to inform their work on the conservation of fungi.

The effective management of fungi data in the UK must align with broader species data frameworks to maximize its value for conservation and research. The Geospatial Commission's report, *Mapping the Species Data Pathway: Connecting Species Data Flows in England* (Economics for the Environment Consultancy Ltd. 2021), highlights the need for clearer data pathways, improved interoperability, and greater accessibility of species data. These priorities closely align with the FAIR data principles (Findable, Accessible, Interoperable, and Reusable), which provide a framework for ensuring that biological records can be effectively shared, verified, and used by stakeholders. By integrating biological recording efforts with national biodiversity databases such as the National Biodiversity Network Atlas (NBN Trust, 2024) and Global Biodiversity Information Facility (GBIF, 2024), standardizing metadata and taxonomic frameworks, and enhancing data verification and licensing, biological records, including fungi, can become more accessible and valuable for decision-making. This report explores current fungi data pathways in the UK, identifying key challenges and opportunities to align with both the Geospatial Commission's recommendations and FAIR data standards, ultimately supporting evidence-based conservation strategies and improving the experience of stakeholders from recorder to data user.

The complex nature of biological recording in the UK is well-known (e.g., Economics for the Environment Consultancy Ltd, 2021) and there are many participants and stakeholders involved. Fungus recording in the UK is spread across two national recording schemes, many local fungus recording groups, and recorders not affiliated to a group but using one or more online recording platform(s), including those not specifically designed for fungi recording. In addition, biological records associated with research or policy projects are held by academic institutes and government agencies, some of which may derive from or overlap with the data gathered by the recording schemes and groups.

There are some taxon group-specific challenges involved in recording and verifying biological records of fungi. Taken as a whole, fungi include a very large number of species in the UK (over 18,000), few of which can be reliably identified from their general appearance alone, which means that photographic records contributed by non-specialist recorders may be impossible to verify. Relatively frequent changes in taxonomy and species concepts add a further complexity to the process.

The past decade has seen a proliferation in digital recording websites and apps, either specifically focussed on fungus recording, or with a wider taxonomic scope but including

fungi, with a sharp increase in the use of the latter in recent years (Figure 4). Whilst the quality of fungus records in databases not overseen by a fungus recording scheme may be variable, they may also include records worthy of consideration for incorporation into national fungus datasets, and present opportunities to engage with new fungus recorders and improve the quality of future records.

The Fungus Conservation Forum produced a promising strategy document (Fungus Conservation Forum, 2008). Targets within this strategy included making fungus distribution data accessible and regularly updated, developing species status monitoring methods, and improving communication between conservation and field recording communities. Whilst excellent work towards these targets has been ongoing by many people, there appears to remain some uncertainly about where fungus records should be shared, as well as varying degrees of duplication between, and access to data in, different data repositories. This is impacting on the ability for evidence-based and data-driven conservation of UK fungi.

This report provides an overview of the availability of biological records of fungi in the UK, considering whether there may be significant gaps in the data, and an estimation of the degree to which data are duplicated across databases. This is complemented by the results of a questionnaire distributed to fungus recorders, local fungus groups and fungus recording schemes, which aimed to explore the routes by which fungus record data are flowing, the motivations of recorders, and the intended use of their records.

The focus of this report is on data pathways, as such, the critical but ancillary resources and infrastructure that underpin fungi recording, such as Index Fungorum/Species Fungorum (Index Fungorum, 2024), the Checklist of British and Irish Basidiomycota, (BasidioChecklist, 2024) and Mycobank (MycoBank, 2024) are out of scope of this report.

The two organisations that play a role as national recording schemes for fungi are the British Mycological Society and the Fungus Conservation Trust. Abbreviations for these schemes and their databases are used in this report, as follows:

- BMS = British Mycological Society
- FRDBI = the BMS Fungal Records Database of Britain and Ireland; this is currently partitioned into FRDBI1 (older records, not yet all online) and FRDBI2 (more recent records, online)
- FCT = Fungus Conservation Trust
- CATE2 = the online database maintained by FCT

The National Biodiversity Network (NBN) Atlas is an important focus for national biological records, receiving records from many of the sources we consider in this report.

1.2 Taxonomic scope

The UK Species Inventory has been described as the most comprehensive curated database of UK wildlife taxonomy (Raper, 2023). It aims to bring together all the standard

reference names for all species and is managed by the Natural History Museum in collaboration with taxonomic experts. Databases containing fungus records which use the UKSI as their taxonomic dictionary include the Fungal Records Database of Britain and Ireland (FRDBI), iRecord, other Indicia-based recording websites, iSpot and others sharing data with NBN Atlas (e.g., Table 2). In recent years work has been underway to update the UKSI for fungi and bring it in line with Kew's Checklist of the British and Irish Basidiomycota as well as the list of names and the taxonomic opinions on Index Fungorum and Species Fungorum (FRDBI, 2024). The first complete iteration of this process was completed in Autumn 2016 and the most recent in 2023.

For those datasets using the UKSI, the summaries in this report are based on the taxonomy updated by BMS for UKSI. This excludes lichens and lichenicolous fungi (which are fungi that grow on lichens), which are dealt with in the UKSI context by the British Lichen Society. For consistency in this report, we have filtered the taxon list to exclude the non-lichenicolous fungi, based on a list provided by BMS (David Mitchel pers. comm).

For some of the databases considered here which do not use the UKSI as their taxonomic dictionary (i.e. CATE2, Observation.org), it was not possible in the timeframe, or with the available access to records, to distinguish this subset of fungi for the purpose of giving a broad overview of the data flow of fungus records, and in these cases wider scope (e.g. all fungi) was considered.

1.3 Record verification

At various points in this report we touch on the concept of record verification. The generally accepted definition of verification within biological recording is “ensuring the accuracy of the identification of the things being recorded” as opposed to the concept of validation: “carrying out standardised, often automated checks on the ‘completeness’, accuracy of transmission and validity of the content of a record” (James 2011). Verification is essential for making biological data both interoperable and reusable, as it ensures that records are reliable, standardised, and can be confidently integrated across multiple platforms. A structured verification process would enable fungi data to be used more effectively and with greater confidence in biodiversity monitoring frameworks. In practice, verifiers are not exclusively concerned with the identification element of a record, they also look at the record’s general level of precision and accuracy (including the record’s location data and other details) and the extent of supporting evidence that has been provided for it.

The most relevant of the Oxford English Dictionary (OED) definitions of “verify” is “To ascertain or test the accuracy or correctness of (something), esp. by examination or by comparison with known data, an original, or some standard; to check or correct in this way.” Although the OED definition supports the idea that some sort of evidence is required in order to verify a record, it also leaves open the possibility of verifying a record based on “comparison with known data” or “by comparison with some standard” (the standard in this case being the normal procedure of the recording scheme).

Within the context of the Indicia software tools for biological recording (as used in iRecord and elsewhere) verification is not regarded as guaranteeing that a record is absolutely correct. Rather, verifiers are making a judgement over whether the record is sufficiently well-evidenced to enable it to be used by the recording scheme that the verifier is contributing to. The terminology used for verification within Indicia reflects this: records are labelled as “accepted” or “not accepted”, rather than as absolutely right or wrong. An “accepted” record is one that can be trusted to provide robust evidence of an occurrence of the species in question; and/or that meets the standards required by the recording scheme represented by the verifier.

When considering whether a record can be accepted, a verifier will take into account any supporting evidence for the record, which may be in the form of a photo, or comments attached to the record that describe the identification process and whether a specimen was examined or retained. Frequently verifiers also have to assess records that have been submitted without supporting evidence (e.g. no associated photo or specimen), and in such cases a judgment usually has to be made based on whether the record seems ‘likely’ (i.e. is not an outlier in any way), and on whether the recorder has, or seems likely to have, the relevant skills and to have taken sufficient care over identification to make the suggested identification trustworthy.

The verification terminology used within Indicia was developed by BRC in 2015 following extensive consultation with recording schemes and records centres, and has remained in use within Indicia as well as being adopted more widely, e.g. for the NBN Atlas. The terms used are shown in Table 1.

Verification tools have been developed within iRecord (section 2.6) to provide support for expert checking of biological records. Many national recording schemes and societies (NRSS) for different taxa in the UK value these tools as a means of vetting records for inclusion in their schemes. Verifiers are generally assigned in collaboration with the national recording schemes and are usually carrying out this task on a voluntary basis. Verifiers can be given access to any subset of records based on a wide range of variables such as taxonomy, geographical area, source of records, or presence of images, and assign one of the pre-defined statuses to each record. Any other website using Indicia can choose to have a data sharing agreement with iRecord to make records available to the verification tools and the expertise of verifiers, and some such websites (e.g., Naturespot.org.uk) also have the same verification tools implemented within their own website. iRecord verifiers are volunteer experts in their field, who are usually appointed in collaboration with NRSS, and in some cases regional recording organisations including Local Environmental Records Centres (LERCs).

As yet there are rather few fungus verifiers registered on iRecord, see discussion in section 2.6.

Table 1. iRecord verification statuses, level terms and descriptions.

Verification status 1		Verification status 2	
Accepted	The record is accepted as meeting the standard required for inclusion by the recording scheme or project in question.	Correct	The verifier can confirm that the species has been identified correctly, usually based on photos within iRecord (or specimens outside iRecord).
		Considered correct	The verifier has not seen photos or specimens but is confident that the record is likely to be correct, based on difficulty of ID, date, location plus recorder skills/experience etc
Not Accepted	The record is NOT accepted as meeting the standard required for inclusion.	Unable to verify	The verifier is confident that the record is not likely to be correct, based on difficulty of ID, date, location plus recorder skills/experience (and where no photos or specimens are available); or photos are available but do not show enough detail to confirm the identification; and/or the record is not sufficiently well documented to confirm (e.g. the location is considered to be too vague).
		Incorrect	The verifier can confirm that the species has not been identified correctly, or the record is erroneous in other respects, based on photos or specimens, or on information from the recorder.
Unconfirmed	The record is in the system but has either not been looked at, or a verification decision has not yet been reached, or the record is regarded as plausible but not fully accepted.	Plausible	The record is plausible based on species, date, and location, but there is not enough supporting evidence for the possibility of misidentification to be ruled out. This is not considered as an Accepted record. This can be a good option for ensuring that unconfirmed records from inexperienced recorders can be dealt with without putting the recorder off by giving an outright rejection. Some recording schemes or projects find that this category is useful for filtering less certain records in or out for analytical purposes, but it is up to each scheme or project to decide how and whether to use this term.
		Not reviewed	The record is in the system but has either not been looked at, or a verification decision has not yet been reached.

1.4 Fungi conservation and biological data

Natural England is an evidence-led organisation, "*using evidence to inform our advice and leadership to drive positive changes in the natural environment*" (Natural England, 2024). One of the most significant pieces of evidence that organisations engaged in nature conservation and research are dependent on is high quality biological records. These form the basis of our understanding of species distribution, population trends, autecology and environmental change. Effective conservation planning and research is therefore dependent on access to current and historical biological data and an understanding of its breadth, strengths as well as weaknesses in its use, such as confidence in its validity, accessibility, scale of duplication across databases, accuracy of records and spatial and temporal gaps.

The complexity of having two fungus recording schemes in the UK is a major obstacle to fungus conservation (Matt Wainhouse, Natural England, pers. comms), since it is not clear or consistent what local recording groups do with the data they collect and where it is shared. Further complicating this is the increased recording on other platforms such as iRecord. Data driven projects being undertaken by Natural England such as the England Grassland Fungi Database and Grassland Fungi Hotspot Modelling, as well as Red-List assessments, State of Nature reporting and the Local Nature Recovery Strategies, mandated under the Environment Act 2021, are impoverished as a result. Understanding the flow of data from recorder to repository and accessing it is fundamental to effective fungus conservation.

Case Study: Red List Assessments and obstacles to data pathways and use

The UK Government has committed to reducing species extinction risk by 2042, as outlined in the Environment Act 2021 and Environmental Improvement Plan. A critical tool in achieving this goal is the Red List assessment process, which determines species' conservation status and informs policy, funding, and land management decisions. High-quality, well-verified data is essential for accurate Red List assessments, yet fungi data in the UK is fragmented across multiple repositories (e.g., FRDBI, CATE2, etc), with their own data access policies, verification processes, and taxonomic frameworks - areas where current fungi data pathways face significant challenges.

The only officially recognised Red List for fungi, the 2013 Red List assessment for Boletaceae (Ainsworth, 2013), relied on data from both BMS and FCT, but subsequent attempts to assess other fungal taxa were hindered by data inconsistencies and access restrictions. In 2015, two separate Red Lists were compiled for 19 fungal genera—one using FRDBI data (Smith *et al*. 2015 and 2016) and another using FCT's CATE2 database (Bailey *et al*., 2015). This identified significant discrepancies (44% of species had different conservation statuses) between the two; the reason for this was not clear, but differences between the databases and interpretation of data are both thought to have contributed. Detailed evaluation of the cause was not possible since the FCT restrict access to CATE2

and do not allow for peer-review of their Red Lists (Jordan *et al*., 2016). As a result, neither of these Red Lists were officially recognised.

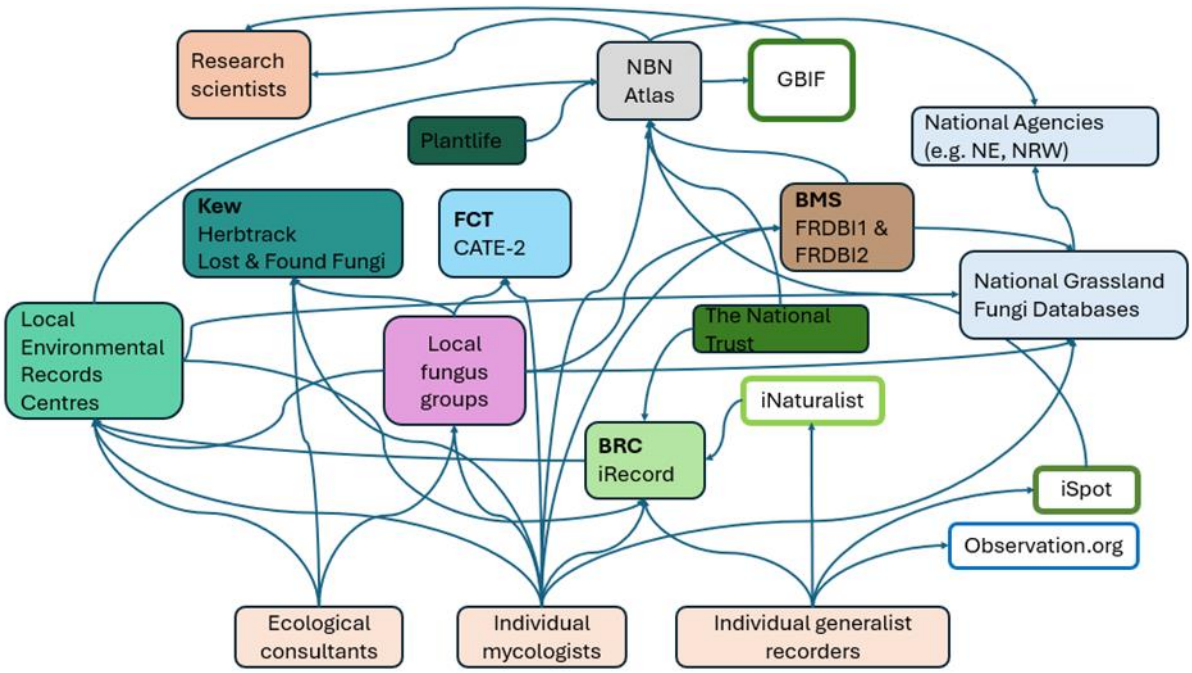
The FCT have since produced a further six Red Lists for fungi between 2015 and 2020, covering a total of 55 families (Jordan *et al*., 2016, Jordan *et al*., 2017 a & b, Jordan *et al*., 2018, Jordan *et al*., 2019, Jordan *et al*., 2020). Of these, only the first four are findable on-line and none of these have been approved as a formal assessment by JNCC. FCT refused proposals made by JNCC including the requirement to use data from CATE2 alongside that from other databases (FCT suggest that other data sources may not have had such a rigorous curation process as CATE2 (see Bailey *et al*., 2015)), and the requirement to make data fully open for peer review (Jordan et al., 2016).

The government's ambition to understand and reduce extinction risk through conservation status assessments is dependent on data. Recognition and alignment with FAIR standards will be a major step towards the development of new Red Lists.

2 UK fungus records

Here we discuss some of the key sources of fungus records in the UK, the data quality checks that the different sources apply (i.e., validation and verification), their coverage, and the likelihood of duplication. We know that there are many ways in which UK fungus records or occurrence data are shared (Figure 1), and that not all sources make their data public, making it difficult to assess the relative abundance of data via these different routes, or likely degree of duplication in data repositories. For the purposes of this report we have access to records available to download from the NBN Atlas, and from within the Indicia system. BMS provided access to records held in the FRDBI. We did not have access to the records held in the FCT's CATE2 database, although we have made reference to the information that is made public by CATE2 via their website.

Figure 1. Theoretical visualisation of potential routes of data flow (blue lines) for UK fungus record. Originators of records located at the bottom. Note that no attempt has been made to illustrate the relative quantity of data shared by these different routes and additional routes between nodes may not be represented.



2.1 BMS: Fungal Records Database of Britain and Ireland

The British Mycological Society (BMS) is a registered charity, with a board of Trustees, focusing on biology research, conservation, and education. The biological recording side of the BMS is volunteer led, overseen by the Field Mycology & Conservation Committee. The BMS offers insurance to local groups, and lists them on its website, and engages local

groups with events such as online meetings to exchange knowledge and share updates, and a bi-annual Group Leaders' Meeting. The Society have produced a Strategic plan 2022-2025 (BMS, 2024), which includes around recording and conservation the key activity to "*Review and develop tools, systems and networks supporting fungus recording in Britain and Ireland*", and their 2015 Conservation Policy (BMS, 2015) also includes a commitment to "*encourage taxonomic, environmental and ecological research that will provide the scientific evidence needed to support work on Red-Listing and fungal conservation in general*". There is a BMS Recording Network Guidance Notes Document on Collecting and Recording Fungi available online (BMS, 2006), though this refers to the now superseded BMS Fungal Records Database.

The BMS now maintain an online biological recording database called the Fungal Records Database of Britain and Ireland (FRDBI). It allows for the input of individual records and has a facility for bulk uploading of records, although this does require careful matching of fields and is as a result often carried out by the database manager (Stuart Skeates, pers. comm). Now in its second iteration, the current FRDBI is built on the Indicia toolkit. Indicia is a free and open-source solution for developing online biological recording, providing a set of services, tools and examples that can be added to many websites to provide online recording functionality, via a comprehensive set of highly configurable components. It is the system that underlies the iRecord website and apps and is managed by the UKCEH Biological Records Centre.

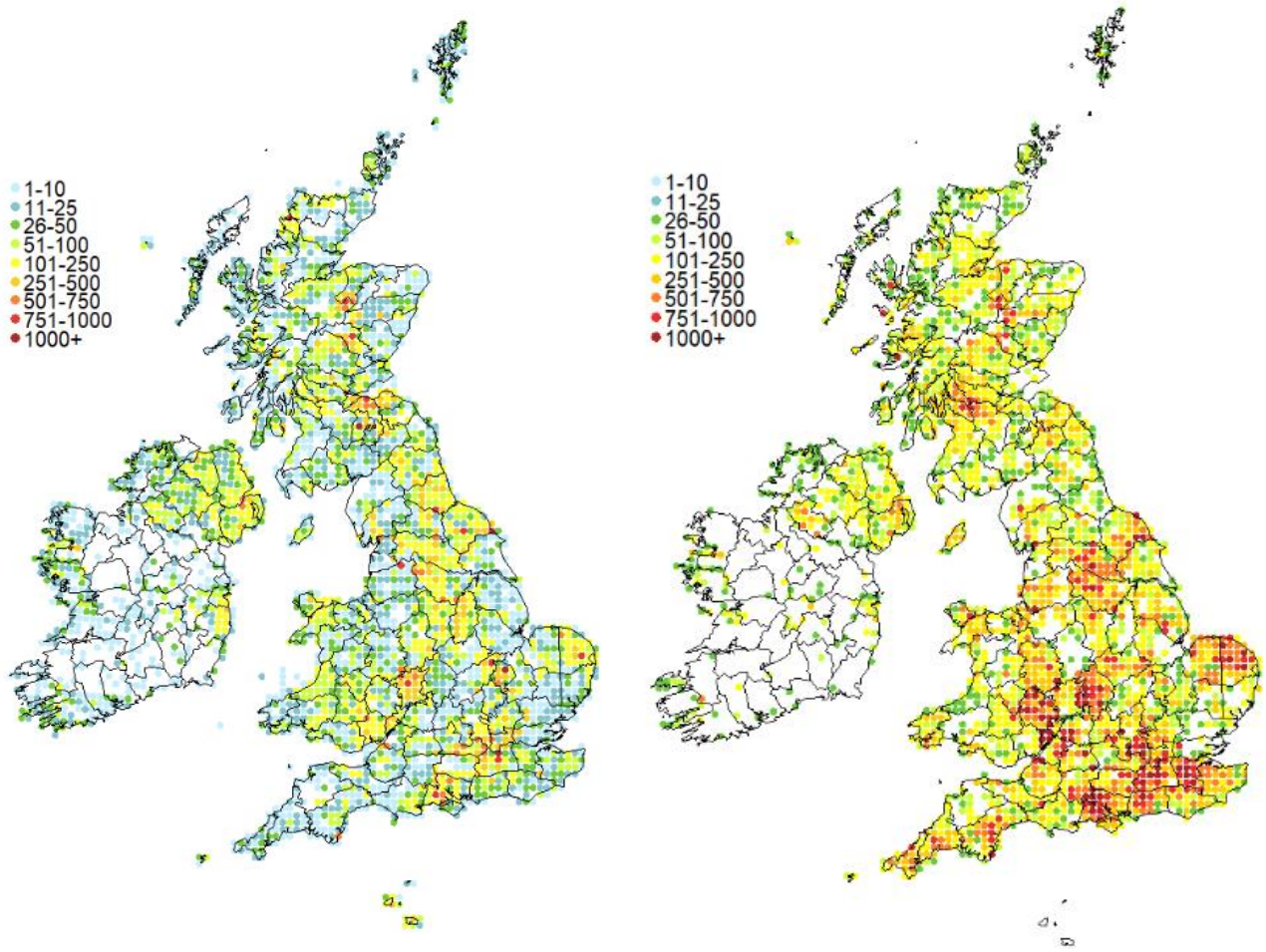
The current FRDBI database does not yet contain all the records previously collected on the original FRDBI database, though data transfer from the older system is under way, with much of the preparation complete (Stuart Skeates, pers. comm). A spreadsheet containing those records from the original FRDBI database not yet incorporated to the current FRDBI database were shared by the BMS for this work. For the purposes of clarity, we will henceforth refer to this dataset as the FRDBI1, and the current online database as the FRDBI2.

This process of combining the two databases has included dealing with incorrect grid references illustrated by records apparently in the sea and mapping many older fields to the more restricted data choices in FRDBI2. The FRDBI1 contains 598,956 records, dated from 1669-2009. Of these 414,252 are non-lichenicolous fungi, the distribution of which is illustrated in Figure 2a which shows the number taxa recorded per hectad. The FRDBI2 contains 1,740,981 fungus records (accessed 1.1.2024), with over 1,000,000 additional non-fungus records with fungal associations (Figure 2b). Of these, 1,694,373 are categorised as 'FRDBI Advanced fungal record' with additional information on for example, habitat or associated species, and 46,608 are categorised as 'FRDBI Simple fungal record' without the extra information. Maps showing the number of fungus taxa recorded per 10km square, giving a proxy for recorder effort, show that the FRDBI coverage is spread across the UK, but that there are some areas with a higher proportion of 10km squares with 500-1000 or more taxa recorded and other areas with a less than 100 taxa recorded per 10km square. Vice-counties that by this measure appear particularly well represented in the FRDBI include South Hampshire, West Sussex, West Kent, Surrey,

East Norfolk, Warwickshire and parts of West Cornwall, South Devon, South-west Yorkshire and Mid-west Yorkshire (Figure 2).

Figure 2. Map of the UK, Ireland, Channel Islands, and Isle of Man showing the number of non-lichenised fungus taxa per hectad represented by records in a) the FRDBI1 database and b) the FRDBI2 database

a) FRDBI1 **b) FRDBI2**



Validation and verification of data in the FRDBI

The FRDBI is primarily used by fungi recording groups with expertise in fungus identification, where more than one person will have looked at the record. Records have largely been submitted on behalf of groups, by local experts, but more recently the online FRDBI is also being used by individual recorders (Stuart Skeates, pers. comm). In the former case records could be deemed ‘verified at source’, although there is no specific record of this in the database to distinguish from those less experienced recorders that may submit records directly to the FRDBI. Optionally, records can be marked as ‘Certain’ or ‘Uncertain’, with the field described as ‘Certainty that the identification is correct as attributed by the recorder’. The verification system provided by Indicia (as used in iRecord,

see below) is not currently incorporated within the FRDBI, although BMS are currently considering a proposal by the database manager to implement the Indicia verification tools in the FRDBI. The dataset shared by the BMS to the NBN Atlas (see below) states that "0% records have verified identifications".

Of the FRDBI1 non-lichenicolous fungus records 123,904 (21%) have a neither a named collector (recorder) or identifier, though almost all do have a code for the attribute 'Origin of record', and all records have a value for the attribute 'Certainty' of 'Certain' or 'Likely'. There is a large degree of variability in the spatial information for records, reflecting the fact that this is a historic database with 52% of the records (311,792) dated before the year 2000. There are 41,616 records with either no grid reference or only the 100km square given, and although 6348 of these have a location name, this may be as broad as 'South England'.

Data sharing from the FRDBI

The FRDBI2 terms and conditions state that the Society may "*make use of the records in any way fit for its purposes including the supply to outside agencies or other third parties, some of which may make the data public*" though the option is given for users to state that they do not wish their records to be shared with other websites, meaning that the FRDBI data is not completely open. Until recently all records had a CC BY-NC-SA licence, the non-commercial aspect of which can limit the use of records, for example by LERCs or country agencies publishing data derived products under Open Government Licences. Now, users can assign a creative commons licence to their records (as well as, separately, their photos), and currently approximately 8% of records have an open licence (OGL, CC0, CC BY), 2% have a restricted licence (CC BY-NC), and 89% have no licence set (March 2024). While the BMS aims to respect individual licences where possible, the terms of the FRDBI mean they are able to share data for specific tasks that meet the aims of the Society, providing personal information attached to records is not published.

The BMS have shared 1,084,244 records from 2006 and earlier with the NBN Atlas, from both the FRDBI 1 & 2. The BMS do intend to share more data with the NBN Atlas but time to do so is a constraining factor, along with licensing constraints and the lack of formal verification.

2.2 FCT: CATE2

The Fungus Conservation Trust (FCT, formerly Association of British Fungus Groups) is a volunteer-run charity that exists to advance the protection of the fungi, aiming to support mycological enthusiasts and promote fungi conservation.

FCT use an online database system known as CATE2, the taxonomic system for which is not explicitly stated (it does not use the UKSI). The database contains 1,634,529 species records of fungi (at 1 January 2024) extending back to 1945. Summary data is accessible openly via the CATE2 web interface. The web interface includes searchable tables with species totals or individual records with limited associated information (including date,

associated organism, medium, abundance, ecosystem and vice county), and similarly searchable maps showing the 10km distribution with an indication of the number of records per 10km. Details that are deemed sensitive and thus excluded from public access include altitude, collector, determiner, grid reference, group, notes, place, placename and recorder.

Validation and verification of data in CATE2

The CATE2 website states that records are only added to the CATE2 database if the recorders are known to the database manager to have lengthy field experience and employing the use of microscopic and chemical analyses as and when necessary for determination.

Data sharing from CATE2

The FCT state on their website that they don't subscribe to 'Creative Commons' licensing because it runs contrary to the wider conservation interest (FCT, 2024). This means that CATE2 data is not made publicly available (except in summary form at the 10km scale on maps, and vice-county scale in tables), and those who are given full registered access to the database are requested to sign a Standard Disclosure Agreement. Data from CATE2 is not shared with the NBN Atlas.

The FCT have expressed concern that a more open data policy "would render all data for all records of rare, vulnerable, endangered species available at maximum resolution to the public, including the now extensive and potentially damaging fungus foraging interest in Britain" (Jordan and others, 2016).

The CATE2 database was provided for a pilot Red Listing exercise of the Boletaceae family carried out by JNCC (Ainsworth *et al*., 2013), where it was used alongside records from the FRDBI database, but we understand that the FCT have since ceased to allow the use of their data in circumstances where it would be combined with data from other sources, as this could lead to analysis being based on a mix of records not all of which have been checked to the same extent.

2.3 National Biodiversity Network (NBN) Atlas

The NBN Atlas is UK's largest publicly accessible collation of biodiversity data. It is an online tool combining multiple sources of biological records across all taxonomic groups, in a single location, with the aim of making these data accessible for use in research, facilitating understanding, and learning about the UK's wildlife.

A wide range of data providers share biological records of fungi via the NBN Atlas. Data filtered to the Fungi kingdom was downloaded from the NBN Atlas on 07 November 2023 and included 1,609,812 records of non-lichenicolous fungi (NBN, 2023). Those data partners who have shared over 1000 records to the NBN within this category are shown in Table 2, and Figure 3 illustrates the distribution of these records (excluding those from the

FRDBI), taking the number of taxa as a proxy for coverage. This includes records shared from some of the sources listed above, but not always the full dataset (e.g., FRDBI2). Although the Biological Records Centre is not the data partner for any dataset on the NBN focused on fungi, data are sent directly by BRC from iRecord on behalf of NatureSpot, CEDaR, Natural England and the Wildlife Trusts (for some datasets), and the full list of data partners for all records of taxa in the Fungi Kingdom is available on the NBN Atlas website.

On the NBN Atlas there are a total 4,205,774 records for taxa within the kingdom Fungi. These include 1,561,948 records of non-lichenicolous fungi (under the taxonomic authority of the BMS within the UKSI), which were shared by 70 data partners shared records of non-lichenicolous fungi, of which 39 data partners shared >1000 records and 27 data partners shared >5000 records (Table 1. Just over 60% of these records (980,767) are from the BMS, with the remainder (581,038 records) from other data partners. Of those records from other data partners, over 70% (425,020) have an identification verification status of 'Accepted', 'Accepted – considered correct' or 'Accepted – correct'. This can be compared with the status 'Unverified' for the BMS data, even though most of this data is likely to be reliable having come from local and national experts. It is not clear on what basis these records have been given this verification status.

Validation and verification of data shared with the NBN Atlas

The verification status terms using on the NBN Atlas are based on the iRecord verification terms (see Table 1). There are 425,020 records of non-lichenicolous fungi on the NBN Atlas with an identification verification level 1 status of 'Accepted', all of which are from data partners other than the BMS. Most of the suppliers of "accepted" records are LERCs, who in many cases will have worked with a local fungus group or other county recorder to check the records. However, it is not known whether the verification applied at local level would be considered appropriate by, or be consistent with, the national recording schemes.

Data sharing from the NBN Atlas

The NBN is the UK node for the Global Biodiversity Information Facility (GBIF). GBIF is "an international network and data infrastructure funded by the world's governments and aimed at providing anyone, anywhere, open access to data about all types of life on Earth" (GBIF, 2024). With the permission of the individual data partners, NBN Atlas datasets are shared with GBIF, and this appears to be the case for the majority, though not necessarily all, fungus datasets. The Natural Capital and Ecosystem Assessment (NCEA)-funded NBN Atlas Accelerator Project (2023-2025), includes a focus on improving data mobilisation with likely changes to include the introduction of 'access controls' which could increase the amount of data shared with the NBN Atlas.

Figure 3. Map of the UK, Ireland, Channel Islands, and Isle of Man showing the number of non-lichenicolous fungus taxa per hectad represented by records shared with the NBN Atlas from all partners including those shown in Table 2, other than the British Mycological Society, and including a) records with any verification status and b) records with a verification level 1 status of 'Accepted'.

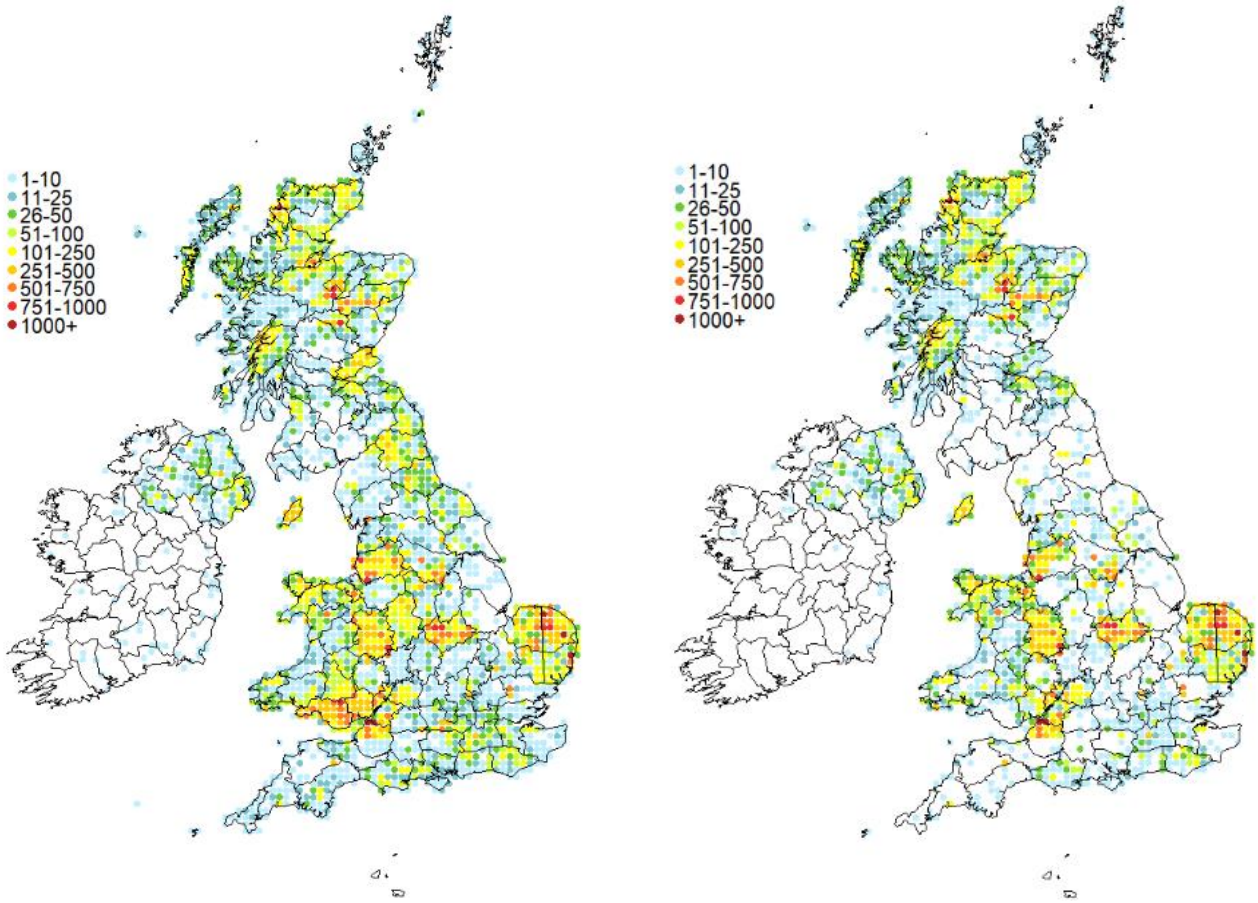


Table 2. Number of records of non-lichenicolous fungi shared with the NBN Atlas by data provider (where >1000 records), and number with the identification verification level 1 status of 'Accepted' (at 7 November 2023).

Data provider	Accepted	Unconfirmed	Total
British Mycological Society	0	980767	980767
Norfolk Biodiversity Information Service	65000	0	65000
South East Wales Biodiversity Records Centre	3413	52723	56136
Leicestershire and Rutland Environmental Records Centre	56051	42	56093

Data provider	Accepted	Unconfirmed	Total
North East Scotland Biological Records Centre	48848	0	48848
Bristol Regional Environmental Records Centre	39428	0	39428
Highland Biological Recording Group	35399	0	35399
Shropshire Ecological Data Network	23663	0	23663
National Trust	22847	0	22847
Cofnod North Wales Environmental Information Service	19343	726	20069
Environmental Records Information Centre North East	0	19487	19487
Greater Manchester Ecology Unit	0	19237	19237
Merseyside BioBank	13323	4714	18037
Royal Botanic Garden Edinburgh	12092	0	12092
Manx Biological Recording Partnership	7652	4408	12060
iSpot	0	11720	11720
Suffolk Biodiversity Information Service	10714	0	10714
Argyll Biological Records Centre	10479	0	10479
NatureSpot	9715	0	9715
Fife Nature Records Centre	411	9301	9712
Rotherham Biological Records Centre	8403	0	8403
Individual recorder [name hidden]	26	7742	7768
BIS for Powys & Brecon Beacons National Park	1633	5980	7613
Gloucestershire Centre for Environmental Records	6419	0	6419
Staffordshire Ecological Record	0	6415	6415

Data provider	Accepted	Unconfirmed	Total
Lancashire Environment Record Network	5915	0	5915
Centre for Environmental Data and Recording	5375	379	5754
Yorkshire Wildlife Trust	3914	0	3914
Outer Hebrides Biological Recording	3862	0	3862
North West Fungus Group	0	2728	2728
The Wildlife Information Centre	2406	303	2709
West Wales Biodiversity Information Centre	1785	879	2664
Natural England	1687	670	2357
Sheffield and Rotherham Wildlife Trust	121	2089	2210
Welsh Government	0	2158	2158
Scottish Wildlife Trust	415	1741	2156
National Trust for Scotland	403	1717	2120
Natural Resources Wales	1292	0	1292
Royal Horticultural Society	1093	0	1093

2.4 Local Fungus Recording Groups

Local fungus groups actively collect data on fungal diversity and distribution in their respective regions. Typically, they conduct regular forays, surveys, and monitoring activities to document fungal species. Many local fungus groups organise training workshops, seminars, and educational events to raise awareness about fungi and their ecological importance.

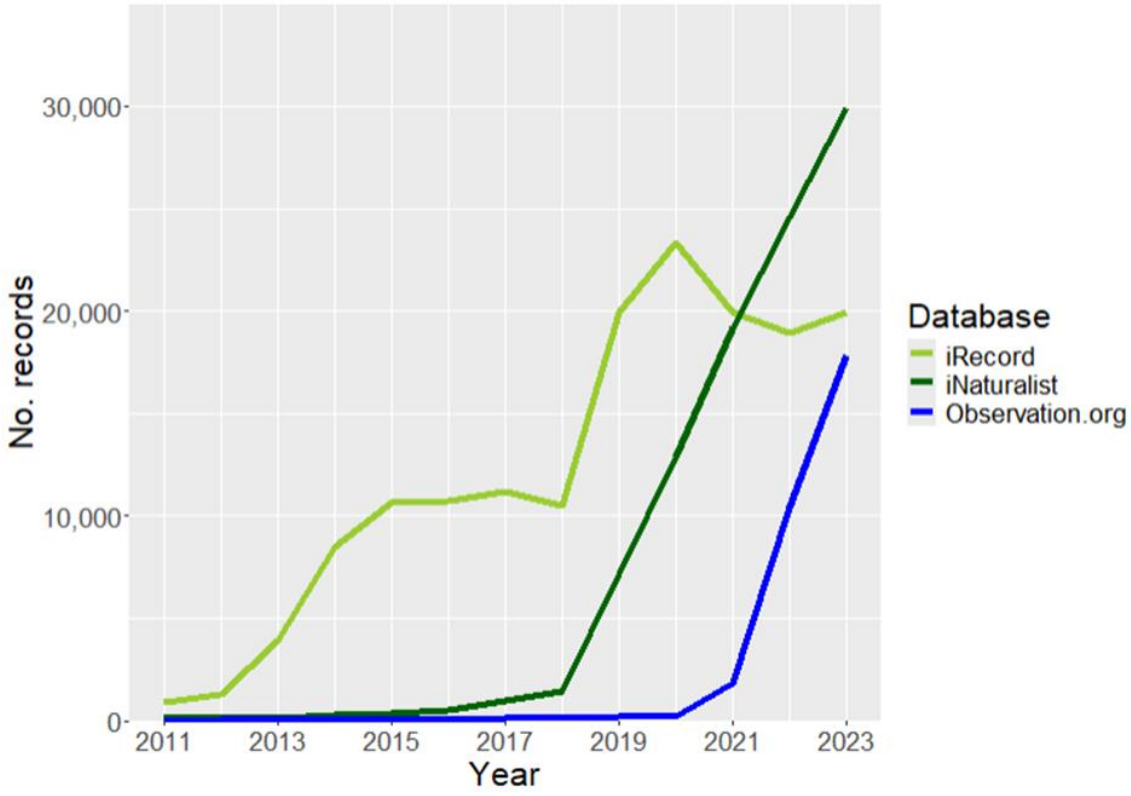
We found reference online to 52 fungi groups in the UK (Appendix 1), the area covered by each being a town or city (4), a county or equivalent area (24), a few counties or equivalent region (11) or a country (1). Many local fungi groups are affiliated with the British Mycological Society (BMS) and listed on their website (44). The Fungus Conservation Trust (FCT) website does not list local groups, instead suggesting people contact them directly for information, but many groups individually state that they support

the aims of or have an affiliation with the Fungus Conservation Trust. It is not certain whether an affiliation with, or being listed on the site of, one of these schemes, necessarily relates to the local groups sending their data to one or both respective scheme databases (i.e., the BMS's FRDBI or the FCT's CATE2). The Scottish Fungi website also provides shared resources for Scotland's fungus recording groups. Local fungus groups may also send their records to Local Environmental Records Centres, many of whom in turn share their data with the NBN Atlas.

2.5 Local Environmental Records Centres

There are 66 Local Environmental records Centres (LERCs) listed on the Association of Local Environmental Records Centres (ALERC) website, of which 62 are in the UK. This includes 44 in England, 13 in Scotland, four in Wales, and one in Northern Ireland. Many LERCs work closely with the relevant local fungus recording group, and in these cases the data held by LERCs is likely to overlap with data held elsewhere. Many, but not all, LERCs share their data via the NBN Atlas.

Figure 4. Number of UK fungus records submitted per year to three prominent multi-taxa online recording websites; iRecord, iNaturalist and Observation.org.



2.6 Online recording platforms

The use of online platforms for biological recording has grown over the last decade or two, including the online elements of the databases used by BMS and FCT. Four additional online platforms that cover multiple taxon groups, and contain substantial amounts of fungus data, are summarised below. The recent sharp rise in use for recording fungi is illustrated for three of these in Figure 24, which shows a six-fold increase in the combined annual record or observation number between 2017 and 2023, to almost 70,000.

iRecord

iRecord is an online biological recording website, and associated apps, maintained by the Biological Records Centre at the UK Centre for Ecology and Hydrology (UKCEH). The goal of iRecord is to help bring together wildlife sightings from many sources, so that they can be checked by experts and made available to support research and decision-making. iRecord has been developed with Indicia, the open-source toolkit for building websites for biological recording on which the FRDBI is also built. iRecord data, and data from many other Indicia implementations (including the FRDBI), is held within an the BRC data warehouse hosted at UKCEH on behalf of the recording community. In most cases records available on iRecord use the UK Species Inventory as the dictionary of taxon names.

There are 277,420 fungus records shared with iRecord for verification, the majority of which (275,675) are non-lichenicolous fungi (Tables 3 and 4). Just over half of these fungus records were entered to the iRecord website (or app), and most other key sources are LERC websites sharing their data with iRecord for verification (Table 3).

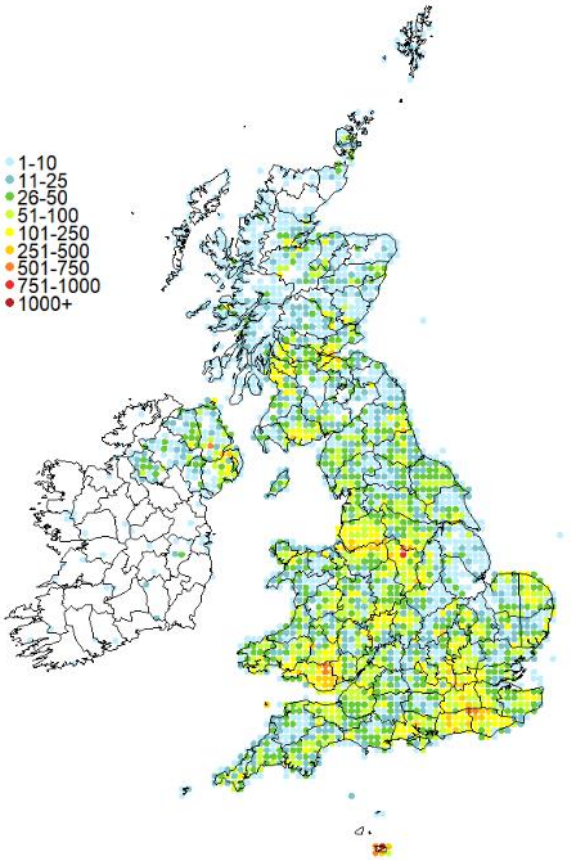
Figure 5a shows the number of fungus taxa recorded per 10km square shared with iRecord, giving a proxy for recorder effort. We can see that iRecord is being used to record fungi to some degree across all UK vice-counties (Figure 5), although the overall coverage is of course considerably lower than the FRDBI by the same measure (Figure 2), with over 50% of 10km squares containing less than 100 fungi taxa, and very few with over 250 fungus taxa recorded.

Table 3. Number of fungus records shared with iRecord, and their verification status, by source website (where >500 records)

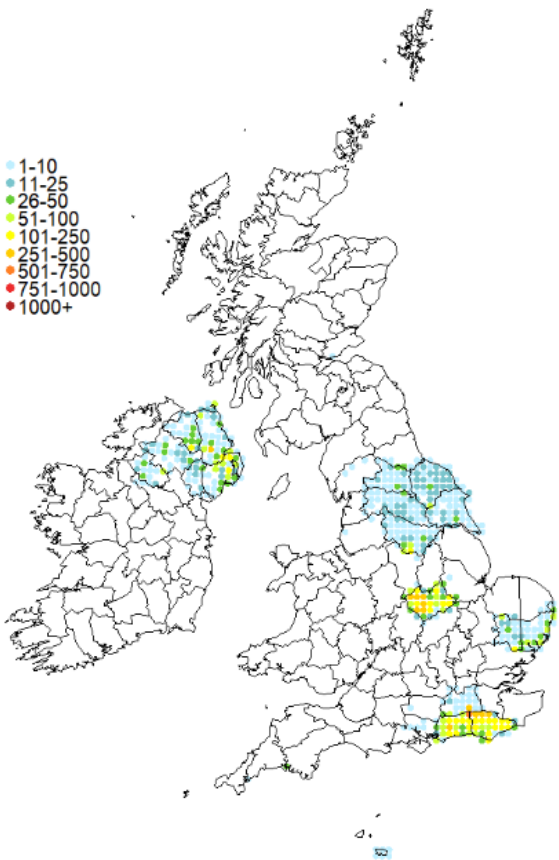
Website	Total	Accepted	Rejected	Unreviewed	% verified
iRecord	128030	15116	526	112380	12
iNaturalist	88360	1603	65	86692	2
SEWBReCord	14903	0	2	14901	0
NatureSpot	14736	13208	890	638	96
JBC Jersey	7623	75	0	7548	1
CEDaR Recording	7233	4481	85	2651	63
Wild Sheffield	2407	139	29	2239	7
WWBIC	1208	0	0	1208	0
NBRC	579	0	0	579	0
B.I.S.	507	0	0	507	0

Figure 5. Map of the UK, Ireland, Channel Islands, and Isle of Man showing the number of non-lichenicolous fungus taxa per hectad represented by records shared with iRecord for verification for a) records with any verification status and b) records which have been 'accepted' by a verifier.

a) all records



b) accepted records



Validation and verification of fungus data in iRecord

There are currently very few verifiers for fungi on iRecord, and those that are present and active are generally associated with such regional organisations that have their own Indicia recording websites linked to iRecord, primarily the Centre for Environmental Data and Recording (CEDaR; Northern Ireland) and Naturespot (Leicestershire and Rutland; Table 3). The difficulty of verifying records for fungi online and often from unknown recorders, which has been widely noted, may explain this, though there have been a few people expressing an interest in the role recently. The BMS, amongst others, have highlighted the challenges in verifying fungus records in this way, and that a wider discussion on the matter would be valuable (Stuart Skeates, personal communication). There is scope for recruiting and supporting additional verifiers, perhaps dividing things up by local area and/or particular taxa within the fungi and taking a team approach to dealing

with the backlog of records as well as providing feedback to recorders as new records are contributed.

Records added to iRecord come from a wide range of recorders, from novices entering their first biological records to experienced recorders who may be using iRecord as their main database. It is possible that there are fungi recorders on iRecord who are known experts, and as such whose records could be accepted as verified, which is an approach essentially taken by many other schemes whereby verifiers can choose to 'accept' records in bulk from known expert recorders.

Data sharing from iRecord

All records added to iRecord are immediately available for browsing on the Explore pages of the website. Local environmental records centres (LERCs) have instant access to records, to ensure that they are not overlooked in the local planning process while they are waiting for verification. Access to unverified records can help ensure that important species and habitats are not harmed due to lack of awareness of their presence.

The majority of records from iRecord are shared with the NBN Atlas, and this is done on a regular basis on behalf of many different NRSSs. Although some fungus records are being verified, the lack of recording scheme oversight means that these records are not being shared with the NBN Atlas in their entirety, although some are being shared by external partners such as LERCs with their own Indicia websites that may have chosen to verify and/or share their records via a different route (e.g. Naturespot).

iNaturalist

iNaturalist is a global online system for collecting wildlife observations. Records can be entered via an app or the website, and automatic image recognition is available to aid with species identification. Use of iNaturalist in the UK has been rapidly growing in recent years, with annual number of observations increasing 13-fold between 2018 and 2022. There are 424,045 records of fungi (including lichenicolous fungi) in the UK on iNaturalist (iNaturalist Community, 2023), although the figure for those records at a resolution and certainty that may be useful for research purposes may be significantly lower. Approximately 65% of these observations were at species resolution or higher, and 145,914 records of 2,073 species had reached research grade. These were made by 18,006 different observers (recorders), with 4,828 people contributing to their identification.

The current growth in number of records being added to iNaturalist (Figure 4) is likely to reflect at least two factors: the UK iNaturalist portal has been strongly promoted by NBN and others, especially for novice recorders; the crowd-sourcing approach used by iNaturalist means that recorders are more likely to get at least some element of prompt feedback, whereas on iRecord this is dependent on having verifiers available.

Validation and verification of iNaturalist data

iNaturalist uses a crowd-sourcing approach to provide help with species identification, and anyone in the iNaturalist community can corroborate or disagree with observations. When more than 2/3 of the IDs agree, the record is classed as ‘research grade’. There have been some criticisms of this approach because the minimum requirement is for two people to agree on the identification, with no consideration of their taxonomic expertise, meaning that ‘research grade’ is a low barrier to clear.

Data sharing from iNaturalist

iNaturalist subscribes to Creative Commons licensing for observations, and for media (photos/sound), the default for all of which is CC BY-NC, meaning that observations can be shared for non-commercial use, if attribution is given to the creator. Records are shared with the Global Biodiversity Information Facility (GBIF) through weekly automatic exports of Research Grade observations that meet licensing requirements. By the end of 2023, 118,831 records of all fungi in the UK had been shared from iNaturalist to GBIF.

In April 2021 a UK portal for iNaturalist was launched and following this, records from iNaturalist that meet licensing requirements, have a "research grade" identification and are able to be matched to the UKSI, are regularly imported to iRecord for the purposes of sharing with and verification by national recording schemes and societies. By the end of 2023, 95,959 UK fungi records (in the UKSI informal group fungus) had been shared from iNaturalist to iRecord and made available there for verification, which are included in 2 and 3. Of these, approximately 2% had been verified, with 1603 (1.7%) accepted, and 48 (0.05%) not accepted, reflecting the low number of iRecord fungi verifiers mentioned above.
By April 2024 a total of 154,537 fungus records (including lichenicolous fungi) on iNaturalist had not yet been imported to iRecord, with the main reasons being records not yet reaching research grade on iNaturalist or the recorder having not assigned a record licence that allows sharing (

Table 4). There were also almost 7,000 records, relating to 447 taxa, not yet shared because of differences in the taxonomy of the UKSI and that used by iNaturalist, and another 10,557 records for which the reason had not yet been identified.

The non-lichenised fungus records shared with iRecord (excluding from iNaturalist) represent 4590 taxa. The 100 most recorded taxa account for 46% of these records, and the 200 most recorded taxa account for 62% of these records. In comparison, the non-lichenised fungus records shared with iRecord from iNaturalist represent 1685 taxa. The 100 most recorded taxa account for 75% of these records, and the 200 most recorded taxa account for 87% of these records.

Table 4. Number of iNaturalist fungi records and conditions not met for import to iRecord (at 17 April 2024)

Reason for iRecord import failing	No. records	% of non-imported records
Not research grade	126,664	81.97
Not allocated a record licence that allows sharing	40,529	26.23
Other	10,357	6.7
Not matched to the UKSI	6,977	4.52

Observation.org

Based in The Netherlands, Observation.org is the largest biological recording platform there, and aims “To share observational data about global biodiversity, past and present, as a source of knowledge for the future. Facilitate observers around the world through a multilingual global observation system with a species registry for all known species and species groups in nature, flora and fauna, and share a data collection of validated field data through that system with anyone anywhere in the world”. Observation.org collaborates with organisations across The Netherlands, Belgium, Germany, Spain, Austria, and Luxembourg, as well as sharing records on a 5x5km scale with GBIF. A total of 31,160 records of fungi in the UK for 787 different taxa have been submitted to Observation.org (at 2 February 2024).

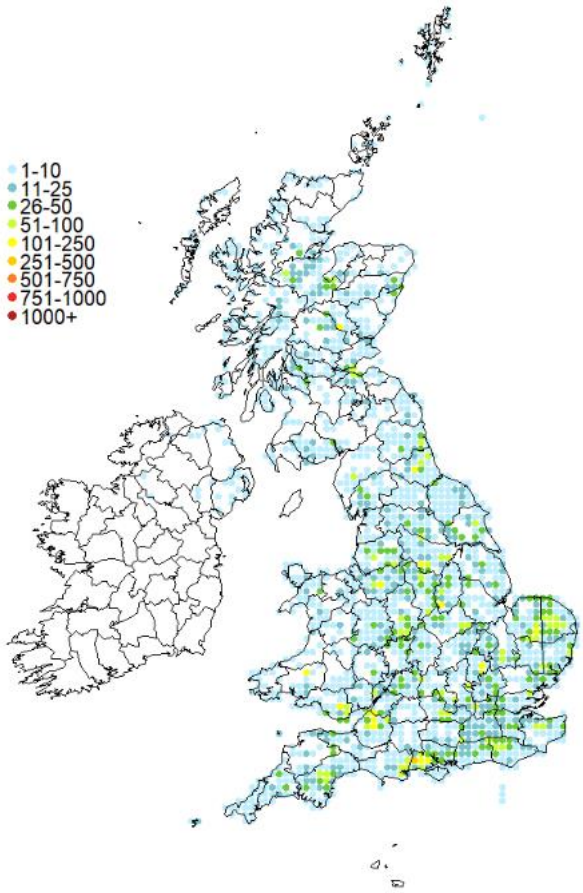
The number of UK fungi records submitted to Observation.org is rising fast (Figure 4), with the number of observers (recorders) almost doubling in 2023. Almost 80% of the 1,876 recorders have submitted less than 10 fungi records, with only 2% submitting over 100 records. Four observers have submitted more than 500 UK fungi records to Observation.org.

Validation and verification of Observation.org data

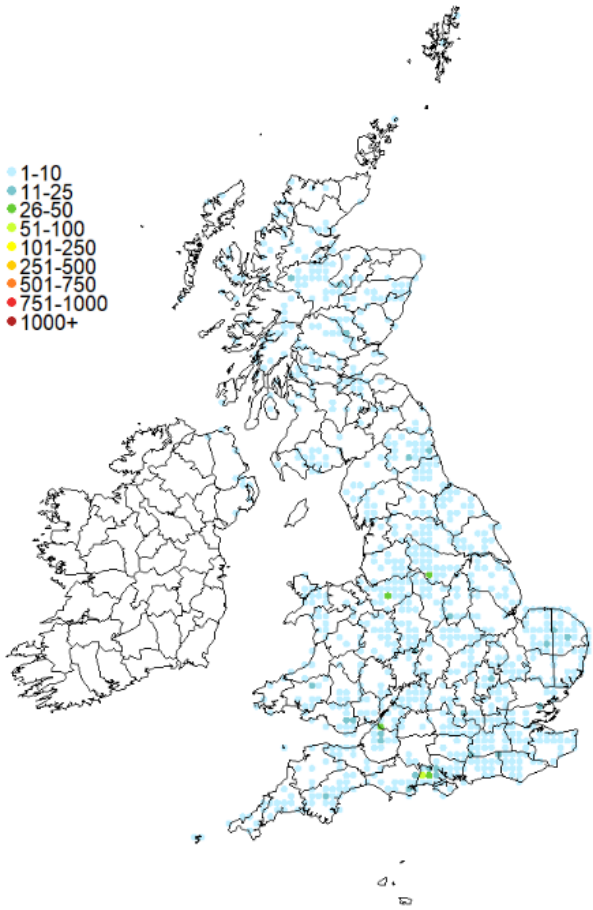
Observation.org have a system of validation whereby records are either automatically approved based on other approved observations in the vicinity (and image recognition if applicable) or checked and corrected by taxonomic experts, some of which are professional and work at institutions like museums and universities, while others have become an expert in their spare time. Validators are not necessarily based in the UK and all validate as volunteers. Table 5 shows the different validation statuses and the basis on which they are assigned. Like Indicia and iRecord, the system has a facility for communicating with recorders, either by adding a comment to a record, or by email. Approximately 11% of records of fungi on Observation.org (3506) have been accepted by verifiers, and less than 100 records have been rejected (Table 5). Of those remaining with unknown verification status, 63% have been reported as ‘certain’ by the observer.

Figure 6. Map of the UK, Ireland, Channel Islands, and Isle of Man showing the number of fungus taxa per hectad represented by (a) all records shared with Observation.org and (b) those with an 'Accepted' status (Code = J, P or A).

a) all records



b) accepted records



Data sharing from Observation.org

Observation.org states that open data is an important starting point, making data and content available for non-commercial use by private individuals, and for other uses, subject to explicit permission of the recorder. Registered users can change the conditions for sharing their data in the user settings, with the default setting for new users being to "share with trusted projects and partners", with photos and sounds subject by default to a CC BY-NC-ND licence. Validated records are regularly shared with GBIF.

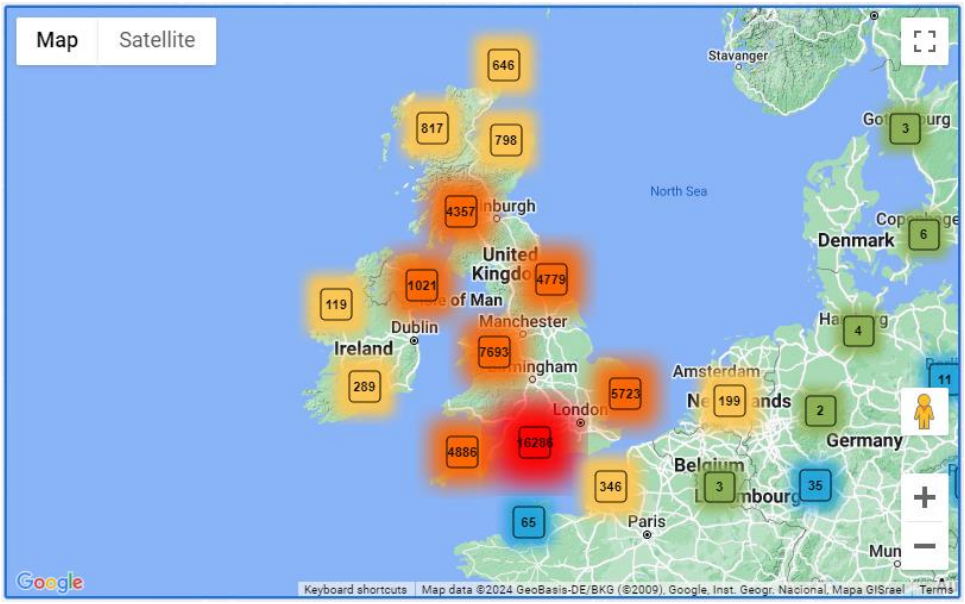
Table 5. Summary of the validation status of UK fungi records on Observation.org

Code	Status	Status description	No. records
O	Unknown (not yet validated)	Observation has not yet been validated	27,509
J	Accepted (with evidence)	Observation is convincingly documented with image or sound, or has been approved by an appointed rarities committee	3,506
N	Rejected	Observation does not meet criteria for validation, has been rejected by an appointed rarities committee, or documentation shows different species. In lists only visible for the validator and observer.	89
I	Pending	Pending validation. In lists only visible for the validator and observer.	21
U	Cannot be validated (yet)	Observation cannot be validated (yet) because of insufficient documentation because validators could not agree, because observer has expressed uncertainty, or because a rarities committee has yet to reach a decision.	15
P	Accepted (by admin)	Observation is accepted based on expert's knowledge (distribution, experience, previous observations) or other available information, but without documentation with image or sound.	11
A	Accepted (automatic validation)	Accepted by automated rules based on validated observations, or my image recognition.	8

iSpot

iSpot is a citizen science project run by The Open University. The iSpot website facilitates community support for the identification of wildlife observations, encouraging recording and collaboration around learning and improving identification skills for all taxa. There have been over 47,000 UK records of lichen and fungi assigned as 'with likely ID' submitted to iSpot (7). Whilst iSpot uses the UKSI taxonomy, it may not always be quite up to date (pers. comm. Mike Dodd, iSpot curator).

Figure 7. Map summarising number of fungus and lichen records submitted to iSpot 'with likely ID' (retrieved from https://www.ispotnature.org/ 23.04.24).



Validation and verification of iSpot data

iSpot aims to keep account of people's expertise, by means of a 'reputation system' of increasing scores each time a contributor's identification (either to their own or other people's observation) is agreed with. Those records shared with the NBN Atlas are described there as unverified.

Data sharing from iSpot

The iSpot Terms of use (iSpot, 2019) state that details of observations and identifications (but not photos) may be shared with others to help to research and conserve wildlife, which may include national recording schemes, LERCs and GBIF. There are 11,720 fungus records shared to the NBN Atlas from iSpot, with the last data exchange on 3 November 2023, and future uploads of data to the Atlas are intended. Anyone can request data direct from iSpot, but manual processing by the curator is required.

2.7 Other fungi data sources

England Grassland Fungi Database

The England Grassland Fungi Database (EGFD) is a site-level, GIS-compatible database that can be used to assess the status and location of grassland fungi sites. It has been developed by David Mitchel and Natural England with the aim of becoming a publicly accessible tool to aid decisions around land use and to safeguard these important sites (Cooch *et al.*, 2022). Similar, compatible databases have been created for statutory nature organisations in Ireland, Northern Ireland, Scotland and Wales (see The Grassland Mapping Fungi Database; Naturescot, 2024).

A large proportion of the 60,000 records initially added to the EGFD database were sourced from the FRDBI (Cooch and others, 2022), and a further 22,062 records were added in 2023, giving a total of 80,082 records.

Validation and verification of England Grassland Fungi Database data

The data compiled for the EGFD will have been subject to various degrees of verification according to the sources from which it was compiled (e.g., see section 2.1.1. regarding the FRDBI) but further verification and validation was also carried out. Approximately 5% of the 60,000 records initially added were either removed as duplicates (1159 records), confidential records (34 records) or poorly referenced records (2032 records), and data cleaning included populating missing fields, and standardising of grid references and site names (Cooch *et al*., 2022).

The Lost and Found Fungi Project

The Lost and Found Fungi (LAFF) project aimed to investigate which fungi species were under-recorded as opposed to genuinely rare or extinct. The project was funded by the Esmée Fairbairn Foundation, managed by the Royal Botanic Gardens, Kew, and ran for six years from 1st July 2014.

At least four species were re-found after a gap of 50 years during the project (Douglas and Ellingham, 2019). The project also developed some innovative approaches to encouraging the recording of fungi, including a system to indicate which species were most readily recognised from photos.

The LAFF dataset (excluding sensitive species) is linked from the project website, available in a Creative Commons BY-NC-SA 3.0 licence.

Plantlife

Plantlife administered the Fungus Conservation Forum until its dissolution in 2009. They have remained committed to fungus conservation, with fungi alongside plants at the core of their recent strategy (Plantlife, 2023) and have recently recruited a new Senior Conservation Officer for fungi. Plantlife has data currently shared with the NBN up to 2013 from survey work on their reserves, and collation is underway of the last 10 years data for inclusion (personal communication). Plantlife hold data from their citizen science waxcap project though this is based on colour morphology rather than species.

Kew Mycology Collection

The Royal Botanic Gardens (RBG), Kew in their Fungarium hold the largest collection of dried fungi in the world, including over 300,000 British specimens. New accessions are made into the Integrated Collections Management Systems (ICMS), (Herbtrak prior to this). The collection includes a large number of Type specimens. RBG Kew adopts an open data policy, licenced under CC-BY (Royal Botanic Gardens, Kew, 2024).

2.8 Comparisons of data between repositories

Individual databases may differ in their strengths and weaknesses, for example a higher level of scrutiny given to records admitted to a database is admirable but could also mean that it may exclude valid records. Table 6 compares total numbers of UK records for fungi across nine databases, at different taxonomic resolution depending on the ease with which this could be summarised at source; kingdom Fungi, the UKSI informal group fungi (including lichenicolous fungi as well as macro-fungi), and the non-lichenicolous fungi. The number of UK records for taxa within the kingdom Fungi contained in the UK national databases considered here ranges from almost 4 million in the NBN Atlas, to 30,000 in the Netherlands-based Observation.org.

Table 6. The number of UK fungus records held in a range of databases, and the availability of data publicly (dates of data access as shown above).

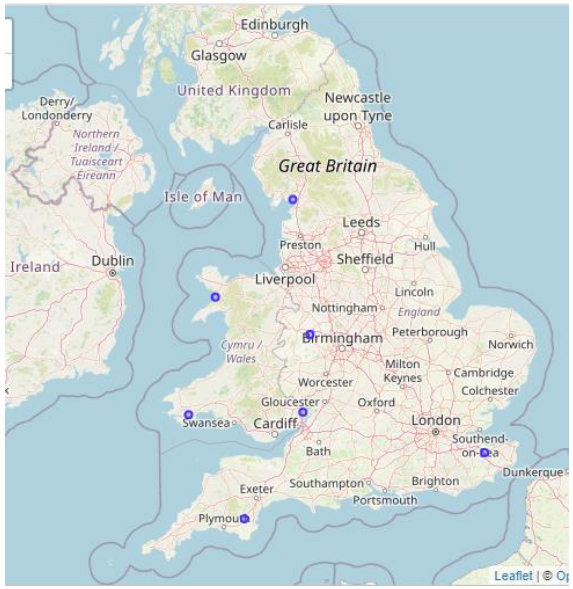
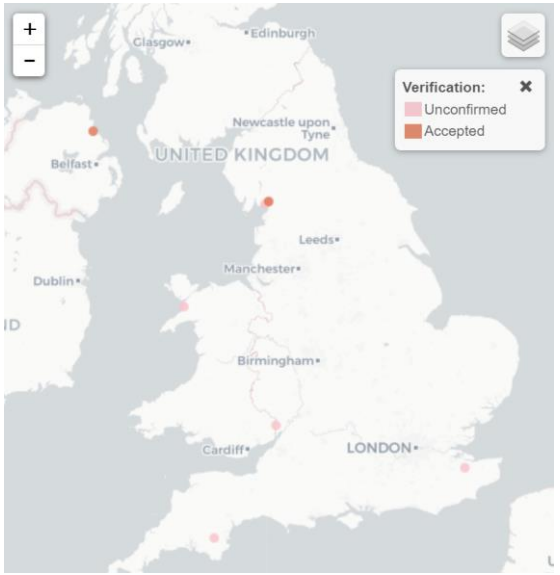
Database	No. records in Kingdom Fungi (percentage described as verified)	No. records in UKSI informal group 'fungus' (percentage described as verified)	Non-lichenicolous fungi (percentage described as verified)	Public availability of data
FRDBI (1 & 2)	2,887,842	2,521,919	2,458,891	CC licensing and much data shared to NBN Atlas, with more planned.
NBN, excluding FRDBI	3,923,493 (68% accepted)	1,884,692 (30% accepted)	1,562,000 (27% accepted)	CC and Open Government licensing.
CATE2	1,641,000* *includes slime moulds	unknown	unknown	Limited resolution publicly available for online viewing. Standard Disclosure Agreement required if data shared for research purposes.
Kew Mycology Collection	380,000	unknown	unknown	Details of much of the collection can be viewed online, and pre-arranged visits and loan requests are possible for research purposes.
iRecord, excluding iNaturalist	226,675 (19% accepted)	193,000 (21% accepted)	175,000 (10% accepted)	Full records (including unverified) available to LERCs. iRecord users can view full records online, and verifiers may download.

Database	No. records in Kingdom Fungi (percentage described as verified)	No. records in UKSI informal group 'fungus' (percentage described as verified)	Non-lichenicolous fungi (percentage described as verified)	Public availability of data
iNaturalist **[of which imported to iRecord]**	424,045 (37% research grade) [129,409 (2% accepted) % accepted]	unknown [106,000 (2% accepted)]	unknown [88,000 (1% accepted)]	CC licensing. Records reaching 'research grade' with appropriate licensing are shared with iRecord regularly.
iSpot	47,000	unknown	unknown	CC licensing and much data shared to NBN Atlas, with more planned.
England Grassland Fungi Database	n/a	80,082 (100% cleaned and checked)	80,082 (100% cleaned and checked)	Ambition for data to be available under Open Government Licence
Observation.org	31,000 (11% validated)	unknown	unknown	CC licensing and validated data regularly shared with GBIF.

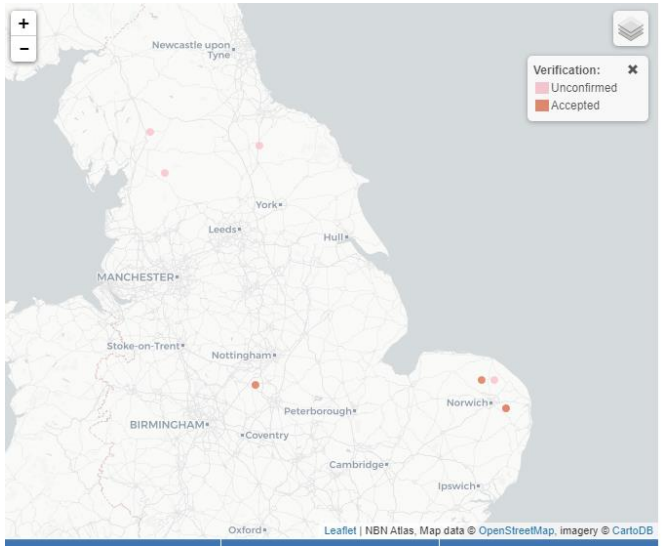
Figure 8) at a coarse scale, with those maps from the NBN Atlas including any FRDBI records shared there. Data from CATE2 was not available for analysis, but based on visual comparisons with maps shown on the CATE2 web interface it appears that the overall distribution mapped by FRDBI and CATE2 is often quite similar, but that iRecord and NBN Atlas generally have considerably fewer records of rarer species. There are examples of records that only appear in one of the available datasets, and even where the mapped distributions look similar there may be differences at a finer scale, and in the detail of the underlying records.

Figure 8. Distribution of records of selected fungus species, as displayed on the websites of a) FRDBI, b) iRecord and c) the NBN Atlas

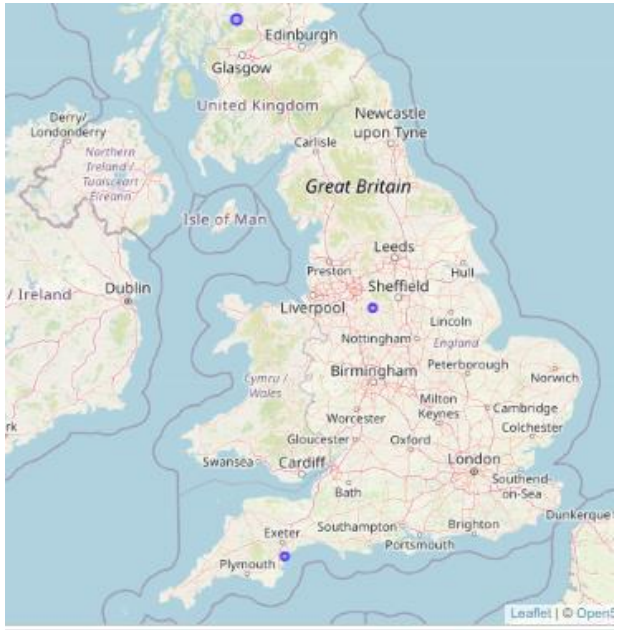
CATE2 maps for these species can be seen via [cate.fungustrust]

Amanita friabilis (P. Karst.) Bas		
a) FRDBI	**b) iRecord**	**c) NBN Atlas**
		

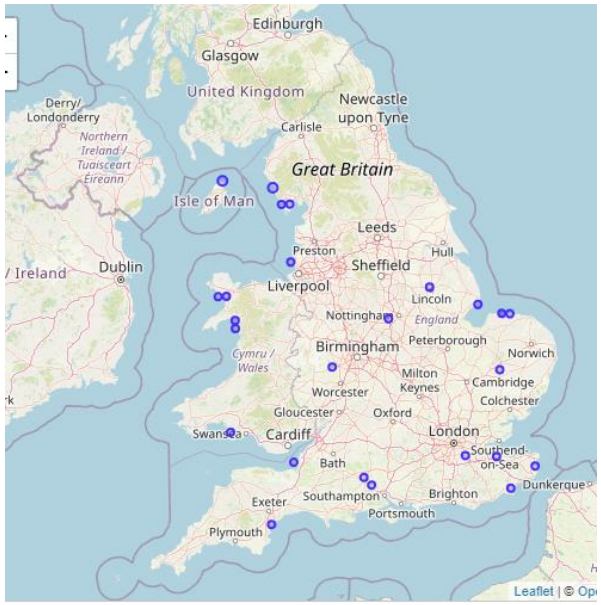
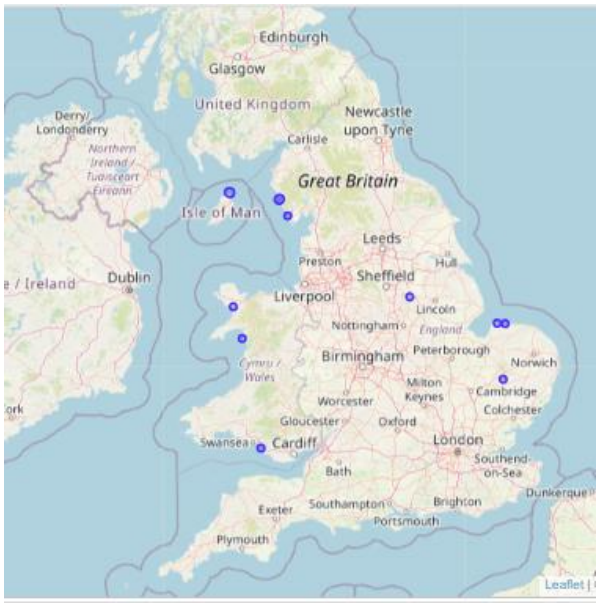
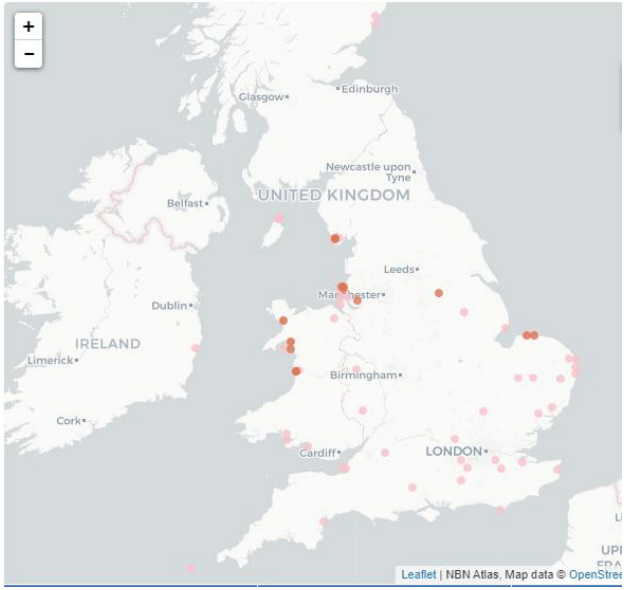
Bovista paludosa Lév

a) FRDBI	b) iRecord	c) NBN Atlas
	**[no records available]**	

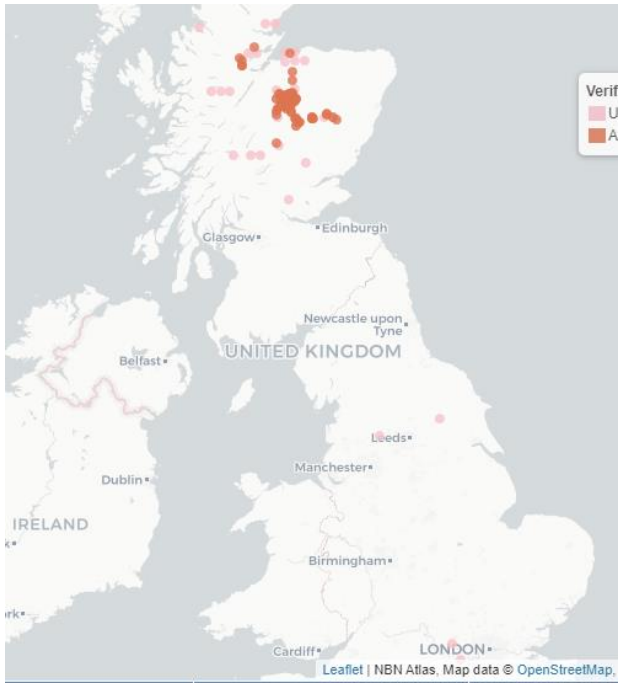
Craterellus melanoxeros (Desm.) Pérez-De-Greg

a) FRDBI	b) iRecord	c) NBN Atlas
		

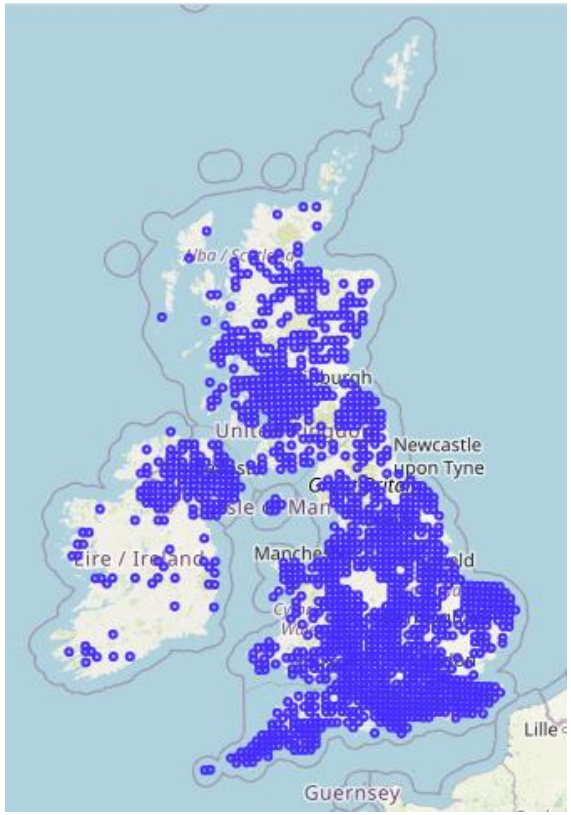
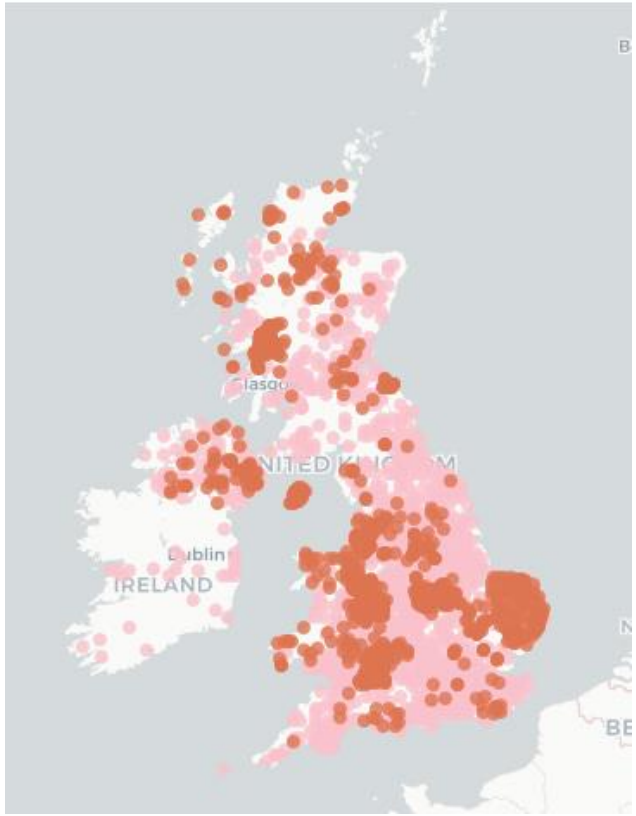
Geastrum schmidelii Vittad.

a) FRDBI	b) iRecord	c) NBN Atlas
		

Phellodon fuligineoalbus (J.C. Schmidt) R.E. Baird

a) FRDBI	b) iRecord	c) NBN Atlas
		

Trametes versicolor (L.) Lloyd

a) FRDBI	b) iRecord	c) NBN Atlas
		

Volume of records in the FRDBI (1 and 2) and CATE2

The FRDBI and CATE2 are the two primary national databases holding fungus records in the UK, and so it is interesting to consider their relative degree of use by recorders. Although we did not have access to the CATE2 data, the publicly accessible online CATE2 interface provides summary statistics that allow the total numbers of records for selected species to be viewed.

We used this to calculate the total number of records for the ten most frequently recorded species in each vice-county in CATE2. Each vice-county had its own 'top ten' species list, and across the UK as a whole 235 species were within the county top ten lists. Of the 235 species from CATE2, there were 62 names that did not have a direct match to the current preferred name in the FRDBI, so it was not possible to compare the same set of taxa consistently. Instead, we took a similar 'top ten' approach to the FRDBI records, taking the ten most frequently recorded species in each vice-county. All records from the FRDBI 1 and 2 were combined, and then 145,995 records where values for all the variables, taxon, grid reference, start date, end date, recorder/collector, location name, and vice county, were duplicates, were filtered out, leaving 2,312,896 records. This is a crude but conservative means of removing duplicates, as there may be other identifying details (e.g., in other attributes such as comments, substrate or associations) which if included could give a higher number of unique valid records within the FRDBI.

Although the 'top ten' approach does not allow for direct comparison of the amount of recording for any particular species, it does provide a proxy for the overall recording effort for each vice-county as represented in the two data sources. The results are shown in Figure 9.

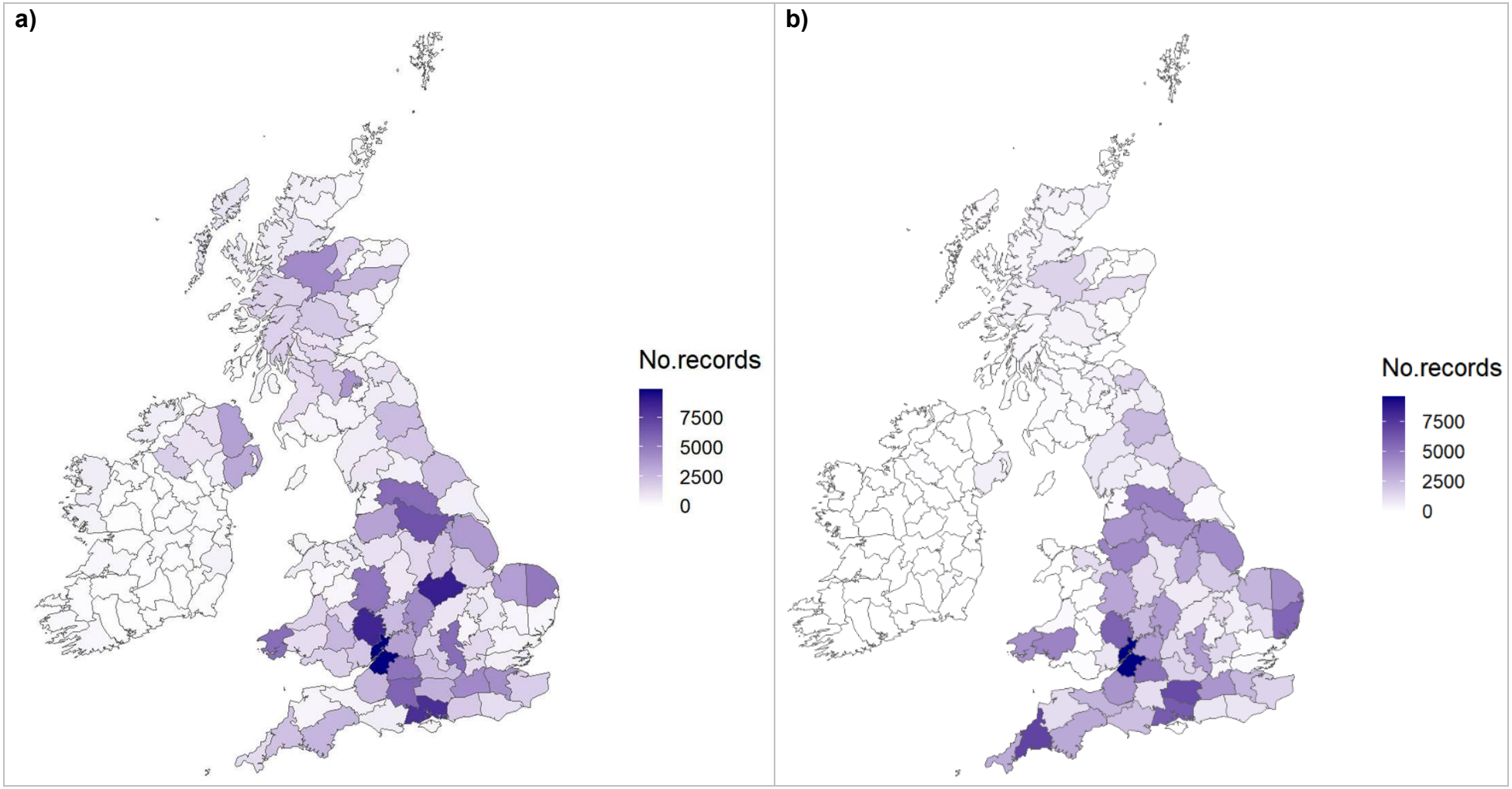
In 24 vice-counties the FRDBI holds over 1000 records more of its ten most recorded species, than CATE 2 does of its own ten most recorded species. For 20 of these vice-counties, this equated to over 50% more records by this measure (Antrim, Argyll, Ayrshire, Breconshire, Buckinghamshire, Down, East Inverness-shire, Fermanagh, Lanarkshire, Leicestershire, Mid Perthshire, Moray, Peeblesshire, Radnorshire, Renfrewshire, South, Wiltshire, South-west Yorkshire, Stirlingshire, West Inverness-shire, West Kent).

Conversely, in 11 vice-counties CATE2 holds over 1000 records more of its ten most recorded species than the FRDBI does of its own ten most recorded species. For nine of these vice-counties, this equated to over 50% more records by this measure (Cheshire, Dorset, East Cornwall, East Suffolk, North Hampshire, North Wiltshire, North Somerset, South Somerset and West Cornwall).

Examples of vice-counties with relatively large numbers of records in both databases by this measure, with over 4000 records each of their respective ten most recorded species, include East Norfolk, Herefordshire, Mid-west Yorkshire, South Hampshire and West Gloucestershire.

In the absence of access to the CATE2 data it is not possible to make a more detailed comparison, and this analysis can only give an approximation of the total recording effort represented in the two data sources. However, it does suggest that there is quite a lot of overlap between the two data sources, with the same vice-counties being relatively well-recorded in each dataset likely representing duplication of records. But there are also some areas where one source has a better representation of the more frequently recorded species than the others indicating that neither database captures all records.

Figure 9. Number of records for the 10 most frequently recorded fungus species per vice-county in a) the FRDBI1 and FRDBI2 datasets; and b) the CATE2 dataset.



2.9 Taxonomic considerations

Taxonomic issues arising from the use of fungus records data for biodiversity research and conservation pose significant challenges. The variation in data collection methods, expertise levels, and taxonomic rigor among these sources can lead to several taxonomic challenges:

- Taxonomic discrepancies or misidentification at source: Recorders may use different taxonomic classifications or identification methods, leading to discrepancies in how species are recorded. Errors in species identification among non-experts are particularly likely with such a complex group as fungi. Misidentification can occur due to similarities between species, lack of detailed morphological examination, or limited taxonomic expertise. For this reason, ad-hoc observations or incidental sightings from non-experts may be of limited use, except for certain easy to identify taxa where records from novices containing photos might be verifiable.
- Taxonomic revisions: Taxonomic knowledge is dynamic, with species classifications and nomenclature constantly being revised based on new scientific discoveries and advancements, and the increasing use of DNA-derived classification. As a result, records collected using outdated taxonomic frameworks may become obsolete or require re-evaluation to align with current taxonomy.
- Discrepancies in taxonomic dictionaries: The various repositories for fungi records do not all use the same taxonomic dictionary, and the degree to which historic taxonomic concepts have been aligned with current taxonomy may differ (i.e., whether historic names are applied correctly as junior synonyms or remain as separate concepts with appropriate qualifiers to associate them with a certain identification guide or system of classification). For example, the taxonomy in CATE2 differs from that of the UKSI, which the FRDBI uses. This adds considerably to the effort needed to combine data from different sources for the purposes of fungus conservation such as Red Lists or other assessments, with caution and specialist fungus taxonomic expertise required to interpret any such comparisons.
- DNA barcoding: Consideration of how DNA barcoding can support field mycology without precluding the use of the broader taxonomic concepts that are practically applicable in the field is necessary. Taxonomic dictionaries should reflect these relationships and thus allow data to be aggregated as required for any analyses.

Addressing these taxonomic issues requires collaboration and communication between fungi taxonomists and those responsible for maintaining different databases. Concerns have been raised by the Fungus Conservation Trust over JNCC's recommendation for submission of voucher validation specimens for all recorded species and the potential increase in workload for recorders and staff at Kew (and other diagnostic centres) that this might entail (Jordan and others 2016). Clarification of the scale on which this was envisaged (i.e. all new vice-county records) would be helpful. Another suggestion from JNCC referenced by Jordan and others (2016) was that a taxonomist be employed to

arbitrate on taxon version issues, which should enable integration of data collected at different taxonomic scales.

3 Investigating current views on data flow and motivations among fungus recorders

This part of the work was led by Martha Henson of Tech Works For Us (TWFU), in consultation with UKCEH and Natural England. TWFU were commissioned to carry out research and consultation with the recording community to learn how they manage and distribute their data and what their motivations for recording are.

The results are summarised below and include verbatim quotes from respondents. In some cases, these quotes show that there is misunderstanding about the roles and functionality of the organisations and systems that are in use; such quotes are not intended as criticisms of those organisations and systems but are included to show the range of perceptions that exists among the respondents.

3.1 Approach

The work was designed to address six research questions:

1. Where are local groups and recorders sharing their records and why?
2. What are their priorities and motivations for recording and sharing their records?
3. Does their data flow match those priorities and motivations?
4. What recording practices are groups recommending, organising or observing?
5. Would they like there to be more guidance about fungi recording practices and data flow and where do they feel this should come from?
6. What do they think the major challenges in this area are?

TWFU carried out a research process over several stages:

1. A review of existing knowledge.
2. Four stakeholder interviews with Matt Wainhouse, Sean Cooch, Stuart Skeates (BMS/FRDBI) and Clare Blencowe to inform development of the questionnaire, narrowing scope to unknown areas and framing the questions to be relevant and clear.
3. Questionnaire. Sent to 44 groups plus additional contacts suggested from the mycological community. This had 66 responses (including one from Australia that was excluded from further analysis). A copy of the questionnaire is shown in the Appendices to this report.
4. Interim findings review.
5. Eight fungi database manager interviews between 30-60 minutes. These prioritised those using CATE2 solely or with FRDBI as there were relatively few respondents using the former, and secondarily those with interesting responses to questions on verification. We also carried out a final interview with Dr Brian Douglas about his experiences working with fungi datasets for the Lost and Found Fungi project at Kew.

3.2 Key messages from respondents

Several key themes emerged from the questionnaire and interviews with field mycologists:

- Fungi recording is unique, and uniquely challenging for various reasons, but especially the difficulty of identification and the very large number of species.
- Group forays are generating the vast majority of records for the respondents, who carry out a thorough identification process before submitting a record anywhere. Therefore, they consider records verified before submission to record databases.
- Verification of records generated through other means (e.g. individual submissions to databases) might be limited by the difficulties of confirming identifications from inexperienced recorders, but there is scope for progress.
- Data flow is complicated to untangle, but duplication and data fragmentation is considered to be more of an issue than missing records.
- Responses to mushroom foraging are a significant factor in decision making. There is a philosophical division of availability vs protection of data for this reason.
- There are opportunities to improve the process and many calls for simplification of data submission to a single database.

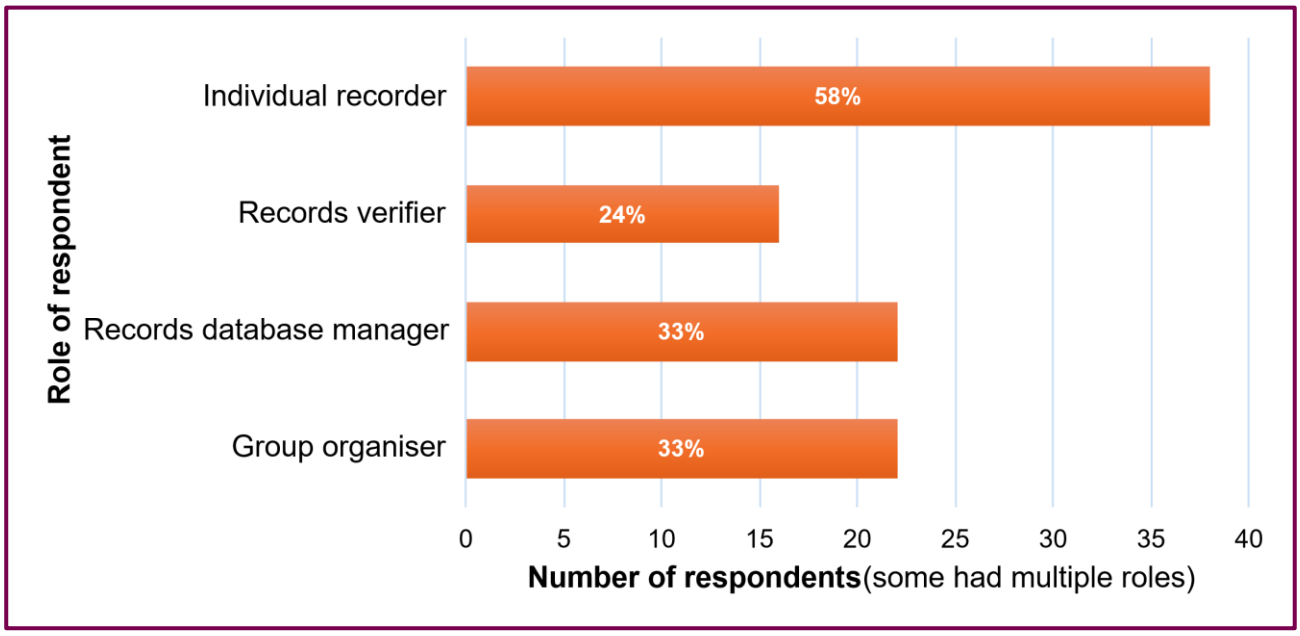
3.3 Research results

Who are the respondents?

An invitation to complete the questionnaire was circulated to representatives of BMS, FCT, 48 publicly listed local fungus groups, LERCs (via ALERC) and selected individual recorders who were known to be active in recording fungi, including mycological consultants. The questionnaire was also publicised via Facebook and X (Twitter).

We received a total of 66 responses to the questionnaire. Of these respondents, 22 had a role as group organiser and 22 as database manager (Figure 10), with 8 taking on both of those roles.

Figure 10. Respondent's role/s in fungus recording



Amount of records held

The majority of respondents held databases with 5,000 or more records, and unsurprisingly the totals were mostly higher for those with a group role (Table 7). Many of the latter held over 10,000 records, sometimes substantially more than 10,000 (of those we interviewed the larger databases contained between 30,000 and 60,000 records.

Most database managers held records that were associated with only a few recorders, sometimes only one. This is probably because most records are gathered on group forays and only one person takes the details of finds and records them for each foray. But also, very knowledgeable recorders were perceived to be very few in number, with the majority of foray attendees being enthusiasts with limited identification skills.

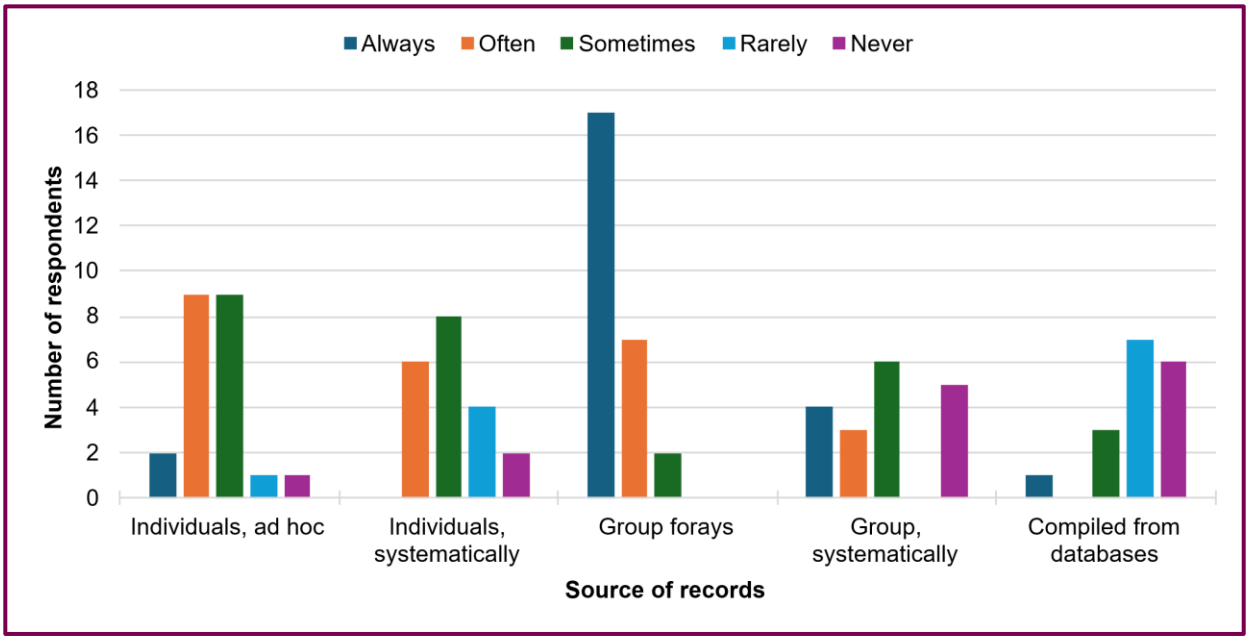
Table 7. Roles and number of records held by questionnaire respondents.

Role in fungus recording	Number of records held					
	0-100	100-1,000	1,000 - 5,000	5,000 - 10,000	10,000+	Total
Group organiser or database manager	2	0	5	4	24	35
Individual recorder (without a group role)	3	7	8	2	5	25
Records verifier (no other group role)	0	0	2	2	1	5

Fungi recording practices and challenges

Most recording reported by respondents results from fungus group forays (Figure 11). Interviews suggest that the number of records coming in from individuals doing independent recording are small, but there were a few cases where particular people do a lot of their own recording.

Figure 11. Source of records collated by fungus groups and database managers.



Fungus group forays are typically led by one or more experts. The rest of the group tend to be less knowledgeable, and the leader confirms and records for the whole group. Recording locations are chosen for their likelihood of finding fungi, conservation interest, access permission and accessibility (especially parking). Some locations are chosen as a result of long-standing arrangements with landowners (e.g. National Trust, Wildlife Trusts, private individuals) and these arrangements tend to include data sharing about finds.

There were some variations in recording practice, e.g. where they take a location (e.g. car park), whether they take more precise locations for rare finds, whether they mark abundance, whether they split into groups based on type of fungi.

Interviewees were keen to make clear the particular challenges of fungi recording and most of these issues came up repeatedly:

- Difficulty of identification. Described as "mind-blowing" by one interviewee. Fungi are extremely speciose, can look very similar, and often require microscopic examination or other techniques to be sure. Even then, it may not be possible to make an identification, and outside expert advice is sought.
- The identification difficulties mean that recording fungi can be very time-consuming, and it can be difficult to make progress unless recorders are in a position to devote significant amounts of time to this.

- Taxonomic complexity and changes are a challenge, and discrepancies among textbooks and species dictionaries can be hard to interpret.
- It can be very hard to formally record any fungi new to the UK because there can be significant time-lags before newly recognised taxa are added to the species dictionaries used by recording platforms.
- Extensive resources can be required for expertise (time, money, equipment such as books, microscopy, and equipment for dealing with DNA analysis – "I have 70 odd fungi reference books", said one interviewee)
- Need for samples (as opposed to photos), and the need for these samples to be in the right condition for examination.
- Increasingly being told by landowners "no picking", which can restrict the ability to take samples for identification purposes.
- Fruiting behaviour of fungi can be erratic and short-lived, and for some species at least the appearance of fruiting bodies can be unpredictable, with species appearing in one year and not the next, or at one site in one year and then a different site the next. This makes it difficult to plan surveys and monitor change.
- Recording is influenced by biases in recorder behaviour, such as a preference for recording rarer species, or for recording more accessible fungi and those that are easier to spot etc. (this is an issue for many taxon groups, not just fungi)
- Constraints such as those listed above lead to a lack of people interested in taking on the recording of this challenging group.

Following on from these challenges, one interviewee pointed out that the idea that records represent reality is "naïve". When people were specifically seeking certain species, the number of records for those species increased, showing that the full characterisation of the fungal community was not always being gleaned from intermittent and undirected group foray approach. It is noted that this point is not necessarily unique to fungi and applies more generally to biological recording.

How are records verified?

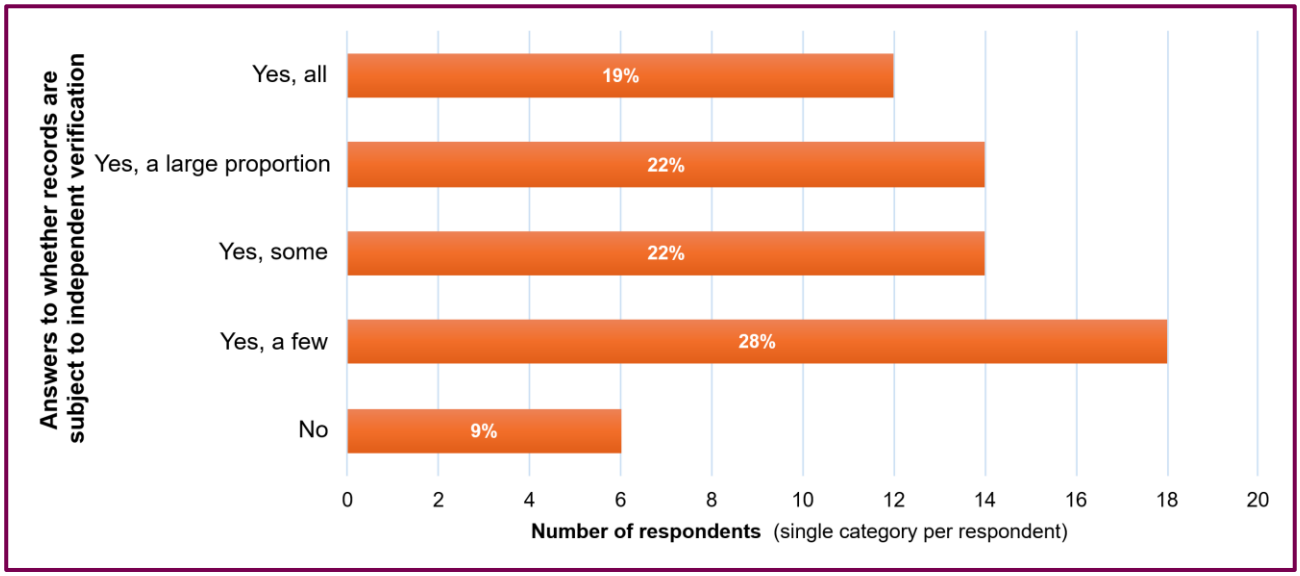
The fungus group recorders that we interviewed consider that the records they are entering are verified. In the first instance, fungi are identified in the field on a foray. Where this is not possible, the expert lead will typically take them home for microscopy and chemical tests. If they are still unable to identify the species, they may confer with others, ask a specialist, or ask Kew/send a sample (although it was noted that Kew has very limited capacity for this and cannot always respond). A small number of groups are using DNA sequencing, either sending whole samples away for DNA extraction and amplification or extracting and amplifying DNA themselves using their own equipment.

If the above processes are not possible or there is still uncertainty over identification, they will not enter the record or may enter it at a higher taxonomic rank (e.g. genus or family).

More effort will be put in to verifying species that are rare or potentially new to the county or country. If records for more common species are uncertain, they are more likely to be discarded rather than pursued.

In the questionnaire we asked “Do records in your data collection go through a verification process (i.e. checking by someone other than the original recorder)?”. The responses indicated that independent verification was in place for a fairly large proportion of records, while 10% received no independent verification (Figure 12). However, it is possible that this question was insufficiently clear, and there may have been inconsistent answers due to differing view of what constitutes an independent verification process as opposed to the standard checking done by the recorder or group.

Figure 12. Proportion of the records collated by questionnaire respondents that receive independent verification.



Opportunities for verifying records from other sources

Verification for records from sources other than field mycology groups, such as those coming into iRecord or iNaturalist, was seen as necessary but very difficult in many cases. Necessary in order to weed out the many likely wrong identifications, but difficult especially in those cases where the recorder’s level of experience is not known to the verifier. Knowing or recognising a recorder’s name and being aware of their level of experience is often an important part of the verification process, and this can be much harder to judge with records contributed online by recorders who are not in touch with the local fungus groups and experts.

Given that most species are unverifiable from photos alone, records cannot by fully accepted if there is insufficient evidence from or trust in the original recorder. There are also very few people with the time and expertise to do this. This means in effect that a very large number of fungal records coming in via online platforms may never be verified in the current system.

However, some interviewees felt that there was a degree of interest in verifying iRecord, for example, although one suggested it is potentially "many lifetimes work".

Some thought that a grading system might help for some species to indicate the level of evidence needed for identification. For example, one group has a list of 60 species that can be identified from visuals alone, and there are already 'Record Cleaner' rules in place that give some indication of identification difficulty for many fungus species. The NatureSpot website has developed a simplified version of the record cleaner approach, using a 'traffic light' system to show difficulty of identification. An existing Danish approach to verification was suggested as a potential model (see the Atlas of Danish Fungi website, plus Heilmann-Clausen *et al*. 2019). If recorders can be given more information on what is required to enable a fungus species record to be accurately identified and verified this could lead to better quality records, and therefore more efficient verification. However, one interviewee suggested it could be discouraging for recorders if the identification process seemed too onerous.

Another suggested that maybe verification was less important that some others believed, in that perhaps erring towards a common species "won't skew the data significantly".

A sceptical interviewee suggested that a rules-based identification grading system would be hard to implement because inexperienced recorders are "not even getting to the right genus".

Considering the role of DNA sequencing

Several respondents mentioned the impact of DNA sequencing. Some field mycologists are already doing it and feel it is a useful tool; a few have set up their own "lab". One said: "Use of DNA is gradually unravelling some of the mysteries that have kept fungi as the poor relative in for example representation in the SSSI system. Maybe this will stimulate more investment both of finance and expertise."

There are significant costs involved in pursuing DNA barcoding (an example given was of £1,200+ to get set up). Not everyone is in favour of applying these approaches to the general recording of fungi, with criticisms including:

- It would be "taking the fun out of it".
- Splitting species further is unnecessary and will make it harder. "How will it help if fly agaric ends up being split into 4 species?"
- It is still a time-consuming process.
- The references for sequences may themselves be incorrectly identified (e.g., in Genbank).
- That it may reduce other ID skills which are still fundamental to provide useful samples and where DNA is not possible.

Recording motivations

Respondents prioritise scientific understanding, fungus conservation and personal enjoyment and gave public engagement and planning processes a lower priority (

Figure 13).

Figure 13. Respondents motivations for collecting fungus records.

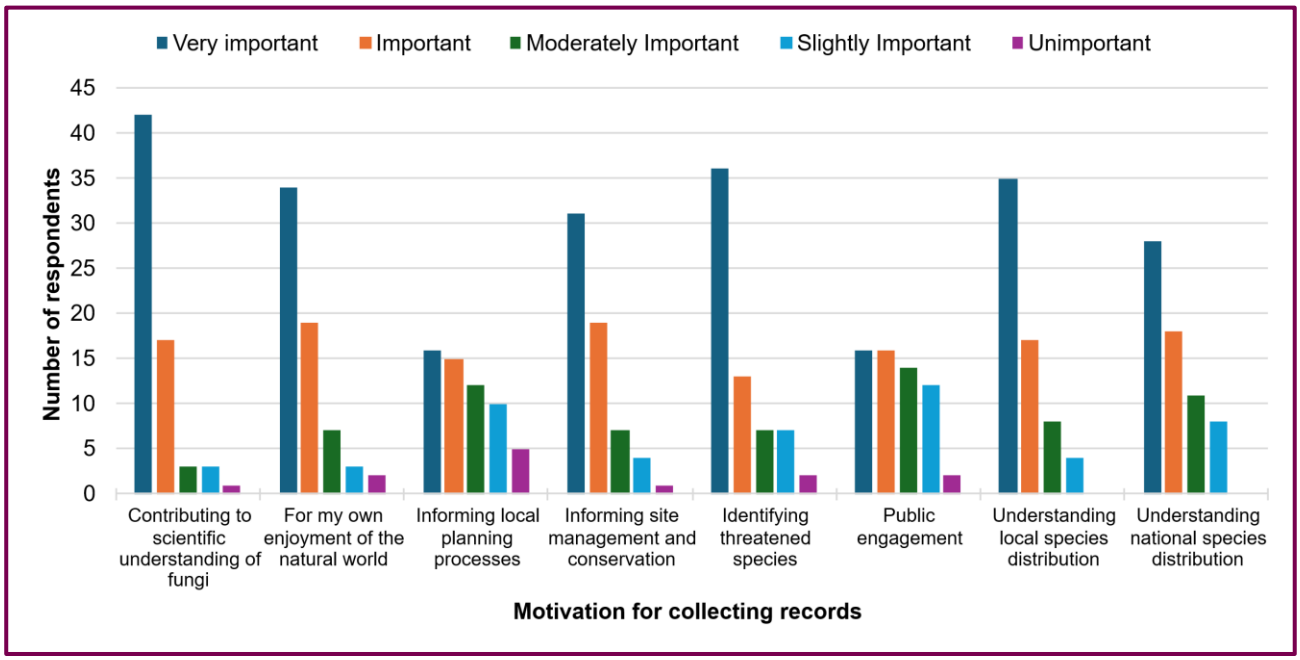


Table 9. Respondents motivations for collecting fungus records, ordered by topics considered of greatest importance.

Motivation	Very important / important	Moderately or slightly important	Unimportant
Contributing to scientific understanding of fungi	89%	9%	2%
For my own enjoyment of the natural world	82%	15%	3%
Understanding local species distribution	81%	19%	0%
Informing site management and conservation	81%	18%	2%
Identifying threatened species	75%	22%	3%
Understanding national species distribution	71%	29%	0%
Public engagement	53%	43%	3%
Informing local planning processes	53%	38%	9%

Interviewees suggest that the social aspects were very important (one mentioned the positive motivation of “pub and a pint after!”). Further motivations mentioned by interviewees were:

- Educating amateur group members.
- Raising public awareness of fungi
- Providing feedback to owners and managers of surveyed sites on what species they have and the importance of habitats for fungi.
- Thrill of rare finds ("trainspotting").

It is worth noting that questions about motivations can produce responses based on what people think they ’ought‘ to say. From the interviews it seemed that personal aspects were more of a fundamental driver, and this is an important part of volunteer recording – people are unlikely to persist with unpaid recording if they are not also enjoying it.

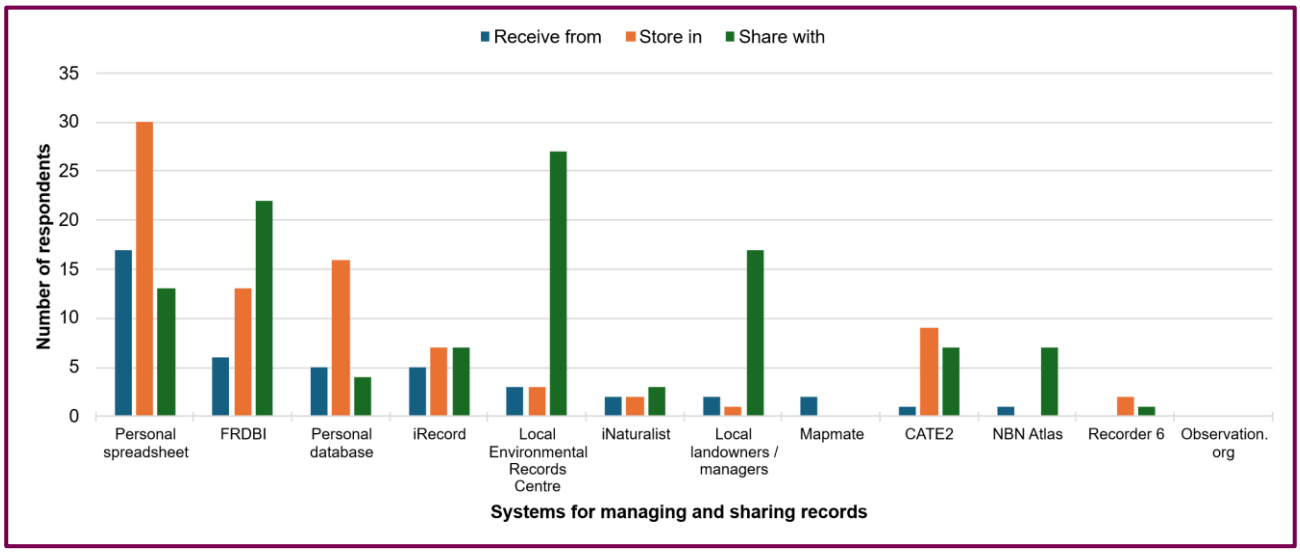
Data sharing

One respondent summarised the issues with data sharing as "a big mess". To summarise, there are two dedicated national fungi databases, CATE2 (from the Fungus Conservation Trust) and FDRBI (from the British Mycological Society) (see sections 2.1 and 2.2 of this report). We received the following responses from people who chose to participate in the questionnaire, but it should be born in mind that this was not a random selection of fungus recorders and may not represent the full picture of where records are being sent:

- There was a minority among the respondents who are solely using CATE2, with only 4 responses that sharing records with CATE2 but not the FRDBI (although these were large datasets, each in the 10,000+ records category).
- 8 respondents are sharing to both.
- 19-21 respondents are sharing only with FRDBI.
- A variety of other systems are being used.
- Personal spreadsheets are favoured for receiving and storing records.
- Other sharing is mostly to landowners, LERCS, NBN, and iRecord.

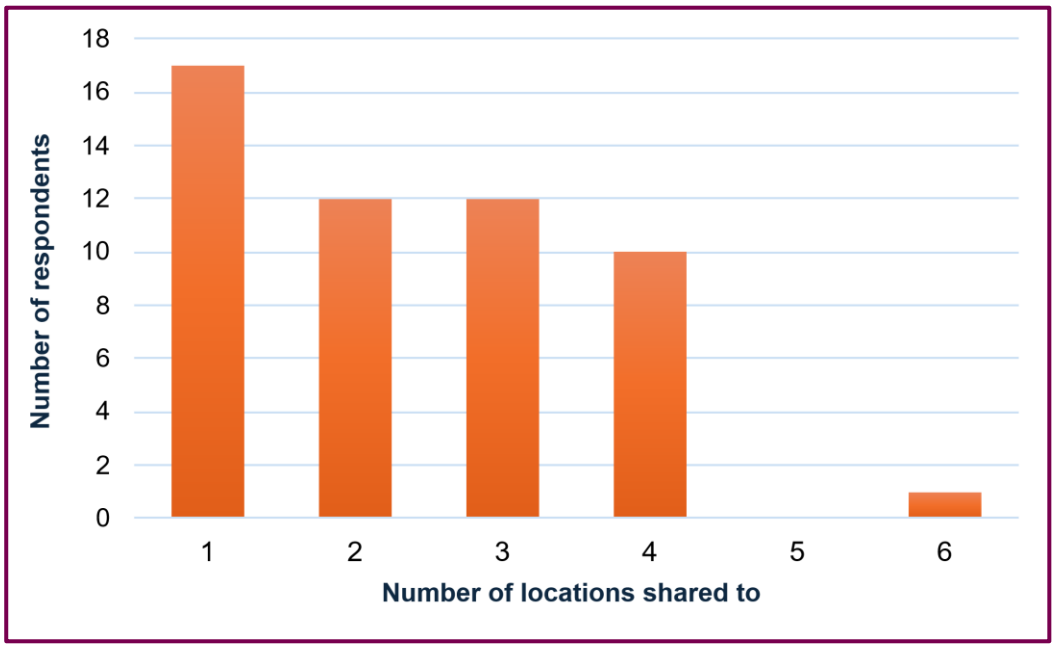
The recording community use a range of approaches to storing and sharing records (Figure 14). However, note that the term ’share‘ can be ambiguous (some respondents seemed to use it synonymously with ’store’).

Figure 14. Systems used for receiving, storing and sharing records.



Many individuals and groups are sharing their records to more than one place. All questionnaire respondents shared their records with at least one other repository (Figure 15).

Figure 15. The number of locations that respondents were "sharing" their data with.



One respondent pointed out that even at local level there was a large amount of complexity as a result of the multiple options for sharing records and the multiple stakeholders who may be interested in those record.

Gaps in data sharing

The potential for data to be overlooked or for gaps in data sharing was not seen by the community as a huge problem as people were generally sharing to multiple places.

However, it remains the case that there is no single repository for all data, and while groups and individuals are putting a lot of effort into data sharing there are different data sharing approaches taken by repositories, for example between FRDBI and CATE2 (section 2.1 and 2.2).

Motivations for data sharing

It was striking how disparate and un-strategic the responses to this question were, and how much this was subject to the personal experience or philosophy of the recorder.

Main factors include:

- Group or personal history - very human factors play a large part in decisions (e.g. where the group chose to send data at its inception or had a good relationship with them).
- Desire for data to be widely available.
- Conversely, desire for data to be closely protected.
- Ease of use (especially bulk record uploads).
- Providing reports to landowners in return for access.
- Relationship or lack of a relationship with local LERCs for varied reasons.

Awareness of the disconnections between the two main fungus national recording system schemes was high, but awareness of what might be happening to data after it is stored (i.e. how accessible it is for research or conservation planning) seems low, and the need for data to be available for conservation planning and monitoring (e.g. via the government agencies) was not often mentioned.

Damage to habitats and fungi are major concerns within the recording community. Foraging is the main issue raised as a risk that prevented sharing of data. There was also concern about unnecessary collection of samples, bad practice from other fungi groups especially towards recording rare species, and one unexplained mention of "data theft".

Those that were concerned about risks from foraging mentioned:

- Too little is known about potential damage to fungi from picking.
- We should leave fungi for the wildlife that feeds on them where resources are scarce.
- Concerned about collateral habitat damage (trampling, etc).
- Risk that misidentification will be dangerous, and don't want to be seen as facilitating the consumption of fungi.

Others were less concerned about risks from foraging. Some are happy to share records openly and at capture resolution. They feel:

- It is already easy to find out where common edibles (ceps/chanterelles/field mushrooms) are.
- Abundance wouldn't be clear from records, so they are not that useful.
- A Swiss experiment comparing foraged areas with non-foraged showing no difference [likely to refer to Egli *et al*., 2006].
- Habitat loss was seen as more important issue.

- An interest in foraging can be a gateway to learning about fungi more generally.

These factors all influenced decisions to share to CATE2, FRDBI, to both or to other databases and linked to their perception of each database.

FRDBI

- Advantages:
    - Free and easy to access.
    - Good, long-standing relationships with BMS.
- Disadvantages:
    - Perception it is “not well run” [this was not a widespread view].
    - Contains errors and duplicates. Also wrongly labelled ’errors’ may be uncorrected.
        - "Some records that I had rejected… then nonetheless appeared on FRDBI!"
        - “The democratisation of FRDBI is, I think, regrettable, as it allows any user, of whatever level of experience, to add personal records, which may not be rigorously checked." [Currently there are about 280 users of the FRDBI, with about 80 of those having contributed more than 1,000 records (S. Skeates pers. comm.), so the number of recorders is relatively low, but could increase].
    - Difficult to upload and not user friendly (but new version (2024) is considered much better having resolved previous issues).
    - Unable to bulk upload. Reliant on the database manager to do this [note: this appears to have been addressed in the recent update to FRDBI].
    - More focused on academic user, neglecting field mycologists.
    - Still dealing with a backlog from FRDBI1 [this refers to the records held by BMS from an earlier database system that have yet to be transferred into the current online database, see section 2.1].
    - Concerns over sharing with "for profit" organisations, and more general issues of recording under non-commercial licences.
    - Given all the above, the records are not being used for conservation purposes [note: FRDBI is the main database used by the statutory nature conservation agencies because of accessibility, pers. comms. Matt Wainhouse, Natural England].
    - Expectation that FRDBI is going to the NBN Atlas, but some users have found that it is missing records and that the NBN Atlas contains duplicates [note: FRDBI was last shared with NBN in 2006].

CATE2

- Advantages:
    - Developed by field mycologists.
    - More "hands-on".
    - Easier to use (e.g automatic filling of information on the list).
    - Cleaner, with fewer errors.

    - Appears to validate results (e.g. checks against dates/substrates) and check names.
- Disadvantages:
    - Expensive FCT membership (prohibitively so in one case).
    - Lots of information required when entering data.
    - Restricts access to the data - this is a big concern for many
        - "We have been asked to provide our records to CATE2 but have declined from doing so, as we have not been given access to CATE2".
        - "I used to put our records on CATE2 until….there was a difference of opinion with the database manager. I now have limited access to these records."
        - "We have requested access CATE2 records for conservation research but been declined each time."
    - May not be that distinct from information available elsewhere
        - "In one site-based project only 0.09% of CATE2 records were found to be unique and not available elsewhere".
        - "I don't think anything in CATE2 is worth having, personally. Because limited people are entering records into it, and those people are not doing rare species". [paraphrased and note that similar criticisms could be made of other database systems].
- Some indication CATE2 users are not aware of what the implications are of the restrictions on database access and data sharing.

Data usage

Interviewees were not getting many requests directly to access their own data. They also described very few examples of use of end data from their own or other records.

Examples were given where interviewees had been involved with projects that collated fungus records from many of the multiple sources identified in this report. In such cases it can take a huge effort to clean the data, removing duplicates especially. Also, the lack of agreement for the CATE2 data to be made public prevented its use in a funded conservation project.

In some cases, records of fungi on the NBN Atlas may only be available with low-precision grid references, not at capture resolution. Full access may require a request to the data provider.

Overall, it remains a significant task to try to gather a comprehensive and ‘clean’ set of fungus records for a particular area or project:

- "I started with 60,000 records, after cleaning it was down to 8,000" [paraphrased].
- "Who is going to do that [large amount of data cleaning]? Not most ecological consultancies, not those doing 20 environmental impact assessments a week" [paraphrased].

Views on Red-Listing

From interviews, respondents expressed a very mixed range of views about both the value and methodology of Red-Listing:

- Even an imperfect list would be helpful [e.g. to raise the profile of fungi in conservation work].
- Get the habitat right and any rare species will do ok too.
- Better to do one species at a time?
- Red lists have a value in protection, "but not be all and end all" [assumed to be expressing a concern that red-listing may put all the attention on a narrow range of species, rather than enabling the conservation of fungi as a whole].
- Potential for misuse in planning (e.g. focus on narrow red listing instead of broader picture, especially where limits had been set very low).
- Can skew findings, e.g. by acting as a disincentive to record species in case they are then perceived as less rare/important [we are not aware of evidence that such a disincentive is widespread, and the opposing view is that red listed species may become more attractive to recorders who wish to see rare species for themselves].
- How reliable can they be given difficulties with fungi?
- Potential for over focus on rare species.
- What if "common" fruiting bodies are those that are under stress? [This refers to the view that fungi are more likely to produce fruiting bodies when the organism as a whole is under stress, and that therefore an increase in records of fruiting bodies could make it appear that a species is doing well when in fact it is in trouble].
- Better to focus on habitat decline [as opposed to a potentially narrow focus on listed species].

Opportunities to improve the recording system

There was a strong desire from the community to have a better system, especially a single database, both for ease and efficiency of submission and for onward data use. Also, this is not a huge community, it may be small enough to map in a more detailed way and track exact use, (or perhaps create something new based on existing datasets).

"Due to the ongoing animosity between FCT and FRDBI (BMS) we are stuck with the ridiculous situation of having two main databases of fungal records, this combined with the several other databases like Cofnod [the Local Environmental Records Centre for North Wales], iRecord etc is creating a mounting legacy of confusion of duplication, especially with the added reluctance to share these scattered data."

"A limited dataset was released by FCT during the last QQR of the WCA [Quinquennial Review of Schedules 5 and 8 of the Wildlife and Countryside Act] so we could propose some additions to the list of protected fungi (currently with DEFRA). So, all is not lost if negotiations are sufficiently diplomatic."

Comments from questionnaire respondents and interviewees discussed various other ideas as well:

- BMS agree that LERC use is non-commercial and comes within original record licensing terms (although there may still be a need to go back to the original recorders for agreement on this) [There are differing views of how to define non-commercial and part of the problem is a mismatch between what a non-commercial licence may mean in legal terms as opposed to how it might be understood by recorders and data users].
- Better tools to interrogate existing data, could this be automated?
- Treat FRDBI records as already verified (or do so for certain groups/people) or auto-validate (better have the record and run risk of some being wrong).
- More funding (people need to be paid to resolve this).
- More consistent use of data sharing agreements.
- Open access data.
- More training.
- More use of iRecord.
- Government prioritising this area, requirement to use fungi surveys in land use projects.
- Improved communication and information and resource sharing.
- Encourage forays to record.
- Move away from "edibles" focus in media.
- Official county recorders.
- Public engagement.
- Improve user experience of software.
- Use of DNA.
- Use social media.
- Breakdown into smaller more manageable groups of fungi (e.g. waxcaps).
- Unique IDs/codes for taxa.
- More people getting involved with fungus recording.
- Agreement on tackling sensitive data.
- More availability of ID guides.

Finally, this research found that fungi recorders were a very passionate group of individuals, who were trying to do the right thing and improve knowledge and understanding of fungi. It seemed they wanted this system to work for the fungi, more than anything else.

4 Conclusions and potential next steps

4.1 Aligning fungi data with FAIR data principles

The data journey from recorder to database and end-user is complex. To effectively integrate fungi data pathways into the Geospatial Commission's Species Data Pathways framework and compliance with FAIR data standards (Findable, Accessible, Interoperable, and Reusable), key improvements could be made to data collection, sharing, verification, and interoperability. Recommendations to this effect are outlined below, however having two competing and not collaborating fungal recording schemes is creating complications in data flows as well as frustrating recorders. The ideal scenario would be for a single recording scheme, or two schemes with complementary rather than overlapping responsibilities. Given the contrasting approaches and lack of collaboration between the schemes, this is unlikely to be resolved in the short-term and may be detrimental to fungal conservation if restrictive data sharing by FCT were maintained or expanded. Effort must then be directed towards encouraging and promoting FAIR data practices. Recorders and database managers undertake their roles in a voluntary capacity and implementing the recommendations below requires support. Thus, two overarching points are made on resource and governance:

- A fungal data group should be established to carry forward these recommendations. Such a group might help to improve communication between stakeholders, identify data issues and work towards alignment with FAIR data standards. The group should include the main stakeholders with representation from the recording schemes, field mycologists, NBN, representatives of the statutory nature conservation organisations and representative end user (e.g. researchers, consultants, local authorities) as a minimum.
- A lack of funding and resources are a significant obstacle to improving data flows. Natural England, other country agencies, DEFRA, JNCC and BRC must investigate ways to support the BMS, FCT and wider community to implement these changes.

4.2 Improving and standardising verification

BMS are willing to explore options for applying a more formal verification process within the FRDBI. BRC can support this approach via the Indicia systems that FRDBI and iRecord use. This could include distinguishing records that have been checked by one or more local group experts from records that are contributed by an individual recorder, so that records from recognised fungus groups can be accepted more swiftly (e.g. using bulk verification options). Some local experts may also be willing to get involved with verification of other records in their area, forming part of a verification team as is the case for many other recording schemes.

The FCT approach to controlling the records that are accepted into CATE2 is admirable in that it does provide a good level of verification and captures a good range of data linked to

the species records. However, the process is not transparent, and lack of data sharing makes this difficult for conservation agencies and others to benefit from.

Verification of fungus records poses particular challenges, and it may well be that a large proportion of records from non-specialist fungus recorders cannot be accepted. Options to explore include:

- Develop guidance that explains which species can be successfully recorded from photos, which require additional methods such as spore prints, and which cannot realistically be recorded without a specimen. The existing record cleaner rules for fungi could form a basis for such an approach.
- Establish recording schemes for certain sub-groups of fungi (in a similar way to the range of recording schemes for particular insect families within the Diptera), which could steer novice recorders to the more practicable taxa and share the workload for verifiers and scheme organisers.
- Potential for BMS/FCT to develop Record Cleaner rules as an aid to recorders and verifiers, helping to identify likely records and potential outliers.
- Development of online recording forms that make it clear what evidence is needed to support different records; this could extend to only allowing data entry of certain species if the right evidence is available.

Agreeing on standardised expert verification processes, quality control measures, and training and support for data contributors, as well as leveraging advances in technology such as DNA barcoding, and image recognition software (in certain limited cases where fungi taxonomists agree this might be possible) could enhance the availability of fungus records for biodiversity research and conservation in the UK.

4.3 Enhancing data accessibility

4.3.1 Open data licensing

Correct application of data licences by organisations like Natural England mean that some records with more restrictive licences cannot be used in their work. To align with FAIR data principles and make fungal data accessible for research and conservation, data providers should move towards Creative Commons licences, prioritising CC0 (public domain) and CC BY (attribution only). Creative Commons licences are needed for data to be findable and accessible on NBN Atlas.

In FRDBI, the CC BY-NC (non-commercial) licence is widely used, but records with this licence cannot be used in some instances, limiting their findability, accessibility and use. An example where this licence may be detrimental would be if the record were to be used by a consultant to inform a planning application or where Natural England data driven outputs under an Open Government Licence and cannot control how outputs can be used or who by. Database managers and recording schemes should encourage the use of less restrictive licences. Natural England should also take an active role in promoting open licences directly with field mycologists with clear examples of why this is important.

CATE2 is the most restrictive database and does not ascribe to any form of open licence. Its highly restrictive nature means it is for the most part unusable, including for conservation. The FCT should consider policies and data licence options that allow more open access for fungal data to have wider use.

4.3.2 Making fungal data findable

In the interviews and questionnaires, respondents identified that there were very few direct requests for their records, suggesting that fungal data is being taken from either recording schemes or the NBN Atlas. Neither the FRDBI or CATE2 are easily accessible because of the need for logins to access data. The NBN Atlas is seen as the best route for enabling biological records to be discovered by a wide range of data users, including internationally though links to GBIF. Currently the largest single dataset for fungi available on the Atlas is that contributed by BMS, with a range of smaller datasets coming from other partners including several LERCs (see section 2.3). However, the BMS dataset has not been updated since 2006, while FCT's data is not currently available at all via the Atlas.

There is clearly scope for more data to be made findable and accessible via NBN Atlas, but this will need to be done in a way that addresses the concerns expressed over access to records and the issues around record quality and verification. Options to consider include the following:

- Indicia has the ability to automate the upload to NBN Atlas so that new records are updated every month or so, and once the process is set up there is no requirement for onerous admin time. This could facilitate the wider use of data from FRDBI and from the other sources that use the Indicia system to store records.
- Indicia provides a range of controls over which records are included in the Atlas upload, e.g. so that datasets sent to the Atlas can be filtered by taxonomic group and/or by verification status.
- NBN Atlas is developing better ways of dealing with unverified records, which could open the way for unverified fungus records to be shared – clearly there are many caveats associated with unverified records but if they are shared it does allow data users to make judgements over how to use them, and unverified records can prompt an additional focus on recording by experienced people or groups to verify potentially interesting records.
- NBN Atlas is also in the process of implementing data access controls that would enable records to be publicly shared at a blurred resolution, but available to agreed partners at capture resolution. Such systems may provide a way of sharing data while alleviating concerns over inappropriate use of locations for rare species. The access controls might also be of interest to FCT in particular as a way of allowing their high-quality data to be made visible without exposing the full details.
- There are other fungus datasets held by individuals, groups and LERCs. It would be beneficial to explore whether more of these datasets can be shared via NBN Atlas, perhaps going via FRDBI or CATE2 if either of those databases are able to make the link to the Atlas, or via LERCs for those that can share to the Atlas.
- Development of a recording App or Indicia-based database for use by local groups could facilitate and increase data-sharing. This should be designed in consultation

with field mycologists and facilitated by the national recording schemes and Natural England.
- FRDBI is currently split across two databases (FRDBI1 and FRDBI2). The databases are being integrated but limited by resource. Natural England and other institutions should consider how they can support this to make all FRDBI data findable.

4.4 Improving data interoperability and integration

Improving interoperability between platforms ensures fungi data can seamlessly flow between them and ultimately used more easily in conservation and research. This could be improved as follows:

- Data integration is limited by the different taxonomic frameworks used by different platforms. NBN, FRDBI and iRecord all follow the UKSI (with the latter two using a regularly updated copy of UKSI stored in the Indicia database). The taxonomic framework used by CATE2 is based on database manager opinion. This may also be leading to duplication where the same record is recorded under a different name on different platforms. If the ambition for fungi data more readily available, a single taxonomic framework should be applied. The UKSI has the benefit of being a standardised approach across recording schemes of all taxa.
- FCT have suggested that a taxonomist be employed to act as arbiter on taxonomic differences (section 2.9). This system is arguably already in place as mycologists at Kew are responsible for updating UK taxonomic concepts which they publish annually. These are used to update UKSI. A third-party arbiter to reconcile differences of opinion on name changes could be investigated, but decisions must be led by evidence. A robust framework would be needed to underpin a consistent approach.
- Different metadata fields in recording databases prevent simple interoperability. The two recording schemes should agree on and adopt a universal metadata standard. to allow for easier integration between platforms and if used universally, could provide straightforward integration of data.
- Identifying duplicate records from multiple platforms. This was considered an issue in interviews where two recording schemes and new recording platforms like iRecord, iNaturalist were leading to records being added to multiple databases. The majority of local groups supply records to FRDBI and CATE2. In most cases, it is possible to identify duplicate records through the combination of different fields (e.g. recorder, date, grid reference), but creates additional work towards data integration, particularly where records are not input identically for example in taxonomic concept or use of a preferred site name. Both FRDBI and CATE2 give records unique IDs. Recorders could include these or their own unique identifiers to aid identification of duplicates.

4.5 Promoting data use in conservation planning and research

Evidence-led conservation is dependent on open access to high quality biological records. Conservation and scientific research were given as the primary reasons for collecting fungi records but access to records or specific databases is preventing their use in this way. The two national recording schemes have been unable to collaborate on conservation projects for over 10 years (though both submitted data to QQR7) with this creating a significant obstacle to using fungal data, particularly in projects with a national scope such as red-listing, reviewing Important Fungus Areas and State of Nature reporting. Importantly the lack of collaboration means the recording schemes are not adequately representing the recording community and their motivation for collecting records in the first place. Awareness of how fungus records were being used to inform conservation activities was also quite low. The following should be considered.

- Where fungus conservation research, planning and action is dependent on records both national recording schemes need to be engaged to collate the majority of records. Where national recording schemes decline data requests or collaboration, it is critical to engage with local groups directly to fill data gaps, for example in red-listing or local nature recovery strategies (LNRS).
- Recorders are often unaware that their data is being used to inform conservation. Natural England and other statutory nature conservation organisations and other users need to engage directly with the recording community to show how their data is and can be used. This would motivate the community to record and share data and allay concerns over improper use.
- Views on red-listing were mixed. The process of red-listing appeared to be misunderstood in some instances and its links to conservation policy (e.g. LNRS, Environment Act targets to reduce extinction risk) and funding were not raised by interviewees. The central role of red-lists in directing conservation planning needs to be better communicated to reduce some of the apparent scepticism from the recording community.
- Restrictive data licensing is impacting on conservation activity. Open licences should be promoted across the board to make records more widely available for use in conservation (section 4.3).

4.6 Support for fungus recording

Most national recording schemes aim to collate records from a wide range of recorders, of varying levels of skill and experience, and many provide training and support to enable new recorders to progress to become better able to record a wider range of taxa. A lot of this work is currently done via a mix of the national organisations and local groups, but there is scope for an approach that gives a higher profile to a national recording scheme for fungi (or several national schemes for groups of taxa within the fungi).

This in turn raises questions over what level and mix of funding and voluntary commitment would be needed to further build on the admirable work already being done by the relatively limited pool of people who have the experience needed to carry out fungus recording, verification, and interpretation. Natural England and other organisations should investigate what funding streams are available to support and improve recording schemes to mobilise data.

The increase in recording of many taxon groups via online platforms such as iRecord and iNaturalist poses particular challenges for fungi given the well-known limitations of photography for fungus identification, and any recording scheme would need to develop an approach to this.

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Appendices

Appendix 1: List of Local Fungus Recording Groups in the UK

Country	Local fungus recording group name
England	Bristol City
	Buckinghamshire Fungus Group
	Cornwall Fungus Recording Group
	Cotswold Fungus Group
	Dean Fungus Group
	Devon Fungus Group
	Dorset Fungus Group
	East Yorkshire Fungus Group
	Essex Field Club
	Gloucestershire Fungus Recording & Research Group
	Hampshire Fungus Recording Group
	Herefordshire Fungus Survey Group
	Hertfordshire and Bedfordshire Fungus Group
	Huntingdon Fungus Group
	Leicestershire Fungi Study Group
	Lincolnshire Naturalists Union
	London Fungus Group
	Mid Yorkshire Fungus Group

Country	Local fungus recording group name
	Norfolk Fungus Study Group website
	North East Fungus Study Group
	North West Fungus Group
	North Somerset & Bristol Fungus Group
	Nottinghamshire Fungus Group
	Oxfordshire (Fungus Survey of)
	Shropshire Fungus Group
	Sorby Fungus Group
	South Cambridgeshire Fungus Recording Group
	Staffordshire Fungus Group
	Surrey Fungus Study Group
	Sussex Fungus Group
	Thames Valley
	Three Counties Fungus Group
	Warwickshire Fungus Survey
	West Midlands Fungus Group
	West Weald Fungus Recording Group
	Worcestershire Fungus Group
	Salisbury Natural History Society (Mycology Section)
	Yorkshire Naturalists Union (Fungi & Lichens Section)

Country	Local fungus recording group name
Northern Ireland	Northern Ireland Fungus Group
Scotland	Clyde and Argyll Fungus Group
	Edinburgh & Lothians Fungus Enthusiasts
	Grampian fungus group
	Highland Biological Recording Group
	Outer Hebrides Recording Group (not just fungi)
	Scottish Borders Fungus Group
	Tayside and Fife fungus group
	Borders Fungus Group
Wales	Camarthenshire Fungi Group
	Fungal Friends (Cheshire & Clywd)
	Glamorgan Fungus Group
	Gwent Fungus Group
	Pembrokeshire Fungus Recording Network

Appendix 2: Fungus Recording Questionnaire

Introduction

Thank you for starting this questionnaire. The UKCEH Biological Records Centre (BRC) wishes to get a clearer idea of the data flow of UK fungus records. This work is supported by Natural England (NE) via the Species Recovery Programme. The aim of this project is to help us understand the complexities of how and why biological records of UK fungi are being collected, stored, shared and verified, so that they can be used more effectively in

fungus conservation from the local to international scale. We also aim to understand motivations for fungus recording so that projects using fungal data reflect recorder interests. We hope that the results of this study will be useful and informative to recorders, recording groups and schemes, conservation organisations, government bodies and other parties interested in the study and conservation of UK fungi.

We estimate it will take 10-15 minutes to complete the questionnaire, and we would be very grateful for your response. We would also like to follow up with online interviews for around 10-12 people, and there is a final question to sign up for being contacted about this (with no commitment to take part). If you do wish to take part in the interviews, we will contact you directly via the email you provide (please note that we may not be able to interview everyone who signs up to this).

For further information about this questionnaire please see our Participant Information Sheet. We will store information securely and will not keep personal data beyond the user research phase of this project. Answers will only be accessible to UKCEH staff and their contracted researcher for this piece of work, Martha Henson of Tech Works For Us. Summarised and anonymised results may be included in public reporting.

If possible, please can you complete this questionnaire **before the end of Wednesday 3 April 2024**. (After that date we will still collect any further responses but participation in interviews will not be possible.) If you have any questions please contact brc@ceh.ac.uk

Data protection

This questionnaire asks for your name and email address, but this is only needed if you wish to be part of any follow-up interviews. We also ask if you are involved with a local group or project. If you submit a response to this survey, you will be giving consent for us to process the data as described here. The data will be processed within the UK and will be stored in compliance with current UK Data Protection Regulations. Both physical and cloud servers used for data storage are based in the UK. Any information provided in the questionnaire will be used in accordance UK Data Protection Legislation. Any information that you supply will be treated as confidential and in any subsequent reporting of the results your comments will be anonymised and combined and analysed with those gathered from other survey participants.

UK data protection legislation clearly defines an individual's rights in relation to their personal data. In data protection terms we are using the 'lawful basis' of 'Consent' for collecting, processing your personal data. Your rights are as follows: Right to access, view and edit information in a timely manner; Right to be forgotten, which means being deleted from the survey results (you can contact the project team at any time and request to be removed from the survey and your details deleted). You can contact the project team at brc@ceh.ac.uk and ask to be removed from the survey and have your details deleted, if your submission can be identified (i.e. via your email address, should you chose to give it). See the UKCEH Privacy Notice.

1. What is your role in fungus recording? Please answer this and the following questions from the point of view of your group role if you have one, and choose whichever is the closest match.*

Group organiser
Records database manager
Records verifier
Individual recorder (I don't have a group role)

Fungus records data flow

2. Which local group or project are you involved with (if more than one, please choose just one to focus on for the purposes of this questionnaire)?

3. Approximately how many fungus records do you or your group hold?

   - 0-00
   - 100-1,000
   - 1,000-5,000
   - 5,000-10,000
   - 10,000+

4. Approximately how many fungus records are added to your database by you or others annually?

   - 0-50
   - 50-100
   - 100-500
   - 500-1000
   - 1000+

5. How many recorders contribute records to your database annually?

   - 1
   - 2-10
   - 11-25
   - 26-50
   - 51-100
   - >100

6. What is the geographical area your role covers (e.g. please list one or more local sites, or your vice-county or LERC boundary, or state if national or international)?

7. How do records tend to be collected in your scheme or group? [choose from Always/ Often/ Sometimes/ Rarely/ Never]

- On an ad hoc basis by individuals
- Systematically by individuals
- On group forays
- Systematically as a group
- Compiled from other existing databases

8. To help us understand the data flow of your fungus records, please indicate which phrases (if any) apply to each of the examples listed.

   Phrases:
   - I/We receive records from
   - I/We store my/our records in
   - I/We share my/our records with
   - Not sure

   Examples:
   - Personal spreadsheet
   - Personal database (e.g. MS Access)
   - Recorder 6
   - Mapmate
   - Local landowners/managers
   - Local Environmental Records Centre
   - iRecord
   - iNaturalist
   - Observation.org
   - National Biodiversity Network (NBN) Atlas
   - FRDBI (British Mycological Society)
   - CATE-2 (Fungus Conservation Trust)

9. If you receive, store or share your records from/with any other system or group, please describe here.

10. Are there any constraints on data sharing in the records you collect? (E.g. licensing, resolution blurring, etc). Can you describe these and why they are in place?

11. What are your motivations for collecting fungus records? Please select their appropriate level of importance to you. [choose from Very important/ Moderately Important/ Slightly Important/ Unimportant]

    - Contributing to scientific understanding of fungi
    - For my own enjoyment of the natural world

- Informing local planning processes
- Informing site management and conservation
- Identifying threatened species (e.g. for IUCN Red Listing)
- Public engagement
- Understanding local species distribution
- Understanding national species distribution

12. If you have any other motivations for making or collecting records of fungi, please describe them, and their level of importance to you.

13. Do records in your data collection go through a verification process (i.e., checking by someone other than the original recorder)?

    - Yes, all
    - Yes, a large proportion
    - Yes, some
    - Yes, a few
    - No

14. Can you tell us more about why you do or do not include verification as part of your process?

Challenges and opportunities in fungus recording

15. What do you think are the most significant challenges in collating and sharing records of fungi for conservation and research, and why?

16. What opportunities do you think there are to help resolve or lessen those challenges?

Would you be interested in discussing this further?

We are conducting online interviews to better understand the needs of the recording community in regards to the areas covered here. If you would be happy to be contacted about an interview, which we would very much appreciate, please leave your name and email address below.

Please note: Leaving your contact details will be taken as consent to be emailed by our researcher for the purposes of arranging an interview only. We may not contact everyone who responds as we are conducting a limited number of interviews.

17. Name:

18. Email address:

Survey complete

Thank-you very much for taking the time complete this questionnaire, and for your continued efforts within the fungus recording community.

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