

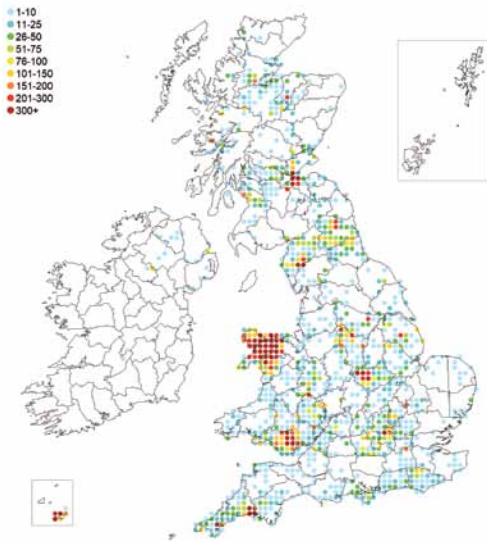
Bryophyte distribution data in iRecord: an introduction to the resource

Sam Amy and **Oli Pescott** provide a guide to an online recording facility which has become widely used by bryologists in the last decade

The recording structures and systems of the British Bryological Society have evolved considerably over the last 30 years and various new tools and approaches have been incorporated without specifically favouring any particular software (Preston, 2014). This note continues in this vein, in that it seeks to inform recorders of the iRecord platform (<https://irecord.org.uk>), and the biological records currently stored there, without specifically recommending it as a preferred product. iRecord is a website and linked mobile app, providing online functionality for the capture, verification and storage of biological records for any taxon group. It was launched in 2012 by the Biological Records Centre (BRC) at UKCEH, in collaboration with various partners. The goal of iRecord is to make it easier for wildlife sightings to be collated, checked by experts and made available to support research and decision-making at local and national levels. iRecord is used primarily in the UK, as the

Republic of Ireland has its own online recording system run by the National Biodiversity Data Centre (<https://records.biodiversityireland.ie/>).

The iRecord system is built upon a free and open-source software framework named Indicia (<http://www.indicia.org.uk/>), which is also supported by the BRC, and provides a toolkit used by numerous other recording websites. Other Indicia-based websites also exist, and these may receive and then share bryophyte records with iRecord. Examples include websites belonging to a subset of Local Environmental Records Centres (e.g. Recording the Wildlife of Leicestershire and Rutland; South East Wales Biodiversity Record Centre) and independent charities (e.g. NatureSpot). More recently, UK records from the international recording website iNaturalist (<https://www.inaturalist.org/>) have also been included. In this article we outline the bryophyte records submitted to iRecord, which in some areas may represent a significant addition to the BBS database currently held at



△ Figure 1. Number of accepted bryophyte records in iRecord per hectad.

UKCEH Wallingford (Amy & Pescott, 2022). We also describe the process by which records are submitted to and processed within iRecord, and how data are exchanged with other systems.

iRecord bryophyte records

There are 67,505 accepted bryophyte records in iRecord, with the annual total peaking in 2020 at 11,341 (Fig. 7). Table 1 lists the vice-counties with over 500 such records and Fig. 1 shows the number of records per hectad (a similar pattern is found by looking at the number of taxa represented per hectad). The platform has been particularly well-used in Midlothian, Cumberland, Leicestershire, much of North Wales, Glamorgan, Cornwall and the Channel Islands, although this picture will also be influenced by verification activity. Other counties where the BBS database indicates that recent recorder activity is high, such as Somerset and much of west Scotland (Amy & Pescott, 2022), are less well represented here.

Table 1. The number of accepted bryophyte records in iRecord for those vice-counties with more than 500 such records.

Vice-county	No. accepted records
49, Caernarvonshire	20,232
41, Glamorganshire	4,465
83, Midlothian	4,425
52, Anglesey	3,862
50, Denbighshire	2,781
48, Merionethshire	2,430
2, East Cornwall	2,356
70, Cumberland	1,920
85, Fifehire	1,058
57, Derbyshire	1,060
24, Buckinghamshire	1,049
36, Herefordshire	1,027
1, West Cornwall	905
63, South-west Yorkshire	788
54, North Lincolnshire	776
67, South Northumberland	735
75, Ayrshire	633
66, County Durham	618
40, Shropshire	604
35, Monmouthshire	548
22, Berkshire	506

These records were submitted by a total of 1,232 different ‘recorders’, of which approximately 5% are in fact pairs or groups of recorders (e.g. 991 records from a few different BBS groups). One recorder is responsible for 42% of the accepted records (clearly an individual using the platform as their main data repository in an area with an active verifier), ten others for a further 28%, whilst almost 1,000 recorders have submitted fewer than ten accepted bryophyte records, of which over half of these have made only a single record. The number

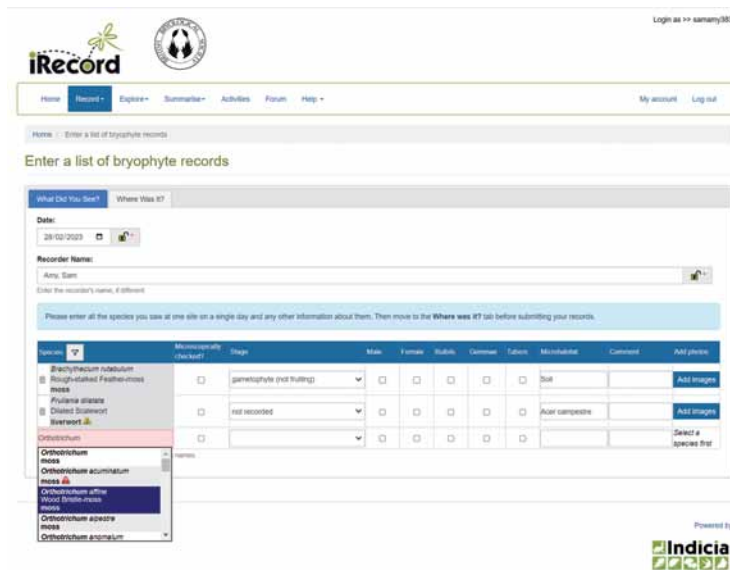


Figure 2. The bryophyte-specific recording form in iRecord; the first page is for adding a species list and details, and the second for site location.

of recorders with low numbers of records is far more pronounced than we see in the main BBS database (Amy & Pescott, 2022) and is no doubt indicative of the fact that iRecord is a useful tool for beginner bryologists, and for non-bryologists submitting casual records who may already be recording other taxa through the system.

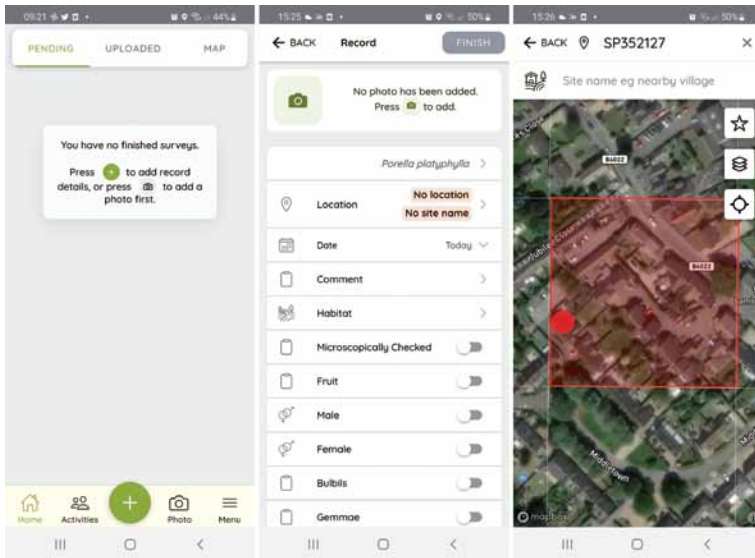
How data are collected in iRecord

By registering for a user account with iRecord (click on 'Create new account' on the iRecord homepage; <https://irecord.org.uk>) recorders can submit, comment on and share records of any taxon. All records entered by a recorder remain linked to their account and can be referred to and amended at any time. On the iRecord website, records can either be entered as casual occurrences, as lists of records (e.g. from site or grid-square recording), or uploaded from a spreadsheet.

Alternatively, there is a bryophyte-specific recording form (Fig. 2) that contains many of the same fields suggested in the BBS *Bryophyte Recording Handbook* (Preston *et al.*, 2012). Such

a form could be further adapted to include additional information, such as herbarium codes and collection numbers, should the BBS wish. The form is on two pages, the first collects the date, recorder name and a list of the species and associated details (whether microscopically checked, various details of reproductive stage, microhabitat, comments etc.) and provides an option to add one or more images. The second page collects site-level information such as location and habitat (see tab 'Where was it?' in Fig. 2). The system gives the user the option to remember the location added, so next time one begins to type this location will appear. Spatial references can be entered either as a grid reference or by finding the correct location and clicking until the correct resolution is reached on the interactive map, which becomes an aerial photograph upon zooming in.

A mobile application for iRecord is also available for submitting individual records (Fig. 3); the app allows offline working and is available for Apple iOS and Android mobile operating systems. When a user 'adds' a casual record on



◀ Figure 3. Selected pages from the iRecord mobile application for individual records. Note that the additional information options are taxon-specific; here the options from the bryophyte form (e.g. bulbils, gemmae) are displayed.

the mobile app by entering a bryophyte species name, it automatically offers the relevant data fields from the bryophyte recording form.

Although not yet available with a form specific to bryophytes, a ‘Plant Survey’ form can be found by clicking and holding on the ‘add record’ button (Fig. 3). This allows the recorder to select a tetrad or monad and add species sequentially as they wander through the square; it also has a useful ‘grid alert’ function which alerts the recorder if they leave the square. Although this form can be used to record bryophytes, it has been designed with vascular plants in mind and does not currently display the bryophyte-specific fields. For each species entered, the grid reference, recorder and date are added by default, with options to add additional information (e.g. native status, stage – related to vascular plants – abundance, determiner, comments and also whether the record should be marked as sensitive or not).

For both the website and mobile application it is possible to switch an account to ‘training mode’, to allow testing of the various processes without submitting actual records.

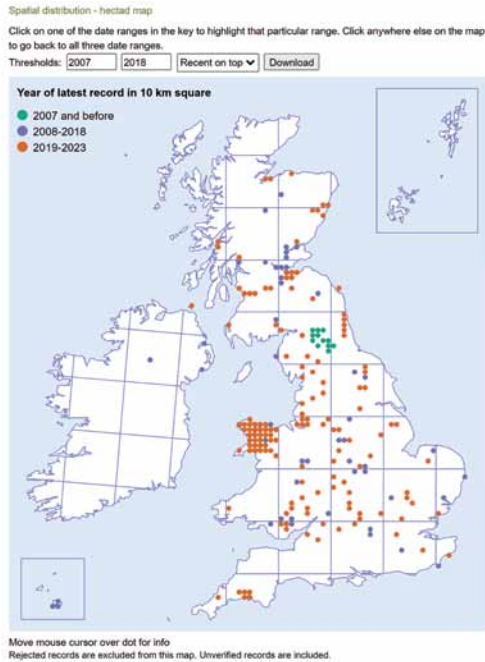
Viewing records on iRecord

All iRecord users can view any records under ‘Explore/All Records’ on the website, searching using a comprehensive set of filtering options (e.g. taxon, date, grid reference, recorder, vice-county or other defined geographical area). It is also possible to download species lists based on all the records within iRecord (e.g. for a particular grid square or county). Users can also download the full details of their own records, which can be viewed, queried, or edited at any time under ‘My records’ on the website. There are also species summary pages including maps with interactive date classes (Fig. 4), accompanied by photos from records of that species and charts showing the phenology of recording activity.

Verification

Verification entails a decision being made on which records are considered acceptable by a recording scheme for further use (e.g. in distribution mapping). The generally accepted definition of verification for biological records is ‘ensuring the accuracy of the identification

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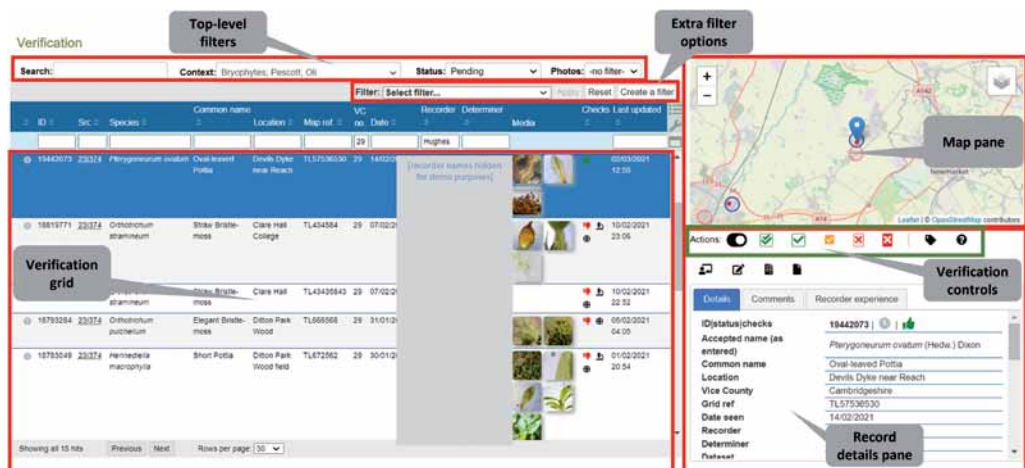
△ Figure 4. Example of iRecord species mapping functionality for *Schistidium crassipilum*.

of the things being recorded’ as opposed to the concept of validation, which relates to ‘checks on the ‘completeness’, accuracy of transmission and

validity of the content of a record’ (James, 2011). For example, an unverified record might be of a rare taxon reported for an unlikely location, whereas an invalid record would be one where the taxon name is misspelt, or with the grid reference or date in incorrect formats. Database systems typically reduce the potential for creating invalid records, e.g. by forcing users to choose from a pre-codified list of names.

Verification is not the same as the formal concepts of confirmation and determination, where identifications are established or checked by humans using physical specimens; rather, it duplicates the process undertaken by Regional Recorders when they receive and accept records from recorders without checking every physical instance of the plants underlying every reported occurrence, as is common in biological recording in Britain and Ireland. The verifier is therefore not expected to guarantee that a record is absolutely correct (which they cannot do, and which, of course, will always be subject to revision in terms of changing taxonomic understanding), but instead are tasked with making a decision about acceptability based on the evidence

▽ Figure 5. The verification page in iRecord (grey labels added).



available. Regional Recorders have always taken most records on trust (or indeed not), and the main difference between this tradition and the iRecord format is simply the wider reach of the platform: any system with a lower bar to participation will, by definition, include more records from naturalists who may be less familiar with bryophytes and BBS recording traditions. Different individuals will have different opinions about the desirability of receiving more records, of less certain quality, from less experienced recorders. In this context, however, it is worth noting that the BBS exists to 'promote the study of mosses and liverworts' and that the Regional Recorder duties also ask that they 'liaise with and encourage members active in their region'. In many cases the users of iRecord will not be BBS members (yet), but any new platform through which people are engaging with the identification of bryophytes arguably deserves the support of the BBS.

As well as general naturalists or interested beginners, iRecord may also receive records from professional biodiversity surveyors who might not otherwise pass records on to a Regional Recorder. Records become accessible in one place to verifiers (Fig. 5) as soon as they are submitted by the recorder, avoiding the need for cutting and pasting multiple spreadsheets, or concerns about backing-up data; accompanying photos remain with each record.

As of February 2023, there are 37 registered verifiers for bryophytes on iRecord (21 active in the last year), many of them also Regional Recorders for the BBS. Based on their knowledge of the local bryophyte flora and the skill level of the recorder, the Regional Recorder checks whether records appear to be correct and may query outliers and check photos or specimens where necessary. Records can be queried within iRecord either via email or, preferably, via comments

which remain with the record for future reference, but for which email notifications are received by the recorder. This system also enables easy sharing with other verifiers if a second opinion is required. The verifier ultimately gives each record an appropriate status, using a set of terms that show whether a record has been accepted or not, and on what basis that decision has been made (Table 2). Verifiers are given the choice to toggle between the 'status levels' they wish to use; either 'Accepted', 'Not Accepted' or 'Plausible', or additionally those extra levels given at verification status level 2. Records can also be redetermined if a photo, or other information, allows verifiers to make a decision on the correct identification; redetermined records re-enter the pool of 'unconfirmed' records, this is because the original recorder could also redetermine a record, meaning that verification would still be required.

For the purposes of verification, filters can be set up with spatial and taxonomic limits, so that Regional Recorders receive only those records made within their own area, for example. The verification facilities support bulk verification of records, so all records of a common and easy-to-identify species, or all records by a trusted recorder, could be verified using the same decision (i.e. a term in Table 2) at the same time. There are also automated checks based on verification rules originally developed on behalf of the BBS by Mark Hill (2012) for the National Biodiversity Network (NBN) Record Cleaner. These highlight records which are out of the known spatial range of a species, or those of species which are inherently difficult to identify. The spatial checks update if accepted records for a species cover previously unrecorded hectads. The results of these checks are intended as a decision-support tool for verifiers, or to highlight to recorders where additional information may be helpful, not as a replacement for human

Table 2. 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.	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 (and would not be exported to the NBN Atlas for those schemes that link directly to NBN). 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.

checks. Verifiers also have additional download capabilities for any records for which they have verification permissions. BBS Regional Recorders who have not yet engaged with verification within iRecord are encouraged to get in touch with the Recording Secretary!

iRecord link with iNaturalist

iNaturalist is a global online platform for collecting wildlife observations; it uses a crowd-sourcing approach and image-recognition from photos to help with species identification. It is a joint initiative of the California Academy of

Sciences and the National Geographic Society. iNaturalist differs from iRecord in that records are labelled as ‘Research Grade’ (the term used by iNaturalist to indicate accepted records) once there is a two-thirds consensus on the identification of the taxon by the community; photos are not an absolute requirement for using the platform, but most records do have photos owing to the crowd-sourced identification element. Within this system, records without photos can never be accepted as Research Grade, potentially limiting its use for some taxon groups and the type of vice-county curator-mediated

biological recording prevalent in Britain and Ireland. However, the use of this platform by naturalists in our area has been growing and in April 2021 a UK portal, iNaturalistUK, was launched (<https://uk.inaturalist.org/>).

Since September 2021, and in recognition of iRecord as one of the main points of online recording engagement with national recording schemes and societies in the UK, records from iNaturalist have been imported into iRecord once they reach Research Grade status (so, by definition, all records imported have photos and a consensus identification on iNaturalist). Whilst iNaturalist is used in the Republic of Ireland, there is currently no separate country 'portal' and the iRecord exchange includes only records from the UK, Isle of Man or Channel Islands. During the import process the species names are matched to the UK Species Inventory and grid references are added alongside the original lat./long. coordinates. The upshot of this is that these records become available for verification and use by those recording schemes using iRecord.

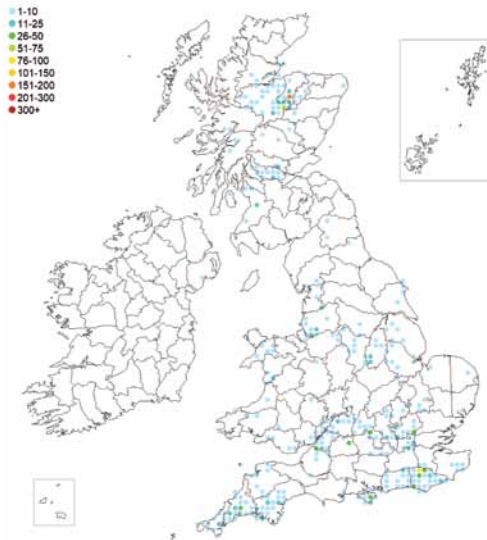
Since records from iNaturalist are imported to iRecord and do not represent the original copy, the verification process is slightly more complicated in terms of how any decision about the acceptability of an iNaturalist record viewed in iRecord is stored and shared back with the original platform. iNaturalist records which are given a verification status in iRecord (i.e. any active decision about a record except for redetermination; Table 2) are 'locked' and so protected from being overwritten by any further iNaturalist record imports. This is likely to be most appropriate for records which a verifier is happy to accept. The procedure for records which cannot be confirmed from the available evidence, or which are clearly wrong, is slightly more involved. A user can redetermine and verify the records in iRecord as usual, but if this is done the

redetermination is not passed back to iNaturalist. An alternative is to suggest a redetermination as a new identification within iNaturalist itself, and there is a button to navigate to the relevant page directly from the iRecord version of the record.

Obviously adding new identifications directly on iNaturalist requires a separate account for that website to be set up, although this is a straightforward process. For uncertain records on iNaturalist, the simplest way of expressing doubt is often to suggest an identification at a broader taxonomic level rather than 'rejecting' a record (which is not a part of their system); suggesting a genus, or even Bryophyta, as the identification, along with a comment expressing why a finer classification is impossible based on the available evidence, should suffice to remove an error. Finally, it should be noted that iNaturalist recorders cannot be directly contacted through iRecord, and engagement with the record on the original platform is the only way of commenting in a way that the recorder is likely to see (although comments can be made against the record in the iRecord system, these will not be passed back to the original copy of the record in iNaturalist).

Because of these issues, and general concern about what constitutes a 'Research Grade' record in iNaturalist, it is fair to say that there have been reservations from the wider iRecord verifier community about the import of these data. However, the iNaturalist community clearly contains some active and skilled bryologists, including some BBS members, and it would be foolish to completely ignore the potential of these data and the educational opportunity afforded by the ease with which one can comment on, and redetermine, records on iNaturalist. Finally, within the iRecord verification interface, iNaturalist records are kept separately, making it easy to address or ignore them as time permits.

As it is just 18 months since iNaturalist



△ Figure 6. Number of accepted bryophyte records in iRecord originating from iNaturalist per hectad.

bryophyte records began to be imported to iRecord, and perhaps also because of the concerns mentioned above, the number of unconfirmed records from iNaturalist is relatively high (Fig. 9) compared to those which have been accepted (Fig. 6). Of a total of 20,744 iNaturalist records

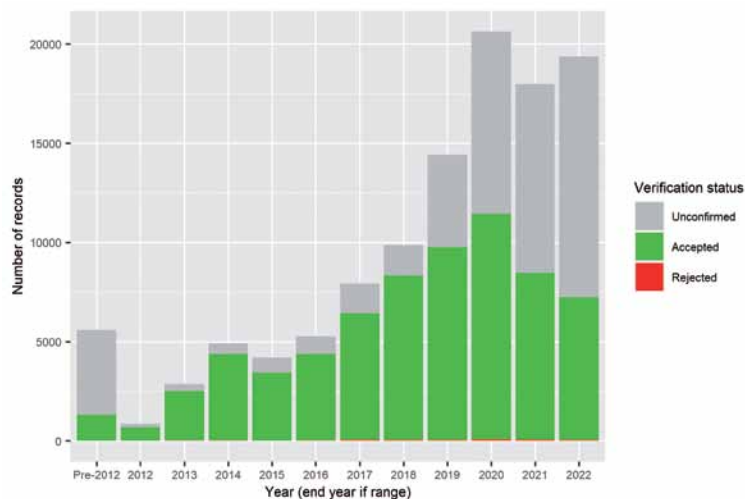
in iRecord, 18,775 remain unconfirmed. Records from iNaturalist make up almost 18% of the total records in iRecord, yet less than 3% of accepted records.

Unconfirmed data in iRecord

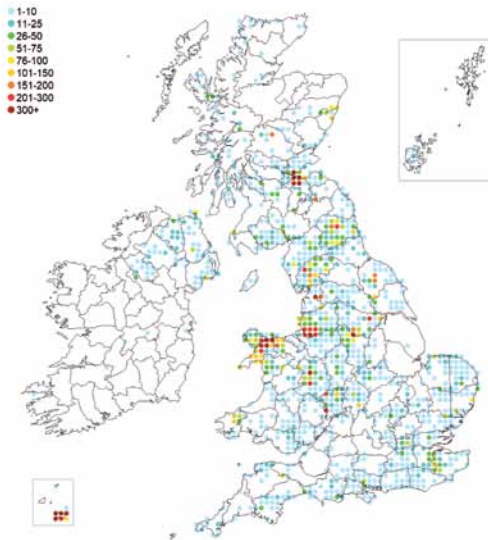
The data described so far in this article relate to the more than 67,000 records that have been reviewed and accepted in iRecord (i.e. verification status 2 is 'correct' or 'considered correct'; Table 2). In addition, there are currently over 47,000 unconfirmed bryophyte records in iRecord, the majority of which have not yet been reviewed. The number of bryophyte records being submitted to iRecord annually continues to rise, but, in recent years, a smaller proportion of these records are being verified (Figs 7 and 8). This can be partly explained by the iNaturalist imports (Fig. 9).

Data availability and exchange

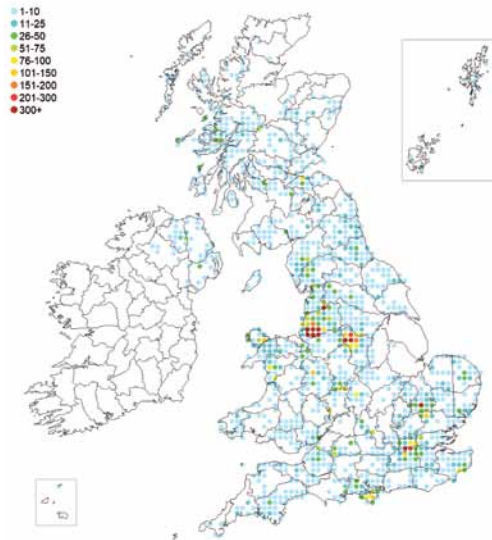
The National Biodiversity Network (NBN) Atlas (<https://nbnatlas.org/>) is a collaborative project that aggregates biodiversity data from multiple sources, making it available and usable online.



◁ Figure 7. Number of bryophyte records in iRecord (including iNaturalist data) by verification status and year.



△ Figure 8. Number of unconfirmed bryophyte records in iRecord (excluding iNaturalist data) per hectad.



△ Figure 9. Number of unconfirmed bryophyte records in iRecord originating from iNaturalist per hectad.

BRC facilitates data-sharing from iRecord to the NBN Atlas, generally on a monthly basis. Most ‘accepted’ bryophyte records can be found on the NBN Atlas as a dataset named ‘Bryophyte records via iRecord’ under the ownership of the BBS (see link below). There were 55,089 such records uploaded to the NBN Atlas on 13 December 2022, with another update due before the publication of this article.

Both the NBN Atlas and iRecord use the UK Species Inventory (UKSI), a taxonomic list managed by the Natural History Museum with ongoing input from taxonomic experts. We have recently completed work to help bring the UKSI in line with the BBS *Census Catalogue* (Blockeel *et al.*, 2021) and accepted taxonomic changes since then, although at the time of writing iRecord and the NBN had not yet imported these changes. When the UKSI import is completed, all bryophyte taxa will be recordable in iRecord under their current accepted names, although synonyms will also be available. It is notable

that the shared use of the UKSI by iRecord and the NBN Atlas has enabled more frequent data sharing to the NBN Atlas from iRecord than has recently been possible from the BBS database. The latter uses a separate taxonomic list (the BRC ‘taxon register’) which not only has to be kept up to date in its own right, but must also be aligned with the UKSI for accurate exports. Other BBS datasets currently listed on the NBN Atlas are ‘Bryophyte data for Great Britain from the British Bryological Society held by BRC: Atlas 2014’ and ‘Bryophyte data for Great Britain and Ireland from the British Bryological Society held by BRC: data compiled post-Atlas’ (see <https://registry.nbnatlas.org/public/show/dp74>). These cover all BBS data holdings in the BRC database. Direct exports from the BBS database are, of course, also regularly supplied to Regional Recorders, and other members, upon request.

There have been 737,000 records submitted to the BBS database since the last Atlas (Amy & Pescott, 2022), and, whilst some of the 60,000

records submitted to iRecord in that time may also have been submitted to the Recording Secretary for inclusion in the BBS database, the figure for iRecord is likely to include significant additions. Where data have been exported from iRecord by recorders and submitted to the Recording Secretary, then those records are also included in the BBS database, but there has so far been no wholesale transfer of data from iRecord to that database. Future developments to the BBS recording infrastructure may make such reconciliations and exchanges more straightforward, and the possibilities in this area are discussed in a separate *Field Bryology* article (Pescott & Amy, 2023).

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