



*Breutelia chrysocoma.*

Andrew Branson

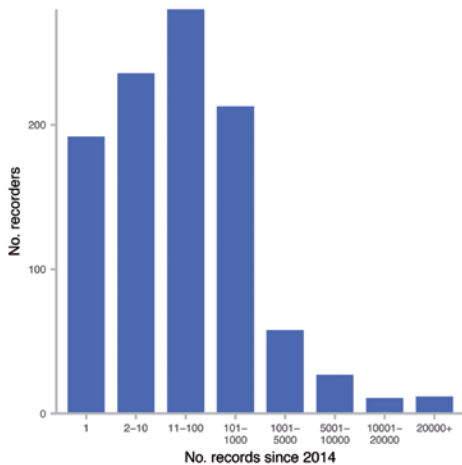
# Patterns of bryophyte recording in Britain and Ireland since the 2014 *Atlas*

**Sam Amy** and **Oli Pescott** summarise over 0.7 million records added to the BBS database since the *Atlas*

The BBS database comprises all records of bryophytes from Britain and Ireland submitted by members, and is maintained by the Biological Records Centre (BRC) at UKCEH Wallingford. These data are used to produce distribution maps, checklists, atlases and conservation assessments, and can be queried to give information on any subset of interest, whether taxonomic, geographic, temporal, or any combination of these. The data are, of course, also used for various ecological research projects, and shared with the wider ecological community through the UK National Biodiversity Network Atlas (<https://nbnatlas.org/>) and the Irish National Biodiversity Data Centre Maps website

(<https://maps.biodiversityireland.ie/>). Both of these structures are also 'nodes' of the Global Biodiversity Information Facility ([www.gbif.org](http://www.gbif.org)), meaning that BBS data are available to all users of that portal as well.

The *Atlas of British and Irish Bryophytes* was published in 2014 (Blockeel *et al.*, 2014), and this note is intended to summarise data additions since then. Many data were processed and loaded to the database in 2020–2021 in advance of the new *Census Catalogue* (Blockeel *et al.*, 2021), and the recent addition of a new botanical data assistant (Sam Amy) to the BRC staff has enabled us to keep up-to-date with incoming records. Since the *Atlas*, we have had over 737,000 records submitted to the database, bringing



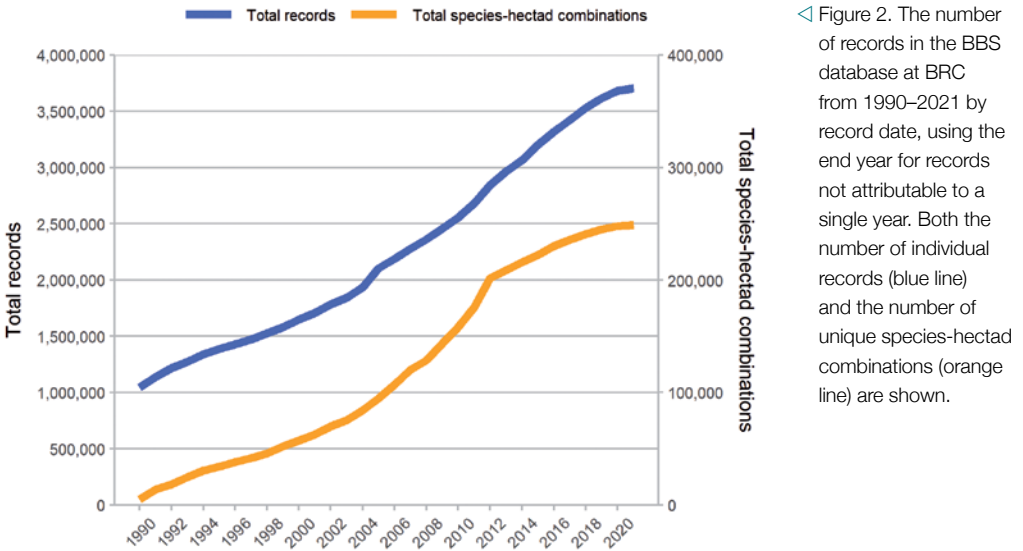
△ Figure 1. Number of records per recorder submitted to the database since 2014.

the total to over 3,700,000. The most prolific BBS recorders account for a disproportionate amount of the records (Fig. 1). With the caveat that contributor lists are often truncated for entry to the database (usually to a maximum of four recorders), and hence some additional contributors are subsumed under the always prolific *et al.*, we recognise some of these efforts below. Six recorders have more than 30,000 records attributed to each of them in 2014–2020 (either individually or jointly, and we stop at 2020 to minimise the lag effect): Tom Blockeel, Sam Bosanquet, Des Callaghan, Nick Hodgetts, Tom Ottley and Sharon Pilkington. In the same period, Mary Ghullam, Andy McLay, Gordon Rothero, Sue Rubinstein and Barry Stewart made more than 20,000 records, and more than 10,000 were contributed by Andrew Branson, Bob Ellis, Richard Fisk, Clare Halpin, Charles and Hilary Hipkin, Liz Kungu, Sean O’Leary, Chris Preston and Rory Whytock. Many records are also attributed to group meetings, such as the BBS meetings (>24,000) and Cambridge Bryological Excursions (>11,000), although

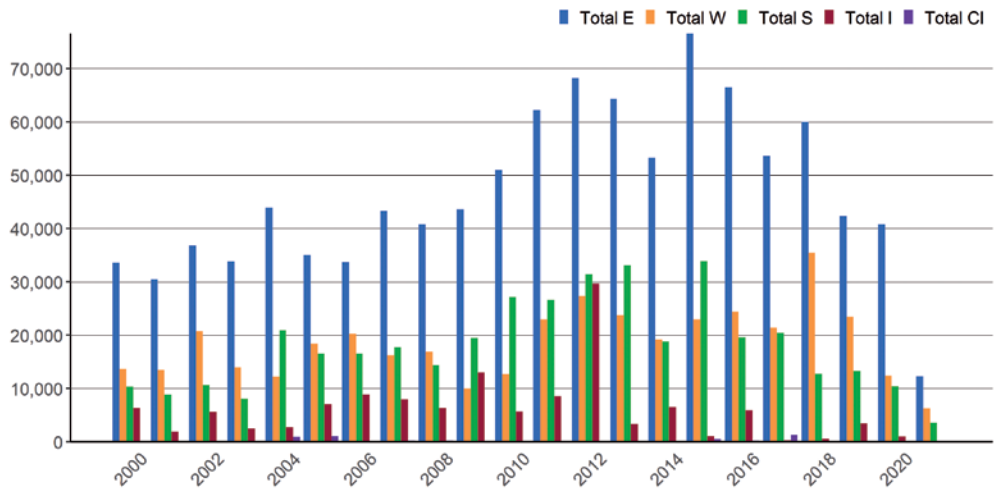
often these are submitted with recorder names in addition. More than 14,000 of the records were collected under the auspices of the Bryophyte Habitats Survey for the BBS Bryophyte Ecology Group (BRECOG), and were recently gratefully received from Jeff Bates. These data are very significant for their even national spread and extensive associated ecological information. This dataset is in the process of being analysed and compiled for publication by Jeff and other members of the BRECOG group.

Almost all records now reach the BBS Recording Secretary in the form of either BBS electronic recording cards or CSV files. Whilst many of the latter have the appropriate headings to match fields in the database, as in the recording spreadsheets provided on the BBS website, this is not always the case. For example, data on habitat type, reproductive characters and whether a microscope was used, are sometimes all contained within a single comments field, and thus some manual sorting is required to retain as much information as possible in an accessible way within the database. We are grateful to the many Regional Recorders who also spend time on such data tidying, as well as the vital role of verifying and compiling, before passing on records. Processing the contents of the c. 270 compiled datasets and batches of recording cards we have received since 2014 would be a much more time-consuming activity without this local effort.

Amendments are also constantly made to the database, including redeterminations of herbarium specimens and errors in the location of historic records which recorders have become aware of. We welcome any such information, and in such cases the original information is maintained for posterity alongside the new. Taxonomic changes are also continuously incorporated into the BBS database. Indeed, for



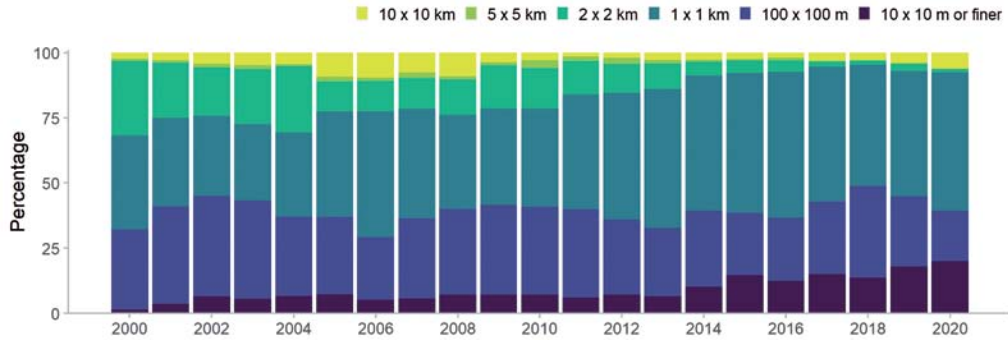
◁ Figure 2. The number of records in the BBS database at BRC from 1990–2021 by record date, using the end year for records not attributable to a single year. Both the number of individual records (blue line) and the number of unique species-hectad combinations (orange line) are shown.



△ Figure 3. Total number of records per year in the BBS database for England (including the Isle of Man), Wales, Scotland, Ireland and the Channel Islands, 2000–2021. The figure is based on records which are attributable to a single year.

the maps presented in this article, records have been converted to the taxonomic ranks accepted in Blockeel *et al.* (2021). Currently, of all the records held in the database, 89% are at the rank of species, 6% variety, 4% species aggregate, 0.6% subspecies and 0.1% genus.

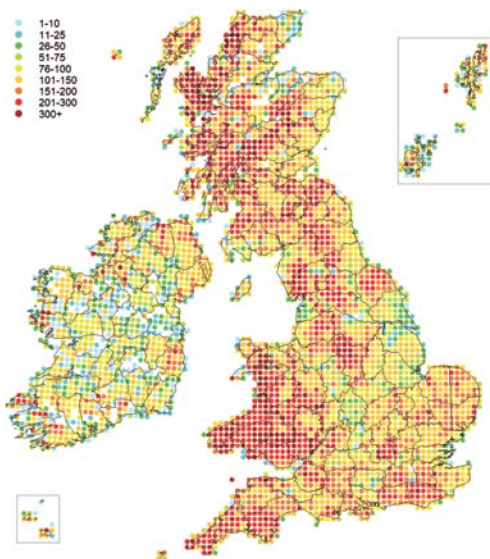
Despite the ‘determined effort to visit under-recorded areas’ for the last *Atlas* and the resulting steep increase in records submitted to the database prior to its publication (see Fig. 2.4 in Blockeel *et al.*, 2014), the recording rate appears to have remained fairly stable since then (Figs 2,



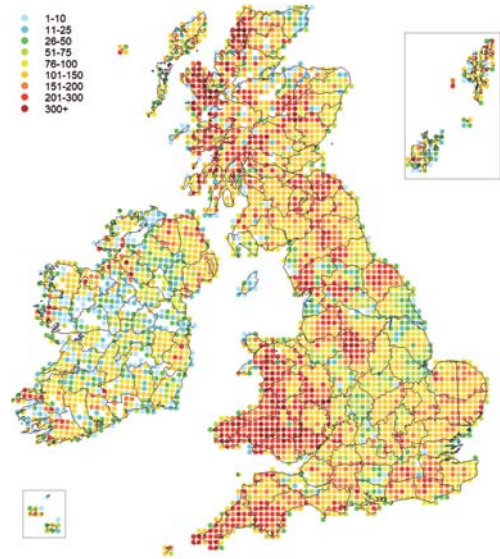
△ Figure 4. Percentage of records in the BBS database at each level of precision, 2000–2020.

3). The apparent decline in the rate of recording since 2019 is partly the result of reduced recording during the COVID pandemic, as well as the inevitable lag between records being collected and reaching the database. The number of new unique species-hectad combinations has, however, reduced significantly since 2013, from a high of over 25,000 in 2012, to a yearly average of around 5800 between 2013 and 2020.

With the ubiquity of GPS technology, the trend for increasing precision of records continues (Fig. 4). The number of records collected at a precision of  $10 \times 10$  m or finer has increased from 1.4% in 2000 to 20% in 2020, with a particularly notable rise since 2014. On the other hand, the number of records at tetrad precision has declined considerably in the last ten years in favour of monads. There has also been

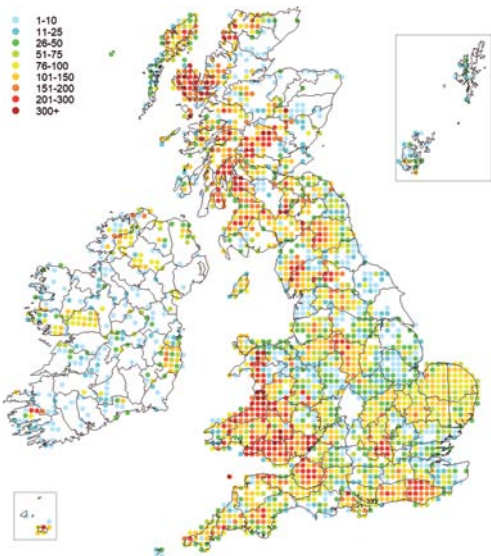


△ Figure 5. Number of bryophyte taxa recorded per hectad since 1990. This and all subsequent maps are plotted with vice-county boundaries.



△ Figure 6. Number of bryophyte taxa recorded per hectad from 1990 to 2013.

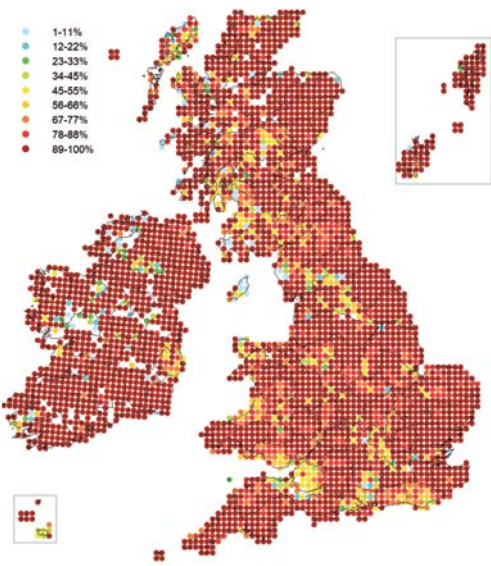




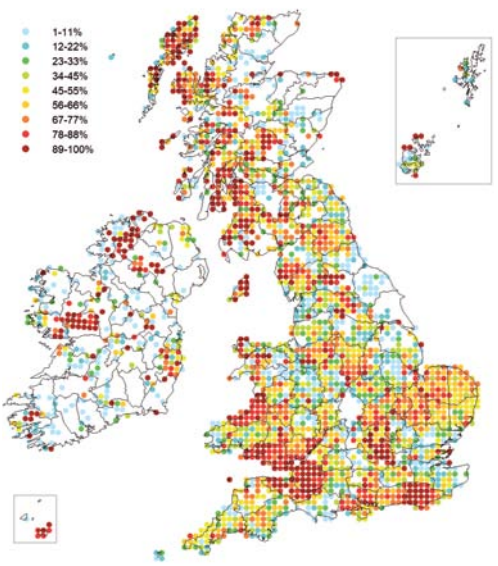
△ Figure 7. Number of bryophyte taxa recorded per hectad since 2014.

a trend towards increasing temporal precision. In the early 1990s around 30% of records were attributed to a date range rather than a single day, the majority of which were either a month or year, in roughly equal proportions. This has gradually reduced to around 0.25% of records attributed to a date range in the past few years, and so far in 2022 all records have had a precise date.

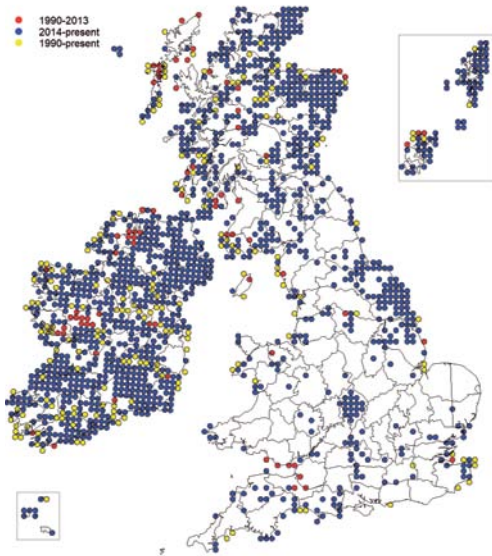
Bryophytes remain very unevenly recorded, and as such it is particularly important to identify geographic areas that may benefit from increased attention. We hope that the maps presented here will prove useful in this endeavour, both to individuals and the Society as a whole. The maps in this note compare records collected from 1990–2013 with those from 2014 to the present day (Figs 5–19), as well as the whole time-period. Almost three-quarters of the records in the 2014 *Atlas* were collected between 1990 and



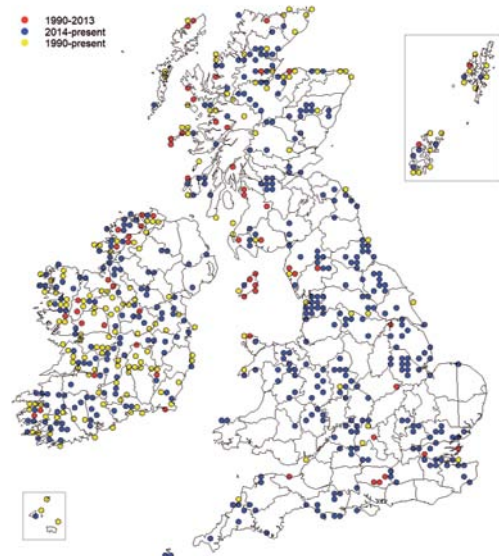
△ Figure 8. Number of bryophyte taxa recorded from each hectad between 1990 and 2013, expressed as a percentage of the overall number of these taxa recorded in the hectad since 1990.



△ Figure 9. Number of bryophyte taxa recorded from each hectad since 2014, expressed as a percentage of the overall number of these taxa recorded in the hectad since 1990.



△ Figure 10. Hectads in which no bryophytes were recorded in 1990–2013, 2014 to present, and in both time periods (1990 to present).

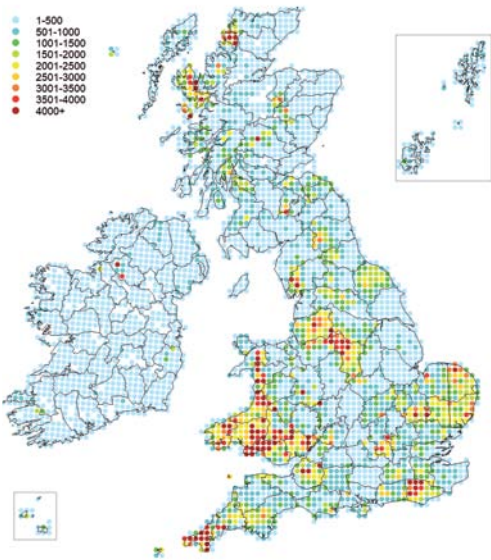


△ Figure 11. Hectads in which 1–10 bryophyte taxa were recorded in 1990–2013, 2014–present, and in both time periods (1990–present).

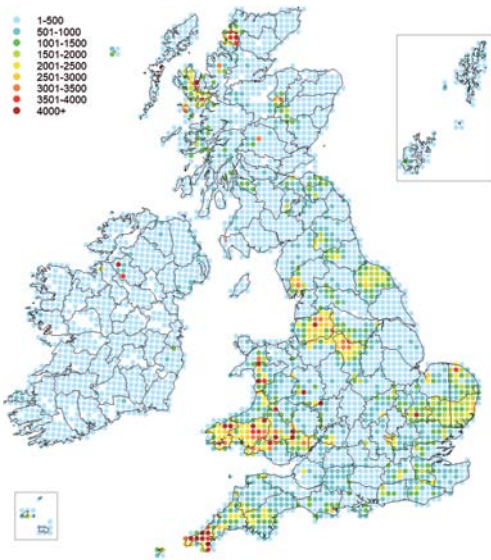
2013, and this provides a useful comparison to the time-period since then for highlighting areas that may benefit from attention over the next decade or so. It is important to note that many areas not well recorded between 1990 and 2013 were focused on before this time, and Chapter 3 of the *Atlas* gives similar comparisons with records from 1950 to 1989 (Blockeel *et al.* 2014). It is not surprising to see a considerably higher level of recording overall in the 23 years between 1990 and 2013 than in the 7.5 years since 2014, and it can also be difficult to disentangle the effects of species diversity from recorder effort when one is dealing with simple counts and summaries (a topic which has spawned a massive technical literature which we do not intend to treat here). However, we can compare a range of simple metrics such as number of taxa (Figs 5–11), number of records (Figs 12–14), average number of records per species (Figs 15–17) and

the number of first records for taxa (Figs 18, 19) to build a picture of recent bryophyte recording in Britain and Ireland. The tradition of recording within vice-county boundaries also helps to distinguish recorder effort from diversity where differences in recording intensity are clearly delineated by them.

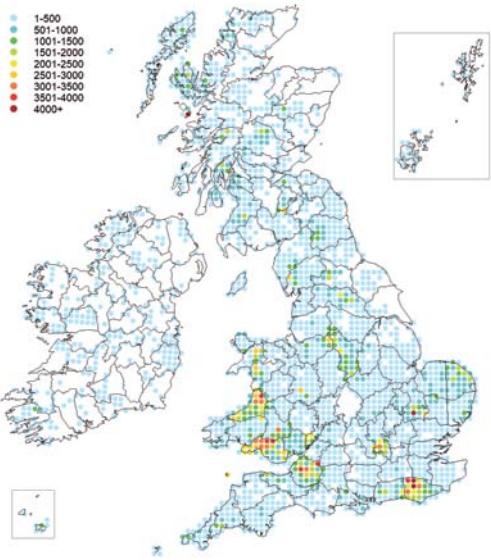
The total number of bryophyte taxa (including species and infraspecific taxa) recorded in each hectad between 1990 and 2022 is shown in Figure 5. The long-recognised west/east gradient in bryophyte species richness, with higher totals in cool, wet, and often upland situations, can be clearly seen here, but the relatively low numbers of taxa recorded in some areas where diversity might be expected to be higher, such as south-west Ireland, may be attributed to lower recorder effort. Initially, the extra records made after 2014 appear to have made little difference to the number of bryophyte taxa recorded per



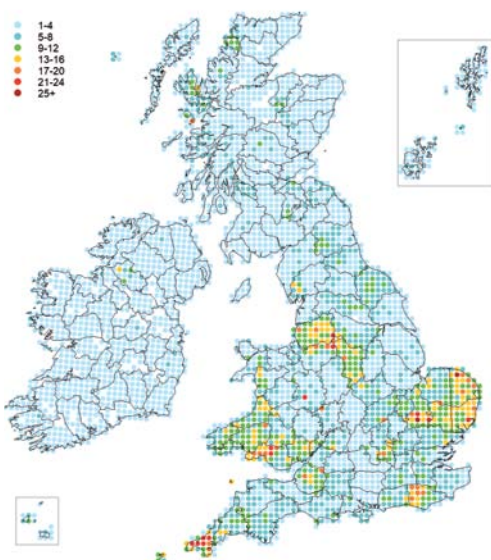
△ Figure 12. The total number of records per hectad since 1990.



△ Figure 13. The total number of records per hectad between 1990 and 2013.

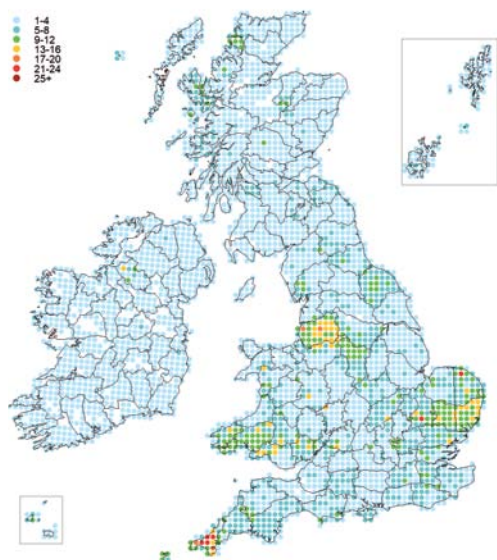


△ Figure 14. The total number of records per hectad since 2014.

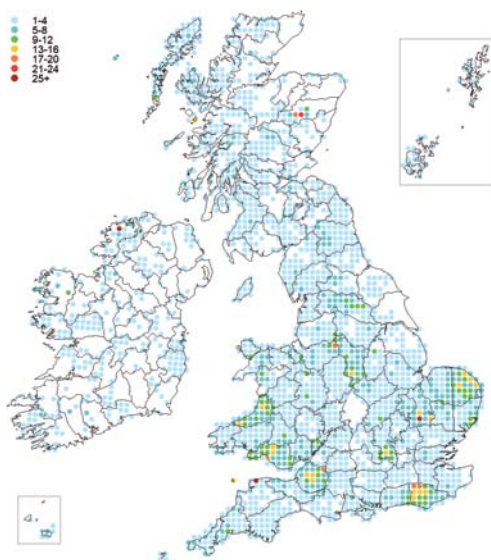


△ Figure 15. Average number of records per species in each hectad since 1990.

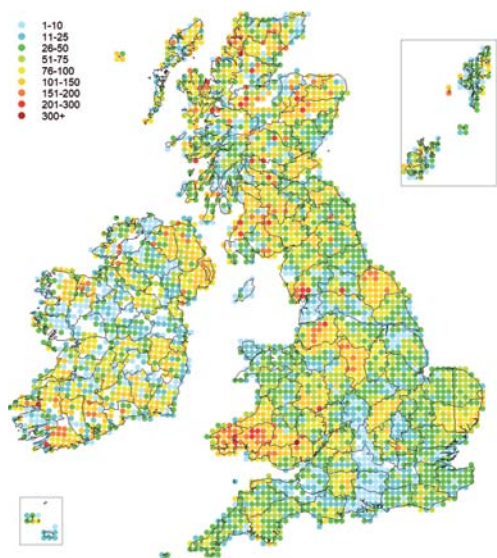




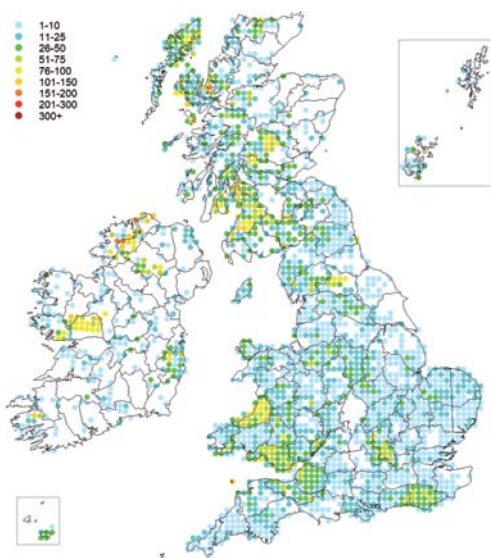
△ Figure 16. Average number of records per species in each hectad between 1990 and 2013.



△ Figure 17. Average number of records per species in each hectad since 2014.



△ Figure 18. Number of bryophyte taxa with a first record for the hectad between 1990 and 2013.



△ Figure 19. Number of bryophyte taxa with a first record for the hectad since 2014.



square, but closer inspection reveals that the range of higher coverage has been extended in many areas since 2014 (Figs 6, 7). Some of the more extensive areas that have had higher numbers of taxa recorded since 2014 include parts of the northern and central Highlands and Dumfriesshire in Scotland, and in England some more discrete areas adhering to vice-county boundaries such as North Somerset and East Sussex. Other areas, such as parts of South Wales, have remained well-recorded throughout. Figs 8 and 9 compare the relative number of bryophyte taxa recorded between the two date-classes 1990–2013 and 2014–2022, showing them in each case as a percentage of the overall number of species found since 1990. This emphasises the differences between the two periods, but does not distinguish between hectads with very many, or very few, records in both. Those areas with high values in Fig. 9 but low values in Fig. 8 imply an effort by recorders to visit previously under-recorded locations. Obvious examples include North and South Somerset, East Sussex, Ayrshire and Renfrewshire.

Since 2014, no records have been made in 34% of hectads, and there are some notable regions from which very few or no records have been received since 2014. These include Warwickshire, Lanarkshire, South-East Yorkshire, the north-east of Scotland, and much of Ireland, and are shown in Figs 10 and 11. Of these, the areas which also had relatively low numbers of taxa recorded in 1990–2013 perhaps merit particular focus, for example, Warwickshire and South-East Yorkshire. Many of those hectads seriously under-recorded since 1990 are around the coast, representing squares with a low proportion of land cover and therefore a lower chance of being visited by bryologists (or even perhaps total inaccessibility in some cases). However, in Ireland there are also over 50

well-distributed inland hectads with no records, considerably fewer in Scotland, and fewer still in England. Of the 6.7% of squares with no records at the time of the 2014 *Atlas*, 1.9% (189 hectads) now have at least one record attributed to them.

The total number of records per hectad is shown in Figs 12–14, and as an alternative measure of the intensity of recording, the average number of records per species is shown in Figs 15–17. These maps have less of the variation than those showing numbers of taxa (Figs 5–7), and suggest those areas which have been the most intensively recorded. Those areas shown here to have a low average number of records per species since 2014 (Fig. 14), but which have a high number of taxa recorded (Fig. 7), are presumably those with a small number of thorough visits within a hectad. Conversely, the opposite pattern is suggestive of less intensive visits, perhaps by less experienced bryologists recording commoner taxa repeatedly.

Figs 18 and 19 show the number of new taxa recorded in each hectad. This includes taxa that may have been present but not found between 1990 and 2013, as well as any genuinely increasing taxa. Also, in the few cases where taxonomic splits have occurred, records of the new species or infraspecific taxa will appear here as new records. The extensive recording effort for the 2014 *Atlas* resulted in many first records of taxa across all countries (Fig. 18). Since 2014, new taxa continue to be recorded across Britain and, less so, Ireland (Fig. 19). Unsurprisingly, those areas with higher taxa numbers in this date-class than the previous (Figs 5–9) have seen the highest gains in the number of first records.

#### Historic datasets added to the database

As well as receiving new records collected since 2014, historic records and datasets are also sometimes compiled and sent for inclusion in

Table 1. Summary by vice-county of dataset of records made by Derek Ratcliffe between 1952 and 1961.

Vice County	No. records	Vice County	No. records	Vice County	No. records
3, South Devon	49	92, South Aberdeenshire	537	105, West Ross	2105
69, Westmorland	10	94, Banffshire	34	106, East Ross	618
70, Cumberland	3	95, Moray	67	107, East Sutherland	190
72, Dumfriesshire	56	96, Easternness	1049	108, West Sutherland	865
73, Kirkcudbrightshire	42	97, Westernness	679	109, Caithness	12
87, West Perthshire	4	98, Main Argyll	417	110, Outer Hebrides	149
88, Mid Perthshire	1184	102, South Ebudes	128	112, Shetland	106
89, East Perthshire	350	103, Mid Ebudes	6		
90, Angus	872	104, North Ebudes	212		

the database. One significant such dataset which has been added since the *Atlas*, and may be of interest to Regional Recorders, comprises records made by the late Derek Ratcliffe between 1952 and 1961. This dataset has had a chequered history. Derek Ratcliffe initially arranged for an assistant to extract records from his notebooks onto BBS recording cards for the 1991–94 *Atlas*, but when this *Atlas* appeared he was irritated to find that the records did not appear in it. It was only when he cleared his office on retirement that he found the cards sitting in a cupboard – they had never been sent to BRC. In working on data for the 2014 *Atlas* preference was given to more recent records, but the records have now been incorporated into the database. They are summarised in Table 1, and the original record cards are currently held at the BRC in Wallingford.

### Updates to the UK Species Inventory

The UK Species Inventory (UKSI) is the taxonomic database for all wildlife found in the UK used by many other systems holding biological records, such as the National Biodiversity Network (NBN) and iRecord. Maintained by the Natural History Museum, the UKSI depends on the leading expert amateur and professional taxonomists for each group of

taxa providing the information to keep it up to date. On behalf of the BBS, we have recently submitted a significant update for bryophytes based on the latest taxonomic developments, which will soon be integrated into the NBN.

### Acknowledgements

Thank you to Sharon Pilkington, for assisting with record processing in advance of the 2021 *Census Catalogue*. Thanks are also due to Val Burton, for originally digitising the Ratcliffe dataset, and to Chris Preston for assistance in checking this for errors. SA also thanks Stephanie Ames, Colin Harrower and Katharine Turvey for their help and guidance on database querying and mapping, and the BBS recorders she has emailed with queries about their records for their gracious replies. SA and OLP are partly supported by NERC award number NE/R016429/1 to UKCEH and the Biological Records Centre as part of the UK Status, Change and Projections of the Environment (UK-SCAPE) programme delivering National Capability.

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