Preston, C.D. 2013. **Following the BSBI's lead: the influence of the Atlas of the British flora, 1962-2012**. *New Journal of Botany*, 3 (1). 2-14. 10.1179/2042349713Y.0000000020

Following the BSBI's lead: the influence of the *Atlas of the British flora*, 1962–2012

C.D. Preston

Biological Records Centre, CEH Wallingford, Maclean Building, Benson Lane, Crowmarsh Gifford, Wallingford, Oxfordshire, OX10 8BB, UK

A formal proposal to map the vascular plants of Britain and Ireland (1950) led to the BSBI Maps Scheme (1954) and thence to the publication of the *Atlas of the British flora* (1962). The distinctive features of the *Atlas* were grid-based mapping, the comprehensive coverage of all native and many alien species and of almost all Ordnance Survey 10 × 10 km squares, the collection of records by volunteers and the use of innovative mapping technology. The Maps Scheme personnel and machinery were transferred to the newly formed Biological Records Centre in 1964. The *Atlas* methods (with the frequent exception of the mapping technology) were soon taken up for the mapping of both plants and animals, especially birds, at both national and regional levels, particularly in Europe and North America. The details of the story are influenced by the popularity of a taxonomic group, the activities of a few highly motivated individuals and the availability of infrastructures to support recording and publishing. In Britain, maps of over 10,000 taxa are now available at the national scale in published atlases (with many more on the NBN Gateway) and the *Atlas* methodology reinvigorated county floras. Although the motives for launching the Maps Scheme were scientific, atlas recording had little impact on academic science until the computer technology became available to create and analyse large electronic datasets. By contrast there was an immediate, although unanticipated, impact on conservation, with the 1962 *Atlas* leading directly to the first British Red Data Book.

Keywords: conservation, county flora, distribution, grid square, map, optimism, phytogeography, recording, standard sampling, volunteer

Introduction

The publication of the *Atlas of the British flora* was celebrated on 28 April 1962 by a dinner at Crosby Hall, Chelsea. In his after-dinner speech, Max Nicholson, the Director-General of the Nature Conservancy, left his audience in no doubt about the importance of the new publication:

> 'Mr. Nicholson ... felt that the Society had made a great leap forward by producing the Atlas, more especially as it was delivered only three hours late! Ornithologists, he felt, had been put to shame by the botanists, and other Societies would soon have to follow the lead given by the B.S.B.I.' (Bowen 1962).

In this paper I examine the influence of the *Atlas* on subsequent botanical studies and on students of other groups, the 'Ornithologists … and other Societies' of Nicholson's speech. I have concentrated on the period up to the publication of the *New atlas of the British & Irish flora* (Preston *et al*. 2002), which appeared at a time when the techniques of recording were being transformed by technological changes. For a complementary article which discusses recent developments in more detail, see Preston *et al*. (2012). I will start by reviewing the nature of the BSBI's achievement in producing the 1962 *Atlas*.

Atlas of the British Flora (1962)

The *Atlas of the British flora* (Perring & Walters 1962) presented maps of 1706 taxa in Britain and Ireland, including all the native, non-critical species then recognised and many aliens. It was the result of a proposal made by Roy Clapham in 1950 at the conclusion of 'a carefully stage-managed conference' in London devoted to 'The study of the distribution of British plants' (Clapham 1951; Allen 1986). The detailed plans were developed by a Maps Committee, set up in 1950 and initially comprising J.E. Lousley (Chairman), A.R. Clapham (Secretary), E. Milne-Redhead, T.G. Tutin, E.C. Wallace & E.F. Warburg. David Webb became involved in detailed discussions about the application of the scheme to Ireland when he joined Clapham, Tutin, C.D. Pigott, P.D. Sell, S.M. Walters and Tyge Böcher (Copenhagen) on their long field trip to Ireland in 1952 (Sell 2007; C.D. Pigott, pers. comm., 2012). In December 1953, the Maps Committee accepted a grant from the Nuffield Foundation to support the scheme, and the Committee was reformed and enlarged (Perring & Walters 1962). Further financial support was later received from the Nature Conservancy.

The BSBI Maps Scheme was launched in 1954 with Max Walters of the Botany School, Cambridge, as Director and Frank Perring (the 'Senior Worker') as the full-time paid organiser of the Scheme. Three of the aims of the Maps Scheme were particularly significant:

- to map records in 10 × 10 km squares of the British Ordnance Survey National Grid, which was specially extrapolated for the purpose to Ireland by Webb (1954);
- to be comprehensive, including all species and covering all grid squares;
- to obtain this comprehensive coverage by enlisting the support of as many volunteer recorders as possible.

These aims are now so familiar from this and numerous later recording schemes that it is tempting to regard them as being inevitable. However, the papers at the 1950 conference had explored different ways in which the British flora might be mapped, and there were certainly influential members of the BSBI who argued for other methods. Almost all agreed that maps which simply showed the presence of species in vice-counties were inadequate; Lousley (1951a) argued that such a map of *Pulsatilla vulgaris* 'exaggerated the distribution and failed to indicate the association of the species with calcareous soils'. Nevertheless, Dandy (1951) mounted a rearguard action in defence of vice-counties, arguing that 'every Briton has some idea of the counties and their arrangement on the map …. Who, however, could be expected to memorize the positions and references of grid-squares?'. One possibility raised by Lousley (1951b) was to show frequency within vice-counties by shading, perhaps with outlying localities as dots, along the lines of the maps which had been published for many years by the Danmarks Topografisk-Botaniske Undersøgelse of the Dansk Botaniske Forening. Clapham (1951), in the last paper of the conference, discussed the alternatives with almost judicial authority and came down in favour of 10-km grid squares.

An alternative to a new, comprehensive survey would have been to plot records from herbaria. Knut Faegri pointed out that the exceptionally large amount of herbarium material in Scandinavia meant that 'to a great extent maps could be prepared from herbarium specimens alone'. However Donald Pigott, who had been gathering data for distribution maps of *Thymus* species (Pigott 1953, 1955), drew attention to the poor representation of common species in herbaria. Some contributors to the discussion session at the conclusion of the conference were simply pessimistic, notably 'Heff' Warburg who argued that 'adequate information about the distribution of some species is unlikely to be available for several years and in the meantime distribution maps prepared from present data would in effect show the homes and haunts of botanists rather than of plants', to which Tom Tutin responded that 'there was a lot of available information which could be sifted … a set of maps even if not perfect was better than no maps at all' (Lousley 1951c).

The BSBI was only able to achieve its ambitious plans for the 1962 *Atlas* by making use of innovative technology, developed for the project by Roy Smith of the firm Powers-Samas (Perring & Walters 1962; Perring 1963a). Powers-Samas specialised in machinery for accountancy and other uses which was operated by punched cards; the firm was undergoing a period of expansion in the post-war years (Carmichael 1996). Plants seen in the field were marked on record cards which listed abbreviated plant names and code numbers, and summarised from these onto a single 10-km square 'master card'. The master cards were used to input data onto forty-column punched cards, one card per record, using an Automatic Key Punch. The data on a set of cards could be printed using a Tabulator, allowing the accuracy of the punching to be checked. After checking, the cards were sorted by a mechanical sorter into species order. Records of less common species were also extracted from herbaria and published books and papers onto forty-column cards, and the cards for a species were used to plot distribution maps mechanically (Figure 1). This allowed an average map with 1000 dots to be produced in 20 minutes and a map of a very common species, with 3500 dots, to be plotted in an hour. Special symbols (such as the open circles which were used for some species to denote pre-1930 records) were usually added to the maps by hand (Perring 1963a).

The collection of records using field cards with abbreviated species names had been pioneered in the Netherlands by the Instituut voor het Vegetatie-Ondezoek in Nederland, who organised the collection of records from rectangles of a Dutch military grid. Kloos (1951) gave an influential talk on these methods at the 1950 conference, and he demonstrated the field card in Quendon Wood, Essex, on the conference excursion. However, the Dutch maps were plotted by hand, and the mechanical plotting was a truly innovative feature of the Maps Scheme.

Once the methods had been worked out, a sustained campaign of field recording was needed. It was the particular need for comprehensive data on common species that led to the decision to run the Maps Scheme as a project which would seek help from volunteer recorders (Perring 1963a). The methods for the scheme were published by Walters (1954) and ‘appeals for help were made in 1954 to all members of the Botanical Society, the British Ecological Society, local Natural History Societies, Field Study Centres, University Botany Departments, and to the public in general through articles and letters to national and local newspapers and scientific periodicals’ (Perring & Walters 1962). An indication of the need to draw on all available help comes from the special provision made for those who were wedded to the outdated taxonomy of Bentham & Hooker’s *Handbook of the British flora*. Special field cards listed species with the nomenclature of this book, notorious for its ‘wrong-headed taxonomy’ (Allen 2010), but they cunningly omitted the code numbers of those species which were defined more broadly than in Clapham *et al*. (1952), so that the records of these taxa could be disregarded. There was also a card which listed 113 common species, with unabbreviated scientific and English names; this was used by many schools. Both experienced botanists and young recruits had to be trained in the new approach; the national grid, for example, had only been printed on Ordnance Survey maps since the Second World War and was therefore unfamiliar to many recorders. Many members of the BSBI who became prominent in later years cut their teeth on the fieldwork for the *Atlas*. They were often recruited and inspired by Frank Perring, whose talents proved to be ideally suited to the task (Preston & Oswald 2006).

One feature which permeated the Maps Scheme was an essential pragmatism, presaged by Tutin’s comment that ‘a set of maps even if not perfect was better than no maps at all’. To reduce the size of the task, coastal squares with only a fragment of land were amalgamated with nearby squares, so that, for example, plants recorded on the promontory of Brean Down, ST25, were (with few exceptions) mapped in the adjacent square ST35. More significantly, the starting date for recent records (mapped as black dots) was altered from 1950 to 1930 so that the surveys of Dorset (by R.D’O. Good) and the Hebrides (by J.W. Heslop Harrison) did not need to be repeated. Species’ aggregates were mapped if records for the segregates were inadequate and the latter held over for inclusion in a *Critical supplement* (Perring & Sell 1968); the *Rosa* species in Section *Caninae* were never mapped at all.

Fleas, fritillaries and cuckoos: national atlases, Britain and Ireland

Frank Perring, his staff and the mapping equipment were transferred from Cambridge to the Nature Conservancy’s newly opened Monks Wood Experimental Station in April 1964 to form the Biological Records Centre (BRC), a name which was only arrived at after some debate (Harding & Sheail 1992). BRC had a broad remit to promote the study of the distribution of plants and animals and publish the results. A ‘List of Surveys and Schemes involving the B.R.C.’ prepared in 1968 enumerates 18 ‘Distribution Maps Schemes’ (Figure 2). The number of schemes grew rapidly after this; Harding & Sheail list 41 founded between 1970 and 1990 and the total number now stands at 80. The early schemes were very varied, but most had no specific funding and departed from the BSBI model in adopting a slower progress towards their ‘final’ atlases, often via interim maps published in journals or in ‘preliminary’ or ‘provisional’ atlases. Beyond this it is difficult to generalise, and it seems best to illustrate the variety of approaches by describing three very different atlases.

Despite Max Nicholson’s admonition at the celebratory dinner, ornithologists were rather slow to ‘follow the lead given by the B.S.B.I.’. In the Foreword to the bird atlas which eventually appeared (Sharrock 1976), James Ferguson-Lees described how:

> ‘For over two years, the possibility was ... discussed. ... There was a seemingly irreconcilable division of opinion between the optimists and enthusiasts on the one hand and the pessimists and diffidents on the other, the latter believing that such a project was doomed to failure through inadequate coverage ... Some

> ornithologists also considered that the whole concept lacked sufficient scientific merit to justify its being undertaken at all'.

However, the optimists were strengthened by pioneer survey work in the West Midlands (Lord & Munns 1970) and a national survey was eventually carried out between 1968 and 1972. Needless to say, the atlas achieved a coverage which impressed even the optimists.

The Lepidoptera scheme, covering butterflies and larger moths, was one of the minority of schemes run directly from BRC. It was founded in 1967, when the entomologist John Heath joined the Centre. Publicity in these early years was good – reaching even me as a shy grammar school boy in Yorkshire. A provisional atlas of butterflies was published in 1970 and started with the statement that it had 'been prepared using the methods evolved by Dr. Franklyn Perring for the "Atlas of the British Flora"' (Heath 1970). Data collection finished in 1982 after 15 years and the resulting butterfly atlas was based on the records of 'many hundreds' of recorders (Heath *et al*. 1984). John Heath died in 1987 and although some distribution maps of moths had been published by then, or appeared later, the moth records have only recently been published in full as the earlier of two major datasets on which the *Provisional atlas of the UK's larger moths* (Hill *et al*. 2010) is based.

The Fleas recording scheme represents one of those run by an individual expert, Bob George, a schoolteacher. His interest in fleas had started in 1950, when he collected fleas from the mice infesting his flat in Gloucester. He was encouraged to start a formal recording scheme by Frank Perring in 1964. By 1974 a provisional atlas was published, but the final atlas was not published until 2008, incorporating data gathered by Bob over 56 years (George 1974, 2008). Bob George worked tirelessly to encourage ornithologists, mammalogists, pet owners and others to send him flea samples and without his single-handed efforts the atlas would not have been produced. The cover is appropriately individualistic, its pale blue background making reference to Bob's time as a Spitfire pilot in World War II.

By 2012, 10-km square distribution maps of over 10,000 species were available in printed atlases, and numerous other maps were available on the National Biodiversity Network Gateway or other internet sites (Preston *et al*. 2012). This represents a remarkable achievement by British and Irish naturalists. In addition to the birds, fleas and Lepidoptera, atlases have been published for most of the other groups listed in 1968, including bryophytes (Hill *et al*. 1991–94), reptiles and amphibians (Arnold 1995), freshwater fish (Davies *et al*. 2004), spiders (Harvey *et al*. 2002), dragonflies (Merritt *et al*. 1996), molluscs (Kerney 1999), leeches (Elliott & Tullett 1982), Simulidae (Davies 1968) and ticks (Martyn 1988). The length of time it took to map the species in these groups is striking. In some cases (e.g. bryophytes) a small but dedicated band of recorders accumulated records steadily for nearly 30 years, but in at least one case (fish) the earlier scheme did not bear fruit and the atlas was the result of a later project.

Downscaling the methods: county atlases

Revival of county floras

One of the major and quite unexpected results of the 1962 *Atlas* was to reinvigorate county floras. Although the first county flora was published in 1660, it was not until the 19th century that they were produced in any quantity (Figure 3). However, the publication of floras had reached a low ebb by 1950. Flora projects tended to be protracted and even when the fieldwork was completed, the economics of publishing provided an additional and sometimes impenetrable barrier to publication. *Flora of Gloucestershire* (Riddelsdell *et al*. 1948) took 71 years to complete and, as Allen (2003) has pointed out, two of the three authors had been dead for seven years by the time it was published. It was even dedicated ‘to the memory of the many contributors who have not lived to see the results of their labours’, and the history of the flora project itself takes up 30 pages. There are extensive lists of records for many species, but there is no clear distinction between old and recent records.

However, by 1950 other authors were experimenting with different formats. Ronald Good’s *Geographical Handbook of the Dorset Flora*, also published in 1948, had dot distribution maps derived from the numerous stands of semi-natural vegetation he had sampled in the 1930s. A ‘Brains Trust’ at the 1950 BSBI conference was asked whether future floras should follow the lines of Dorset or Gloucestershire. The ‘Brains’ favoured Gloucestershire, but Tom Tutin commented ‘that perhaps local floras would be unnecessary once the projected series of maps was published!’ (Lousley 1951c).

In fact, it took botanists little time to work out how to scale the *Atlas* methodology down to the county scale. Grid squares could be reduced in size and the technique of compiling records onto ‘master cards’ would of course also work at the local scale. E.S. Edees was the first to realise that the tetrad or 2 × 2 km square was the most practical scale, and by the time that the BSBI met in 1961 for a conference on local floras he had already begun compiling data on this basis, and there were similar projects in Hertfordshire, Hampshire, Warwickshire and Surrey. However, in reviewing the options for ‘dividing the area’ at this conference, Frank Perring simply listed tetrads as one of the options, alongside 5-km, 2.5-km and 1-km squares – he pointed out that 2.5-km squares might be favoured over tetrads as ‘it will take less time to mark your set of 2½″ maps than to cover all those extra squares’ (Perring 1963b). However, a consensus was soon reached and Perring (1964) recommended that ‘as far as possible the “tetrad” (2 × 2 km. square) should be adopted as the basic unit of collection’. Unlike the field survey techniques, the *Atlas* methods of map production were not downscalable, as Powers-Samas or other mechanical or computer-mapping machinery was not available to all. Even the British Trust for Ornithology had to get the maps for the first bird atlas plotted at BRC. Most authors of the local floras had to plot their maps by hand, an operation which became easier once dots became available as ‘Letraset’ transfers.

It was J.G. Dony (1967) who was the first to complete a tetrad flora, *Flora of Hertfordshire*. He became a powerful advocate of tetrad mapping. It appealed to the same rationalist streak that led him to devote much of his BSBI Presidential Address to a less successful proposal to replace vice-counties by 50 × 50 km squares (Dony 1968). The number of published floras increased as botanists realised that tetrad mapping provided an attractive and informative method of summarising distributions at the county scale (Figure 4A).

Early county tetrad floras varied in their design and content. In some, the text was similar in nature to that of a traditional flora, although less lengthy as the maps replaced the earlier lists of localities (Dony 1967; Edees 1972). Publishing constraints often required the maps to be grouped together at the end of the book, which reduced their impact. At the other extreme were atlases which mapped records from a recent survey, ignored historical records and included only a very brief accompanying text (Dony 1976; Philp 1982). Some innovations made in the early days have not taken hold. Cadbury *et al*. (1971) recorded a single 1-km square in each tetrad, a strategy which appears to combine the main disadvantage of a sample survey (the absence of complete coverage) with the main disadvantage of a complete survey (the effort needed to visit all tetrads); only Smith *et al*. (2002) has followed this example. Cadbury *et al*. (1971) also included habitat data on their maps; recording habitats systematically was probably a useful innovation but an examination of the maps suggests that there is little point in presenting these data cartographically. Again, only one disciple has followed this lead (Trist 1979). In recent years authors have taken advantage of the opportunities offered by modern printing methods to integrate text, maps and photographs into outstanding, if increasingly bulky, syntheses (Chater 2010; Sanford & Fisk 2010).

County atlases for other groups

Ornithologists have adopted tetrad recording just as enthusiastically as botanists, and it is now the usual means for recording the distribution of breeding birds at the county scale (Figure 4B). The first tetrad atlas covered the London area (Montier 1977). As with vascular plants, there was initial uncertainty about the most appropriate scale for mapping, and the tetrad survey of the birds of Kent, carried out between 1967 and 1973, started as a 1-km square survey but this proved to be too ambitious (Taylor *et al*. 1981). The introduction of systematic tetrad surveys as part of the second national survey of breeding birds (Gibbons *et al*. 1993) introduced the method to many ornithologists. Unlike the botanists, ornithologists have managed to cover large areas of Scotland at the tetrad scale (e.g. Murray *et al*. 1998; Francis & Cook 2011). For the forthcoming (third) atlas of breeding birds, many English counties have carried out a complete tetrad survey. Butterflies are also well covered; local atlases are listed by Asher *et al*. (2001) and Fox & Asher (2010).

County tetrad atlases have also been published for bryophytes (Figure 4C) and for a wide range of other animal groups, but the number depends on the availability and enthusiasm of experts in a county and perhaps to some extent on the intrinsic interest of the county and the availability of infrastructure to support recorders. Suffolk, for example, is a varied lowland county with both an active Naturalists' Society and an active Local Records Centre and tetrad maps are available for amphibians, bryophytes, birds, bumblebees, butterflies (two atlases, one a resurvey), dragonflies, mammals, land and freshwater molluscs, reptiles and vascular plants. In neighbouring Cambridgeshire, which includes large areas of arable fenland that perhaps deter all but the most determined tetrad recorder, only birds, butterflies, mammals and orthopteroids have been mapped at this scale.

The spread into Europe and beyond: national and regional atlases

As mentioned earlier, the use of a national grid to structure recording was pioneered in the Netherlands, but the successful completion of the 1962 *Atlas of the British flora* was undoubtedly influential in demonstrating its potential. In Europe national vascular plant atlases have been produced for several countries, largely in the west. There are, for example, vascular plant atlases for Belgium, Luxembourg and northern France (Van Rompaey & Delvosalle 1972, 1979; Van Landuyt *et al*. 2006; Delvosalle 2009; Stichting Floron 2011), the Netherlands (Mennema *et al*. 1980, 1985; Van der Meijden *et al*. 1989) and Germany (Haeupler & Schönfelder 1988; Benkert *et al*. 1996). An 'atlas partiel' covering the whole of France includes maps of 645 taxa (Dupont 1990). There is a surprising diversity of approach, even in western and central Europe, exemplified by four of the Nordic countries. Finland has an excellent national database, with maps available on-line (www.luomus.fi/kasviatlas) but not in book form, but few local atlases. In Sweden the reverse is the case, with no national atlas (although there are plans to produce one) but a series of excellent province floras (reviewed by Jonsell 2003), one of the closest continental parallels to the British county floras. Many of the recent province floras have grid maps. In Denmark the Atlas Flora Danica project approaches fruition. This was influenced by the BSBI Monitoring Scheme project (see below) and aims to achieve exhaustive coverage of at least a sample of 5 × 5-km squares. Fieldwork finished in 2011 and 1300 of 2200 5-km squares have been visited. Publication is expected in 2013 as two volumes including 2000 distribution maps. For Norway coastal species (Faegri 1960), alpine species (Gjaerevoll & Voll-Gjae 1990) and plants with a south-eastern range (Faegri & Danielsen 1996) have been mapped, but as localities rather than grid-based occurrences – not surprisingly, in view of the topography of the country.

Some of the most perceptive reviews of the 1962 Atlas came from reviewers living in the U.S.A., who realised that 'it has a significance and importance quite outside the immediate context of the British flora' (Green 1964). Another expatriate, H.G. Baker (1962), hoped that 'it might be possible to follow a similar pattern of work elsewhere, even in North America'. However, grid mapping has not been taken up by North American botanists, where almost all atlases of vascular plants are based on political units. Steyermark's *Flora of Missouri* (1963) mapped the presence of species within the state in counties and this has been a particularly influential model (R. Schmid, *in litt*. 2012). National maps showing the presence of vascular plant species in the states and counties of the U.S.A. are available on the internet (e.g. www.bonap.org, http://plants.usda.gov) and the records plotted are frequently derived solely from herbarium collections. Had the 1950 BSBI conference had a different outcome, perhaps our records might now be mapped on the NBN Gateway in counties and parishes?

Despite the initial hesitations of British ornithologists, the procedures pioneered by the BSBI have been applied most widely and frequently to map bird distributions, and bird atlases have recently been reviewed by Gibbons *et al*. (2007) and Dunn & Weston (2008). Grid mapping was actively promoted by the European Ornithological Atlas Committee, formed in 1971, and the national atlases for Denmark and France were published in 1976, the same year as the first British and Irish atlas (Ellison 2010). In North America the method 'quickly became established throughout the continent' (Ellison 2010); the first bird atlas pilot projects were launched in Maryland in the early 1970s, and the first state atlas, covering Vermont, published in 1985. By 1990 all the Atlantic coastal states from Maine to Virginia had completed fieldwork for their first bird atlases. Gibbons *et al*. (2007) identified 411 national or regional atlases from nearly 50 countries, most from Europe (308) and North America (74) with rather few from Africa (12), Asia, including the Middle East (5), the Pacific area (11) and South America (1). Some 30% of atlases included a measure of abundance or relative abundance. The average period of field survey was relatively short (5.9 years, with an additional 3.7 years needed for writing up) and the average time between repeat atlases was 16.7 years.

One bird atlas deserves special mention for the sheer scale of the achievement. For *The atlas of Australian birds*, 3,000 'atlassers' visited the 812 1° latitude × 1° longitude squares of the Australian mainland and larger islands in five years (1977–1981) and mapped a total of 656 breeding species and regular migrants (Blakers *et al*. 1984). A repeat atlas has since been produced, based on recording between 1998 and 2002 (Barrett *et al*. 2003). The first bird atlas stimulated botanists to enlist volunteers to produce *The Banksia atlas* (Taylor & Hopper 1988), which mapped the distribution of the 75 Australian *Banksia* species (two of which were recognised as new as a result of the project).

As in Britain, it is impossible to do justice to the European national and regional atlases for other plant and animal groups, which defy generalisation. Kudrna (2002) has reviewed the European butterfly databanks and atlases. Examples of regional atlases, chosen almost at random, include atlases of the vascular plants of the Auvergne (Antonetti *et al*. 2006), one of an increasing number of regional French atlases which have been published recently, the bryophytes of Baden-Württemberg (Nebel & Philippi 2000–05), the hoverflies of the

Netherlands (Reemer *et al*. 2009), one of a series of superb Dutch atlases, and the Orthoptera of East Austria (Zuna-Kratky *et al*. 2009).

Mapping at the European scale

Despite their major differences, there are strong parallels between the 1962 *Atlas* and the *Flora Europaea* project. *Flora Europaea* was the product of the same pragmatic outlook; all but one of the editors 'had studied at one stage or another at Cambridge, and all were to some extent influenced by the outlook associated with its Department of Botany' (Webb 1978). Max Walters was an editor of both publications and David Webb, an editor of *Flora Europaea*, also played a major role in the BSBI project. Another factor to which Webb attributed the success of *Flora Europaea* was the editors' 'optimism born of ignorance'; the ignorance was perhaps less with the 1962 *Atlas* but the optimism was no less important.

Flora Europaea had been conceived in 1954 in rather more romantic circumstances than the *Atlas*, 'in a cafe near the Sorbonne in July, 1954, under the influence of a little Calvados' (Webb 1978). The first volume was published in 1964 (Tutin *et al*. 1964). The two projects came together in Edinburgh at the 10th International Botanical Congress in August 1964, when it was decided to experiment with mapping plants on the 50-km squares of the UTM grid. Frank Perring was appointed Acting Secretary and pursued the proposal with his usual gusto. By the *Flora Europaea* symposium in Denmark in August 1965 he was able to announce that he had 'visited a number of countries during the Spring and discovered great enthusiasm for the scheme' (Perring 1966) and that he had prepared ten experimental maps. Less characteristically, he said he could undertake no further work on the project (the minutes of the BRC Advisory Sub-committee suggest that he was under pressure to do no more). An offer to base the permanent secretariat in Helsinki was accepted and in December 1964 Juha Suominen took over the running of the project from Dr Perring. The first volume of *Atlas Florae Europaeae* was published eight years later (Jalas & Suominen 1972) and the project proceeds at a steady pace.

There are taxonomically comprehensive European distribution maps for only a few other groups; these include birds (Hagemeijer & Blair 1997) and mammals (Mitchell-Jones *et al*. 1999). The European Invertebrate Survey started a mapping project in 1974 and produced 27 trial maps in 1981, 11 Hymenoptera, 12 Lepidoptera and 4 nematodes (Heath & Leclercq 1981), but it later abandoned its mapping role (Harding & Sheail 1992), largely in favour of promoting invertebrate recording at national data centres and advocating invertebrate conservation at the European scale. Butterflies were eventually mapped by Kudrna (2002), and 492 of Europe's *c*. 1500 millipedes have recently been mapped by Kime & Enghoff (2011). There is also a European atlas of plant parasitic nematodes, based on contributions from 14 countries (Alphey & Taylor 1986). The nematode maps are based on professionally collected samples from 14 countries, a very sparse coverage compared to the other European maps. Together with the accompanying, slightly more detailed national atlases, they constitute the only dull distribution maps I have ever seen.

Scientific impact: the dog that barked in the night

The motivation for proposing a BSBI mapping project arose form the strong interest in plant distribution amongst professional botanists. There were perhaps two components to this. The first was an interest in the relationship between the distribution of plants at different scales, and in particular in the way in which the range of a species at the continental scale was reflected in its more local distribution. Boyko (1947) expressed this interest rather formally in his Geo-ecological Law of Distribution, which stated that the 'specific topographical distribution (micro-distribution)' of a species was a 'parallel function' of its 'general geographical distribution (macro-distribution)'. A treatment of the general geographical distribution of British species had been initiated by E.J. Salisbury's paper 'The East Anglian Flora' in 1932 and was developed by J. R. Matthews in his presidential address to the British Ecological Society and in a subsequent book (Matthews 1937, 1955). However, at this point ecologists encountered the problem that the only comprehensive information available on the distribution of species in Britain and Ireland was at the vice-county scale, whereas for Scandinavia Hultén's *Atlas* (1950) provided a much more detailed treatment. Reinforcing this interest in distribution were the emerging results of palaeobotanical reseach on the British and Irish flora, soon to be summarised in Godwin's *History of the British flora* (1956). These studies provided detailed evidence of changes in flora since the last glacial period and greatly clarified the third, time, dimension of the picture. Max Walters and Donald Pigott brought together these ecological and historical strands in a classic paper which suggested that the distribution of certain species could be explained by their restriction to habitats which had remained open throughout the post-glacial (Pigott & Walters 1954). It is not surprising, therefore, that J.R. Matthews, who wrote the Foreword to the 1962 *Atlas*, said that he thought it would 'make a special appeal to the ecologist and plant-geographer, and in view of the possible significance of polyploidy in phytogeography, the cytogeneticist may turn over its pages not without interest'.

One might, therefore, have expected the *Atlas* to have a big impact on the scientific community. Indeed, on its publication Major (1964) said that 'this book, at least for British botanists, marks the end of an era of poorly based ecological hypothesizing and inaugurates a rational one'. However, its impact appears to have been surprisingly slight. It certainly provided fundamental background information, as demonstrated for example by the inclusion of distribution maps in the *Journal of Ecology*'s 'Biological Flora of the British Isles' series and (with fossil records added) in the second edition of Godwin's *History of the British flora* (1975). It also provided the background for the research by Donald Pigott and his colleagues on the range limits of species such as *Cirsium acaule* and *Prunus padus*. However, Pigott was already interested in these questions, and there is little evidence that the 1962 *Atlas* either altered the research agenda or contributed data which were directly analysed in many scientific studies. Harding & Sheail (1992) draw attention to the significance of Frank Perring's comment in 1970 that the queries he had received since the foundation of BRC were nearly all species- or locality-orientated (Perring 1970); he had not (by implication) received many requests for data for more complex analyses.

One paper which did subject the *Atlas* maps to detailed analysis was Conolly & Dahl's (1970) study of the modern and Quaternary distribution of Arctic-montane species. Conolly & Dahl worked through the *Atlas* and matched species ranges to isotherms, plotting the most informative isotherms on the relevant maps. Rabinowitz *et al*. (1986) made use of the distribution maps of plants published in the Biological Flora series and the accompanying text to allocate species to 'seven forms of rarity' (Rabinowitz 1981) in a study which required them to count the dots on 160 published maps. These papers perhaps provide a clue to the relative lack of impact. The *Atlas* provided a visual picture but it was only with ingenuity and very great patience that it could be analysed by existing techniques. By the early 1990s computer technology had begun to make more complex analyses possible. As Harding & Sheail (1992) commented, 'It may seem surprising that it is only in its 25th year that BRC and ITE colleagues have been seriously able to address some of the biogeographical questions relating to species and to begin the "careful analytical and experimental research" alluded to by Clapham and Godwin [in an unpublished document] nearly 30 years earlier'.

Since 1992 analytical studies have flourished (see Preston *et al*. 2012), although the same cannot be said of experimental research.

Conservation: an unexpected impact

In retrospect, one of the surprising features of the 1962 *Atlas* is that conservation, unlike science, received no mention in the planning of the project and virtually none in the final publication (Perring 1992). Although the BSBI was 'in the forefront of the conservation movement' in the 1950s (Dony 1968; Milne-Redhead 1971), no connection appears to have been made between these activities and the Maps Scheme. However, the maps in the *Atlas* not only provided an immediate visual demonstration of the rarity of the rarest species, but they also demonstrated the decline of many more widespread plants. This arose from a decision which had been taken earlier to distinguish pre-1930 records from later records on the maps of uncommon species. I estimate that 20% (165 of 786) of the species mapped as pre/post 1930 show a clear evidence of decline. This was mentioned in the introductory pages of the *Atlas* in what appears to have been something of an afterthought (Perring & Walters 1962, p. xxiv). It also struck some contemporary reviewers. C.C. Townsend (1963) noted that 'the decreases of such species as *Mertensia* and *Otanthus* are well-known; but the extent of the decrease of, for example, *Crepis mollis*, may come as a shock to many'. P.S. Green (1964) described these maps as 'most revealing when considered along with such modern phenomena as the widespread lowering of the watertable or the use of clean seed in agriculture'. D.H. Kent, BSBI recorder for Middlesex and perhaps therefore more accustomed than most to the decline of widespread plants, thought that 'the method of using different symbols on a single map to show pre- and post-1930 records …. could have been usefully extended to many other diminishing species, e.g. *Berberis vulgaris*, *Erophila verna*, *Viola palustris*, *Geranium lucidum*, *Saxifraga tridactylites*, various species of *Potamogeton* and *Orchis simia*' (Kent 1963).

Perring & Walters had expected to write a book about the phytogeography of the British flora after the completion of the *Atlas* and its *Critical supplement* (Perring & Sell 1968), but the position of BRC within the Nature Conservancy and the increasing concern for conservation in the 1960s led events to take a different turn (Perring 1992). In the late 1960s, Frank Perring came to regard it as 'imperative that we produce a Red Data Book … with all possible haste' and after the necessary research into the records of candidate species, Perring & Farrell (1977) wrote the first British Red Data Book. The inclusion of species was based on a strict criterion, with rare species defined as those in 15 or fewer 10-km squares. Declines were indicated by 10-km square totals before and after 1960. Similarly, scarce species were defined as those in 16–100 squares and their distribution was reviewed by Stewart *et al*. (1994). The presence of both rare and scarce species is one of the criteria used for selecting Sites of Special Scientific Interest (Nature Conservancy Council 1989).

Since the pioneer Red Data Book there has been much progress in distinguishing rarity from threat, and in measuring the rates of decline of species. A particular impetus for such studies was provided in Britain by the resurvey during the BSBI Monitoring Scheme (1987–88) of a sample of the 10-km squares originally recorded in the 1962 *Atlas*, and by the complete resurveys of birds, butterflies and vascular plants published between 1993 and 2002. These developments are, however, too far removed from the immediate influence of the 1962 *Atlas* to be discussed in detail here.

Why has the *Atlas* methodology been so successful?

There can be little doubt that the successful completion of the 1962 *Atlas* had a major impact on naturalists in Britain, Europe and North America. Why have the techniques been so successful in recruiting field recorders? One factor is surely that the demands required of the recording are inherently simple, but the products of their activity, maps and atlases, are so interesting and attractive that they both reward recorders for their efforts and interest a wider readership.

The reasons for the impact of the *Atlas* perhaps become clearer if one looks at other attempts in the same period to convert naturalists into 'amateur scientists'. Such exhortations were something of a theme of the prefaces of post-war books for naturalists. Stuart Smith, for example, an amateur ornithologist of some distinction, wrote in *How to study birds* (1945):

> 'the main aim of the average bird-watcher has been the recording of rarities in the field … we need to introduce to our hobby a new aim … not to compile long lists of birds seen, but rather to record their actions, postures and habits'.

W.B. Turrill in his New Naturalist volume *British plant life* (1948) gave a similar homily:

> 'The author is himself convinced that much energy is wasted by field naturalists … through undue emphasis being placed on rarities and "new records". There are so many problems awaiting solution that could be investigated, and many of them solved, by carefully thought-out experiments and patient observations'.

E.B. Ford in *Butterflies* (1945) recognised that:

> 'there must be a large number of collectors and naturalists who have no intention of becoming amateur scientists. Indeed I should not wish all of them to do so; but I hope that some of them may …. Accordingly, I have pointed out numerous interesting lines of experiment and observation which could be undertaken by anyone using the simplest means.'

Unfortunately some aspiring amateur scientists might have found Ford's instructions rather off-putting. To estimate population size, for example, a study he thought 'admirably suited to the collector or naturalist who wants to increase the value of his hobby', he said:

> 'it is essential that [collectors] should arrange their data, as they obtain it, in the manner shown in Text-Fig. 9, otherwise confusion is certain to arise and valuable work will be wasted …. if they are not inclined to examine their results themselves, they should obtain the help of a statistician'.

These authors all stressed that research could be undertaken with very simple equipment, and even, as Smith (1945) put it, 'carried out by the ordinary bird-watcher from the comfort of a chair at his dining-room window'. However, none seemed to recognise that the ability to design and carry out observations, let alone write them up, might need a background of knowledge and a degree of self-confidence that few readers were likely to possess. Obtaining the help of a statistician was unlikely to be as easy to many of Ford's readers as it was to a Reader in Genetics at the University of Oxford.

How different these suggestions are to the essential simplicity of atlas recording, in which the recorder was positively encouraged to 'compile long lists' and to feed his or her data into an established structure, with no further responsibility for the outcome once the record cards were posted off. It is perhaps not surprising that the BSBI Maps Scheme and the later projects it inspired were so much more successful than these earlier efforts to recruit volunteers.

Has the concentration on grid mapping had any disadvantages? This is perhaps an impossible question to answer, as we need to know how natural history would have developed in its absence. Volunteer recorders have, of course, taken part in many additional projects other than fieldwork devoted to mapping, especially for birds, but it seems likely that for many groups mapping schemes have taken up much of the available time and effort. There was, especially in the first decades of grid mapping, a frequent failure to distinguish recording from mapping, and records were collected for tetrads or 10-km squares rather than simply summarised at this level. This arose from a natural and perhaps inevitable desire to do the minimum work needed to achieve the immediate objective, and in particular to reduce the number of records needed to be input into early databases. The habit of recording in this way became ingrained in the first generation of atlas recorders and it proved difficult to wean them onto methods of recording which provided data which could be used in multiple ways. Peter Sell (pers. comm.) also argues that the need to devote time to mapping has reduced the extent to which botanists examine plants themselves, but I doubt whether many of those who have played such a valuable role as grid recorders would otherwise have devoted their time to infraspecific taxonomy or the study of critical groups. To a large extent the mapping schemes have generated the recorders which they have then put to use. Few BSBI 'network research' projects in the immediate post-Atlas era attracted many participants and, tellingly, the most successful, the mistletoe survey (Perring 1973), was basically a detailed mapping scheme for a single species. I consider that the advantages of grid-based mapping projects greatly outweighed any disadvantages, but I have perhaps been too closely involved with grid-based recording projects to give an objective assessment.

Conclusion

I started this paper with the words of Max Nicholson. I will conclude with the summary of another ornithologist, written nearly 50 years later. In the *Second atlas of the breeding birds of Maryland*, W.G. Ellison (2010) described the 1962 *Atlas* as 'the great-grandfather of the hundreds of natural history grid-based atlases that were to follow in the next few decades as the atlas movement swept over the face of the earth'.

Acknowledgements

This paper is based on a paper given at a BSBI Conference 'A great leap forward – Biological Recording since the 1962 *Atlas of the British Flora*', held in Edinburgh in 2012. It has benefitted from my subsequent work with David and Helen Roy, and I thank them for sharing their knowledge so enthusiastically and generously. I also thank Donald Pigott for his comments on the relationship of the 1962 *Atlas* to his own research, and for his recollections of the development of the *Atlas* project. David Gibbons and Mark Gurney (RSPB) and Carole Showell (BTO) provided information about bird atlases, Per Hartvig, Raino Lampinen and Wouter Van Landuyt updated my knowledge of plant atlases in Denmark, Finland and the Low Countries respectively, Rudi Schmid set out for me the reasons why grid mapping has not been taken up by North American botanists and Björn Beckmann plotted the maps in Figure 4. Louise Marsh insisted that I write up the paper promptly, Paul Harding, David Pearman and David Roy kindly commented on an earlier draft and the reviews by Arthur Chater and Trevor James were equally helpful.

References

Allen, D.E. 1986. *The botanists.* Winchester: St Paul's Bibliographies.

Allen, D.E. 2003. Four centuries of local flora-writing: some milestones. *Watsonia*, 24: 271–280.

Allen, D.E. 2010. *Books and naturalists.* London: Collins.

Alphey, T.J.W. & Taylor, C.E. 1986. *European atlas of the Longidoridae & Trichodoridae*. [Invergowrie:] Scottish Crop Research Centre.

Antonetti, P., Brugel, E., Kesler, F., Barbe, J.-P. & Tort, M. 2006. *Atlas de la flore d'Auvergne*. Chavaniac-Lafayette: Conservatoire Botanique National du Massif Central.

Arnold, H.R. 1995. *Atlas of amphibians and reptiles in Britain*. London: HMSO.

Asher, J., Warren, M., Fox, R., Harding, P., Jeffcoate, G. & Jeffcoate, S. 2001 *The millennium atlas of butterflies in Britain and Ireland.* Oxford: Oxford University Press.

Baker, H.G. 1962. British topographic botany. *Science,* new series, 138: 506.

Barrett, G., Silcocks, A., Barry, S., Cunningham, R. & Poulter, R. 2003. *The new atlas of Australian birds*. Melbourne: Royal Australasian Ornithologists Union.

Benkert, D., Fukarek, F. & Korsch, H., eds. 1996. *Verbreitungsatlas der Farn- und Blütenpflanzen Ostdeutschlands*. Jena: Gustav Fischer.

Blakers, M., Davies, S.J.J.F. & Reilly, P.N. 1984. *The atlas of Australian birds*. Carlton: Melbourne University Press.

Bowen, H.J.M. 1962. Dinner to celebrate the publication of the "Atlas of the British Flora". *Proceedings of the Botanical Society of the British Isles*, 4: 490.

Boyko, H. 1947. On the role of plants as quantitative climate indicators and the Geo-Ecological Law of Distribution. *Journal of Ecology,* 35: 138–157.

Cadbury, D.A., Hawkes, J.G. & Readett, R.C. 1971. *A computer-mapped flora: a study of the county of Warwickshire*. London: Academic Press.

Carmichael, H. 1996. *An ICL anthology: anecdotes and recollections of the people from ICL.* Surbiton: Laidlaw Hicks Publishers.

Chater, A.O. 2010. *Flora of Cardiganshire.* Aberystwyth: privately published.

Clapham, A.R. 1951. A proposal for mapping the distribution of British vascular plants. In: J.E. Lousley, ed. *The study of the distribution of British plants*. Oxford: Botanical Society of the British Isles, pp. 110–117.

Clapham, A.R., Tutin, T.G. & Warburg, E.F. 1952. *Flora of the British Isles*. Cambridge: Cambridge University Press.

Conolly, A.P. & Dahl, E. 1970. Maximum summer temperature in relation to the modern and Quaternary distributions of certain Arctic-montane species in the British Isles. In: D. Walker & R.G. West, eds. *Studies in the vegetational history of the British Isles*. Cambridge: Cambridge University Press, pp. 159–223.

Dandy, J.E. 1951. The Watsonian vice-county system. In: J.E. Lousley, ed. *The study of the distribution of British plants*. Oxford: Botanical Society of the British Isles, pp. 23–29.

Davies, C.E., Shelley, J., Harding, P.T., McLean, I.F.G., Gardiner, R. & Peirson, G., eds. 2004. *Freshwater fishes in Britain – the species and their distribution*. Colchester: Harley Books.

Davies, L. 1968. *A key to the British species of Simulidae (Diptera) in the larval, pupal and adult stages*. Ambleside: Freshwater Biological Association.

Delvosalle, L. 2009. *Atlas floristique IFFB: France NW., N. et NE., Belgique-Luxembourg: Ptéridophytes et Spermatophytes*. Bruxelles: Institut Floristique Franco-Belge.

Dony, J.G. 1967. *Flora of Hertfordshire*. Hitchin: Hitchin Museum.

Dony, J.G. 1968. The B.S.B.I. in a changing Britain. *Proceedings of the Botanical Society of the British Isles*, 7: 311–323.

Dony, J.G. 1976. *Bedfordshire plant atlas.* Luton: Borough of Luton Museum and Art Gallery.

Dunn, A.M. & Weston, M.A. 2008. A review of terrestrial bird atlases of the world and their application. *Emu,* 108: 42–67.

Dupont, P. 1990. *Atlas partiel de la flore de France.* Paris: Museum National d'Histoire Naturelle.

Edees, E.S. 1972. *Flora of Staffordshire.* Newton Abbot: David & Charles.

Elliott, J.M. & Tullett, P.A. 1982. *Provisional atlas of the freshwater leeches of the British Isles*. Ambleside: Freshwater Biological Association.

Ellison, W.G., ed. 2010. *Second atlas of the breeding birds of Maryland and the District of Columbia*. Baltimore: Johns Hopkins University Press.
Faegri, K. 1960. *Maps of distribution of Norwegian vascular plants. Volume I: Coast plants*. Oslo: Oslo University Press.
Faegri, K. & Danielsen, A. 1996. *Maps of distribution of Norwegian vascular plants. Volume III: The southeastern element*. Bergen: University of Bergen Botanical Institute.
Ford, E.B. 1945. *Butterflies*. London.
Fox, R. & Asher, J. 2010. *2010 Atlas of butterflies in Britain and Ireland*. Wareham: Butterfly Conservation.
Francis, I. & Cook, M. 2011. *The breeding birds of north-east Scotland*. Aberdeen: Scottish Ornithologists' Club.
George, R.S. 1974. *Provisional atlas of the insects of the British Isles: Part 4, Siphonaptera, fleas*. Huntingdon: Biological Records Centre.
George, R.S. 2008. *Atlas of the fleas (Siphonaptera) of Britain and Ireland*. Shrewsbury: FSC Publications.
Gibbons, D.W., Donald, P.F., Bauer, H.-G., Fornasari, L. & Dawson, I.K. 2007. Mapping avian distributions: the evolution of bird atlases. *Bird Study*, 54: 324–334.
Gibbons, D.W., Reid, J.B. & Chapman, R.A., comps. 1993. *The new atlas of breeding birds in Britain and Ireland: 1988–1991*. London: T. & A.D. Poyser.
Gjaerevoll, O. & Voll-Gjae, R. 1990. *Maps of distribution of Norwegian vascular plants. Volume II: Alpine plants*. Trondheim: Tapir Publishers.
Godwin, H. 1956. *The history of the British flora.* Cambridge: Cambridge University Press.
Godwin, H. 1975. *The history of the British flora*, ed. 2. Cambridge: Cambridge University Press.
Good, R. [1948]. *A geographical handbook of the Dorset flora*. Dorchester: Dorset Natural History and Archaeological Society.
Green, P.S. 1964. Atlas of the British flora [review]. *Economic Botany*, 18: 285.
Haeupler, H. & Schönfelder, P., eds. 1988. *Atlas der Farn- und Blütenpflanzen der Bundersrepublik Deutschland*. Stuttgart: Eugen Ulmer.
Hagemeijer, W.J.M. & Blair, M.J., eds. 1997. *The EBCC atlas of European breeding birds: their distribution and abundance*. London: T. & A.D. Poyser.
Harding, P.T. & Sheail, J. 1992. The Biological Records Centre: a pioneer in data retrieval. In: P.T. Harding, ed. *Biological recording of changes in British wildlife*. London: HMSO, pp. 5–19.
Harvey, P.R., Nellist, D.R. & Telfer, M.G., eds. 2002. *Provisional atlas of British spiders (Arachnida, Araneae).* 2 vols. Huntingdon: Biological Records Centre.
Heath, J., ed. 1970. *Provisional atlas of the insects of the British Isles: Part 1, Lepidoptera Rhopalocera*, *Butterflies*. Huntingdon: Biological Records Centre.
Heath, J. & Leclercq, J., eds. 1981. *Provisional atlas of the invertebrates of Europe. Maps 1–27.* Abbots Ripton: Institute of Terrestrial Ecology.
Heath, J., Pollard, E. & Thomas, J.A. 1984. *Atlas of butterflies in Britain and Ireland*. Harmondsworth: Viking.
Hill, L., Randle, Z., Fox, R. & Parsons, M. 2010. *Provisional atlas of the UK's larger moths.* Wareham: Butterfly Conservation.
Hill, M.O., Preston, C.D. & Smith A.J.E., eds. 1991–94. *Atlas of the bryophytes of Britain and Ireland*. 3 vols. Colchester: Harley Books.
Hultén, E. 1950. *Atlas of the distribution of vascular plants in NW Europe*. Stockholm: Generalstabens Litografiska Anstalts Förlag.

Jalas, J. & Suominen, J. 1972. *Atlas florae Europapaeae. 1 Pteridophyta (Psilotaceae to Azollaceae).* Helsinki: Committee for Mapping the Flora of Europe and Societas Biologica Fennica Vanamo.

Jonsell, B. 2003. Swedish provincial floras – a survey of their history and present status. *Watsonia*, 24: 331–336.

Kent. D.H. 1963. Atlas of the British flora [review]. *Watsonia*, 5: 396–397.

Kerney, M.P. 1999. *Atlas of the land and freshwater molluscs of Britain and Ireland*. Colchester: Harley Books.

Kime, R.D. & Enghoff, E. 2011. *Atlas of European millipedes (Class Diplopoda). Volume 1, Orders Polyxenida, Glomerida, Platydesmida, Siphonocryptida, Polyzoniida, Callipodida, Polydesmida.* Fauna Europaea Evertebrata, 3. Sofia-Moscow: Pensoft and Leiden: European Invertebrate Survey.

Kloos, A.W. 1951. The study of plant distribution in Holland. In: J.E. Lousley, ed. *The study of the distribution of British plants*. Oxford: Botanical Society of the British Isles, pp. 64–68.

Kudrna, O. 2002. *The distribution atlas of European butterflies*. Stenstrup: Apollo Books.

Lord, J. & Munns, D.J. 1970. *Atlas of breeding birds of the West Midlands.* London: Collins.

Lousley, J.E. 1951a. Maps showing plant distribution in Britain and European countries (exhibit). In: J.E. Lousley, ed. *The study of the distribution of British plants*. Oxford: Botanical Society of the British Isles, pp. 43–47.

Lousley, J.E. 1951b. The Watsonian vice-county system in practice. In: J.E. Lousley, ed. *The study of the distribution of British plants*. Oxford: Botanical Society of the British Isles, pp. 30–42.

Lousley, J.E., ed. 1951c. *The study of the distribution of British plants*. Oxford: Botanical Society of the British Isles.

Major, J. 1964. A basis for floristics and plant ecology in Britain. *Ecology*, 45: 206.

Martyn, K.P. 1988. *Provisional atlas of the ticks (Ixodoidea) of the British Isles*. Huntingdon: Biological Records Centre.

Matthews, J.R. 1937. Geographical relationships of the British flora. *Journal of Ecology*, 25: 1–90.

Matthews, J.R. 1955. *Origin and distribution of the British flora*. London: Hutchinson & Co.

Mennema, J., Quené-Boterenbrood, A.J. & Plate, C.L., eds. 1980. *Atlas of the Netherlands flora. I: Extinct and very rare species*. The Hague: Dr. W. Junk.

Mennema, J., Quené-Boterenbrood, A.J. & Plate, C.L., eds. 1985. *Atlas van de Nederlandseflora. 2: Zeldzame en vrij zeldzame planten*. Utrecht: Bohn, Scheltema & Holkema.

Merritt, R., Eversham, B.C. & Moore, N.W. 1996. *Atlas of dragonflies in Britain and Ireland*. London: HMSO.

Milne-Redhead, E. 1971. Botanical conservation in Britain, past, present and future. *Watsonia*, 8: 195–203.

Mitchell-Jones, A.J., Amori, G., Bogdanowicz, W., Krystufek, B., Reijnders, P.J.H., Spitzenberger, F., Stubbe, M., Thissen, J.B.M., Vohralik, V. & Zima, J. 1999. *The atlas of European mammals*. London: Academic Press.

Montier, D.J., ed. 1977. *Atlas of breeding birds of the London area.* London: Batsford.

Murray, R.D., Holling, M., Dott, H.E.M. & Vandome, P. 1998. *The breeding birds of south-east Scotland: a tetrad atlas 1988–1994*. Edinburgh: Scottish Ornithologists' Club.

Nature Conservancy Council 1989. *Guidelines for selection of biological SSSIs*. Peterborough: Nature Conservancy Council.

Nebel, M. & Philippi, G., eds. 2000–05. *Die Moose Baden-Württembergs*. 3 vols. Stuttgart: Verlag Eugen Ulmer.

Perring, F.H. 1963a. Data-processing for the Atlas of the British flora. *Taxon*, 12: 183-190.
Perring, F.H. 1963b. Dividing the area. In: P. J. Wanstall, ed. *Local floras*. London: Botanical Society of the British Isles, pp. 21–27.
Perring, F.H. 1964. A guide for local flora writers. *Proceedings of the Botanical Society of the British Isles*, 5: 283–302.
Perring, F.H. 1966. Mapping the flora of Europe. *Botanisk Tidsskrift*, 61: 328-332.
Perring, F.H. 1970. The last seventy years. In: F.H. Perring, ed. *The flora of a changing Britain*. Hampton: E.W. Classey, pp. 128–135.
Perring, F.H. 1973. Mistletoe. In: P. S. Green, ed. *Plants: wild and cultivated*. Hampton: E.W. Classey, pp. 139–145.
Perring, F.H. 1992. BSBI distribution maps scheme – the first 40 years. In: P.T. Harding, ed. *Biological recording of changes in British wildlife*. London: HMSO, pp. 1–4.
Perring, F.H. & Farrell, L., comps. 1977. *British Red Data Books: 1. Vascular plants.* Lincoln: Society for the Promotion of Nature Conservation.
Perring, F.H. & Sell, P.D., eds. 1968. *Critical supplement to the Atlas of the British flora*. London: Thomas Nelson & Sons.
Perring, F.H. & Walters, S.M., eds. 1962 *Atlas of the British flora*. Thomas Nelson & Sons, London.
Philp, E.G. 1982. *Atlas of the Kent flora*. Maidstone: Kent Field Club.
Pigott, C.D. 1953. *A taxonomic revision and ecological study of British* Thymus. Ph.D. thesis, University of Cambridge.
Pigott, C.D. 1955. Biological flora of the British Isles. *Thymus* L. *Journal of Ecology*, 43: 365–387.
Pigott, C.D. & Walters, S.M. 1954. On the interpretation of the discontinuous distributions shown by certain British species of open habitats. *Journal of Ecology*, 42: 95–116.
Preston, C.D. & Oswald, P.H. 2006. Franklyn Hugh Perring (1927–2003). *Watsonia,* 26: 197–207.
Preston, C.D., Pearman, D.A. & Dines, T.D., eds. 2002. *New atlas of the British and Irish flora.* Oxford: Oxford University Press.
Preston, C.D., Roy, D.B. & Roy, H.E. 2012. What have we learnt from 50 years of biological recording? *British Wildlife*, 24: 97–106.
Rabinowitz, D. 1981. Seven forms of rarity. In: H. Synge, ed. *The biological aspects of rare plant conservation*. Chichester: John Wiley & Sons, pp. 205–217.
Rabinowitz, D., Cairns, S. & Dillon, T. 1986. Seven forms of rarity and their frequency in the flora of the British Isles. In: M.E. Soule, ed. C*onservation biology: the science of scarcity and diversity*. Sunderland, Massachusetts: Sinauer Associates, pp. 182–204.
Reemer, M., Renema, W., Van Steenis, W., Zeegers, T., Barendregt, A., Smit, J.T., Van Veen, M.P., Van Steenis, J. & Van der Leij, L.J.J.M. 2009. *De Nederlandse zweefvliegen (Diptera: Syrphidae)*. Leiden: KNNV Uitgeverij.
Riddelsdell, H.J., Hedley, G.W. & Price, W.R., eds. 1948. *Flora of Gloucestershire*. Cheltenham: Cotteswold Naturalists' Field Club.
Salisbury, E.J. 1932. The East Anglian flora: a study in comparative plant geography. *Transactions of the Norfolk and Norwich Naturalists' Society*, 13: 191–263.
Sanford, M. & Fisk, R. 2010. *A flora of Suffolk*. Ipswich: privately published.
Sell, P.D. 2007. Stuart Max Walters (1920–2005). *Watsonia*, 26: 215–227.
Sharrock, J.T.R. 1976. *The atlas of breeding birds in Britain and Ireland*. Tring: T. & A.D. Poyser.
Smith, P.M., Dixon, R.O.D. & Cochrane, M.P. 2002. *Plant life of Edinburgh and the Lothians.* Edinburgh: Edinburgh University Press.
Smith, S. 1945. *How to study birds.* London: Collins.

Stewart, A., Pearman, D.A. & Preston, C.D. 1994. *Scarce plants in Britain.* Peterborough: Joint Nature Conservation Committee.
Steyermark, J.A. 1963. *Flora of Missouri.* Ames: Iowa State University Press.
Stichting Floron 2011. *Nieuwe atlas van de Nederlandse flora*. Nijmegen: Stichting Floron.
Taylor, A. & Hopper, S. 1988. *The Banksia atlas*. Canberra: Australian Government Publishing Service.
Taylor, D.W., Davenport, D.L. & Flegg, J.J.M. 1981. *The birds of Kent: a review of their status and distribution.* Meopham: Kent Ornithological Society.
Townsend, C.C. 1963. Distribution maps of British plants. *Kew Bulletin*, 17: 232.
Trist, P.J.O., ed. 1979. *An ecological flora of Breckland*. East Ardsley: EP Publishing.
Turrill, W.B. 1948. *British plant life*. London: Collins.
Tutin, T.G., Heywood, V.H., Burges, N.A., Valentine, D.H., Walters, S.M. & Webb, D.A., eds. 1964. *Flora Europaea. Volume 1: Lycopodiaceae to Platanaceae.* Cambridge: Cambridge University Press.
Van der Meijden, R., Plate, C.L. & Weeda, E.J., eds. 1989. *Atlas van de Nederlandse flora. 3: Minder zeldzame en algemene soorten*. Leiden: Onderzoeksinstituut Rijksherbarium/Hortus Botanicus.
Van Landuyt, W., Hoste, I., Vanhecke, L., Van den Bremt, P., Vercruysse, E. & De Beer, D., eds. 2006. *Atlas van de flora van Vlaanderen en het Brussels Gewest*. Brussels: Instituut voor natuur- en bosonderzoek, Nationale Plantentuin van België & Flo.Wer.
Van Rompaey, E. & Delvosalle, L. 1972. *Atlas de la flore Belge et Luxembourgeoise: ptéridophytes et spermatophytes*. Meise: Jardin Botanique National de Belgique.
Van Rompaey, E. & Delvosalle, L. 1979. *Atlas de la flore Belge et Luxembourgeoise: ptéridophytes et spermatophytes*, ed. 2. Meise: Jardin Botanique National de Belgique.
Walters, S.M. 1954. The distribution maps scheme. *Proceedings of the Botanical Society of the British Isles*, 1: 121–130.
Webb, D.A. 1954. The distribution maps scheme – a provisional extension to Ireland of the British national grid. *Proceedings of the Botanical Society of the British Isles*, 1: 316–319.
Webb, D.A. 1978. Flora Europaea: a retrospect. *Taxon*, 27: 3–14.
Zuna-Kratky, T., Karner-Ranner, E., Lederer, E., Braun, B., Berg, H.-M., Denner, M., Bieringer, G., Ranner, A. & Zechner, L. 2009. *Verbreitungsatlas der Heuschrecken und Fangschrecken Ostösterreichs*. Vienna: Verlag Naturhistorisches Museum Wien.

Legends for figures.

Figure 1 (A) The tabulator modified by Powers-Samas to plot maps for the *Atlas of the British Flora* (1962). (B) Max Walters (right) and Tom Tutin (centre) discussing a trial map with an unidentified lady at the launch of the BSBI Maps Scheme, April 1954.

Figure 2 An early list of recording schemes associated with BRC, from a paper prepared by F.H. Perring, G.F. Peterken & G.L. Radford for the BRC Advisory Sub-Committee, 15 October 1968. Only the mapping schemes are shown.

Figure 3 The number of county floras published per decade, 1660-2012. Columns in black indicate floras published before the 1962 Atlas, those in grey indicate those published afterwards.

Figure 4 The vice-counties in Britain and Ireland with atlases of species mapped in 5-km, 2-km or 1-km squares. (A) vascular plants; (B) birds; (C) bryophytes; (D) Orthoptera. Many bird atlases cover administrative counties and these have been mapped in the closest vice-counties.

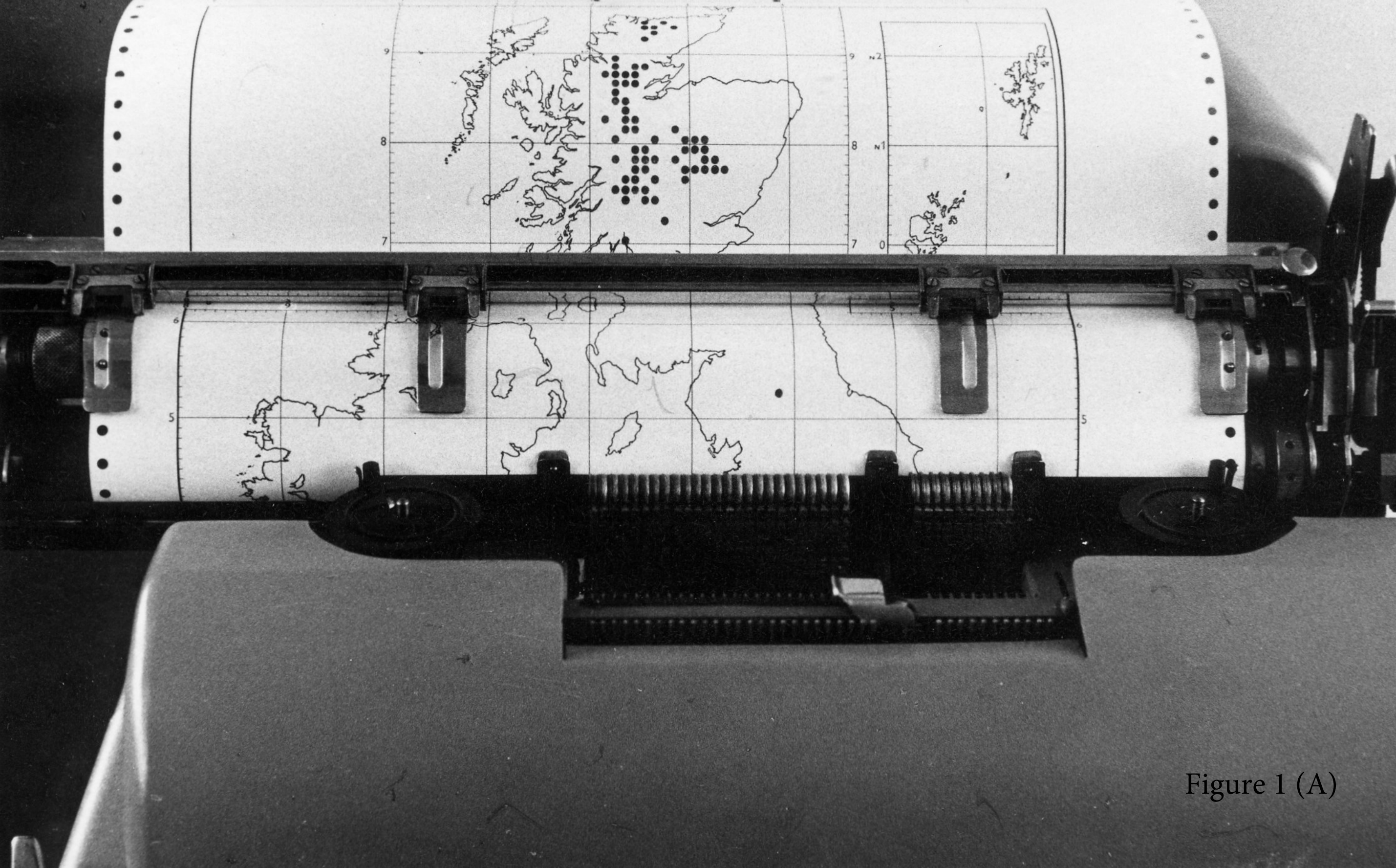
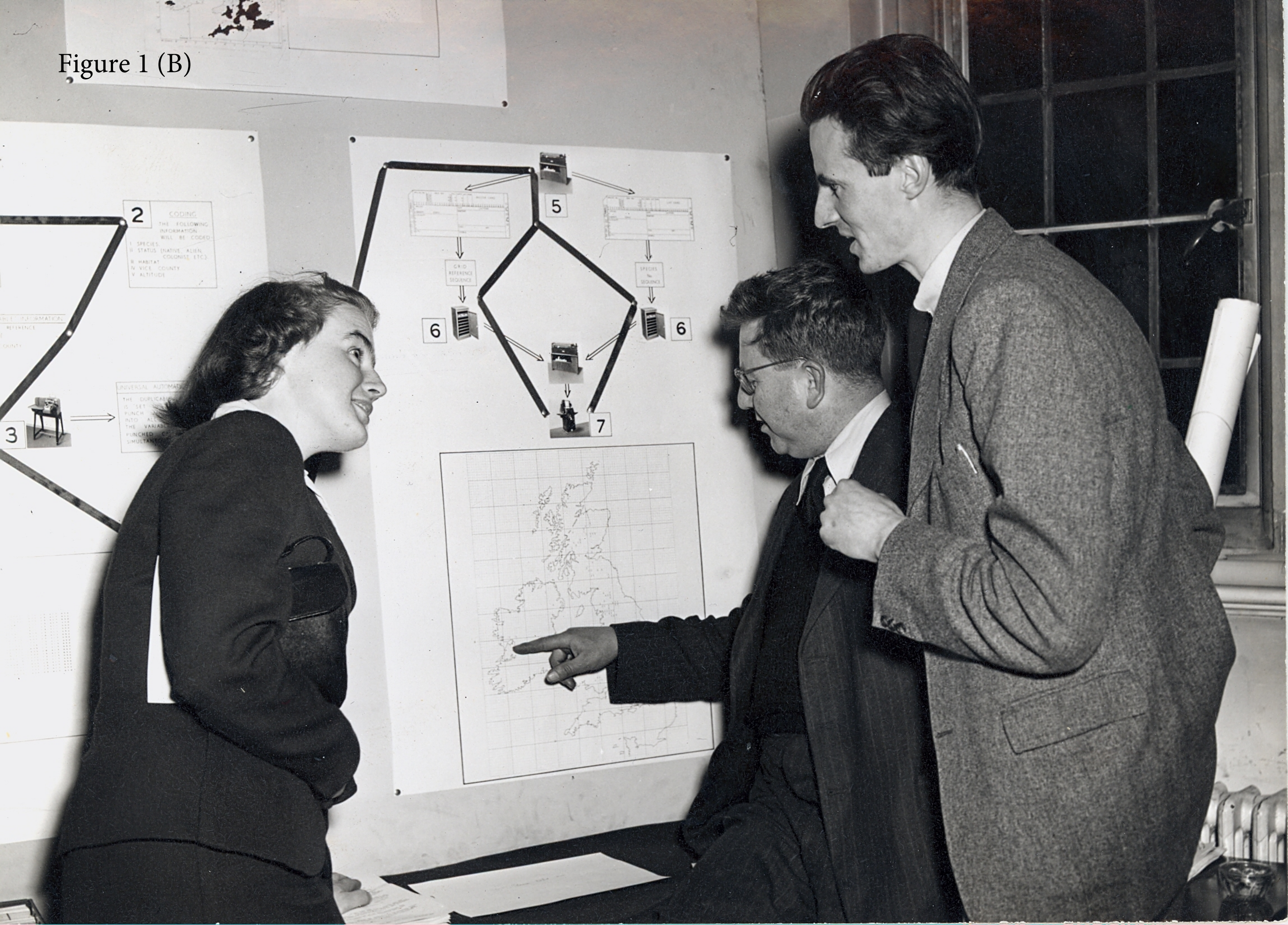


Figure 1 (A)

Figure 1 (B)



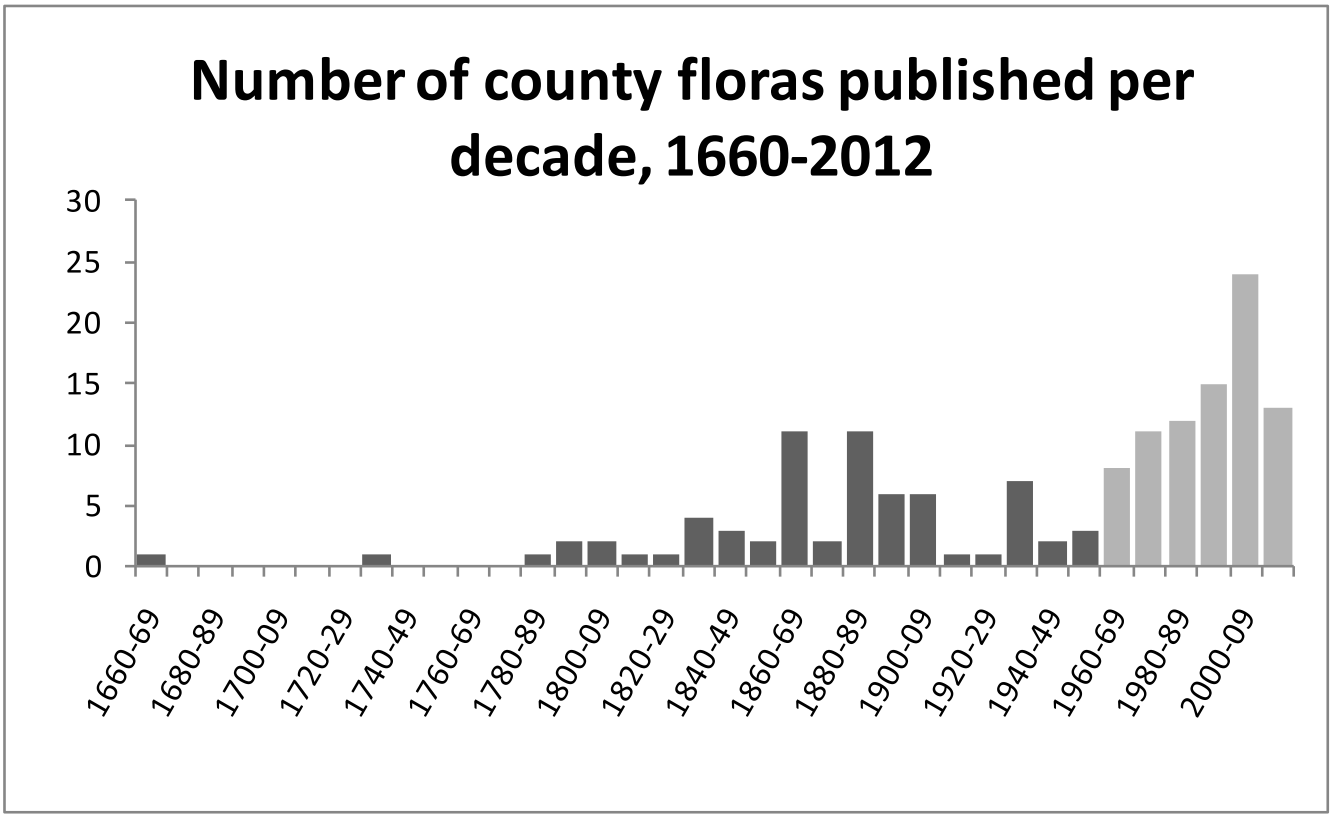
2
CODING
THE FOLLOWING INFORMATION WILL BE CODED
I SPECIES.
II STATUS (NATIVE, ALIEN, COLONIST, ETC).
III HABITAT
IV VICE COUNTY
V ALTITUDE
3
5
GRID REFERENCE SEQUENCE
6
6
7

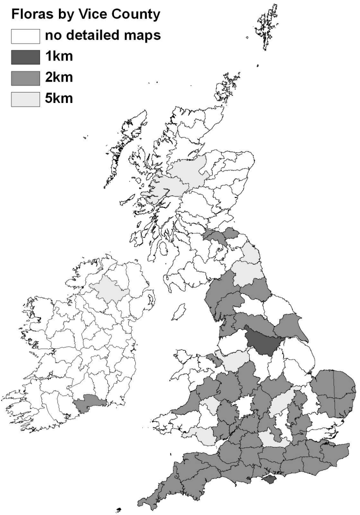
Figure 2

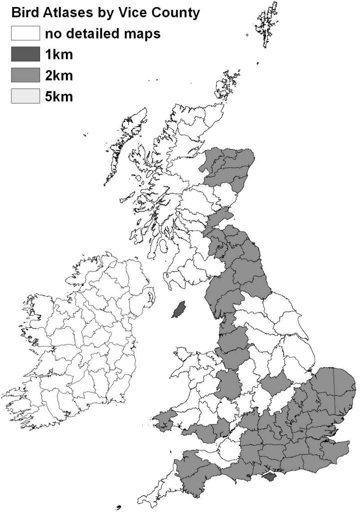
B. LIST OF SURVEYS AND SCHEMES INVOLVING THE B.R.C.

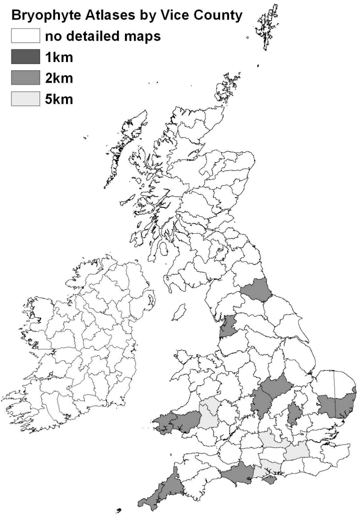
	Subject	Responsibility	Period	BRC
M	DISTRIBUTION MAP SCHEMES			
M1	Flowering plants and ferns	BSBI/NC	1954-68	FHP
M2	Lepidoptera	NC/BRC	1967-77	JH
M3	Bryophytes	BBS	1960-	FHP
M4	Lichens	BLS	1966-	FHP
M5	Deer	FDS	1967-	FHP
M6	Reptiles and Amphibians	NC/BRC	1965-70	FHP
M7	Birds	BTO	1968-72	FHP
M8	Freshwater Fish	NC	1966-	FHP
M9	Fleas	Mr. R. George	1950-	FHP
M10	Spiders	BSSG	1964-	FHP
M11	Dragonflies	NC/BRC	1968-	JH
M12	Molluscs	Conch Soc	1962-	FHP
M13	Leeches	Mr. T. T. Mann	1950-	FHP
M14	Simulidae	Mr. L. Davies	1950-	FHP
M15	Ants	Mr. K. Barrett	1964-	FHP
M16	Ticks	Mr. G. Thompson	1945-	FHP
M17	Cave Life	Cave Research Group	1938-	FHP
M18	Bryophyte communities	Mr. P. D. Coker	1967	FHP
E	EUROPEAN MAPPING SCHEMES			
E1	Flora Europea	Committee	196?-	FHP, MNH
E2	Insecta Europea	IE Working Party	1968-?88	JH
S	SPECIES			
S1	Ringing recoveries	BTO	1909-	FHP
S2	Ringing counts	BTO	1965-	FHP
S3	Nest records	BTO	1939-	FHP

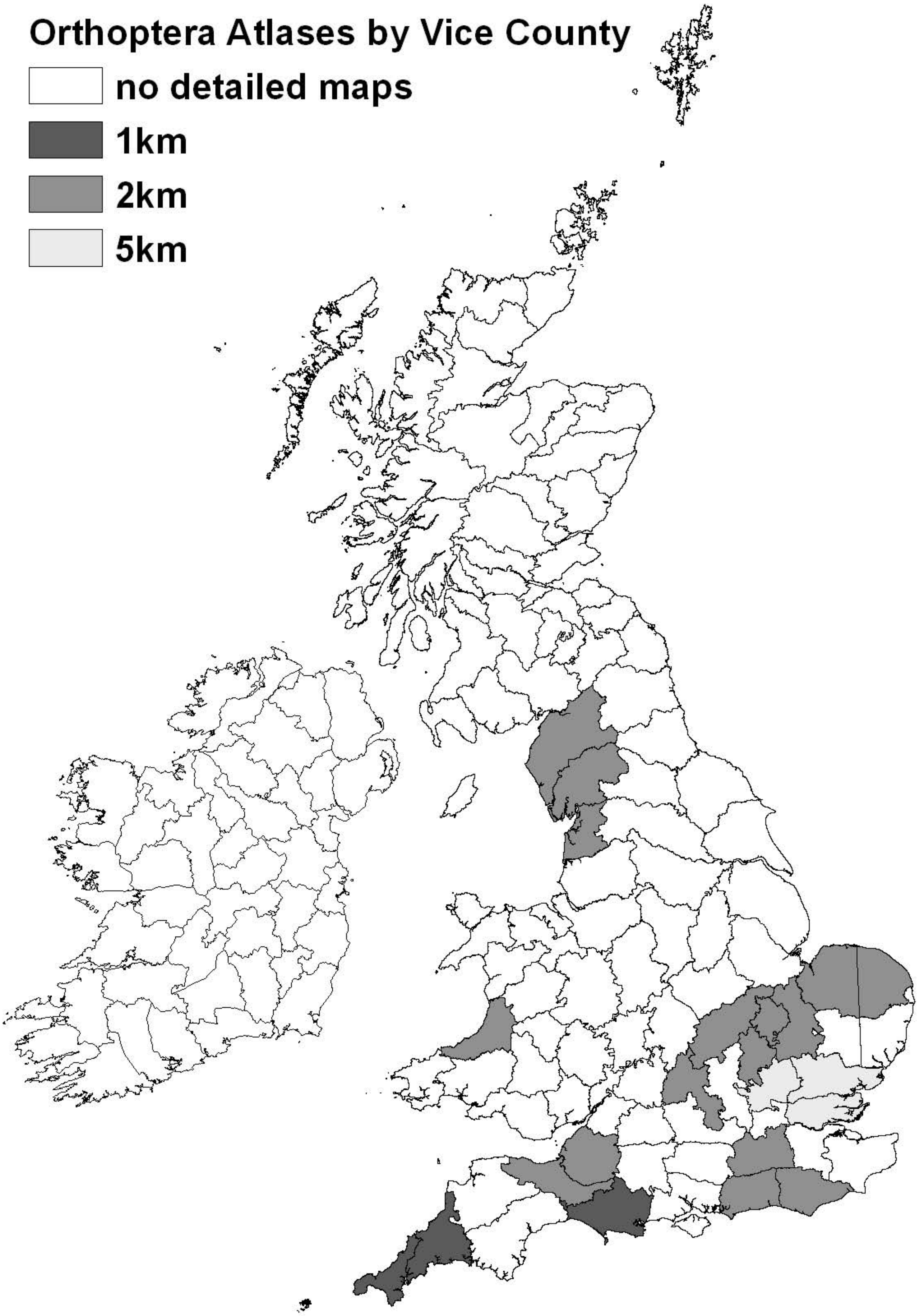
Figure 3


Number of county floras published per decade, 1660-2012
30
25
20
15
10
5
0
1660-69
1680-89
1700-09
1720-29
1740-49
1760-69
1780-89
1800-09
1820-29
1840-49
1860-69
1880-89
1900-09
1920-29
1940-49
1960-69
1980-89
2000-09


Floras by Vice County
no detailed maps
1km
2km
5km


Bird Atlases by Vice County
no detailed maps
1km
2km
5km


Bryophyte Atlases by Vice County
no detailed maps
1km
2km
5km


Orthoptera Atlases by Vice County
no detailed maps
1km
2km
5km