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TOWARDS A NEW DEFINITION OF RARE AND SCARCE PLANTS

This address will review progress in recording over the last 40 years, with particular reference to Rare (found in not more than 15 10-km squares) and Scarce Plants (found in 16–100 10-km squares), and will suggest that the old definitions for these categories, whilst they might have been perfectly adequate at the time, are no longer the best we can do. They should be replaced by more precise measures of distribution and to that end I will examine the merits of tetrads (2 × 2 km squares) and 1-km squares, touch on sites and populations, and suggest what I think is the best of the alternatives.

As you all know recording by 10-km squares really took off with the *Atlas of the British Flora* (Perring & Walters 1962), for which fieldwork began in the early 1950s. Before this, maps showing distribution by vice-counties had been used, but it was the invention of the National Grid, and its general appearance on maps after the Second World War that gave the necessary impetus.

The first attempt to cover "Rare Plants" in Britain appeared in 1977 (Perring & Farrell 1977, 2nd ed. 1983), using the quite arbitrary (but perfectly acceptable in terms of a percentage of our native flora) definition of Rare as being in 15 10-km squares or fewer. Since then, the then Nature Conservancy Council (NCC) enshrined this definition in its Sites of Special Scientific Interest guidelines (Nature Conservancy Council 1989), and that for the less rare, now called Scarce, as being in 16–100 10-km squares. This last was equally arbitrary but, again, logical in that it covered another 20% of the native plants, and 100 squares is a nice round figure, and so on.

It is now 1996; 10-km grid squares and recording have been around for 40 years. The 1962 *Atlas* has spawned a mass of county Floras on a 2 × 2 km square and 5 × 5 km square basis, and a few area Floras have used 1 × 1 km squares. A mass of more detailed information is now available – on a 2 × 2 km (tetrad), 1 × 1 km (4 figure grid reference) and even, dare I say, on a site basis (6 figure grid reference), yet we continue to display, categorise and judge Britain's Rare and Scarce plants on the coarse basis of 10 × 10 km squares. On the other hand this is the appropriate approach for an overall view of our whole flora, as in our own new *Atlas 2000*. Here we need coverage, for the whole of the British Isles, of over 3000 species. We also need to know which may be increasing or declining, because even after the Scarce Species project we still have no idea what is happening to species that may be declining but which fell beyond its parameters. The Monitoring Scheme (Rich & Woodruff 1990), undertaken during 1987–8, has offered plenty of thoughts here. Also, since BSBI's pioneering 1962 *Atlas* many other groups, from birds to woodlice, have been covered at the 10-km range and thus we need a modern 10-km square Atlas as a baseline. But I am not remotely content to rest the *Red data book* and *Scarce plants* on this basis and I wish to expand on this.

The *Scarce plants atlas* (Stewart *et al.* 1994) covered 325 species. With not too much effort (mainly trying to ensure that the grid references would be fine enough where we had site details) a further 73 maps were produced showing the number of tetrads in which particular species were recorded within each 10-km square. Of course there are anomalies and imperfections here, in that:–

- some upland species may not be well enough recorded (but I think it probably works now for England and much of Wales and lowland Scotland);
- a tetrad may contain many records or just one;
- only numerals up to 9 (out of 25 in each 10-km square) fit elegantly on to a map. Extra numerals had to be shown by notes, although it would be possible to use more symbols;
- and, of course, as you will hear, the data we have are much less than adequate in terms of accurate grid references;

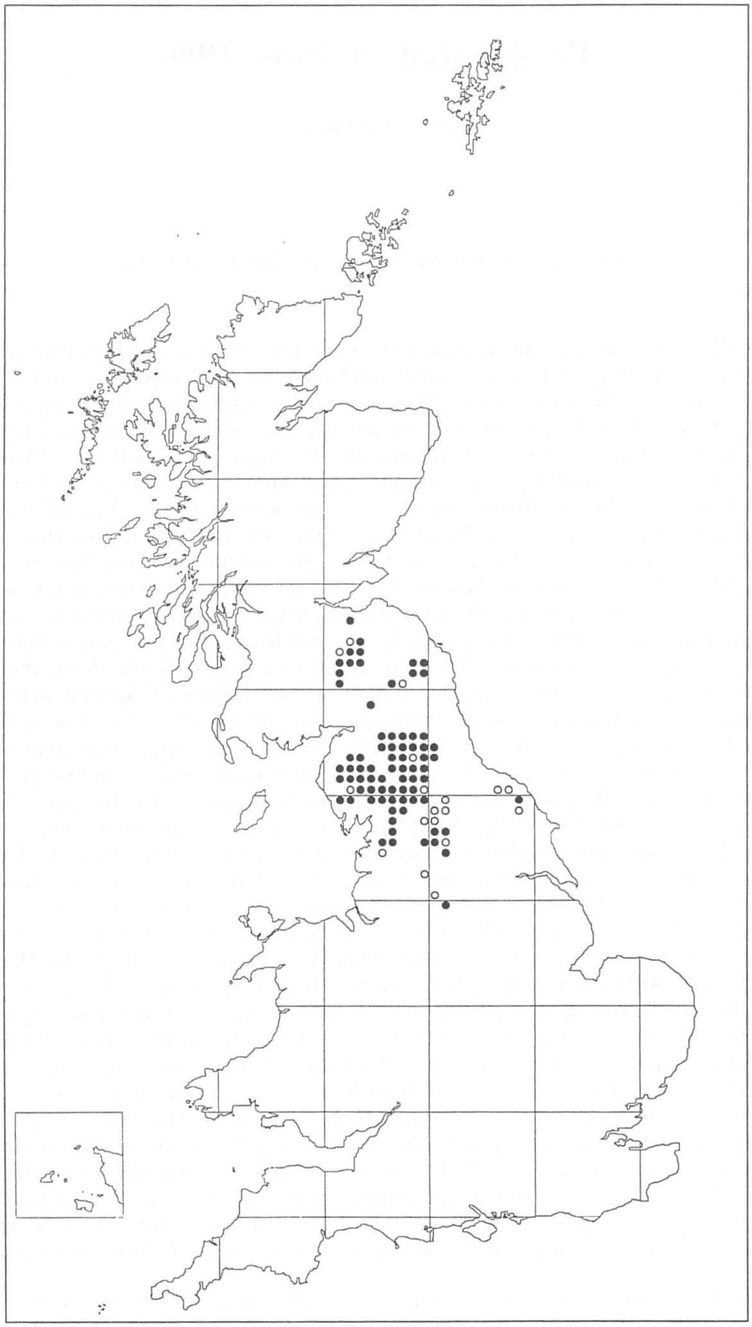
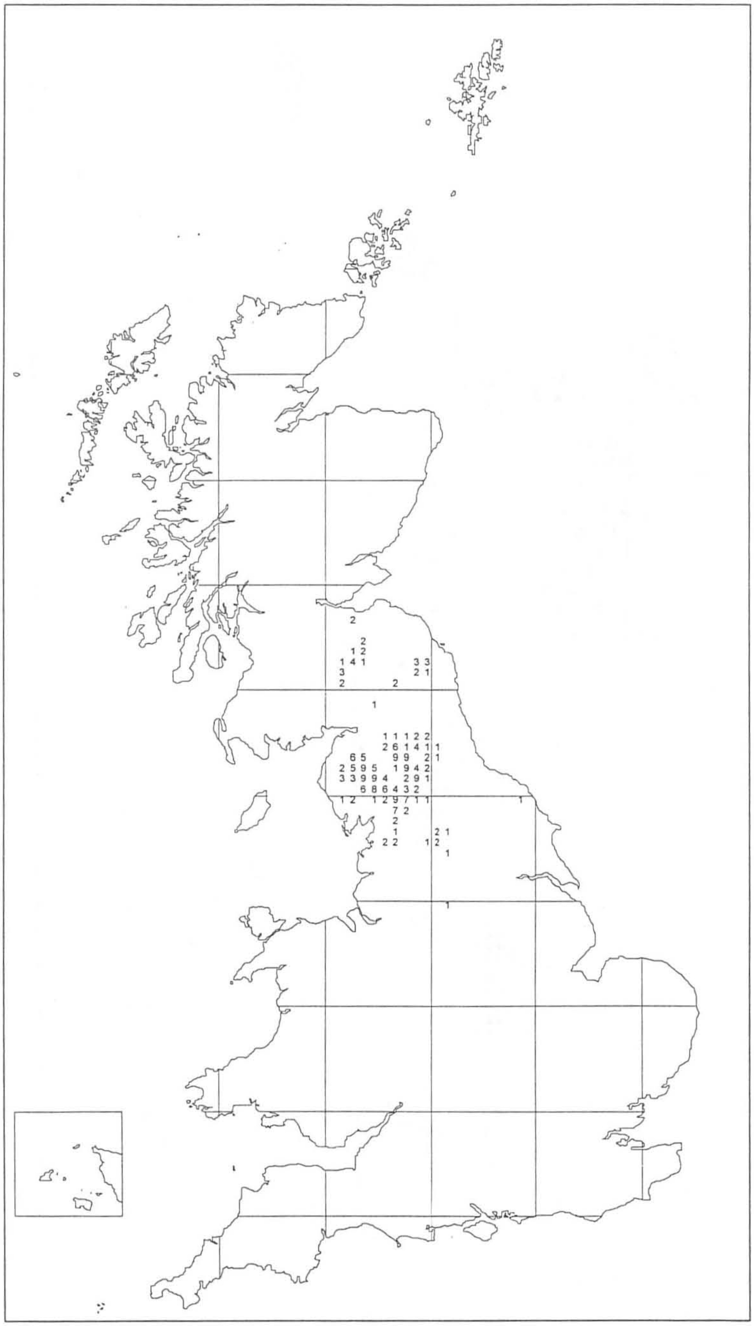


FIGURE 1. The distribution of *Myosotis stolonifera* in Britain at 10-km scale (left hand page) and tetrad distribution within 10-km squares (right hand page) (from Stewart, Pearman & Preston 1994).



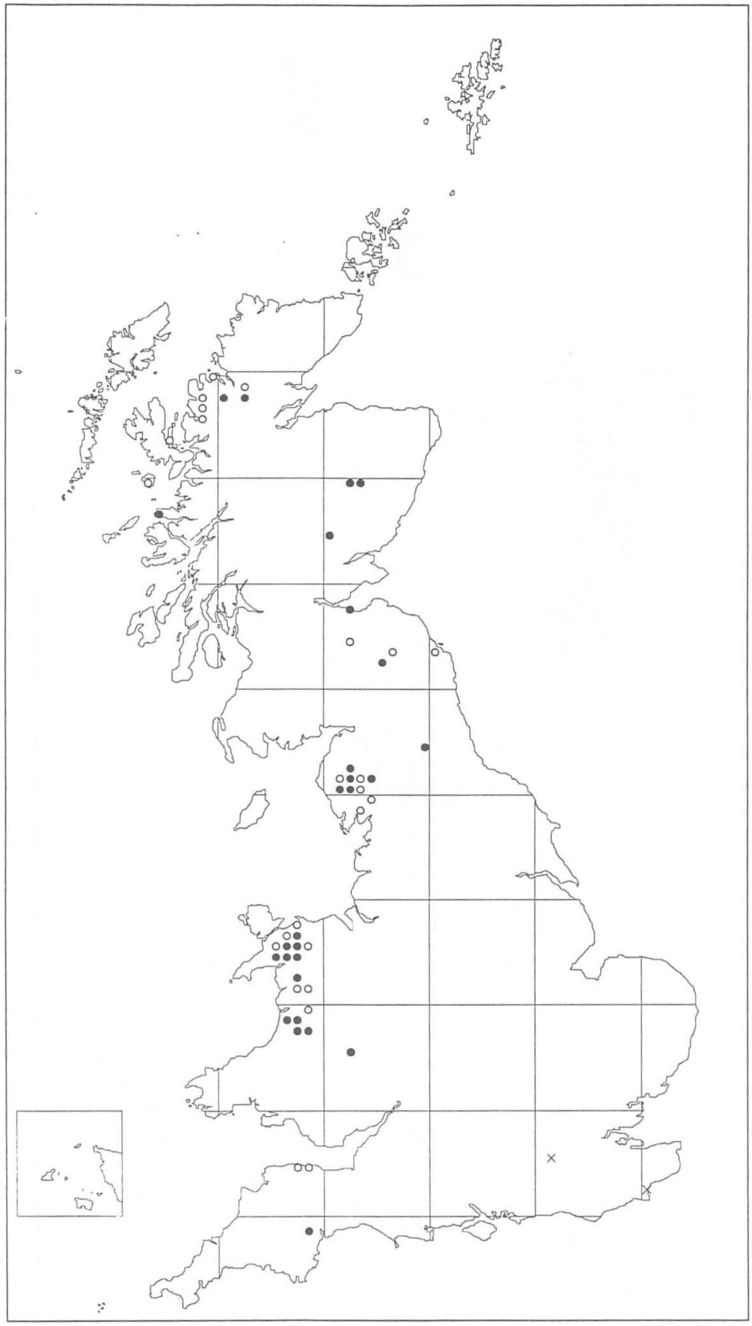
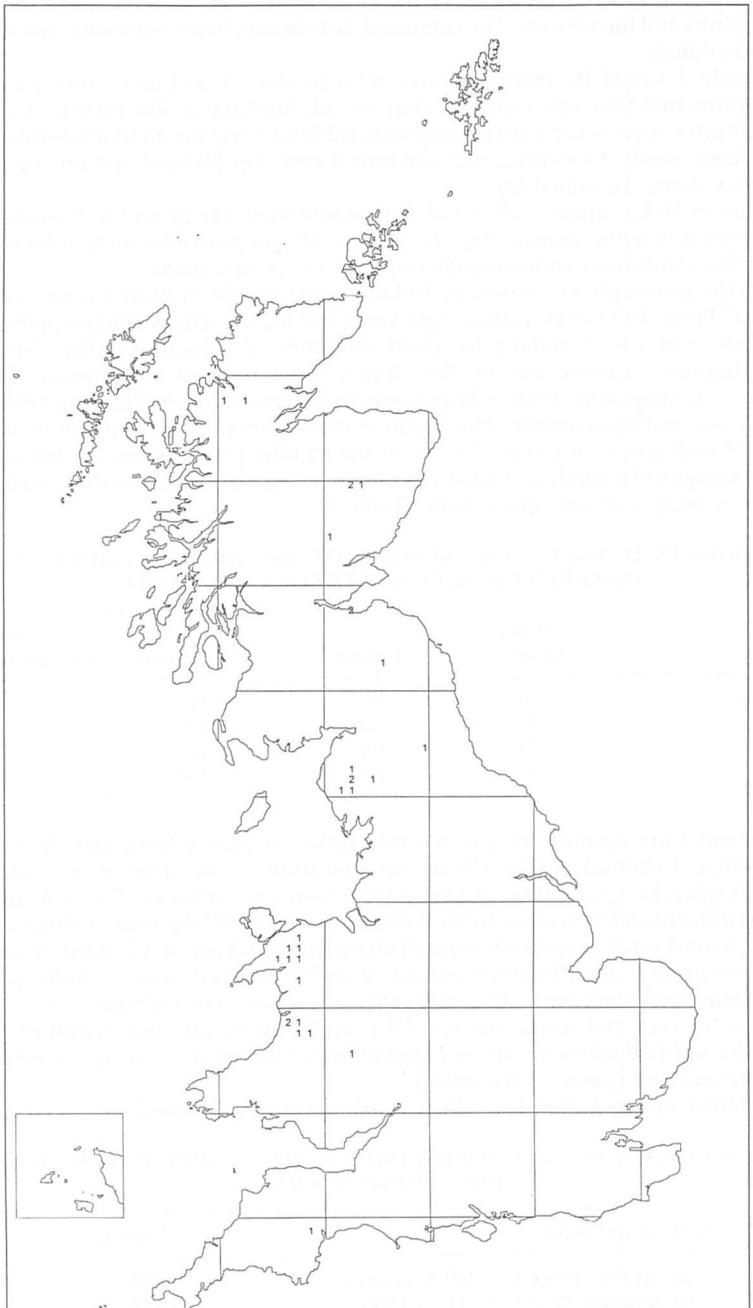


FIGURE 2. The distribution of *Asplenium septentrionale* in Britain at 10-km scale (left hand page) and tetrad distribution within 10-km squares (right hand page) (from Stewart, Pearman & Preston 1994).



but, as any map is a simplification, the extra information that a tetrad map shows definitely outweighs the effort and the caveats. The centres of distribution begin to emerge and the vulnerable areas can be identified.

I never thought I would be enthusing over tetrads, since I feel in County Flora terms and conservation terms that they are a disaster (but no side-tracking at this point) – but I think that tetrad maps for rarer species are a major step forward (and a use for all that information carefully gathered and never used). Of course, they are only a first step forward and for the rarest species much finer scales should be aimed for.

Two examples of 10-km square and tetrad distribution maps are given for *Myosotis stolonifera** (Fig. 1) and *Asplenium septentrionale* (Fig. 2). The tetrad map gives a far more relevant picture and it can be seen that *Asplenium septentrionale* could be a very rare plant.

Examples of the coarse picture shown by 10-km squares can be produced from looking at every County "tetrad" Flora. In Dorset, I spent eight years looking for sedges, and mapping them on a 1-km square basis, and also searching for good examples of habitats for the "Sites of Nature Conservation Interest" scheme run by the Dorset Wildlife Trust and Dorset Environmental Records Centre. The map at the back of *Sedges and their allies in Dorset* (Pearman 1994) shows the 1 km square coverage and demonstrates that I went to the majority of 1-km squares in the county that were not wall-to-wall arable or towns. As one of the handful produced on a 1-km square basis, I consider the coverage to be good, as it allows meaningful comparisons at the three scales, and shows what is hidden by using a 10-km square scale (Table 1).

TABLE 1. SEDGES IN DORSET – THE NUMBER OF SQUARES RECORDED SINCE 1980 AT DIFFERENT SCALES AND FREQUENCY RATIO

	10-km squares	Tetrads	1-km squares	Frequency ratio (tetrads/10-km squares)
Carex acutiformis	30	151	212	5·03
C. divulsa	31	86	107	2·77
C. riparia	30	106	149	3·53
C. remota	34	259	460	7·62

Thus tetrads and 1-km squares can give a totally different picture from that shown by a 10-km square atlas. When I showed Arthur Chater my first draft of this address he criticised me for choosing tetrads when he assumed much finer information was available. This is definitely not the case. There are still quite a few records in the *Red data book* (*RDB*) database without six figure grid references, and a substantial proportion of the *Scarce plants* database, not just for those species that might be common locally, like *Phyteuma orbiculare* on the Sussex downs or alpine species such as *Carex saxatilis*, but for whole counties that only collect records on a tetrad basis. An area of 2 × 2 km is far too coarse for rare and scarce species. Of course I appreciate that tetrad or 1-km square recording may be satisfied with one site or population per tetrad or 1-km square (even with a six figure grid reference) and ignore all the others.

Just out of interest, and to demonstrate the scale of the problem, Table 2 indicates the numbers of

TABLE 2. ACCURACY OF POST-1970 RECORDS IN THE SCARCE PLANTS DATABASE (BRC, MONKS WOOD)

Scale of recording	No. of records
6 fig. grid reference (i.e. 100 m square)	26000
4 fig. grid reference (i.e 1-km square)	11500
Tetrad only	5500
10-km square only	5500
Total	48500

* Nomenclature follows Stace (1991).

post-1970 records of different degrees of accuracy, held on the *Scarce plants* database at the Biological Records Centre, Monks Wood. 46% do not have a six figure grid reference, and this is after 40 years of recording!

The different roles of *Recording* and *Mapping* should be made clear.

Recording (and monitoring) of rare and scarce plants should always be on as fine a basis as is practical, at least to a six figure grid reference, i.e. to within 100 metres, and attempts should be made to define a site. This is a problem for many reasons – the spreading through rhizomes or

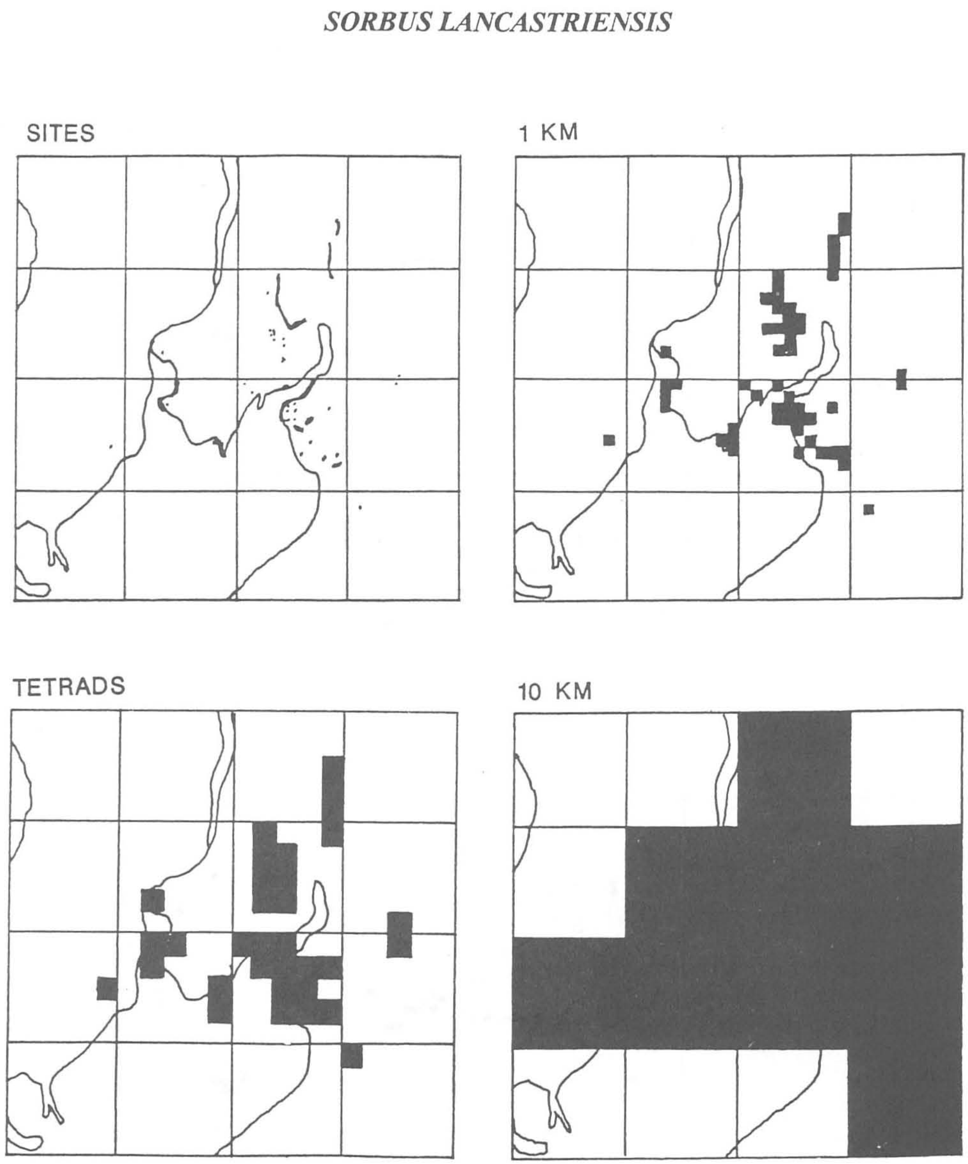
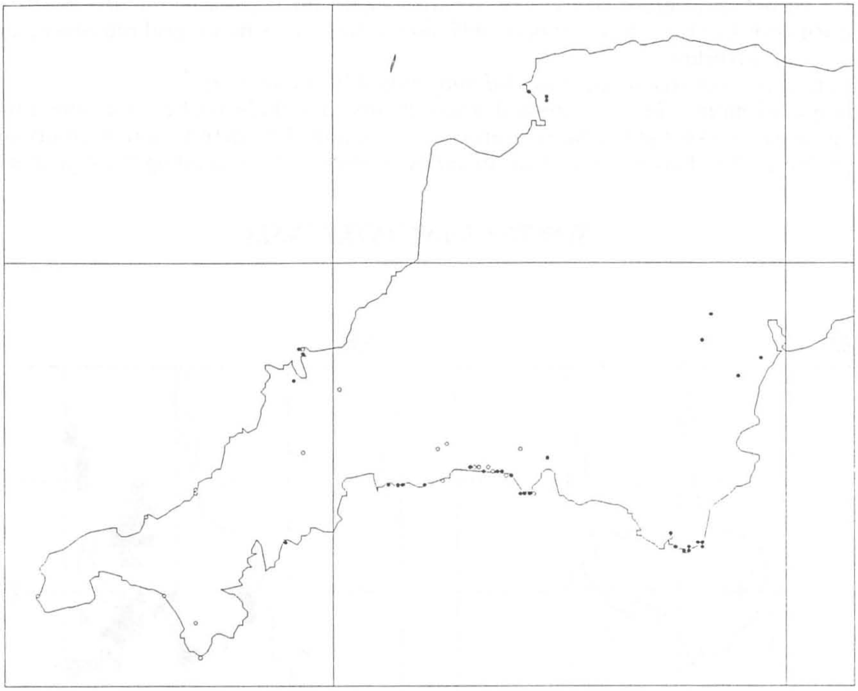


FIGURE 3. The distribution of *Sorbus lancastrienis* in Lancashire: upper left – site distribution; upper right – 1-km square distribution; bottom left – tetrad distribution; and bottom right – 10-km square distribution (prepared by T. C. G. Rich).



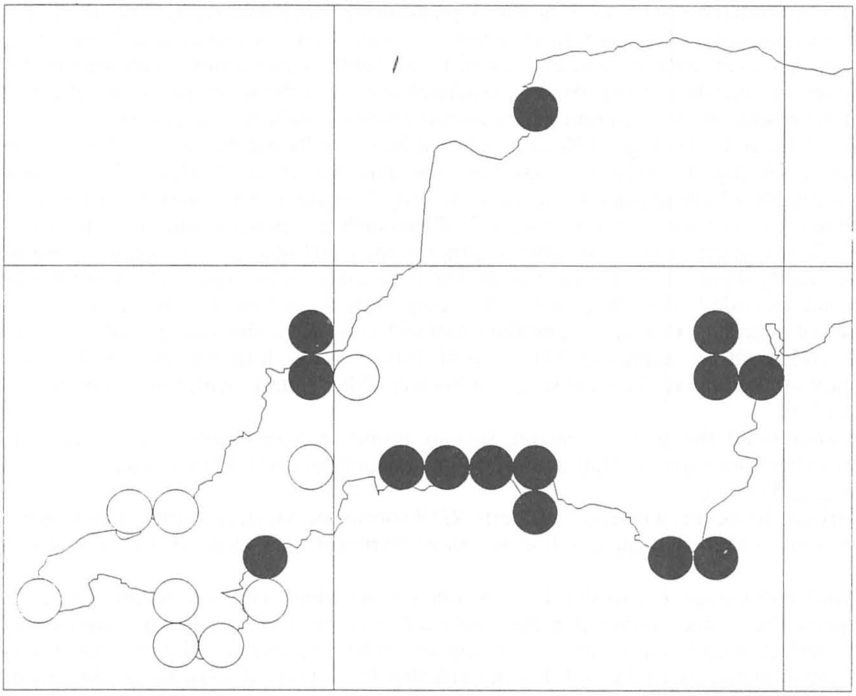


FIGURE 4. The distribution of *Lotus angustissimus* in Cornwall and Devon: facing page, upper – 1-km square distribution; facing page, bottom – tetrad distribution; and this page – 10-km square distribution. ○ pre-1970; ● 1970–1995. (Prepared by M. Wigginton, JNCC.)

stolons of so many perennials, the fragmentation of a locally common species over an area, and the spread of the site over several 1-km squares. Progress needs to be made in settling some arbitrary definitions, and perhaps "moveable" 1-km squares might help. It can be seen from the map of *Sorbus lancastriensis* (Fig. 3), that defining a site is not an easy task, although perhaps easier with a tree species.

For *Mapping* there is inevitably a simplification, and from the map of *S. lancastriensis*, I think 1-km squares or tetrads are quite satisfactory. It is feasible to map most of the current *RDB* plants at a 1-km square scale, but only some of the Scarce plants given the caveats in Table 2. At the site scale, it might only be possible to prepare maps of sites for a handful of *RDB* plants and I doubt whether any Scarce plants could yet be done.

Two examples of maps at the different scales have been prepared, *Sorbus lancastriensis* (Fig. 3) and *Lotus angustissimus* (Fig. 4). In fact for *Lotus angustissimus* one might go further and say that in the years 1993 and 1994:

- three 1-km squares for Pentire have seven sites and 200–300 plants;
- 14 1-km squares for South Cornwall have 15 sites and 600 plants;
- seven 1-km squares from Prawle to Start Point have 13 sites and 6500 plants;

and all the other 1-km squares have few sites and tiny populations. I am not certain how you map this, and how you take into account the effects of burning and clearing, and good and bad seasons.

Again Simon Leach would argue that the extra effort in looking for every site of *Lotus angustissimus* has put it over the national 10-km square *RDB* threshold, and possibly over what I am going to suggest as my tetrad threshold too, although it depends on which cut-off date you use! A difficult problem, but as I shall say later, one that we are close (well, fairly close) to overcoming.

These two sets of maps (Figs 3 & 4) show a valuable picture and I hope my successor in 2000 will be standing here similarly demonstrating that *Asplenium septentrionale* really is restricted to only 40 sites in 'x' 1-km squares and 'y' 2-km squares whereas, say, *Carex rariflora*, little known to many of us, but an absolute gem to the aficionado, is wall-to-wall in the east Grampian mountains with huge sites with many thousands of plants over its restricted area. For the moment, then, tetrad maps are as fine as it is possible to go to obtain a meaningful comparison between species.

Chris Preston and the Biological Records Centre have kindly produced tetrad totals for all the Scarce species, and Martin Wigginton has done the same for all the *RDB* species. Although the details are available I have restricted the tables to only the rarest scarce and the commonest *RDB* species. All figures have been adjusted to post-1970 records and figures, and only the lowest tetrad numbers for Scarce species, and the highest numbers for *RDB* species are shown. Those from the *RDB* are inevitably slightly better recorded and the commoner Scarce species may not have been so conscientiously recorded. But the point I am trying to make is that the tetrads must be a more effective way of defining a rare plant, and the order of frequency is substantially different from that shown on a 10-km square sequence. The table of Scarce species found in low numbers of tetrads (Table 3) shows that many really are infrequent in each 10-km square, with frequency ratios ranging from 1·20 to 2·50.

On the other hand the table of Scarce species found in high numbers of tetrads (Table 4) demonstrates that some species that are found in low numbers of 10-km squares are much more frequent in tetrad terms.

In comparison, however, when one converts *RDB* species into tetrads rather than 10-km squares (Table 5) it will be seen that quite a few are more common than many of the so-called 'Scarce' species.

It is relevant at this stage to consider the 73 Scarce species which were also mapped as tetrads (Fig. 5). Some species have been omitted in the lower left section of the graph for clarity only. I have looked at the effect of under-recording, or not fine enough recording, on all species in the tables and this graph, and adjusted where I can. I do not think that lack of tetrad recording in upland areas will do other than slightly blur the picture, because these are better-recorded species.

At this point one could bring together the strands illustrated to date, and say:

- a small number of 10-km squares but high tetrad numbers indicates a local or restricted distribution, but not uncommon where it occurs, e.g. *Carex humilis* found in 28 10-km squares and 124 tetrads; whereas
- a small number of 10-km squares, but low tetrad numbers indicates scattered, possibly widespread even, but now with isolated sites and populations, e.g. *Asplenium septentrionale* and *Vulpia unilateralis*. These are the vulnerable species that we should be really concerned about.

Potentially interesting are those in quite a few 10-km squares, but with low tetrad numbers that one might not have thought of as vulnerable, e.g. *Silene gallica*, *Thelypteris palustris* and *Pilularia globulifera*.

There has been much work done, particularly in the bird world, on these ratios of tetrads to 10-km squares, and the resulting ratio has been usefully called a "frequency index".

Le Duc, Hill & Sparkes (1992) use this concept and the *New atlas of breeding birds in Britain and Ireland* (Gibbons *et al.* 1993) makes great use of "frequency" maps (p. 457 et seq.). The "frequency index" could be a valuable conservation tool, provided, of course, that the basic data are correct, or even that the basic data are available! I asked David Gibbons, one of the joint editors of the Bird Atlas, as to whether they had used low frequency ratios as a conservation tool. He replied that there was no need to, as they had population counts of all the rare and important species – totally different from the botanical experience. But for the common species, we can already use Monitoring Scheme data to plot similar maps and hope to use this technique in the new Atlas 2000.

I do not know whether it is relevant that for these 73 Scarce Species (Fig. 5), the average number of tetrads per 10-km square was 2·2 – i.e. there were records from only 2·2 out of a possible 25 tetrads for these species. I repeated the exercise for the 30 most common (in tetrad terms) of the *RDB* species, and found, to my surprise, that the average was 2·16. When all the Scarce species were included the average was 1·95, but all the caveats about locally common, coastal and upland species need to be taken into account.

TABLE 3. "SCARCE" SPECIES FOUND IN LOW NUMBERS OF TETRADS – 1970 ONWARDS TOTALS

	Tetrads	10-km squares	Frequency ratio (tetrads/10-km squares)	Comments
Corynephorus canescens	17	12	1·41	
Veronica spicata	20	16	1·25	
Carex vulpina	22	12	1·83	
Luzula arcuata	22	12	1·83	
Calamagrostis stricta	22	15	1·46	
Galium pumilum	23	19	1·21	
Cyperus longus	23	20	1·15	Picture confused by planting
Vulpia unilateralis	24	20	1·20	
Cystopteris montana	25	15	1·67	
Melampyrum sylvaticum	26	21	1·23	
Alchemilla glomerulans	27	24	1·12	Certainly under-recorded
Pulsatilla vulgaris	28	19	1·47	
Galium parisiense	29	19	1·53	
Mentha pulegium	29	20	1·45	
Ribes alpinum	29	20	1·45	
Lathyrus palustris	29	22	1·32	
Chenopodium chenopodiodes	30	12	2·50	Probably in at least 32 tetrads
Spiranthes romanzoffiana	30	18	1·66	
Phleum alpinum	30	21	1·43	
Circaea alpina	30	24	1·25	
Ophioglossum azoricum	31	24	1·25	Probably in >13 more 10-km squares and >15 tetrads
Asplenium septentrionale	31	27	1·15	
Najas flexilis	31	15	2·07	
Illecebrum verticillatum	32	16	2·00	
Elatine hydropiper	32	19	1·68	
Sagina saginoides	32	20	1·60	
Alopecurus borealis	32	24	1·33	
Crepis mollis	32	28	1·14	Probably in at least 43 tetrads giving ratio of 1·54
Carex appropinquata	32	21	1·52	
Marrubium vulgare	32	19	1·68	
Ranunculus tripatitus	33	19	1·73	
Juncus filiformis	33	20	1·65	
Atriplex longipes	34	27	1·26	
Daphne mezereum	34	24	1·41	
Ajuga chamaepitys	35	20	1·75	
Salix reticulata	35	17	2·06	
Allium schoenoprasum	36	17	2·12	Probably in at least 39 tetrads giving ratio of 2·29
Sorbus porrigentiformis	36	21	1·71	
Linum perenne	36	24	1·50	
Dianthus armeria	38	36	1·06	Probably in 33 tetrads, 31 10-km squares, giving ratio of 1·06
Silene conica	39	22	1·77	
Adiantum capillus-veneris	39	26	1·50	
Frankenia laevis	39	28	1·39	
Juncus biglumis	40	23	1·74	
Draba norvegica	40	24	1·67	
Polypogon monspeliensis	41	21	1·95	
Melampyrum cristatum	41	23	1·78	
Linnaea borealis	41	32	1·28	
Carex ericetorum	42	26	1·61	
Actaea spicata	42	22	1·91	

TABLE 3. (continued)

	Tetrads	10-km squares	Frequency ratio (tetrads/10-km squares)	Comments
Arabis glabra	42	31	1·35	15 tetrads are 1970–1979 only
Salix arbuscula	42	23	1·82	
Veronica alpina	42	28	1·50	
Juncus castaneus	43	24	1·79	
Sorbus devoniensis	43	24	1·79	
Helianthemum canum	44	17	2·59	
Carex maritima	44	41	1·07	Probably in at least 47 tetrads, giving ratio of 1·15
Nuphar pumila	44	22	2·00	
Juncus balticus	44	39	1·13	
Juncus alpinus	45	28	1·61	
Trifolium occidentale	46	17	2·71	
Peucedanum palustre	46	22	2·10	
Minuartia sedoides	46	27	1·70	
Impatiens noli-tangere	47	16	2·94	
Cerastium arcticum	47	28	1·67	
Vicia bithynica	48	33	1·45	
Sonchus palustris	48	21	2·29	
Fallopia dumetorum	48	34	1·41	
Cerastium cerastioides	50	21	2·38	

TABLE 4. A SELECTION OF "SCARCE" SPECIES FOUND IN HIGH NUMBERS OF TETRADS AND LOW NUMBERS OF 10-KM SQUARES – 1970 ONWARDS TOTALS

	Tetrads	10-km squares	Frequency ratio (tetrads/10-km squares)
Cardamine bulbifera	81	19	4·26
Carex digitata	72	25	2·88
Carex humilis	124	28	4·43
Dryopteris submontana	85	27	3·15
Gentianella germanica	65	21	3·10
Orchis purpurea	57	20	2·85
Ornithogalum pyrenaicum	95	23	4·13
Primula elatior	92	27	3·41
Pulmonaria longifolia	83	20	4·15
Wolffia arrhiza	82	25	3·28

At this stage in 1996, I do not think there is sufficient information to draw conclusions from these ratios, but I really do believe it is a subject for future exploration. To me it seems extraordinary low. I would have thought we could acquire 1-km square data fairly easily for the rarer species, and then move to six figure grid references. But why are the figures so consistently low?

These figures might be put into context by looking at any County "tetrad" Flora to see what sort of frequencies one finds by including all plants. Perhaps Daisy and Dandelion and Nettle would tend towards the maximum of 25 and no doubt Jack Oliver from Wiltshire has done some work on this,

TABLE 5. *RED DATA BOOK* SPECIES FOUND IN HIGH NUMBERS OF TETRADS – 1970 ONWARDS TOTALS

	Tetrads	10-km squares	Frequency ratio (tetrads/10-km squares)
Fumaria occidentalis	84	27	3·11
Scrophularia scorodonia	77	29	2·66
Gastridium ventricosum	52	26	2·00
Erica ciliaris	49	15	3·27
Poa infirma	44	26	1·69
Genista pilosa	41	13	3·15
Ophrys sphegodes	36	14	2·57
Salvia pratensis	36	24	1·50
Cirsium tuberosum	35	14	2·50
Lotus angustissimus	35	25	1·40
Phleum phleoides	33	12	2·75
Potamogeton nodosus	33	11	3·00
Bunium bulbocastanum	32	12	2·67
Carex rariflora	32	15	2·13
Gentiana verna	30	4	7·50
Lithospermum purpurocaeruleum	30	15	2·00
Muscari neglectum	30	23	1·30
Silene otites	30	8	3·75
Carex ornithopoda	28	11	2·55
Cynodon dactylon	28	21	1·33
Bartsia alpina	26	13	2·00
Erica vagans	26	5	5·20
Euphrasia vigursii	26	15	1·73
Kobresia simpliciuscula	25	12	2·08
Orobanche purpurea	25	17	1·47
Physospermum cornubiense	25	9	2·78

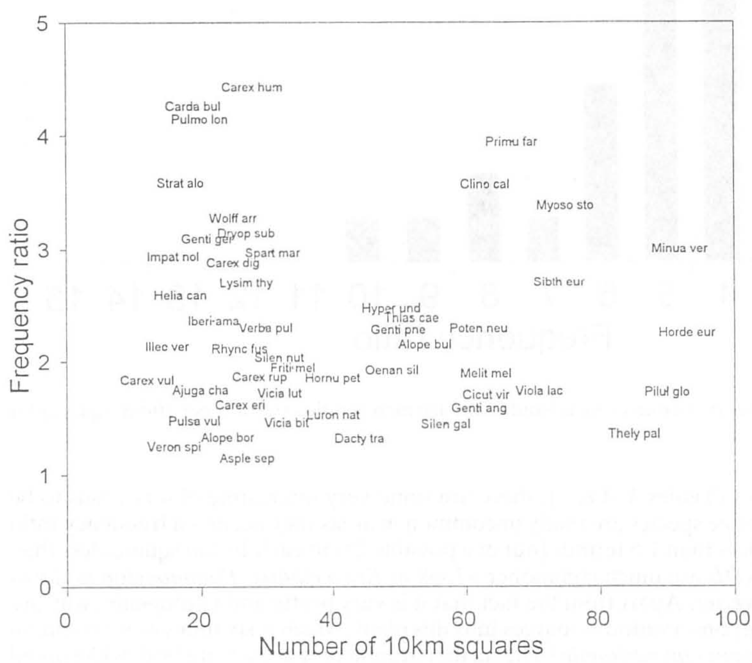


FIGURE 5. The relationship between the frequency ratio (number of tetrads per 10-km square) and number of 10-km squares for Scarce Species. (Based on post-1970 records.)

but I would like to know what is the average. Because it is a small manageable suite I have produced a chart for Dorset Cyperaceae (Fig. 6), with the only caveat that no sedge is a really ubiquitous plant. The average frequency ratio here is 4·16 tetrads/10-km square. Interestingly enough, on a 1-km square: 10-km square basis the average only increases to 4·45. It would be useful to know if there was a predictable relationship between tetrads and 1-km square frequency ratios.

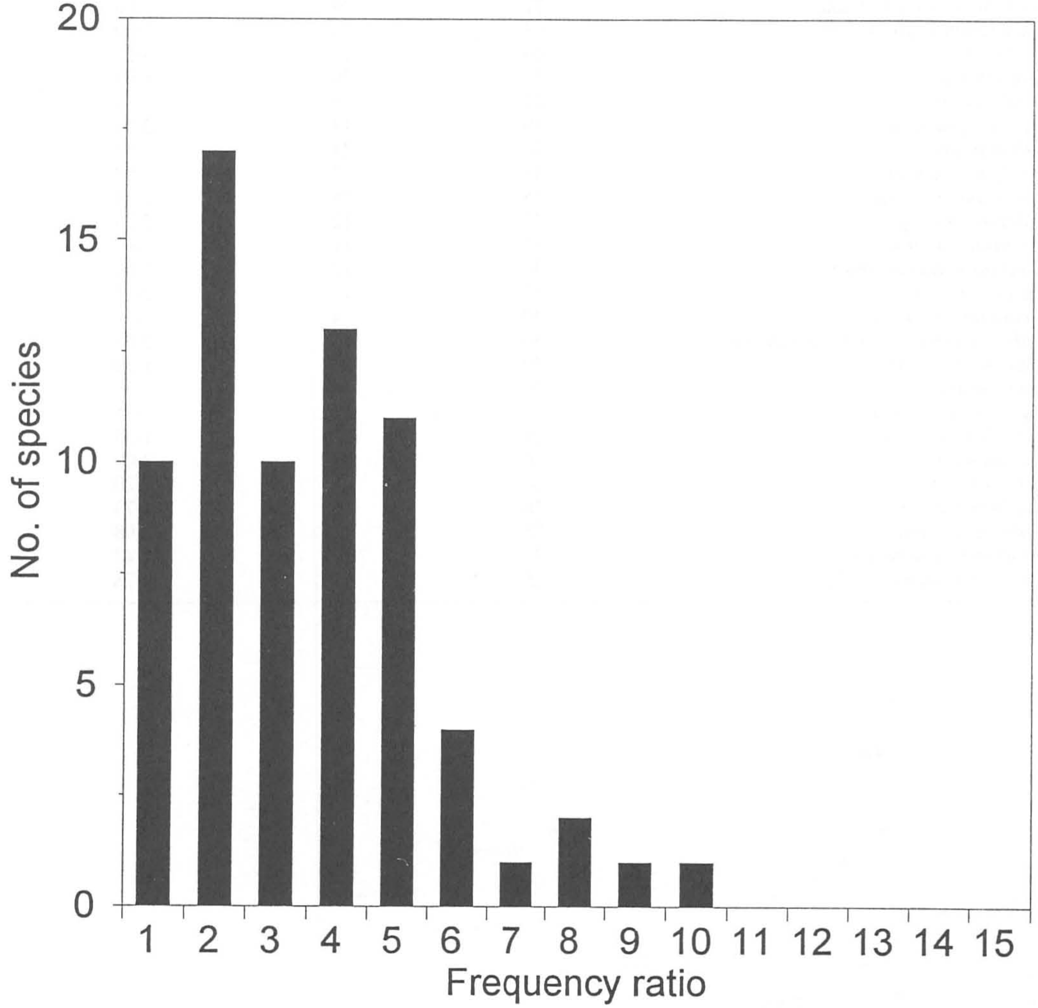


FIGURE 6. The number of species occurring in each band of the frequency ratios (tetrads per 10-km square) for Cyperaceae in Dorset.

Looking then at the tables (Tables 3, 4 & 5), there are some very interesting observations to be made. Many of the rarer Scarce species are really uncommon in areas they occur – a frequency ratio of under 1·5 – i.e. found in less than 1·5 tetrads (out of a possible 25) in each 10-km square, less than 6%. Most of the less rare *RDB* are much commoner – look at *Erica ciliaris, Potamogeton nodosus* and especially at *Gentiana verna*. Apart from the fact that it is very pretty and photogenic, why are we even considering putting conservation resources into this plant, which is six times more common where it occurs than *Asplenium septentrionale*? The further argument that they are both widespread and frequent in Europe, is outside the scope of this address, but is something that JNCC, by adopting the new IUCN guidelines on *Red data book* plants, is beginning to address. I suppose cynics would quite fairly argue that "public appeal" must be brought into the equation, and that is why birds and dormice always win and *Gentiana verna* will always beat *Asplenium septentrionale*! But that is for the politicians in JNCC and the three country agencies, not for me!

Table 6 shows Scarce plants, which have been reliably recorded, that have the lowest frequency ratios. I would be very happy to use conservation resources on these species. *Cyperus longus* was on this list, but I have left it out as it is now much more common as a garden escape than a native. From personal experience they are locally rare, they are certainly scattered and they are more worthy in my mind of conservation effort than many *RDB* species. I appreciate that this begs another question. I am being simplistic in saying that 'x' species should be protected and 'y' species should not. The reality might be that all are protected in the parts of their range where they are most vulnerable or looked after in their core areas because they are core areas – another reason for acquiring more precise data. Some of these, particularly those lower in the list, may well be under-recorded, but again, there are some very interesting observations to be made about species

TABLE 6. "SCARCE" SPECIES WITH LOW FREQUENCY RATIOS – 1970 ONWARDS TOTALS
(based on Stewart, Pearman & Preston 1994)

	Tetrads	10-km squares	Frequency ratio (tetrads/10-km squares)
Dianthus armeria	33	31	1·06
Festuca arenaria	55	52	1·06
Juncus balticus	44	39	1·13
Asplenium septentrionale	31	27	1·15
Carex maritima	47	41	1·15
Corallorrhiza trifida	76	65	1·17
Vulpia unilateralis	24	20	1·20
Galium pumilum	23	19	1·21
Centaurea cyanus	156	127	1·23
Melampyrum sylvaticum	26	21	1·23
Ophioglossum azoricum	46	37	1·24
Circaea alpina	30	24	1·25
Veronica spicata	20	16	1·25
Atriplex longipes	34	27	1·26
Linnaea borealis	41	32	1·28
Zostera marina	99	77	1·28
Deschampsia setacea	71	55	1·29
Equisetum pratense	117	89	1·31
Pyrola media	111	85	1·31
Arabis glabra	41	31	1·32
Lathyrus palustris	29	22	1·32
Alopecurus borealis	32	24	1·33
Limosella aquatica	73	55	1·33
Orobanche rapum-genistae	129	97	1·33
Ulmus plotii	44	33	1·33
Hammarbya paludosa	127	95	1·34
Lycopodium annotinum	105	78	1·34
Pyrola rotundifolia (all)	91	68	1·34
Dianthus deltoides	104	77	1·35
Thelypteris palustris	115	85	1·35
Mertensia maritima	136	100	1·36
Sorbus rupicola	76	56	1·36
Isoetes echinospora	108	79	1·37
Torilis arvensis	112	82	1·37
Scandix pecten-veneris	182	131	1·39
Silene gallica	82	57	1·43

seemingly widespread but apparently at very low frequency. I will return at the end to suggest how we might use this frequency ratio in conservation terms.

I am going to commit a major crime at this stage, and change the subject, before coming back for a final assault. The reason for this is that the more I delved into the *Scarce plants* database, the more avenues I found that could be explored using this discrete set of data, and it seemed a shame to miss this opportunity to share them with you.

One avenue I explored came from a table in *Scarce plants in Britain* (Stewart *et al.* 1994, Table 3) which listed the totals of Scarce plants that have ever been found in each vice-county, and compared them with the numbers recorded for that project, i.e. after 1970. I found it difficult to assimilate 112 vice-counties, and I thought it would be useful to interpose a third date, 1930, as that was the date for current records in the 1962 *Atlas of the British Flora* (Perring & Walters 1962). I have grouped the vice-counties into regions (the same as used by the Ecological Flora database in York), and shown the losses up to 1930, between 1930 and 1970, and after 1970 (Table 7). I have then shown them as a percentage of species lost, and alternatively, as a variation from the norm, because that shows the regional differences much better. There are, at least, a couple of caveats, as I have shown, but I think the figures are very interesting. In this case we are talking about an *absolute* loss of species in the *entire* vice-county, so, although the picture is perforce crude, it shows that we have lost almost a third of all the individual Scarce Species recorded in each of the vice-counties. The date classes allow you to see whether the losses have occurred recently or before 1930 and the variations from the norms show when was the worst in each region. More work could be done by looking at all the species listed by County Floras as becoming extinct – most Floras, even perfunctory tetrad Floras, contain at least this sop to the past.

This leads neatly on to the second part of my address; should we redefine 1–15 10-km squares and 16–100 10-km squares for the *RDB* and Scarce categories, in the light of 40 years of recording? I believe we should, and there are several ways of doing so.

Firstly, there is the concern of under-recording; Simon Leach elegantly expressed his concerns in a note in *BSBI news* last year (Leach 1995) where he said that greater recording effort only meant that Scarce Species were found in more squares, occasionally leading to tipping over the 100 10-km square barrier into being "not Scarce"!

Tim Rich in his Monitoring Scheme report (Rich & Woodruff 1990), estimated that the 1962 *Atlas* possibly under-recorded by a factor of 50%. Certainly, in preparing the *Scarce plants atlas*, we felt really concerned about species that showed a decline between 1962 and 1992, despite all the extra recording. I must say at this point that I have grave reservations about using statistics to extrapolate the distribution of rare plants, which often occur in restricted niches or have a very uneven distribution in the country as a whole. Tim Rich, using Monitoring Scheme data, has attempted to do this. Although my statistical knowledge was rudimentary, and a long time ago, and my admiration for him as being one of the few original thinkers on plant distribution knows no bounds, I think he is mistaken on this point. The Monitoring Scheme is excellent for evenly distributed and/or common plants, and is increasingly used nationally for work on these, but I do not think it can be used for Scarce and *RDB* plants or those with an uneven distribution.

Secondly, there is the concern that 10-km square recording fails to show historical losses. Information on this is very rare indeed. Because of the late arrival of the National Grid, and because intensive recording only started in the 1960s, we have few or no baselines with which to compare.

One of the only exceptions to this is again in Dorset, where the late Prof. Good recorded species from 7500 stands of vegetation in the 1930s. He marked these stands on a set of six inch Ordnance Survey maps, which made it possible to add the later National Grid. Andy Byfield and I thus were able to revisit more than 400 of his heathland sites, where he had recorded 41 heathland plants, which we chose because of their interest to an informed botanist looking at heaths. They included 18 Scarce plants and four *RDB* plants, so fitted nicely into my other work.

I doubt if Good went to all his sites on a random basis, but that he gravitated to the better sites, and he was actually looking at representative examples of habitats rather than all possible sites of particular species. For example, he looked at over 1000 heathland sites, including 30 on Hartland Moor alone, but still would not have looked everywhere.

The full results are at last being published (see Byfield & Pearman, 1994 for preliminary findings), but I use *Lycopodiella inundata* as an example here just to show how limited is 10-km square data. His data and our researches since are summarised in Table 8. This shows that an atlas produced in

TABLE 7. LOSS OF SCARCE SPECIES PER GROUPS OF VICE-COUNTIES (I.E. SUM OF TOTALS OF SPECIES PER V.C.)

Area	V.c. numbers	All records	Loss up to 1930	Records 1930+	Loss 1930–1970	Records 1970+	Loss ever
SW	1–6,9–11	741	81	660	103	557	184
SE	13–21	772	114	658	155	503	269
SC	7–8,12,22–24,30,32–34,36–38	786	145	641	164	477	309
E	25–29,31,53–54,61	671	112	559	109	450	221
NC	39–40,55–58	284	74	210	64	146	138
S. Wales	35,41–46	338	34	304	66	238	100
N. Wales	47–52	295	47	248	46	202	93
NW	59–60,69–71	302	51	251	53	198	104
NE	62–67	384	87	297	83	214	170
S. Scotland	68,72–85	436	115	321	61	260	176
E. Highlands	86–96	612	87	525	71	454	158
W. Highland	97–103	289	22	267	41	226	63
N. Scotland	104–112	417	20	397	72	325	92
	Totals	6327	989	5338	1088	4250	2077

Area	V.c. numbers	% Losses Up to 1930	% Losses 1930–1970	% Losses 1970+	Variation from norm Up to 1930	Variation from norm 1930–1970	Variation from norm 1970+
SW	1–6,9–11	10·9	13·9	24·8	+4·7	+3·3	+8·0
SE	13–21	14·8	20·0	34·8	+0·8	−2·8	−2·0
SC	7–8,12,22–24,30,32–34,36–38	18·5	20·8	39·3	−2·9	−3·6	−6·5
E	25–29,31,53–54,61	16·7	16·2	32·9	−1·1	+1·0	−0·1
NC	39–40,55–58	26·1	22·5	48·6	−10·5	−5·3	−15·8
S. Wales	35,41–46	10·1	19·5	29·6	+5·5	−2·3	+3·2
N. Wales	47–52	15·9	15·6	31·5	−0·3	+1·6	+1·3
NW	59–60,69–71	16·9	17·5	34·4	−1·3	−0·3	−1·6
NE	62–67	22·7	21·6	44·3	−7·1	−4·4	−11·5
S. Scotland	68,72–85	26·4	13·9	40·3	−10·8	+3·3	−7·5
E. Highland	86–96	14·3	11·5	25·8	+1·3	+5·7	+7·0
W. Highland	97–103	7·6	14·2	21·8	+8·0	+3·0	+11·0
N. Scotland	104–112	4·8	17·3	22·1	+10·8	−0·1	+10·7
	Average	15·6	17·2	32·8			

Notes
1. E.W. and N. Scotland very good even with poorer 1970+ recording;
2. Some of the pre-1930 figures might be skewed by poor early recording, etc.

TABLE 8. *LYCOPODIELLA INUNDATA* IN DORSET USING PROFESSOR GOOD'S DATA

	Good (1932–38)	B/P (1990–92)	Scarce (1970–92)	Now (1991–94)
No. of sites	48	6	28	20
No. of tetrads	34	5	26	25
No. of 10-km squares	10	3	10	6

1939 would have shown ten extant 10-km squares, and that the *Scarce Atlas* showed ten extant 10-km squares. But within that:

a. we only refound it in 3 out of 10 of *his* squares (we did not, of course, look as carefully for new sites as we did for old);
b. we only refound it in 6 out of 48 of *his* sites;
c. the scarce total of 10-km squares was the same, but the number of sites had declined from 48 to 28; and
d. the tetrad total still under-represented the known loss at site level (only down from 34 to 26).

There are at least three caveats:

a. I have not, of course, covered populations. It is possible (although not true in this case) that 99% of the Dorset population present in 1932–1938 is still present in 1994. I think, despite the difficulties, populations must be assessed. The broad bands that Dick David used for his *Carex* counts – A 1–20, B 21–100, C hundreds, D thousands are probably fine for most purposes;
b. some plants have better "mobility" than others. *Limosella* springs to mind. Again, I do not think this applies to *Lycopodiella*, but "mobility" must be borne in mind when considering plant trends; and
c. it is a long time ago! I have not mentioned this, but by using the 1970 baseline, which is probably the only practical one in a country of disparate habitats and spread of recorders – we are seriously out-of-date, and that there were another 15 years of agricultural improvement and heathland dereliction to go before any lessening of pressure on plant sites and populations.

So, in 1900, *L. inundata* was widespread and 10-km square mappings would have been adequate to show its decline. By the 1930s it had a very localised distribution in Britain, so it came into the category of localised species whose decline can be easily seen on a tetrad scale but scarcely on a 10-km scale. In addition the 10-km picture is inadequate because *L. inundata* has a localised distribution, but tends to be fairly common in areas it does occur in.

Many of us have felt that the national 10-km square picture, at least for the Scarce and Rare plants where we can prove it, increasingly represents a shroud – the dots are still there but the number of tetrads and populations inside each dot are diminishing. As I have said above, we have little or no comparative data. Good's Dorset data show this neatly, and, of course, I could do it for many other species from Dorset. Here the loss in the number of 10-km squares has barely started to show, years after a finer resolution would have shown the same. If other areas had similar data available for comparison then I am sure we would see the same pattern.

In September, 1995 JNCC adopted radically new guidelines for *RDB* plants based on IUCN criteria. These new guidelines are much stricter and more quantitative than the old and, I feel, are a major step forward in conservation terms. It is time-consuming to calculate and apply, but is exactly on the right lines. It will cover about 60% of the plants in the "old" *RDB* (Perring & Farrell, 1983) and will be an adjunct to what I am proposing as it will deal with only the most threatened plants.

To summarise my points then, I suppose there are three alternatives in defining *RDB* and Scarce plants:–

1. to accept that the 1962 *Atlas* considerably under-recorded and therefore double the Scarce Plant limit to 200 10-km squares;
2. to move to a tetrad basis so *RDB* species are those occurring in 1–50 tetrads and Scarce those in 51–250 tetrads; and
3. to decide, as did those who originally chose 1–15 10-km squares for *RDB* and 16–100 10-km squares for Scarce species, that the rarest 20% in tetrad terms of our 1500 native species are *RDB*, and the next 20% are Scarce. There is an interesting recent book on rarity (Gaston 1994) with many thoughts on this, which suggests 25%, but I feel that is academic at this stage.

This last alternative would have the extra advantages that individual species could not be reassessed without assessing all, and therefore there would be greater stability between resurveys, and perhaps a greater chance of catching declining species, as they are ranked in percentage terms.

There might of course be a political point here. Our excellent environmental masters might object to a fixed percentage of plants always being protected, always needing funding and blocking nice new roads! However the day when rare plants are doing anything other than retreating is some way off and thus I feel a percentage figure is quite realistic at this stage.

I think that all these approaches – 10-km square, tetrad, 1-km square, site, post-1970, post-1987 etc., suffer from another drawback. They are numerical criteria based on a point in time. I am sure one needs a more subjective approach based on decline and threat, or a more objective approach based, say, on population size. But populations, as I have said earlier, are extremely difficult to count, and more difficult to map. The only readily available information now might be these frequency ratios that I mentioned earlier, which seem to me a relatively crude but valuable extra tool to go alongside and raw 10-km square or tetrad information. Something is needed to balance rarity with frequency, as in the two extreme examples I showed earlier of *Gentiana verna* and *Asplenium septentrionale* (Table 6).

The authors of the last edition of the *Red data book* (Perring & Farrell 1983) attempted something along these lines using "threat" categories, but it was much too subjective. We need a "rarity index" to express the fact that there is no need to worry about *G. verna* (unless they build a much bigger reservoir in Teesdale!!). Their *RDB* system awarded points for perceived threats, and to some extent the new IUCN guidelines do the same. I have made a first attempt at a new system, aimed primarily at Scarce Species, and those *RDB* species which are not covered by the new IUCN guidelines, falling into the Lower Risk (LR) category. I have dropped points used by Perring & Farrell (1983) for Attractiveness, Remoteness and Accessibility, since I do not perceive these to be threats today. I am totally convinced that today plants are lost almost entirely by ignorance and neglect; ignorance of their existence and neglect of their habitat. Apart from a handful of orchids and a couple of ferns I think that all references to threats of collecting should be routinely excised from any publication. I am also deeply sceptical about the success in protecting species in habitats protected by conservation agencies – note that I am saying species in their habitats rather than habitats. Our work in Dorset has shown little difference in protection whether the site is a NNR, a SSSI or has no protection, the species are still lost in large numbers (Table 9). The key to protection is management, management and management.

TABLE 9. MAINTENANCE OF PLANT SPECIES DIVERSITY ON PROTECTED AND UNPROTECTED HEATHLAND STANDS IN DORSET

	Number of indicator species recorded in 1991–1993 as % of indicator species recorded by Prof. Good (1931–1938)
SSSIs overall	57%
Reserves (NNR, RSPB, DWT)	50%
Other extant sites	35%
Destroyed sites – now Forestry	13%
now Agriculture	7%

My first attempt uses the frequency ratios I have been describing, and a figure for the rate of decline. To arrive at a figure for the decline, I have expressed post-1970 10-km squares as a percentage of post-1930 squares. I have had to use 10-km records as there are no historical figures of a finer resolution, but in time we should be able to improve on this. Thus *Corynephorus canescens* is found, post-1970, in 71% of the squares it was recorded in post-1930. *Ranunculus tripartitus*, on the other hand, is only found in 39% of its previous squares, and thus has declined more. I have then multiplied this percentage by the frequency ratios I have described earlier to give a Threat Index (Table 10). The lower the Threat Index figure, the greater the threat. I totally appreciate this is a first attempt, and that there is an element of rearranging the deckchairs in producing revised lists of rarity when the actual plants continue to vanish. But it is no use pretending that budget cuts do not exist, and whilst going for wider and more worthwhile goals we must improve the data we have available now.

I never thought I would be quite so keen on the division of NCC into country agencies, but we now have Chris Sydes in Scottish Natural Heritage and Andy Jones in Countryside Council for Wales actively trying to provide this information and who knows, English Nature might think about

TABLE 10. A NEW 'THREAT INDEX' FOR A SELECTION OF SPECIES

	1970+: 1930+ 10-km squares	%	Frequency Ratio	Index
Scarce				
Corynephorus canescens	12:17	71	1·41	100
Veronica spicata	16:17	94	1·25	118
Carex vulpina	12:21	57	1·83	104
Luzula arcuata	12:19	63	1·83	115
Galium pumilum	19:43	44	1·21	53
Chenopodium chenopodioides	12:23	52	2·50	130
Dianthus armeria	36:83	43	1·06	46
Asplenium septentrionale	27:35	77	1·15	89
Linum perenne	24:31	77	1·50	116
Cystopteris montana	15:18	83	1·67	139
Orchis ustulata	66:134	49	1·79	88
Pulsatilla vulgaris	19:40	48	1·47	70
Illecebrum verticillatum	16:19	84	2·00	168
Elatine hydropiper	19:21	90	1·68	152
Ranunculus tripartitus	19:48	39	1·73	68
Carex humilis	28:30	93	4·42	412
Commoner *RDB*				
Fumaria occidentalis	15:17	88	3·11	274
Gastridium ventricosum	25:41	61	2·00	122
Erica ciliaris	14:16	87	3·27	286
Genista pilosa	13:15	87	3·15	273
Ophrys sphegodes	15:26	57	2·57	148
Lotus angustissimus	24:34	71	1·40	99
Carex rariflora	17:17	100	2·13	213
Gentiana verna	4:6	67	7·50	500
Erica vagans	5:7	71	5·20	371

it before too long. If I was rewarded for every time I have been approached for information on *Gentianella anglica* in the past two years, I would be in the mountains in Turkey instead of here. Yes, it has declined in 10-km square totals, and yes it has retreated westwards, and yes it is an endemic (collect £200 and pass go) but 1994 surveys showed 3 million in the Isle of Wight and half a million in Dorset. We currently have no way of knowing if this is good or bad and whether resources should be put into this plant at the expense of others. Another favourite is *Dianthus armeria* (Table 11) which is suddenly on everybody's threat list. I am not certain why this is so, because I cannot trace careful investigative work on it. But for once somebody's hunch is right (Martin Wigginton says it is mine – but age dims memory and in fact I think it was Ro FitzGerald who suggested it to English Nature and me) and the figures are certainly dire – remember it had the lowest ratio in Table 9. But having gone so far, why haven't we up-to-date (post-1990) information, and as it is an easy matter to count an annual, why are there no population data?

I suspect that is another of my failings, that I'm a plodder, one who accumulates information, rather than somebody with vision (and poetic licence) who is sure *Dianthus armeria* or *Gentianella anglica*, and others are declining and need lots of Species Action plans. But these examples only

TABLE 11. RECORDS OF *DIANTHUS ARMERIA*

Recording scheme	Years	10-km squares	Tetrads	1-km squares	Sites
1962 *Atlas*	1930+	40			
Scarce plants atlas (adjusted)	1970+	31	33	33	34
	1970–79 only				10
	1980–89 only				14
	1990+				10

demonstrate that we already have or can complete more precise data within a very few years and that it is essential that we do so.

So in conclusion, I feel I must nail my colours to the mast, and I am recommending:–

1. a real campaign by JNCC and its allies to get complete 1-km square, six figure grid references and site data, and where feasible populations too, for all Rare and Scarce Plants;
2. that we re-define Rare and Scarce Plants on a tetrad basis, with the rarest 20% as *RDB*, and the next 20% as Scarce; and
3. that we weight these figures by a frequency ratio of tetrads/10-km squares, and endeavour to move to 1-km squares/10-km squares within five years. We should also explore the feasibility of combining these ratios with a "decline" rating as set out in Table 10.

The BSBI and I would be delighted to do the job.

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REFERENCES

BYFIELD, A. J. & PEARMAN, D. (1994). *Dorset's disappearing heathland flora.* Unpublished report for R.S.P.B.

GASTON, K. J. (1994). *Rarity*. Chapman & Hall, London.

GIBBONS, D. W., REID, J. B. & CHAPMAN, R. A., eds (1993). *The new atlas of breeding birds in Britain and Ireland: 1988–1991*. T. & A. D. Poyser, London.

LEACH, S. J. (1995). The new list of 'Nationally Scarce' plants. *BSBI news* **6**: 22–23.

LE DUC, M. G., HILL, M. O. & SPARKES, T. H. (1992). A method for predicting the probability of species occurrence using data from systematic surveys. *Watsonia* **19**: 97–105.

NATURE CONSERVANCY COUNCIL (1989). *Guidelines for the selection of biological SSSIs*. Nature Conservancy Council, Peterborough.

PEARMAN, D. (1994). *Sedges and their allies in Dorset*. Dorset Environmental Records Centre, Dorchester.

PERRING, F. H. & FARRELL, L. (1977). *British red data books: 1 – Vascular plants.* Society for the Promotion of Nature Conservation, Lincoln.

PERRING, F. H. & FARRELL, L. (1983). *British red data books: 1 – Vascular plants*, 2nd ed. Royal Society for Nature Conservation, Lincoln.

PERRING, F. H. & WALTERS, S. M. eds (1962). *Atlas of the British flora*. T. Nelson & Sons Ltd, London.

RICH, T. C. G. & WOODRUFF, E. R. (1990). *The BSBI monitoring scheme 1987–88.* Nature Conservancy Council CSD Report No. 1265.

STACE, C. A. (1991). *New Flora of the British Isles*. Cambridge University Press, Cambridge.

STEWART, A., PEARMAN, D. A. & PRESTON, C. D. eds (1994). *Scarce plants in Britain*. Joint Nature Conservation Committee, Peterborough.