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The use of B.S.B.I. Monitoring Scheme data to predict nationally scarce species in Britain

D. A. PEARMAN

The Old Rectory, Frome St Quintin, Dorchester, Dorset, DT2 0HF

C. D. PRESTON, D. B. ROY

I.T.E., Monks Wood, Abbots Ripton, Huntingdon, Cambs., PE17 2LS

and

A. STEWART

D.E.R.C., The Barracks, Bridport Road, Dorchester, Dorset, DT1 1SN

ABSTRACT

It has recently been argued that the results of the B.S.B.I. Monitoring Scheme, a sample survey, can be used to identify species which may be nationally scarce in Britain. The practical usefulness of this method for estimating the frequency of uncommon species is discussed and shown to be limited by the large confidence limits associated with small sample sizes. The frequency estimates based on Monitoring Scheme data are tested for scarce species and for species in the Potamogetonaceae and Ruppiaceae, and are shown to under-estimate the distribution of many species. The revision of the list of nationally scarce species should await the results of the Atlas 2000 project, a geographically comprehensive project which will collate records collected over a longer time-span.

KEYWORDS: plant surveys, mapping, rare species.

INTRODUCTION

In Britain, nationally rare species are currently defined as those present in 1–15 10-km squares (Perring & Farrell 1983) and nationally scarce species are defined as those in 16–100 10-km squares. We recently contributed to a review of the distribution of nationally scarce species (Stewart *et al.* 1994). The species selected for review were those on an existing list of scarce species (Nature Conservancy Council 1989), corrected and modified in the light of later information. This list is in turn based on the distribution maps in the *Atlas of the British flora* (Perring & Walters 1962), the last geographically comprehensive survey of the British vascular flora.

In a recent paper, Rich (1997) has argued that the results of the B.S.B.I. Monitoring Scheme rather than those presented in the *Atlas of the British flora* should have been used to select the potentially scarce species. In the B.S.B.I. Monitoring Scheme, a sample of 1 in 9 of the British 10-km squares (or "hectads") were surveyed in two years' fieldwork (1987–88). Rich (1997) dismisses as incorrect the suggestion of Stewart *et al.* (1994) that this survey was not designed to detect trends in relatively uncommon species, arguing that "the sample survey as designed should have detected trends in all species, though clearly not as sensitively as a more detailed study, and less accurately for relatively uncommon species". He asserts that the results of the scheme "could have been related to Britain as a whole using standard statistical methods to provide a more up-to-date, rigorous selection of species to be investigated". Rich suggests that as the Monitoring Scheme sampled approximately 1 in 9 10-km squares, the total number of squares in which a species occurs can be estimated by multiplying the number of squares in which it was recorded in the Monitoring Scheme by approximately nine. To be precise,

$$N = \frac{M \times 2860}{317} \pm 1.96 \times 2860 \times \sqrt{\frac{1}{317} \times \frac{M}{317} \times \left(1 - \frac{M}{317}\right)}$$

where N is the number of 10-km squares containing the species expected nationally ±95% confidence limits, M is the number of 10-km squares recorded in the Monitoring Scheme, 317 is the total number of 10-km squares covered by the Monitoring Scheme and 2860 is the number of 10-km squares in Britain. (The formula cited above is the one used by Rich, although it is cited incorrectly in his paper.)

In this paper, we examine the limitations of Rich's method as a predictive tool for rarer species. We then test the accuracy with which this method predicts the distribution of scarce plant species and of another group for which data have recently become available, the Potamogetonaceae and Ruppiaceae.

RICH'S METHOD APPLIED TO UNCOMMON SPECIES

Stewart *et al.* (1994) suggest that the results of the Monitoring Scheme should not be used to provide data on relatively uncommon species; Rich (1997) disagrees. The difference between the two points of view is almost certainly semantic rather than a real difference of opinion. Rich (1997) argues that the results will detect trends in the distribution of all species, but less accurately for the relatively uncommon species. We maintain that there comes a point where the accuracy is sufficiently low that one has to conclude that the method is not working, rather than working less accurately. There are, for example, 16 of the 253 nationally scarce species listed by Stewart *et al.* (1994) and an additional 145 out of some 310 rare species included in the *Red data book* (Perring & Farrell 1983) *which were not recorded in any of the 10-km squares recorded for the B.S.B.I. Monitoring Scheme in 1987–88*. It would be difficult to argue that the Monitoring Scheme has provided much useful data on these species.

If a species is recorded in a few Monitoring Scheme squares, the prediction of the number of squares in which it occurs nationally is necessarily accompanied by large confidence limits. This severely limits the practical usefulness of Rich's method for uncommon species. Even a species recorded in ten Monitoring Scheme 10-km squares is predicted as occurring in 90±55 squares nationally, i.e. between 35 and 145 squares. This spans the range between species which are manifestly scarce to those which are much too frequent to qualify. Rich (1997) lists as potentially scarce all those species where the *minimum* prediction falls below 100 squares, as long as these are not known from other evidence to be more frequent. Only eight of the 65 species listed by Rich (1997) have a *maximum* predicted national distribution below 100 squares (*Barbarea stricta*, *Callitriche brutia*, *Equisetum hyemale*, *Juncus ranarius*, *Monotropa hypopitys*, *Salicornia fragilis*, *Utricularia australis* and *U. ochroleuca*). Six species (*Calystegia soldanella*, *Eryngium maritimum*, *Glaucium flavum*, *Silene acaulis*, *Spartina anglica* and *Vaccinium uliginosum*) which are listed as potentially scarce are estimated as occurring nationally in the range 96–246 squares. As Rich (1997) states, it is unlikely that many of the species will qualify as scarce.

TESTS OF RICH'S METHOD

SCARCE SPECIES

We have compared the predicted distribution of the potentially scarce species included in *Scarce plants in Britain* (Stewart *et al.* 1994) with the known distribution of the species as reported in that book. The Monitoring Scheme results correctly predict the distribution of 231 species (72%) using Rich's methods, over-estimate the distribution of one species (<1%) and under-estimate the distribution of 91 species (28%).

There were 62 species considered by Stewart *et al.* (1994) which turned out to be present in more than 100 10-km squares, and were therefore too frequent to be considered as nationally scarce. The results of the Monitoring Scheme predict that 59 of these (95%) might be scarce, i.e. the minimum prediction of these species is fewer than 100 10-km squares, and that twelve (19%) will be scarce, i.e. the maximum prediction for these species is fewer than 100 squares. (These 62 species are omitted from Rich's paper as they were already known not to be scarce.) These results suggest a tendency of the Monitoring Scheme results to under-estimate the national distribution of species.

POTAMOGETONACEAE AND RUPPIACEAE

The accuracy of the predictions made by Rich's (1997) method can be tested against another recently published dataset. In an account of the Potamogetonaceae and Ruppiaceae, Preston (1995) presented updated distributional data for the British taxa. The 24 species and the three commonest hybrids in these families are considered here. In compiling the distributional data, attempts were made to collect as many reliable records as possible for 18 species and the three hybrids, e.g. by contacting B.S.B.I. vice-county recorders. These are subsequently described as the well-recorded taxa (although they may not be well-recorded by the standards of other, more popular groups). The vice-county recorders were not contacted for records of six of the commoner species, and the 10-km square distribution of these species may therefore be underestimated. These six species are described here as the under-recorded taxa.

The number of squares in which the well-recorded and under-recorded taxa have been recorded in the period from 1970 onwards is compared in Table 1 to the figures predicted from the Monitoring Scheme results. The Monitoring Scheme data are derived from Rich & Woodruff (1990) and the expected national totals calculated using the equation cited above.

The results in Table 1 show that four of the 21 well-recorded taxa were not recorded at all in the Monitoring Scheme. The predicted number of squares falls below the recorded number for 15 of the remaining 17 taxa. For seven taxa, the recorded number is greater than the range predicted by the Monitoring Scheme results, based on the 95% confidence limits. If one assumes that there was no significant decrease in these taxa between 1970 and 1988, the results of this test also suggest that the Monitoring Scheme data tends to underestimate the national frequency of species. The Monitoring Scheme prediction exceeds the known 10-km square distribution for two of the under-recorded taxa, and it is almost certainly a more accurate estimate of their frequency. The estimate is below the recorded total for one under-recorded species, even though the recorded total is believed to be too low.

POSSIBLE REASONS FOR UNDER-ESTIMATION USING RICH'S METHOD

The results discussed above suggest that the Monitoring Scheme results consistently underestimate the distribution of species. Rich (1997) implicitly assumes that the results of the Monitoring Scheme provide an adequate list of the species in the 10-km squares surveyed. There are two reasons to suggest that this assumption may not be justified:

1. There were two aspects to the botanical recording for the Monitoring Scheme. Recorders were asked to record the flora of three tetrads (2 × 2 km squares) within each 10-km square. They were also asked to record the species in the rest of the square. Our personal experience in recording for the Monitoring Scheme suggests that in areas where there were many botanists, both the specified tetrads and the rest of the squares were well recorded. However, in areas where there were few resident botanists, or which had to be recorded by visitors, the tetrads tended to be visited but the recording of the rest of the square was sometimes inadequate. This suggestion is supported by Rich & Woodruff's (1990) analysis of the Monitoring Scheme database and by the data plotted in Fig. 1, which show that for a minority of 10-km squares almost all the records received came from the designated tetrads. The results of the Monitoring Scheme 10-km square survey are therefore likely to underestimate the number of 10-km squares in which a species occurs nationally. This does not preclude the use of tetrad rather than 10-km data to assess the national frequency of species.

2. Some species are likely to be under-recorded in a survey limited to two field seasons. These include species which are difficult to detect in the field or to identify once found. Botanists with a particular interest in such difficult or critical species are much more likely to record them than those who do not have such specialised knowledge. The knowledge of such species is therefore likely to grow gradually as specialists in a county or country cover the area. In order to test whether species were under-recorded, we have examined the extent to which each nationally scarce species was

TABLE 1. COMPARISON OF NATIONAL FREQUENCY PREDICTED FROM MONITORING SCHEME DATA WITH OBSERVED VALUES FOR MEMBERS OF THE POTAMOGETONACEAE AND RUPPIACEAE

Species	No. of 10-km squares recorded in Monitoring Scheme	Predicted number of squares nationally ±95% confidence limits	No. of squares recorded nationally (Preston 1995)	Monitoring scheme prediction as percentage of observed value
Well-recorded taxa†				
Groenlandia densa	21	189±78	211	90
Potamogeton acutifolius	0	0	11	0
P. alpinus	15	135±67	236	57
P. berchtoldii	57	514±121	522	98
P. coloratus	7	63±46	71	89
P. compressus	0	0	30	0
P. epihydrus	0	0	1	0
P. filiformis	6	54±43	94	57
P. friesii	4	36±35	110	33
P. gramineus	18	162±73	227	71
P. lucens	16	144±69	231	62
P. × *nitens*	3	27±31	108	25
P. nodosus	1	9±18	8	113
P. obtusifolius	13	117±62	225	52
P. praelongus	5	45±39	110	41
P. pusillus	31	280±94	319	88
P. rutilus	0	0	12	0
P. × *salicifolius*	1	9±17	21	43
P. trichoides	8	72±49	83	87
P. × *zizii*	3	27±31	37	73
Ruppia cirrhosa	2	18±25	47	38
Under-recorded taxa†				
Potamogeton crispus	91	821±142	733	112
P. natans	184	1660±155	1018	163
P. pectinatus	68	614±129	657	93
P. perfoliatus	49	442±114	524	84
P. polygonifolius	154	1389±157	695	200
Ruppia maritima	7	63±46	126	50

† See text for explanation.

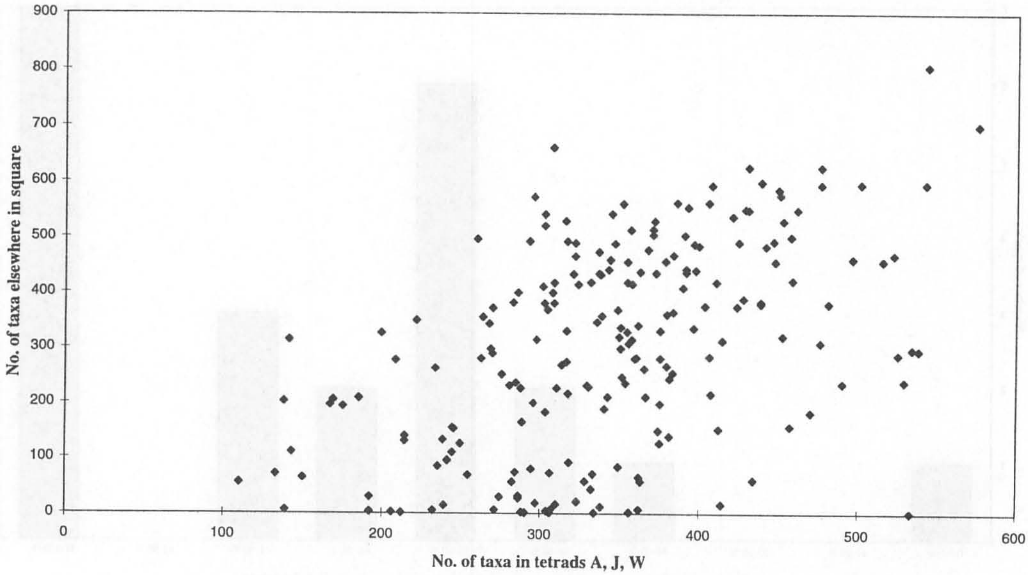

FIGURE 1. The total number of taxa recorded in tetrads A, J and W for each British 10-km square covered by the B.S.B.I. Monitoring Scheme, plotted against the number of additional taxa recorded during the Scheme elsewhere in that 10-km square. Squares which lack records from tetrads A, J or W were excluded from the analysis: the excluded squares are coastal squares without land in one or more of these tetrads or unrecorded inland squares.

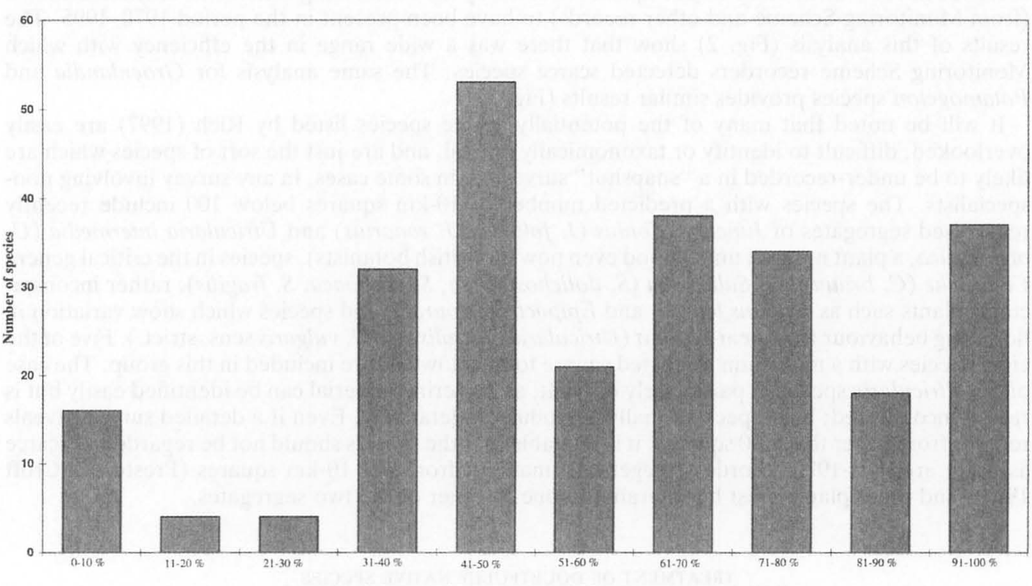

FIGURE 2. The number of 10-km squares in which nationally scarce species were recorded during the B.S.B.I. Monitoring Scheme (1987–88), expressed as a percentage of the total number of Monitoring Scheme squares in which they were recorded between 1970 and 1995. The number of species (vertical axis) falling in successive 10% bands is plotted.

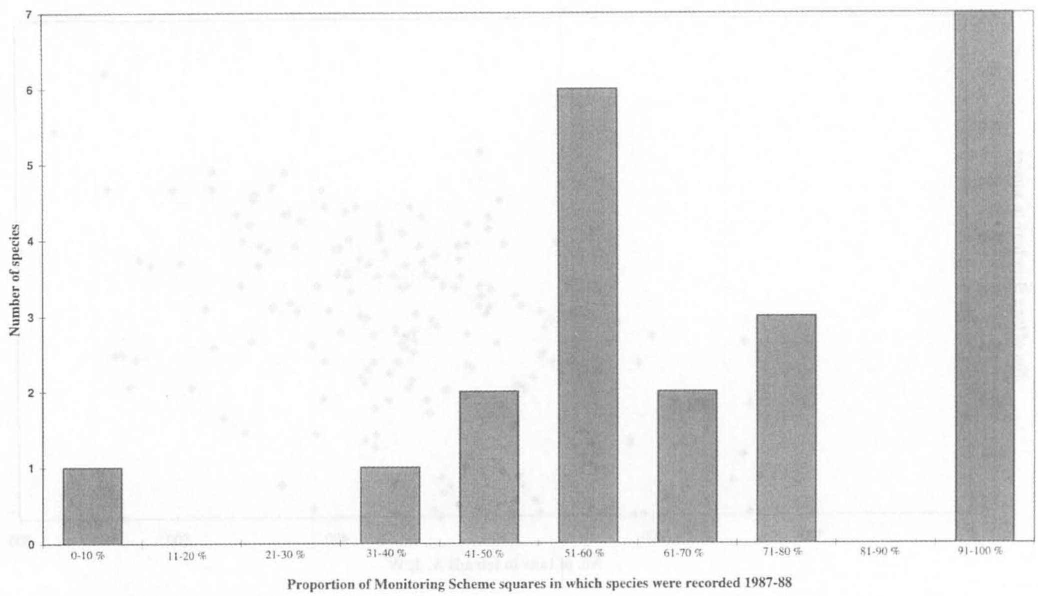

FIGURE 3. The number of 10-km squares in which *Groenlandia* and *Potamogeton* species were recorded during the B.S.B.I. Monitoring Scheme (1987–88), expressed as a percentage of the total number of Monitoring Scheme squares in which they were recorded between 1970 and 1995. The number of species (vertical axis) falling in successive 10% bands is plotted.

recorded in 1987–88 in those 10-km squares covered by the Monitoring Scheme in which it is known (from Monitoring Scheme and other records) to have been present in the period 1970–1995. The results of this analysis (Fig. 2) show that there was a wide range in the efficiency with which Monitoring Scheme recorders detected scarce species. The same analysis for *Groenlandia* and *Potamogeton* species provides similar results (Fig. 3).

It will be noted that many of the potentially scarce species listed by Rich (1997) are easily overlooked, difficult to identify or taxonomically critical, and are just the sort of species which are likely to be under-recorded in a "snapshot" survey or, in some cases, in any survey involving non-specialists. The species with a predicted number of 10-km squares below 100 include recently recognised segregates of *Juncus bufonius* (*J. foliosus*, *J. ranarius*) and *Utricularia intermedia* (*U. ochroleuca*, a plant not well understood even now by British botanists), species in the critical genera *Callitriche* (*C. brutia*) and *Salicornia* (*S. dolichostachya*, *S. europaea*, *S. fragilis*), rather inconspicuous plants such as *Bromus lepidus* and *Epipactis purpurata*, and species which show variation in flowering behaviour from year-to-year (*Utricularia australis* and *U. vulgaris* sens. strict.). Five of the eight species with a maximum predicted square total below 100 are included in this group. The case of the *Utricularia* species is particularly difficult, as flowering material can be identified easily but is rarely encountered; both species usually reproduce vegetatively. Even if a detailed survey reveals records from fewer than 100 squares, it is arguable that the species should not be regarded as scarce as there are post-1970 records of vegetative material from 242 10-km squares (Preston & Croft 1997), and these plants must be referable to one or other of the two segregates.

TREATMENT OF DOUBTFULLY NATIVE SPECIES

Rich (1997) describes as "welcome and objective" the fact that *Briza minor* and *Poa palustris* are excluded as aliens from the list of scarce species. In this Stewart *et al.* (1994) followed Stace (1991). However, Rich (1997) lists *Barbarea stricta* as a potentially scarce species, as he himself (Rich 1987) regards it as probably native although Stace (1991) describes it as probably introduced. In the controversial subject of native status there are numerous individual opinions, and the only practical course open to us as editors of *Scarce plants in Britain* was to follow a standard source. All botanists will, if given a chance, argue for the inclusion of some taxa and oppose the inclusion of others. Thus, one of us (D.A.P.) strongly favoured the inclusion of *Briza minor* as a native and another (C.D.P.) would have excluded *Erodium moschatum* as an alien, but we both agreed to set aside our personal opinions and follow Stace (1991).

In *Scarce plants in Britain* our explanation for including *Brassica oleracea* as a scarce species is inadequate; we are therefore to blame for the fact that it has been misunderstood by Rich (1997). Stace (1991) regards this species as possibly native and we therefore include it as a scarce species. We accept that it is impossible in many instances to distinguish native from alien colonies, but as there are fewer than 100 10-km square records for all the established coastal colonies, native and alien, we list the species as scarce. The confusion arises as the author of the *Brassica oleracea* account (Richards 1994) considers that the species is introduced. Following our arguments would not result in the inclusion in the lists of rare or scarce species of taxa which are accepted as introductions in all their British localities.

TREATMENT OF ARABLE WEEDS

The particular and in some ways insuperable difficulties of dealing with arable weeds are discussed in *Scarce plants in Britain* (Stewart *et al.* 1994, p. 473). These difficulties have been highlighted by the publication, also in 1994, of a booklet by Wilson & Sotherton (1994). Whereas we published records of *Ranunculus arvensis* from 221 10-km squares from 1970 onwards and over 100 from 1980 onwards, Wilson & Sotherton believe that there may be as few as six viable populations left. Similarly they describe *Scandix pecten-veneris* as probably occurring now in fewer than 25 10-km squares, although there are records from 85 squares from 1980 onwards and 131 squares from 1970 onwards. In evaluating the status of these rapidly declining species we decided to alter the criterion for inclusion of scarce species and take records from 1980 onwards, rather than use the 1970 date employed for the other species. This decision was made on purely pragmatic grounds. We accept Rich's (1997) view that it is inconsistent and subjective, but we believe that where circumstances differ, uniformity of treatment is not necessarily desirable. Retention of the normal 1970 cut-off date for these species, as Rich (1997) recommends, appears to us to be an unrealistic option.

CONCLUSIONS

We do not dissent from Rich's (1997) view that the list of scarce species in Stewart *et al.* (1994) is provisional; all such lists inevitably are. We ourselves stated that there must be a strong possibility that the list would require revision in the light of current work on rare species (Stewart *et al.* 1994, p. 18) and that other formerly commoner species may now qualify as scarce (Stewart *et al.* 1994, p. 12). However, it would be a more efficient use of resources to await the results of the Atlas 2000 project (Pearman & Preston 1996), which will provide up-to-date geographically comprehensive data on the distribution of the British flora, rather than investigate the particular species listed by Rich in isolation.

We also agree with Rich (1997) that it might be preferable to define rare and scarce species as a percentage of the British flora rather than in absolute terms, although this would require a co-ordinated look at both rare and scarce species. It will probably be desirable to assess the distribution of both rare and scarce species in a more small-scale unit than the 10-km square (Pearman 1997).

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