ENGLISH NATURE

Use of breeding bird atlas data to identify important areas for upland breeding birds in northern England

No. 48 - English Nature Research Reports

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Use of Breeding Bird Atlas Data to Identify Important Areas for Upland Breeding Birds in Northern England.

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ISSN 0967-876X

Please refer to this document as:

Brown, AF, Stillman, R.A & Gibbons, DW (1993). Use of breeding bird atlas data to identify important areas for upland breeding birds in northern England. English Nature Research Report No. 48.

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Summary

This report provides an evaluation of the relative importance of different areas of upland in northern England for upland breeding birds. It uses data from the 1988-91 'New Atlas of Breeding Birds' (Gibbons *et al.* 1993) at the tetrad and at the ten-kilometre square scale. Seven important bird areas are identified, each consisting of a series of tetrads holding at least 1.5 times the mean regional species-richness and importance index of upland birds. Their relationships to existing Sites of Special Scientific Interest, Important Bird Areas and proposed Special Protection Areas are discussed.

Introduction

The English uplands are breeding grounds for a number of Red Data Birds (Batten *et al.* 1990) of which fourteen species are regarded by English Nature as of High Conservation Priority (Brown and Grice 1993). The breeding populations of some of these species are of international importance: seven are listed on Annex 1 of the EC Directive on the Conservation of Wild Birds (EC 79/409) and several others come under the terms of the directive as migratory species. Special measures must be taken by EC member states to protect these species within their traditional range. Such special measures include the designation of Special Protection Areas (SPA's).

Despite this acknowledged importance, we have relatively imprecise information concerning the distribution and abundance of upland breeding birds in parts of England and thus only imprecise information on which are the more important areas for focussed conservation activity. This owes much to the remoteness of upland areas, the lack of skilled local volunteers to conduct regular surveys and the low density and high degree of dispersion shown by many upland breeding species. Comprehensive and recent data exists for several upland areas in midland and southern England: Bodmin Moor (Chown and Akers 1984), Dartmoor (Mudge *et al.* 1979, Sitters, 1988 and Chown, Wotton and Robins 1992), Exmoor (Colombe, Woodland and Robins 1992), Shropshire Moors (Shropshire Ornithological Society 1992) and for the Pennines to the south of Skipton in Yorkshire (Brown and Shepherd 1990). Data for the remaining upland area, where the majority of birds occur and where six of the eight English upland proposed Special Protection Areas (pSPA's) are located (Pritchard, 1992), is dated, not comprehensive, and was collected using several different methods over an extended period (Shepherd 1990). There is an urgent need for an evaluation of the relative importance of different parts of the northern English uplands using contemporary and comprehensive data.

This document provides such an evaluation using data drawn from the 'New Atlas of Breeding Birds in Britain and Ireland' (Gibbons *et al.* 1993). We identify species-rich areas and those supporting the more important species. We identify groups of species characteristic of different types of upland and assess whether the important areas we identify in the present study correspond to the pSPA's already identified in the area. We comment on the value of this type of study in providing an objective context for the evaluation of the relative importance of extensive land areas.

Methods

All data used in this evaluation were obtained from the 'New Atlas of Breeding Birds in Britain and Ireland' (Gibbons *et al.* 1993). Data for this atlas were collected between April 1st and July 31st 1988-1991, inclusive, from at least eight tetrads in every ten-kilometre square. Observers selected their own tetrads for survey. Two hours were spent surveying each tetrad for birds, to ensure that no systematic bias in recording effort occurred across Britain and Ireland. Species were recorded as present or absent for each surveyed tetrad. A small proportion of tetrads were visited either twice (less than 5%) or three times (less than 0.5%) in different years during the survey period. In such cases, each species was recorded as present in the tetrad if it was recorded on any of the visits. It is thus likely that a larger number of species were found in these tetrads due to this increased sampling effort. This effect could be removed by using the mean number recorded on the visits, and rounded up to the nearest whole bird. However, results obtained in this way would only differ when a species was recorded on only one visit to tetrads visited on three occasions. As such records comprise less than 0.5% of the total, were well scattered throughout the study area, and single tetrads were never selected as important bird areas, we have not corrected for these ocurrences. The abundance of species within each ten-kilometre square was expressed as the proportion of surveyed tetrads containing the species. Gibbons 1991 and Gibbons *et al.* (1993) provide full details of methods.

For the current project, data for all ten-kilometre squares containing unenclosed upland to the north of Skipton were selected (164 in total). Data were thus available for moorlands as well as upland enclosures and, in some areas, adjacent non-upland. A total of 24 bird species, typical of the uplands of northern England were selected for study (Table 1). Birds such as Wren, Tree Pipit and Pied Wagtail were excluded: although found in the uplands, they are more characteristic of the lowlands. Dotterel and Golden Eagle were not include by virtue of their extreme rarity in the area. Data on the presence of each of the twenty four species were obtained for each surveyed tetrad in each of the 164 ten-kilometre squares of the study area.

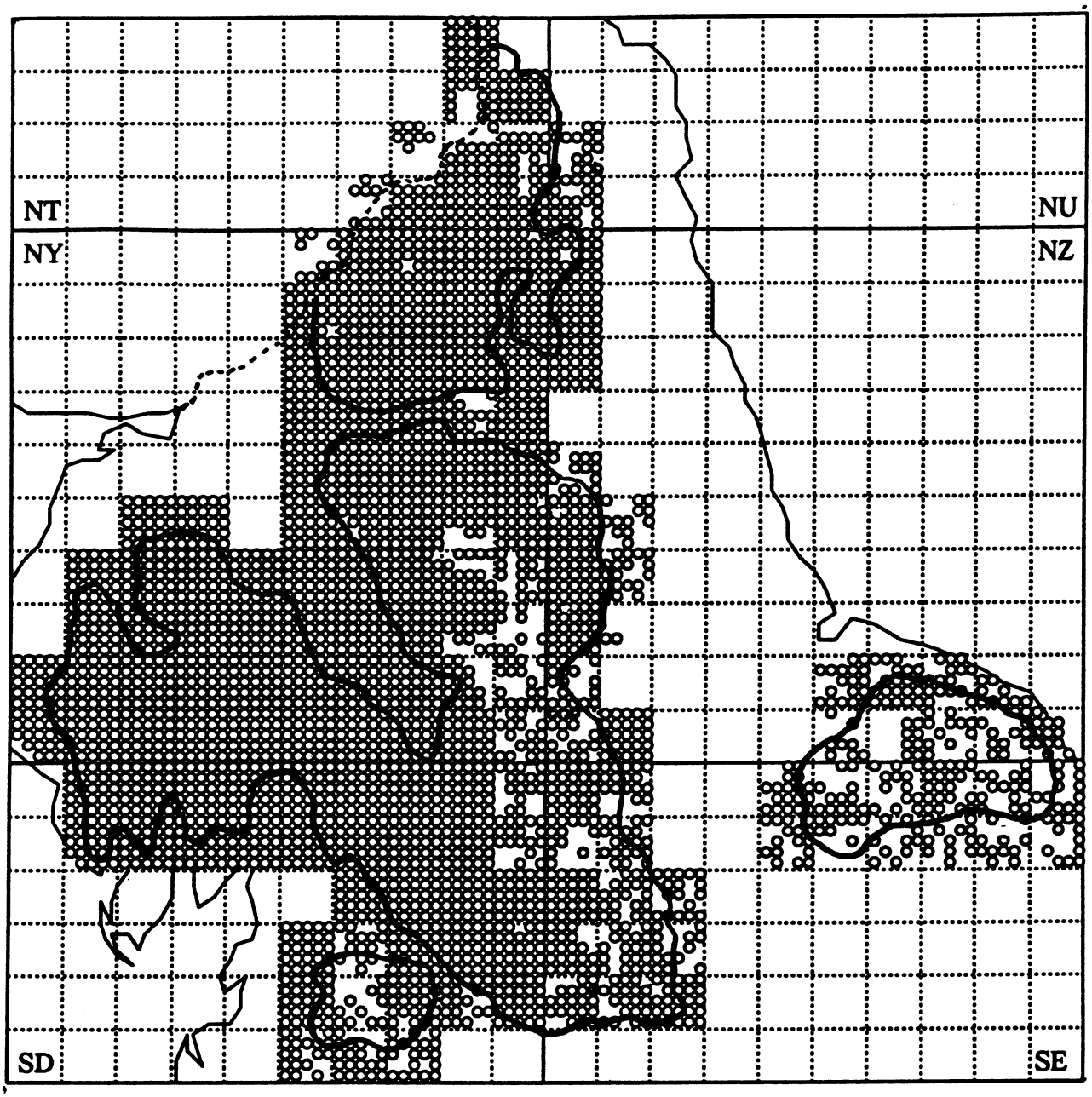

Figure 1. The northern England study area. The solid line indicates the very approximate boundary of unenclosed upland. Circles represent tetrads for which survey information is available in the ten kilometre squares selected for the study.

Table 1. The number of tetrads and ten kilometre squares occupied by each of the 24 upland breeding birds in the study area, 1988-1991. Data from Gibbons *et al.* 1993.

Species	Number of occupied tetrads	Number of occupied $10km^2$
Teal	130	62
Goosander	203	99
Hen Harrier	24	14
Buzzard	407	64
Merlin	86	48
Peregrine	121	53
Red Grouse	744	116
Black Grouse	114	44
Oystercatcher	809	124
Golden Plover	515	94
Lapwing	1869	158
Dunlin	102	38
Snipe	780	134
Curlew	2321	159
Redshank	606	110
Common Sandpiper	623	134
Short-eared Owl	129	56
Grey Wagtail	950	158
Dipper	742	152
Whinchat	124	37
Wheatear	1226	145
Ring Ouzel	342	85
Raven	146	44
Twite	59	30

Results

Data Availability

Figure 1 shows the northern England study area. The approximate boundary of unenclosed land is marked. Note that areas outwith this boundary, including enclosed pastures, rivers and woodlands are also regarded as upland in character for the purposes of this report. Some areas of non-upland will inevitably be present in some ten-kilometre squares. Coverage of the uplands by the survey clearly varies between massifs. The English Lake District, Northumberland, the Cumbrian Pennines and the Pennines of north-west North Yorkshire are well sampled, with data for all or nearly all tetrads being available. By contrast, data for many tetrads in the North Yorks Moors, the Forest of Bowland and the eastern parts of North Yorkshire and of western County Durham are not available.

Distribution and Relative Abundance of Species

The number of tetrads and ten-kilometre squares occupied by each species is given in Table 1. Information is thus available on how widespread a species is at two scales. Figure 2 shows the relationship between these two scales: one indicating the geographical range of a species (as indicated by the percentage of 10 kilometre squares occupied in the study area) and the other indicative of relative abundance in occupied ten kilometre squares (percentage of surveyed tetrads occupied). The figure shows that some species, in particular curlew and lapwing, are widespread and relatively abundant throughout their range. Others, such as grey wagtail and dipper are also widespread but much less abundant. Others such as Hen Harrier and Twite are rare and local. The distribution of each species is given in Appendices 1-23a and b. Maps at the tetrad scale indicate whether the species was recorded or not during the survey period in each tetrad. Maps at the ten-kilometre square scale show relative abundance (% of surveyed tetrads occupied within each ten kilometre square). Note that maps are not presented for several species to protect confidentiality of nest sites. As would be expected, there are clearly large differences between the distributions of individual species.

Evaluating Relative Importance

In order to assess the relative importance of different areas for upland birds two attributes were computed for each tetrad and ten kilometre square. Species richness of upland birds for each ten-kilometre square (expressed as the mean number of upland species recorded per tetrad) is shown in Figure 3. Clearly some squares support a higher average number of species than others, but at this scale it is difficult to be more precise about which areas are more or less species rich. A measure of the importance of each tetrad for upland birds was then derived using an index related to both the number of upland species in the tetrad and their abundance in the study area. A similar approach has previously been used to assess the relative importance of parts of Wales for birds and for the British uplands as a whole (Avery & Leslie 1990; Bates *et al.* 1993).

The 'importance index' is described by

$$\text{Importance index per tetrad} = \sum_{n=1}^{N} \frac{1}{Tn}$$

where: n = species number
N = total number of species recoded in tetrad
T = total number of tetrads occupied in study area by nth species in tetrad

Figure 4 shows the mean importance index for tetrads within each square at the ten-kilometre square level. Again, at this scale it is difficult to be precise about the important areas, although this interpretation allows much greater discrimination between squares than the index of species richness. Figures 5 and 6 present the data at the tetrad scale. Those tetrads with a species richness (Figure 5) or an importance index (Figure 6) equal to or greater than the mean for the study area are highlighted. Figures 7 and 8 similarly highlight tetrads with a species richness score (Figure 7) or importance index (Figure 8) 1.5 times the mean value for tetrads in the study area. All four maps thus highlight to different degrees and using different methods, the more important areas for upland birds in northern England.

A number of areas appear to be consistently more important than others. These are areas where ten or more tetrads with both a species richness and an importance index at or above 1.5 times the mean value for northern England are found adjacent or clustered near to to each other. Single tetrads or small and isolated groups of tetrads have not been highlighted as important bird areas. These important birds areas, together with other areas (A-D) selected for discussion, are marked on Figure 9:

1. Important area 1: The border uplands. This area comprises The Cheviot SSSI, Otterburn Moors, Harbottle Moors SSSI, Simonside Hills SSSI and the Kielderhead and Emblehope Moors SSSI .

2. Important area 2: includes Geltsdale and Glendue Fells SSSI, Hexamshire Common, Stanhope Common, Wolsingham Park Moor, Middlehope Moor and Whitfield Moor.

3. Important area 3: includes much of Moorhouse and Cross Fell SSSI, Appleby Fells SSSI and a large part of the Upper Teesdale SSSI.

4. Important area 4: includes Kexwith Moor, Hurst Moor, East Bolton Moor and Redmire Moor, an area centering on Reeth.

5. Important area 5: includes the hills of Upper Nidderdale, Angram Common, Great Whernside, Langstrothdale Chase, Abbotside Common and the Mallerstang-Swaledale SSSI.

6. Important area 6: includes Shap Fells SSSI and Crosby Ravensworth SSSI.

7. Important area 7: part of the Forest of Bowland SSSI.

Patterns in the Distribution of Species

It is evident from the distributional data concerning individual species presented at appendices 1-23a and b that different species show similar patterns of distribution. In order to aid interpretation of the importance evaluations above, we studied the associations between species using multi-dimensional scaling, based on the Pearson correlation coefficient between the relative abundance of species within ten-kilometre squares. An ordination of the species was produced in two dimensions which explained 83% of the variation in associations between species. Figure 10 shows the distribution of upland species in the northern England study area in relation to the two dimensions. Average linkage cluster analysis based on the ordination was then used to identify groups of species with similar distributions. Four such groups were identified (Figure 11 and indicated on Figure 10): species characteristic of river valleys: Goosander, Common Sandpiper, Grey Wagtail and Dipper (Figures 12 and 13); characteristic moorland species associated with the unenclosed land: Teal, Hen Harrier, Merlin, Black Grouse, Red Grouse, Golden Plover, Dunlin, Snipe, Short-eared Owl, Ring Ouzel and Twite (Figures 14 and 15); species characteristic of enclosed farmland: Oystercatcher, Lapwing, Curlew, Redshank (Figures 16 and 17) and species characteristic of cliffs, broken or steeply sloping ground: Buzzard, Peregrine, Wheatear, Whinchat and Raven (Figures 18 and 19). Table 2 provides summary information on the numbers of tetrads within which the group, or species within the group, were recorded and on the relative importance of the groups in a northern England context.

The groups are clearly distributed differently. The farmland group is, numerically, the most widely distributed, consisting of four widespread species. It is, however, poorly represented in central Lakeland and in the Kielder area where suitable habitat has been blanket afforested. By virtue of their ubiquity, species within this group will tend to exert relatively little influence on the importance of a tetrad.

In contrast, the moorland group, comprising eleven species, clearly includes a number of less widespread, rare or locally distributed species, as indicated by the low mean number of occupied tetrads per species in this group. Species within this group will tend to have the greatest influence on the relative importance index computed for each tetrad. The northern Pennines are clearly the centre of distribution for this group, with poor representation in the Lake District and the North Yorkshire Moors (though see earlier notes on coverage of tetrads in this area). The cliff bird group and the river valley group are both, numerically at least, intermediate in that they each appear to support a small number of moderately widespread species. Geographically, however, they are very differently distributed. The river valley group is found throughout the study area but the cliff bird group becomes more abundant towards the west of the study area, broadly reflecting topographical trends. It is particularly well represented in Lakeland and the Yorkshire Dales.

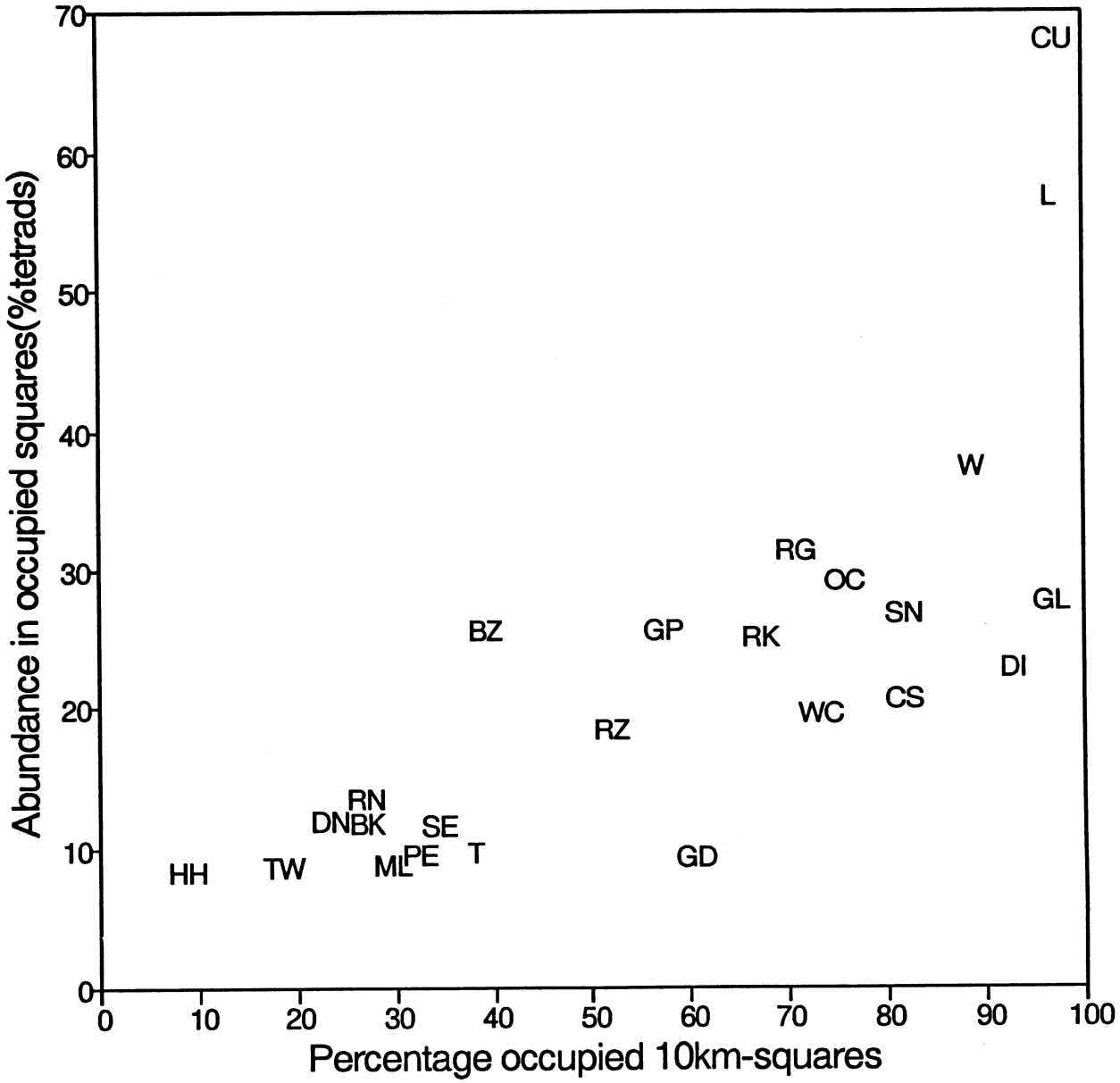

Figure 2. Relationships between range and relative abundance in upland birds in the northern England study area.

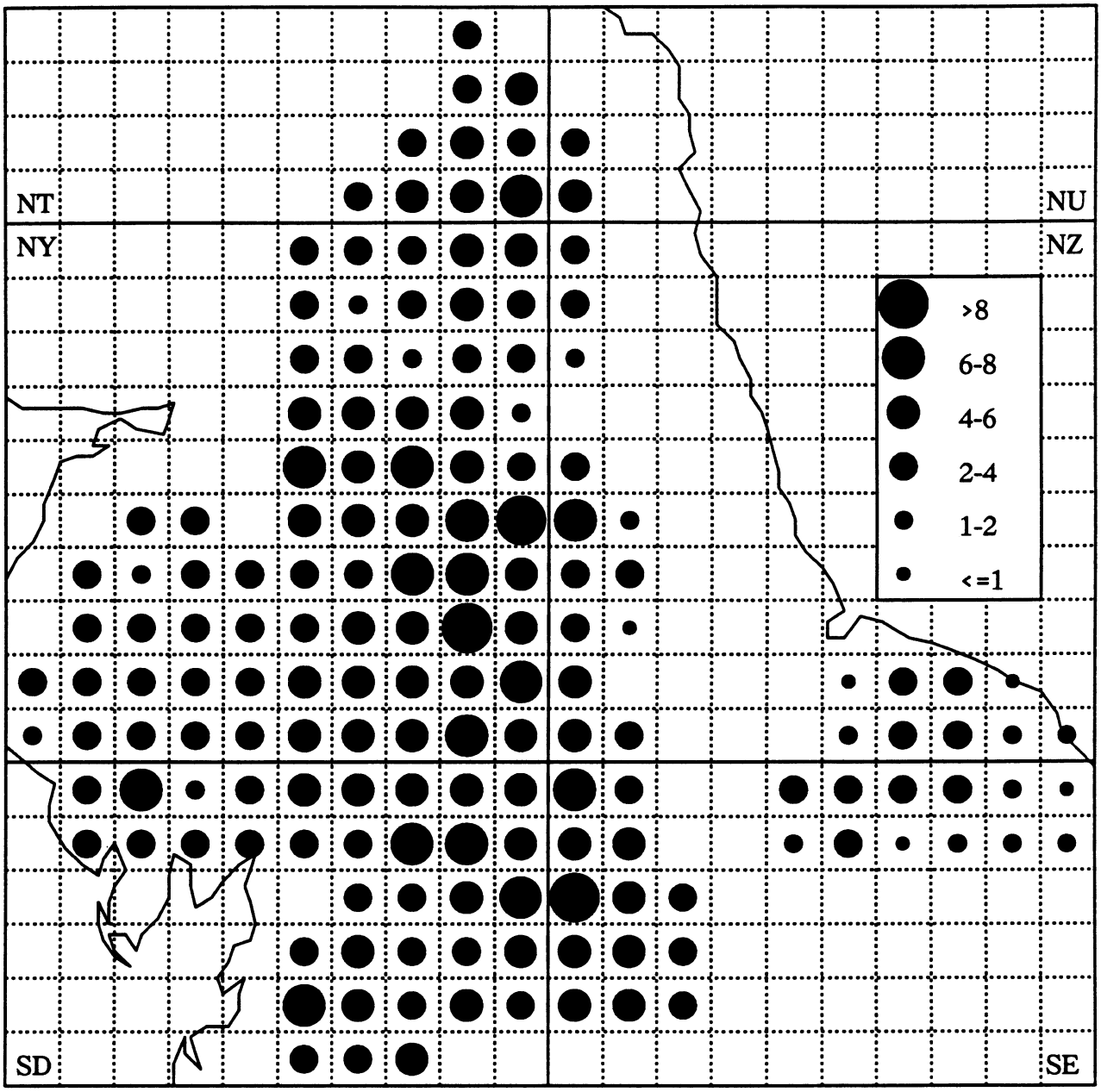

Figure 3. Species richness expressed as the mean number of species recorded per surveyed tetrad in each ten kilometre square of the study area.

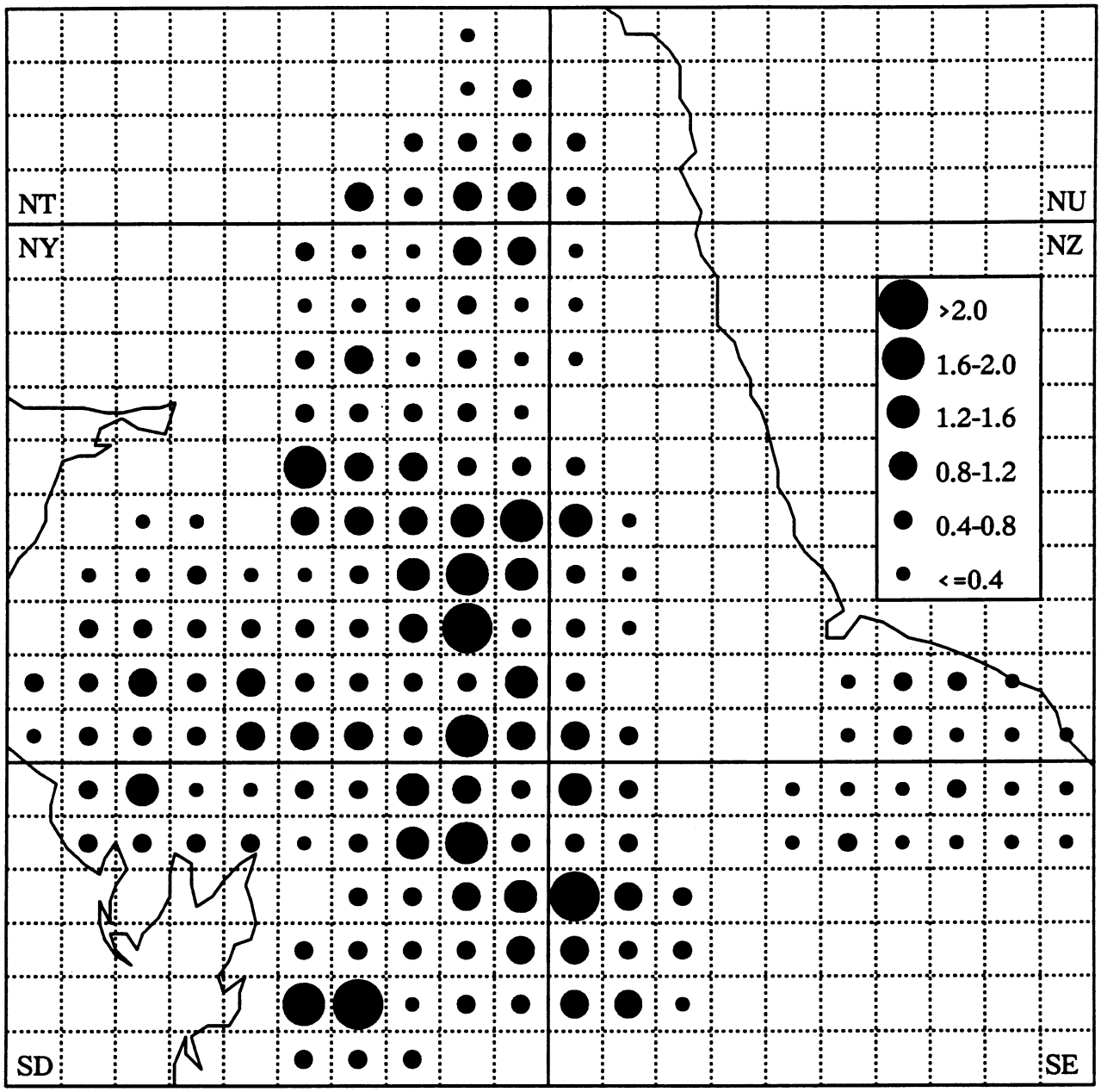

Figure 4. Relative importance of ten kilometre squares for upland breeding birds in northern England expressed as mean importance index per surveyed tetrad. Importance index is sum of individual species scores each of which is reciprocal of the number of occupied tetrads in northern England.

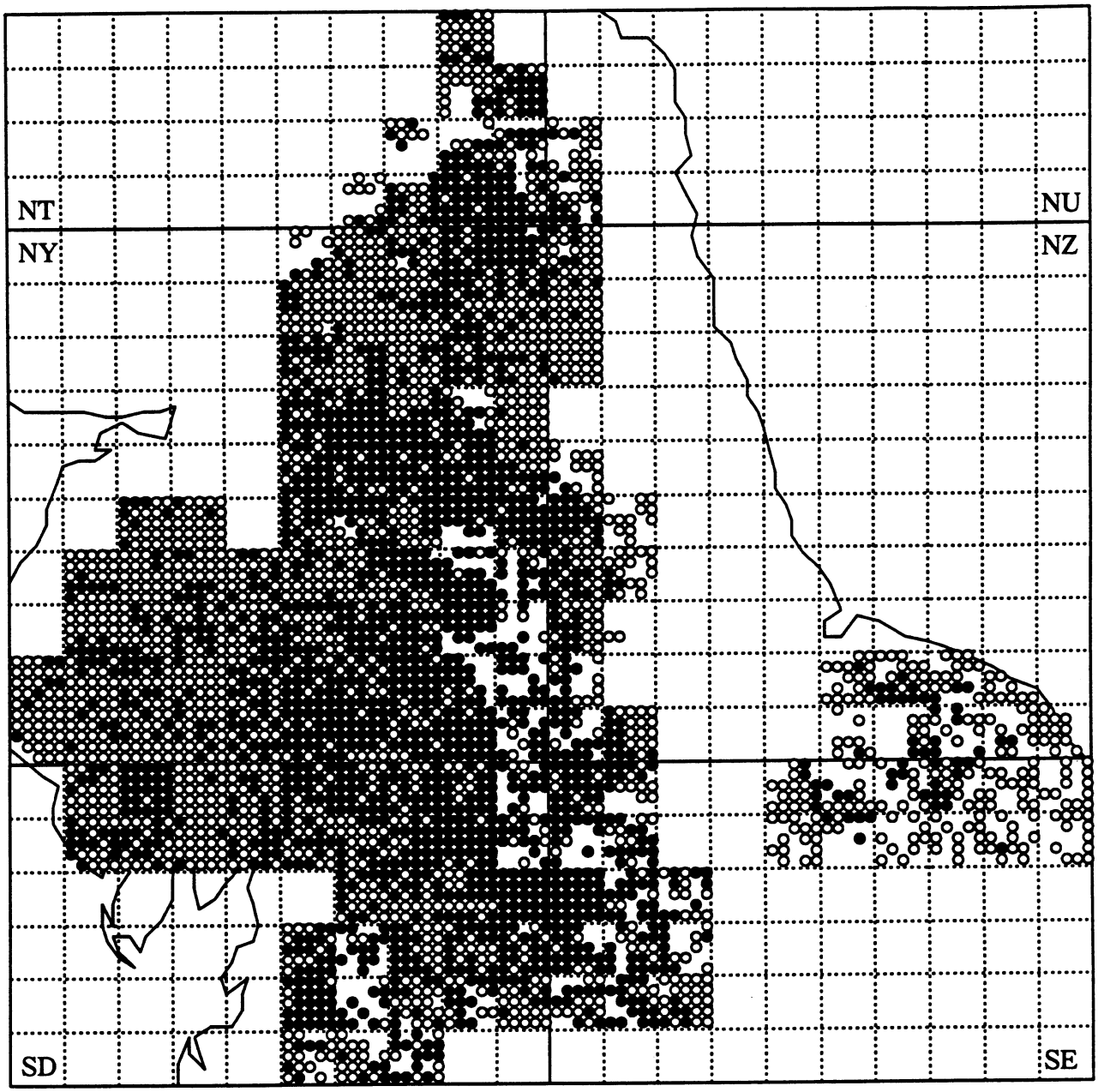

Figure 5. Relative species richness: filled circles are tetrads with at least the mean number of species recorded per tetrad in the study area. Open circles had less than the mean.

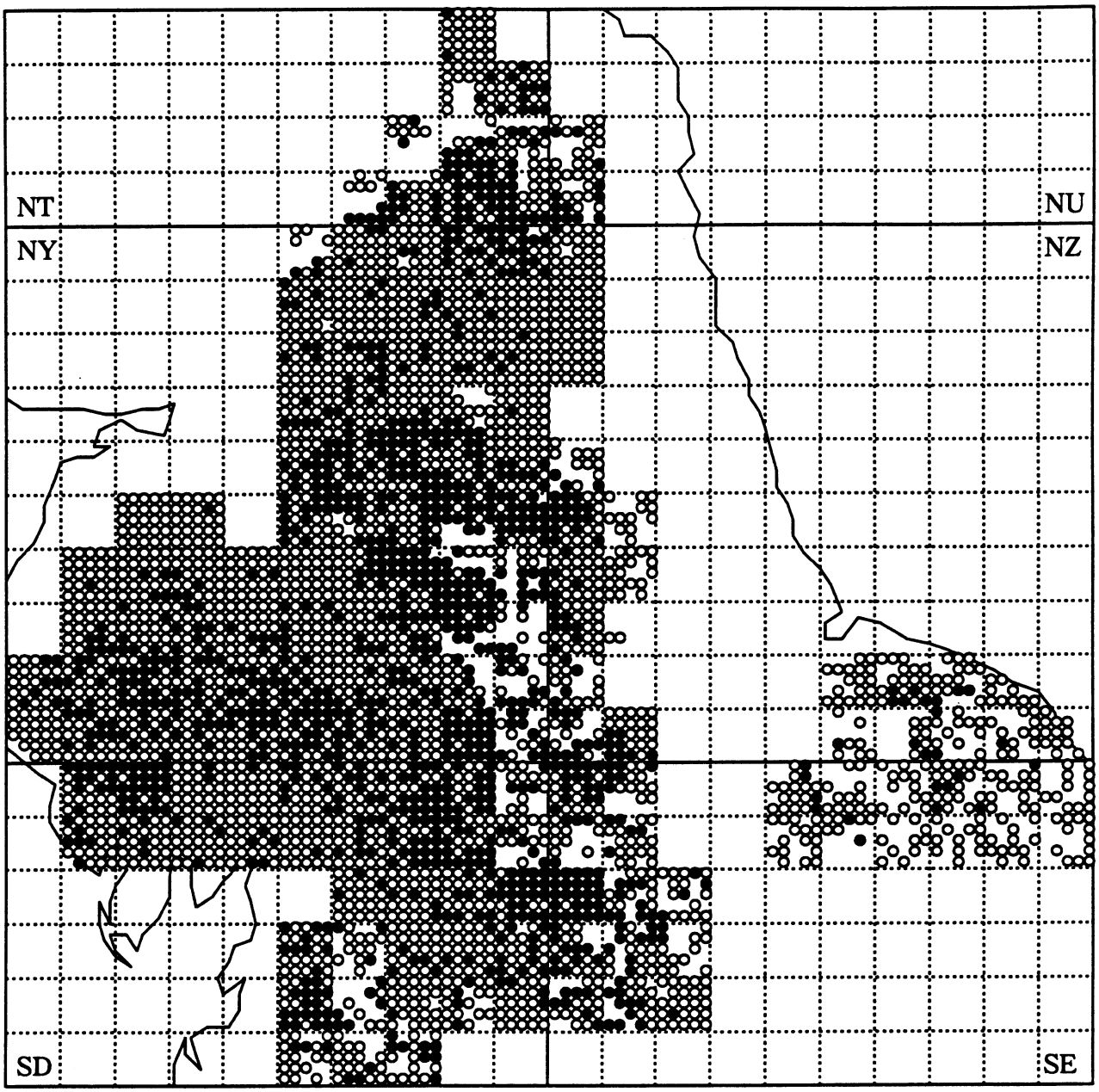

Figure 6. Relative importance: filled circles are tetrads with at least the mean importance index for tetrads in the study area. Open circles are tetrads with less than the mean.

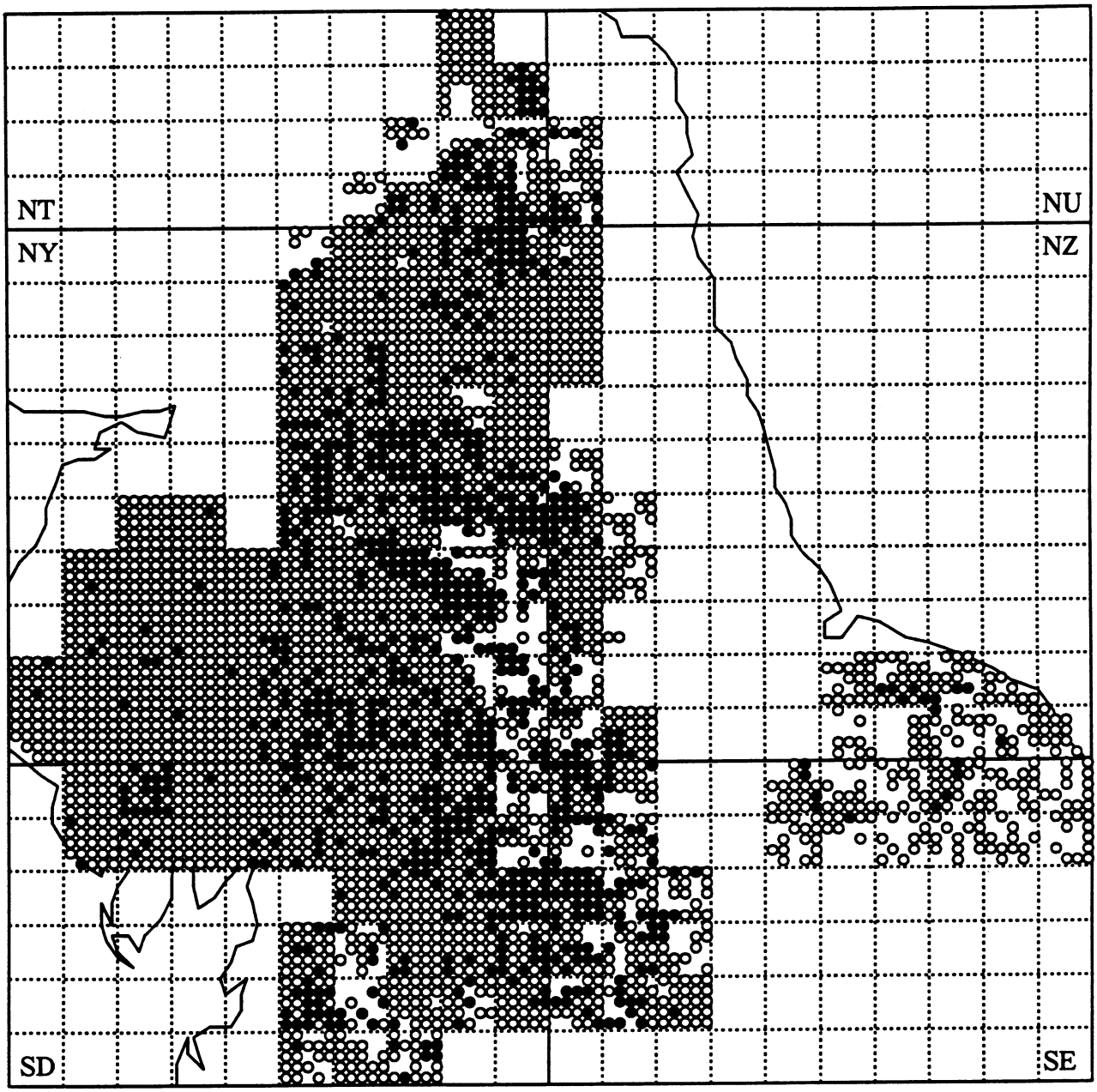

Figure 7. Species richness: filled circles are tetrads with at least 1.5X the mean number of species recorded per tetrad in the study area. Open circles are tetrads with less than 1.5X the mean.

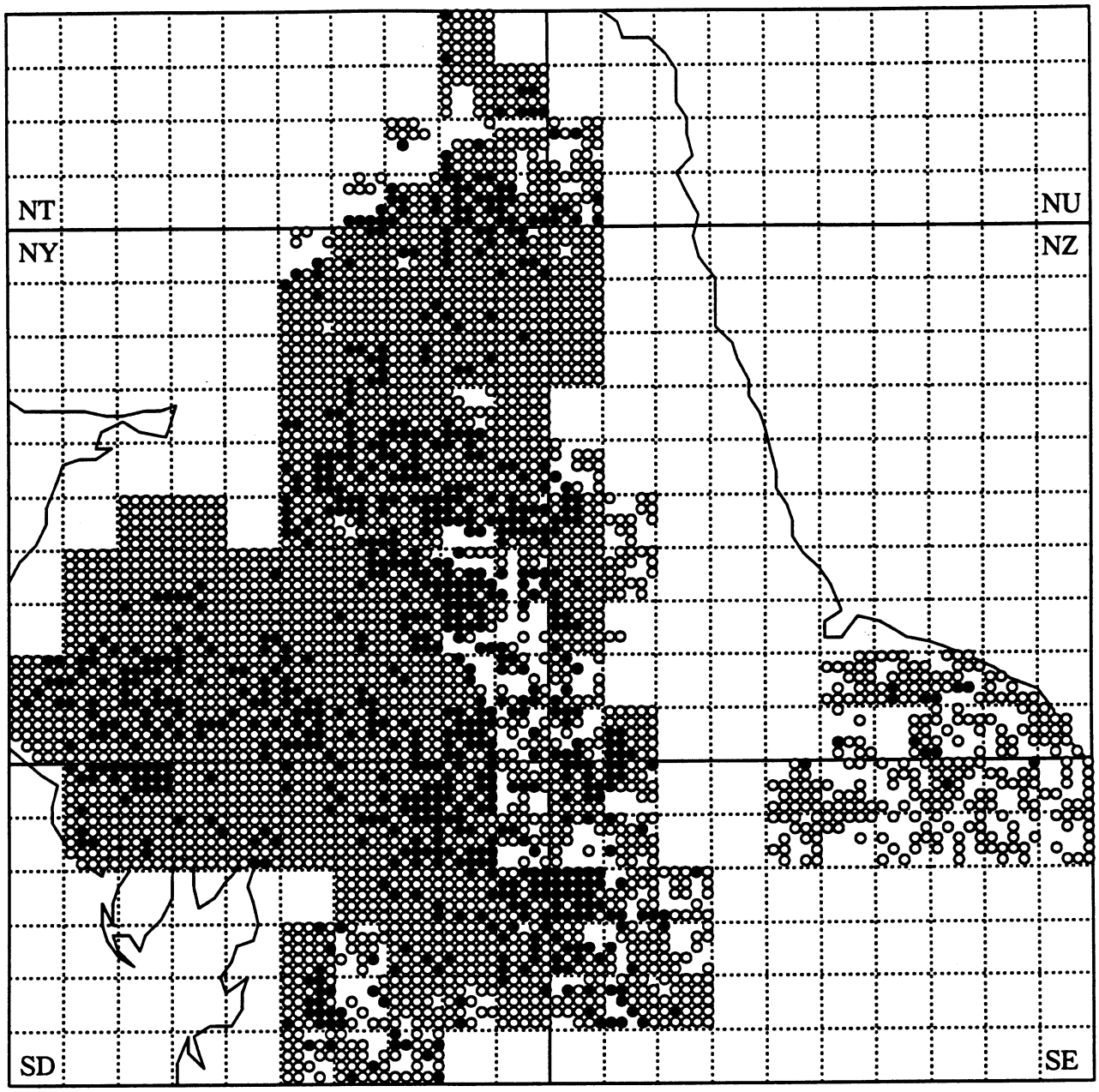

Figure 8. Relative importance: filled circles are tetrads with at least 1.5X the mean importance index for tetrads in the study area. Open circles are tetrads with less than 1.5X the mean.

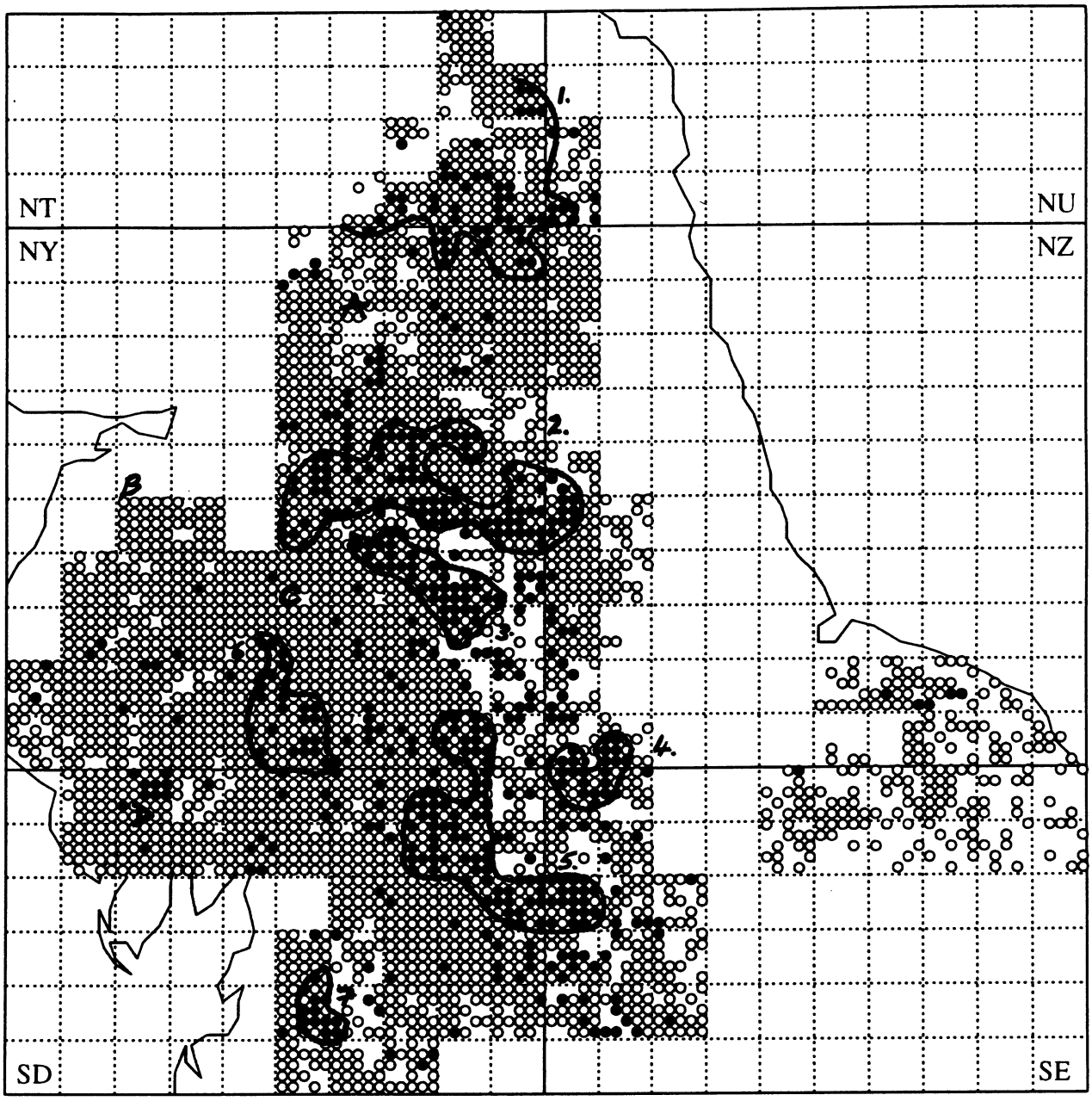

Figure 9. Important bird areas 1-7: areas containing concentrations of tetrads with a species richness and mean importance index at least 1.5X the mean for the study area (indicated by filled circles). Open circles are tetrads with less than 1.5X the mean species richness or importance index. Also indicated are areas A-D referrred to in discussion.

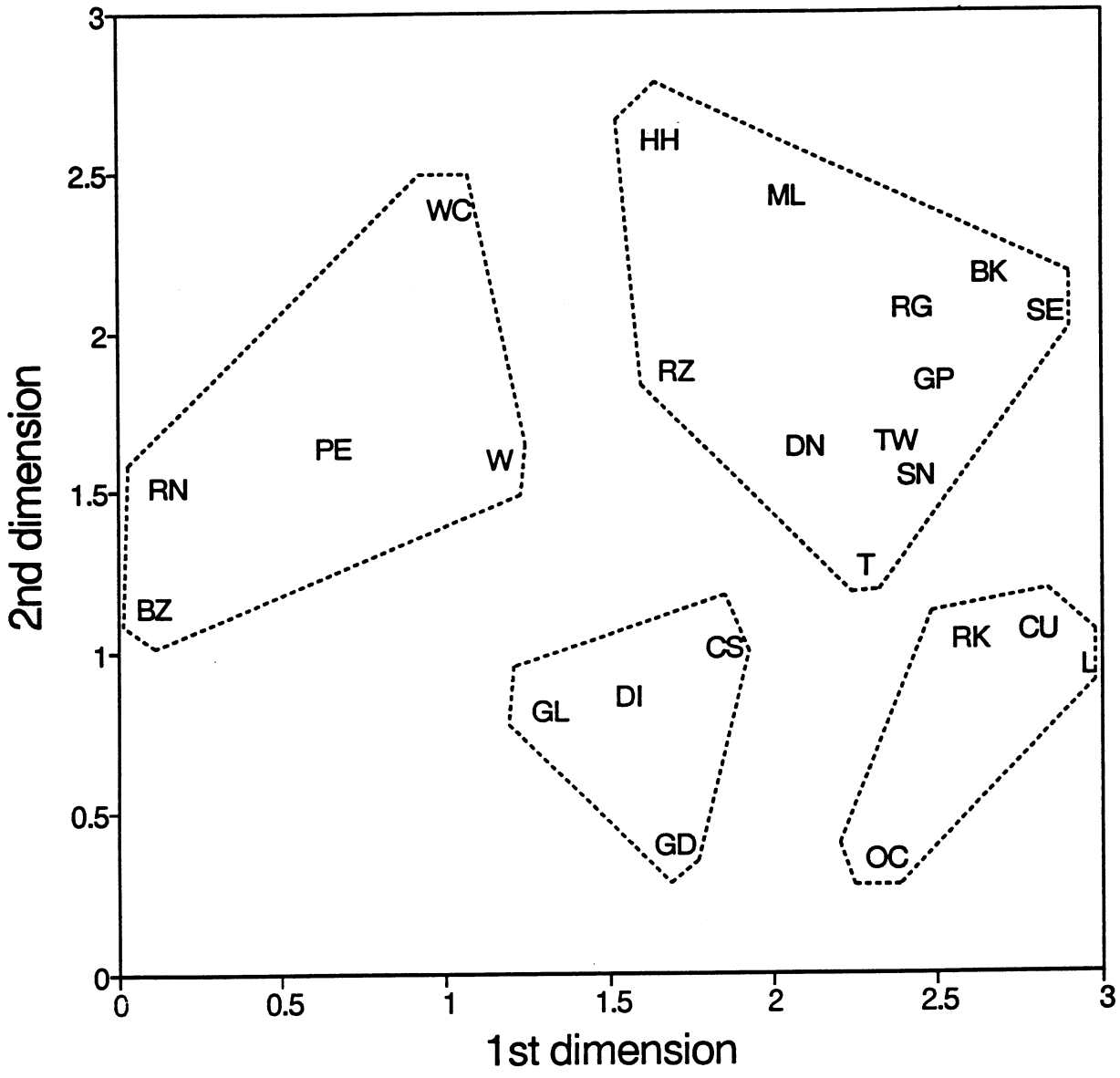

Figure 10. Two-dimensional scaling of pearson correlation coefficients of bird abundance in the northern England study area. The dotted line represents four species groups produced using average linkage cluster analysis.

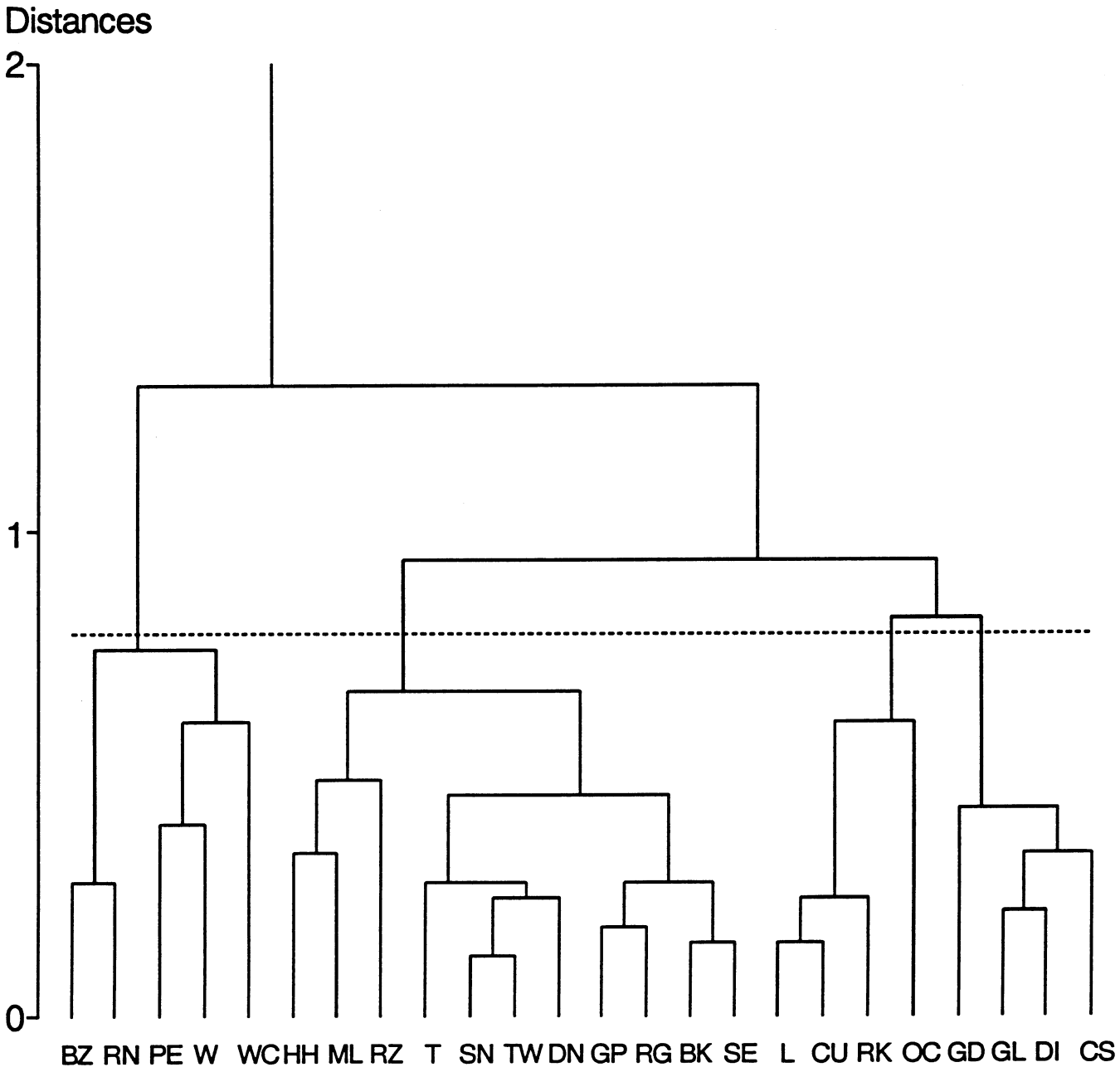

Figure 11. Average linkage cluster analysis of bird abundances in the northern England study area. The dotted line represents the cut-off used to separate the species into groups.

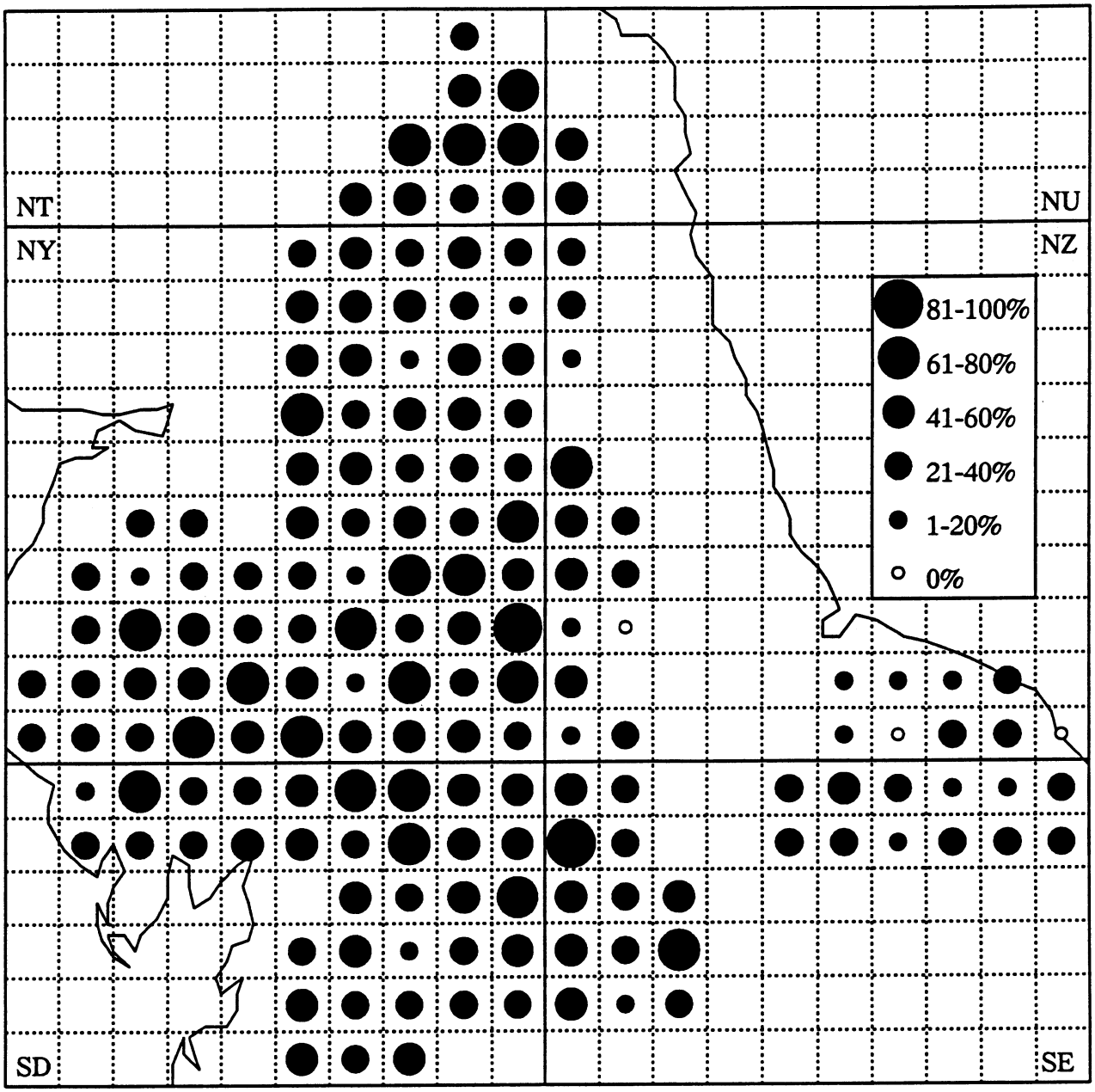

Figure 12. The percentage of surveyed tetrads in each ten kilometre square in which one or more species characteristic of the river valley group were recorded in the northern England study area.

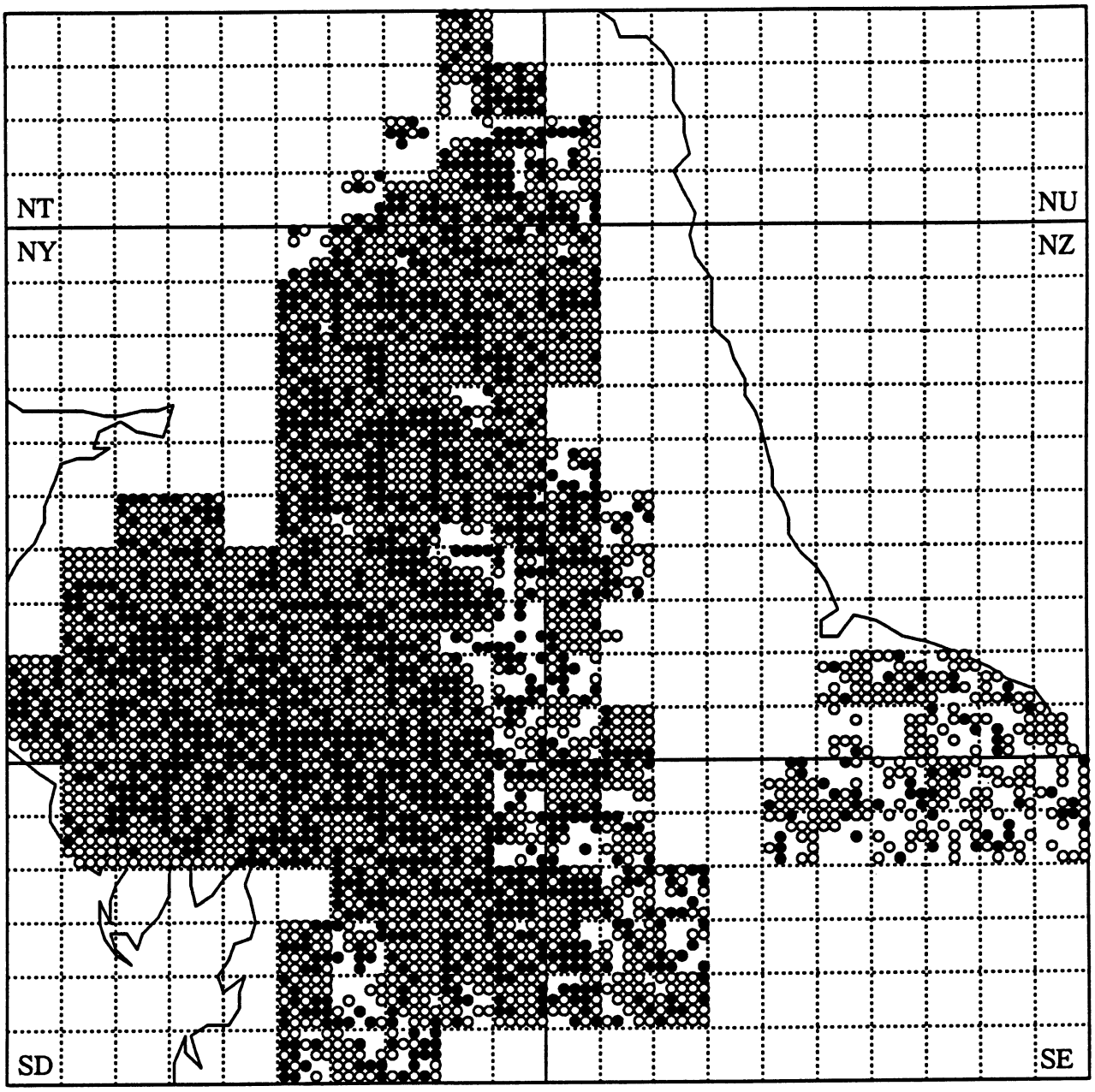

Figure 13. The distribution of tetrads containing one or more species characteristic of the river valley group in the northern England study area.

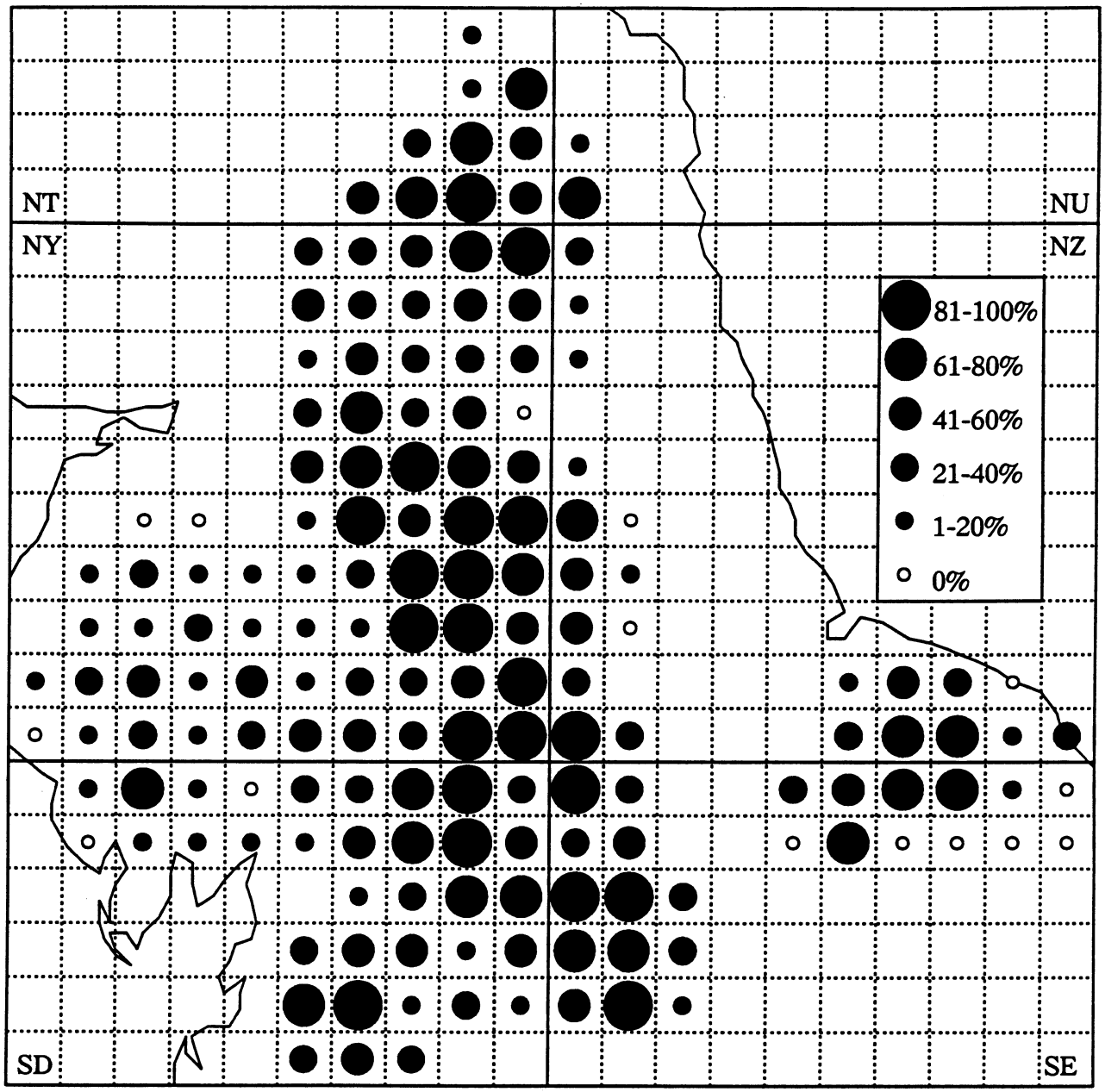

Figure 14. The percentage of surveyed tetrads in each ten kilometre square in which one or more species characteristic of the unenclosed upland group were recorded in the northern England study area.

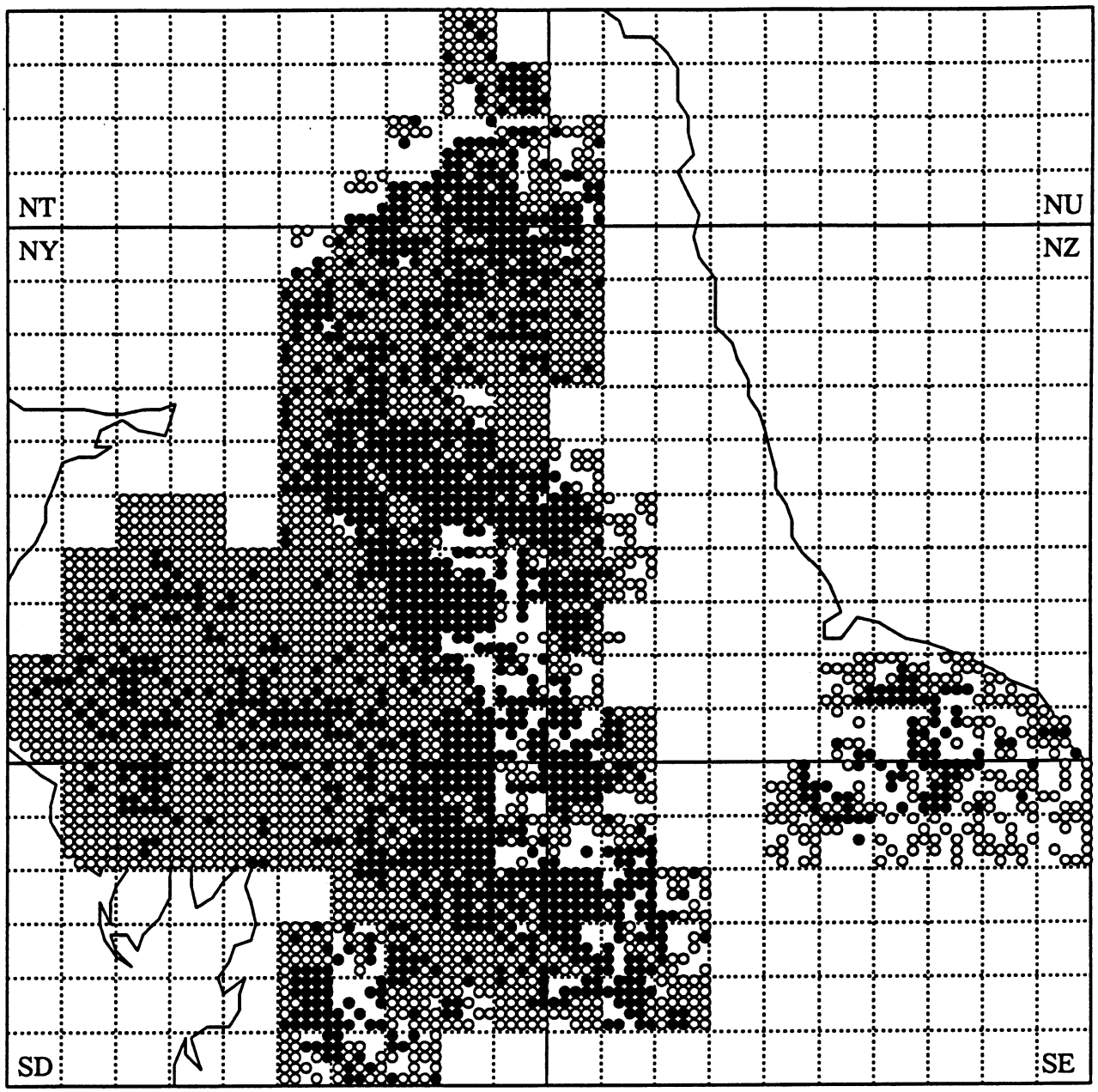

Figure 15. The distribution of tetrads containing one or more species characteristic of the unenclosed upland group in the northern England study area.

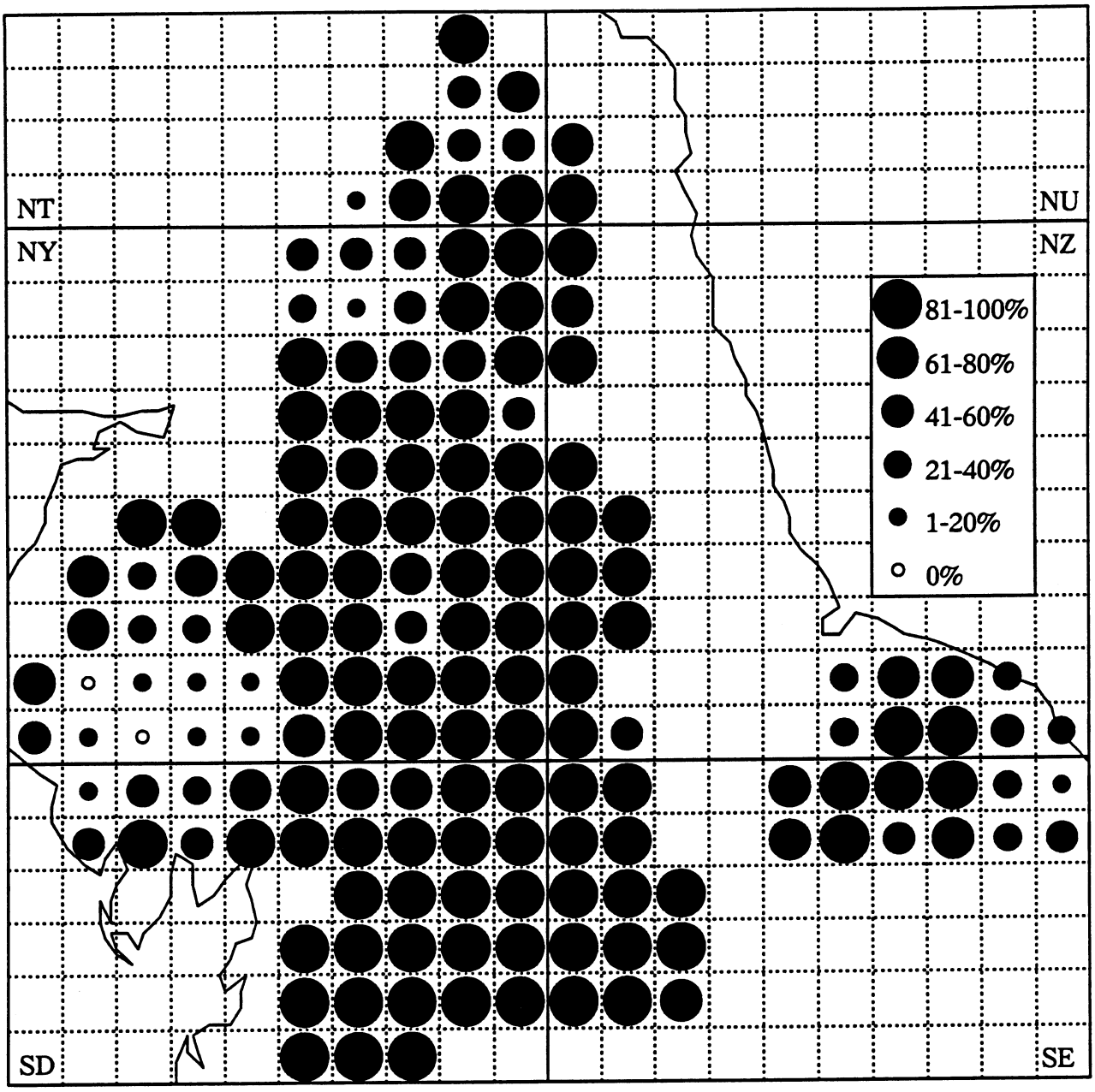

Figure 16. The percentage of surveyed tetrads in each ten kilometre square in which one or more species characteristic of the enclosed farmland group were recorded in the northern England study area.

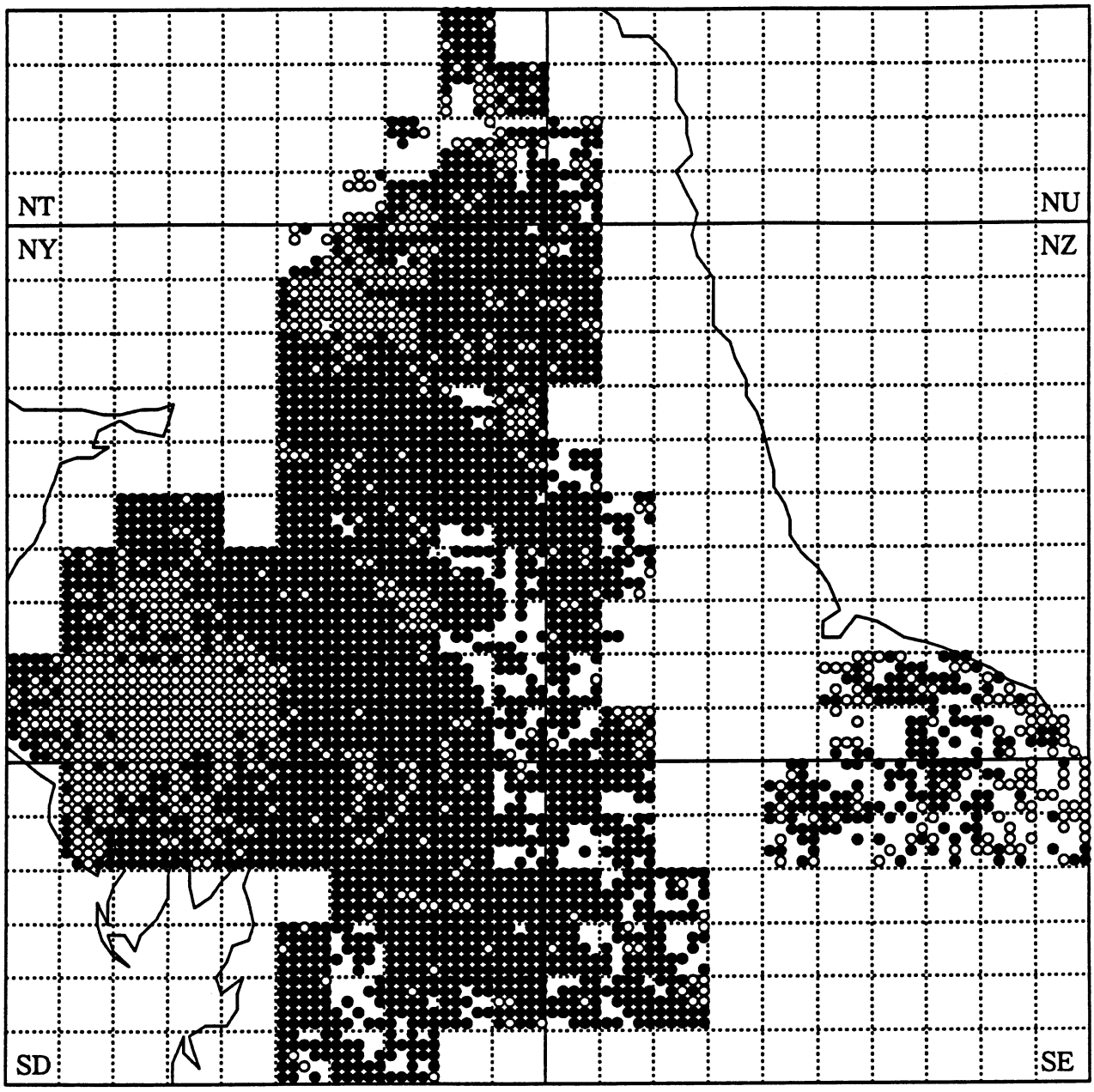

Figure 17. The distribution of tetrads containing one or more species characteristic of the enclosed farmland group in the northern England study area.

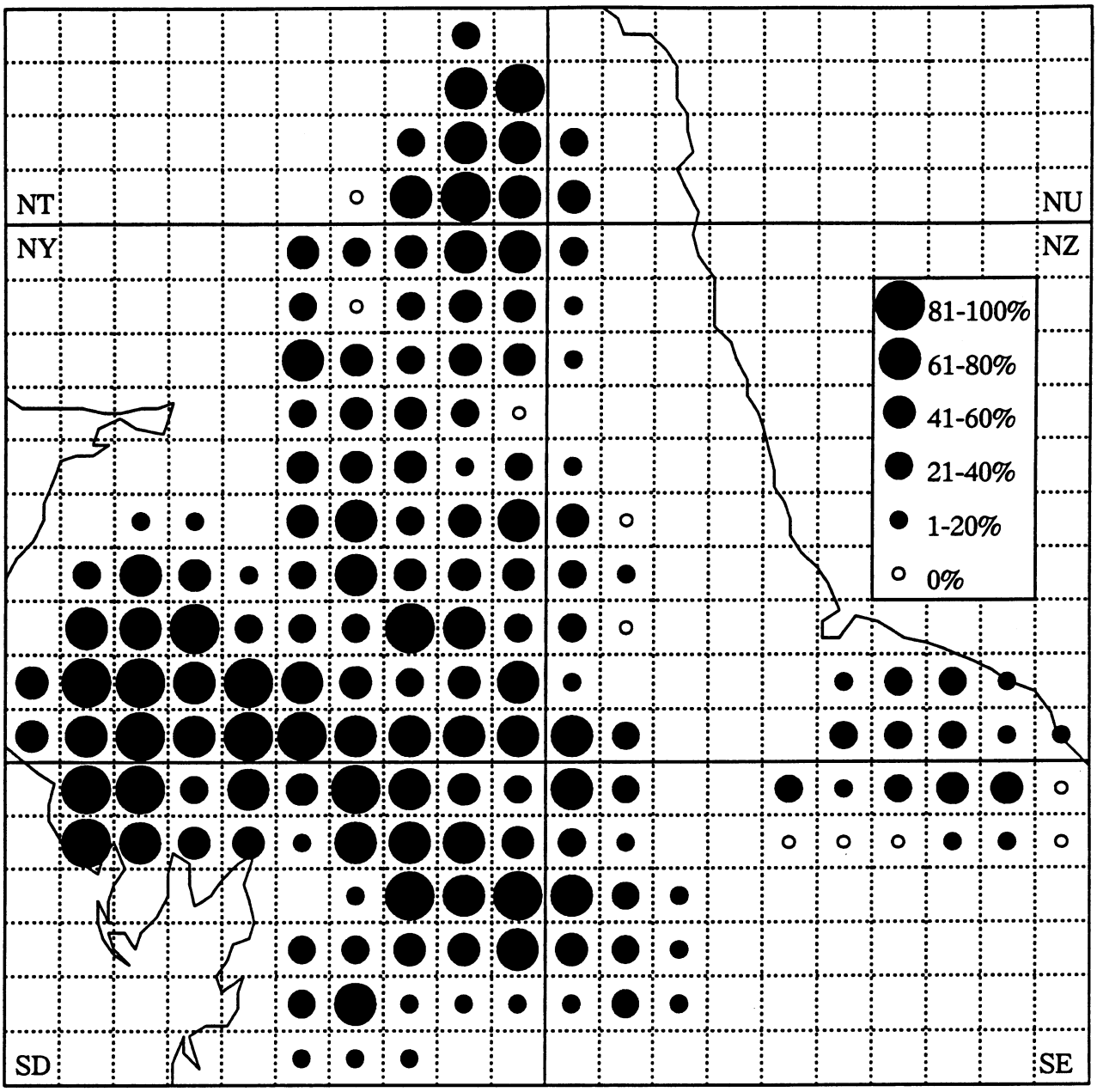

Figure 18. The percentage of surveyed tetrads in each ten kilometre square in which one or more species characteristic of cliffs, broken or steeply sloping ground were recorded in the northern England study area.

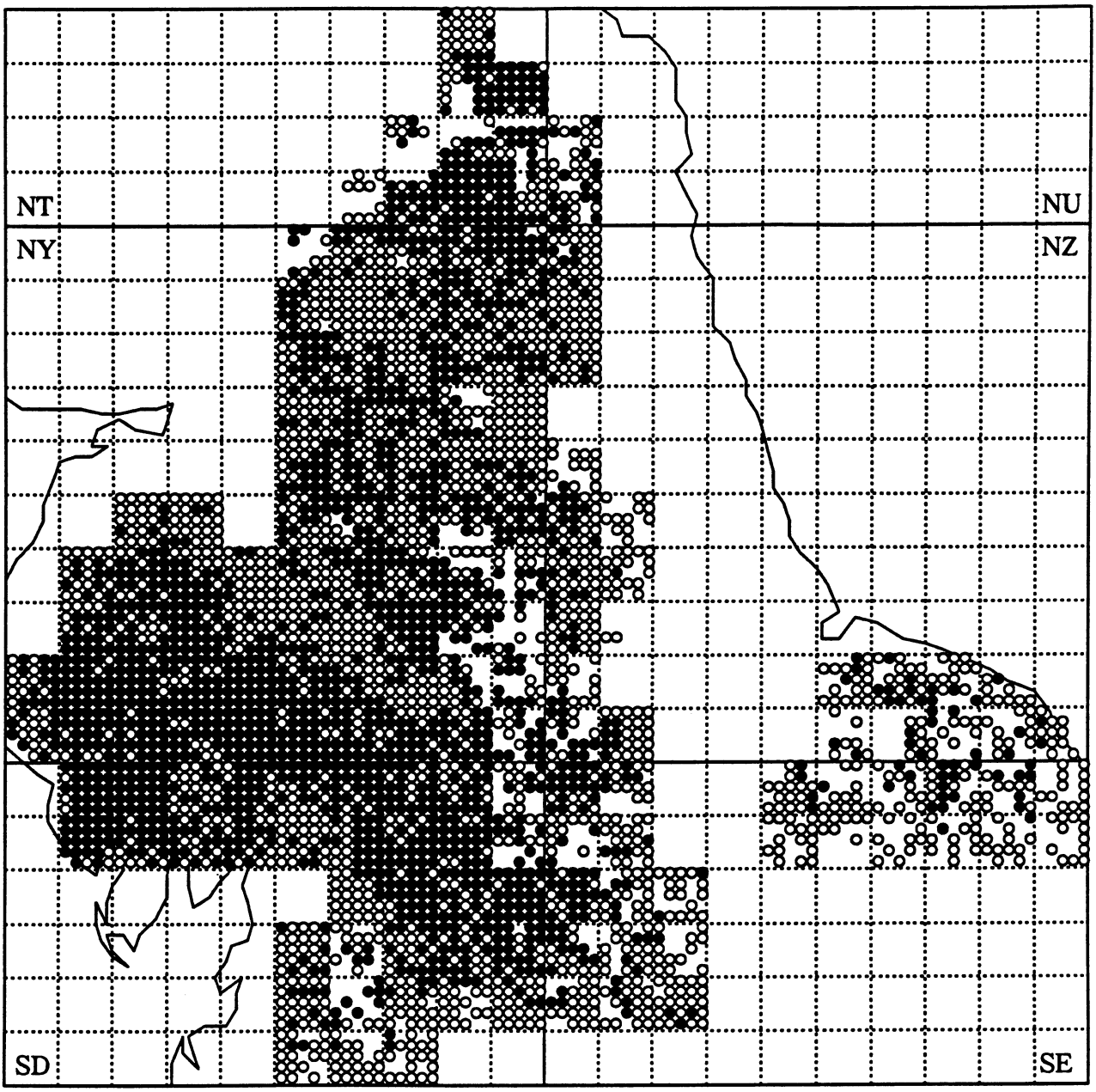

Figure 19. The distribution of tetrads containing one or more species characteristic of the cliffs, broken or steeply sloping ground in the northern England study area.

Table 2. Summary parameters for four species-groups identified in the northern England study area.

	Farmland group	Moorland group	River Valley group	Cliff group
N° of species in group	4	11	4	5
N° of tetrads occupied by group	2616	1423	1422	1661
N° of tetrads occupied by all species in group	5580	3011	2479	2415
Mean N° of occupied tetrads per species	1395	274	624	483

Discussion

The evaluation presented in this report has enabled discrimination between areas relatively species-rich and species-poor for upland breeding birds in northern England and between the more and less important areas in terms of the relative abundance of the species they hold. The use of indices of importance calculated in the manner presented in this report could lead to an over-emphasisis on rare species, since scores for squares are a function of scarcity as well as species richness. However, some bias towards the less widespread or uncommon species is exactly the aim of the exercise. The removal of the very rare species from consideration might prevent too much bias but it would be difficult to determine at what point a species should or should not be included in the index computations. We opted to include all species and prevented undue emphasis on squares containing rare species by not selecting isolated squares as important bird areas.

The data available permitted an evaluation over much of the area. However, data for the border area with Scotland, North Yorks Moors, much of the eastern Pennines and parts of the Forest of Bowland were too fragmented to allow a useful assessment of their importance for upland breeding birds at the tetrad, as distinct from the ten kilometre square level. In contrast, several important bird areas are indicated and it is interesting to note that many of these are already SSSI. The evaluation also serves to demonstrate that the reverse is not necessarily the case. The most notable examples are the SSSI's on the Carboniferous limestone of Craven: Whernside SSSI, Pen-Y-Ghent and associated SSSI's, Ingleborough SSSI, Attermire SSSI and Malham-Arncliffe SSSI. None appear to hold particularly important breeding upland bird populations in a northern England context. This should not be surprising as, along with most other upland SSSI's in the study area they were selected largely for their important vegetation communities and upland habitats. Clearly there is no firm relationship evident at this scale between quality of habitat as perceived by humans and as perceived by birds. Other parts of the study area hold below average populations of upland breeding birds for other reasons. Area A (refer to Figure 9 for locations), around Kielder, is afforested; Areas B (north Lakeland) and C (Eden Valley) are both within the study area as their ten-kilometre squares contain upland but these areas are either on the upland fringe or may, perhaps, not be upland at all. Area D appears to be anomalous and although it is very species rich and important, the boundaries of this interest, corresponding with the ten-kilometre square boundary suggest some sampling artifact.

The evaluation, of course, provides no information on absolute population sizes, breeding densities or on breeding success. Differences in these parameters between upland massifs or habitat types may be as important as differences in species richness and relative importance for bird conservation. However, obtaining information on these must come from more specialised surveys or intensive studies. This evaluation highlights areas where such surveys might most profitably be directed. Priority areas should be the important bird areas outwith existing SSSI's : important bird areas 2, 4 and 5.

The relationship between the important bird areas identified herein and the Important Bird Areas of Pritchard (1992) is noteworthy. Area 1, the border uplands does not correspond with any site identified in that publication. Areas 2 and 3 appear to correspond with the North Pennine Moors pSPA. Areas 4 and 5 correspond to the Yorkshire Dales Moorlands pSPA, Area 6 with the Shap Fells pSPA and Area 7 with the Forest of Bowland pSPA. It is not possible to determine an area corresponding with the North Yorks Moors pSPA owing

to a lack of data in the area. The North of England Montane Sites pSPA has been suggested for the English Lake District. The current evaluation suggests that much of the bird interest in Lakeland is diffuse, being associated with crags and upland woodlands and very small areas of montane heath. We cannot identify an area of importance to correspond with this pSPA from this study.

Clearly, the current evaluation has provided contextual information which may be of value in justifying the selection of SPA's in the northern English uplands. Further information will be required to fully justify their designation as SPA's. We suggest that initial emphasis is placed on compiling more precise data on raptors for the whole study area as this is available from raptor study groups and individuals and is supplied to country statutory conservation agencies as a condition of the licensing of nest visits or other disturbance to Schedule 1 breeding birds. Data on populations of other species can be obtained by specific survey directed to the priority areas identified in this report.

An evaluation of the kind presented herein has allowed a very rapid assessment of the relative importance of a very large land area for a specific group of birds. It provides a large amount of contextual information and allows a number of statements to be made about the resource. Atlas data provide a relatively inexpensive method of accomplishing these tasks. We found that the level of resolution offered by information presented at the ten-kilometre square scale was not fine enough to allow us to distinguish between more and less important areas. This may well be less of a problem in larger, national scale studies. The analyses highlight the value of data capture at a finer scale of resolution during a national survey. Unfortunately, not all tetrads were surveyed during the survey period (this was not an aim of the Atlas) and this does present problems for analyses at the tetrad, as distinct from the 10 kilometre square level. These may be particularly acute in more remote areas, such as in the north and west of Scotland. However, in the English lowlands in particular, coverage is excellent and analyses of the type presented herein should aid strategic planning for conservation in the wider countryside through, for example, regional or county conservation strategies or indicative forest strategies.

The current evaluation was of a restricted area of the uplands and included selected species typical of the uplands. The methods used may readily be applied to data referring to the full extent of upland Britain and to the full range of upland breeding species. Indeed, it is likely that an analysis at the British scale would reveal much clearer species groupings and areas of importance, due to the larger range of environmental gradients and habitats at the British scale than exist within northern England. Such a study would be of clear value in providing a contextual framework for upland bird conservation in Britain. The index of importance used in the present study takes no account of the importance of species in a British or European context as it was specifically derived to aid targetting of conservation related activity in a northern England context. Use of a reciprocal based on national and international population sizes would be essential for a national scale study, but it would also be of value in providing a national and international context for regional studies.

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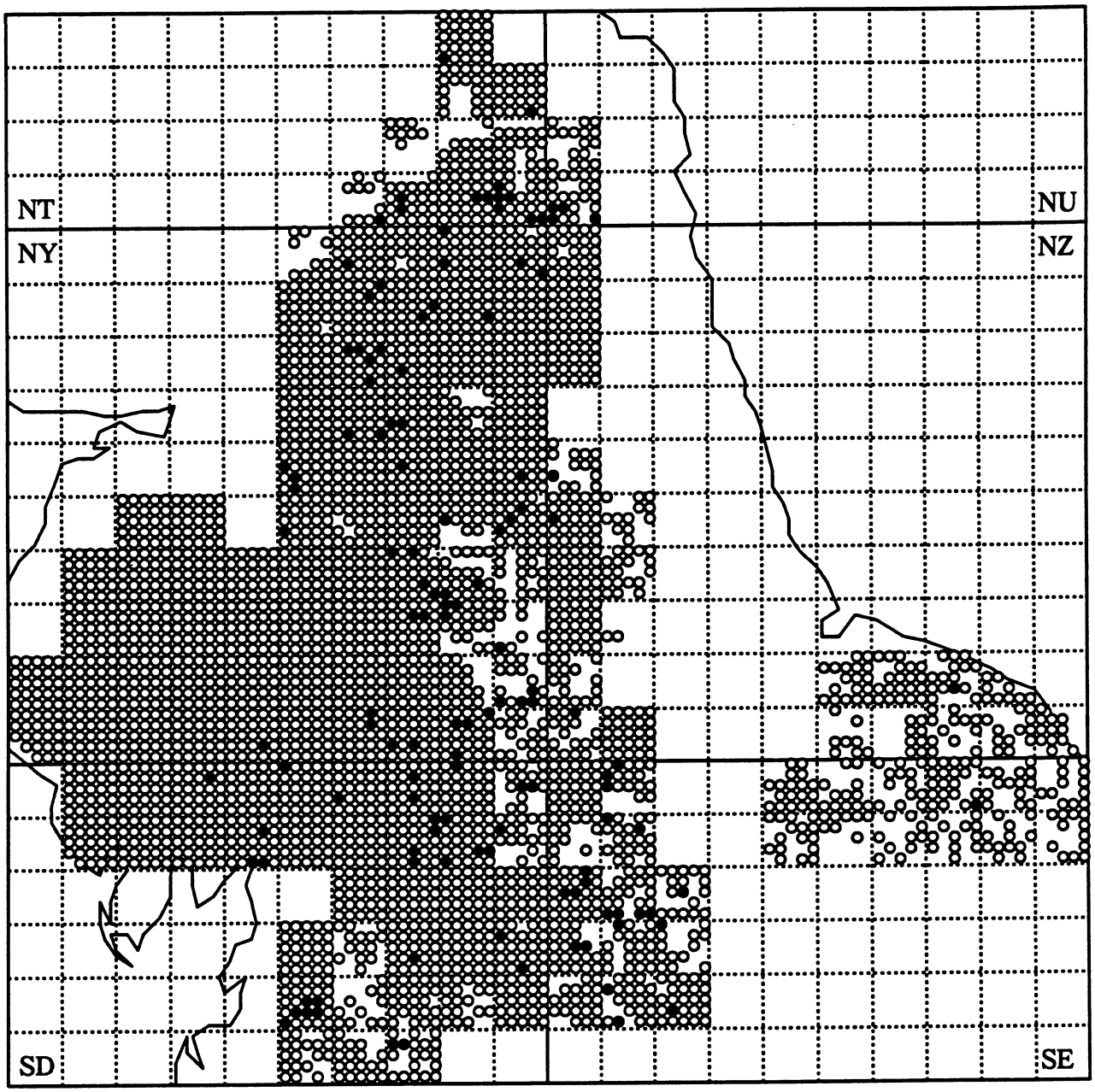
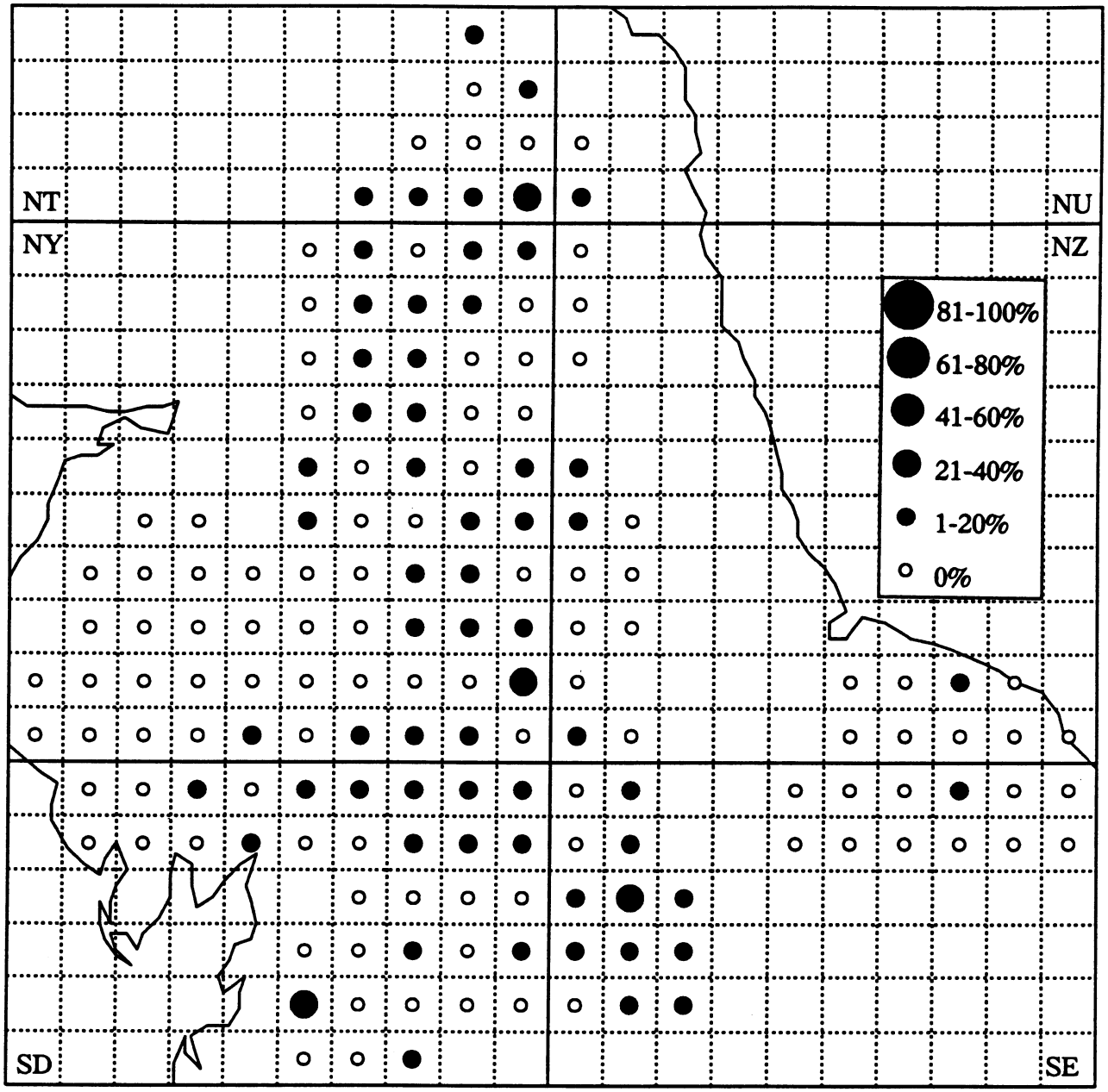


APPENDIX 1a

The distribution of teal in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

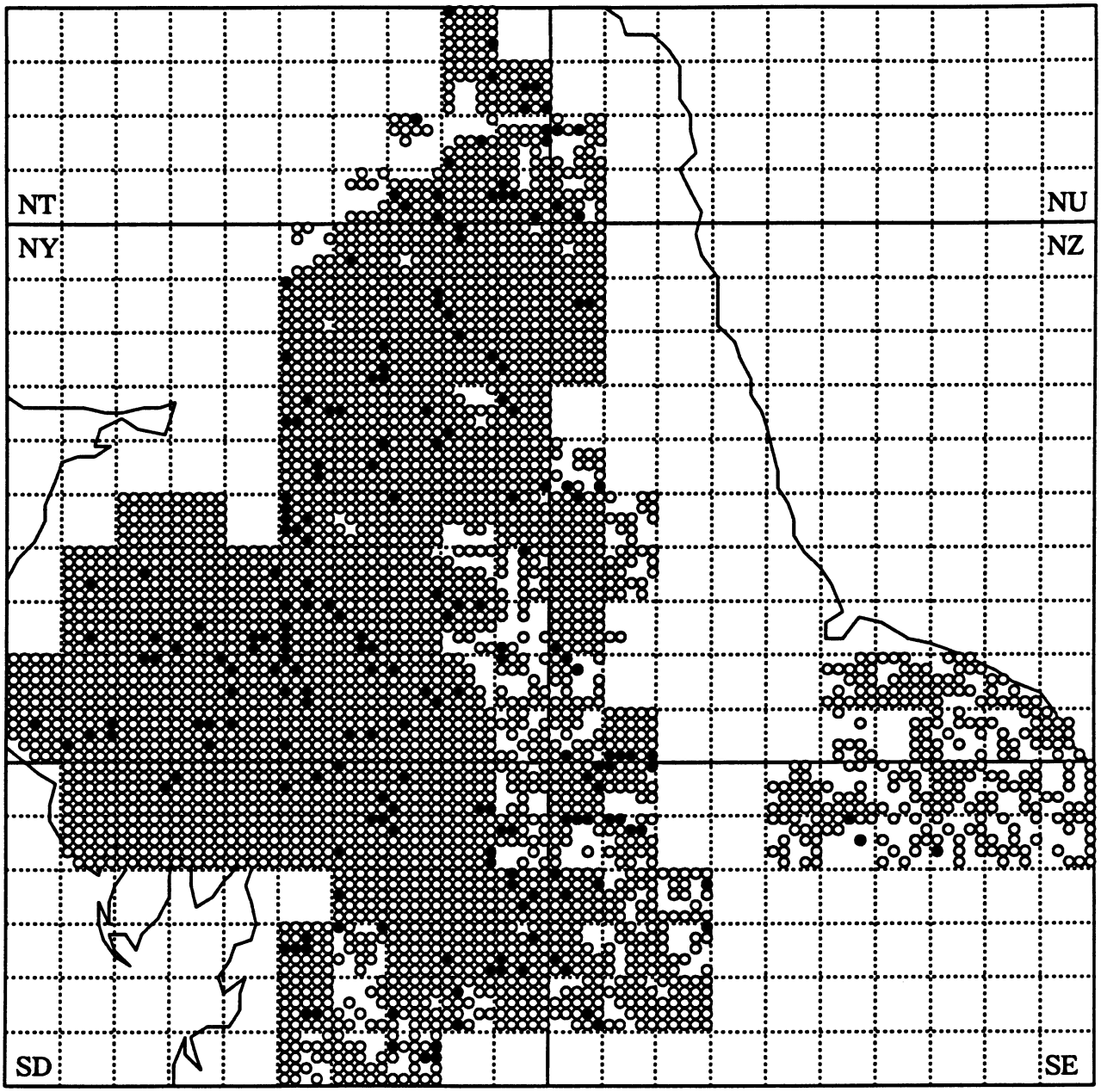
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 1b

The distribution of teal in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

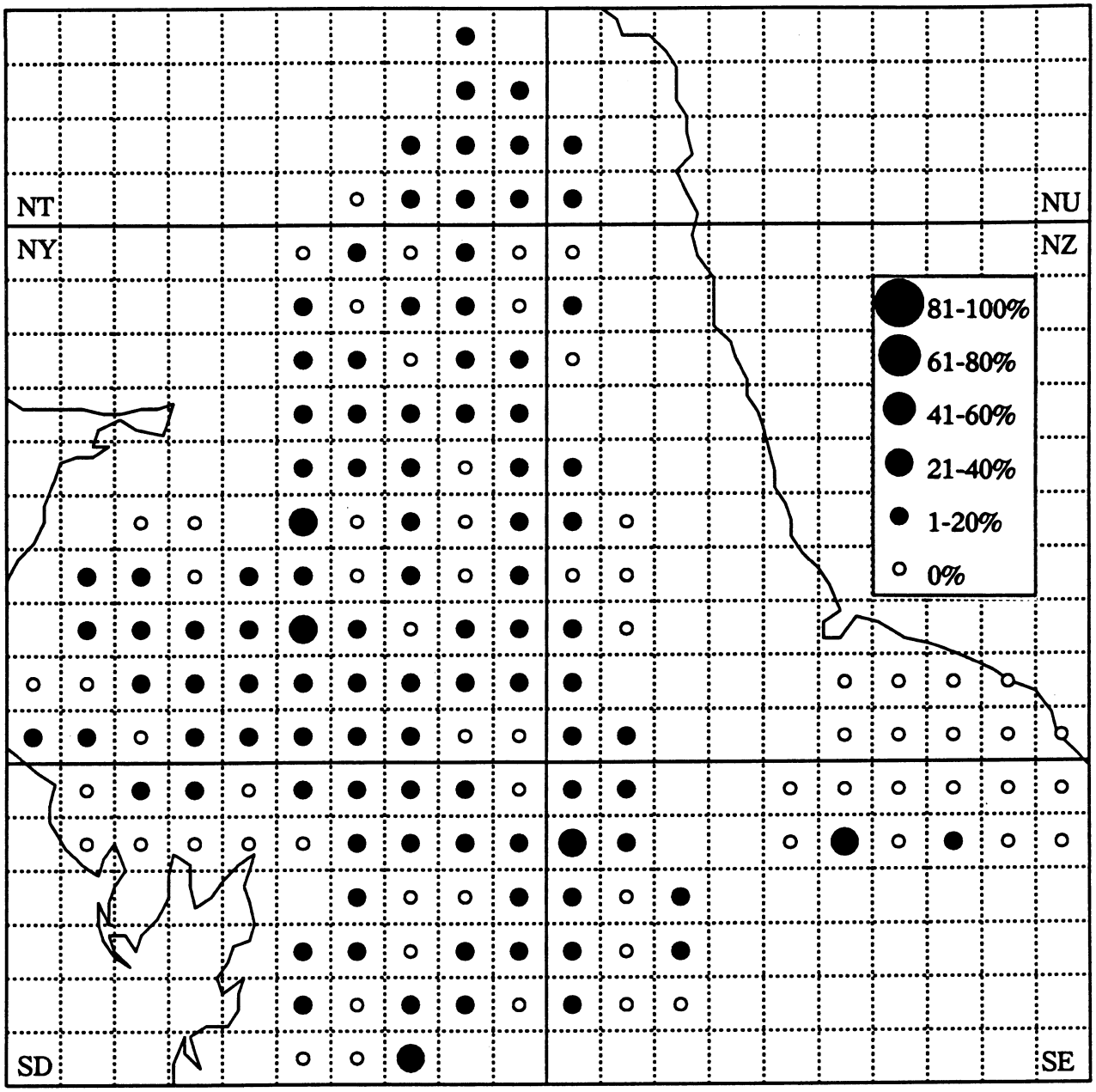
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 2a

The distribution of goosander in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

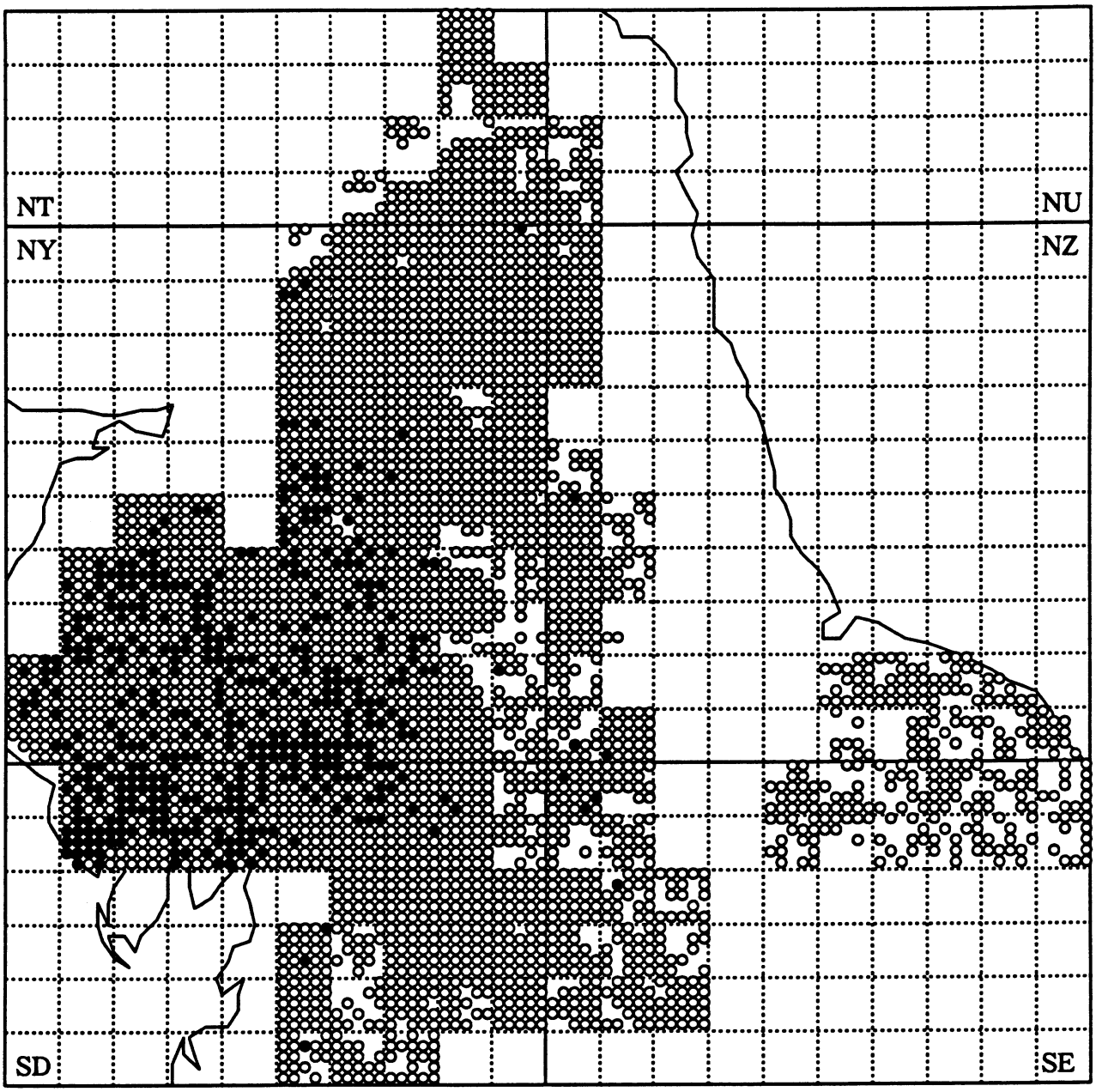
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 2b

The distribution of goosander in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

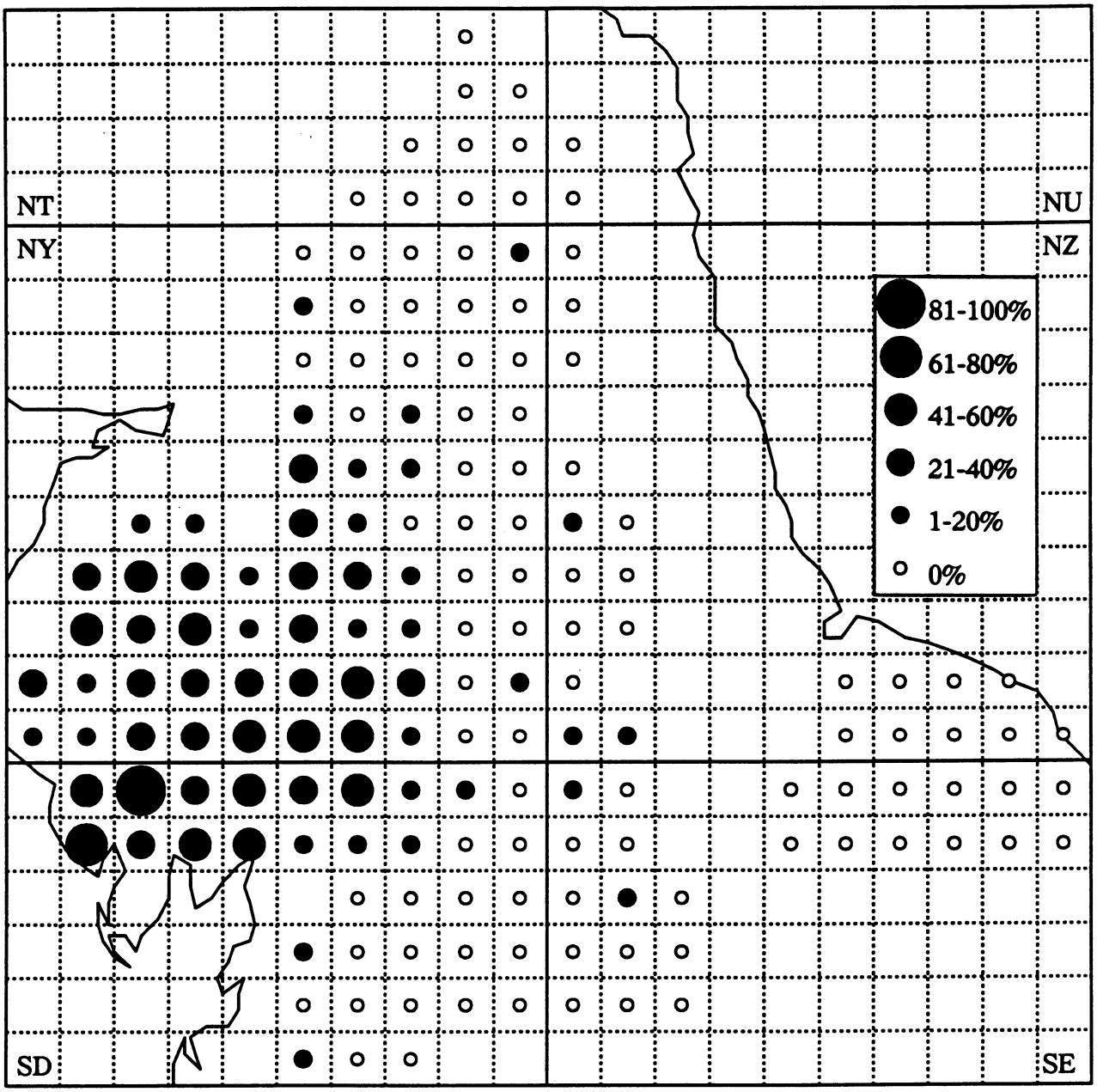
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 3a

The distribution of buzzard in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

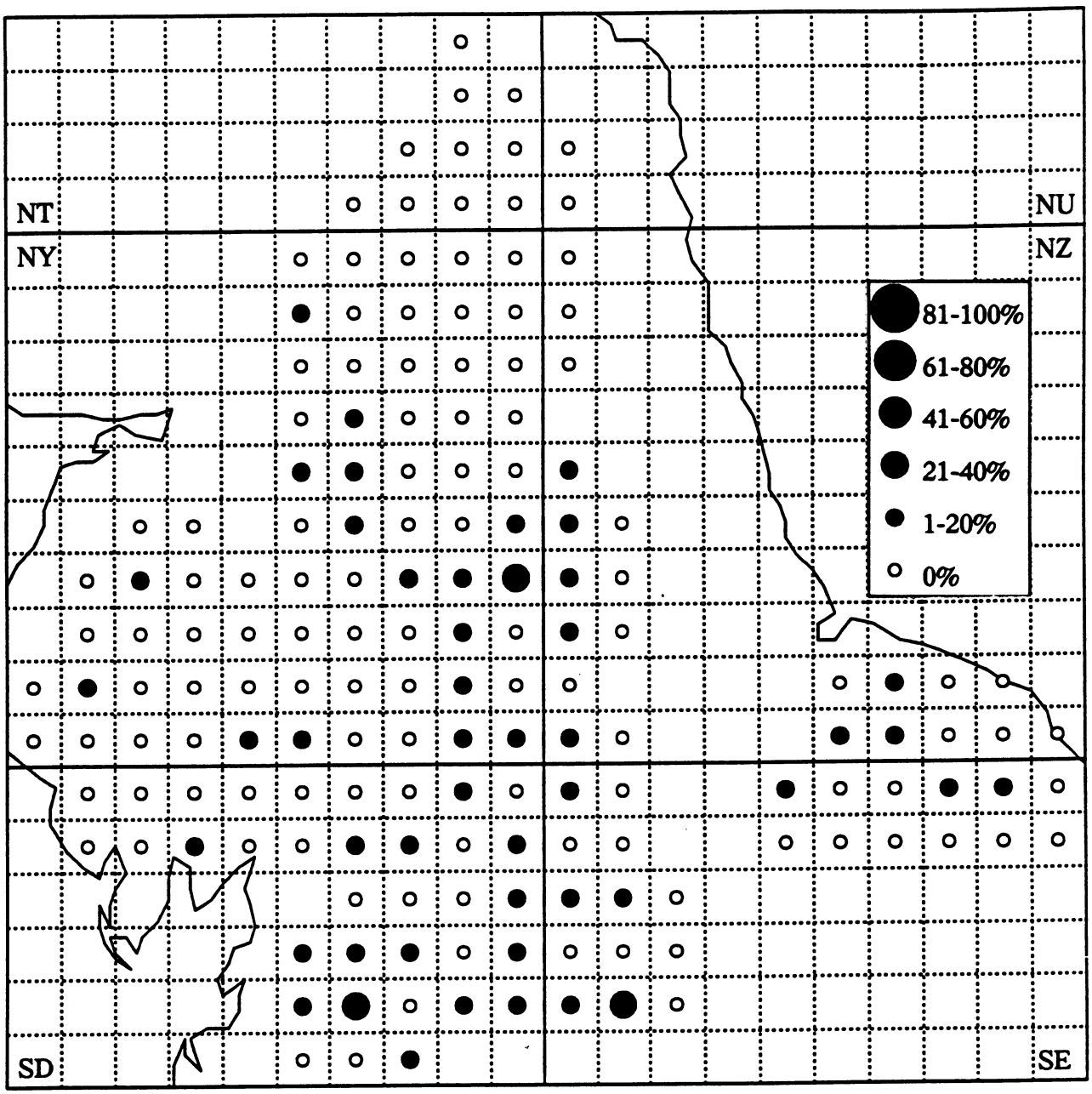
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 3b

The distribution of buzzard in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

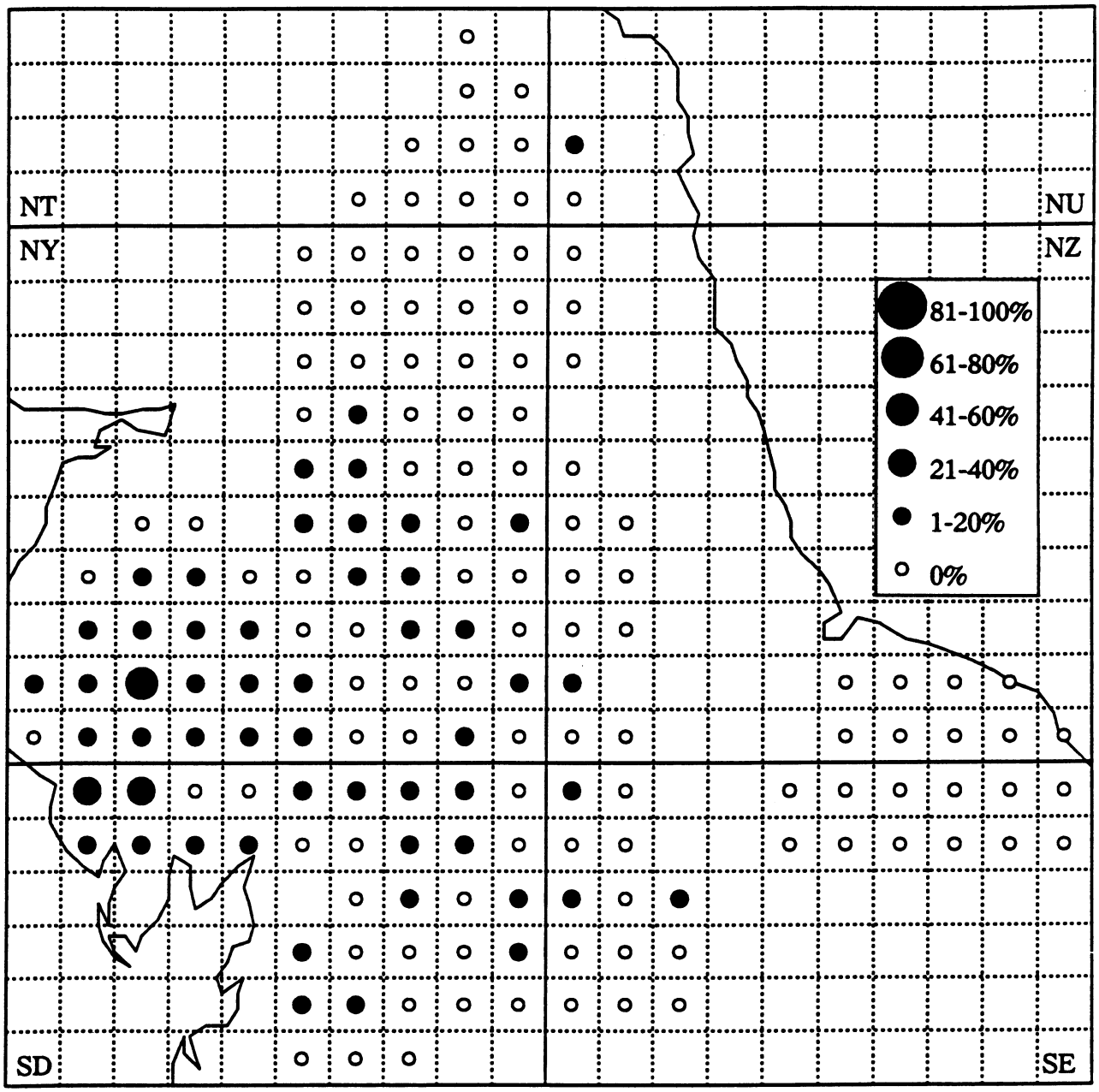
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 4

The distribution of merlin in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

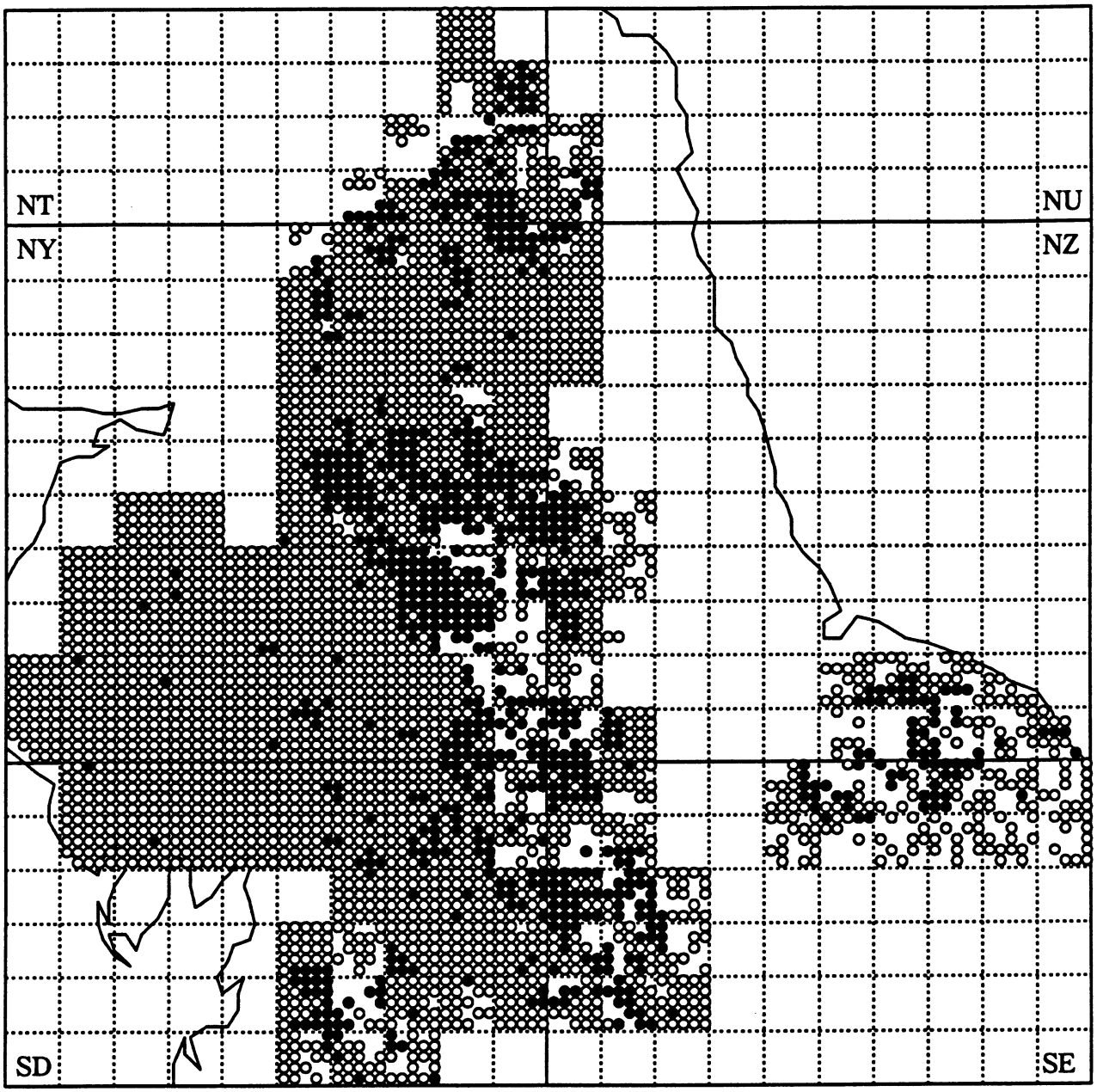
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 5

The distribution of peregrine in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

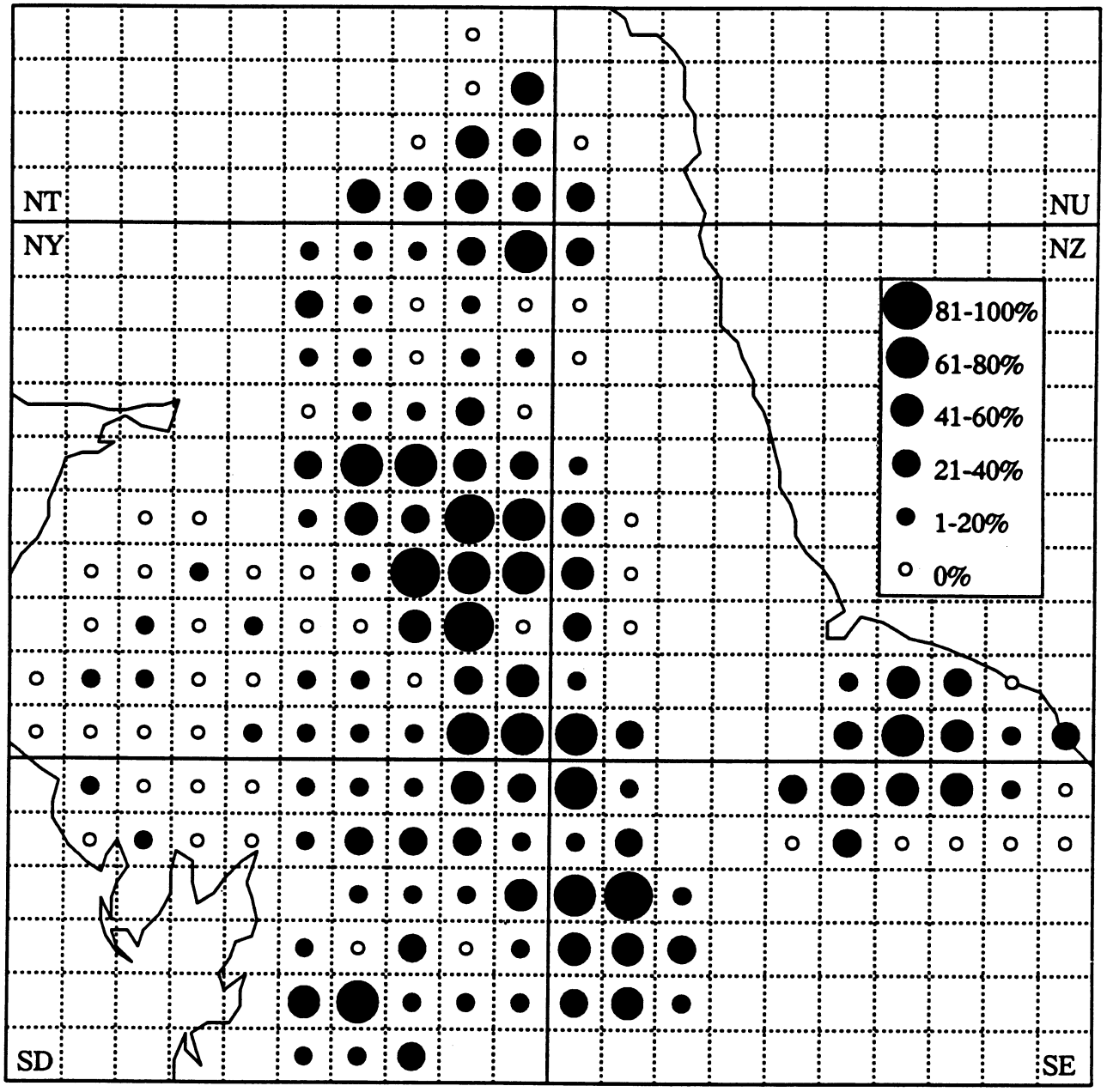
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 6a

The distribution of red grouse in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

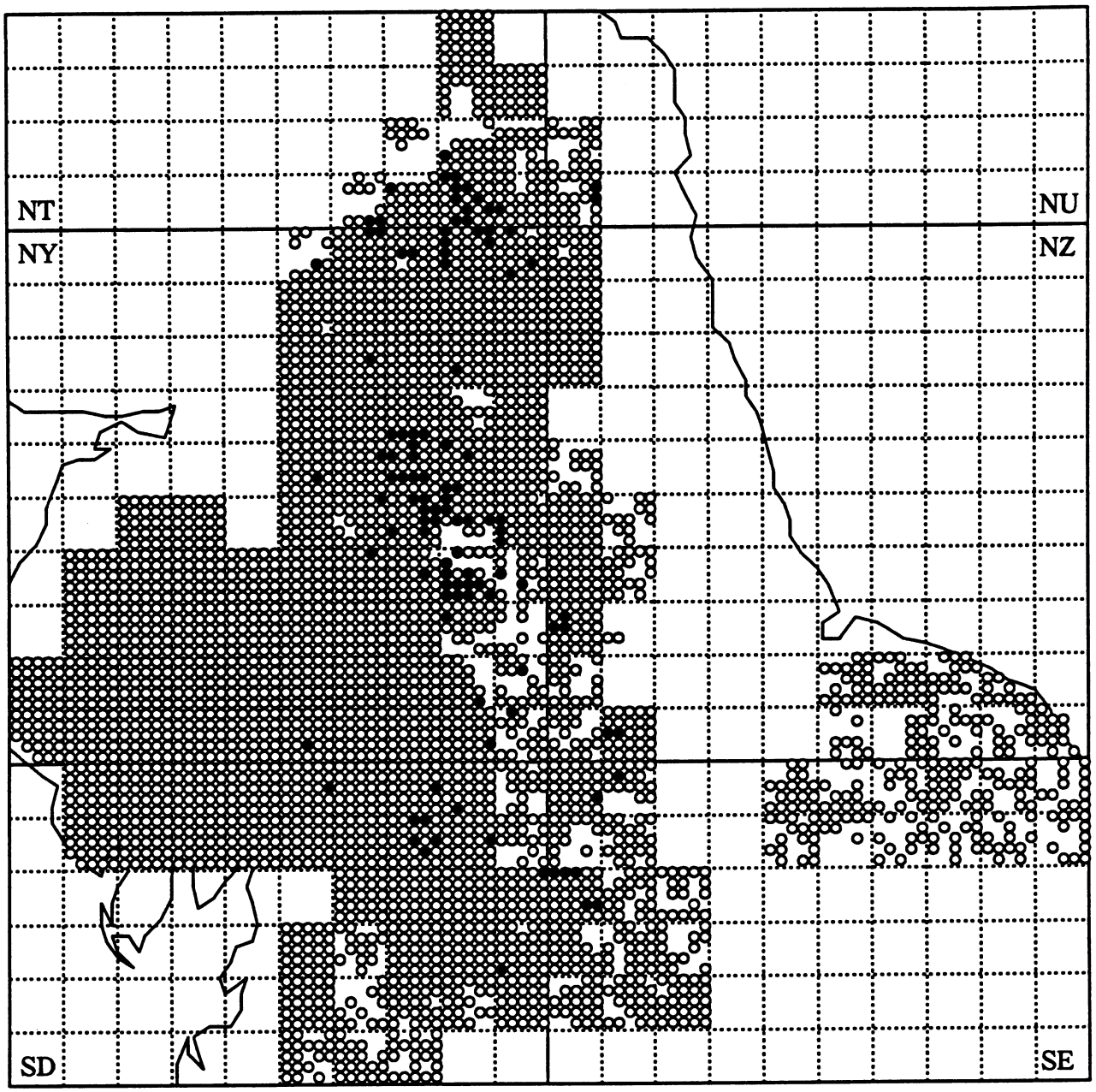
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 6b

The distribution of red grouse in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

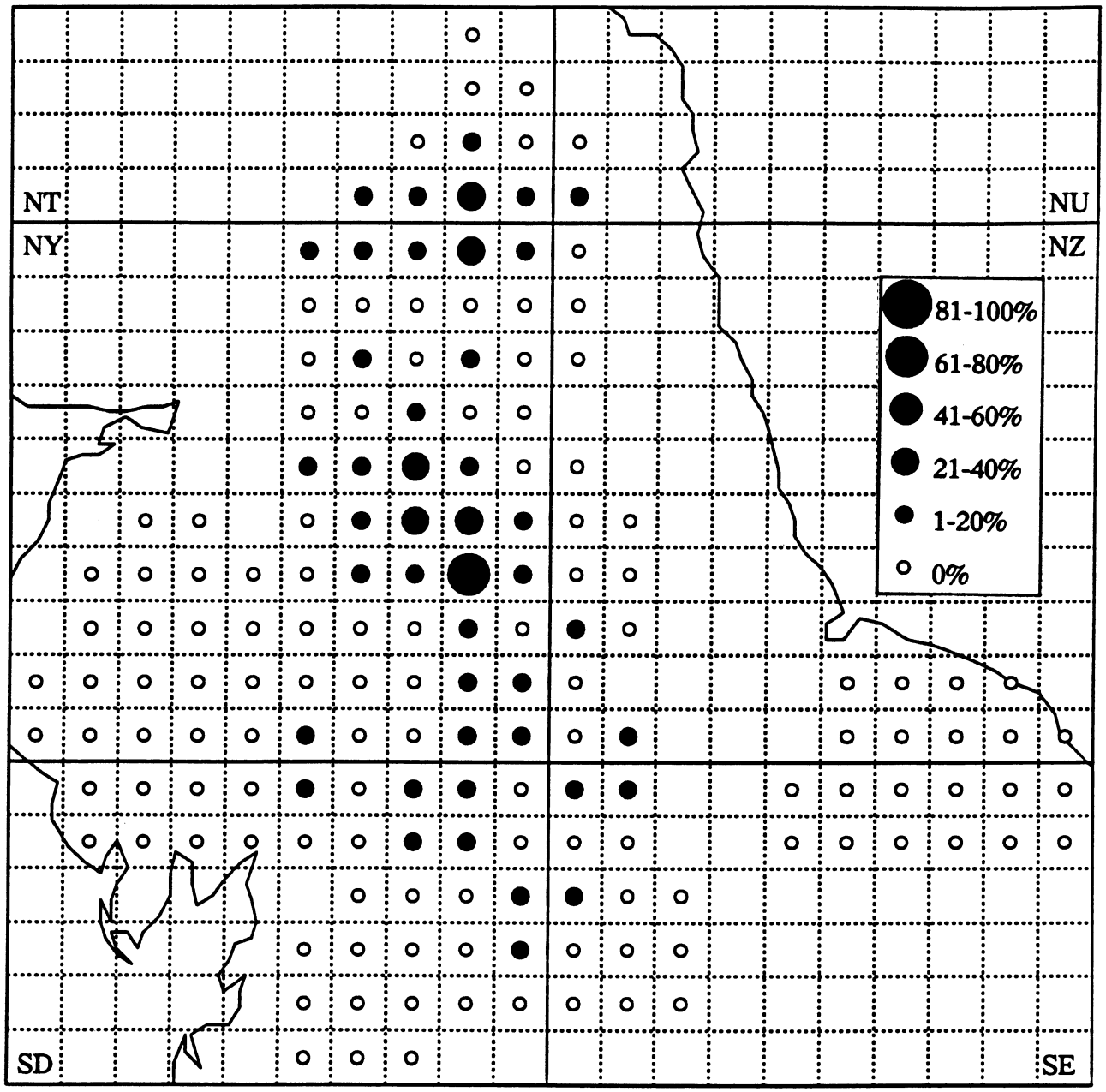
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 7a

The distribution of black grouse in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

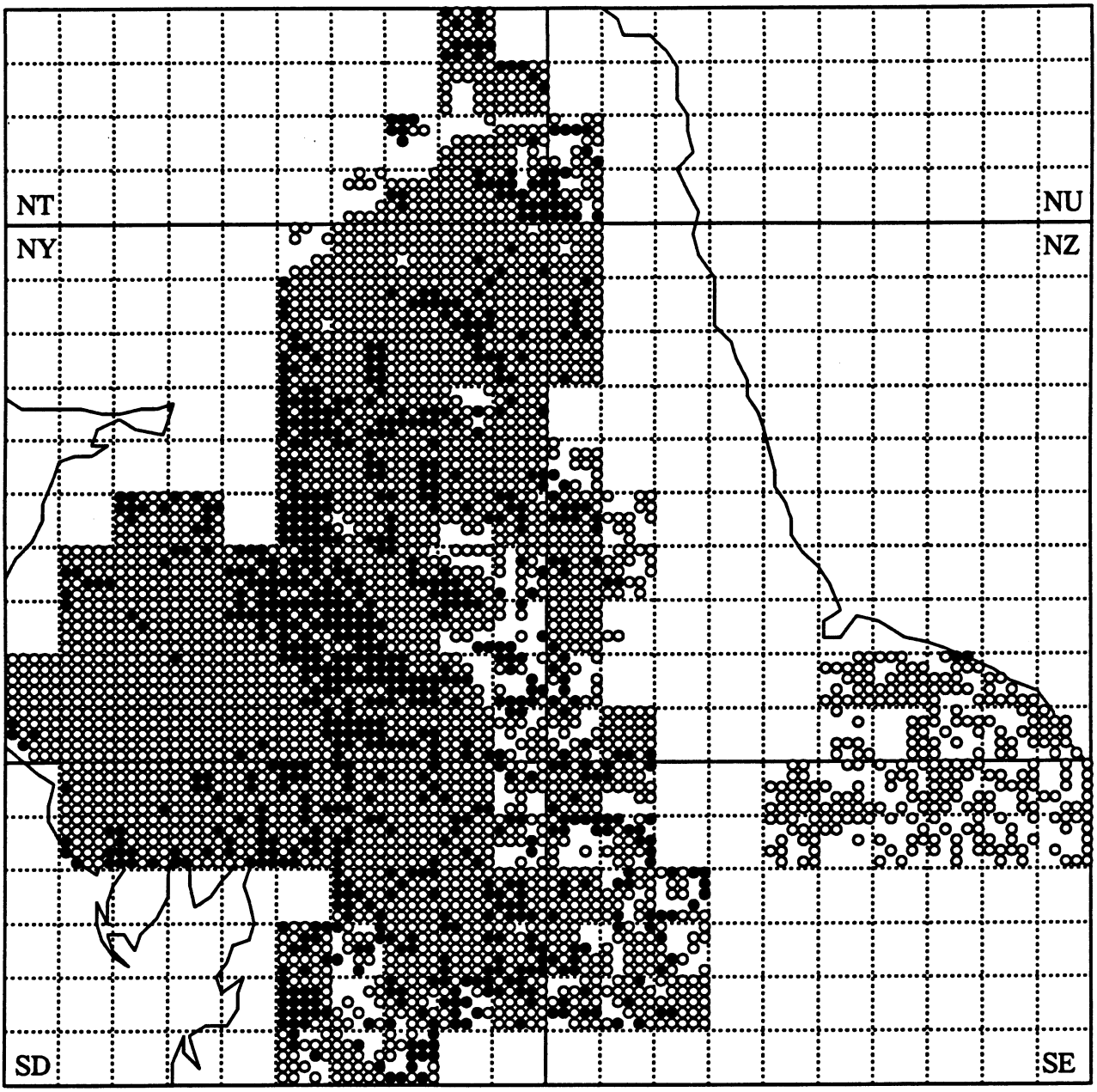
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 7b

The distribution of black grouse in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

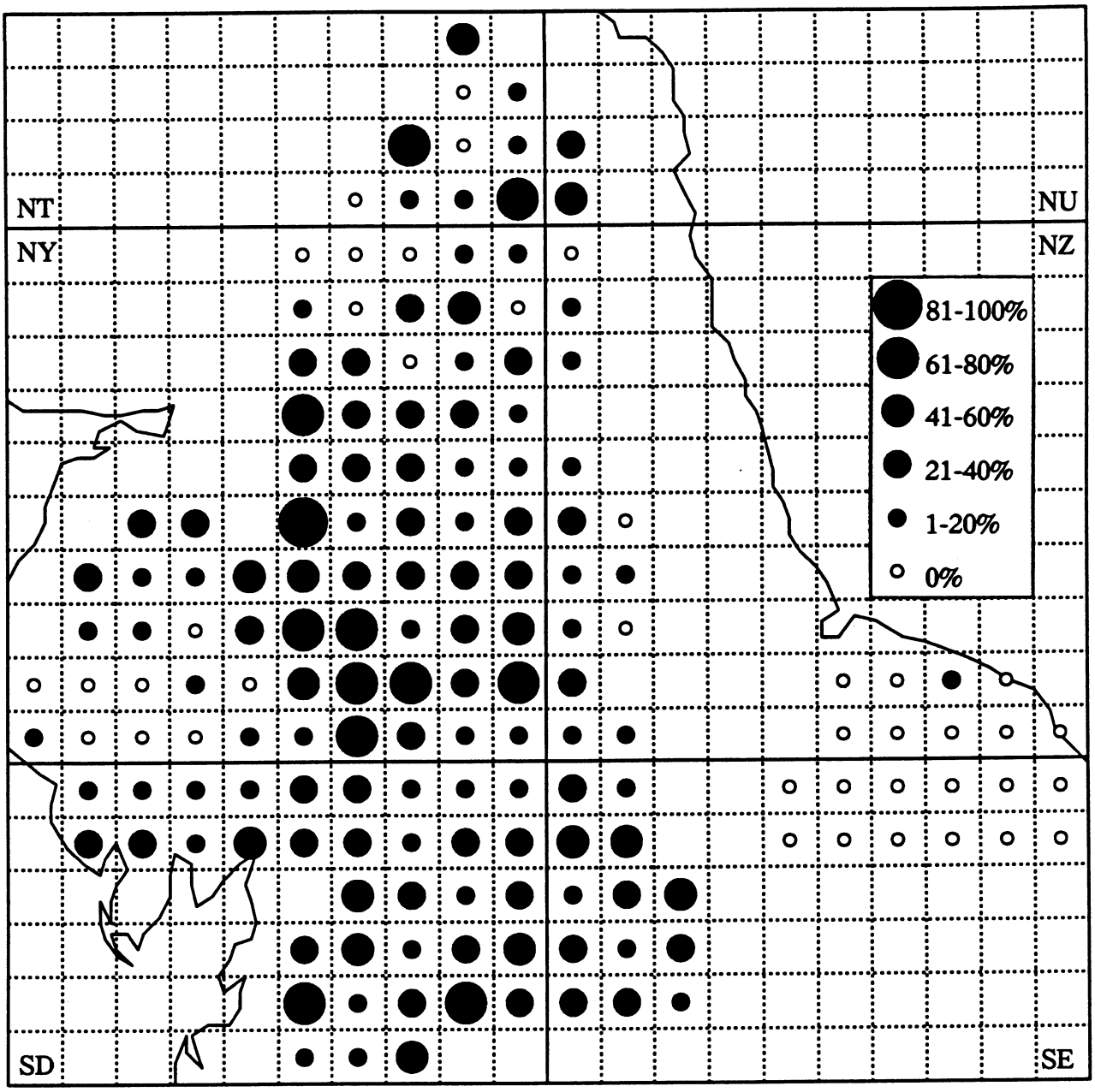
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 8a

The distribution of oystercatcher in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

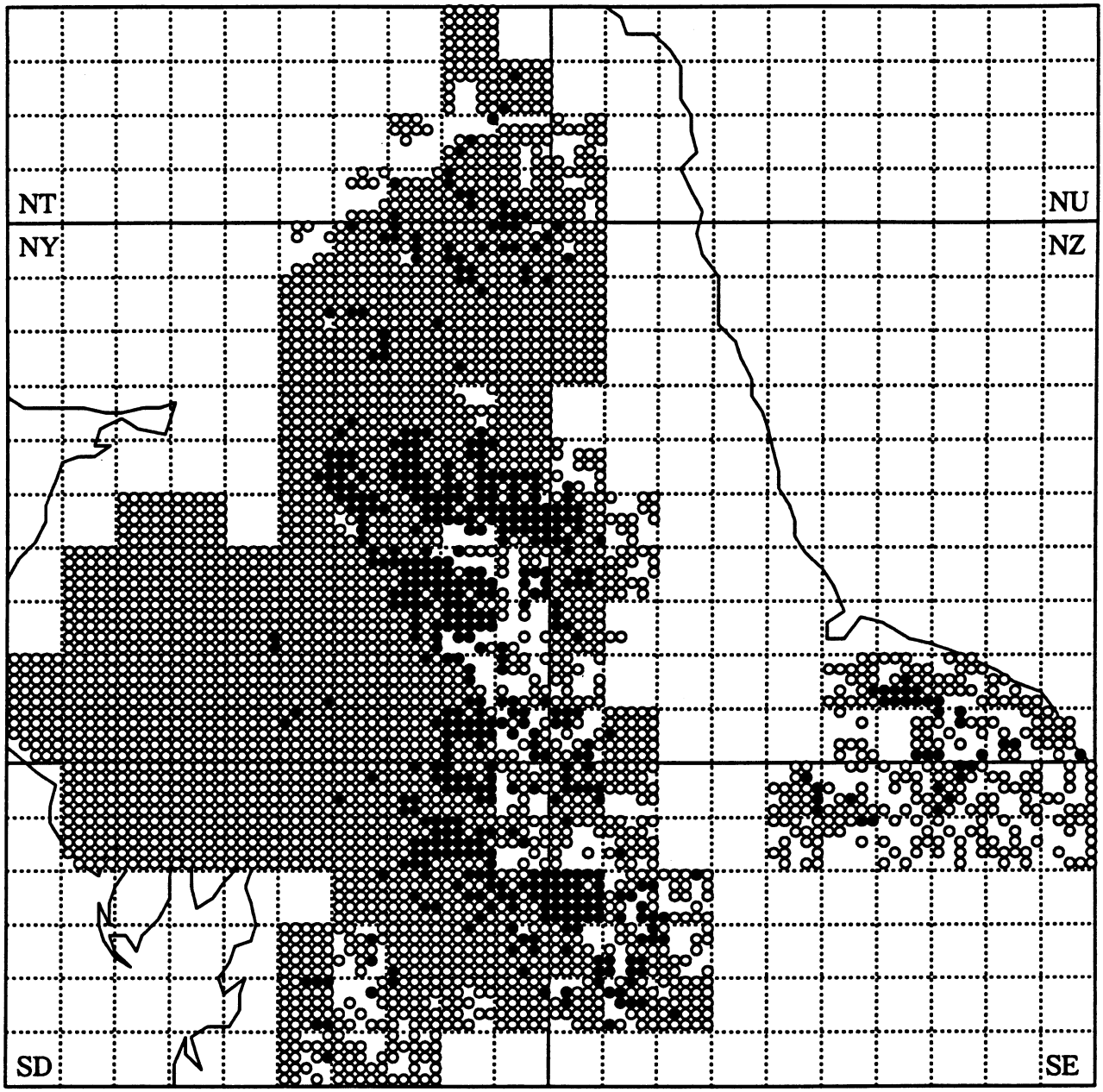
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 8b

The distribution of oystercatcher in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

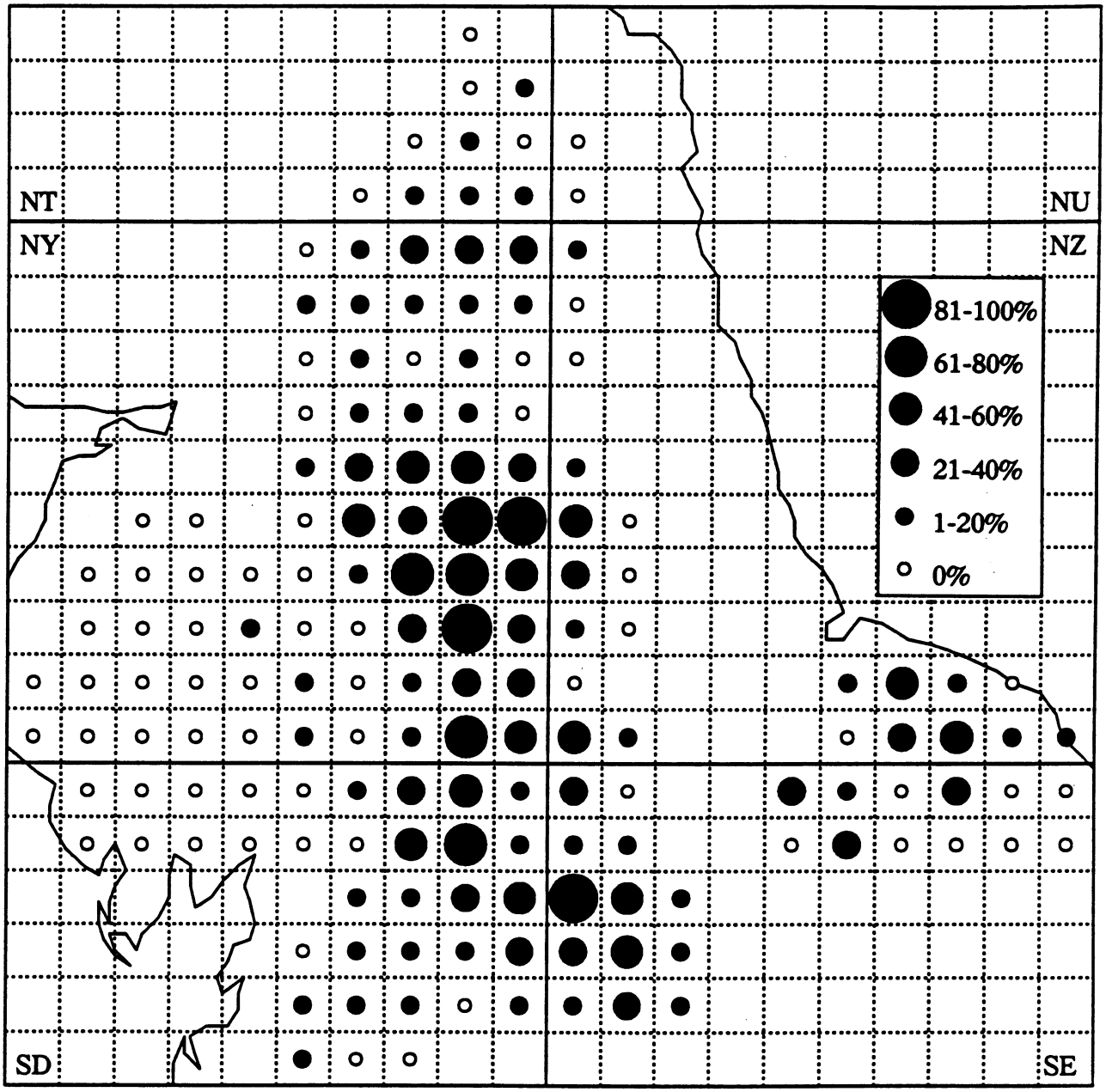
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 9a

The distribution of golden plover in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

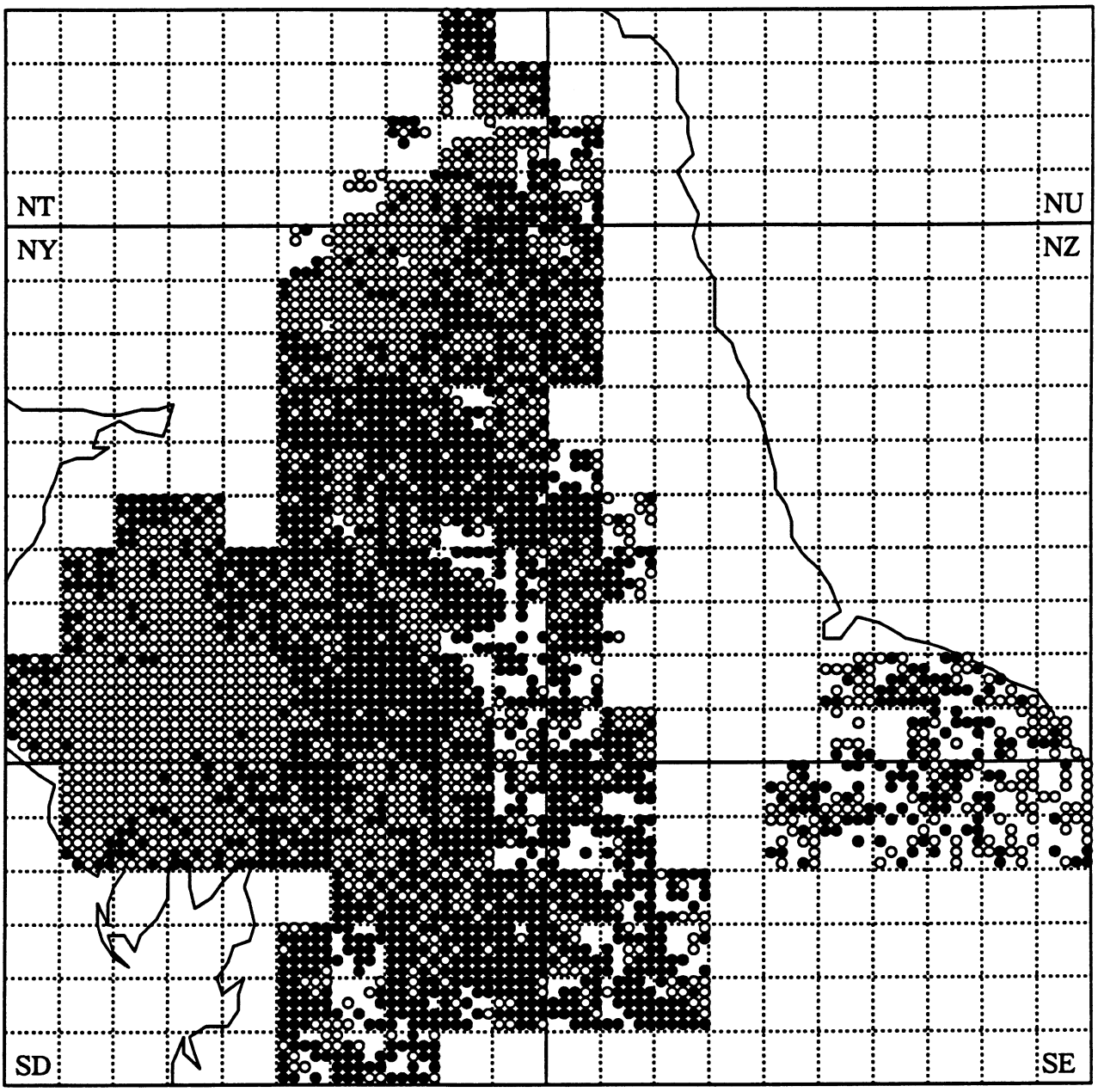
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 9b

The distribution of golden plover in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

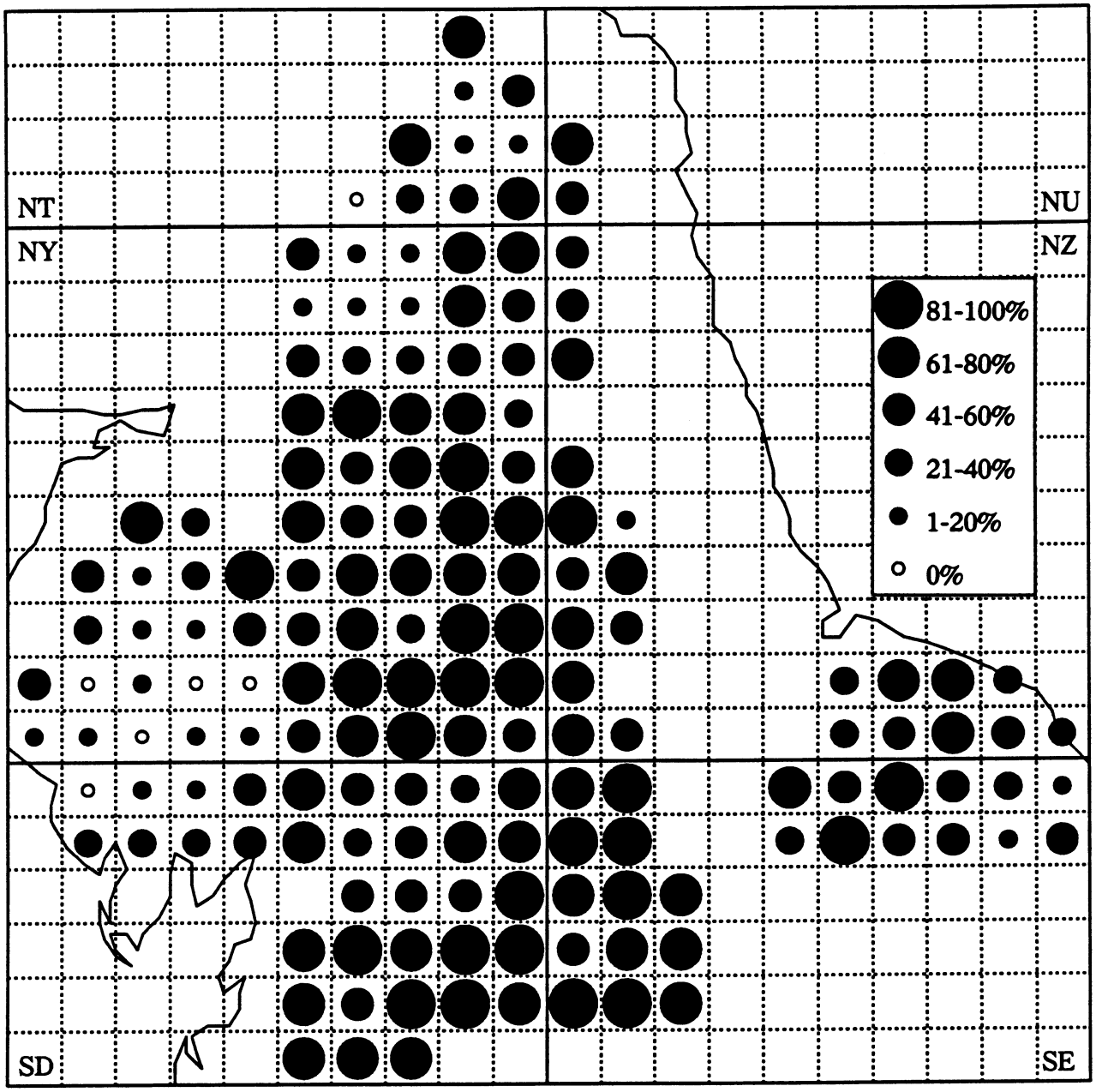
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 10a

The distribution of lapwing in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

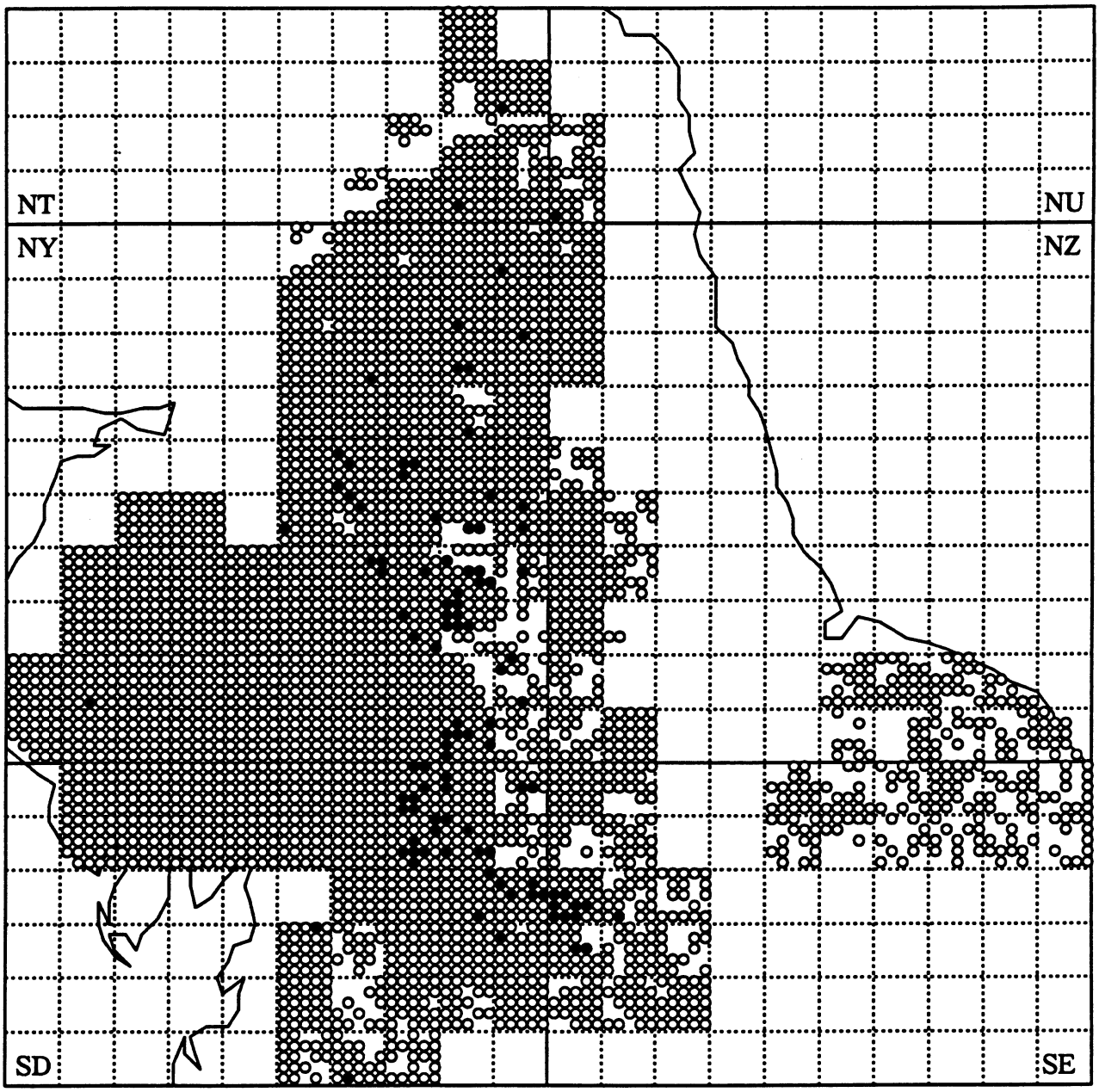
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 10b

The distribution of lapwing in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

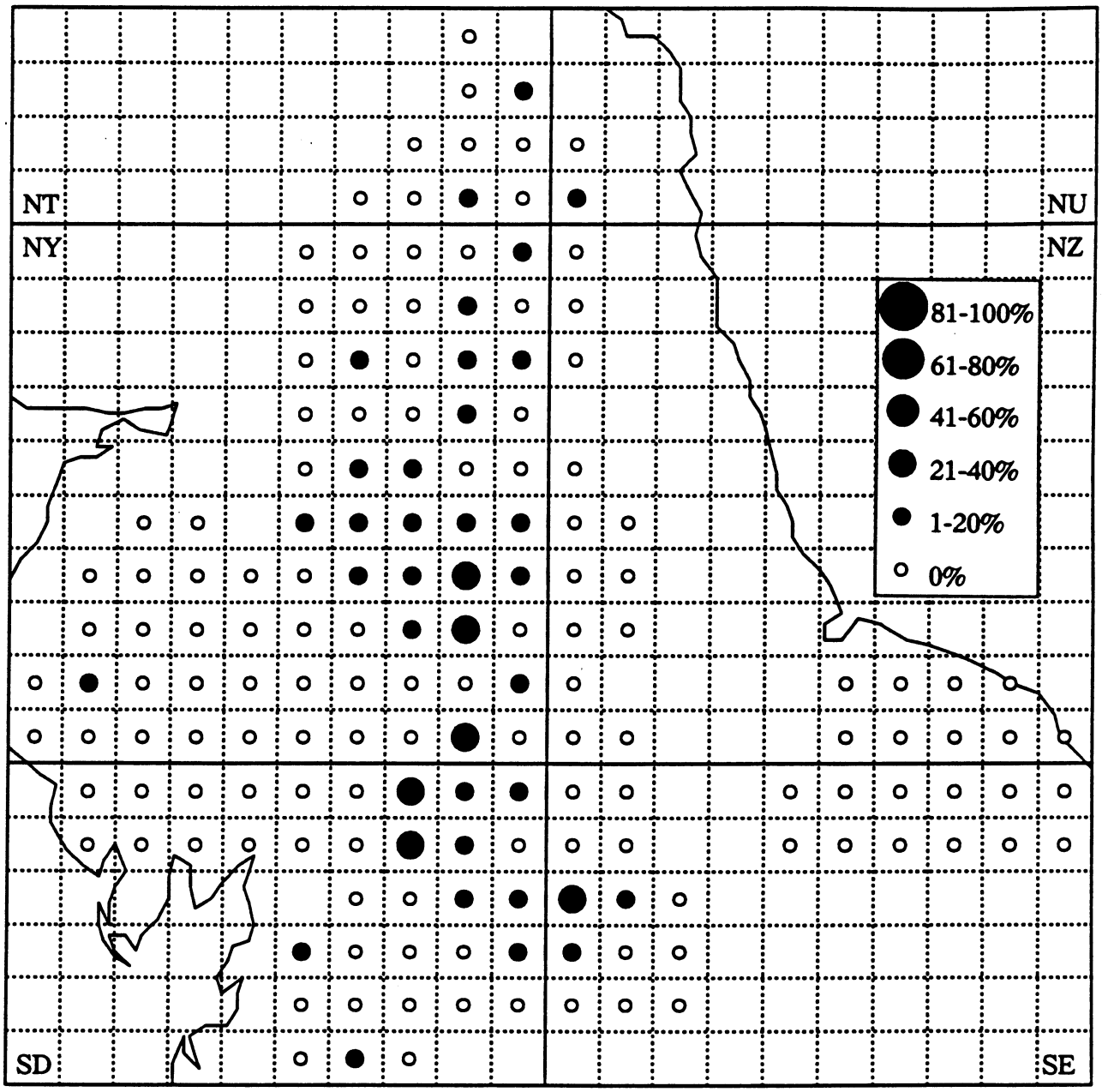
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 11a

The distribution of dunlin in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

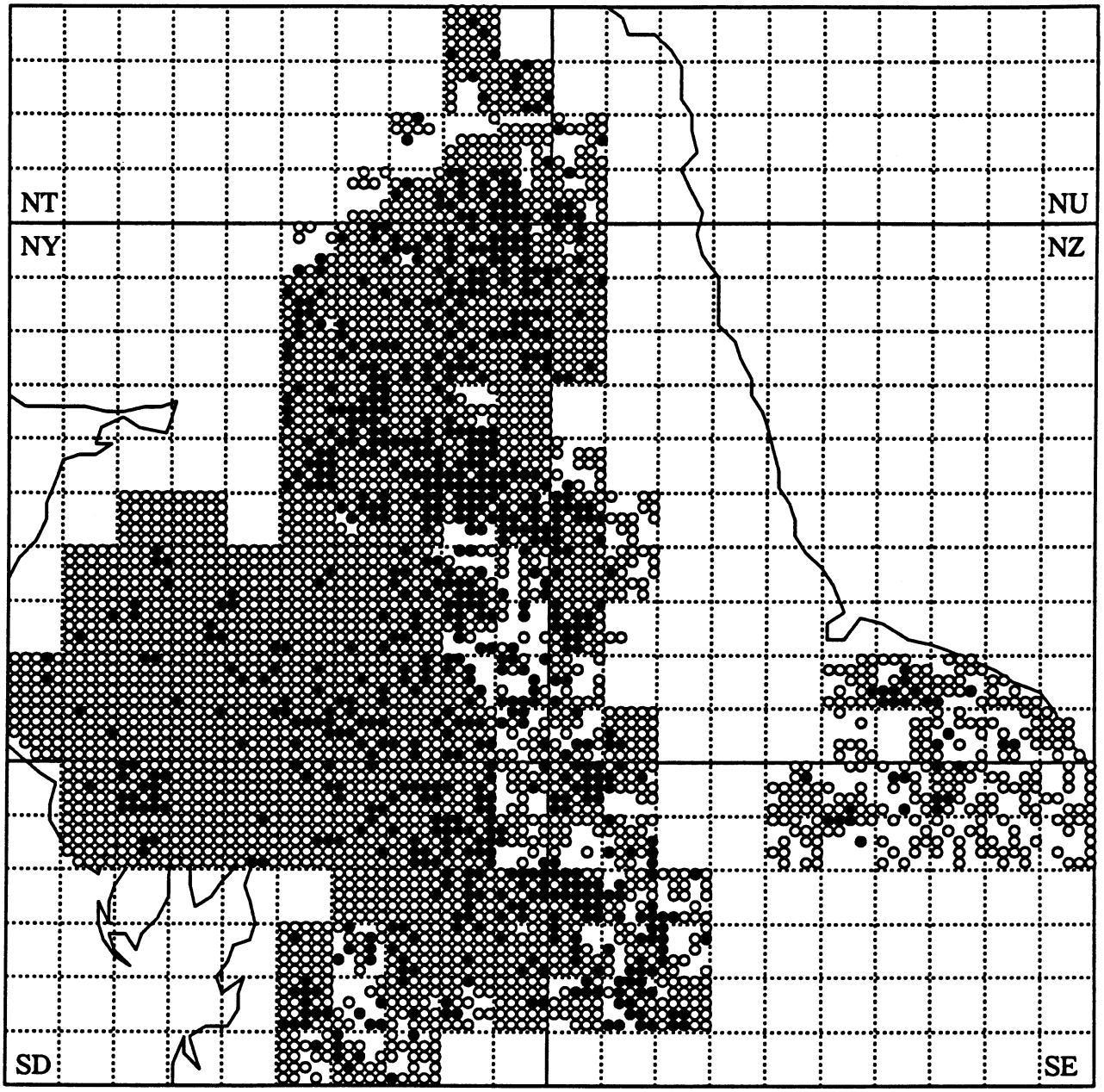
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 11b

The distribution of dunlin in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

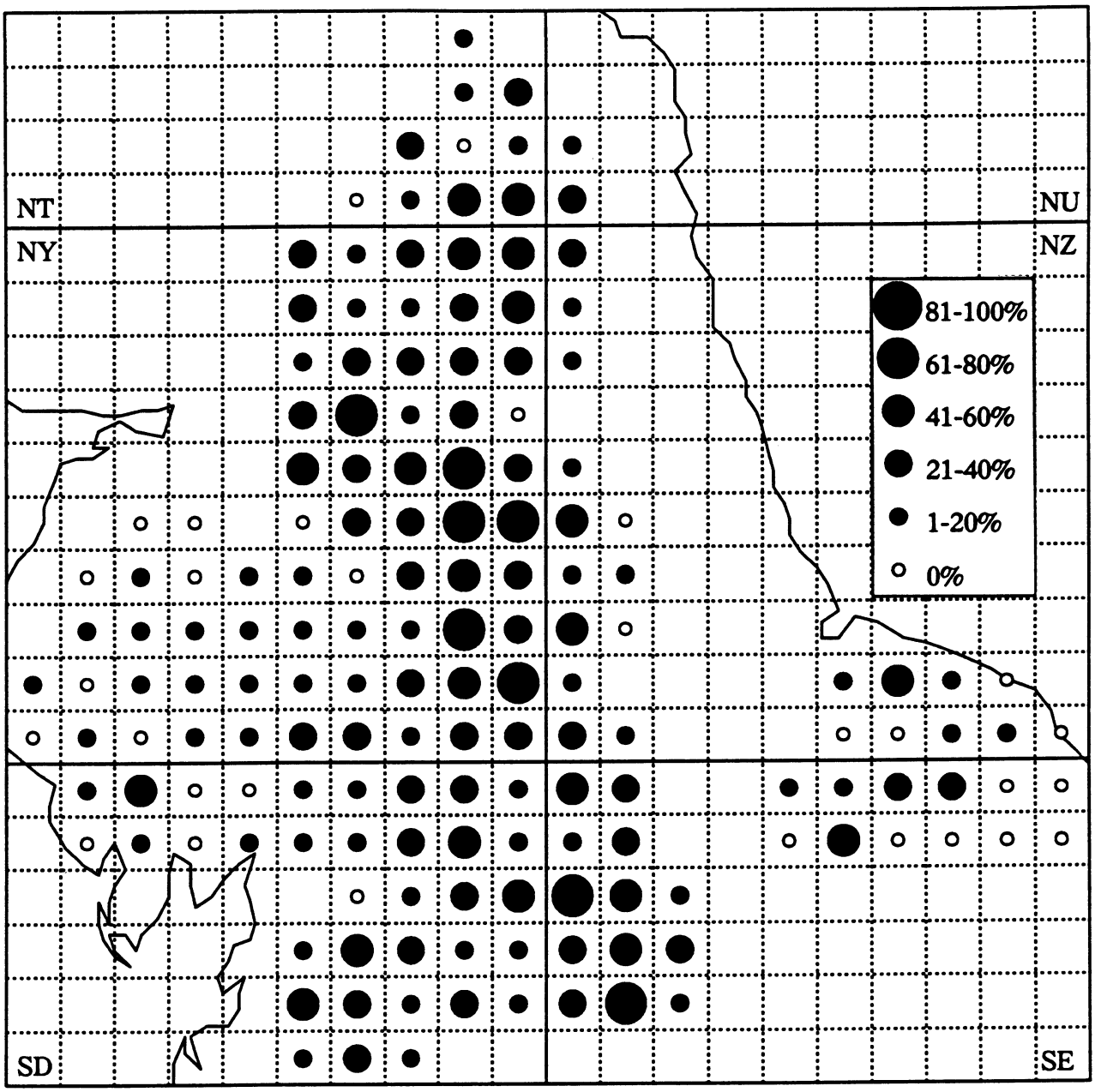
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 12a

The distribution of snipe in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

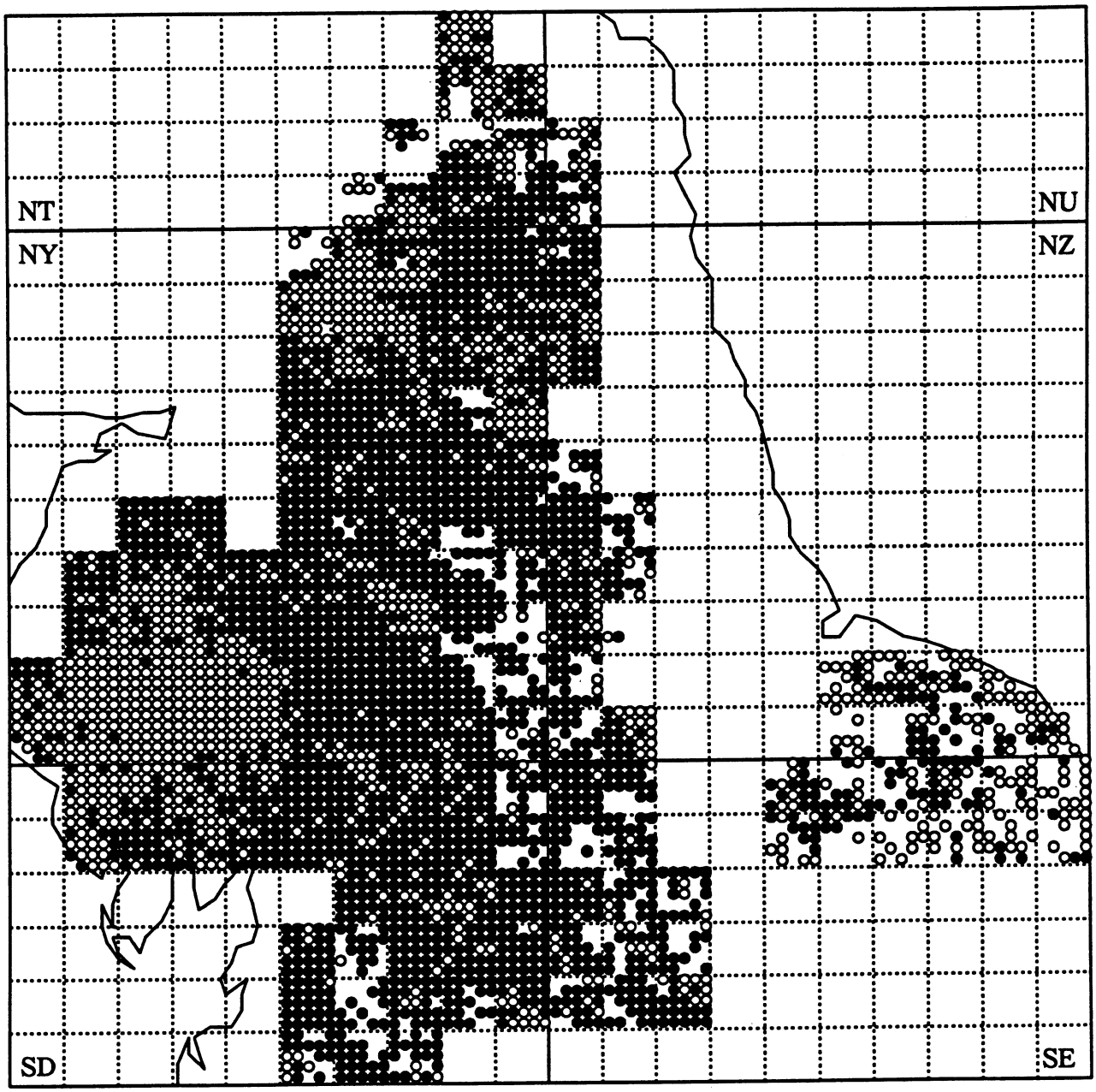
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 12b

The distribution of snipe in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

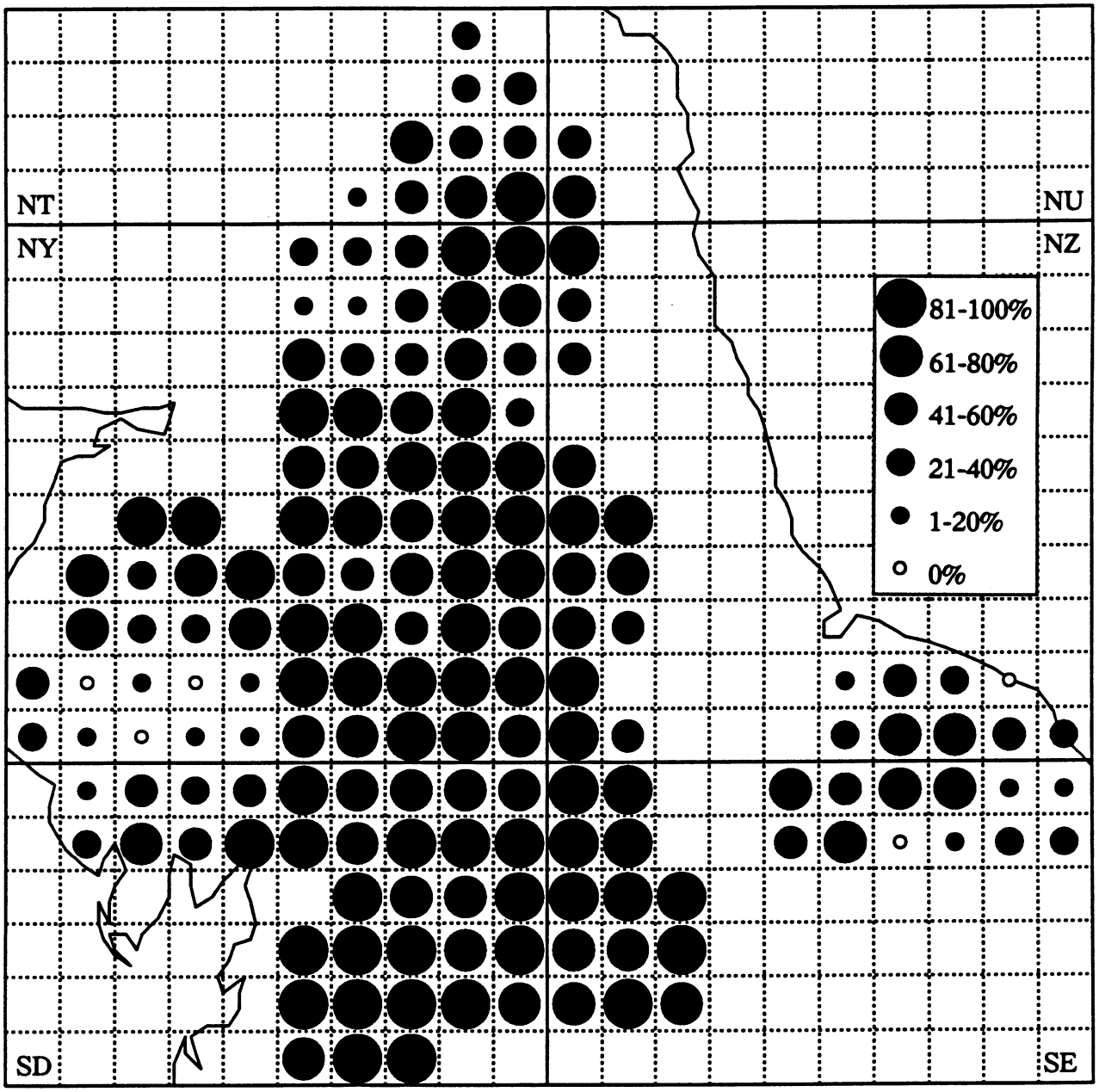
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 13a

The distribution of curlew in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

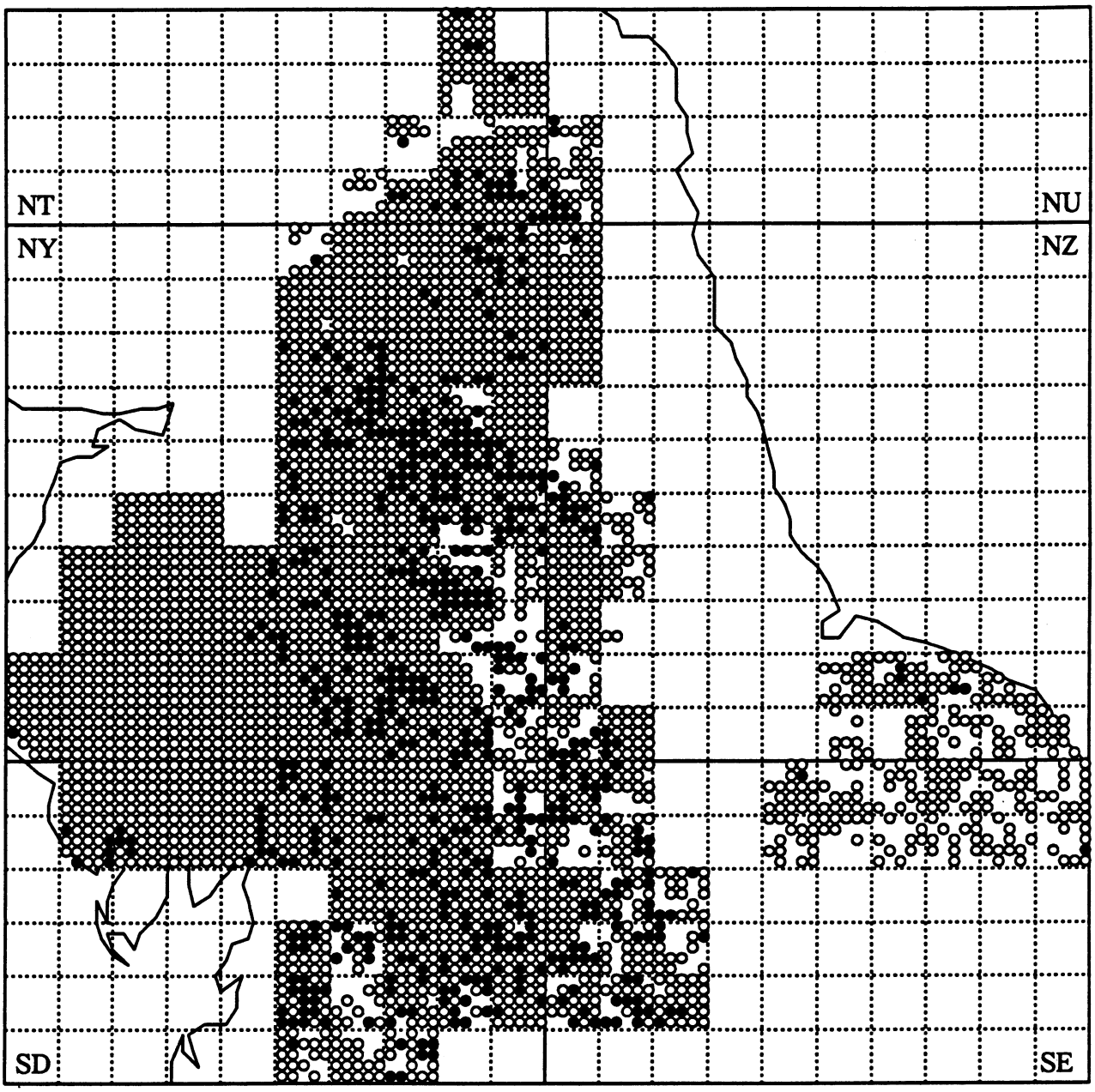
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 13b

The distribution of curlew in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

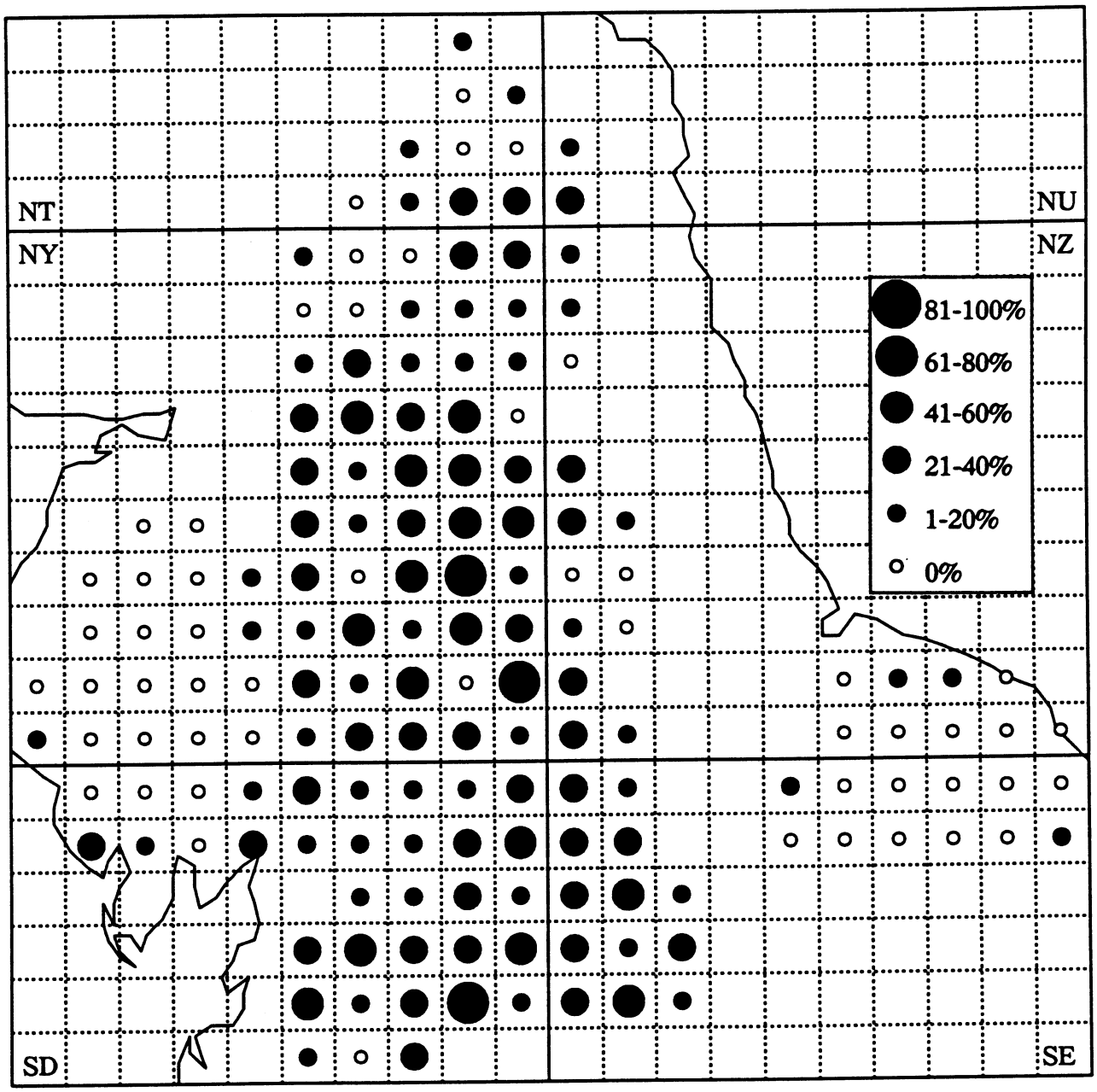
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 14a

The distribution of redshank in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

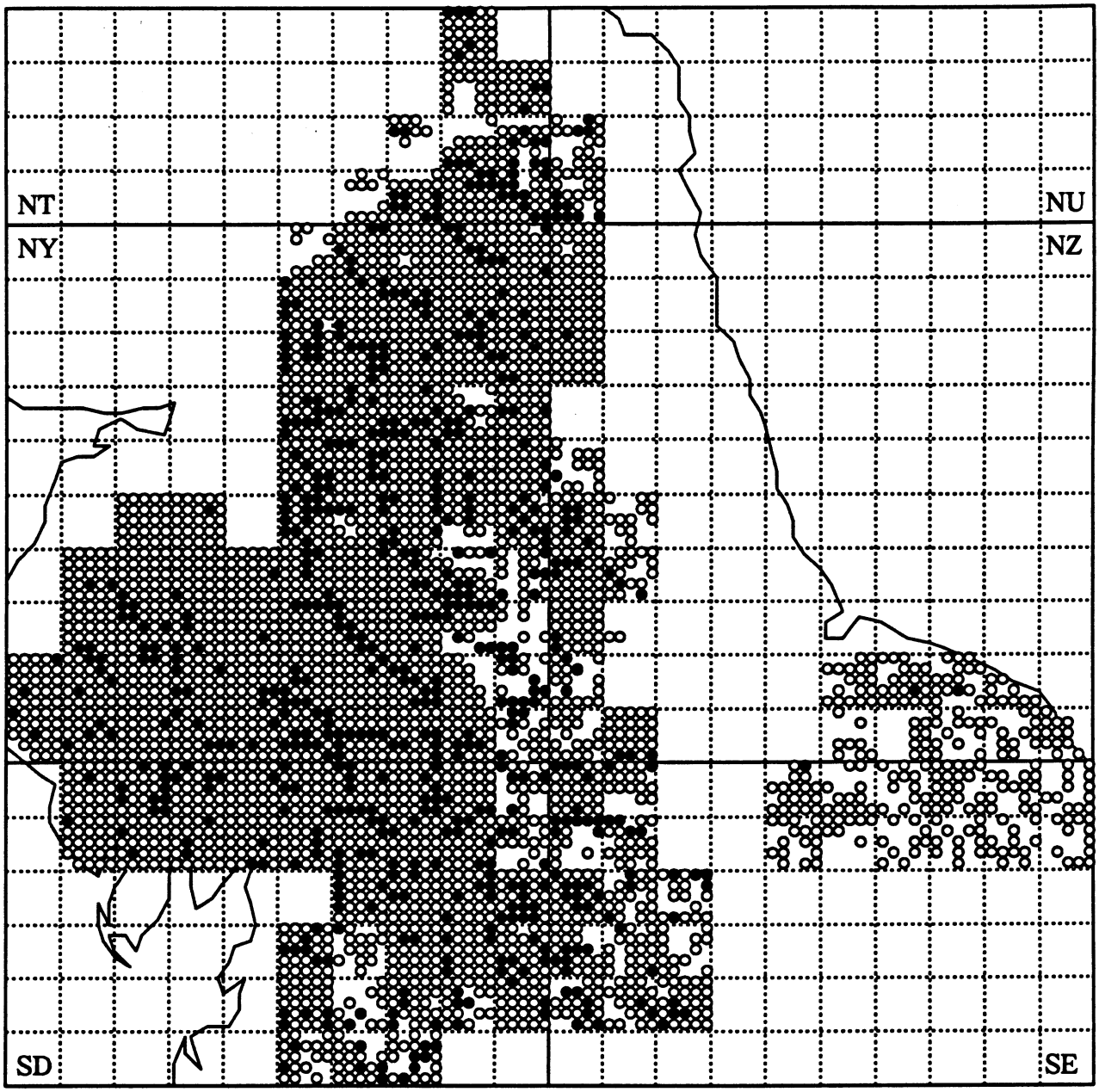
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 14b

The distribution of redshank in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

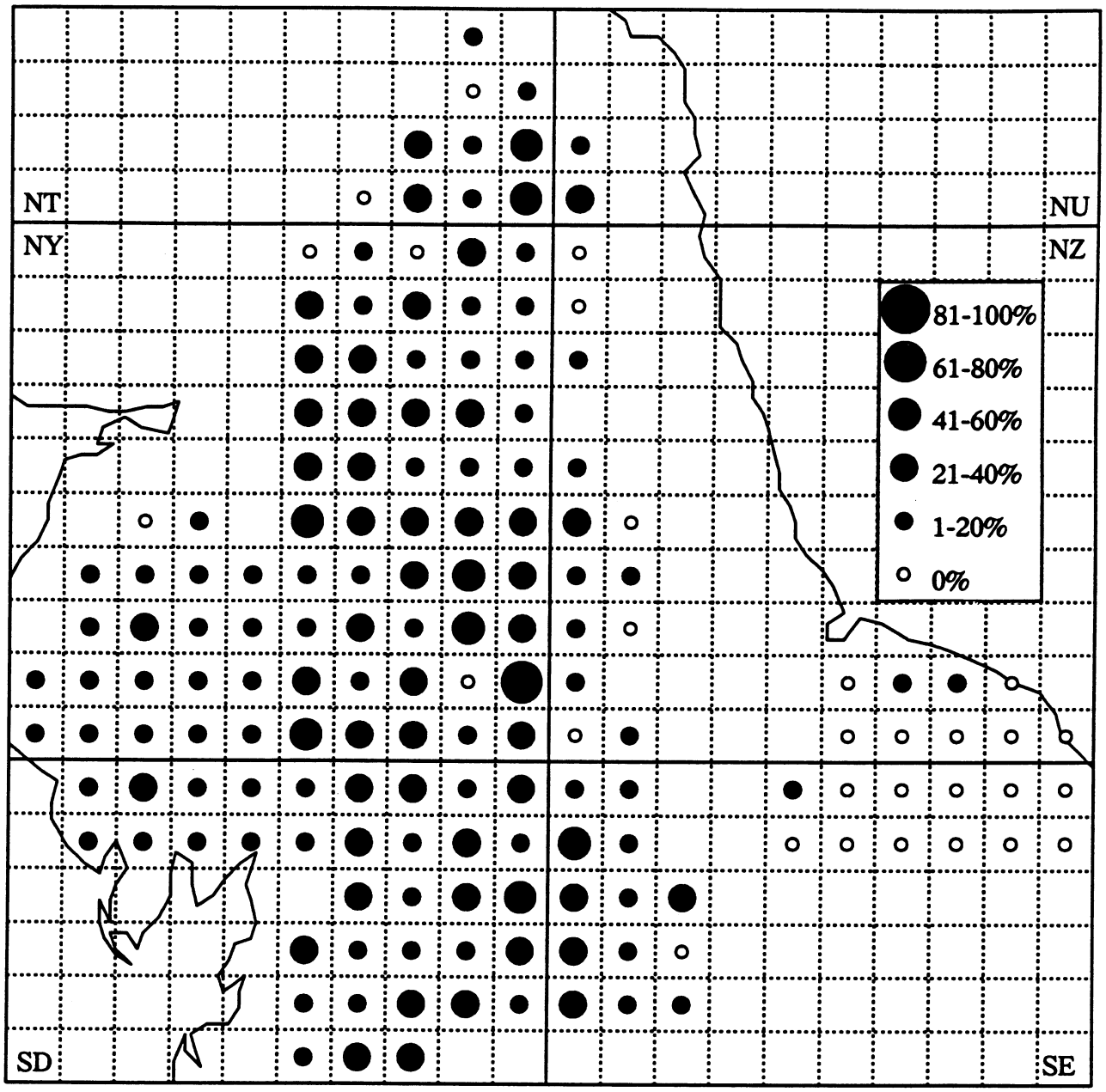
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 15a

The distribution of common sandpiper in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

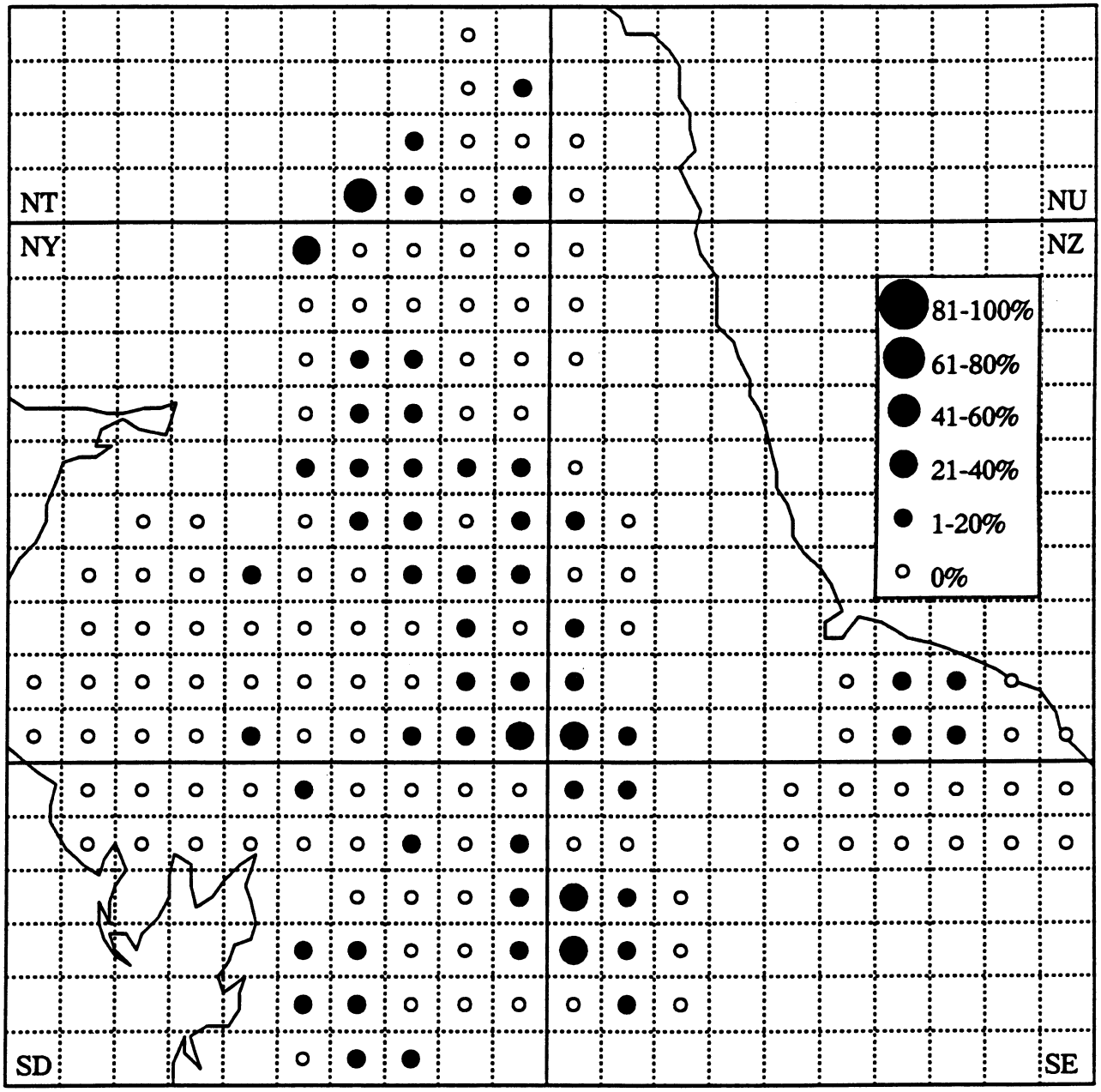
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 15b

The distribution of common sandpiper in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

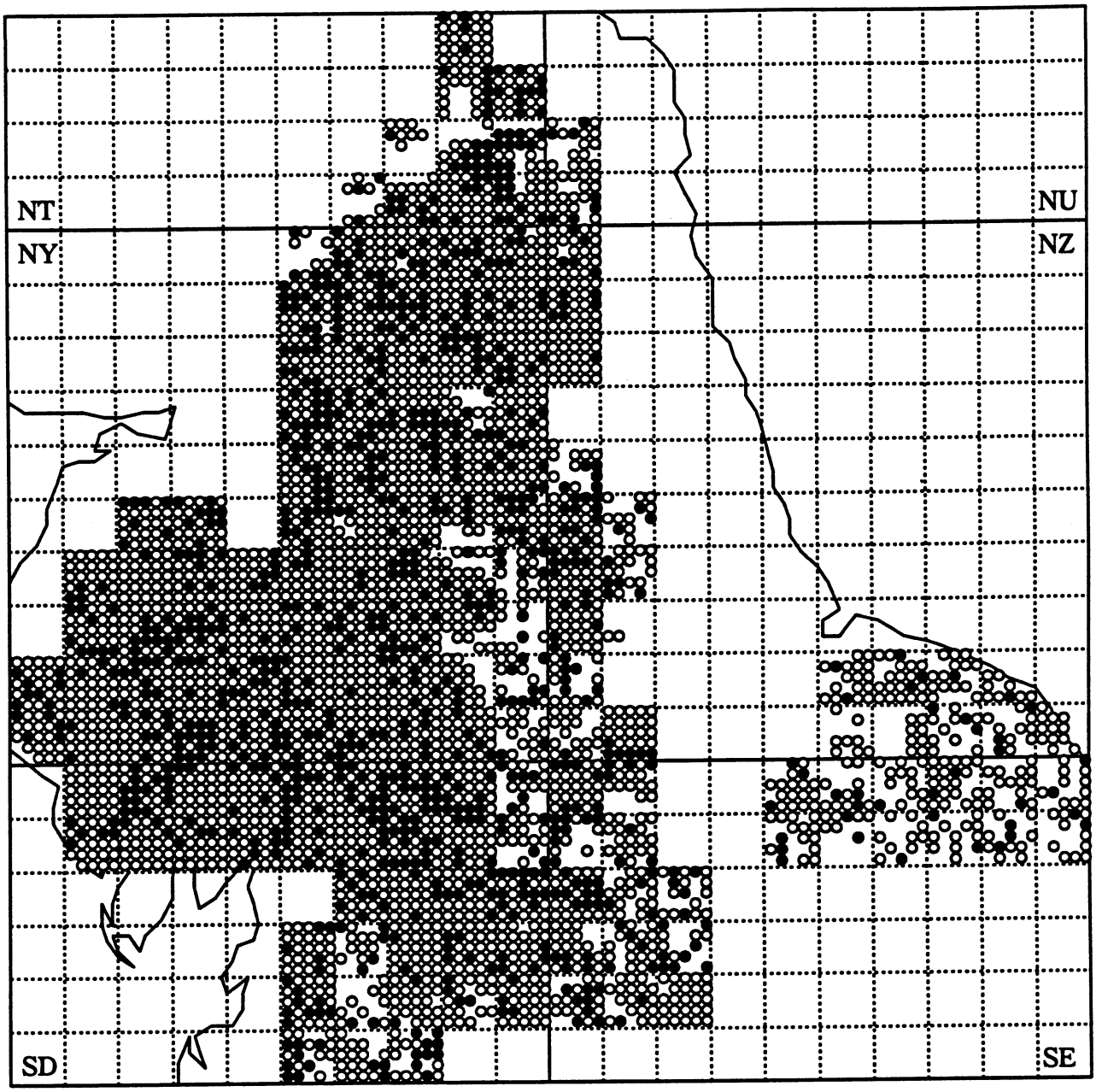
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 16

The distribution of short-eared owl in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

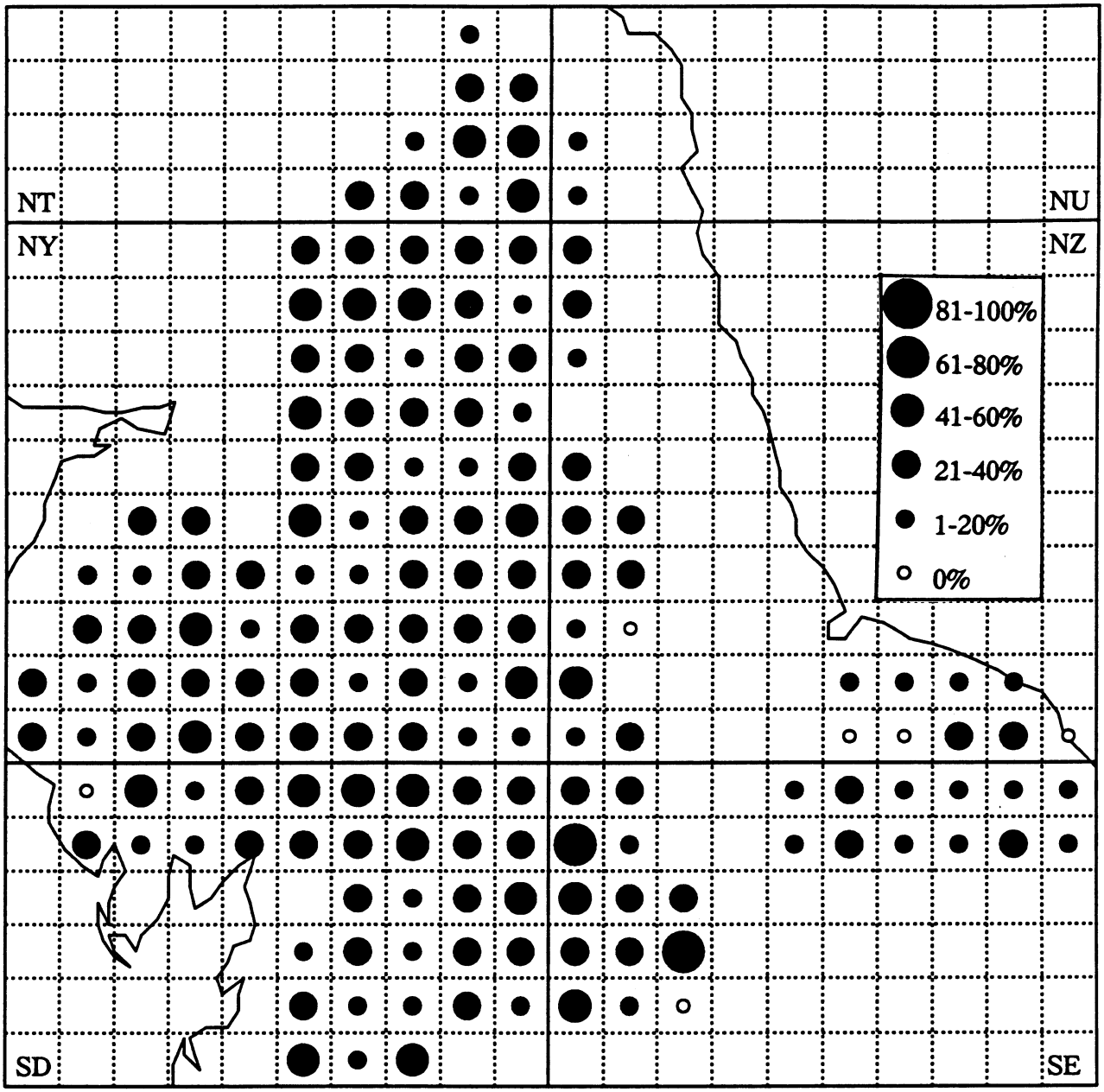
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 17a

The distribution of grey wagtail in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

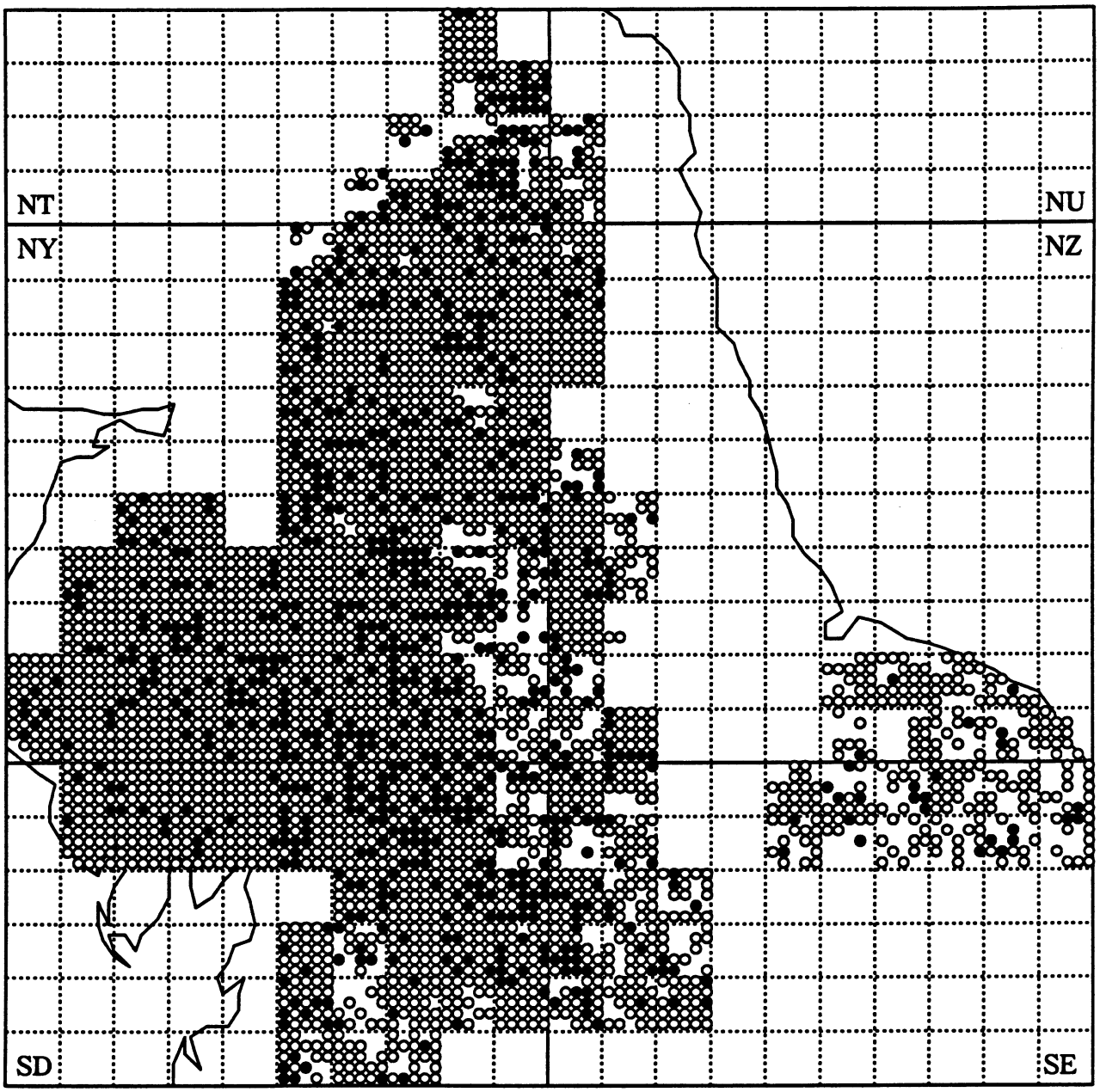
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 17b

The distribution of grey wagtail in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

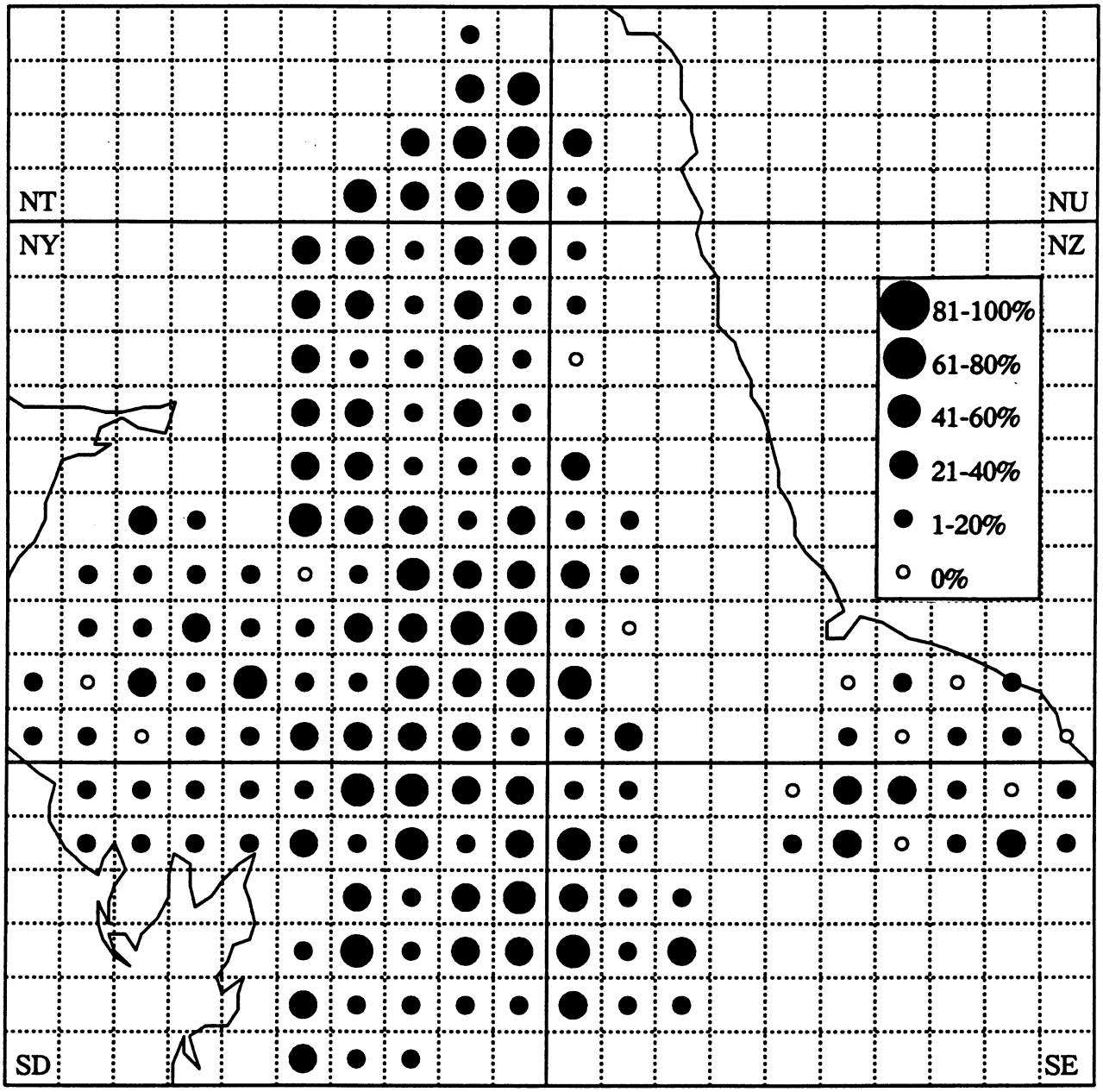
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 18a

The distribution of dipper in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

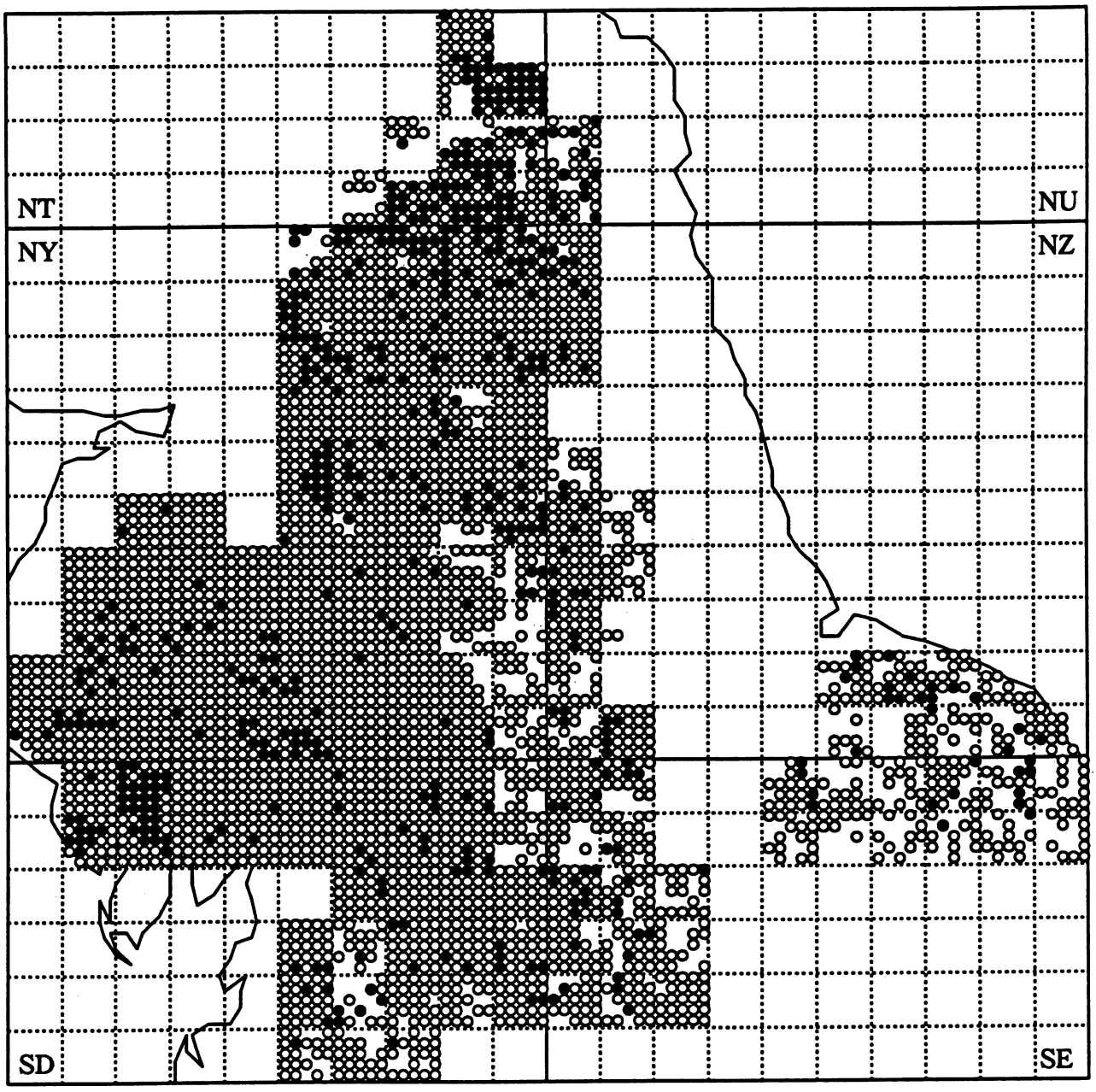
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 18b

The distribution of dipper in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

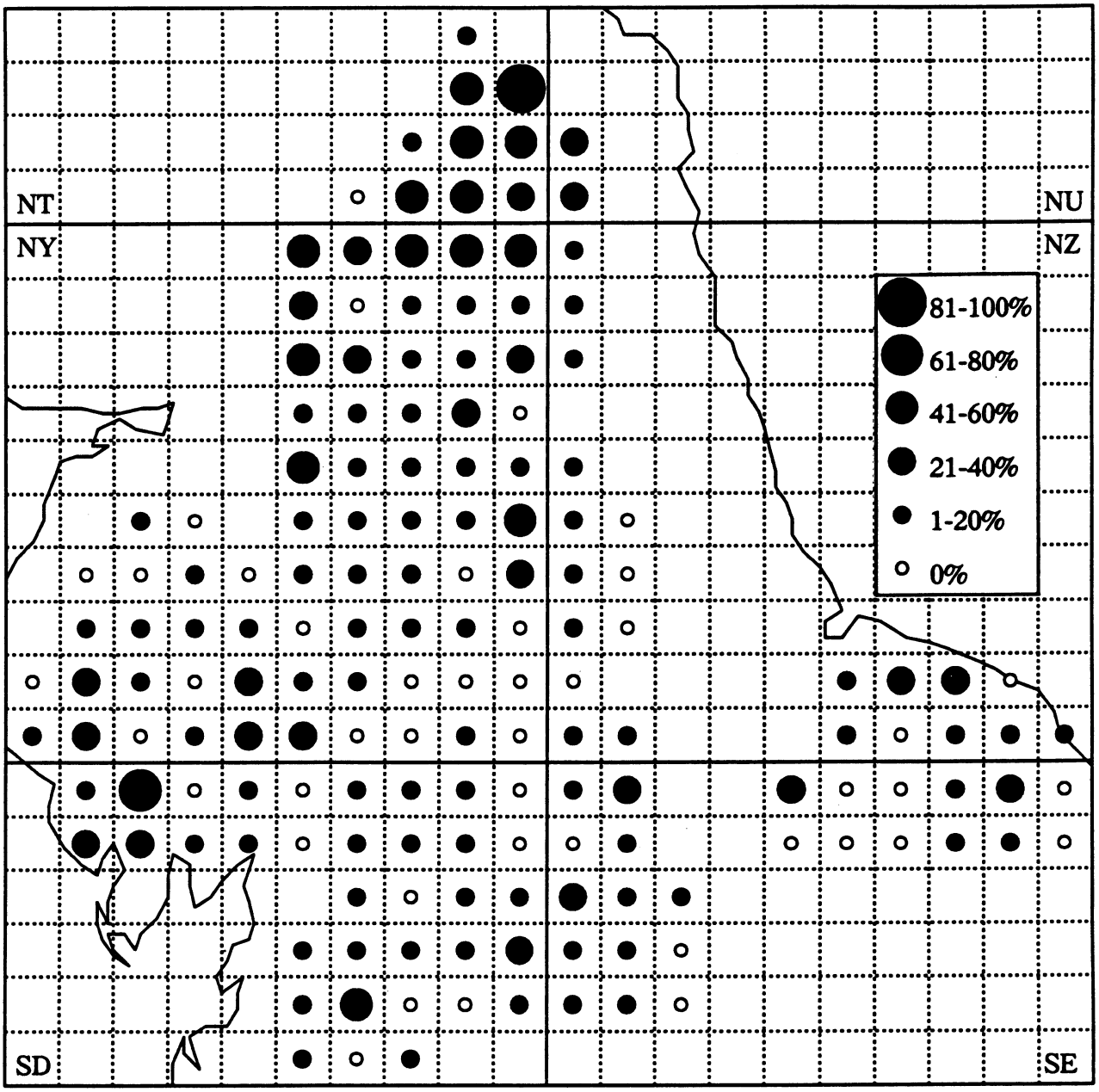
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 19a

The distribution of whinchat in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

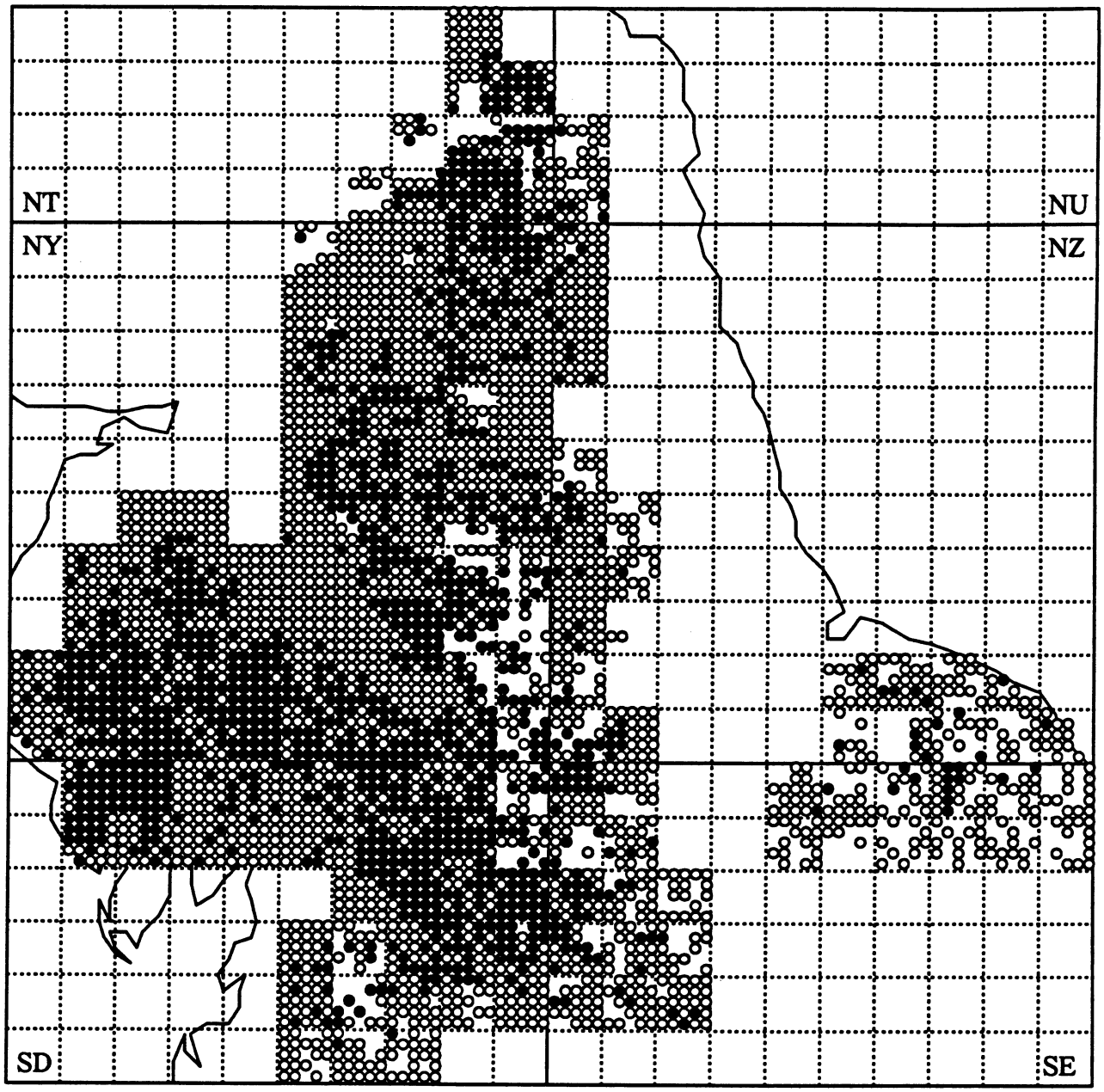
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 19b

The distribution of whinchat in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

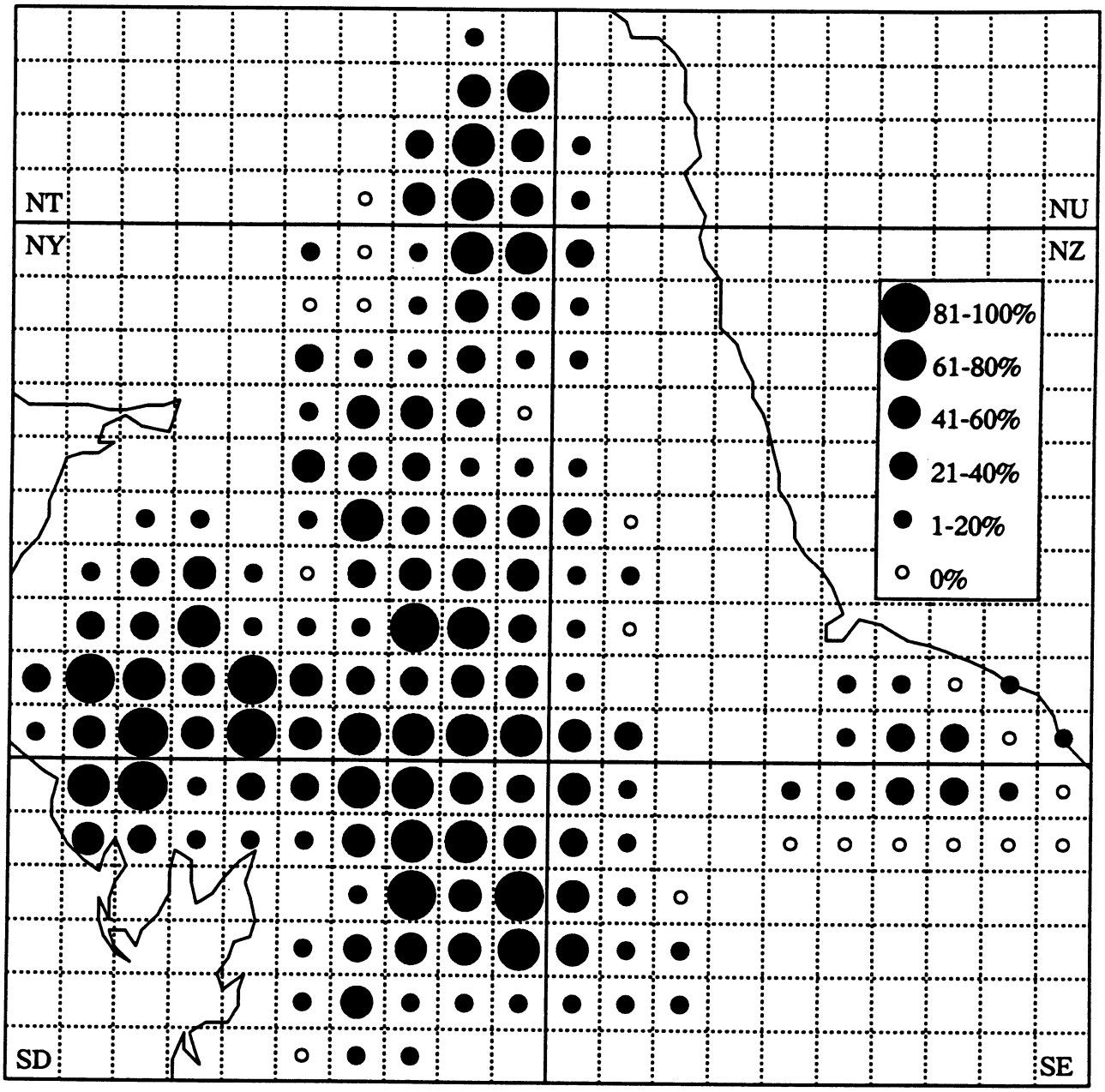
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 20a

The distribution of wheatear in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

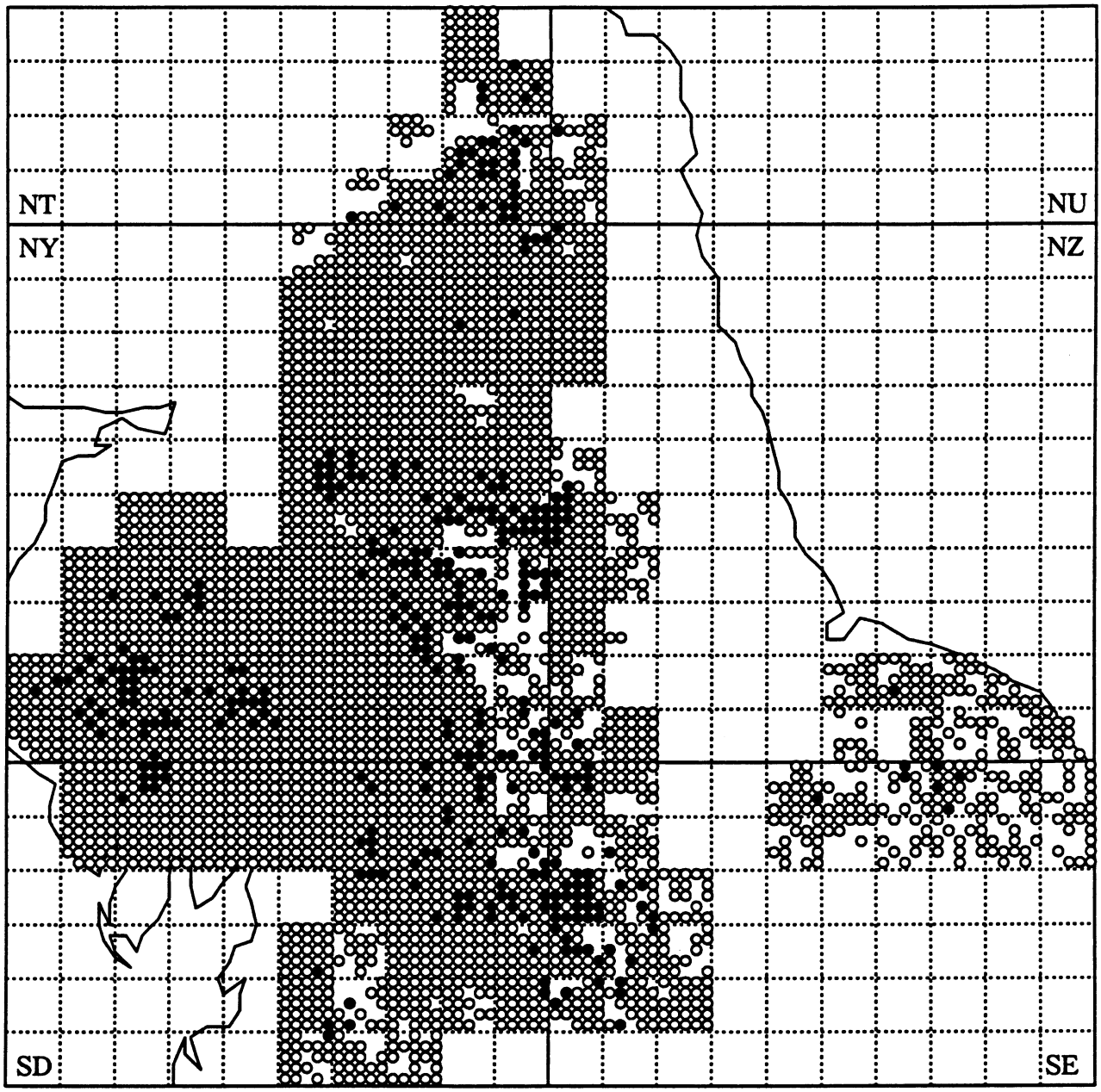
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 20b

The distribution of wheatear in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

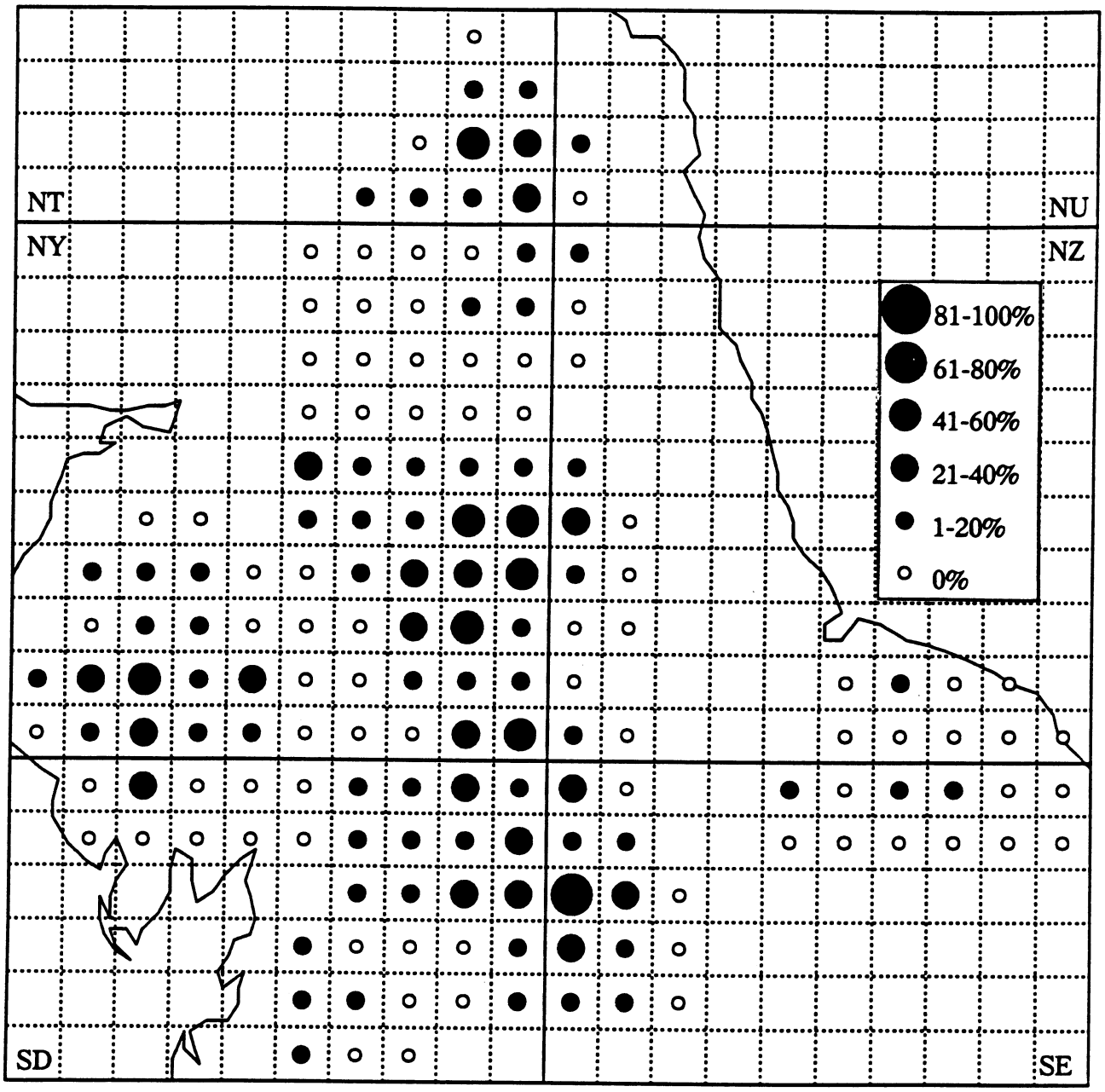
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 21a

The distribution of ring ouzel in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

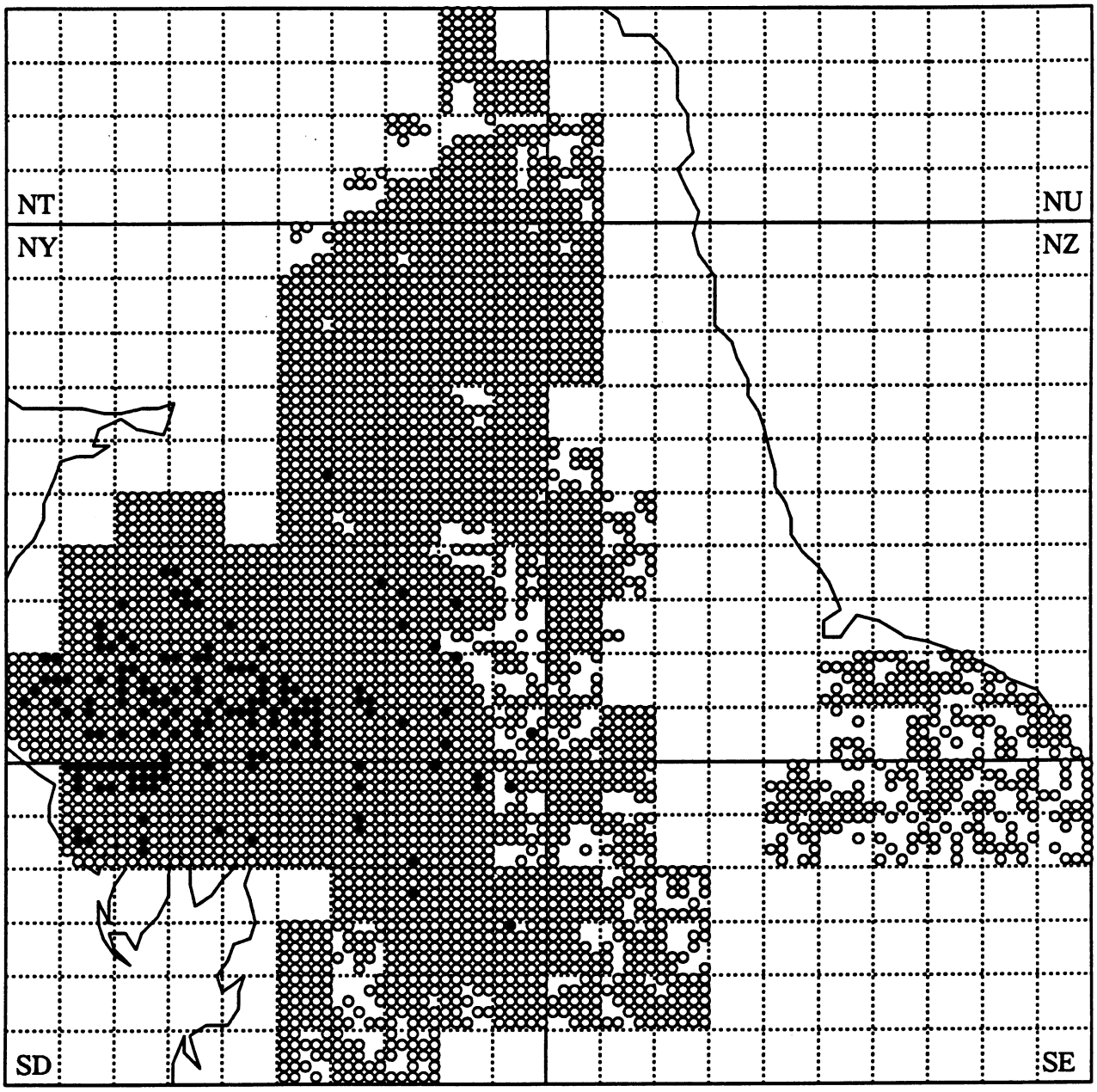
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 21b

The distribution of ring ouzel in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

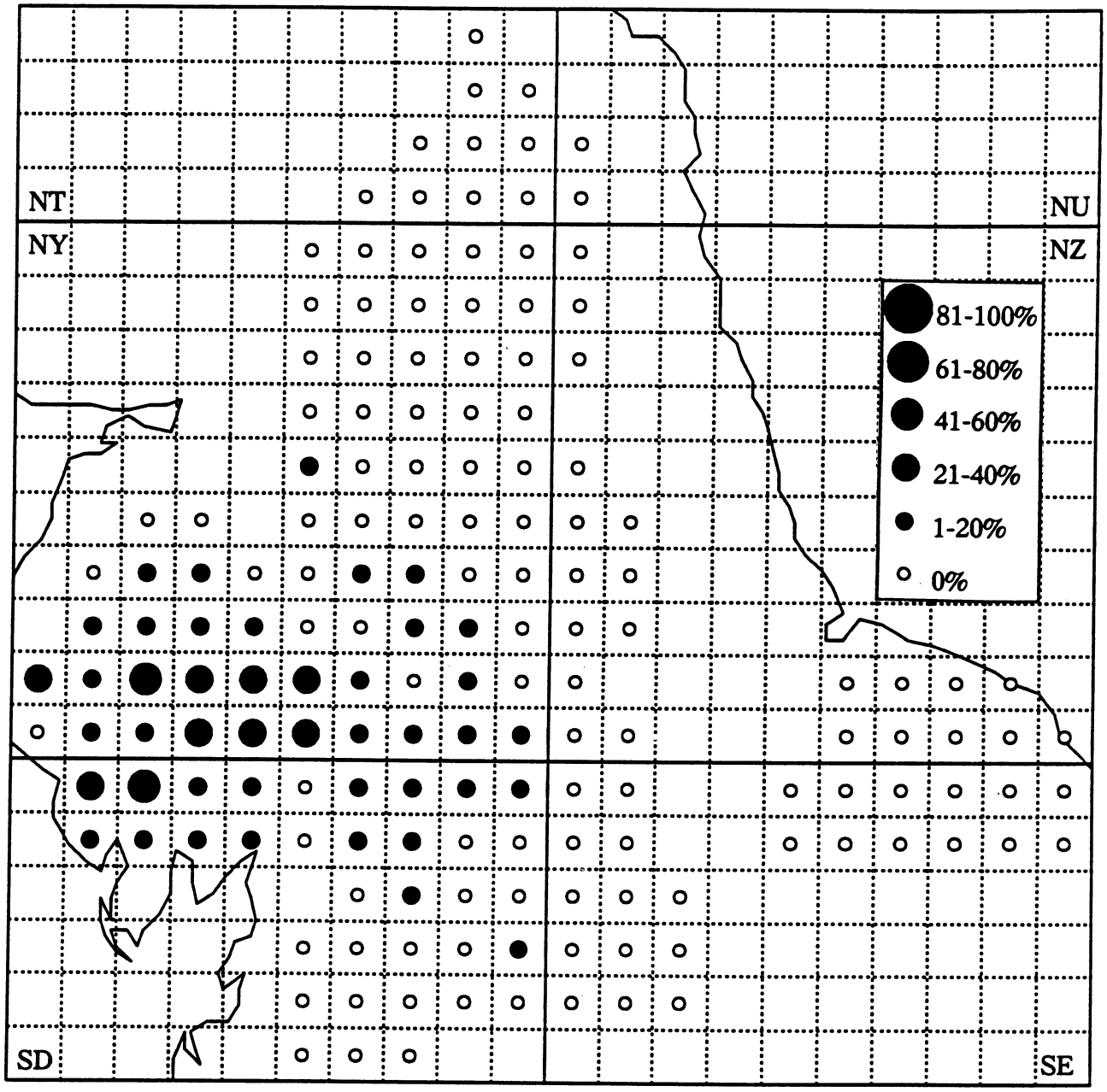
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 22a

The distribution of raven in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

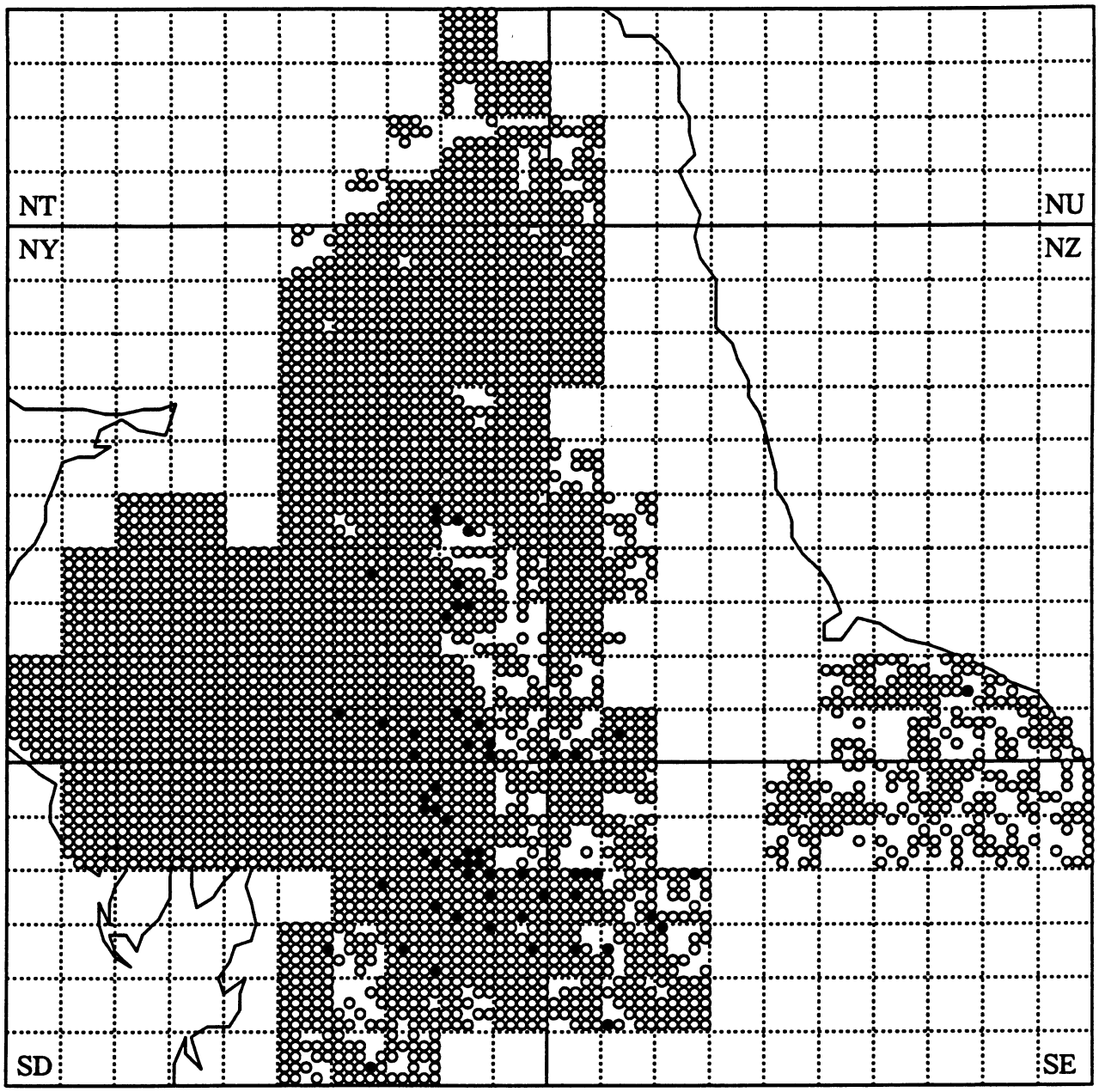
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 22b

The distribution of raven in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

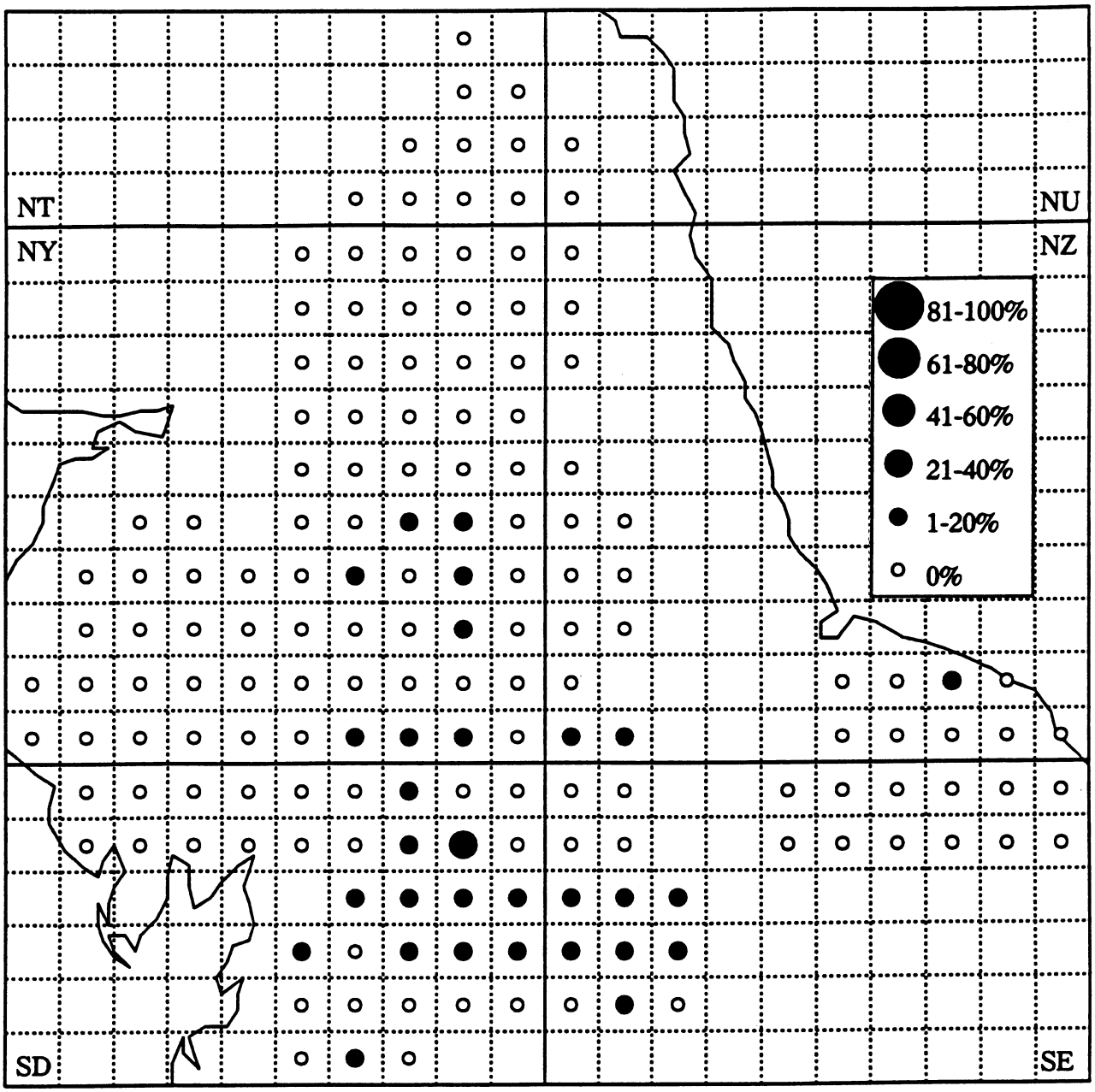
Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 23a

The distribution of twite in the uplands of northern England. Filled circles indicate tetrads where birds seen or bred, open circles indicate surveyed tetrads where birds were not recorded.

Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.



APPENDIX 23b

The distribution of twite in the uplands of northern England, expressed as the percentage of surveyed tetrads occupied per ten kilometre square.

Data from Gibbons et al., 1993, New Atlas of Breeding Birds in Britain and Ireland.