Ornis Fennica 71:102–108. 1994

# Reliability of the mapping method for censusing Blue Tits *Parus caeruleus*

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*Received 8 April 1994, accepted 27 July 1994*

The bird assemblage of the 30-ha mature oak forest in Moscow was censused by the mapping method during the period from 1 April to 30 June 1993. Special attention was paid to obtaining simultaneous records of singing birds. In a 12.2-ha part of the forest, the actual number and distribution of territories of the Blue Tit was studied by mapping the positions of individually marked birds and nest-searching. The total number of territories evaluated in the 12.2-ha study plot, on the basis of mapping censuses, was 22. The actual number of territories was the same (22–22.5). Six "paper territories" coincided fairly well with the respective actual territories. For seven more "paper territories", it was possible to find counterparts among the actual territories. One actual territory covered the two "paper territories", and one of the "paper territories" seemed to combine the two actual ones. Registering the calling birds seemed to provide useful additional information for evaluating the species map. There was no evidence that female singing interfered with the census work.

## 1. Introduction

The mapping method (Williams 1936, Enemar 1959, Pinowski & Williamson 1974, Tomiałojć 1980) is considered to be the most accurate technique to census territorial birds in the breeding season. As with any sampling technique, however, the method has some serious shortcomings (see Ralph & Scott 1981, Verner 1985, Verner & Milne 1990 for a review). The low accuracy of the standard version of the mapping method was demonstrated in some studies (Bell et al. 1973, Jensen 1974, Diehl 1974, Mannes & Alpers 1975, Mackowicz 1977, Nilsson 1977). It was suggested to be mainly the result of insufficient attention to collecting registers of simultaneously singing males, and/or extremely dense vegetation preventing penetration without flushing the birds (Tomiałojć 1980). Tomiałojć (1980) proposed the combination of improvements that now is widely known as the combined version of the mapping method. More recent tests showed nearly 100% accuracy in censusing several species of *Phylloscopus* warblers and some other passerines (Enemar et al. 1979, Tomiałojć 1980, Tiainen & Bastian 1983, Paut & Roth 1983, Borowiec & Ranoszek 1984, Hogstad 1984). However, special attention to collecting registers of simultaneously singing birds during field work does not eliminate considerable variation among analysts, especially if some analysts have no field knowledge about the study plot and its bird population (Morozov 1994).

Among European forest birds, tits *Parus* spp. were reported to be difficult to census by the standard version of the mapping method, especially if their population densities are high (Mannes & Alpers 1975, Nilsson 1977, see also Fuller & Marchant 1985). Low visit efficiency and the lack of natural clustering seem to be the main problems. Females of many tit species (including the Blue Tit *Parus caeruleus*) sing fairly often and their song is similar to the males (Cramp & Perrins 1993), so this may cause difficulties when using simultaneous registers of singing birds to divide territories. The aim of this study is to evaluate the accuracy of the combined version of the mapping method for censusing Blue Tits under moderately high population density.

## 2. Materials and methods

### 2.1. Study site and field work

The study was conducted in Moscow in 1993. Bird censuses were performed in a 30-ha study area located within an extensive forest "island" (ca. 200 ha) in the Central Botanical Garden of the Russian Academy of Sciences. The forest is dominated by 80–300-year-old oak *Quercus robur* (height 20–26 m). For a description of the vegetation see Morozov (1994). There are no nest boxes. The study area is crossed by nine nearly parallel lines subdivided into 50 m intervals.

All censuses were made in the morning. Special attention was paid to obtaining simultaneous records of singing birds. The study area is too large to census during one morning. For this reason, from mid-April it was covered by census work during two mornings which together formed one "complete visit". Fifteen "complete visits" were conducted between 1 April and 30 June. All bird species were censused. In May and early June, census work usually started 0.5–1 hour before local sunrise. Before sunrise, the author moved quickly trying to cover as large area as possible to census Song Thrushes *Turdus philomelos* and Robins *Erithacus rubecula*. Birds of other species were recorded casually. After sunrise, this area was censused again more accurately. Some parts of the study area have been passed twice after sunrise or/and in both consequent mornings. Because the author visited many parts of the study area twice per morning and, after sunrise, was moving slowly along close parallel lines, the same bird could be recorded more than once from the same or different points during a visit. The dense layer of hazel *Corylus avellana* made it difficult to follow birds and to search for nests higher than 6–7 m above the ground. The average speed of the survey was 2.3 hours/10 ha.

During 23 March – 12 April 1992 and 23 March – 4 April 1993, 55 Blue Tits and 120 Great Tits *Parus major* were individually colour-ringed in the 12.2-ha subarea of the study area. Birds were captured by semi-automatic and automatic traps with captive birds as a lure. A playback of conspecific songs was also used to attract birds to the traps. The birds were lured into the traps with sunflower seeds. The birds captured were aged and sexed (when possible) according to Vinogradova et al. (1976) and Svensson (1984).

During 18 April – 5 May, the 12.2-ha study plot was visited to map the actual territories of the Blue Tit, to reveal the composition of the breeding pairs, and to find as many nest holes as possible. Few additional observations were made later in May. Several individuals of both sexes with territories in the plot remained unmarked. Due to a lack of time, if the nest of a pair was found in the early stages of the study, less attention was paid later to mapping the territory of the pair (see territories *a*, *b1* and *h* in Fig. 2), in order to concentrate on other individuals. Locations of territories, their number, and their owners were determined precisely, but not their sizes and configurations. Total time expenditures on this work were 82.2 hours. Approximate boundaries of territories (solid and dashed lines in Fig. 2) were drawn based mostly on extreme positions of singing or calling males.

After the emergence of leaves in early May, it became very difficult to distinguish individual birds. For this reason, on 21 and 22 May a playback of conspecific songs within territories was used to attract individual birds downwards. Each nest hole found was monitored until fledging of the young. If no adult birds were observed near the hole during the first half of June, monitoring was continued until the end of June.

All field work was conducted by the author. During census visits, I strictly followed the procedure described above and did my best to ignore any knowledge about the actual distribution of individually marked tits.

### 2.2. Interpretation of the species map

I could not be the analyst, since I knew the actual number and locations of Blue Tit territories. That is why I asked my colleague, Mr. I. Yu. Titov, to evaluate the map of the Blue Tit. A considerable mutual discrepancy among different analysts is usually observed (Svensson 1974, Best 1975, Verner & Milne 1990, but see O'Connor 1981), even if the number of visits has been high and simultaneous records were intensively collected during field work (Morozov 1994). I. Yu. Titov was chosen since my earlier investigation of inter-analyst variation, based on the field material from the same study area (1992) and involving 21 analysts and the maps of 14 bird species, showed the highest degree of consistency between his and my results in terms of both the number of territories delineated and their configurations (Morozov 1994, for I. Yu. Titov's estimates see analyst # 10 in the Appendix). Thus, before evaluating the map of the Blue Tit for this study, he already had one year of experience in interpretational work. He was slightly familiar with the study area since he followed me during one visit. Also, he had one year of experience of field work by the mapping method in two coniferous stands (with no Blue Tits) in the Moscow Region in 1993.

The analyst was instructed to follow the recommendations of Priednieks et al. (1986), which combine IBCC recommendations (Pinowski & Williamson 1974) with the combined version of the mapping method (Tomiałojć 1980). Additionally, it was recommended: 1) to consider records made during two complementary study mornings to be one "complete visit" (see section 2.1); and, 2) to use the minimum number of 3–4 "complete visits" records to accept a cluster of observations as a "territory". Interpretational work was done for the whole 30-ha study area.

## 3. Results and discussion

### 3.1. Number of territories and their fates

Twenty territories were interpreted by the analyst to be located mainly within the study plot (Fig. 1: territories *B–R*, *U–W* and the nameless territory lying between territories *P* and *R*). The analyst hesitated about whether to evaluate the two parts of the "paper territory" *B* as two different territories (divided by the dotted line with "?" in Fig. 1), or not, and stopped at the latter decision. Four more "paper territories" (*A* and three nameless territories in the lower and the lower right parts of Fig. 1) can be considered to have about half of their registrations within the plot. Thus, the total number of territories evaluated in the study plot is 22.

Twenty-one actual territories seem to have been completely located in the study plot (Fig. 2: territories *a–f*, *h–t* and *x–z*). Also, parts of some territories were located within the plot. So, the total number of actual territories was 22–22.5, i. e. equal to the number of evaluated ones. Figure 2 shows the cumulative picture and does not reflect temporal shifts of the boundaries of the actual territories. For example, territories *b2* and *f* are overlapped considerably in Figure 2, since the former territory was occupied substantially earlier than the latter one.

Ten nest holes were found at the stages of hole inspection or nest building. One more nest was found during the nestling stage (see dots and encircled dots in Fig. 2). An interesting behaviour was observed in three presumably bachelor territory owners (*l*, *p*, and the unringed owner of the nameless territory shown by the dashed line in the lower left part of Fig. 2). In late April and early May they alternated intensive singing and removing the wood material from the holes selected. One more presumably bachelor territory owner, *x*, was observed repeatedly entering the hole on 3 May (see open circles in Fig. 2).

The response of most territory owners to a playback of conspecific songs was not strong, but most males (including presumably bachelor ones) seemed to stay at their territories. The birds from the territory *b2* were the only exception; their nest hole was found to be occupied by the Great Tits.

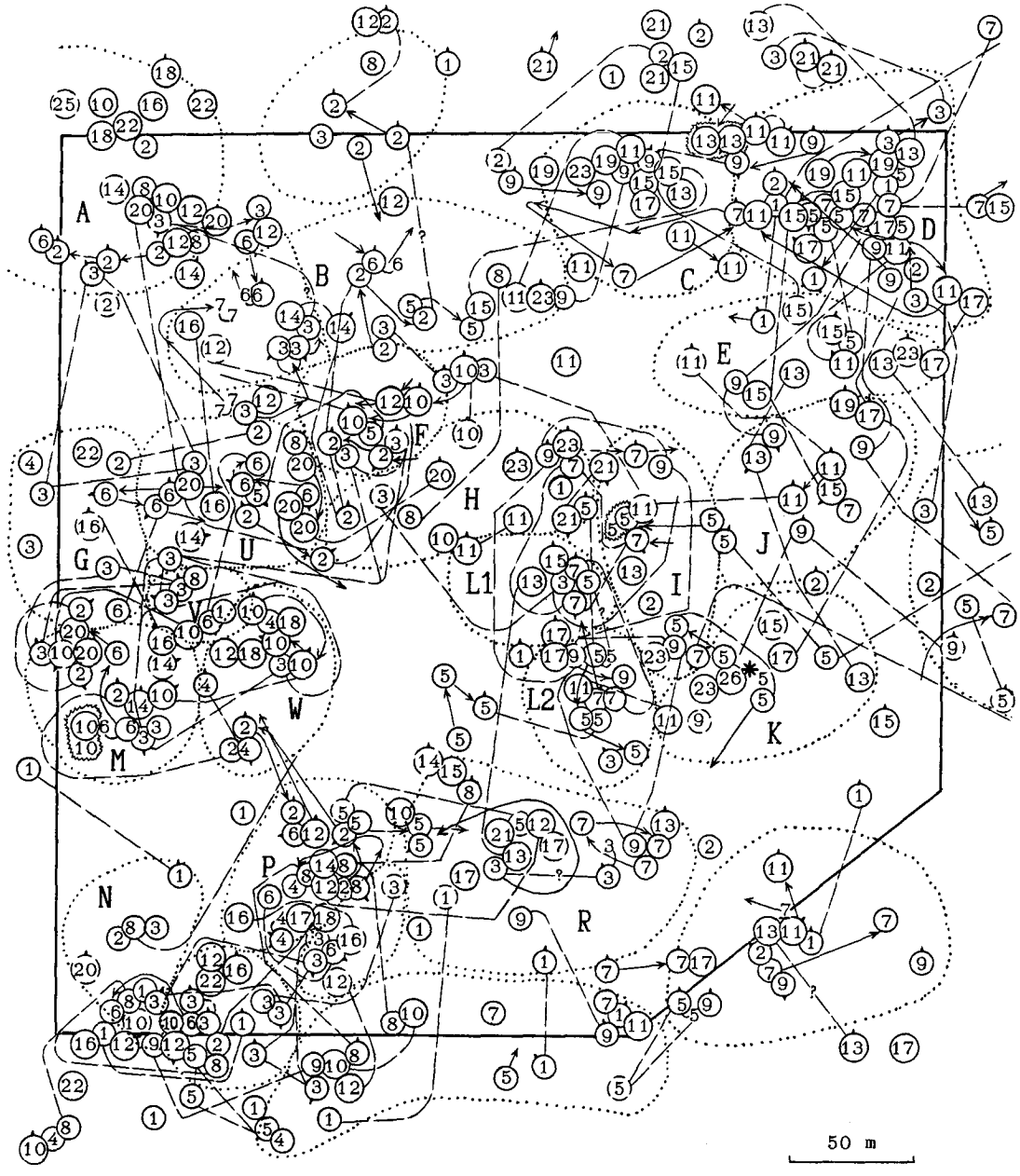


Fig. 1. The species map for the 12.2-ha study plot. Numbers within solid and broken circles show precise and approximate locations of singing birds, respectively. Circles with "beaks" refer to birds producing harsh, scolding "tsee-tsee-tsit" and "chur-r-r" calls, which in spring often precede song or aggressive encounters. Numbers without circles indicate the precise locations of non-singing and non-calling birds (usually in pairs). The underlined numeral refers to a bird collecting nest material. The nest found during the census visit is shown by a star. Symbols encircled by the toothed line indicate aggressive encounters between individuals. The numbers from 1 to 8 correspond to the dates 1, 6, 11, 16, 17, 23, 24, and 30 April, the numbers from 9 to 19 — to the dates 1, 6, 7, 11, 12, 17, 18, 22, 23, 29, and 30 May, the numbers from 20 to 26 — to the dates 4, 6, 12, 13, 20, 29, and 30 June, respectively (see section 2.1 for details). The relative sizes of the symbols (both numerals and circles) are enlarged in comparison with their relative sizes on the original species map drawn by hand. Solid and broken arrows indicate observed and presumed movements, respectively. Dashed lines (both straight and curved) connect the locations of simultaneously recorded individuals. The territories delineated by Mr. I. Yu. Titov are shown by the dotted lines and indicated by the capitals.

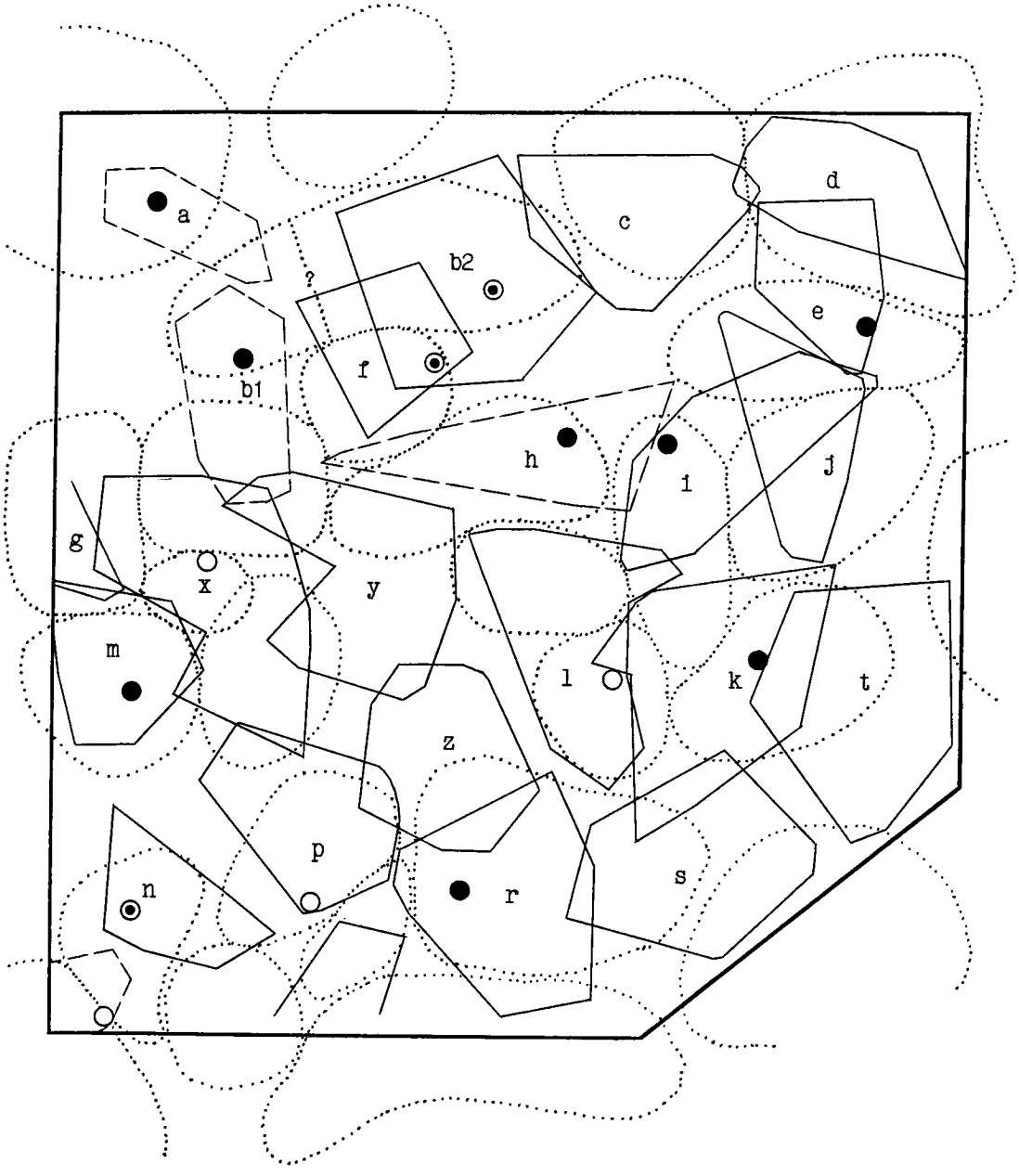


Fig. 2. Comparison between the locations of evaluated (dotted lines: from Fig. 1) and actual territories (solid and dashed lines) in the 12.2-ha study plot. Small letters refer to the actual territories. Dashed lines show the approximate area of actual territories delineated on the basis of few registrations (from 5 to 12 except those done near the nest, with few observed movements). The territory owners *c*, *d*, *j*, *l*, *p*, *t*, *x*, and *y* seemed to remain unmated at least to early May. Dots indicate the locations of nest holes observed to be visited by adults carrying food for nestlings. Encircled dots show the locations of holes which had been arranged by the members of the pairs in late April or early May but were abandoned later. Open circles refer to holes which seemed to be occupied by presumably unmated territory owners in late April or early May and abandoned later.

For unknown reasons, two more nest holes, which had been arranged by the pairs in late April or early May, were abandoned later. No birds were recorded near the holes of presumably bachelor males during June. Thus, only eight nest holes were found to be visited by adults carrying food for nestlings.

### 3.2. Location of territories

As Best (1975) emphasized, the main goal of mapping censuses is to estimate the actual number of territories and to delimit them roughly. It is reasonable to expect, however, a fairly good correspondence between actually existing territories and evaluated ones. Six "paper territories" *C*, *D*, *F*, *H*, *M*, and *P* correspond well to the actual territories *c*, *d*, *f*, *h*, *m*, and *p*, respectively (Fig. 1 and 2). It is also possible, taking into account nest locations, to identify the "paper territories" *A*, *E*, *J*, *I*, *K*, *N*, and *R* with the actual territories *a*, *e*, *j*, *i*, *k*, *n*, and *r*, respectively. The actual territory *l* obviously covers the two "paper territories", *L1* and *L2*. The "paper territory" *B* seems to combine the two actual territories, *b2* and *b1*. Actual territories *s* and *t* have no counterparts among the "paper territories". A high degree of spatial discrepancy can also be seen in the part of the plot covered by the actual territories *x*, *y*, and *z*. The congestion of imaginary territory boundaries within the territory *x*, occupied by the bachelor male, could probably be explained by high intruding activity of neighbours and/or the presence of non-territorial intruders during the first half of April.

## 4. Conclusion

The main result of this study is that 15 mapping visits (with some visits conducted before the nest building stage), and special attention to simultaneous records of singing birds, provide nearly 100% accuracy in estimating the number of Blue Tit territories, and fairly good accuracy in identifying the locations of many of them, if delineation of "paper territories" is based mainly on cutting the lines denoting simultaneous records as Tomiałojć (1980) recommended. Records of calling birds seem to provide useful additional information for interpretational work (see Fig. 1). There was no evidence that female singing interfered with the census work.

Thus, like the results of Tomiałojć's (1980) methodological study on tits, the results of this test give rise to some optimism. However, they must be interpreted with caution. Mapping of the Great Tit territories in the same study area is much more complicated (see Morozov 1994). The results obtained in this study, must not be applied to other tit species, or to Blue Tit populations with densities sharply differing from that recorded in this study, before more methodological investigations of tits are conducted.

*Acknowledgements.* I am grateful to Deputy Director Dr. A. S. Demidov for his permission to conduct the study at the territory of the Central Botanical Garden. I am very indebted to I. Yu. Titov for the evaluation of the map of the Blue Tit. I. K. Hanski, M. Mönkkönen and H. Pietiäinen made many valuable comments on the earlier version of this paper. Financial support came from the Russian Academy of Sciences and the International Science Foundation.

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