

# The accuracy and efficiency of territory mapping tested on Willow Warblers *Phylloscopus trochilus* and Chiffchaffs *Ph. collybita*

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Willow Warblers and Chiffchaffs were censused in southwestern Germany in a 200-ha study area, a quarter of which consisted of suitable habitats for these warblers. The territory mapping method yielded 16 Willow Warbler and 31 Chiffchaff territories. The true number of territories of the Willow Warbler was exactly the same, but the number of Chiffchaff territories was underestimated by one. The true territories were determined by marking males individually with colour rings and studying their territories using play-back techniques. All the mapped territories coincided with the true ones. The "mapping efficiency" was  $77 \pm 13\%$  for the Willow Warbler and  $74 \pm 22\%$  for the Chiffchaff. Twenty-eight of the 31 mapped Chiffchaff territories and all the Willow Warbler territories were registered on at least four of the first seven visits.

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## Introduction

Although the territory mapping method for censusing breeding birds is internationally standardized (Anon. 1969) and widely used, its accuracy and efficiency have seldom been tested by determining the actual number of territories (see, e.g., Berthold 1976, Tomiałojć 1980, Ralph & Scott 1981). We carried out such a test on populations of the Willow Warbler *Phylloscopus trochilus* and the Chiffchaff *Ph. collybita* in southwestern Germany. Stationary males of both species were marked individually with colour rings, and their territories were delimited with play-back experiments and other observations of the birds. These territories were then compared with those identified by the mapping method.

There are some earlier tests of the accuracy and efficiency of the mapping method for censusing *Phylloscopus* warblers. In the test of Enemar et al. (1976), the number of territories of the Willow Warbler was overestimated by the mapping method in a subalpine birch forest. In that test, however, the interpretation of territories was partly based on the nests found, which may have introduced some error. To find out why their first test had revealed an overestimate, and to assess the efficiency of their census, Enemar et al. (1979) made a second test, in which the true number of territories was obtained by marking males individually with colour rings and then determining territory boundaries by direct observations. In this

test, they found 100% agreement between the real and estimated populations size, although the limits of the territories interpreted from mapping observations did not completely correspond to the true boundaries. The "mapping efficiency" was 71%. In a similar test in Białowieża National Park in eastern Poland, the number of Wood Warbler *Ph. sibilatrix* and Chiffchaff territories were slightly overestimated (by 1.9 and 3.6% as an average of five cases, respectively; Tomiałojć 1980).

Both the previous studies and the present one show that the mapping method is accurate in censusing common European *Phylloscopus* warblers.

## Methods

The study was conducted in the surroundings of the village Möggingen (Radolfzell) and the Lake Mindelsee ( $47^{\circ}46'N$ ,  $9^{\circ}01'E$ ) in southwestern Germany in the spring of 1982. The study area was about 200 ha, but only a quarter of it was covered by forest, hedges, extensive bushes and other habitats suitable for the Willow Warbler and Chiffchaff, the rest consisting of fields, meadows and human settlement.

The majority of males with territories were marked individually, mainly on 9–30 April (two Willow Warbler and five Chiffchaff males with territories in the study area avoided capturing and marking; one of these Chiffchaffs had replaced a marked male). Their territories were delimited with the aid of played-back song in late April and early May.

Mapping censuses were carried out in the early morning between 28 April and 28 May. About 1/4 of the study area was visited nine times, but the major part

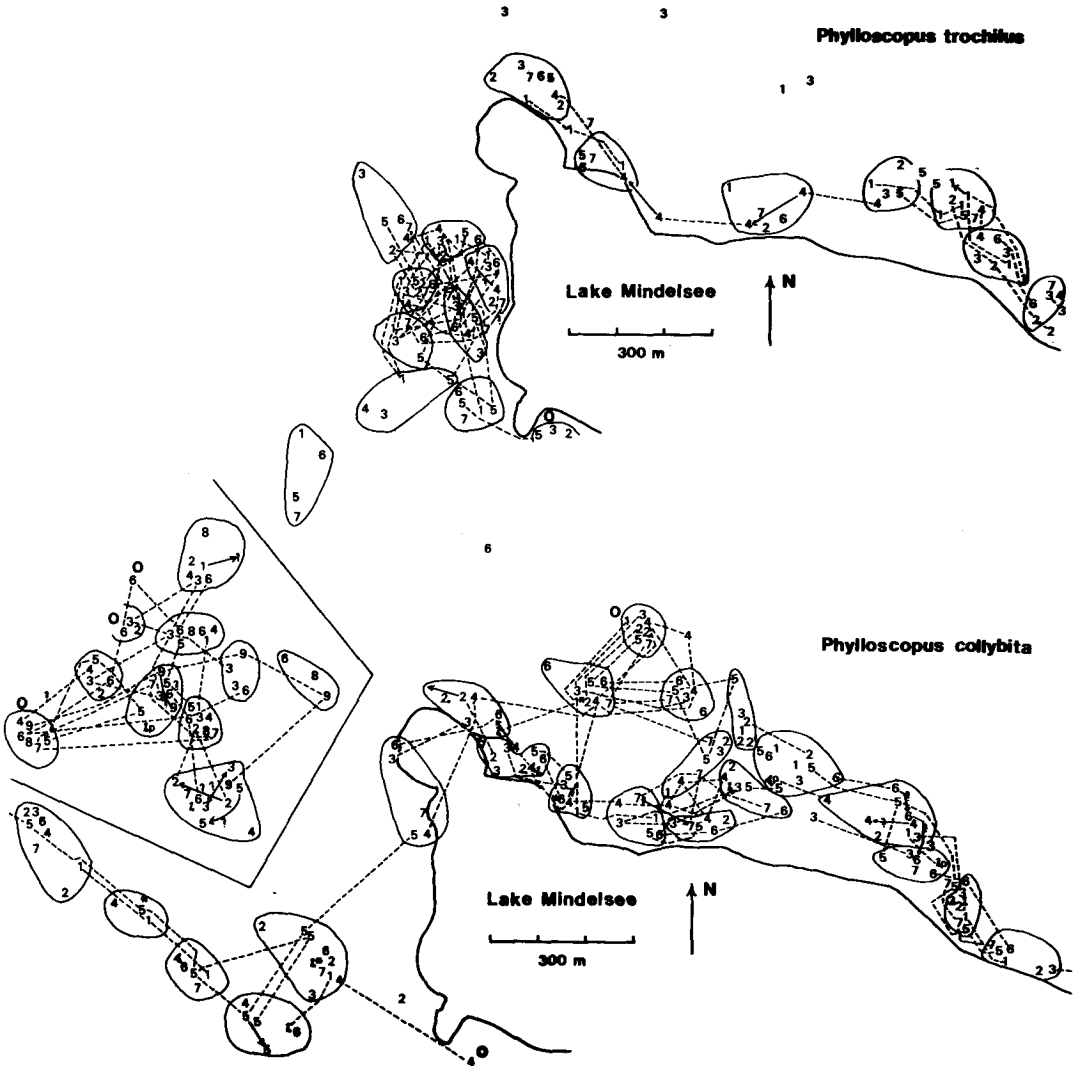


Fig. 1. Distribution of the Willow Warbler and Chiffchaff records. The numerals (normal type = singing, italics with a dot at the base = calling, bold-face = territorial conflict) indicate the sequence of the visits on which the records were made. Other symbols: p = pair; star = nest found; arrow with, and without, another record: observed direction of movement, and observed change of posts, respectively; and dashed line = simultaneous observation of two different individuals. A question mark indicates that the observer was slightly uncertain whether the two observations concerned one or two individuals. Double records originate from neighbouring routes which the observer has followed. The territories distinguished are encircled by thin lines. Territories outside the study areas are indicated by O. Numerals outside territories indicate records of surplus individuals, or records that could not be assigned to any particular territory. Open areas between the territories roughly indicate the places of habitats unsuitable for the Willow Warbler or Chiffchaff. In the Chiffchaff map, the northwestern part of the study area is projected into the large central meadow area (cf. Fig. 2). The single Willow Warbler territory in the northwestern part is not shown (recorded during visits 1-4 and 6-8.)

only seven. Each visit lasted for 3-4 hours. The census was mainly based on records of singing males, but we also recorded intensive calling and a few territorial conflicts between males. We paid special attention to simultaneous singing of males, and were careful to record this fact; importance of such records has been stressed by other workers, especially Tomiałojć (1980). The identification of territories on the species maps was based

on clusters of observations which could be separated from each other either by contemporaneous recording or by intervening stretches of unsuitable habitat. One of us (JT) conducted the marking of the birds and delimited the territories, while HVB, unaware of the true territories, made more than three quarters of the mapping censuses. Because of shortage of time, JT made the rest of the censuses, but he had considerable

previous experience of mapping censuses and we believe that he was able to follow the standard procedure, unaffected by his knowledge of the true territories. The territory maps were interpreted by JT.

## Results

The mapping census resulted in 31 Chiffchaff and 16 Willow Warbler territories (Fig. 1). The easternmost Willow Warbler observations were considered insufficient for a territory (two observations, made on 1 May and 3 May) and there was a similar case on the northern side of the study area.

The true numbers of territories was 32 for the Chiffchaff and 16 for the Willow Warbler. The territories obtained by the mapping corresponded well with those based on observations of colour-marked birds; each territory mapped could be identified with a true territory, except that one mapped Chiffchaff territory comprised two true ones (Fig. 2). These territories, on the northern side of the northwestern end of Lake Mindelsee, could not be separated by records of simultaneous singing. All the other territories could be clearly distinguished by the mapping method.

The "mapping efficiency", defined as the mean number of visits in the interpreted territories and expressed as percentage  $\pm$  SD of the total visits (we used the first seven visits as the total) (see Enemar et al. 1979), was  $75 \pm 22$  % for the Chiffchaff, and  $77 \pm 13$  % for the Willow Warbler. The figure for the Chiffchaff is  $74 \pm 22$  % if we divide the cluster comprising two true territories into two clusters (see Figs. 1 and 2). Most (28/31) Chiffchaff territories were registered at least four times. One was registered only once, and one was registered twice, although these territories were occupied throughout the census period (the male of the first pair, however, was not permanently present). Further evidence of the existence of these territories was obtained on visits 8 and 9, which were made in that particular area; note that the census-taker (HVB) was not aware of the effect of these visits on the result, and he alone decided to make two more visits. All the Willow Warbler territories were registered on at least four of the first seven visits, and 14 of the 16 territories at least five times.

## Discussion

Our test supports the theory of the mapping method, for the coincidence between the true and mapped territories was almost complete (see Fig. 2). In fact, we also censused the Chiffchaffs in the neighbourhood of the census area (see Fig. 1) with 100 % accuracy. There were only a few territories in the close vicinity, because our study area was mostly bordered by open habitats.

We believe that the careful attention paid to noting simultaneous observations contributed greatly to the high accuracy of our censuses; without these observations, the interpretation would have been very difficult and probably incorrect.

Concentration on only two species may, of course, have increased the efficiency of the censuses (see Scott and Ramsey 1981). As singing Willow Warblers and Chiffchaffs are easily detected, however (and both species sing quite actively), and as our censuses were mainly based on singing, the advantage gained from concentrating on two species was probably small. Moreover, this advantage must have been diminished by the fact that our censuses were fairly rapid, which decreased the time for observing birds. In ordinary censuses, the time needed to cover those parts of our study area containing habitats suitable for the Chiffchaff and Willow Warbler would have been more than 10 hrs (up to 15 hrs according to the recommendation of Tomiałojć (1980) and the experience of Pakkala, Piironen, Tiainen, Vickholm and Virolainen in southern Finland (unpubl.); no recommendation regarding the census speed is made in Anon. (1969)).

It is possible that the accuracy of our census was improved by the patchiness of our study area (this may also have increased the efficiency).

The mapping efficiency of our censuses was also high, though not significantly higher than the values previously calculated for the Willow Warbler. Enemar et al. (1979) estimated efficiency at  $71 \pm 20$  % (mean  $\pm$  SD; 10 visits, 15 territories) in subalpine birch forest. Previous estimates (Enemar 1959, 1963, Enemar et al. 1979) have been 74 % in subalpine birch forest, and  $73 \pm 14$  % in a deciduous wood in southern Sweden, but these values were calculated only by reference to the mapped territories, as the true territories were not known. The efficiency values are, of course, somewhat affected by the decisions regarding the territory to which each observation should be assigned (if there are two nonsimultaneous observations, three different interpretations are possible).

The efficiency was slightly, though not significantly, higher for the Willow Warbler than for the Chiffchaff. The Chiffchaff arrives in the study area some weeks before the Willow Warbler, and its singing had probably slightly decreased in intensity at the time of our censuses, breeding being more advanced than in the Willow Warbler. The daily singing period of the Chiffchaff seemed to be longer in April than in May. The short duration of our visits in early morning probably increased the census efficiency to some extent.

The individual variation in detectability was not especially great in our census, in contrast to the case of the Red-backed Shrike *Lanius collurio* in the study area of Diehl (1981). There were, how-

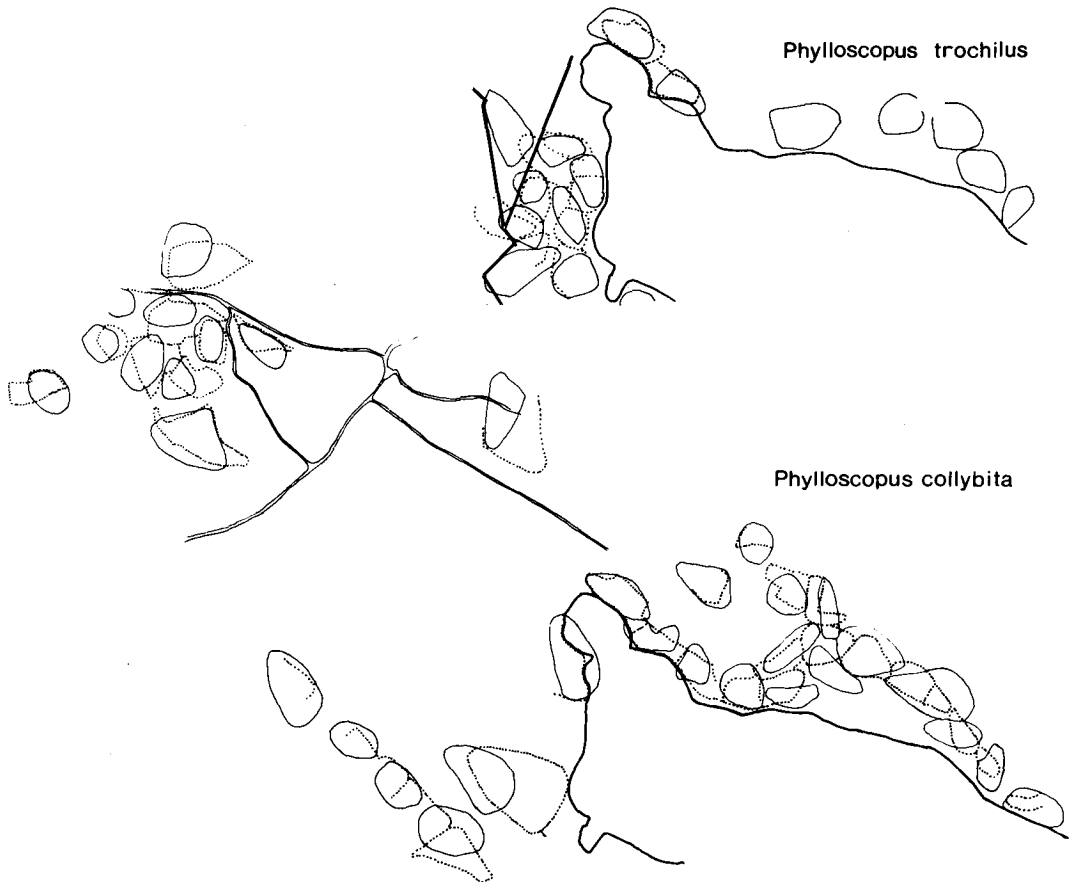


Fig. 2. Coincidence of mapped (solid lines; from Fig. 1) and true territories (dotted lines) of the Willow Warbler and Chiffchaff. Some main roads shown with double lines. Note that the delimitation of mapped territories only indicates which records were considered to belong together. Not all the true Willow Warbler territories were delimited exactly on the northern side of Lake Mindelsee, but all the males were ringed.

ever, two Chiffchaff territories, which would not have been identified, due to too few records, if we had made only seven visits to all parts of our study area (eight to ten visits should be made after the international recommendations; Anon. 1969).

In one, the male was permanently present, but remained silent during the counting; it usually sang more actively later in the morning. In the other, the male may have held a second territory outside the study area. According to the international recommendations, two records should suffice for a territory if only seven visits are made (Svensson (1978) suggests that at least three records should be required). This may, however, lead to errors in the following two cases: firstly, a male not belonging to the permanent population may stay for a few days, and be recorded on two successive visits, and secondly, two temporally well separated records may originate from differ-

ent visitors. The use of only seven visits to the whole study area would have lowered the accuracy of the Chiffchaff census from  $31/32=97\%$  to  $29/32=91\%$ .

For further discussion, the reader is referred to Enemar et al. (1979).

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### Selostus: Kartoitusmenetelmän tarkkuus ja tehokkuus pajulinnun ja tilitaltin laskennassa

Testasimme kartoitusmenetelmän tarkkuutta ja tehokkuutta pajulinnun ja tilitaltin reviirejä puolustavien koiraiden laskemiseksi 200 hehtaarin suuruisella alueella Länsi-Saksan lounaisosassa. Suunnilleen neljännes tutkimusalueesta oli uunilinnuille soveliaista biotooppia.

Kartoitustulosta verrattiin todelliseen tilanteeseen, joka saatiin selville väriengastamalla lähes kaikki alueen koiraat ja määrittämällä sen jälkeen niiden reviirien rajat.

Kartoituslaskennan mukaan alueella oli 16 pajulintuja 31 tiltalttreviiriä. Todelliset lukumäärät olivat 16 ja 32. Kaikki kartoittamalla tulkitut reviirit sopivat kohtuullisen hyvin yhteen todellisten reviirien kanssa.

Kartoitustehokkuus laskettiin havaintokertojen osuutena kaikista käyntikerroista kullekin reviiirille erikseen. Pajulinnun keskimääräinen kartoitustehokkuus oli 77 % ja tiltaltin 74 %. Käyntikertoja oli seitsemän. 28 tulkituista 31 tiltalttreviiristä havaittiin vähintään neljällä käyntikerralla. Kaikki pajulintureviirit havaittiin vähintään neljällä ja 14 vähintään viidellä käyntikerralla.

Tutkimuksemme yhdessä muutaman aiemmin julkaistun tutkimuksen kanssa osoittaa, että pajulinnun ja tiltaltin (nähtävästi myös sirittäjän) laskentatuloksen tarkkuus kartoitusmenetelmää käytettäessä on lähellä täydellistä laajalla alueella Euroopassa.

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## Tredje kongressboken

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