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How much time is required to survey land birds in forest-dominated atlas squares?

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Using bird atlas data from south-central Sweden and information on survey effort for the corresponding 5 × 5 km grid squares, we assessed how much time is required to get reliable presence/absence data for forest birds. We restricted the analyses to a suite of 28 species considered common enough and sufficiently generalised in their requirements to be present in all survey squares largely dominated by forest. For a set of 183 squares having more than 2/3 of their area covered by forest, the non-linear relationship between survey duration and the number of species detected showed that a total survey duration of less than ca. 16 h was often insufficient for getting a reliable species list. There was, however, much variation in efficiency for such shorter survey durations. We conclude that a total survey duration of ca. 40–45 h should constitute a fair compromise between maximising survey quality and minimising effort, if the fieldwork is done by a range of birdwatchers of varying competence. However, longer surveys may be required for uncommon or specialised species. These findings have implications for the planning of further atlas work in forested areas and for the use of bird atlas data in various research fields.

1. Introduction

Ornithological atlas data have a large number of applications, including education, recreation, documentation of distributions and population changes, applied conservation and management, as well as the study of bird-habitat relationships (Donald & Fuller 1998). One further potential use of bird atlas data is the study of spatial and temporal variation in the composition of species assemblages and in species richness patterns (e.g., von Euler & Svensson 2001, Mikusinski *et al.* 2001, Lund & Rahbek 2002). Such atlas data have been collected both at the scale of individual countries (e.g., Svensson *et al.* 1999, Väisänen *et al.* 1998) and at the continental scale (Hagemeijer & Blair 1997). Due to the multitude of applications, bird atlas work constitutes an essential area within ornithology.

In most cases, national atlases provide presence/absence data for cells of a regular grid covering a country, or part of it, as well as breeding indices for the species that were recorded (Bibby *et al.* 1992). A crucial issue is whether recorded 'absences' are true absences or simply reflect the non-detection of the species. This issue has im-

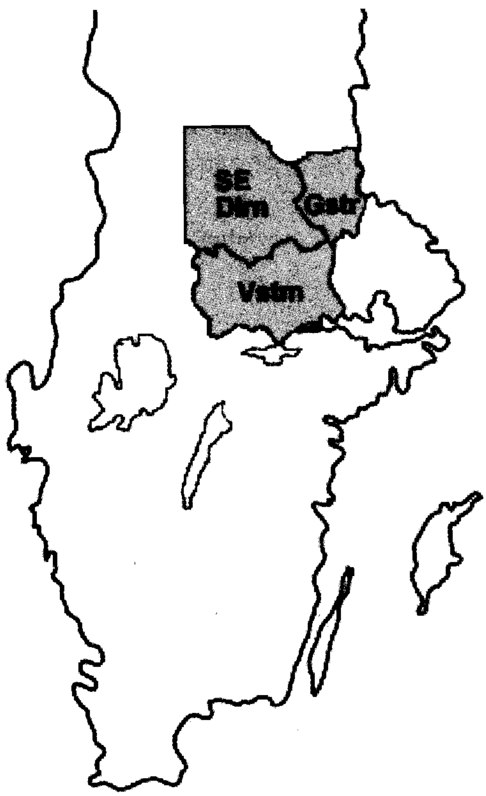

Fig. 1. Map of southern Sweden showing the study area, covering the southeastern part of the county of Dalarna (SE Dlrn), Gästrikland (Gstr) and Västmanland (Vstm).

plications particularly in the study of bird-habitat relationships (Drapeau *et al.* 1999) and of patterns in the composition of bird assemblages (Cam *et al.* 2000, Kerr *et al.* 2000). Moreover, a better knowledge of the relationship between survey effort and presence/absence data reliability would be useful in future atlas work, which is imminent in several regions.

Many methodological studies have been aimed at improving the reliability of bird surveys based on the line transect and point count survey methods (e.g., Järvinen & Väisänen 1981, Ralph *et al.* 1995, Drapeau *et al.* 1999). However, for surveys based on the area search method and applied at much larger spatial scales — as in bird atlas squares — few such studies have been performed (Slater 1994, Johnson & Sargeant 2002). Therefore, there is a need to develop methods that would improve knowledge on effectiveness for future atlas work and, when using already published atlas data, to distinguish grid cells that were well surveyed from those that were less sufficiently so. Atlas databases often include information about survey effort — usually as the number of observers and the time spent in the survey unit by each of them. Using such information from the Swedish Bird Atlas (Svensson *et al.* 1999), we sought to assess how much time is necessary in order to get reliable presence/absence data for forest bird species in 5 × 5 km survey squares.

2. Material and methods

2.1. Study area and bird atlas data

We used data from three adjacent counties in south-central Sweden: southeast Dalarna, Gästrikland, and Västmanland, (Fig. 1). Forests cover about 71% of the land area in this region. Coniferous stands largely dominate (84% of the forest area), whereas deciduous stands and mixed stands (8% each) make up a minor proportion of the forest area. Stands older than 100 years represent only 11% of the forest area (SLU 2002). The study area is situated entirely within the middle Swedish lowlands of the south Scandinavian zoogeographical province (Gustafsson 1996) and harbours a land bird fauna composed of a mixture of northern and southern boreal species.

Birds were surveyed by 90 voluntary observers in squares of 5 × 5 km during the period 1974–1984. According to the instructions provided to the field workers, the squares were usually surveyed on several visits spread over the breeding season. For each square, the field worker(s) provided information on the date and duration of each visit and a total list of the bird species observed with the associated breeding indices (Svensson *et al.* 1999). Since all visits were pooled in the species list, we used the sum of the total time spent in the square by all independent observers as a measure of survey effort. Because this study focuses on presence/absence data, no distinctions were made among the different breeding indices; we simply included all records that had been accepted for the atlas.

2.2. Selection of atlas squares

A square was considered 'largely dominated by forest' if more than two thirds (66%) of its area was covered by forest. Only the squares fulfilling that criterion were retained for the analyses. Forest cover was measured using a digital version of the Swedish Road Map (*vägkartan*) and a Geographic Information System. Only forests suitable for wood production (growth of at least 1 m^3/ha per year) were considered. Forest cover data on these maps is from the period 1992–2000. Because no major forest cover changes have occurred in the study area during the past three decades (total decrease of 1.3% in forest cover from 1970 to 1999, SLU 2002), we assume that this measure provides an adequate estimate of the cover of forest land for the atlas survey period. Indeed, the aim here is not to measure the influence of forest cover on birds, but simply to eliminate from the analyses the squares that were not obviously dominated by forest at the time of survey.

Visits made earlier than 15 March or later than 15 August can be considered as suboptimal because many migrants are absent from the study area at that time. Moreover, most of those visits were night surveys conducted for owls (Strigiformes), a taxon that is not considered in the present study (see below). Given that all visits were pooled in the species lists, it was impossible to eliminate the species observed only during those unusually early or late visits. Therefore, we excluded from the analyses all squares including at least one visit outside the period 15 March–15 August. Additionally, we excluded the squares that were not surveyed at all during the main period of singing, i.e. 15 May–30 June, because this is inconsistent with instructions for atlas work.

2.3. Species retained for the analyses

We limited this study to forest birds because forests — especially coniferous — are by far the dominating habitat in the region. We define forest birds as species using forest environments for breeding and foraging. Owls were not included because they necessitate night surveys in late winter or early spring, which were not regularly conducted in all squares. Different atlas squares support different bird assemblages since they vary in the proportion occupied by different land cover types (principally forest, agricultural land, mires, water bodies, and urban areas). Therefore, the number of species observed in a given square depends not only on survey effort, but also on the occurrence of different habitats and their relative proportions. To account for that, we selected a pool of species that are considered as generalists in the coniferous boreal forest and that are common enough to be expected to occur in every atlas square largely dominated by forest in the study area (SOF 2002). First, we excluded all forest species that are specialised in their habitat requirements and that would not find suitable habitat in every managed forest of large area in the study area (Cramp 1977–1994, Svensson *et al.* 1999, Angelstam *et al.* in press). For example, species dependent on deciduous or old-growth stands were discarded because they might not find habitat in all forested squares. The resulting list of forest generalists contained 32 species.

Second, we estimated the mean densities of those species using line transect data from 37 forest transects spread over the study area (the Swedish *Standardrutter* project). The transects were 8 km long and were surveyed between 1 and 7 times in different years during the breeding season in the period 1996–2002. For transects that had been surveyed in more than one year we used the average number of pairs for all years. Individuals were noted regardless of their distance from the transect line. Because the distances and angles of the observations were not measured, it was impossible to get species-specific detection functions. Therefore, we defined a zone of varying width for different species and assumed that all individuals were detected within that band. The half-width of the zone (one side of the transect) for a given species was selected using the distance from which individuals can normally be heard in forest environments, based on field experience (Appendix).

We then divided the number of territorial males of each species by the total area of the band to get an estimate of the mean density per km^2. The minimum area of forest in the selected atlas squares was 66% × 25 km^2, i.e. 16.5 km^2. Note, however, that most squares had much more forest cover than this minimum value. Since territories are probably not spread uniformly across the landscape, we assumed that a mean density per km^2 equivalent to at least 4 pairs/16.5 km^2 would be sufficient in order to expect the species to be present in every forest-dominated atlas square. This corresponds to a mean density of 0.24 pairs/km^2. Four species that would otherwise have been included by the habitat criterion alone were excluded from the analyses because their estimated densities were lower than that value: Goshawk (*Accipiter gentilis*), Sparrowhawk (*A. nisus*), Golden Eagle (*Aquila chrysaetos*), and Black Woodpecker (*Dryocopus martius*). The final list of common forest generalists contained 28 species (Appendix).

A risk with that method is that some of the individuals heard within the zone may have part of their territory outside of it, which would result in an overestimation of density. Moreover, some of the individuals that were heard may have been outside the defined zone. On the other hand, a number of individuals are missed in every transect, which causes a negative bias. We assumed that these positive and negative biases compensated each other. In case of doubt, we preferred to be generous in our estimates of zone width. As a consequence, the mean densities presented in the Appendix are conservative and probably constitute underestimates for many species. But since the aim was to get a conservative list of species that should be found in every forest-dominated square, this does not constitute a problem. Yet, our conservative density estimates should not be used or referred to as true absolute densities for the region or habitats that we have studied.

We stress the importance of the selection of the 28 species assumed to breed in all retained squares. Doing this we are confident that the absence of a species in a list indicates that this species was missed by the observer and not that this species was absent. Hence, we have created a test set of squares with 'known' species totals. The only alternative method would have been to make standard atlas surveys within squares with fully known species lists, which are practically impossible to obtain at this spatial scale.

2.4. Statistical analyses

Since the pre-selected forest species are assumed present in all squares largely dominated by forest (SOF 2002), the number of observed species from that pool should not increase with an increasing forest cover above the minimum of 66%. We used linear regression to test whether the slope of this relationship was different from zero.

The selected bird species span over a large range of detectabilities and therefore are expected to accumulate gradually with total survey time. We modelled the relationship between the number of observed species and total survey duration using the following non-linear regression:

$$Y_i = \beta_0 (1 - e^{-\beta_1 x_i}) + \varepsilon_i \qquad (1)$$

where Y_i is the number of species from the pool of 28 forest species observed in square *i*, β_0 is a constant giving the asymptote for the function, β_1 is a constant describing the slope of the rising curve, x_i is the total time spent in square *i*, and ε_i is the error term. This equation is adequate for describing relationships that exhibit a positive but decreasing slope tending toward a theoretical maximum and has been used for analysing species accumulation curves (Gauthier & Aubry 1995).

3. Results

Among the 263 atlas squares for which reliable data on survey duration was available, 200 fulfilled the criterion of being covered by more than 66% forest land. Of these, 15 were excluded from the analyses because they had been visited outside the period 15 March–15 August and 2 were excluded because they had not been surveyed at all during the main singing season. Thus, the final dataset contained 183 atlas squares.

The slope of a linear regression of the number of species on forest cover was not significantly different from zero ($R^2 = 0.01$, $P = 0.15$), suggesting that the amount of forest above the minimum of 66% does not influence the observed number of forest generalist species at this spatial scale.

For the total pool of 28 species, the mean number of squares where a given species was observed was 158.1 (SD = 23.4). No single spe-

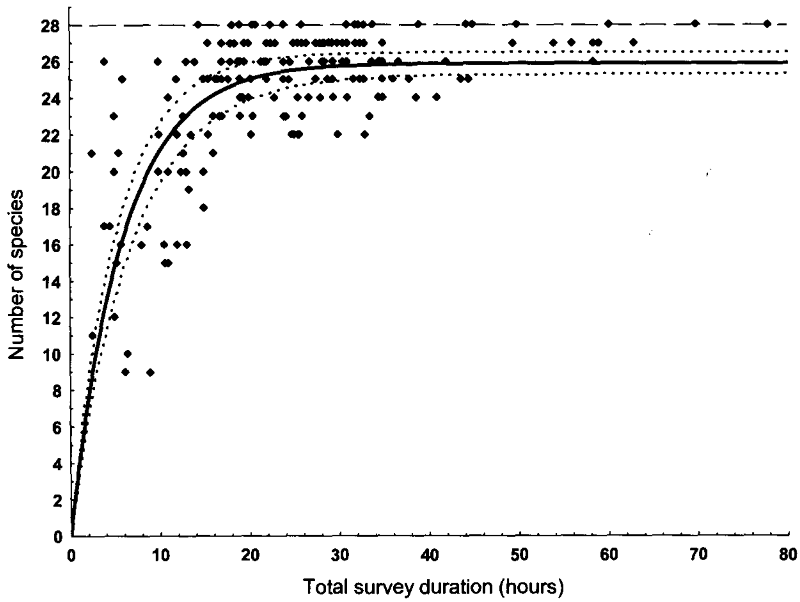

Fig. 2. Number of observed species from a pool of 28 pre-selected species assumed present in every square as a function of total survey duration, based on 183 atlas squares of 5 × 5 km in central Sweden. The plain line depicts the non-linear regression of the form $Y = 25.9\,(1 - e^{-0.169x})$ and the dotted lines show the 95% confidence interval.

cies was observed in absolutely every survey square, although some common species were detected in all but a few squares (Appendix). One species — the Wren (*Troglodytes troglodytes*) — remained undetected in a large number of squares, being observed in only 80 of the 183 squares.

Only survey durations longer than ca. 45 h ensured that at least 90% of the selected species were detected (Fig. 2). Durations shorter than ca. 16 h were often insufficient to allow detecting most of the species. However, there was much variation in the number of detected species for those shorter survey times. The non-linear regression provides a fairly good fit with the data ($R^2 = 0.41$), although the asymptote (25.9 species, 95% confidence interval 25.3–26.5) is somewhat lower than the theoretical value of 28 species. This reflects the observation that some of the surveys of very long duration (45–65 h) did not allow detecting absolutely all species from the pool. The slope, as expressed by the derivative of the function, becomes less than 0.1 species/h (i.e., 1 new species/10h) after 22.4 h of survey. According to the fitted function, a survey duration of 20–25 h would be likely to allow the detection of approximately 90% of the selected species, and further inventory would result only in marginal improvements in the predicted number of observed species.

4. Discussion

Very few studies have addressed efficiency in bird censuses where the survey units cover large areas in forested landscapes. In an assessment of the amount of fieldwork necessary for surveying breeding birds in 1 × 1 km squares dominated by forest, Svensson (1971) found that a minimum of 5–6 h was necessary in order to detect at least 90% of the species. Based on standard atlas work in twelve British squares of 10 × 10 km for which the number of breeding species had been estimated independently, Sharrock (1974) found that about 80% of the breeding species could be observed during 16 hours of field work. Judging from the curve presented in that paper, a plateau in the number of observed species would not have been reached even after twice that number of hours. However, it would be difficult to directly compare Sharrock's (1974) results with ours because the British squares were dominated by farmland. In hardwood forests of southeastern Canada, the species accumulation curve based on atlas squares of 10 × 10 km with unknown species totals reached a plateau after approximately 15 h (Gauthier & Aubry 1995). In contrast, the present study from south-central Sweden shows that a survey duration of 15 h was insufficient for a plateau to be reached even if the area was much smaller (5 × 5 km).

As shown in Fig. 2, some surveys with durations as long as 45–65 h did not ensure that all common bird species were observed. This could be a consequence of (1) the actual absence of some species in certain squares, or (2) the non-detection of species that were present. If some of the species assumed present were actually absent from some squares, the real species pool in those squares would be lower than the expected 28 species, resulting in lower data points in Fig. 2. However, we emphasise that the choice of the species pool was done in a conservative manner and hence, this factor would not create much noise in the data. Therefore, the non-detection of some species seems a more plausible alternative. To verify that, one would need considerably more data for very long survey durations (ideally > 100 h) in order to see whether the plateau would eventually move up and reach the total species pool. Yet, our results seem to support Sharrock's (1974) experience from the British atlas, namely that new breeding species can still be found in a square even after as many as 200 hours of concentrated work by two experienced observers.

Some species that are extremely common in the study area (e.g., Chaffinch *Fringilla coelebs* and Willow warbler *Phylloscopus trochilus*) remained undetected in a few squares, in spite of the fact that all squares were surveyed for at least 2 1/2 hours. Given their high densities, those species were most probably missed by the observers. If, for example, some observers did not have the list of species in the field, they could simply have 'forgotten' to pay attention to some species. Another possibility is that the observers simply forgot to note all species on the field protocol. Surprisingly, the Wren remained undetected in a very large proportion (56%) of the squares. Possible explanations for non-detection could include combined effects of relatively sparse population levels after some unusually cold winters during the atlas period and the fact that this species has rather cryptic habits.

In order for our results to be extended to complete bird assemblages, one has to assume that species other than those selected harbour a similar distribution of detectabilities. Regarding forest birds, some of the species that were not retained for the analyses could be harder to detect because of lower abundance or more specialised habitat requirements compared to the pre-selected pool of common generalists. Such species would therefore require even longer surveys. Concerning birds of habitats other than forest, they may differ considerably from forest birds in terms of detection probabilities. For example, birds of open areas are typically easier to detect than forest birds (Bibby & Buckland 1987). One could thus expect that shorter survey times would be required for birds of open areas.

As shown by the regression analysis, total survey time does not explain all variation about the curve. Several additional factors can affect the results of bird atlas surveys, among others: (1) the level of competence and motivation of the field workers (Sauer *et al.* 1994); (2) the number of visits (Dettmers *et al.* 1999); (3) the season and time of day for each visit (Drapeau *et al.* 1999); (4) the characteristics of the terrain that affect ease of movement and of observation (Bibby & Buckland 1987, Bibby *et al.* 1992, Slater 1994); and (5) the weather (Slater 1994).

Regarding the level of competence or motivation of the field workers, we consider our study to be representative of most atlas work, since the data were gathered by a large number of individual observers. The 183 atlas squares were surveyed by 90 amateur observers varying in their methods and capabilities, just as in any real-life atlas work. This factor could explain the large variation observed in the number of detected species for shorter survey times. The number of visits could also have an effect on the number of detected species. In this study we combined all visits and used total survey time because no partial species lists for separate visits were available. For breeding bird surveys in 1 x 1 km squares dominated by forest, Svensson (1971) showed that the number of visits did not have any effect on the number of species observed after accounting for total survey time. Slater (1994) came to the same conclusion for plots of 200 × 100 m in Australian woodland. It may be so, however, that the number of visits has some importance in the case of 5 × 5 km squares. Indeed, these squares are relatively large, with the consequence that the different habitats may be better covered by several repetitions if the observer(s) use(s) different routes of access into the square on different visits.

Concerning time of year and time of day, these factors are known to influence the results of bird surveys (Bibby *et al.* 1992, Drapeau *et al.* 1999) and could explain some of the variation about the regression curve in Fig. 2. Unfortunately, our data does not allow the testing of this effect on the number of detected species, because the species lists were compiled for all visits confounded. Nevertheless, we controlled to some extent the factor 'time of year' by excluding from the analyses all squares that were not surveyed at all during the main period of singing, i.e. 15 May–30 June, and all squares including visits outside the period 15 March–15 August. Once again, we argue that our data are representative of most atlas work, since it is virtually impossible to visit all grid cells at the best time of the year and of the day for logistical reasons and because those 'most proper times' vary among species. Furthermore, differences in weather can account considerably for differences in survey effectiveness. However, in this instance this effect was probably weak, since observers tended to select days with suitable weather and most atlas squares were surveyed during several visits spread over the breeding season, thereby reducing variance among plots in this factor.

A further factor is the spatial coverage of a square by the observer. Of particular importance is how well habitats of rare and inconspicuous species have been surveyed. Unfortunately, no detailed information on spatial coverage was available for the Swedish bird atlas. In a Finnish study of changes in species distributions between two atlas surveys, Väisänen (1998) explicitly considered variations in areal coverage among squares. This factor is probably marginal in the present study, which is based on common dispersed generalists. Yet, generally for such surveys, there remains a conflict between the lower efficiency of even coverage of all habitats of a square and the higher efficiency of focusing the effort on the most profitable parts (Sharrock 1971).

5. Conclusions

This study provides useful guidelines for bird surveys on large areas in forested environments. First, a total survey duration of less than ca. 16 h is often insufficient for obtaining a reliable species list in 5 × 5 km forest squares. While some experienced observers detect most of the species in a few hours, others miss a large number of species even after 10–20 hours. For survey durations between ca. 20–40 h, there is some variability in effectiveness, but the large majority of the species are detected. Finally, even with surveys lasting as long as ca. 60 h, there is no guarantee that absolutely all species present will be detected. The results suggest that a survey duration of 40–45 h should constitute a good compromise between maximising survey quality and minimising effort, as long as one is ready to accept that a few species may remain undetected in a given square. However, longer surveys may be required for uncommon or specialised species. Note that these recommendations are based on data collected by a large number of amateur observers of varying competence. Work performed by experienced or specifically trained field-ornithologists would certainly result in higher efficiency.

The forests and the bird communities in our study area are representative of a large part of Fennoscandia. Thus, we believe that these guidelines can be applied for the planning of future atlas work in a large part of that region. Moreover, those findings have implications for the *a posteriori* use of bird atlas data. Indeed, by combining data on the time spent in each square with the results of this study, one can distinguish the squares that were well surveyed from those that were insufficiently so. This provides opportunities for using atlas data in a variety of applications necessitating relatively complete species lists.

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Sammanfattning: **Hur mycket tid krävs för att inventera fåglar i skogsdominerade atlasrutor?**

En fågelatlas visar normalt arters förekomst eller frånvaro inom likstora kvadratiska rutor. Viktigt är om en arts frånvaro i en artlista från en sådan ruta betyder att den verkligen saknas eller bara har missats av inventeraren. Vi utnyttjar här data från Svensk fågelatlas för att bestämma hur många timmar man måste inventera en 5 × 5 km stor atlasruta för att få ett tillfredsställande resultat. Vi använde data från Västmanland, sydöstra Dalarna och Gästrikland (Fig. 1), som tillhör samma zoogeografiska område och har en likartad landfågelfauna. En viktig förutsättning för analysen var att kunna jämföra inventeringsresultaten med en "känd" fågelfauna i varje inkluderad atlasruta. Denna kända fågelfauna konstruerade vi på så sätt att vi valde 28 skogslevande arter, som är så vanliga och har så generella biotopkrav att vi nästan säkert kan räkna med att de måste ha häckat i samtliga rutor med tillräckligt mycket skog (Appendix). Bedömningen gjordes med hjälp av de täthetsdata som fanns från de 37 standardrutter (Svenska häckfågeltaxeringen) som inventerats inom studieområdet 1996–2002. Tätheterna uppskattades genom att vi antog att fåglarna registrerats inom zoner av olika bredd. Vi använde zoner med god säkerhetsmarginal för att vara säkra på att vi inte överskattade tätheterna (Appendix). Täthetsvärdena kan därför inte användas som sanna täthetsvärden för boreal skog utan tjänar bara syftet att välja arter för denna uppsats. Skogslevande arter valdes eftersom skog, främst barrskog, är den dominerande biotopen i den aktuella regionen. När skogsandelen var större än två tredjedelar tillkom inga nya arter med ytterligare ökande skogsareal. Vi utnyttjade därför data från enbart rutor med mer än två tredjedelar skog. Vi uteslöt också ett fåtal rutor där inventeringarna utförts utanför den rekommenderade period som omfattade fåglarnas huvudsakliga sångperiod. Det fanns 183 rutor som uppfyllde våra kriterier. Eftersom det ingår arter med mycket olika grad av upptäckbarhet förväntar vi att antalet registrerade arter skall öka gradvis med ökande antal inventeringstimmar, nämligen enligt formeln $Y_i = ß_0 (1 - e^{-ß_1 x_i}) + \varepsilon_i$, som för ökande antal inventeringstimmar går mot en asymptot. Y_i är antalet arter (av de 28), $ß_0$ är en konstant som ger asymptoten, $ß_1$ är en annan konstant, x_i är totala inventeringstiden och ε_i är en felterm. Fig. 2 visar hur antalet arter ökade med ökad inventeringstid. Endast rutor som inventerats längre än ca 45 timmar hade minst 90% av de 28 arterna registrerade. Tider kortare än ca 16 timmar var oftast klart otillräckliga. Regressionslinjen är en god anpassning till observationspunkterna (R^2 = 0,41) och visar att 90% av de 28 arterna i medeltal hade registrerats efter 20–25 timmar. Det är dock stor variation fram till ca 40 timmar och inte ens efter så lång tid som 45–65 timmar hade alla arter registrerats. Vårt resultat stämmer väl med studier av atlasrutor i Storbritannien där man konstaterat att man fortfarande kan hitta nya häckande arter efter så mycket som 200 timmars inventeringsarbete. De samhällen av skogslevande fåglar som vi studerat är representativa för stora delar av Fennoskandien. Därför tror vi att dessa riktlinjer kan användas för planering av framtida atlasarbete inom en stor del av denna region. Riktlinjerna bör också kunna användas i analyser av befintliga atlasmaterial för att skilja på rutor som är bra och dåligt inventerade. Man måste dock hålla i minnet att andra skogsarter, som inte är med i denna studie, kan kräva längre inventeringstider, särskilt sällsyntare arter och arter som har speciella biotopkrav. De slutsatser vi nått gäller för projekt som utnyttjar ett stort antal frivilliga amatörornitologer med varierande kompetens och ambitioner, något som gäller för de flesta atlasprojekt. Mycket erfarna eller särskilt tränade inventerare uppnår givetvis högre effektivitet. Högre effektivitet kan också uppnås vid inventering av biotoper som är mera lättinventerade än skog, särskilt olika typer av öppen mark.

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Appendix. Bird species of the boreal forest considered enough common and generalised in their requirements to be present in every 5 × 5 atlas square largely dominated by forest, their frequency of observation in the 183 squares retained for the analyses, half-width of the zone used to estimate density from line transect data, and their estimated mean densities in forests of the study area.

Species	Number of squares where detected*	Half-width of zone (m)	Estimated mean density (pairs/ km²)
Black Grouse (*Tetrao tetrix*)	149	400	0.27
Capercaillie (*Tetrao urogallus*)	128	100	0.41
Woodpigeon (*Columba palumbus*)	177	200	2.16
Cuckoo (*Cuculus canorus*)	173	400	0.40
Great Spotted Woodpecker (*Dendrocopos major*)	177	100	1.23
Tree Pipit (*Anthus trivialis*)	179	100	7.98
Wren (*Troglodytes troglodytes*)	80	100	1.28
Dunnock (*Prunella modularis*)	144	50	2.36
Robin (*Erithacus rubecula*)	173	50	12.39
Blackbird (*Turdus merula*)	169	200	1.83
Fieldfare (*Turdus pilaris*)	168	100	3.98
Song Thrush (*Turdus philomelos*)	176	200	2.51
Redwing (*Turdus iliacus*)	176	200	1.70
Mistle Thrush (*Turdus viscivorus*)	116	200	0.34
Willow Warbler (*Phylloscopus trochilus*)	181	100	26.38
Goldcrest (*Regulus regulus*)	163	50	6.69
Spotted Flycatcher (*Muscicapa striata*)	155	50	3.57
Pied Flycatcher (*Ficedula hypoleuca*)	172	100	2.22
Willow Tit (*Parus montanus*)	170	100	0.66
Crested Tit (*Parus cristatus*)	145	100	0.89
Coal Tit (*Parus ater*)	147	100	0.52
Great Tit (*Parus major*)	174	100	3.76
Treecreeper (*Certhia familiaris*)	135	50	1.03
Jay (*Garrulus glandarius*)	160	50	1.12
Chaffinch (*Fringilla coelebs*)	182	100	22.27
Siskin (*Carduelis spinus*)	170	50	16.28
Crossbills (*Loxia* spp.)	154	100	1.72
Bullfinch (*Pyrrhula pyrrhula*)	134	50	1.41

* From a total of 183 atlas squares.