Avocetta 33: 131-136 (2009)

Comparison of population indices derived from the Finnish Constant Effort Site and National Bird Monitoring Scheme data

MARKUS PIHA, JARI VALKAMA, RISTO A. VÄISÄNEN AND PERTTI SAUROLA

Finnish Museum of Natural History - P.O. Box 17, FI-00014 University of Helsinki, Finland (markus.piha@helsinki.fi)

Abstract – We studied the concordance of population trends and indices between data from (1) the Finnish Constant Effort mist-netting Scheme (CES) and (2) line transect and point count based National Bird Monitoring Scheme (NMS). Population indices of nine common passerines between 1987-2006 were calculated with log-linear Poisson modelling (TRIM). The concordance of trends and population indices between the two monitoring schemes was studied by including the scheme as a covariate in the models. In general, the overall 20-year linear trends were rather similar between CES and NMS data across species, although the magnitude (but not sign) of trends differed in two species. On the other hand, when the short-term fluctuations were included in the comparisons, time-series of five species (out of nine) showed significant differences between the two monitoring schemes. These findings highlight that although long-term trends may usually be coherent, two data-sets may give different results if subjected to detailed analyses of between-year changes.

INTRODUCTION

Various bird monitoring schemes are applied worldwide to gather knowledge on population trends and fluctuations. Most census techniques, such as standardized line transect or point counts (see Bibby *et al.* 2000), provide useful data for producing local or regional population indices that can be used in various correlative studies and for conservational issues in general. Standardized censuses can be relatively easily made by volunteers enabling the monitoring of large areas. However, mere indices do not provide information about the productivity or survival, which are key properties of population dynamical studies.

Bird censuses are always subject to some sources of error. For example, observers vary in their skills and motivation (Enemar *et al.* 1978, Cunningham *et al.* 1999), and skills develop with census experience, whereas motivation may decrease or increase (Kendall *et al.* 1996). Phenological responses of birds to climate change pose further challenges to bird monitoring, especially to schemes based on one (or few) visits. The migratory behaviour and breeding phenology of birds have advanced rapidly (*e.g.* Crick & Sparks 1999, Jonzén *et al*. 2006), and hence their territorial behaviour has changed in relation to the timing of standardized bird census seasons. Without correcting for the shift in timing, spurious population trends may be observed due to long-term changes in seasonal detectability.

The Constant Effort Sites Scheme (CES) was introduced by the British Trust for Ornithology (BTO) in 1981 (Baillie *et al.* 1986), and currently there are CES schemes running in 14 European countries. There is an equivalent scheme to CES in North America called Monitoring Avian Productivity and Survivorship (MAPS; DeSante *et al*. 1995). CES is based on the mist netting of birds with a standard protocol, where the effort invested in catching and marking of individuals is controlled. The major advantage in mark-recapture data gathered in CES is that this type of data makes detailed studies of population size, productivity and survival possible (see e.g. Peach *et al.* 1996, 1999). If population trends are derived from CES data, a major benefit compared to census data is that observer error is minimized. Another advantage is that the effect of advancement of territorial activities as a response to climate change is presumably less in CES than in census data. This is because CES does not rely on observations but on constant capture and recapture probability over years, and CES usually incorporates numerous efforts that cover the majority of the breeding season increasing the "detection" probability of individuals. For example, in Finland the majority of sites have 12 visits distributed evenly between May and August. The major disadvantage of CES is that it is very time consuming and that the number of qualified ringers capable of field work limits the number of active sites. Furthermore, another notable limitation of

CES is that sites cannot be selected at random and it is only possible to sample particular habitats. In addition, species coverage from counts is naturally greater than from CES. Habitat changes pose a further bias to CES data, since vegetational succession may change capturing probability between years, although the vegetation of sites is endeavoured to be held constant. The problem of vegetation changes is likely to be less pronounced in census data, since the large number of census routes and the larger areas covered by census increases the occurrence probability of habitats with various successional stages, whereas the CES data are confined to the habitats within the given sites.

The aim of this paper is to study whether the Finnish CES sites and the National Bird Monitoring Scheme (NMS; based on line transects and point counts) data provide similar population trends and indices for nine common species, Robin *Erithacus rubecula*, Redwing *Turdus iliacus*, Sedge Warbler *Acrocephalus schoenobaenus*, Common Whitethroat *Sylvia communis*, Garden Warbler *Sylvia borin*, Willow Warbler *Phylloscopus trochilus*, Blue Tit *Parus caeruleus*, Scarlet Rosefinch *Carpodacus erythrinus* and Reed Bunting *Emberiza schoeniclus*. The possible causes for the differences are discussed.

MATERIAL AND METHODS

CES data

The Finnish CES project began already in 1987 (1986 was a pilot year; Haapala *et al.* 1987). Most of the sites are situated in wet or shrubby habitats typically with abundant *Salix* spp. vegetation. Altogether 106 sites have been ac-

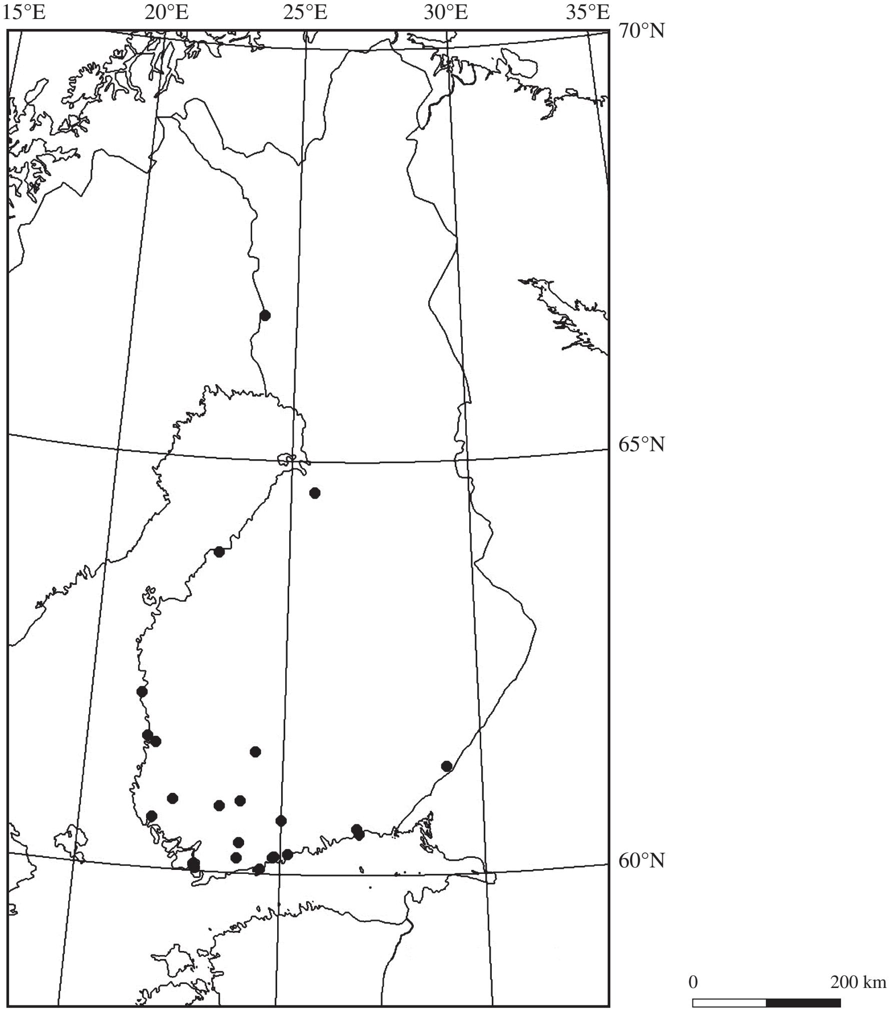

Figure 1. The locations of Constant Effort Sites included in the calculation of population indices.

tive during the study period 1986-2006, with an average of 32 active sites per year (Haapala *et al.* 2007). Sites that had existed at least 10 years (altogether 25 sites) were included in the analysis. Two sites changed effort or procedure during the study period and were thus treated as new sites in the analysis. Hence the total number of sites in the analysis was 27. The geographical distribution of sites was concentrated to southern Finland (Fig. 1). Only years with an equal number of standard capture days within a site were included in the analysis (mean 9.3 years per site, range 4-19), and other years were treated as missing data (for example only years 1987, 1989 and 1996 were included in the data for a site *i*, where visits per year: 1987:10 visits, 1988:8, 1989:10, 1990:7, 1991:6, 1992:11, 1993:5, 1994:0, 1995:9, 1996:10). This was done in order to standardize the effort per site between years. The total number of captured adult individuals per year per site was used for calculating population indices. For the data selected to the analysis, the annual capture effort per site was on average 6634 mist net metre hours (averages: mist net length = 98 m, capture days = 11, hours per capture day = 6).

NMS data

The Finnish national monitoring data of breeding land birds consist of line transects, (each 4-6 km long), point count routes (20 points x 5 minutes), and mapping areas.

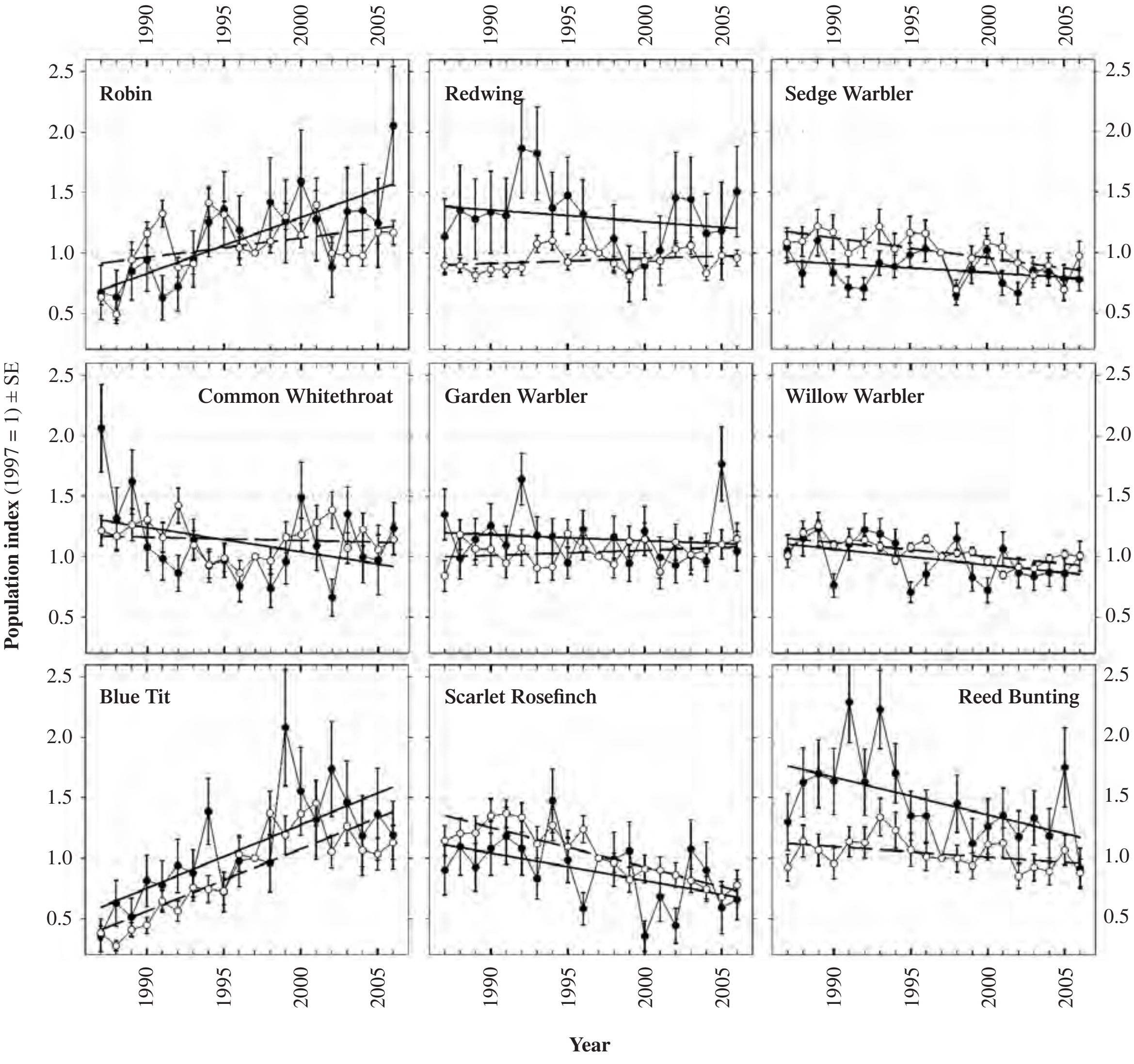

Figure 2. Population indices of the studied species between 1987-2006. Closed circles: Constant Effort Sites (CES), open circles: National Bird Monitoring Scheme (NMS). Trends are represented with ordinary linear regressions (solid line: CES, dashed line: NMS).

Table 1. Overall (additive) population changes per year between 1987-2006 in Constant Effort Site (CES) and National Bird Monitoring Scheme (NMS) data and mean numbers of observations per year.

	Mean population change (%) **per year** (± S.E.)		**Mean number of observations per year**	
Species	**CES**	**NMS**	**CES** (individuals)	**NMS** (pairs)
Robin	4.3 ± 1.0 **	2.0 ± 0.3 **	45	577
Redwing	-0.8 ± 1.0 NS	0.4 ± 0.2 NS	53	913
Sedge Warbler	-0.8 ± 0.7 NS	-1.7 ± 0.4 **	167	249
Common Whitethroat	-1.5 ± 0.9 NS	-0.2 ± 0.3 NS	66	290
Garden Warbler	-0.5 ± 0.8 NS	0.5 ± 0.2 *	106	723
Willow Warbler	-1.3 ± 0.6 *	-1.1 ± 0.1 **	263	5153
Blue Tit	5.7 ± 1.1 **	7.1 ± 0.5 **	34	182
Scarlet Rosefinch	-3.0 ± 1.3 *	-3.3 ± 0.3 **	46	319
Reed Bunting	-2.2 ± 0.7 **	-0.9 ± 0.4 *	92	211

*** p < 0.005, ** p < 0.01, * p < 0.05, NS p > 0.05

Table 2. The importance of the monitoring scheme in explaining the differences in (a) trends and (b) annual indices between the two schemes. Models with significant effect ($p < 0.05$) of scheme as measured by Wald test are represented in bold font. $\text{AIC}_{\text{NO SCHEME}}$ and $\text{AIC}_{\text{SCHEME}}$ are the Akaike Information Criterion values (smaller is better) for the models without and with scheme as a covariate, respectively. ΔAIC stands for the change in AIC value when covariate was added in the model. Large positive values (> 3 in most studies) indicate that the model with a covariate is better.

(a) Linear trend models

Species	**Wald**	**df**	**p**	**$\text{AIC}_{\text{NO SCHEME}}$**	**$\text{AIC}_{\text{SCHEME}}$**	**ΔAIC**
Robin	**3.93**	**1**	**0.048**	**-328.43**	**-333.61**	**5.18**
Redwing	1.86	1	0.172	-520.89	-523.14	2.25
Sedge Warbler	1.14	1	0.286	-849.92	-847.99	-1.93
Common Whitethroat	1.73	1	0.189	-1285.38	-1285.41	0.03
Garden Warbler	**4.35**	**1**	**0.037**	**-1290.70**	**-1291.80**	**1.10**
Willow Warbler	0.18	1	0.672	1010.34	1009.41	0.93
Blue Tit	1.33	1	0.249	-1322.84	-1322.42	-0.42
Scarlet Rosefinch	0.37	1	0.544	-1349.81	-1348.42	-1.39
Reed Bunting	**6.07**	**1**	**0.014**	**-1520.75**	**-1525.22**	**4.47**

(b) Annual effects models

Species	**Wald**	**df**	**p**	**$\text{AIC}_{\text{NO SCHEME}}$**	**$\text{AIC}_{\text{SCHEME}}$**	**ΔAIC**
Robin	29.81	19	0.054	-749.93	-761.08	11.15
Redwing	21.41	19	0.315	-605.73	-605.25	-0.48
Sedge Warbler	22.65	19	0.253	-910.53	-899.65	-10.88
Common Whitethroat	**53.92**	**19**	**0.000**	**-1328.45**	**-1353.73**	**25.28**
Garden Warbler	**58.46**	**19**	**0.000**	**-1368.70**	**-1398.28**	**29.58**
Willow Warbler	**68.51**	**19**	**0.000**	**495.17**	**391.39**	**103.78**
Blue Tit	**36.02**	**19**	**0.011**	**-1432.28**	**-1431.60**	**-0.68**
Scarlet Rosefinch	**37.42**	**19**	**0.007**	**-1374.39**	**-1384.30**	**9.91**
Reed Bunting	27.25	19	0.090	-1568.79	-1561.92	-6.87

In recent years, the number of repeated counts per year has been 85-100 (of which ca. 60% line transects, 30% point count routes, and 10% mapping areas).

The total number of pair observations per year was used as the data for calculating population indices. In average, about 20 000 pair observations (all species) were made annually. The NMS data are expected to cover habitats approximately in same proportions as habitats exist in Finland since the census makers are instructed to establish new routes in a manner that the habitat composition represents local conditions. However, a slight skew towards more bird-rich habitats, such as wetlands and scrubby habitats, is expected since the routes have been mainly established by volunteer bird watchers. A detailed description of the Finnish bird monitoring scheme is given in Väisänen (2005, 2006).

STATISTICAL METHODS

Population indices and overall trends between 1987 and 2006 were calculated using log-linear Poisson modelling as implemented in TRIM (version 3.53; Statistics Netherlands; see Pannekoek & van Strien 2004). Final indices presented in the figures were produced using a model with separate parameters for each time-point, taking overdispersion and serial correlation into account. The base year (index = 1) was set to 1997.

The concordance of trends and population indices between the two monitoring schemes was studied by including the scheme as a covariate in the models. Firstly, in order to study whether the long term 20-year trends were similar in the two data sets, linear (on the log-scale) trend models were fitted with and without the covariate. Then the change in Akaike Information Criteria (AIC) was calculated in order to evaluate if the covariate significantly improved the model. In addition, Wald test for the significance of the covariate (as implemented in TRIM) was performed. Secondly, we performed similar AIC and Wald tests for the importance of the covariate in a model where each year is parameterized separately (“time effects” model in TRIM). Using this analysis we inspected the differences in short term fluctuations between the two data sets.

RESULTS AND DISCUSSION

In principle, the CES and NMS data provided rather similar long-term trends between 1987-2006 (Fig. 2, Table 1). The Robin and Blue Tit populations increased strongly, whereas Willow Warbler, Scarlet Rosefinch and Reed Bunting populations decreased. Including the scheme as a covariate to linear trend models improved the model performance for three species while the scheme was insignificant for the other 6 species (Table 2a). The three species that showed different trends between the schemes were Robin (both schemes indicate strong increase), Reed bunting (both schemes indicate decrease) and Garden Warbler (only NMS trend significantly different from zero). In fact, in case of Garden Warbler, the small change in AIC indicates that the effect of the scheme in the linear trend model is not very important (Table 2a).

When the short-term fluctuations were included in the comparisons by fitting annual effects models (where each year was parameterized separately), the monitoring scheme was more important. Population indices derived from the two schemes seemed to be in concordance in four species, while for the other five species the indices differed (Table 2b, cf. Fig. 2). However, while the Wald test was only nearly significant in Robin, the large change in AIC indicates an important effect of scheme. Conversely, in case of Blue Tit the small change in AIC indicates that the effect of the scheme is not important (Table 2b). The annual variation in population indices was larger in CES than NMS data which is most likely due to a smaller sample size in CES (Fig. 2).

In addition to observation error in both NMS and CES data, there are some potential methodology related explanations for the differences between CES and NMS data. Firstly, CES sites are more limited in habitat composition than the larger NMS data set. Hence, according to theory of habitat selection (cf. Rosenzweig 1981) larger between-year variations in CES population indices are expected for species whose optimal habitats are not wet or bushy habitats, the predominant habitat type of Finnish CES sites. In accordance of this, two species showing the strongest short-term synchrony between the two schemes, the Sedge Warbler and Reed Bunting are wet and bushy habitat specialists. Secondly, line transect and point count methodology may dampen the annual fluctuations of very abundant species (see Bibby *et al.* 2000), because with high population densities, the detectability of distant aural observations decreases and *vice versa*, an effect for which CES data should be immune.

A hypothetical example of this could be the population indices of the Willow Warbler, where three clear drops in CES indices in 1995, 2000 and 2005 are absent in NMS indices. Thirdly, some very late arriving migratory species, such as the Garden Warbler and Scarlet Rosefinch, may have very low densities during the census time in years when timing of spring migration is delayed. This and other phenological issues may induce further variability in NMS data which is likely not observed with CES data with its season lasting some four months.

In summary, CES and NMS data-sets provide rather similar long-term trends, but short-term fluctuations are not synchronous for most species. There are many potential reasons for asynchrony including geographical and habitat specific differences in population indices. Hence, it is highly important to consider habitat and sampling methodology effects in the light of focal species' ecology before conducting time-series analyses. We emphasize that even high-quality data-sets may give different results if subjected to detailed analyses of between-year changes. More studies are needed to evaluate the applicability and robustness of various monitoring data to population dynamical analyses. More specifically, we need studies on how differences in habitat, phenological and geographic subsets of various monitoring data affect further analytical results, and, in which cases large pooled monitoring data sets should be preferred to smaller subsets.

REFERENCES

Baillie SR, Green RE, Boddy M, Buckland ST 1986. An evaluation of the Constant Effort Sites Scheme. BTO Research Report No. 21. BTO Thetford, Norfolk, UK.

Bibby CJ, Burgess ND, Hill DA, Mustoe SH 2000. Bird census techniques, 2nd edn. Academic Press, London.

Crick HQP, Sparks TH 1999. Climate change related to egg-laying trends. Nature 399: 423-424.

Cunningham RB, Lindenmayer DB, Nix HA, Lindenmayr BD 1999. Quantifying observer heterogeneity in bird counts. Australian Journal of Ecology 24: 270-277.

DeSante DF, Burton KM, Saracco JF, Walker BL 1995. Productivity indices and survival-rate estimates from MAPS, a continent-wide programme of constant-effort mist-netting in North America. Journal of Applied Statistics 22: 935-947.

Enemar A, Sjöstrand B, Svensson S 1978. Effect of observer variability on bird census results obtained by a territory mapping technique. Ornis Scandinavica 9: 31-39.

Haapala J, Heikinheimo M, Valkama J 2007. Constant Effort Ringing in Finland in 2006. Linnut-vuosikirja 2006: 92-97. [In Finnish with English summary]

Haapala J, Koskimies P, Saurola P 1987. SSP - A mistnetting project for monitoring bird populations in Finland? Lintumies 22: 76-78. [In Finnish with English summary]

Jonzén N, Lindén A, Ergon T, Knudsen E, Vik JO, Rubolini D, Piacentini D, Brinch C, Spina F, Karlsson L, Stervander M, Andersson A, Waldenström J, Lehikoinen A, Edvardsen E, Solvang R, Stenseth NC 2006. Rapid advance of spring arrival dates in long-distance migrants. Science 312: 1959-1961.

Kendall WL, Peterjohn BG, Sauer JR 1996. First-time observer effects in the North American Breeding Bird Survey. Auk 113: 823-829.

Pannekoek J, van Strien A 2004. TRIM 3 Manual (TRends & Indices for Monitoring data). Statistics Netherlands, Voorburg.

Peach WJ, Buckland ST, Baillie SR 1996. The use of constant effort mist-netting to measure between-year changes in the abundance and productivity of common passerines. Bird Study 43: 142-156.

Peach WJ, Siriwardena GM, Gregory RD 1999. Long-term changes in over-winter survival rates explain the decline of reed buntings *Emberiza schoeniclus* in Britain. Journal of Applied Ecology 36: 798-811.

Rosenzweig ML 1981. A theory of habitat selection. Ecology 62: 327-335.

Väisänen RA 2005. Monitoring population changes of 84 land bird species breeding in Finland in 1983-2004. Linnut-vuosikirja 2004: 105-119. [In Finnish with English summary]

Väisänen RA 2006. Monitoring population changes of 86 land bird species breeding in Finland in 1983-2005. Linnut-vuosikirja 2005: 83-98. [In Finnish with English summary]