

## **Monitoring of numbers in passage populations of passerines over 42 years (1958-1999) on the Courish Spit of the Baltic Sea**

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*Abstract.* Sokolov, L.V., Yefremov, V.D., Markovets, M.Yu., Shapoval, A.P. & Shumakov, M.E. (2000): Monitoring of numbers of passage populations of passerines over 42 years (1958-1999) on the Courish Spit of the Baltic Sea. *Avian Ecol. Behav.* 4: 31-53.

The analysis of trends in numbers of passage populations in autumn in 24 passerine species on the Courish Spit on the Baltic Sea recorded by trapping in large Rybachy-type traps showed a significant increase in the majority of species in the 1960s and 1980s and a decline in the 1970s and 1990s. In ten out of 12 species under consideration we found a significant positive relationship between number estimates of local juveniles during the post-fledging period on the Courish Spit and numbers of autumn migrants. In nine out of 12 species a significant negative relationship was recorded between the numbers of juveniles on autumn migration and the timing of breeding on the Courish Spit. A test for relationship between the mean monthly temperatures in spring and in summer in our area and numbers of autumn migrants revealed a positive correlation of numbers with mean April temperature in 11 species. We conclude therefore that the long-term number dynamics of autumn passerine migrants on the Courish Spit is a good estimate of the trends in breeding populations that migrate over our study site in autumn. Long-term fluctuations in the numbers of passerines in the Baltic region are in our opinion primarily related to the global climate change in Europe in the 20th century. Considerable increases in numbers in 1960s and 1980s are most likely explained by warm springs that were frequent in these decades. High spring air temperature caused earlier arrival and breeding, and also higher breeding success and offspring survival, which has led to an increase in breeding and passage populations in these decades.

*Key words:* population dynamics, autumn migration, passerines, climate, air temperature.

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### **1. Introduction**

Recently much data has been made available that suggests a considerable, not infrequently dramatic, decline of a number of passerine species in Europe, primarily long-distance migrants (Busse 1994, Busse et al. 1995, Wozniak 1997, Berthold et al. 1998, 1999, Chamberlain & Fuller 1999, Gatter 1999). The decline of passerines in some parts of Europe, in particular in Central Europe, is explained by the authors either in terms of anthropogenic factors, or by global warming. Warming is believed to be taking place currently in both hemispheres. A number of authors believe that it is the aridization, primarily of the Sahara, and the frequent droughts in Africa that caused a considerable decline of many trans-Saharan migrants in Europe (Peach et al. 1991, 1995b, Jury 1997, Balmer & Peach 1998, Berthold et al. 1998, 1999).

In an earlier paper (Sokolov 1999) it was shown that the long-term significant fluctuations in the numbers of breeding populations of passerines in the Baltic region do exist, and it was suggested that they are related to the climate change in Europe in the second half of the 20th century. These data however suggest that considerable warm spells in the northern hemisphere in the 1960s and especially in the 1980s not only did not cause a decline in populations of passerines that breed on the Courish Spit and spend their winter in Europe and in Africa, but, on the contrary, facilitated

a significant increase in the bulk of the species under study. A decline of the local breeders on the Courish Spit was recorded in the 1970s and 1990s when the climate grew colder, primarily in spring (Sokolov et al. 1998). Thus, our data on the numbers dynamics of Courish populations are not consistent with the data from Central Europe. It becomes highly important to know whether the numbers of the northern populations of passerines, that pass through the Courish Spit in autumn, varied in line with Courish populations. Ringing recoveries show that, in autumn, passerine populations from NW Russia, Finland, Sweden, and Eastern Baltic countries migrate through the Courish Spit (Payevsky 1973, Bolshakov et al. 1999).

The goal of this study was to reveal the pattern of population dynamics, and the long-term trends over a period of more than 40 years in the passage populations of passerines spending their winter in Europe and in Africa. We attempted to understand, which environmental factors govern the numbers dynamics of the passage populations in the Baltic region.

The long-term trends in the numbers of passerines on autumn migration in the Baltic area has been studied earlier (Dolnik & Payevsky 1976a, 1979, Payevsky 1983, 1985, 1990a, b). These authors did not however analyse the dynamics of numbers in relationship with the data on climate change in the northern hemisphere.

## 2. Material and methods

We used the results of 42-years (1958-1999) of monitoring numbers of passage passerine populations in autumn (defined as August 15 – October 31) on the Courish Spit on the Baltic coast. This project has been carried out by the Biological Station Rybachy of the Zoological Institute, Russian Academy of Sciences.

We separately analysed numbers of juveniles and adults captured in two Rybachy-type traps (for a detailed description of the traps see: Dolnik & Payevsky 1976b) with the entrance oriented towards the NE. One trap was in operation in 1958-1985 (# 3 in Fig. 1,2), another from 1977 until present (# 5). Rybachy-type traps are annually in operation during the same period (April 1 – November 1) at the same site in pine plantations (for a detailed description of the habitat see: Payevsky 1999). Autumn passage for the majority of species in the study occurs on the Courish Spit from August 15 until November 1. Before mid August the vast majority of local birds leave their natal area (Sokolov 1997).

We analysed year-to-year variations in the numbers of juveniles trapped between August 15 – October 31 in 24 species. To reveal long-term trends, three partly overlapping periods were considered: between 1958 and 1977 (20 years); between 1977 and 1990 (14 years); and between 1985 and 1998 (14 years). We took into consideration that from autumn 1977, a new trap (# 5) came into use. This trap was put up 200 m from the old trap (# 3) in a younger pine plantation. The requirement for long enough time intervals resulted in constructing overlapping second and third time periods.

The dynamics of adult numbers was analysed in ten species in which ageing based on reliable characters was done from 1973 (Vinogradova et al. 1976).

Statistical significance of trends was tested by Spearman's rank correlation (Lloyd & Ledermann 1984). The same test was applied to compare numbers of breeding and passage populations, juvenile and adult migrants, and to reveal a relationship between numbers of migrants and timing of breeding. When analysing the impact of air temperature on avian populations we used the data on mean monthly temperatures in the study area in spring and in summer over 32 years (1959-1990).

Table 1. Long-term trends in the numbers of juvenile passerines during autumn migration on the Courish Spit (Spearman's rank correlation coefficient: + p&lt;0.10, \* p&lt;0.05, \*\* p&lt;0.01, \*\*\* p&lt;0.001).

Species	Years		
	1958-1977	1977-1990	1985-1998
Long-distance migrants			
<i>Hippolais icterina</i>	-0.31	0.07	-0.73**
<i>Phylloscopus sibilatrix</i>	-0.50*	0.82***	-0.83***
<i>Phylloscopus trochilus</i>	-0.70**	0.67*	-0.82***
<i>Ficedula hypoleuca</i>	-0.71**	0.64*	-0.73**
<i>Muscicapa striata</i>	-0.63**	0.40	-0.78**
<i>Phoenicurus phoenicurus</i>	-0.78***	-0.38	-0.68**
<i>Sylvia curruca</i>	0.20	-0.12	-0.80***
<i>Sylvia communis</i>	-0.80***	0.70**	-0.82***
<i>Sylvia borin</i>	-0.69**	0.46+	-0.81***
Medium- and short-distance migrants			
<i>Sylvia atricapilla</i>	-0.05	0.70**	-0.80***
<i>Phylloscopus collybita</i>	-0.06	0.62*	-0.55*
<i>Erithacus rubecula</i>	-0.22	0.05	-0.21
<i>Sturnus vulgaris</i>	-0.60**	-0.20	-0.09
<i>Carduelis spinus</i>	-0.43*	0.35	-0.40
<i>Fringilla coelebs</i>	-0.57**	0.60*	-0.81***
<i>Fringilla montifringilla</i>	-0.58**	0.22	-0.42
<i>Parus montanus</i>	-0.61**	0.76**	-0.80***
<i>Parus ater</i>	-0.25	0.74**	-0.01
<i>Parus caeruleus</i>	-0.03	0.65*	0.18
<i>Parus major</i>	-0.23	0.80***	-0.72**
<i>Emberiza citrinella</i>	-0.60**	0.07	-0.78**
<i>Regulus regulus</i>	-0.23	0.35	-0.09
<i>Aegithalos caudatus</i>	0.01	0.23	0.05
<i>Pyrrhula pyrrhula</i>	-0.16	0.47+	-0.13

### 3. Results

#### 3.1. Long-term trends in the numbers of passage juveniles

In the 1960s and 1980s numbers of juveniles in autumn in most species were higher than in the 1970s and 1990s (Fig. 1, Tab. 1). A pronounced trend towards lower numbers in the 1970s as compared with the 1960s was recorded both in birds that spend their winter within Europe and in trans-Saharan migrants (Tab. 1). In the 1980s a new increase in numbers of the majority of species was revealed (Fig. 1). In many species a significant positive trend in the numbers of passage populations was recorded during these years (Tab. 1). In the 1990s as compared with the 1980s, numbers of migrants significantly declined in the bulk of species (Fig. 1, Tab. 1). The exceptions were the Blue Tit *Parus caeruleus* and the Goldcrest *Regulus regulus* that did not show any decline.

Figure 1. Dynamics of numbers of juveniles on the Courish Spit. Thin line – trap 3; thick line – trap 5.

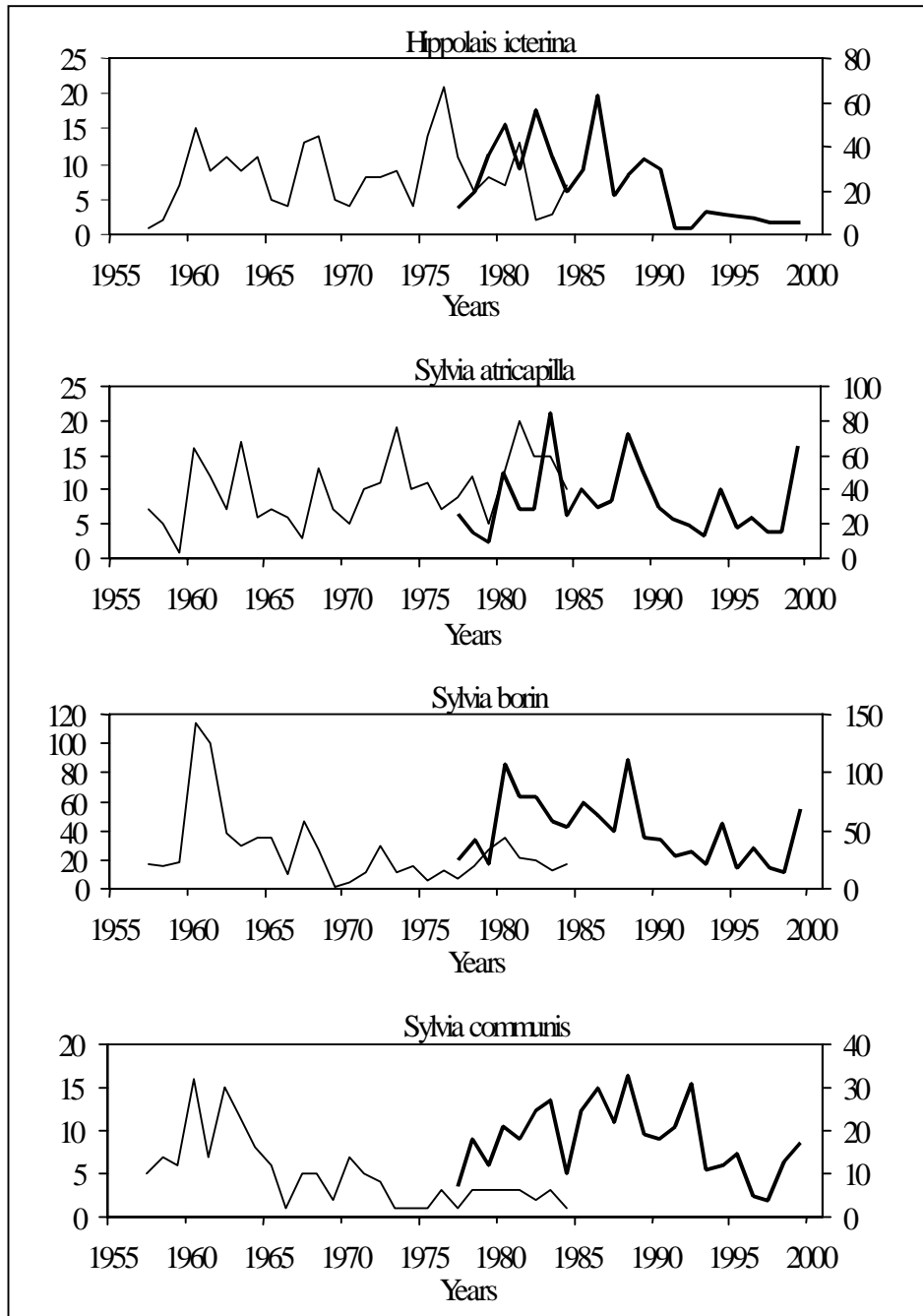


Figure 1. Continued

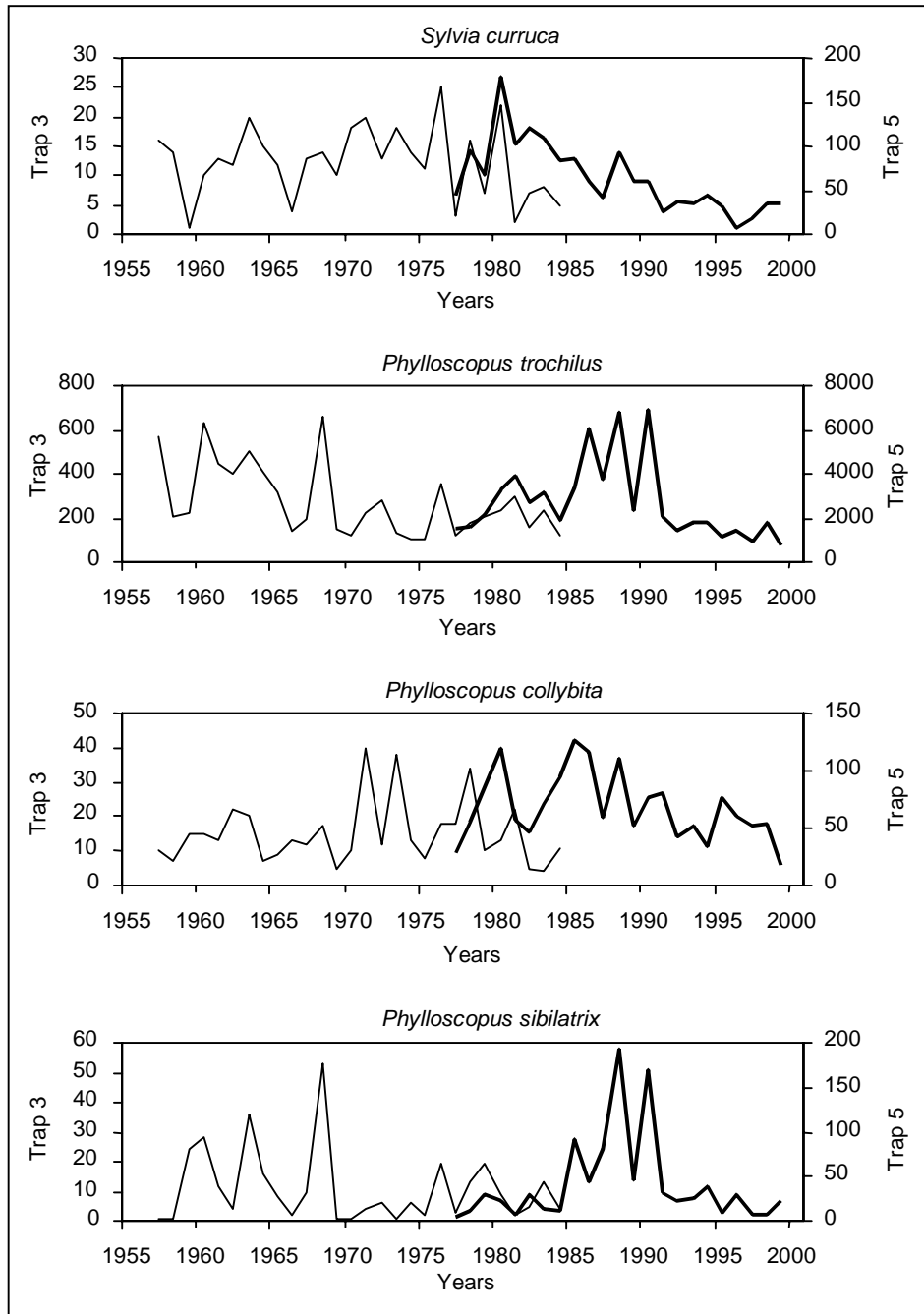


Figure 1. Continued

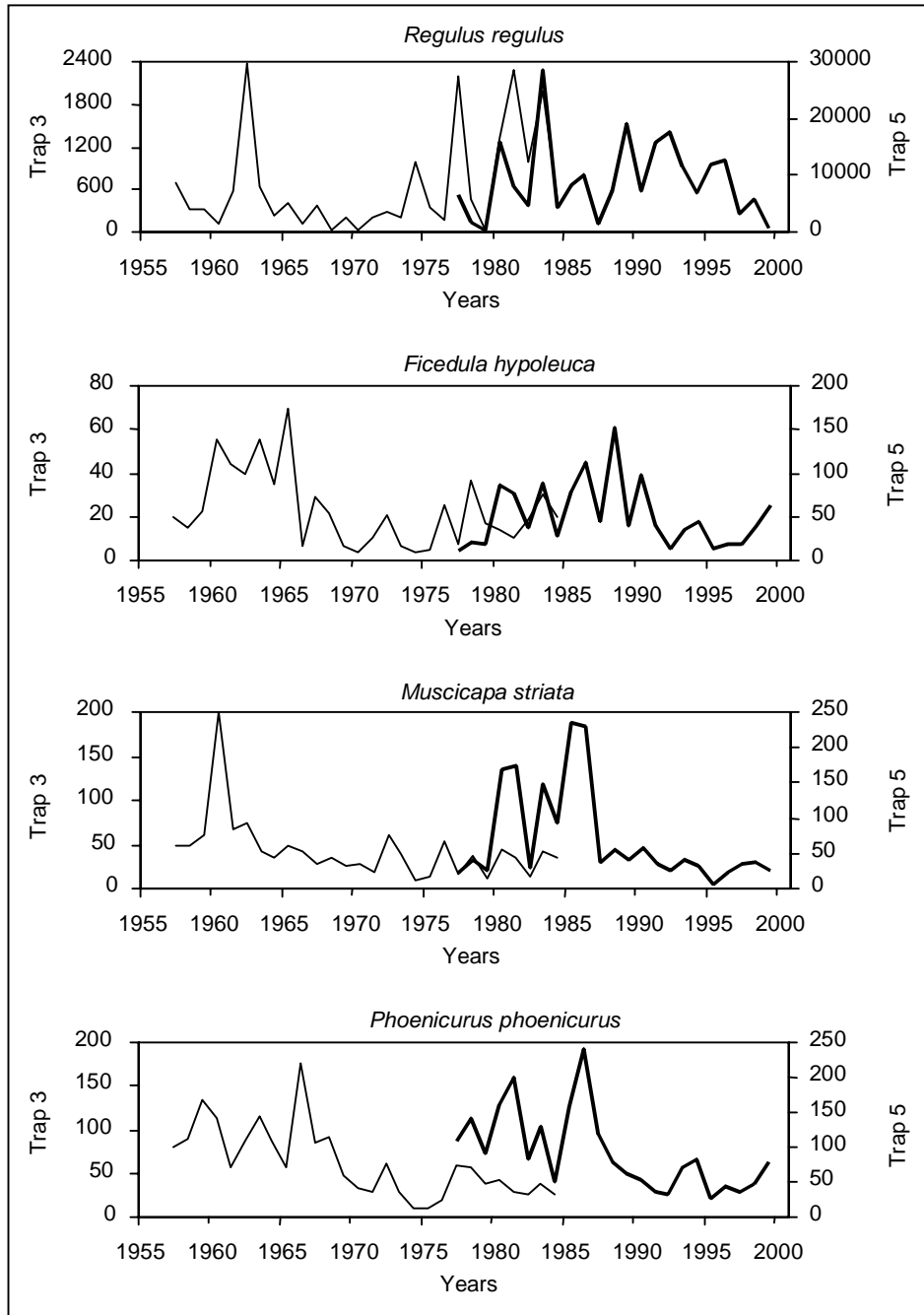


Figure 1. Continued

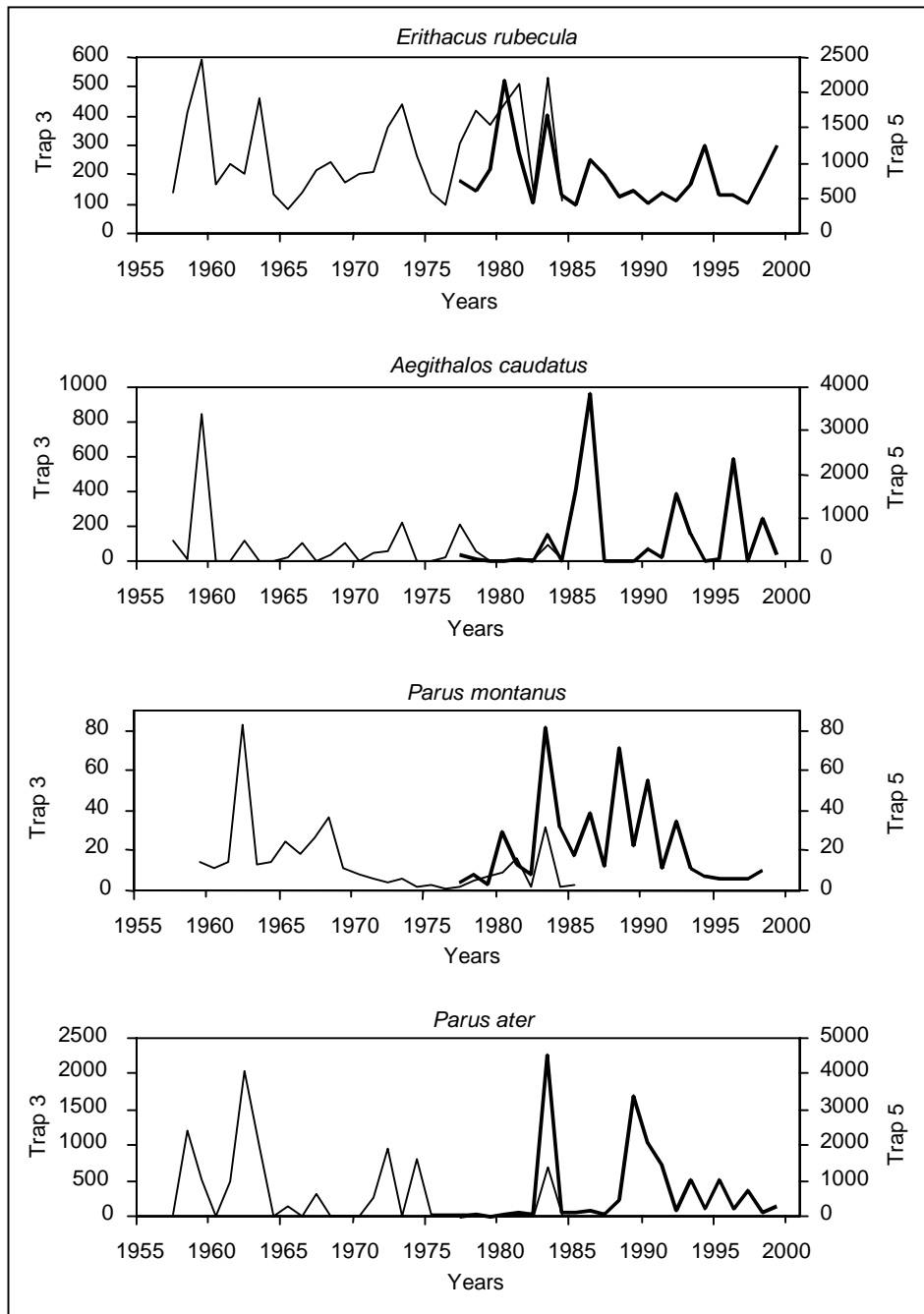


Figure 1. Continued

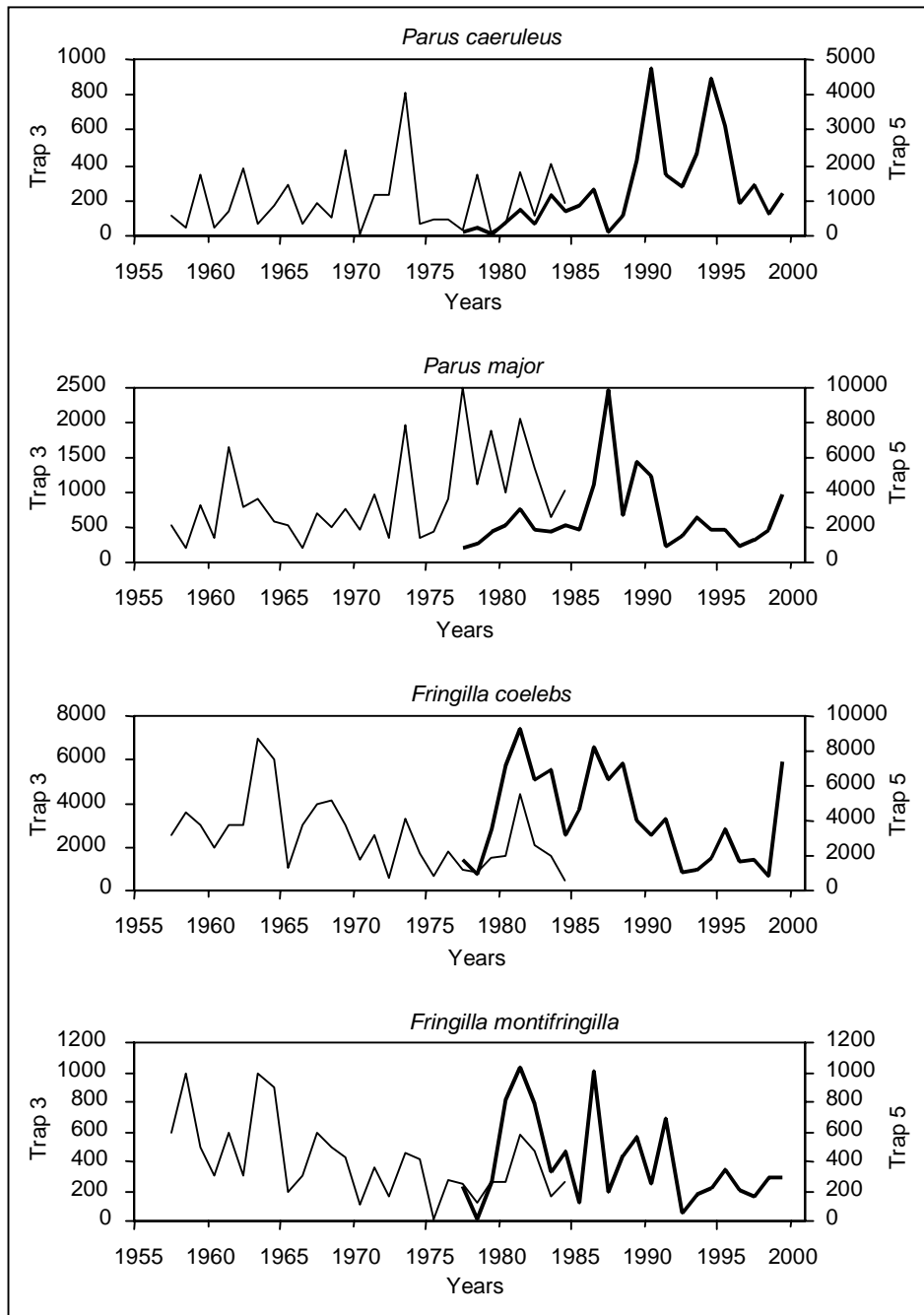
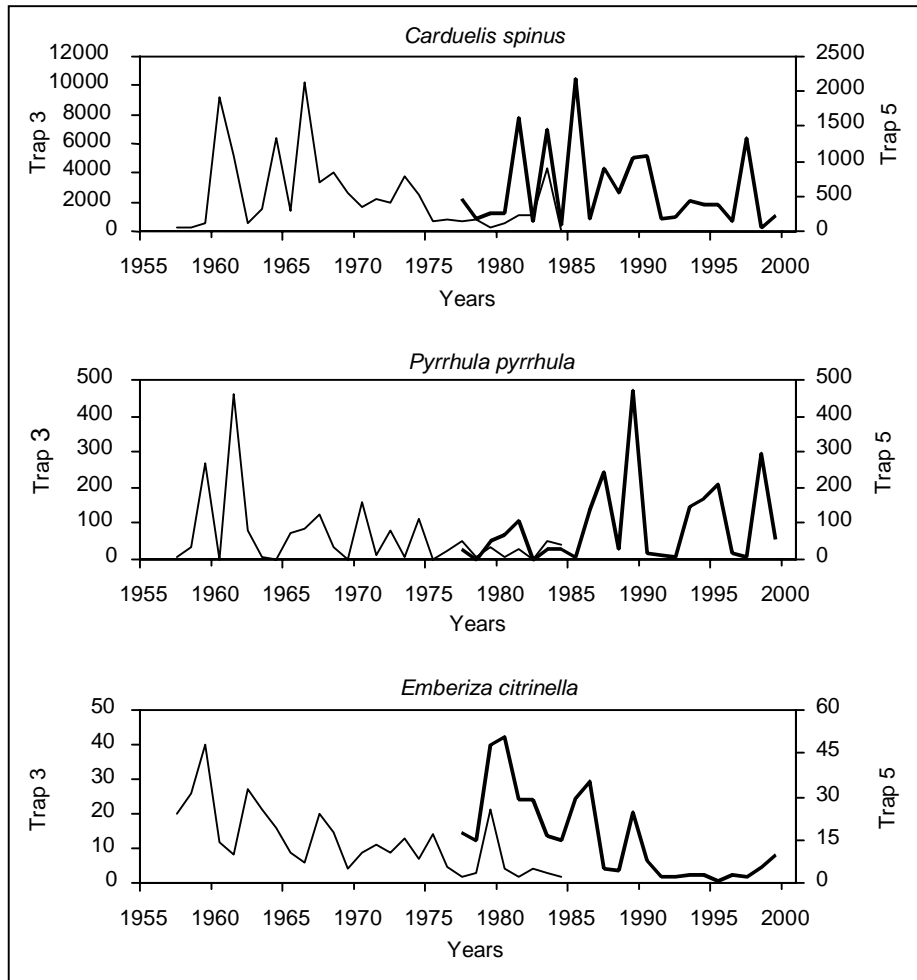




Figure 1. Continued



### 3.2. Trends in the numbers of passage adults

The analysis of year-to-year fluctuations in the numbers of passage adults in ten species showed highest numbers mainly in the 1980s both in long-distance migrants (Willow Warbler *Phylloscopus trochilus* and Redstart *Phoenicurus phoenicurus*) and in species that spend their winter in Europe (Robin *Erithacus rubecula*, Siskin *Carduelis spinus*, Chaffinch *Fringilla coelebs*, Brambling *Fringilla montifringilla*, Great Tit *Parus major* and Coal Tit *Parus ater*) (Fig. 2, Tab. 2). Only in the Blue Tit and in the Goldcrest were highest numbers recorded in the 1990s. In practically all species, number dynamics of both sexes were identical over the whole study period (Fig. 2, Tab. 3). A highly significant correlation between numbers of adults and juveniles was recorded in nine species over the period 1976-1998 (Tab. 4).

Figure 2. Dynamics of numbers of adult birds on the Courish Spit. Thin line – females; thick line – males.

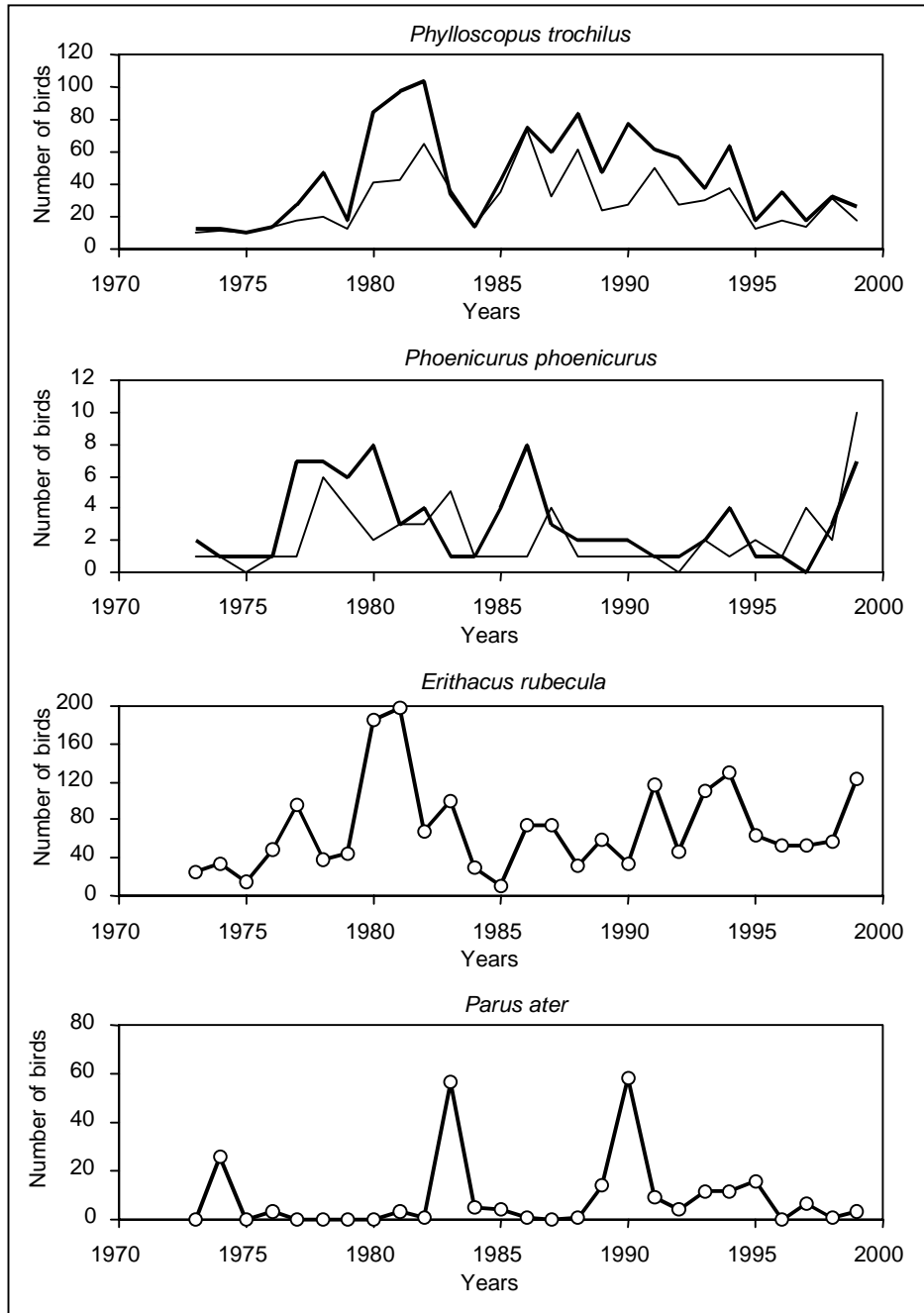


Figure 2. Continued

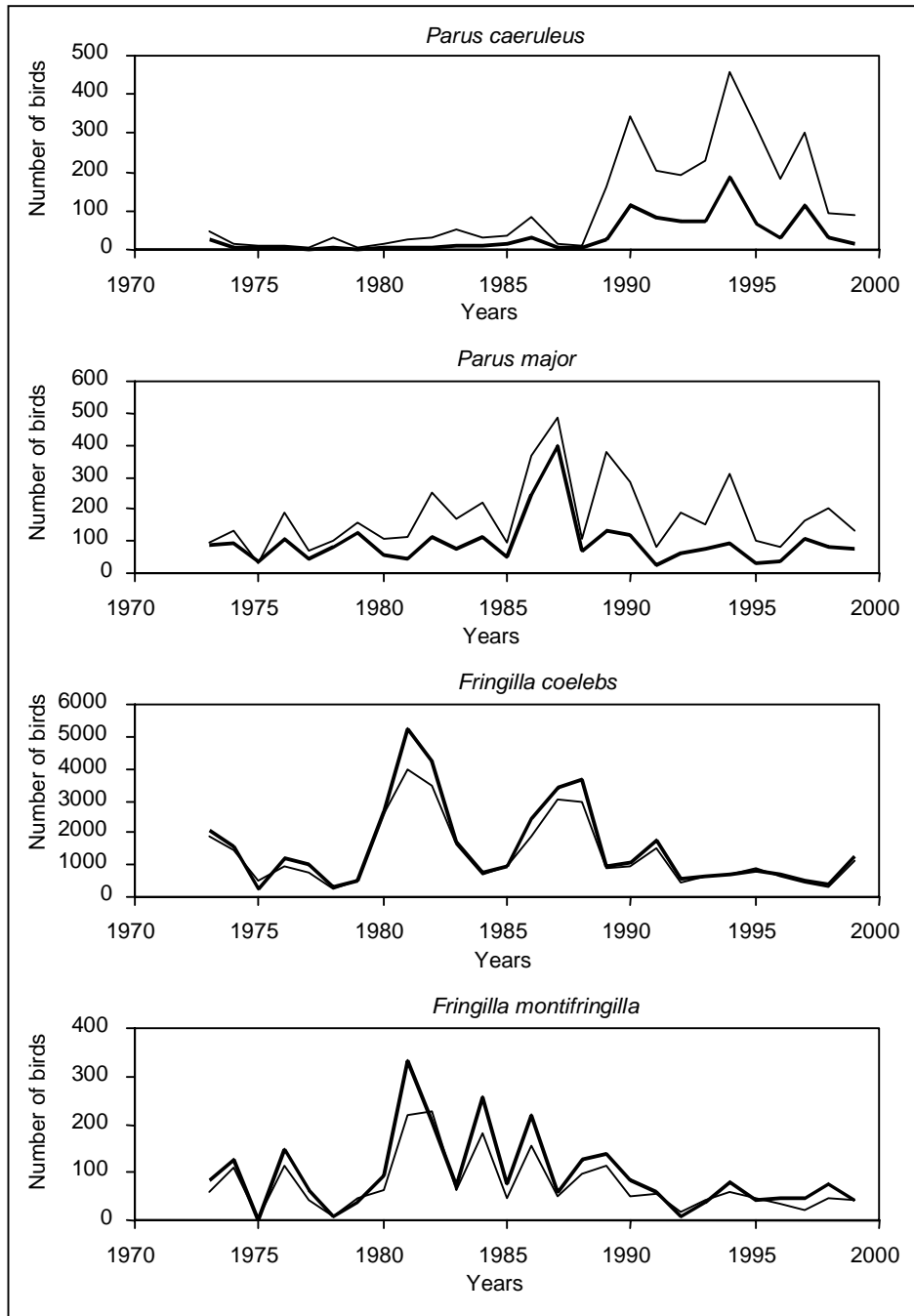
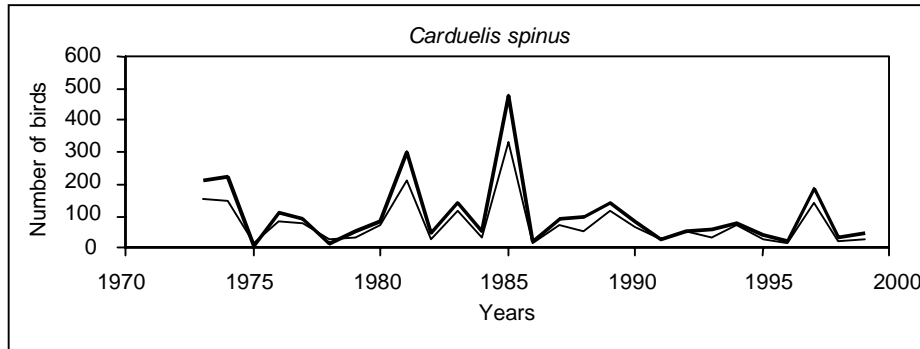


Figure 2. Continued

Table 2. Long-term trends in the numbers of adults during autumn migration on the Courish Spit (Spearman's rank correlation coefficient: +  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ ).

Species	Years 1977-1990		Years 1986-1998	
	Males	Females	Males	Females
<i>Phylloscopus trochilus</i>	0.21	0.34	-0.76**	-0.58*
<i>Phoenicurus phoenicurus</i>	-0.54*	-0.59*	-0.40+	-0.42+
<i>Erithacus rubecula</i>		-0.13		-0.04
<i>Carduelis spinus</i>	0.38+	0.25	-0.34	-0.33
<i>Fringilla coelebs</i>	0.39+	0.43+	-0.85***	-0.87***
<i>Fringilla montifringilla</i>	0.38+	0.42+	-0.56*	-0.68**
<i>Parus ater</i>		0.71**		0.04
<i>Parus caeruleus</i>	0.57*	0.60*	0.45+	0.48*
<i>Parus major</i>	0.48*	0.66**	-0.46+	-0.48*
<i>Regulus regulus</i>	0.29	0.24	-0.06	-0.12

### 3.3. Relationship between numbers of migrating juveniles in autumn and numbers during the post-fledging period on the Courish Spit

An analysis of annual dynamics of numbers of passage and local (fledged on the Courish Spit) juveniles in 12 species in 1959-1998 showed a highly significant positive relationship in both intra-continental and long-distance migrants (Tab. 5). Only in the Willow Warbler was this relationship not significant.

Table 3. Correlation between the numbers of adult males and females, 1975-1999 (Spearman's rank correlation coefficient: \*  $p < 0.05$ , \*\*\*  $p < 0.001$ ).

Species	$r_s$
<i>Phylloscopus trochilus</i>	0.88***
<i>Phoenicurus phoenicurus</i>	0.35*
<i>Carduelis spinus</i>	0.95***
<i>Fringilla coelebs</i>	0.96***
<i>Fringilla montifringilla</i>	0.91***
<i>Parus caeruleus</i>	0.87***
<i>Parus major</i>	0.86***
<i>Regulus regulus</i>	0.90***

Table 4. Correlation between the numbers of juveniles and adults, 1975-1999 (Spearman's rank correlation coefficient: \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ ).

Species	$r_s$
<i>Phylloscopus trochilus</i>	0.61**
<i>Phoenicurus phoenicurus</i>	0.76***
<i>Erithacus rubecula</i>	0.73***
<i>Carduelis spinus</i>	0.83***
<i>Fringilla coelebs</i>	0.91***
<i>Fringilla montifringilla</i>	0.83***
<i>Parus caeruleus</i>	0.90***
<i>Parus major</i>	0.64**
<i>Regulus regulus</i>	0.83***

#### 3.4. Relationship between numbers of passage juveniles and the timing of post-fledging dispersal of Courish birds

The comparison of numbers of passage juveniles in autumn with the mean trapping date of local birds in Rybachy-type traps (which is related to the timing of breeding in the Courish population [Sokolov & Payevsky 1998]) showed a significant negative correlation in nine species out of the 12 studied. In years with early breeding and juvenile dispersal in the Courish population, high numbers of juveniles of the same species are recorded on autumn migration, and vice versa (Tab. 6).

Table 5. Correlation between the numbers of juveniles during autumn migration and during the post-fledging period in some passerines on the Courish Spit, 1959-1998 (Spearman's rank correlation coefficient: +  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ ).

Species	$r_s$
<i>Hippolais icterina</i>	0.69***
<i>Phylloscopus sibilatrix</i>	0.66***
<i>Phylloscopus trochilus</i>	0.25
<i>Ficedula hypoleuca</i>	0.50**
<i>Sylvia curruca</i>	0.62**
<i>Sylvia communis</i>	0.30+
<i>Sylvia borin</i>	0.66***
<i>Sylvia atricapilla</i>	0.55**
<i>Phylloscopus collybita</i>	0.52**
<i>Fringilla coelebs</i>	0.35*
<i>Parus caeruleus</i>	0.46**
<i>Parus major</i>	0.38**

Table 6. Correlation between numbers of migrating juveniles in migration and the onset of juvenile dispersal (mean date of first five captures) during the post-fledging period on the Courish Spit, 1959-1990 (Spearman's rank correlation coefficient: +  $p < 0.10$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ ).

Species	$r_s$
<i>Hippolais icterina</i>	-0.35*
<i>Phylloscopus sibilatrix</i>	-0.47**
<i>Phylloscopus trochilus</i>	-0.46**
<i>Ficedula hypoleuca</i>	-0.55**
<i>Sylvia curruca</i>	-0.04
<i>Sylvia communis</i>	-0.18
<i>Sylvia borin</i>	-0.54**
<i>Sylvia atricapilla</i>	-0.46**
<i>Phylloscopus collybita</i>	-0.33+
<i>Fringilla coelebs</i>	-0.13
<i>Parus caeruleus</i>	-0.51**
<i>Parus major</i>	-0.32+

### 3.5. Relationship between numbers of passage juveniles in autumn and spring and summer air temperatures

We analysed relationships between the number of juveniles trapped in autumn and spring and summer air temperatures as measured at the study site over 32 years (1959-1990). In 11 species a significant positive correlation with the mean April temperature was found (Tab. 7). Only in some species were correlation coefficients with other mean monthly temperatures significant.

Table 7. Correlation between numbers of migrating juveniles in autumn and mean spring and summer air temperatures on the Courish Spit, 1959-1990 (Spearman's rank correlation coefficient: \* p<0.05, \*\* p<0.01, \*\*\* p<0.001).

Species	t °C March	t °C April	t °C May	t °C June	t °C July
Long-distance migrants					
<i>Hippolais icterina</i>	0.07	0.30*	0.32*	-0.04	0.10
<i>Phylloscopus sibilatrix</i>	-0.05	0.48**	0.11	0.13	0.21
<i>Phylloscopus trochilus</i>	-0.27	0.39*	0.19	0.17	0.06
<i>Ficedula hypoleuca</i>	-0.24	0.39*	0.19	0.06	0.03
<i>Muscicapa striata</i>	-0.24	0.34*	0.14	0.06	-0.04
<i>Phoenicurus phoenicurus</i>	-0.28	-0.02	0.02	0.18	-0.09
<i>Sylvia curruca</i>	-0.11	0.01	0.23	-0.26	-0.08
<i>Sylvia communis</i>	-0.28	0.25	0.25	-0.04	-0.07
<i>Sylvia borin</i>	-0.15	0.20	0.09	-0.07	0.03
Medium- and short-distance migrants					
<i>Sylvia atricapilla</i>	0.09	0.28	0.22	0.05	0.41*
<i>Phylloscopus collybita</i>	-0.16	0.43**	0.31*	-0.06	-0.04
<i>Erithacus rubecula</i>	0.01	0.14	-0.02	0.19	0.09
<i>Carduelis spinus</i>	0.07	0.07	0.18	0.40*	0.12
<i>Fringilla coelebs</i>	-0.29	0.16	0.23	0.08	0.11
<i>Fringilla montifringilla</i>	-0.07	0.26	0.17	0.12	0.18
<i>Parus montanus</i>	-0.04	0.56***	0.11	0.10	-0.08
<i>Parus ater</i>	0.28	0.55**	0.25	-0.26	0.24
<i>Parus caeruleus</i>	0.19	0.49**	0.09	0.02	0.24
<i>Parus major</i>	-0.09	0.38*	0.11	-0.08	0.05
<i>Emberiza citrinella</i>	0.03	0.17	0.17	-0.02	-0.17
<i>Regulus regulus</i>	0.15	0.39*	0.09	-0.28	0.13

## 4. Discussion

Earlier it has been shown that numbers of both adult and juvenile passerines were significantly higher in the populations of the Courish Spit in the 1960s and 1980s, than in 1970s and 1990s (Sokolov 1999). It was suggested that the reason for this is the impact of climate. Early and warm springs, most frequent in the 1960s and 1980s, had an important impact not only on the timing of arrival and breeding, but on the breeding success as well. In the 1970s and 1990s, on the contrary, cold and late springs prevailed, which delayed arrival and the onset of breeding and thus inhibited breeding success. Two comparatively long warm spells in the 20th century, the first one with the peak in the 1930s and 1940s, the second one with a maximum in the 1980s, as well as a temporarily temperature increase in the early 1960s, were recorded all over the northern hemisphere (Borisnikov 1988, Kondratiev 1992, 1993, Patin 1997). The analysis of annual fluctuations of mean monthly air temperatures in ten regions of European Russia (from the Smolensk Region up to the Kola Peninsula) showed that synchronous fluctuations of spring temperatures occur over a huge area (Sokolov et al. 1998). During the last four decades two significant long-term increases in the mean April temperature were recorded, in the 1960s and 1980s, compared with the 1970s (Sokolov et al. 1998). Only in these periods were significant shifts of the timing of spring migration towards earlier arrival observed in the Baltic region (Žalakevicius 1997, Sokolov et al. 1998), in the Ukraine (Fesenko et al. 1996), in Germany (Moritz 1993), in the U.K. (Loxton et al. 1998, Mason 1995, Moss 1998, Crick 1999). The timing of breeding was also significantly shifted towards an earlier season at different sites in the northern hemisphere (Crick et al. 1997, Crick and Sparks 1999, Sokolov & Payevsky 1998).

We suggest that increased numbers of adults and juveniles on the autumn passage on the Courish Spit recorded in the bulk of analysed passerines in the 1960s and 1980s are also explained primarily by the climatic influence. This is supported by (1) the significant relationship between the numbers of passage populations and mean April temperatures in a number of species (Tab. 7); (2) the pronounced relationship between numbers of passage populations and the timing of breeding on the Courish Spit (Tab. 6); (3) the highly significant correlation between the numbers of migrants and local Courish breeders in the bulk of species (Tab. 5).

Data from other authors also suggest that population numbers from other European sites showed a pattern similar to that found on the Courish Spit. Long-term trapping (1948-1995) of 54 passerine species in autumn at Ottenby (Öland, Sweden) in the Baltic Sea some 330 km to the NW from the Courish Spit, showed an increase in 42 species (78%) in the 1960s; in 16 species (30%) in the 1970s, mainly in the second half of the decade in short-distance migrants; in 43 species (80%) in the 1980s and in 19 species (35%) in the 1990s (Pettersson 1996).

Long-term mist-netting mainly in autumn at Falsterbo (the southernmost tip of the Scandinavian Peninsula) between 1947 and 1980 also revealed highest numbers of migrants in many passerines (at least in 19 short- and medium-distance migrants and 11 long-distance migrants) in the 1960s (Roos 1984). In early 1970s in a few species only was an increase recorded. At the beginning of the 1980s numbers again increased in a number of species (six short-distance and 14 long-distance migrants). Swedish authors found a significant correlation between the numbers of migrating Blue Tits at Falsterbo in autumn and the numbers of ringed nestlings in Sweden over the period 1980-1994 ( $r_s = 0.702$ ,  $p < 0.01$ ) (Heldbjerg & Karlsson 1997). A positive correlation ( $r_s = 0.67$ ,  $p < 0.01$ ) was found between ringing totals at Falsterbo and the number of pairs recorded within a nestboxes project in 60 km north-east of Falsterbo. Ringing figures for migrants and nes-



tlings increased in 1984 (5518 and 10500, respectively) compared with the previous years (1980 – 2250 and 5800, 1981 – 1546 and 6100, respectively). High numbers of migrating Blue Tits were recorded until the end of the study period (1994 – 6091 and 16000), except for 1987 (303 and 6000) and 1992 (221 and 12000). According to our data, these were years with a cold and late spring, and with a rainy summer (Sokolov et al. 1998). Significant correlations were found by Swedish authors between the ringing totals at Falsterbo and at Hammarö (Värmland, Sweden, some 430 km north of Falsterbo) ( $r_s = 0.821$ ,  $p < 0.01$ ); and at Falsterbo and at Stignæs in Denmark (100 km west of Falsterbo) ( $r_s = 0.582$ ,  $p < 0.05$ ).

Mist-netting data from the Danish island of Christiansø in the Baltic Sea roughly on halfway between Öland and Falsterbo in 1976-1983 showed higher numbers in many passerines migrating in autumn to European destinations (13 species) and to Africa (16 species) in the early 1980s as against the late 1970s (Lyngs et al. 1990). The opposite pattern was recorded in just a few species.

The analysis of data in the literature on long-term monitoring projects of breeding populations carried out by various methods shows that numbers of many passerines, incl. long-distance migrants, at different European sites were higher in the 1980s, at least in early 1980s, than in the 1970s. Thus, results of the Danish breeding bird census programme, designed to monitor the fluctuations in the populations of common breeding birds showed a pronounced growth in 1975-1983 in eight species that spend their winter within Europe, and in seven long-distance migrants, incl. Tree Pipit *Anthus trivialis*, Pied Wagtail *Motacilla alba*, Willow Warbler, Garden Warbler *Sylvia borin*, Whitethroat *Sylvia communis*, Thrush Nightingale *Luscinia luscinia*, and Icterine Warbler *Hippolais icterina* (Nohr & Braæ 1986). Svensson et al. (1986) compared long-term monitoring data (1976-1983) of 39 passerines in Sweden by breeding bird counts, visual surveys at Falsterbo and trapping in mist-nets and Heligoland traps at Ottenby (in spring and in autumn separately). Greater number of positive than negative correlation coefficients suggests, in their opinion, some general agreement between migration counts at Ottenby and Falsterbo and the number of breeding birds in southern Sweden. Relationships between breeding bird counts in southern Sweden and numbers of autumn migrants at Ottenby were tested in 31 passerine species. Positive relationships (with correlation coefficient more than 0.40) were found in 21 species. They were significant or slightly significant in long-distance migrants (Thrush Nightingale  $r = 0.79$ , Tree Pipit  $r = 0.69$ , Icterine Warbler  $r = 0.67$ , Whitethroat  $r = 0.62$ , Pied Wagtail  $r = 0.57$ , Willow Warbler  $r = 0.56$ , Spotted Flycatcher *Muscicapa striata*  $r = 0.48$ , Garden Warbler  $r = 0.46$ ) as well as in species that migrate within Europe (Linnet *Cannabina cannabina*  $r = 0.77$ , Blackcap *Sylvia atricapilla*  $r = 0.62$ , Bullfinch *Pyrrhula pyrrhula*  $r = 0.60$ , Blackbird *Turdus merula*  $r = 0.59$ , Greenfinch *Carduelis chloris*  $r = 0.58$ , Reed Bunting *Emberiza schoeniclus*  $r = 0.58$ , Goldcrest  $r = 0.53$  and some others). Svensson et al. (1986) report that in a number of species (Robin, Dunnock *Prunella modularis*, Garden Warbler, Icterine Warbler, etc.) a considerable increase occurred in the 1980s.

Wesołowski & Tomialojć (1997) analysed breeding bird dynamics in a primaeval temperate forest in Białowieża National Park (Poland) over a 20-year period (1975-1994). Out of 23 passerines, in 15 a positive population trend (in ten species significant) was recorded. It was found in species that migrate within Europe (Great Tit, Blue Tit, Chaffinch, Song Thrush *Turdus philomelos*, Dunnock, etc.) and in long-distance migrants (Pied Flycatcher *Ficedula hypoleuca*, Collared Flycatcher *Ficedula albicollis*, Spotted Flycatcher). A significant decline was recorded only in the Starling *Sturnus vulgaris*, Tree Pipit, and Wood Warbler *Phylloscopus sibilatrix*. The short-term variation in bird numbers was to some extent correlated with abundance of defoliating caterpillars, winter severity, and changes in rodent numbers.

A study of number dynamics in some breeding insectivorous birds in arable fields in Lower Saxony (Germany) showed that between 1978 and 1987 numbers of 13 species (Robin, Chiffchaff *Phylloscopus collybita*, Garden Warbler, Whitethroat, Icterine Warbler, Marsh Warbler *Acrocephalus palustris* and Reed Warbler *Acrocephalus scirpaceus*) increased, in some species very significantly (Pannach 1989). A slight decline was observed in the Blackbird and Blackcap.

The warm spells in the U.K. (ten out of 15 warmest years were recorded since 1980) caused a considerable habitat transformation, which has led to changes in numbers of many avian species, and to earlier breeding (Moss 1996). A number of garden-breeding passerines commence breeding a fortnight earlier and raise more young than 30 years ago. In the 1980s numbers of such long-distance migrants as Willow Warbler, Reed Warbler and Spotted Flycatcher breeding in Britain, the Netherlands and some other countries were high, but they sharply declined in 1991 (Foppen & Reijnen 1996, Balmer & Peach 1998). Willow Warbler ecology was studied in the central Netherlands at a study plot of 50-60 ha (Foppen & Reijnen 1996). A considerable decrease in the breeding density was recorded in 1991 and 1992. Survival rates of marked individuals estimated by return rates in these years was lower than in others, although the breeding success remained unchanged. In the same years a decline in the breeding density of the Willow Warbler and some other species was recorded all over the Low Countries. The authors suggest that low survival rate of adults was caused by the conditions in their winter quarters in Africa. British ornithologists (Peach et al. 1991, 1995a, b, Balmer & Peach 1998) observed clear relationships between survival rates for some long-distant migrants and annual rainfall in the African winter quarters and between survival rates for resident species and winter weather. Increased mortality amongst adult Willow Warblers in 1991 and 1992 suggests that problems in the African winter quarters have probably caused the large decline in breeding birds. Our data however suggest that the decline in Willow Warbler numbers at our site, both during breeding (Sokolov 1999) and on autumn migration (this study, Fig. 1, 2) was primarily induced by cold springs in these years, which caused low breeding success in northern populations. In these years adult mortality could be high, both on migration and in the beginning of the breeding season. Unfavourable conditions in the African winter quarters could certainly contribute to the decline in numbers, as suggested by the British colleagues.

There are data from other European sites available, that suggest an increase in breeding populations of some long-distance migrants during the last two decades. In Tatarstan (Russia) numbers of the Garden Warbler, Icterine Warbler, Scarlet Rosefinch *Carpodacus erythrinus*, Tree Pipit, Spotted Flycatcher, Wood Warbler and Willow Warbler were growing (Ivliev 1999). In Latvia and Estonia numbers of some long-distance migrants also increased in the 1980s (Baumanis 1990, Baumanis & Celminš 1993, Leivits 1999). In the western Netherlands densities of the Wood Warbler, Willow Warbler, Sedge Warbler *Acrocephalus schoenobaenus* and Reed Warbler significantly increased since early 1980s (Bernardus et al. 1999).

However, long-term trapping data from the autumn passage in Europe, mainly in Poland, Germany, and Austria, are at variance with our results. The data by Busse and co-authors (Busse & Cofta 1986, Busse & Marova 1993, Busse 1994, Busse et al. 1995, Wozniak 1997) from the Vistula Spit (Mierzeja Wislana) in Poland, which is very similar to the Courish Spit and located very close to our study area, showed high numbers of autumn passage populations, primarily long-distance migrants, only in the 1960s. Then a steady decline or stable low numbers are recorded until now. No increase was recorded in the bulk of species on the Vistula Spit in the 1980s, in a striking variation with our data. This is very surprising, as both teams are sampling the same flow of autumn migrants. The decline of passage passerines on the Vistula Spit probably refers to the

strong change of the habitat where the Polish colleagues are annually mist-netting migrants. Pine plantations that were low and dense in the 1960s have by now reached a substantial height. Many passerines probably avoid them, which causes a steady decline in many species.

The analysis of our data (Fig. 1) suggests that by the beginning of the 1980s the capture efficiency of the trap # 3 had much declined, apparently just because of the habitat change over 20 years. Another trap # 5 was put up in 1977 at a new site with young pine plantations. This new trap allowed us to detect a rather long-term increase in the numbers of migrants in the 1980s. It is not improbable that the decline recorded in the 1990s in the bulk of species reflects not only the natural phenomenon, but a lower capture efficiency by this trap due to pine growth. It is difficult to get an estimate of capture efficiency. At the end of 1999 we thinned out the pine plantation and removed the largest trees in front of the entrance of the trap in an attempt to compensate for the natural habitat change. It is unclear whether we are able to detect, using this trap, the next increase in bird numbers, if it occurs. In the autumn of 1999 the present trap however detected a growth in numbers of some species (Fig. 1, 2).

Berthold and co-workers showed negative trends in population size for 20 species, in 12 cases at all three or at two of the three stations, at two German sites (Reit, N Germany and Mettnau, SW Germany) and at an Austrian site (Illmitz, E Austria) during the periods 1974-1983 and 1989-1993 in their MRI-programme. Only four species (Black Redstart *Phoenicurus ochruros*, Blackcap, Nightingale *Luscinia megarhynchos* and Wood Warbler) showed exclusively positive trends, but each at only one station was statistically significant, and the remaining 11 species have quasi-stable populations (Berthold et al. 1999). However, a detailed analysis of the data presented separately for different periods and stations, shows an increase, not a decline, in quite a number of species: Reed Bunting ( $r = 0.55$  at Reit), Robin ( $r = 0.46$  at Reit), Chiffchaff ( $r = 0.43$  at Reit, 1974-1993), Dunnock ( $r = 0.42$  at Mettnau), Goldcrest ( $r = 0.39$  at Mettnau), Blue Tit ( $r = 0.52$ ,  $p < 0.05$  at Illmitz, 1974-1993), Goldfinch *Carduelis carduelis* ( $r = 0.60$ ,  $p < 0.01$  at Illmitz, 1974-1993), Pied Flycatcher ( $r = 0.65$ ,  $p < 0.01$  at Illmitz, 1974-1993), Spotted Flycatcher ( $r = 0.63$ ,  $p < 0.01$  at Illmitz, 1974-1993), Moustached Warbler *Acrocephalus melanopogon* ( $r = 0.63$  at Illmitz), Grasshopper Warbler *Locustella naevia* ( $r = 0.47$  at Reit), Savi's Warbler *Locustella luscinoides* ( $r = 0.50$  at Mettnau), Icterine Warbler ( $r = 0.40$  at Illmitz, 1974-1993).

What are the reasons for the inconsistency between our and Scandinavian data, especially concerning long-distance migrants, and the data from Germany and Austria? An explanation could be that we capture on autumn migration birds from northern populations, whereas our German colleagues mainly sample individuals from Central European populations. Populations of most long-distance migrants controlled by us increase in the 1980s compared with the 1970s, whereas the populations controlled in Central Europe declined. German authors explain the decline in many long-distance migrants during the recent decades by reference to global warming. It is then unclear why this factor did not influence northern populations that probably use the same African winter quarters as their Central European conspecifics (Payevsky 1973, Zink 1973). Western tropical Africa where many Palaearctic migrants spend their winter suffered a most acute deficit of rainfall in 1968, 1972, 1973 and 1982-1984 (Jurry 1997). An average rainfall was recorded only in 1994. Droughts caused degradation of vegetation, decrease in insect abundance, decrease in water surface area, i.e. food availability and habitats deteriorated. During these periods, numbers of many species declined. Especially marked was the decline in warblers, Sand Martin *Riparia riparia*, Redstart and Red-backed Shrike *Lanius collurio*. Human influence also contributed to the

situation. Data presented by Jury (1997) suggest that numbers of many long-distant migrants from both northern and southern parts of their breeding ranges should have been declining during the 1970s and 1980s. However, our data show that Baltic populations of long-distance migrants did not decline in the 1980s, to the contrary, numbers of many species significantly increased. We thus believe that inconsistencies between our results and German (Berthold et al. 1999) and Polish (Busse 1994, Busse et al. 1995, Wozniak 1997) data on population dynamics of autumn migrants are more likely to reflect methodological inconsistencies between survey methods, than the real variation in the population trends.

Thus, on the basis of our data we reach the following main conclusions.

1) During the second half of the 20th century numbers of many passerines (long- medium- and short-distance migrants) trapped during autumn migration on the Courish Spit, varied not only on year-to-year basis, but also on the long term.

2) In most cases in many species two decades were characterised by comparatively high numbers of passage populations, and for two decades lower numbers were typical.

3) Long-term fluctuations of the numbers of passage passerines in our region are in our opinion primarily related to the global climate fluctuation in Europe in the 20th century. Considerable population increases in the 1960s and 1980s were most probably caused by warm springs that prevailed during these decades. Above-average air temperatures led to early arrival and breeding, and to higher breeding success and offspring survival, which caused increasing numbers of breeding and passage populations during these periods.

4) Numbers of passage populations are frequently positively related to the numbers of breeding populations of passerines. It allows the researchers in some cases to derive correct conclusions concerning long-term dynamics of breeding populations in Europe on the basis of the long-term standardised trapping projects at the sites of mass migration, primarily in autumn.

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