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Post-breeding movements of Blue Tits *(Parus caeruleus)* in a West Hungarian stopover site

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Abstract In this study the post-breeding movements were analysed by used data of the birds ringed from 2001 to 2007 on the Bird Ringing Station of Tömörd (West Hungary). In total, 2691 individuals of Blue Tits were marked between from 5th August to 8th November in 2001–2007. On average, migration of the Blue Tits started on 25th August. The median date of the passage calculated from the average daily captures were 7th October for juveniles and 15th October for adults. The peak period of migration fell on the end of September and early October in the years 2001–2007. We established that the Blue Tit was a partial migrant species, but it did exhibit intensive migration in 2004. It can be in context with less beech crop and number of Bule Tits breeding in Alps and Carpathians as well as on the northern areas. Significantly more Blue Tits were captured in the grassland with scrub in the intesive migration year (74% in 2004) than in the weak migartion year (42% in 2003). According to recoveries of birds ringed at Tömörd the migratory Blue Tits probably followed SSW direction from Tömörd and wintered at the Adriatic region (Croatia).

keywords: partial migration, habitat preference, *Parus caeruleus*, West Hungary

József Gyurácz, Péter Bánhidi & Andrea Kóródi 2011. A kék cinege *(Parus caeruleus)* őszi vonulásának dinamikája egy nyugat-magyarországi élőhelyen – Ornis Hungarica 19: xx-xx.

Összefoglalás A kék cinege kóborlásának és vonulásának dinamikáját vizsgáltuk a Tömördi Madárvártán (47°21’23”N 16°40’04”E, Vas megye) 2001 és 2007 között befogott madarak napi fogása alapján. Az egyes években augusztus 5-től november 8-ig tartó vizsgálatok során összesen 2691 kék cinegét gyűrűztünk. Az őszi vonulás kezdő napjának az első 3-as zsírkategóriájú madár befogásának napját tekintettük, melynek alapján a kék cinege őszi vonulása átlagosan augusztus 25-én kezdődött. A hét év napi fogásainak átlaga alapján megállapított medián dátum a fiatal (elsőéves) madaraknál október 5-re, öreg (egy évesnél idősebb) példányoknál október 15-re esett. A őszi vonulás legintenzívebb időszakát szeptember végén és október elején tapasztaltuk 2001 és 2007 között. A kék cinege őszi vonulásának éves dinamikája a parciális vonuló fajokéhoz hasonlóan alakult, de 2004-ben az inváziós vonulókra jellemző módon, a többi évekhez képest igen nagy egyedszámban vonultak át a vizsgált területen. Külföldi vizsgálatok eredményei alapján feltételezzük, hogy az átvonuló kék cinegék számának nagyarányú növekedése kapcsolatban lehetett azzal, hogy az Alpok, Kárpátok és az északabbi országok területén kevés bükkmakk termett, ami a kék cinegék egyik fő tápláléka a téli időszakban. 2004-ben a kék cinegék lényegesen nagyobb hányadát fogtuk be a gyepes-bokros élőhelyen (74%), mint a kisebb vonulási intenzitású években (42% 2003-ban). A Tömördön gyűrűzött és külföldön megkerült madarak alapján megállapíthatjuk, hogy a tovább vonuló kék cinegék egy része D-DNy-i irányt követett, és az Adria partvidékén telelt.

kulcsszavak: parciális vonulás, élőhely-választás, *Parus caeruleus,* Nyugat-Magyarország

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Introduction

The Blue Tits breed in west Palearctic region. Their eastern European populations were considered typical irruptive migrants with fluctuation in the numbers of birds migrating over Europe from year to year and very variable parameters of migration (Cramp 1998). However, it has been recently proved that Blue Tits migrate every year in relatively stable numbers in northern, central and eastern Europe, thus they are typical, regular, partial migrants in this region (Nowakowski & Vähätalo 2003, Nyquist 2007).

More definitions have been proposed to describe partial migration and the most accepted one includes both individuals that migrate and others that do not migrate from the same breeding site (Terrill & Able 1988, Berthold 2001). Among the migrants, juveniles and females in general predominate (Smith & Nilsson 1987). In some years, many birds of the populations of more partially migrating bird species leave their breeding areas to appear in other sites, mainly west and south European regions, as irruption or invasion species. The Blue Tits also makes altitudinal movements from highest breeding areas.

The partial migration and autumn migration of the Blue Tit has not examined in detail yet in Hungary. In this study the post-breeding movements were analysed by used data of the birds ringed from 2001 to 2007 on the Bird Ringing Station of Tömörd (West Hungary). The main aspects of the analysis were:

1. To register annual change of the numbers of caught birds.
2. To describe the progress in time (dynamics) of the post-breeding movement by analysis of daily capture-recapture data.
3. To compare the migration dynamics of Blue Tit with an obligat (Whitethroat – *Sylvia communis*) and an irruptive (Brambling – *Fringilla montifringilla*) migrant.
4. To describe the habitat use of the migratory birds by analysis of sites of captures.
5. To reveal the wintering sites of the migratory birds of Tömörd area by evaluating recoveries.

Study area and methods

The birds were captured and ringed on the Bird Ringing Station of Tömörd (47°21’23”N 16°40’04”E) in the west of Hungary *(Figure 1.)*. For catching the birds we used 28 numbered mist-nets (12 meter long and 2,5 meter high with 5 shelves and a mesh size of 16 mm). The nets were positioned in four different habitat types around the ringing station:

Forest: The 6–9 m high trees and bushes made up a compact, dense edge vegetation.

Figure 1. Location of the Tömörd ringing site in Hungary
(Figure is from the website of SEEN)
1. ábra A Tömördi Madárvárta földrajzi helyzete
(A SEEN honlapjának ábrája)

It had an ecoton community. Its characteristic plant species were: *Quercus cerris*, *Prunus spinosa, Crataegus monogyna, Pyrus pyraster.* There were 4 nets in this habitat.

Bushy: The 2-3 m high bushes made up a compact, dense vegetation, which was dissected by small grass patches. Its characteristic plant species were: *Prunus spinosa, Crataegus monogyna, Pyrus pyraster, Rosa canina.* 11 nets were standing in this habitat.

Grassland with scrub: It made a transition between the wet habitates of the swamp and the steppe communities that used to cover the croplands around. There were a few bushes in the grassland. Its characteristic plant species were: *Calamagrostris epigeios, Cirsium arvense, Arrhenatherum elatius, Verbascum thapsus.* There were two small patches of *Sambucus ebuli*. There were 7 nets in this habitat.

Marsh: Characteristic plants were *Glyceria maxima, Typha latifolia, Salix cinerea*. It was dried out in 2000 and 2001. There was 0.5-1 ha open water in the other years. There was a line of 6 nets here.

All birds were ringed according to Actio Hungarica (Szentendrey et al. 1979) and they were aged according to Svensson (1994). The fat reserves were estimated visually according to Busse (2000) ranging from 0 (no fat) to 8 (bulging fat).

The average daily captures of the years were compared using one-way ANOVA. Migration curve was calculated based on the average daily captures of the years smoothed by a 3-day moving average. Based on this information the peak migration period (when we captured the most birds in that season) and the month with the highest captures were identified. In order to see if there was a difference between age groups in median dates of daily captures the Kruskal-Wallis test was used. By using the minimum stopover time of the recaptured birds the migration dynamics curves were plotted. The beginning of migration was determined based on the analysis of the fat score of the captured birds and the dynamics of daily captures. Birds on migration accumulate much larger fat reserves than in other seasons. This fact made it possible to distinguish residents from migrants, as well as the discrimination of the beginning of migration from the post breeding dispersal. In this study it was assumed that the beginning of migration was the day when the first passage of very fat birds i.e. in which the fat covered completely the intestines (fat score 3 or higher) was noted (Busse 2000). The number of caught birds in each year was standardised with the mean for the studied period (as a percentage of the mean: X). Annual fluctuations in the numbers of birds were described by reference to a fluctuation index (FI) according to Busse (1994):

$$FI = \sum (X_y - X_{oy})^2 \, n^{-1}$$

where X_y is the number of birds trapped in year y, X_{oy} is a 3-year moving average for the same year and n the number of years. The number of caught birds in each habitat was averaged by the number of the nets put in different kinds of biotpes. The distributions (%) of the capture rate in the different habitat types for years with low and high captures (2003 and 2004) were compared by χ^2-test (Fowler & Cohen 1992). The Past computer program was used for statistical analysis (Hammer et al. 2006).

Results

In total, 2691 individuals of Blue Tits were marked between from 5th August to 8th November in 2001-2007. The average daily

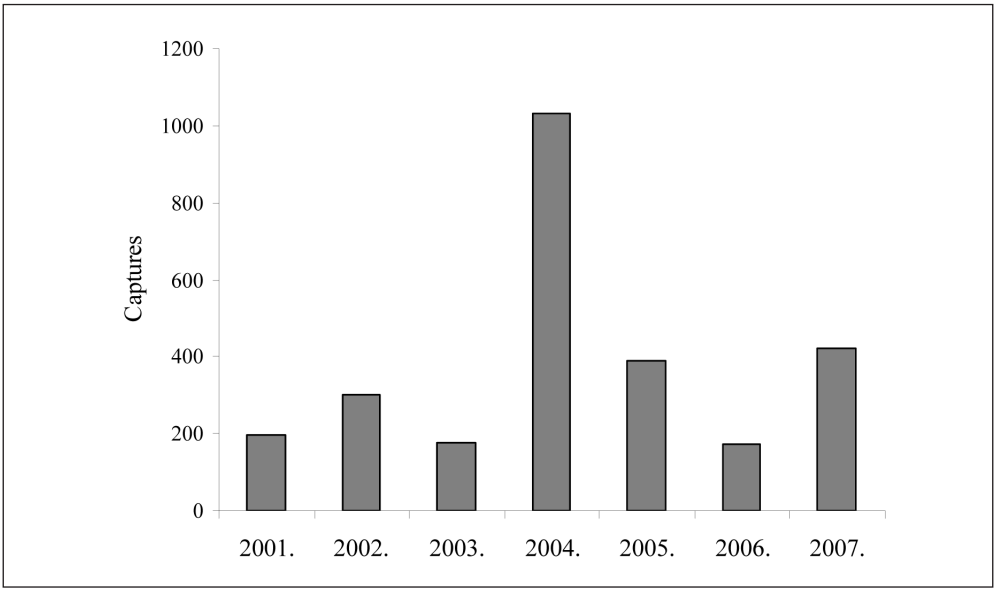

Figure 2. The number of birds ringed between August 5 and November 8 from 2001 to 2007
2. ábra A gyűrűzött madarak száma augusztus 5. és november 8. között 2001-től 2007-ig

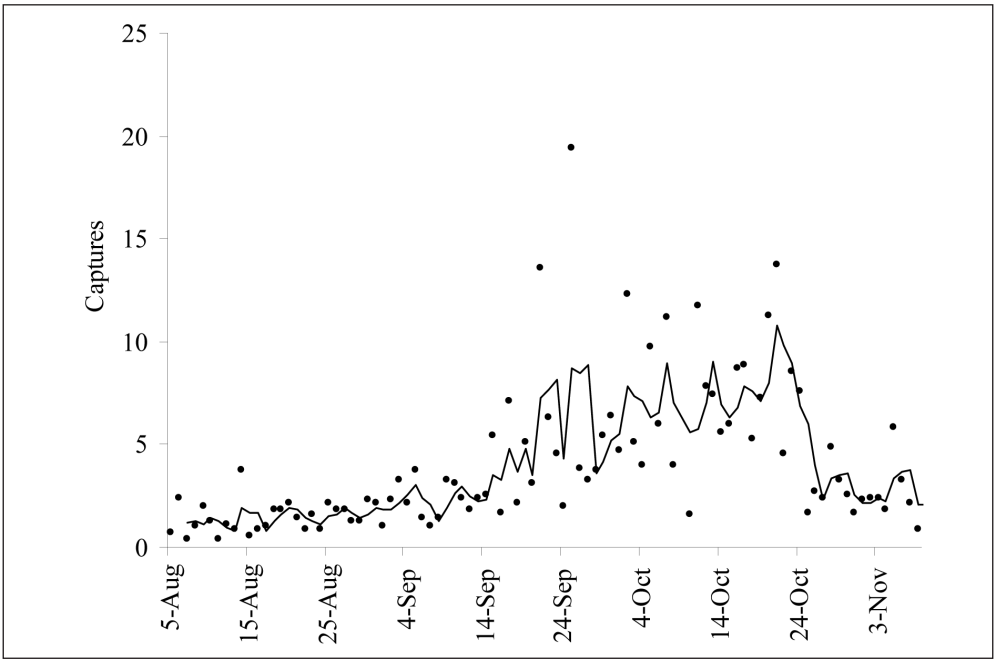

Figure 3. Average daily captures (2001–2007) and migration dynamics (smoothed moving average) of Blue Tits
3. ábra A kék cinegék átlagos napi fogás értékei (2001–2007) és vonulásuk dinamikája (mozgóátlag)

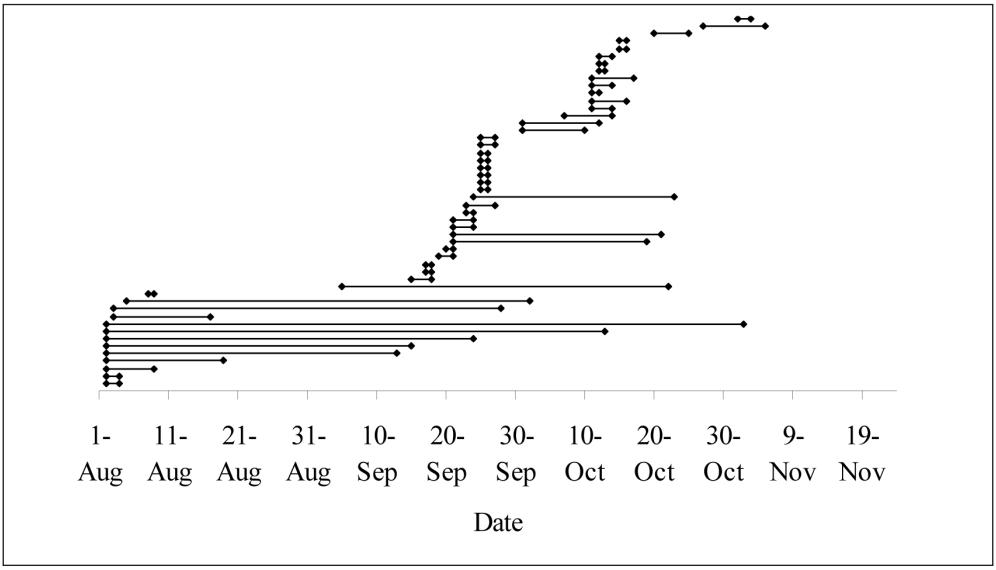

Figure 4. Individual capture histories of Blue Tits captured more than once within a season during the study period, 2004. Each point indicates a capture of this bird and lines join the captures of the same individual

4. ábra A 2004-ben visszafogott kék cinegék tartózkodási ideje. A vonalak ugyanannak a madárnak első befogását és utolsó visszafogását jelző pontot köti össze

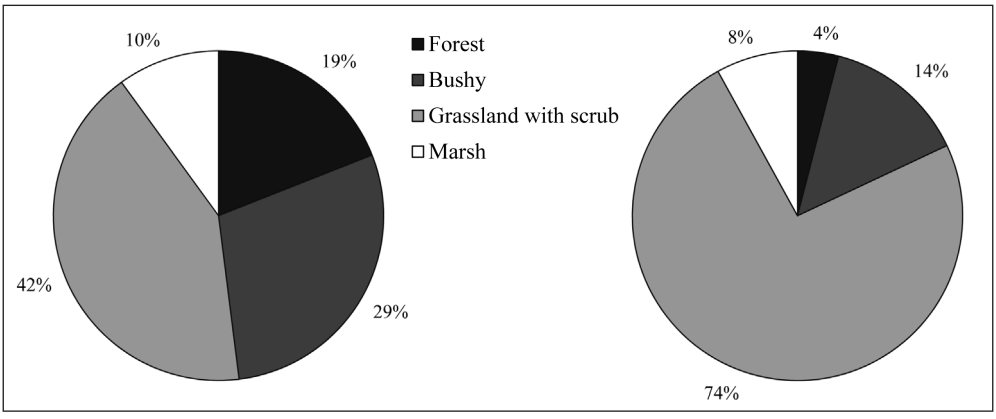

Figure 5. Capture rate (%) of Blue Tits in the four habitats, 2003

5. ábra A befogott kék cinegék eloszlása élőhely-típusonként, 2003

Figure 6. Capture rate (%) of Blue Tits in the four habitats, 2004

6. ábra A befogott kék cinegék eloszlása élőhely-típusonként, 2004

	Year	X_y	X_{oy}	X_y-X_{oy}	$(X_y$-$X_{oy})^2$
Blue Tit	2001.	51	53.10	-2.10	4.40
	2002.	78	63.86	14.14	200.02
	2003.	45	82.96	-36.96	1366.19
	2004.	268	223.93	44.07	1942.52
	2005.	101	119.60	-18.60	346.00
	2006.	45	50.30	-5.30	28.11
	2007.	110	105.25	4.75	22.52
Whitethroat	2001.	69	71.69	-2.69	7.25
	2002.	101	91.27	9.73	94.59
	2003.	90	105.53	-15.53	241.21
	2004.	132	128.49	3.51	12.29
	2005.	147	133.70	13.30	176.81
	2006.	97	104.46	-7.46	55.66
	2007.	64	64.84	-0.84	0.71
Brambling	2001.	2	2.85	-0.85	0.72
	2002.	1	-1.28	2.28	5.19
	2003.	0	-21.98	21.98	483.08
	2004.	13	108.02	-95.02	9028.42
	2005.	671	527.46	143.54	20603.73
	2006.	10	106.25	-96.25	9263.87
	2007.	3	-21.32	24.32	591.32

Table 1. Data for fluctuation index of selected species in the years 2001-2007 (n=7 years) at Tömörd. Autumnal numbers of birds (X_y) are presented as percenetage of the mean numbers caught in the years 2001-2004.

1. táblázat A vizsgált fajok fluktuációs index számításának adatai 2001 és 2007 között (n=7 év). A madarak éves egyedszáma a 2001 és 2007 közötti átlagos éves fogás százalékában van kifejezve

captures changed significantly *(one-way ANOVA, F=13.53, df= 6/658, P<0.0001)*. The most birds were captured in 2004, the least in 2006 *(Figure 2.)*. The highest standardised annual trapping number (X_y) was higher for the Blue Tit than for Whitethroat and it was lower than for Brambling *(Table 1.)*. The fluctuation indices were 558.54 for the Blue Tit, 84.08 for the Whitethroat and 5710.9 for Brambling. The annual proportion of juvenile Blue Tits was greater than 80 percent.

On average, migration of the Blue Tits started on 25th August. The median date of the passage calculated from the average daily captures were 7th October for juveniles and 15th October for adults *(Kruskal-Wallis test, H=44.01, P<0.001)*. The peak period of migration fell on the end of September and early October in the years 2001-2007. The most capture occured in October. The date of the last capture was 8th November *(Figure 3.)*.

The annual proportion of recaptured birds changed between 5% (2004) and 15%

Capture Type	Age/Sex	Date	Place	Coordinates	Distance km	Direction degree	Elapsed days
Ringing	juvenile female	21.10.2004.	Tömörd (AH)	47°21′23″N 16°40′04″E	390	193	443
Recovery	adult	07.01.2006.	Vransko Jezero, Pakoљtane, Croatia	43°56′57″N 15°30′57″E			
Ringing	juvenile	16.10.2000.	Tömörd (AH)	47°21′23″N 16°40′04″E	258	133	139
Recovery	adult male	04.03.2001.	Sombor Yugoslavia	45°46′N 19°07′E			
Ringing	juvenile	05.10.2010.	Tömörd (AH)	47°21′23″N 16°40′04″E	485	171	26
Recovery	juvenile	31.10.2010.	Metkovic Croatia	43°03′N 17°39′E			

Table 2. Data for all the Blue Tits ringed at Tömörd and recovered abroad
2. táblázat Tömördön gyűrűzött és külföldön megkerült kék cinegék adatai

(2006). 62 per cent of the all recaptured birds were male. According to the distribution of recpatures, the local breeding birds captured in August stayed until the early November and probably overwintered at the study area. The most of birds arrived in the peak migration period left the area quickly by the end of October *(Figure 4.)*. Significantly more Blue Tits were captured in the grassland with scrub in 2004 (74%) than in 2003 (42%) ($\chi^2=24,06$, $df=3$, $P<0.001$, *Figures 5. and 6.*). There were three birds ringed at Tömörd and recovered abroad *(Table 2)*.

Discussion

The Blue Tit was dominant songbird in the study area. We established that the Blue Tit was a regular partial migrant species with a very intensive migration in 2004. In South Sweden during autumns of 2001–2005 the highest number of birds was caught in also 2004 (Nyquist 2007). According to fluctuation indices the migration dynamics of Blue Tit at Tömörd was more similar to migration of obligatory migrant Whitethroat than those of irruptive migrant Brambling. Nowakowski & Vähätalo (2003) also showed that the fluctuation index of Blue Tit was similar to index of obligatory migrants in the years 1971–97 on the cost of the Baltic Sea. Many definitions have been proposed to describe partial migration and the most accepted one includes both individuals that migrate and others that do not migrate from the same breeding area (Terrill & Able 1988, Berthold 2001). Among the migrants, juveniles and females in general predominate (Smith & Nilsson 1987, Nyquist 2007). The smaller part of the local population of Tömörd, primarily the males are resident, the juveniles' and the females' majority being migrating. The autumn migration was beginning in the second part of August. The juveniles migrated significantly earlier, than the adults. There have been two major hypotheses proposed to explain the differences in migratory behavior between age- and sex classes: the body-size hypothesis

and the dominance hypothesis. According to the first hypothesis, small individuals are more likely to migrate than large ones due to different abilities to tolerate starvation. Relative to their basic metabolic rate, larger individuals should have greater reserves if energy stores are proportional to body size and thus survive temporary food shortage better than small individuals. Consistent with the other hypothesis, dominant members of a population force the less dominant conspecifics to migrate by means of competition (Smith & Nilsson 1987, Nyquist 2007).

European recoveries of Blue Tits indicate main axis of distant movements from north-east to south-west (Cramp 1998). The Blue Tits recoveried in Hungary were ringed in Austria, Litvania, Poland, Russia and Slovakia (Török 2009). According to recoveries of birds ringed at Tömörd the migratory Blue Tits probably followed SSW direction from Tömörd and wintered at the Adriatic region (Croatia). In some years, large parts of the populations of many partially migrating bird species leave their breeding grounds to appear in other areas as invasion species. Nilsson et al. (2006) emphasized the importance of population density and food abundance for Blue Tit migration. The most important factors determining the dynamics of Blue Tit migration in a given year was the size of an important winter food source, the beech crop (more migrants at lower crops) and the size of the breeding population (more migrants at higher densities). The intensive migration (2004) in the study area (Tömörd) can be in context with less beech crop and number of Bule Tits breeding in Alps and Carpathians as well as on the northern areas (Poland and Baltic region). The Polish analysis (Chruściel 2006) showed that Blue Tit migration on the southern coast of the Baltic Sea started in mid-September and lasted till the end of October. Date of migration beginning was not constant – it changed from year to year in Poland and West Hungary. On the contrary, the end of migration was relatively stable – it was most often in the last days of October, or exceptionally in the first days of November in both countries. Median passage date was on the beginning of October in Poland and in the first half of October in Hungary. The most northern migratory birds migrated on the end of September and in the first half of October on the study area of Tömörd. The proportion of recaptured birds was smaller and the stopover time of recaptured birds was shorter in the years with intensive migration than in the others.

Flocking behaviour of the wintering birds is expected to relate inversely to food supply of habitat (Grubb 1987, Székely & Juhász 1993). Although the most Blue Tits were captured in grassland with scrub, the forest and the bushy habitat types in terms of feeding and fat accumulation were better habitats, than the grassland with scrub and the marsh (Kóródi et al. 2008). We suggest the territorial spacing of Blue Tits may prevent the formation of large flocks during their stopover time in the local forest and bushy. Significantly more tits were displaced to poorer grassland with scrub in the intensive migration (2004) than in the weak migration (2003). The local marsh could be less suitable for tits stopovered at Tömörd due to the lack of reed.

The present analysis has showed the partial migration of Blue Tit in the study area, but the global climate change can modificate the migration strategies of birds. In response to warmer winters making the habitats more profitable and increasing the survival of residents. Based on Helbig

(2003) as well as Pulido & Berthold (2003), we predict that the migratory part of partially migratory populations is declining as a response to global warming.

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