

# Habitat selection by Burrowing Owls *Athene cunicularia* in the Pampas of Argentina: a multiple-scale assessment

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**Abstract.** Human-induced habitat changes have been typically linked to negative effects on native species, but an increasing number of studies show that many species are unaffected by these changes or even benefited from them. The Burrowing Owl *Athene cunicularia* is a raptor species that has deserved special attention in recent years due to its capacity to live in a variety of natural and modified habitats. In this study, we analyzed habitat characteristics that determine the habitat selection of the Burrowing Owl at the nest-patch, territory and landscape scales in the Pampas of Argentina. We performed broadcasting call surveys to evaluate presence-absence of owls at random points. In addition, we measured habitat variables in the field and used satellite imagery to obtain land-use information. We used Generalized Linear Models to explore the influence of habitat variables on the probability of occupancy by Burrowing Owls. Our results indicate that Burrowing Owls demonstrate good ability to live in a wide variety of habitat types and with different disturbance levels in the Pampas. At the nest-patch scale, which includes the nest-site and the surrounding patch around it, the presence of owls was positively associated with the horizontal visibility and was influenced by the land-cover type. At the territory scale, the occurrence of owls was positively associated with the presence of active (non-vegetated) dunes and negatively with croplands. At the landscape scale, the presence of owls was negatively associated with the disturbance level and positively with the amount of borders between habitats. A unique multi-scale model containing variables of the three spatial scales was more robust to explain variation in Burrowing Owl occupancy patterns than any single-scale model. This would reveal the hierarchical nature of habitat selection by Burrowing Owls in the Pampas, comparable to that observed in North American populations.

**Key words:** *Athene cunicularia*, nest-patch, territory, landscape, urban areas, agroecosystems, sand dunes, habitat selection, owl

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## INTRODUCTION

Choosing a place to live is one of the most important decisions made by wildlife, because it is directly related to the access to resources that animals need to fulfill their ecological requirements (Wilbur et al. 1974, Wiens 1989, Boyce & McDonald 1999). It is assumed that animals use environmental cues to select the habitats where they maximize their chance to survive and breed successfully (Rosenzweig 1985, Danchin et al. 1998). Given that the balance between risks and rewards frequently changes according to the scale of measurement, habitat selection is an inherently scale-sensitive process (Mayor et al. 2009, McGarigal et al. 2016).

Human-induced environmental perturbations are important factors affecting habitat selection by animals, because they produce changes in the

resources profile (Howard et al. 2001). Habitat reduction and fragmentation affect important resources which may be either impoverished (e.g., by decreasing food availability) or improved (e.g., by decreasing predation risk or competition), depending on the species, its position in the food web, and/or its behavioral plasticity (Chalfoun et al. 2002, Kight & Swaddle 2007). Although the increase of the perturbation has been typically linked to negative effects on native species (Howard et al. 2001, Verhulst et al. 2001), an increasing number of studies show that many species may be benefited by environmental changes, in particular those that exhibit high behavioral plasticity or ability to colonize novel habitats (Sih et al. 2011, Møller et al. 2014).

Since most raptors are top predators that occur in low numbers, use large areas for hunting, and have an intensive parental care (Newton 1979),

# Analysis of spatial point pattern shows no desertion of breeding Mute Swan areas by the other waterbirds within fishpond

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Gayet G., Calenge C., Broyer J., Mesléard F., Vaux V., Fritz H., Guillemain M. 2016. Analysis of spatial point pattern shows no desertion of breeding Mute Swan areas by the other waterbirds within fishpond. *Acta Ornithol.* 51: 151–162. DOI 10.3161/00016454AO2016.51.2.002

**Abstract.** Mute Swan *Cygnus olor* numbers have recently increased in a dramatic fashion in Western Europe and in North America, suggesting there could be potential consequences for the rest of the waterbird community. Breeding Mute Swan pairs may behave territorially towards other waterbirds, taking advantage of their larger size, and hence cause concern regarding their potential effects on waterbird communities. We studied how the within-site distributions of breeding Mute Swans and other waterbirds were related to each other, in order to assess if there is support to the assertion that breeding Mute Swans may affect the distribution of the other waterfowl within waterbodies. We mapped waterbird and swan distribution within fishponds during the Mute Swan breeding period. Relying on spatial point pattern analysis, our first finding is that breeding Mute Swans were located in the vicinity of the other waterbirds, using the same area within fishpond. Waterbirds do not completely desert the area used by breeding swan pairs within a waterbody, hence not supporting the claim that Mute Swans dislodge the other species. If an exclusion process by Mute Swan breeding pairs towards waterbirds exists, it is not strong enough to generate deserted areas by waterbirds around breeding Mute Swans. Our second finding is that breeding Mute Swans were not located where the density probability function for waterbird presence was the greatest within a fishpond, i.e. breeding Mute Swans were not located in the centre of groups formed by other waterbirds within each fishponds. This may indicate slightly different micro-habitat preferences or use within fishponds, or could indicate the potential occurrence of interactions. In conclusion, these results question whether the increasing Mute Swan populations actually directly threaten the other waterbird communities in such habitats, and require population control as is often claimed.

**Key words:** community, spatial pattern of points, Ripley's K, waterbirds

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## INTRODUCTION

Processes which affect species assemblage in communities are of key interest for decision makers involved in bird conservation strategy development, especially where expanding species may affect communities. To identify circumstances in which expanding species are expected to affect communities, case studies about species interac-

tions are required in a variety of contexts, as a preliminary to meta-analyses. Generally, a variety of processes affect species assemblage. Species coexistence is influenced by species-specific ability to forage in a structured habitat (Orians 2000), habitat heterogeneity (e.g. Tilman 1982), species average size (Oksanen et al. 1979, Leyequien et al. 2007) and species interactions (Case & Gilpin 1974, Calsbeek & Sinervo 2002). Habitat selection

# Breeding performance, apparent survival, nesting location and diet in a local population of the Tawny Owl *Strix aluco* in Central Lithuania over the long-term

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Grašytė G., Rumbutis S., Dagys M., Treinys R. 2016. Breeding performance, apparent survival, nesting location and diet in a local population of the Tawny Owl *Strix aluco* in Central Lithuania over the long-term. *Acta Ornithol.* 51: 163–174. DOI 10.3161/00016454AO2016.51.2.003

**Abstract.** In the present study, we used 37-year long dataset on Tawny Owls from the annual monitoring of nestboxes at a sample plot in Central Lithuania. We expected that Tawny Owls responded to changes in land use practices, stemming from a change in both political and economic system, which may affect prey abundance and composition, breeding performance and demography. To analyze temporal changes in monitored parameters, we divided the study period into three phases (1978–1989, 1990–2001 and 2002–2014), corresponding to different socio-economic conditions. The number of nesting pairs of Tawny Owls decreased significantly in the last 13 years of the study, but the number of successful pairs fluctuated without any trend. The clutch size and number of nestlings varied without significant trends, but nesting success improved over the last 13 years. Annual apparent survival probability of the female Tawny Owls did not vary significantly over the study period (model averaged values between 0.71 and 0.73). Owls occupied nestboxes irrespective to the distance from the agricultural land during the first two study periods, but since early 2000s, owls tended to occupy nestboxes located deeper in the forest. Birds and small mammals were similarly important as prey items by biomass. Since the 1990s, the share of *Microtus* voles significantly decreased in the diet, while that of birds increased. In summary, changes in the diet, improved nesting success of the Tawny Owl and tendency of nesting in forest interior may indicate ongoing complex responses to the changes in environmental conditions.

**Key words:** owls, nestbox, monitoring, demography, diet, survival, long term trends, breeding parameters

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## INTRODUCTION

Due to their position in food chains, avian predators are important, easy to track indicators to elucidate long-term changes in the environment quality (Helander et al. 2008). During recent decades, many avian predator populations have increased due to successful conservation actions (e.g., Pyrenean Bearded Vultures *Gypaetus barbatus*, Golden Eagle *Aquila chrysaetos*, White-tailed Eagle *Haliaeetus albicilla*; Carrete et al. 2006, Fauce et al. 2011, Helander & Bignert 2013), but others have declined (Rutz & Bijlsma 2006, Krüger et al. 2012). Some increased populations have shown density-dependent decreases in breeding performance (Carrete et al. 2006, Beja & Palma 2008), in others productivity has remained unchanged (Bai et al. 2009), while in some populations both number of breeding pairs and breeding output

have increased (Helander & Bignert 2013). The reasons underlying these changes include the responses of birds to human-induced landscape and habitat changes, reduced persecution and population growth or decline (Newton 2003). Moreover, changes in habitat use during the nesting period may occur over the long-term, as for example, increasing use a particular nesting structures (Vaitkuviene & Dagys 2015) or occupancy of new macrohabitats (Bai et al. 2009). In summary, variable, multidirectional changes and trends in key vital rates are known over the long-term in raptor populations. After an extensive review of raptor monitoring in Europe, a lack of data was noticed for several common diurnal raptor species and owls (Vrezec et al. 2012). This weakens the understanding on raptor population dynamics and restricts general conclusions concerning their status.

# Growth performance of nestling Cuckoos *Cuculus canorus* in cavity nesting hosts

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Grim T., Samaš P. 2016. Growth performance of nestling Cuckoos *Cuculus canorus* in cavity nesting hosts. *Acta Ornithol.* 51: 175–188. DOI 10.3161/00016454AO2016.51.2.004

**Abstract.** Generalist brood parasites, like Common Cuckoos *Cuculus canorus*, target many host species. Why other sympatric hosts are not used, or actively avoided, remains one of the main gaps in our understanding of parasite-host coevolution. Cavity nesting passerines always represented a text-book example of unsuitable hosts but recent evidence casts multiple doubts on this traditional view. In general, any species can become an unsuitable host for a parasite at laying, incubation, or nestling stages with the last one being much less studied than the others. Therefore we examined Cuckoo chick performance in five cavity nesting host species, including one regular Cuckoo host — the Common Redstart *Phoenicurus phoenicurus* and four non-hosts: the Pied Flycatcher *Ficedula hypoleuca*, Spotted Flycatcher *Muscicapa striata*, Great Tit *Parus major*, and Coal Tit *Periparus ater*. Natural nests of non-hosts, as opposed to artificial nest boxes with small entrance holes, are often placed in cavities that show both entrance and inner cavity sizes large enough for female Cuckoos to lay and Cuckoo chicks to fledge. We did not find any evidence for chick discrimination in non-hosts, i.e., no chicks were rejected, attacked, or neglected. Cuckoo chicks grew similarly in nests of all four species of non-hosts, similarly to chicks in host Redstart nests, and generally better than in nests of the most numerous Cuckoo host, the Reed Warbler *Acrocephalus scirpaceus*. Although Cuckoo chick fledging mass was highly host species-specific (i.e., showed high statistical repeatability across various host species), we did not find any evidence for the hypothesis that host body size (mass) positively affects parasite chick growth (fledging mass or age). These findings provide impetus to further study apparently unsuitable hosts and perhaps even reconsider traditional classifications of host suitability in the context of brood parasite-host coevolution.

**Key words:** brood parasitism, fledging, growth, host selection, hole nesting birds, metareplication

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## INTRODUCTION

Some brood parasites are specialists at individual female level (typically, each female lays her eggs into the nests of only a single species) but generalists at the species level (different females parasitize different species). This pattern is especially pronounced in Common Cuckoos *Cuculus canorus* (hereafter: Cuckoos) where individual females only rarely lay in nests of other than their focal host (Davies 2000). This is supported by both observations (telemetry: Honza et al. 2002) and molecular analyses (Skjelseth et al. 2004). At the same time, the list of recorded Cuckoo hosts is longer than 100 species (Davies 2000). Generally, a typical Cuckoo host might be defined as a small passerine feeding its chicks with insects and building an open nest (Davies 2000). In contrast, birds feeding their chicks with non-insect diet (e.g., fruits) and building closed nests (e.g., tree or

ground holes) are considered unsuitable hosts (Davies 2000). Although these parameters are important on average (see, e.g., comparative studies: Soler et al. 1999), they cannot explain why some particular passerine species are used by Cuckoos, whereas others are not. Contrary to traditional classifications, some insectivorous passerines are unable to raise the young Cuckoo to fledging (Asian Verditer Flycatchers *Eumyias thalassinus*, Yang et al. 2013) while some non-insectivorous passerines are able to do so (Song Thrush *Turdus philomelos*, Grim 2006a). Some cavity-nesters are excellent Cuckoo hosts (Common Redstarts *Phoenicurus phoenicurus*, hereafter: Redstarts, Rutila et al. 2002) whereas some open-nesters are not (European Greenfinches *Carduelis chloris*, Samaš et al. 2012).

Are these particular examples exceptions to the rule or do they reflect more general patterns? This question cannot be answered via comparative

# Survival and site fidelity of urban Blackbirds *Turdus merula* — comparison of Cormack-Jolly-Seber and Barker models

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Jankowiak Ł., Wysocki D., Greño J. 2016. Survival and site fidelity of urban Blackbirds *Turdus merula* — comparison of Cormack-Jolly-Seber and Barker models. *Acta Ornithol.* 51: 189–197. DOI 10.3161/00016454AO2016.51.2.005

**Abstract.** Studies dealing with the individual survival of birds in open populations usually estimate survival according to capture-recapture models like the Cormack-Jolly-Seber (CJS). In fact, these models estimate local apparent survival ( $\phi$ ), which is a combination of the probabilities of true survival ( $S$ ) and site-fidelity ( $F$ ), i.e. death and emigration are confounded. These  $S$  and  $F$  parameters can be estimated by using 'robust' models (e.g. Barker's model), which use additional resighting and dead reports data. We aim to compare the results (and associated biological implications) obtained by analysing juvenile and adult survival in a Polish urban population of Blackbirds *Turdus merula* using both the CJS and Barker models. Our CJS models estimated high  $\phi$  values for both juvenile and adult birds (0.48 and 0.62, respectively). The lower scores for juveniles could be interpreted as low juvenile overwintering survival. By fitting Barker models to the same dataset we determined that juvenile site fidelity was lower than that of adults (0.91 and 0.93, respectively), so natal dispersal was slightly greater than breeding dispersal. The high fidelity causes similarity between apparent survival and true survival parameters ( $S$ : 0.51 for juveniles, 0.64 for adults). The results are comparable with data from other urban populations. Thus, using robust models certainly allows one to reduce the noise of movements confounding and/or masking survival probabilities, but one can also determine the individual or environmental variables affecting any of them separately.

**Key words:** dispersal, natal dispersal, temporal migration, philopatry, sedentariness

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## INTRODUCTION

In wildlife populations, survival (e.g. Tinbergen & Boerlijst 1990, Adriaensen et al. 1998) and dispersal (Desrochers & Magrath 1993, Both et al. 2012) are often considered to be among the key demographic mechanisms underlying population dynamics: both mortality and migration therefore govern population structure. While many studies have focused on populations of migratory birds (e.g. Newton 2008), sedentariness and philopatry in non-migrants have received less attention. Both of these terms reflect the number of individuals in a studied population remaining in the natal or breeding area. Dispersal from a site can be divided into (1) natal dispersal, which is movement from the place of birth to a potential or the first reproductive site, and (2) breeding dispersal, which is movement between successive breeding sites. The latter can be sub-divided into

within-season breeding dispersal, during which individuals move following nesting failure or success, and between-season breeding dispersal, in which individuals change the breeding site from one season to another (Greenwood & Harvey 1982).

The survival probabilities of small birds at a particular site are frequently analysed by using capture-recapture models, the Cormack-Jolly-Seber (CJS) formulation being the most often used one (Lebreton et al. 1992, Naef-Daenzer et al. 2001, Williams et al. 2002, Greño et al. 2008). In the CJS, the probability of encounter ( $p$ ) is explicitly modelled in order to correct for possible biases in survival estimates. Although this model does not enable true survival ( $S$ ) to be estimated, it does allow one to estimate apparent survival ( $\phi$ ), which is a combination of the probabilities of true survival and site fidelity ( $F$ ). Therefore,  $\phi$  indicates the probability of a given individual being alive

# Agri-environment scheme habitat preferences of Yellowhammer *Emberiza citrinella* on English farmland

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McHugh N. M., Goodwin C. E. D., Hughes S., Leather S. R., Holland J. M. 2016. Agri-environment scheme habitat preferences of Yellowhammer *Emberiza citrinella* on English farmland. *Acta Ornithol.* 51: 199–209. DOI 10.3161/00016454AO2016.51.2.006

**Abstract.** Agri-Environment Schemes (AES) have been implemented across Europe in an attempt to address biodiversity losses associated with agricultural intensification. For many declining farmland bird species, the reduced availability and suitability of nesting and foraging habitats are thought to play a major role in population declines and some AES have hoped to counteract this by encouraging the provision of such habitats. This study aimed to determine the relative importance of AES on the territory selection of a widespread but declining farmland bird, the Yellowhammer *Emberiza citrinella*. Yellowhammers were more likely to locate territories in areas containing 'enhanced margins'; i.e. where field margin habitats were sown with wild flowers and/or agricultural legumes. An average of  $0.033 \pm 0.008$  ha of this 'enhanced margin' habitat was present within 100 m of Yellowhammer territories compared to  $0.020 \pm 0.008$  ha within 100 m of random points. This preference may reflect the higher invertebrate chick food abundance associated with this habitat as they contained, on average 46.3% and 36.8% more invertebrate food items than cereal and floral crops respectively. Alternatively, given that chick food abundance was similar between grass and enhanced field margins, this observed preference may be the result of a more open sward structure which increases prey accessibility and improves predator avoidance. Yellowhammers selected territories containing early succession hedgerows, as these constitute the most suitable nesting sites, and preferred territories containing a suitable songpost. Our results suggest that management strategies aiming to conserve breeding Yellowhammers should focus on increasing the coverage of invertebrate rich AES habitats such as floristically-enhanced margins and pollen and nectar plots, and ensure that they are located within typical foraging ranges of cut hedges with elevated songposts.

**Key words:** farmland bird, yellowhammer, wildflower, invertebrates, agri-environment, agriculture, farmland biodiversity, field boundary, habitat selection, AES

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## INTRODUCTION

Across Europe, changes in land use due to agricultural intensification are a key anthropogenic cause of biodiversity declines (Donald et al. 2006, Stoate et al. 2009). The growth and intensification of the farming industry has been linked to declines in invertebrates, with parallel declines in farmland bird populations (Newton 2004). Bird declines were attributed to a reduction in the amount of suitable nesting and foraging habitat on farmland (Wilson et al. 1997, Vickery et al. 2001). Although farmland bird species belonging to a range of taxa have declined as a consequence of these land-use

changes, Passeriformes (passerines) have been most affected (Newton 2004).

The widespread declines of European farmland bird populations have been a primary concern in relation to farmland biodiversity health. In an attempt to reverse these trends agri-environment schemes (AES) have been implemented across Europe, funded by the Common Agricultural Policy (CAP). Farmers involved in AES undertake prescriptive management strategies that, in part, aim to improve biodiversity problems (Kleijn & Sutherland 2003, Stoate et al. 2009) with financial incentives to compensate for any resulting loss of income.

# Blackcaps *Sylvia atricapilla* on migration: a link between long-term population trends and migratory behaviour revealed by the changes in wing length

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Ożarowska A., Zaniewicz G., Meissner W. 2016. Blackcaps *Sylvia atricapilla* on migration: a link between long-term population trends and migratory behaviour revealed by the changes in wing length. *Acta Ornithol.* 51: 211–219. DOI 10.3161/00016454AO2016.51.2.007

**Abstract.** Recent climate change has a major impact on the sizes and distribution of bird populations, the phenology of their breeding/migration and migratory behaviour (migration distance, migration strategy). We documented changes in the numbers of juvenile Blackcaps migrating in autumn through the S Baltic that were paralleled by changes in wing length of captured individuals during a 43-year study period (1967–2009). We suggest that the observed trends may indicate changing population composition of migrating birds. In the Blackcap, wing length distinguishes among different populations and increases with increasing migration distance of a given population. Available published data show that long-distance and short-distance Blackcaps pass the study region. Hence, we assumed that shorter-winged birds are short-distance migrants wintering in the southern Europe, and that longer-winged individuals are long-distance migrants wintering in the sub-Saharan region. It seems that in 1967–1980 most Blackcap populations declined, but, as wing length slightly increased, the rate of this decline has been higher in the shorter-winged/short-distance Blackcaps. Over the subsequent 24 years alongside with rapidly growing numbers of birds, we noted a remarkable decrease in wing length. This indicates a pronounced increase in the number of short-distance individuals compared to long-distance migrants. Both groups may benefit from improved conditions at their breeding grounds, but the shorter migration route and favourable conditions at wintering sites north of Sahara could favour short-distance migrants over the longer distance and longer-winged Blackcaps.

**Key words:** Blackcap, population trends, short-distance migrants, long-distance migrants, long-term dynamics

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## INTRODUCTION

Recent changes in environmental conditions, related to climate change, have a major impact on the numbers and distribution of bird populations, as well as their life-cycle, including the timing of seasonal activities, such as breeding and migration (Tryjanowski et al. 2002, Cotton 2003, Jenni & Kéry 2003, Marra et al. 2005, Hüppop & Winkel 2006, Tøttrup et al. 2006, Thorup et al. 2007). In Europe, species respond to changing climate by the range expansion northwards (e.g., Brommer et al. 2012) and decreasing migration distances (e.g., Visser et al. 2009, Ambrosini et al. 2016).

The Blackcap *Sylvia atricapilla* is among one of the most adaptive species responding to changing

ecological factors, which may also induce the changes in its migratory behaviour (Berthold & Terrill 1988, Busse 1992, Berthold 1995, Kopiec & Ożarowska 2012). The species shows a complex pattern of migration. Northern, central, and eastern European breeding populations are obligatory migrants. Southern European populations (north of the Mediterranean) and north-western African Blackcaps are partial migrants, while Mediterranean and Atlantic Islands races (*S. a. pauluccii*, *heineken*, *gularis*) are primarily resident (Shirihai et al. 2001). Regarding migratory distance, some European populations either cover shorter distance and winter in the southern part of Europe or north Africa (short-distance migrants) or travel as far as sub-Saharan Africa (long-distance

## Genetic diversity of the Azores Blackbirds *Turdus merula* reveals multiple founder events

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**Abstract.** We assessed the genetic diversity and phylogeography of the Azores Blackbird *Turdus merula*, based on sequences of two mitochondrial genes (Cytochrome b and NADH Dehydrogenase subunit 2) and one nuclear gene (Aconitase 1 – intron 9) from 45 individuals and an outgroup of 15 birds from Madeira, continental west Europe and north Africa. Our results revealed the lack of genetic structure on these islands and the presence of, at least, two different lineage groups that may indicate two different founder events of the Azores by Blackbirds.

**Key words:** Blackbird, *Turdus merula*, Azores, islands, phylogeography

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### INTRODUCTION

Oceanic archipelagos are important systems to study the evolutionary processes in small populations. The Azores, the most isolated of the North Atlantic archipelagos, holds a subset of avian passerine populations related to West Palearctic species (Illera et al. 2012). The genetic diversity and phylogeography of these populations has been the focus of several recent studies, revealing significant genetic differences to populations from other geographic areas such as the Bullfinches *Pyrrhula pyrrhula* and Chaffinches *Fringilla coelebs* (Töpfer et al. 2010, Rodrigues et al. 2014a). Other studies have presented small or no genetic differences from the Azores passerines to other populations, namely Canaries *Serinus canaria*, Blackcaps *Sylvia atricapilla*, Robins *Erithacus rubecula* and Goldcrests *Regulus regulus* (Dietzen et al. 2006, 2008, Rodrigues et al. 2013, 2014b). For the Blackbird *Turdus merula*, very little information is available.

The Blackbird is one of the most common and widespread bird species in the Western Palearctic, breeding throughout Eurasia and North of Africa to the European Atlantic islands (Collar 2005). The family Turdidae has a relatively old origin, in the mid to late Miocene (Klicka et al. 2005), followed by an early dispersal throughout Africa, from where a worldwide radiation took place (Nylander et al. 2008). The Blackbird showed a recent and fast radiation along Eurasia (Voelker et al. 2007), and there is little or no information for the Atlantic islands populations.

In general, the taxonomy of the current Blackbird subspecies is largely based on morphometric and coloration traits, and at least 15 different subspecies have been recognised, including those from Atlantic islands (Clement et al. 2000a). The Azores subspecies *T. merula azorensis* (Hartert & Ogilvie-Grant 1905) breeds on all the Azorean islands. However, this sub-specific status is based only on coloration and morphometric traits, which are often subjective and poorly defined.

# Negative effects of high temperatures during development on immediate post-fledging survival in Great Tits *Parus major*

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**Abstract.** We analyzed the effect of nest temperatures, fledging date, age at fledging, fledging mass and size on post-fledging survival of Great Tits *Parus major* in eastern Spain. We manipulated temperature during nestling development in 26 nests (average temperature was 39.8, 34.6 and 26.4 °C for heated, control and cooled nest-boxes, respectively), and used radio-telemetry to monitor the survival of 48 nestlings (16 heated, 18 cooled, 14 controls) during the first 15 days after fledging. Heated chicks were lighter than control and cooled chicks. Estimated survival of heated fledglings was lower than that of controls. Additionally, survival of control fledglings increased with size, but this relationship was reversed for heated fledglings. Our results suggest that high temperatures experienced in the nest could have negative consequences on immediate post-fledging survival, and that smaller nestlings may deal more effectively with temperatures surpassing their optimal thermal range.

**Key words:** Great Tit, heat stress, post-fledging survival, radio-telemetry

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## INTRODUCTION

In passerine birds, mortality during the first year after hatching may be as high as 70–90% (Perrins 1986, Verboven & Visser 1998, Naef-Daenzer et al. 2001), and there is evidence that the immediate period following fledging (i.e. the post-fledging dependence period) is particularly critical (Perrins 1979, Drent 1984, Naef-Daenzer et al. 2001). However, for most bird species, following chicks after fledging is difficult due to their cryptic nature, and little is known about their behavior. The development of radio-tracking techniques and mark-based capture-recapture analyses have helped to shed some light on this stage (Lebreton et al. 1992, Skalski et al. 1993, White & Burnham 1999, review in Cox et al. 2014).

Among the factors which have been shown to be related to post-fledging survival, fledging date and body condition at fledging seem to be especially important, with heavier and early-fledged individuals generally having higher survival probabilities (Tinbergen & Boerlijst 1990,

Naef-Daenzer et al. 2001, Monrós et al. 2002). Age at fledging could also be relevant, as remaining longer in the nest might improve flight capacity (Dial 2003). Consequently, factors affecting chick development during the nestling period could affect post-fledging survival through their effect on nestling condition at fledging (Greño et al. 2008). Suboptimal nest temperatures may also limit nestling development (Rodríguez & Barba 2016a, b). Cold temperatures might require nestlings to invest in thermoregulation, at the expense of processes such as growth or the activation of a cell-mediated immune response (Dawson et al. 2005). High temperatures, in turn, can also affect nestling condition by leading to reduced food intakes, thereby affecting tissue growth (Murphy 1985, Geraert et al. 1996), or cause dehydration and respiratory illnesses (Belda et al. 1995, Patz et al. 2005). Additional consequences of heat exposure may include alterations of metabolic rate and oxidative stress, which may lead to the production of heat-shock proteins in different tissues (Salo et al. 1991).

# Spatial variation in long-term trends in a metapopulation of the globally threatened Aquatic Warbler *Acrocephalus paludicola* in Poland

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**Abstract.** The Polish breeding population (3,200–3,250 males) of the globally threatened Aquatic Warbler *Acrocephalus paludicola* represents almost 25% of the global population. Except for the relatively stable large population in the Biebrza valley in north-east Poland less is known about population trends of peripheral populations in western, central and south-eastern regions of the country and whether trends differ depending on region. We investigated the long-term population dynamics in 38 small populations between 1969–2013 in the four Polish regions. Summarizing the trends of all small populations of Aquatic Warblers showed a significant decline in total number of individuals and declining number of populations over time. However, population trends were distinctly different in the different regions, with stable dynamics in south-east, moderate decline in north-east and sharp decline in the central and western regions. During the study period 19 out of 38 populations became extinct (11 populations in the western region, two in central region, four in north-east region and none in the south-east region). Five of these populations were later recolonised thus suggesting a pattern of metapopulation dynamics. To mitigate the negative trends and increased risk of local and regional extinction in the western and central parts of Poland effort should be put to increasing dispersal among populations by increasing the number of stepping stone patches between the viable large eastern populations and the smaller central and western ones.

**Key words:** conservation, dynamics, extinction, metapopulation, threatened species, Aquatic Warbler, *Acrocephalus paludicola*, additive model

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## INTRODUCTION

Populations of endangered species are often spatially subdivided between networks of separate habitat patches surrounded by unsuitable habitat matrix. Because such local populations are usually small they are prone to extinction due to demographic and environmental stochasticity and reduced genetic variability (Hanski 1989). However, when dispersal of individuals occurs among habitat patches local populations close to extinction may be rescued and patches with extinct populations may be recolonized, forming a network of local populations, i.e. a metapopulation displaying dynamics in local extinctions and recolonisations (Hanski 1989). Thus, in a

metapopulation some suitable habitat patches will be unoccupied at any time step. In a metapopulation where habitat patches differ in quality and size, furthermore, one expects source-sink dynamics with a surplus from sources dispersing to sink patches (Pulliam 1988, Dias 1996). In such source-sink metapopulations, the dynamics of sink populations may reflect both local population demography and productivity of the neighboring source populations. The dynamics of small populations may be therefore an indicator of the overall status of the metapopulation (Dias 1996).

The Aquatic Warbler *Acrocephalus paludicola* is a wetland species breeding in a network of spatially separated patches in eastern Europe. It is a globally threatened passerine bird, listed as