Research Article

Responses of Songbirds to Magpie Reduction in an Urban Habitat

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ABSTRACT Bird communities change in response to urbanization, which poses a challenge for conservationists. We examined the consequences of the recent increase in European cities of black-billed magpie (*Pica pica*), which has become the main bird nest predator in many urban parks, yet its impact remains disputed. We tested predator role in the limitation of postfledging and adult numbers of 10 common songbird species. We conducted before–after, control–treatment experimental magpie removal in the suburbs near Paris, France, during our 3-year study. We also compared the productivity and the relative densities between urban and rural habitats for 14 songbirds. We found that magpies had very limited effect on songbird productivity, even for species sensitive to predation by corvids. In addition, impact of the magpie on population levels of passerines would also be minimized because we found no relationship between productivity of prey and their densities. Thus, the recent colonization of urban parks by magpies should not threaten persistence of local songbird populations. Yet, there was evidence that a small number of non-territorial bird species were attracted to places where magpies were removed. Magpie densities may have modified habitat selection for foraging that might be explained by predator avoidance. But overall, characteristics of urban habitat explain variations of productivity and densities of songbirds better than did magpie predation. In France, conservationists widely use the control of predators, aiming at increasing levels of prey populations. Despite very high densities of magpies in urban parks, we gave evidence that removal of this predator was ineffective to preserve populations of common passerines. This would suggest that the risk induced by the presence of magpies is independent of its density, and conservationists must carefully assess its impact. In the future, we recommend management policies include long-term monitoring of magpie–prey interactions during breeding season to detect potential changes in songbird responses to magpie presence. (JOURNAL OF WILDLIFE MANAGEMENT 71(8):2624–2631; 2007)

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Urbanization is perceived as a new study context in ecology and brings to light important issues of nature management inside cities (McDonnell and Pickett 1990, Alberti et al. 2003). Basically, anthropogenic pressures in urban areas lead to changes in population abundances and species composition of animal communities (Sukopp et al. 1995, Marzluff 2001). For instance, during the past few decades many avian nest predators (e.g., cats, corvids, and rats) have expanded their distribution into urban environments (Marzluff 2001, Sorace 2002). In many cases, these predators have an advantage in cities because they are relieved of predation pressures from larger predators that are excluded from cities (Soulé et al. 1988, Marzluff et al. 1994). In addition, those avian nest predators may benefit from anthropogenic food sources to the point that they become more abundant than in their natural habitat. Hence, the increase of avian predators in urban environments may promote unsustainable predation rates on nest productivities (i.e., higher than in natural habitats), which in turn may result in the decline of some prey birds (Smith and Quin 1996).

The black-billed magpie (*Pica pica*) is currently increasing in suburbs. This generalist predator has become abundant in western European cities during the last 50 years, as have other corvids throughout the world (Marzluff et al. 1994, Gregory and Marchant 1995, Jokimaki and Huhta 2000, Jerzak 2001, Soh et al. 2002). This increase in cities is especially due to magpie abilities to find food in small vegetation patches and to exploit anthropogenic food remains (Jerzak 2001). The magpie is also a nest predator in urban landscapes as it is in natural landscapes (Timsit and Clergeau 1998). The magpie mainly depredates young of open-nesting passerines because the nests are more visible than those of hole-nesters (Birkhead 1991). We stress the importance of magpie predation on such short-lived species (e.g., passerines) because the local extinction risk of their populations is, in theory, more sensitive to the fecundity parameter than to adult survival (Krebs 2001). Nonetheless, magpies' impact on prey population persistence remains disputed. Some studies argue that magpie predation has little impact because small birds killed by this predator are few (magpie regular diet is <2% small birds and 80% invertebrates; Balanca 1984). However, diet analyses supposedly underestimate true predation because such studies are unable to detect remains of predation on eggs (e.g., eggshells). In addition, many studies have monitored the success of natural or artificial nests to assess the impact of nest predation by magpies (Jokimaki et al. 2005). However, several problems are associated with these methods (Batary and Baldi 2004, Burke et al. 2004, Faaborg 2004). As predation pressure is high until the independence of fledglings (Newton 1998), nest failure rates could be a biased index of true predation.

In a suburban environment, we conducted experiments to test whether magpie predation had an effect on the fecundity and the numbers of adult songbirds. We expected magpie predation decrease fecundity for open-nesting, but not for hole-nesting, songbirds (Birkhead 1991, Newton 1998). Second, we compared the relative density of the

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surveyed prey populations between urban and rural habitats at the scale of the Atlantic biogeographic zone in France. We also tested whether the variation of relative densities of songbird populations may be correlated to variation in fecundity in urbanized versus rural habitats. We hypothesized that a decrease in songbird fecundity due to magpie predation may have reduced urban population densities in cities.

STUDY AREA

We chose 15 study sites surrounding Paris, France, situated as far as 53.5 km from the town center ($\bar{x} = 24.2 \pm 17.8$ [SD] km). We divided the sites into 2 groups according to magpie density (see Methods below). Group A included those sites with low density or absence of magpies ($n = 11$ sites). We surveyed 1 site for 3 years, 6 sites for 2 years, and 4 sites for 1 year between 2003 and 2005. Sites were distributed in agricultural or seminatural landscapes with a low level of urbanization and low human frequentation in the close surroundings. Vegetation layers were primarily bushes or scrubs, undergrowth, and marsh. Group B included 4 urban sites (Courneuve [Ce], Ile-Saint-Denis [ISD], Sausset [St], and Villetaneuse [Ve]) where mean magpie density reached 1.3 adults/ha (Ligue pour Protection des Oiseaux 2001). This was an extremely high density (Birkhead 1991, Jerzak 2001), although typical of urban parks in the suburbs surrounding Paris (F. Chiron, Museum of Natural History, personal observation). Urban study sites consisted of large mown grass patches, with bushes and trees providing nesting covers for songbirds. A populated urban matrix surrounded urban study sites (5,855 inhabitants/km^2 in 1999; Institut National de la Statistique et des Études Économiques 1999) that ranged in area from 12.5 ha to 450 ha. From 2003 to 2005, we surveyed 2 sites (Ce and St) for 3 years and the 2 others for 2 years.

METHODS

Songbird Population Monitoring

Usually, the monitoring of either natural or artificial nests allows estimation of an index of young productivity through the value of nest success (Bibby et al. 2001). But this method can fail to provide a good estimation of nest success because the inspection of nest contents usually stops a few days after hatching when juveniles are not yet independent from parental care. Thus, this method misses a crucial period of predation on juveniles, the effects of which may vary among prey species after hatching. The number of postfledged juveniles, rather than nest success, is a more reliable index of the effect of predation on young productivity.

From 2003 to 2005, we used mist-nets to capture passerines and to count the number of juveniles and adults (Svensson 1992). Mist-nettings were well appropriate for our study to count birds because several songbird species were living in different habitats and were sometimes difficult to observe, so mist-netting improved standardization of our protocol. We fixed the number and the location of mist-nets among years within each trapping site ($n = 15$), following the French Constant Effort Site method (Julliard and Jiguet 2002). In a given site and during a year, we sampled songbird populations between May and mid-July from 3 to 5 times according to the sites. We identified each captured bird as adult or juvenile and banded it with an individually numbered metal ring allowing further identification, thus avoiding double-counting. At the level of each site and during a year, the abundance of juveniles and adults is the mean number of individuals caught across sessions of capture.

We thus determined the proportions of juveniles among banded individuals of a given species on each site in our study area from 2003 to 2005. Because we expected it to be correlated with local nestling success (Bart et al. 1999, Newton 1999, du Feu and McMeeking 2001), the proportion of juveniles provided an estimate of postfledging productivity.

Second, we used the French Breeding Bird Survey (Julliard and Jiguet 2002) to compare the relative density of songbirds in urbanized landscapes and in other landscapes from 2001 to 2004. For this survey, the same observer counted visible individuals and singers during a fixed period of 5 minutes on permanent 2 × 2-km squares. We randomly chose the squares, ensuring that sampled habitats were representative (Jiguet 2001). Each sampling unit was a cluster of 10 points evenly distributed in the square. In each point, skilled observers counted breeding birds and classified the habitat into 1 of 5 categories: human settlement, forest, scrub, natural open land, or farmland. We calculated the relative density of a given species in a given habitat as the number of individuals counted divided by the number of points sampled in that habitat. We restricted analyses to the Atlantic biogeographic zone in France (260,000 km^2), which encompassed our netting study area.

Magpie Experimental Removal

We studied variations of prey parameters (no. of ad and juv captured and postfledging productivity) in response to magpie experimental reduction from 2003 to 2005 using the Constant Effort Site method described above. We based our experiment on a before-after–control-treatment design conducted in 2 urban sites (Ce and St; Fig. 1). Each site included one control and one magpie removal plot in close proximity ($\bar{x}$ distance apart = 600 m). This design allowed simultaneous comparisons of prey parameters between the treatment and control plots (2 each) when magpie reduction occurred in 2005. We monitored songbird populations prior to reduction (in 2003 and 2004) to avoid misinterpreting any differences between control and removal plots unrelated to magpie removal. No other change in habitat management inside plots occurred during the study period.

Reduction and Monitoring of Magpie Density

We attempted to reduce the number of magpies in the 2 removal plots during the whole songbird breeding season. We designed the period of reduction to encompass egg laying, incubation, hatching, nesting, and fledging period of most songbirds. Thus, removal lasted from the end of

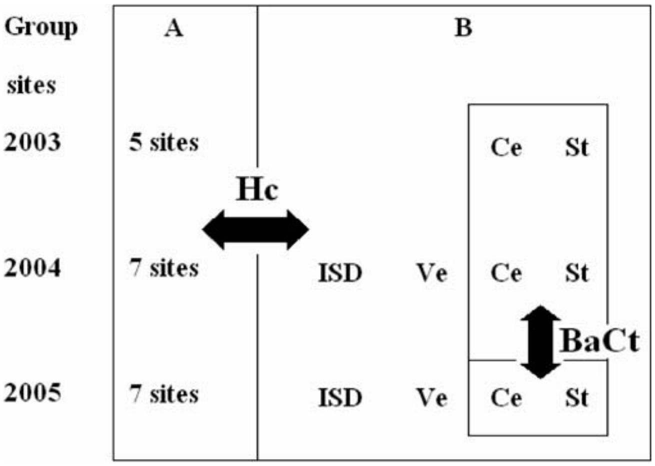

Figure 1. Study design to test magpie impact (before-after–control-treatment) and habitat correlations (Hc) on prey parameters of a given species from 2003 to 2005. The magpie predation effect resulted from a before-after–control-treatment (BaCt) comparison of the numbers of postfledged juveniles and adults between control and removal areas within Courneuve and Sausset parks near Paris, France. Habitat test is issued from comparison of postfledging productivity between urban sites (Ile-Saint-Denis [ISD], Villetaneuse [Ve], Courneuve [Ce], and Sausset [St]) and others set up in agricultural or seminatural landscapes without magpies.

March until mid-July. In March, magpies have already set up their territories and excluded nonbreeding flocks from study sites. We removed magpies within a 300-m radius around the point where we monitored songbird populations. Using small cages with decoys, we attempted to capture every pair of magpies. Trapping is successful as soon as the territorial pair decides to drive the intruder (i.e., decoy) out of its territory. Then, one or both territorial mates enters the cage and is trapped. We observed the behavior before capture and the shape of external sexual parts to determine breeders from nonbreeders (Birkhead 1991, Svensson 1992). We ringed all captured magpies and released them a safe distance from the study site (as far as 200 km). To maintain low magpie density, we systematically repeated removal (until Jul) when new pairs established in the removal area. In addition, we also captured nonbreeders (24% of captures) to more efficiently reduce population density in removal areas. Prior to reduction, we estimated magpie density primarily on nests we found in March, and secondly, according to conspicuous territorial behavior of birds, which provides the strongest evidence of the presence or location of pairs (Bibby et al. 2001). We recorded magpie nests within a 300-m radius of the point where we sampled songbird populations.

We monitored magpie density based on a point count method that accurately measures corvid density (Luginbuhl et al. 2001). We monitored 2 points for 10 minutes at each control and removal plot (4 points/urban site) each week from March to July in 2005. We placed the 2 points at each plot so that we could cover >50% of the plot area with binoculars. We monitored control and removal plots alike to assess differences in their local densities. In addition, we recorded relative densities of other bird predators to detect any effect of the release of other predator populations that could have benefited from magpie control (Soulé et al. 1988). Such predators included carrion crow (*Corvus corone*), jay (*Garrulus glandarius*), Eurasian kestrel (*Falco tinnunculus*), domestic cat, and red fox (*Vulpes vulpes*).

Statistical Analyses

In 2005, we estimated magpie density reduction as the decrease in the number of magpies counted within removal plots divided by the variations we calculated at the corresponding control plots after April using a chi-square test. Then we estimated responses of songbirds species to experimental magpie density reduction. We selected only songbird species with $\geq$15 individuals banded over the 3 years in each treatment group (control and removal plots) to reduce Type I error. First, we estimated variations of both adult and postfledging songbirds banded before and after reduction relative to changes we observed at the corresponding control plots. We tested for an interaction between the treatment groups (removal vs. control plots) and the density reduction of magpie in a generalized linear model (GLM), using a log link function assuming Poisson distributions of the numbers of songbirds captured (juv and ad). Because removal and control plots of each site (Ce and St) were close together, we assumed the effect of year to be constant among sites. We tested relative changes in songbirds captured using a chi-square test (>200 individuals) or 2-sided Fisher's exact test for small sample sizes (i.e., between 15 and 200 individuals).

Second, we assessed variations of the proportion of juvenile songbirds between urban and nonurban sites (namely the relative postfledging productivity) for species with $\geq$15 birds banded over the 3 years in each habitat group. We assumed a binomial distribution of the proportion of juveniles, among banded songbirds, using a logit link function. We excluded data of songbirds sampled in 2005 within removal areas from the analysis. We calculated the relative postfledging productivity in urban habitat for a given songbird species as

$$\text{Relative PFP}_{\mathrm{U}} = \text{Logit}(\%\text{juv})_{\mathrm{U}} - \text{Logit}(\%\text{juv})_{\mathrm{NU}},$$

where U = urban sites and NU = nonurban sites. We assessed the statistical effect of the habitat on the proportion of songbird juveniles, while controlling for other factors supposed to vary with the productivity (i.e., the species, site, nest type, yr, and date of capture). Thus, we assessed the habitat effect in a same model M1 (GLM, Type I) and using an analysis of variance (Type I error):

$$\text{Logit}(\%\text{juv}) \sim \text{species} + \text{year} + \text{nest type} + \text{date of capture} + \text{habitat} + \text{site}. \quad \text{(M1)}$$

In this model, the habitat is nested to site effects to account for productivity variations among sites of a given habitat. We also tested for interactions between all factors. Finally, we estimated the relative density in urban habitat of each songbird species as the increase rate between urban and nonurban sites. We performed all statistical analyses with S-Plus software (MathSoft, Inc., Bagshot, United Kingdom).

Table 1. Variations in the densities of magpies and of other predator species after trapping, April–June 2005, near Paris, France. Trends of magpie densities at removal plots (Courneuve and Sausset) shows that reduction is effective until June.

	Index[a] of magpie density after removal (Feb–Mar = 100)					Index of non-magpie predator density after removal (Feb–Mar = 100)		
Site	**Feb–Mar**	**Apr**	**May**	**Jun**	**Reduction of magpie density**	**Feb–Mar**	**Apr–May–Jun**	**Predator release (*F*-test)**
Courneuve	100	73	62	48	$\chi^2 = 3.48$, df = 1; $P = 0.06$	100	85	$P = 1.00$
Sausset	100	44	54	37	$\chi^2 = 9.47$, df = 1; $P < 0.01$	100	250	$P = 0.17$
No. of magpies trapped	0	41	33	19				

[a] We calculated this index as the magpie density variations observed at removal plots divided by variations at control plots.

RESULTS

Assessing Trapping Efficiency on Magpie Density

Territory mapping at the 2 urban sites (Ce and St) before trapping indicated very high densities of breeders at removal as well as control plots ($\bar{x} = 0.49 \pm 0.05$ [SE] pair/ha). Field observations also suggested a large number of magpie nonbreeders that increased local densities but were difficult to quantify. After April, we reduced the density of magpies to 42% (48% at Ce and 37% at St) of the density on the 2 removal plots relative to control plots (Table 1). The expansion of territories of neighboring pairs and then the replacement of removed pairs by former floaters (i.e., magpies without territory that were formerly excluded by breeders and now attempted to nest) were 2 consequences of magpie removal.

As expected, we had to trap each time a territory was occupied, to sustain low magpie density. Indeed, the total of magpies captured ($n = 93$) compared with the number of breeding pairs settled before removal ($n = 31$ pairs) suggested that magpie immigration from outside the plots was important. The numbers of other predators we observed did not change after magpie density reduction at Courneuve and Sausset (Table 1). Further, we observed a few number of predators other than magpie over the study period (<20 contacts/plot).

Variations of the Numbers of Postfledged Juveniles and Adults Banded After Magpie Density Control

We analyzed the variations of abundances for 10 songbird species (Table 2). Based on the before-after–control-treatment method, the overall number of postfledged juveniles caught with mist-nets was 40% larger than before magpie density reduction in 2005. But at species level, magpie density reduction only increased the number of blue tit (*Parus caeruleus*) juveniles. For other species, the number of juveniles caught did not vary (when excluding the blue tit from the data set, we found $\chi^2 = 6.58$, df = 7, $P = 0.47$).

Table 2. Numbers of adults and postfledged juvenile songbirds caught before (2003 and 2004) and after (2005) magpie density reduction within control and removal plots within Courneuve and Sausset, near Paris, France.

		No. of ad		No. of juv		Variations after magpie density reduction		
Species	**Plots**	**Before**	**After**	**Before**	**After**	**Ad**	**Juv**	**Contrast between age classes**
Dunnock[a]	Control	20	13	17	7	$\chi^2 = 0.06$, NS[b]	$\chi^2 = 0.53$, NS	$\chi^2 = 1.14$, NS
	Removal	38	20	24	17			
Blackbird[a]	Control	30	30	4	5	$\chi^2 = 3.12$, NS	*F*-test, NS	$\chi^2 = 0.12$, NS
	Removal	58	30	9	8			
Garden warbler[a]	Control	4	5	1	2	*F*-test, NS	*F*-test, NS	$\chi^2 = 2.52$, NS
	Removal	21	9	1	13			
Blackcap[a]	Control	13	25	21	18	Negative $\chi^2 = 8.47$, $P < 0.01$	$\chi^2 = 0.92$, NS	$\chi^2 = 9.31$, $P < 0.01$
	Removal	63	36	74	95			
Greater whitethroat[a]	Control	9	17	10	6	$\chi^2 = 0.86$, NS	$\chi^2 = 0$, NS	$\chi^2 = 0.37$, NS
	Removal	17	17	49	25			
Chiffchaff[a]	Control	5	1	21	5	*F*-test, NS	*F*-test, NS	$\chi^2 = 0.02$, NS
	Removal	10	8	9	7			
Great tit[c]	Control	13	7	37	44	*F*-test, NS	$\chi^2 = 0.03$, NS	$\chi^2 = 0.26$, NS
	Removal	7	2	22	23			
Blue tit[c]	Control	6	10	41	30	*F*-test, NS	Positive *F*-test, $P < 0.01$	$\chi^2 = 1.11$, NS
	Removal	1	2	4	18			
Long-tailed tit[a]	Control	5	2	4	5	Positive *F*-test, $P < 0.01$	*F*-test, NS	$\chi^2 = 2.23$, NS
	Removal	1	20	4	27			
House sparrow[c]	Control	36	30	37	45	$\chi^2 = 2.36$, NS	*F*-test, NS	$\chi^2 = 0.37$, NS
	Removal	14	24	1	5			
Total	Control	141	140	193	167	$\chi^2 = 3.55$, NS	Positive $\chi^2 = 5.13$, $P = 0.02$	$\chi^2 = 9.15$, $P < 0.01$
	Removal	230	168	197	238			

[a] Open-nesting species.
[b] NS = non-significant.
[c] Hole-nesting species.

Table 3. Numbers of adult and postfledged juvenile songbirds caught during 3 years in nonurban sites ($n = 11$) and urban sites ($n = 4$) near Paris, France, 2002–2005. We also present the estimated proportion of fledged juveniles (PFP) in urban and nonurban habitats and the relative PFP in urban habitat.[a]

	Nonurban		Urban			
Species	**No. of juv**	**No. of ad**	**No. of juv**	**No. of ad**	**Relative PFP**	**P (F_{stat})**
Dunnock[b]	46	132	67	83	0.84	NS[c]
Robin[b]	234	120	14	14	−0.67	NS
Song thrush[b]	21	52	6	12	0.21	NS
Blackbird[b]	101	239	35	208	−0.92	** ($F_{1,12} = 17.6$)
Garden warbler[b]	34	122	6	27	−0.23	NS
Blackcap[b]	433	413	155	122	0.19	NS
Greater whitethroat[b]	62	64	78	40	0.70	NS
Reed warbler[b]	42	188	36	224	−0.33	NS
Willow warbler[b]	64	176	9	11	0.81	NS
Chiffchaff[b]	210	221	49	24	0.76	NS
Great tit[d]	434	97	115	37	−0.36	NS
Blue tit[d]	200	63	104	23	0.35	* ($F_{1,12} = 6.1$)
Long-tailed tit[b]	59	48	28	16	0.35	NS
House sparrow[d]	24	63	83	93	0.85	NS
Total	1,964	1,998	785	934	−0.16	NS

[a] The relative PFP in urban habitat is estimated as the logit differences of the proportion of juv caught between urban sites and nonurban sites. Negative values indicate a lower proportion of juv in urban sites than in nonurban sites, and positive values indicate a better productivity in urban sites. We assessed the habitat effect on PFP after controlling for the effects of other factors (i.e., species, type of nest, site, date, and yr of capture).

[b] Open-nesting species.

[c] NS = non-significant.

[d] Hole-nesting species.

* $P < 0.05$, ** $P < 0.01$.

Overall, the number of adults caught did not differ before and after magpie reduction (Table 2). However, at the species level, the number of adult blackcaps (*Sylvia atricapilla*) caught was 70% lower than before magpie removal, whereas the number of adult long-tailed tits (*Aegithalos caudatus*) increased 50 times during the same period. These results suggested that changes in the number of songbirds banded following magpie removal were rapid, but changes varied between species and age classes (Table 2).

Relative Postfledging Productivity and Relative Density in Urban Habitats

Attributable to the large pool of sites, we selected 14 of the 57 sampled species for habitat comparisons (Table 3). Between 2003 and 2005, we banded 6,800 individuals over the 15 sites.

Controlling for effects of species, nest type, site, year, and date of capture, we assessed the variations in postfledging productivities among breeding habitats (i.e., namely the relative productivity in Table 3). Overall, we found no variation of the postfledging productivity between urban and nonurban habitats during our 3-year investigation (Table 3). Not all species responded alike (there was an interaction between habitat and species; $F = 49.12$, df $= 12$, $P < 0.01$). The postfledging productivity of blackbird (*Turdus merula*) populations was 72% (SE = 13%) lower in urbanized areas than in the countryside, whereas blue tit postfledging productivity was 105% (SE = 50%) larger in urban habitat than in the countryside (Table 3).

Between 2001 and 2004, we counted 252,000 individuals on 2,900 point counts. Considering these 14 species (except the reed warbler [*Acrocephalus scirpaceus*], which we did not contact in urban sites), species densities were 16% larger in nonurban than in urban habitats on average (Table 4). In fact, dunnock (*Prunella modularis*), blackbird, and house sparrow (*Passer domesticus*) populations were denser in urban than in nonurban areas, similar to magpie populations. Conversely, relative densities of warblers (blackcap, garden warbler [*Sylvia borin*], whitethroat [*Sylvia communis*], willow warbler [*Phylloscopus trochilus*], and chiffchaff [*Phylloscopus collybita*]) and long-tailed tits decreased from 27% to 67% less. Overall, variations of species densities were not related to variations of their postfledging productivity values (Fig. 2).

Table 4. Relative densities of songbirds (including magpie and carrion crow) in urbanized areas compared to other habitats (forest, scrub, marshland, and farmland) estimated from 2001 to 2004 based on French Breeding Bird Survey restricted to the Atlantic biogeographic zone (France).

Species	Relative density in urban area (%)	P
Dunnock	+86	***
Song thrush	−30	***
Blackbird	+39	***
Robin	−67	***
Blackcap	−27	***
Garden warbler	−39	***
Whitethroat	−67	***
Chiffchaff	−56	***
Willow warbler	−61	***
Long-tailed tit	−33	***
Blue tit	+4	**
Great tit	+24	***
House sparrow	+441	***
Carrion crow	−44	***
Magpie	+176	***

** $P < 0.01$, *** $P < 0.001$.

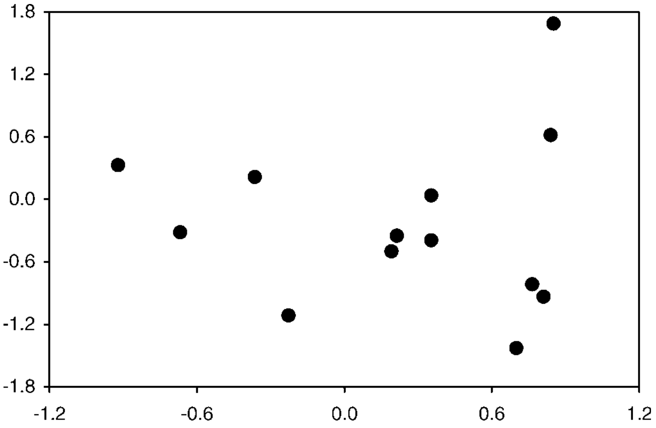

Figure 2. Relationship between the relative density of songbirds in urbanized landscapes (log scale) calculated using data of French Breeding Bird Survey for the Atlantic biogeographic zone (France), and the relative postfledging productivity in urbanized landscapes (logit-scale) estimated from Constant Effort Site during the 2001–2005 period.

DISCUSSION

We aimed to test whether magpie predation had an effect on the fecundity of songbirds in urban parks. Our results gave evidence for a lack of negative magpie impact on the breeding success of the songbirds studied. Overall, we showed that the reduction in magpie densities stimulated the numbers of juveniles caught of only the blue tit. In addition, although open-nesting songbirds are known to be the most sensitive to predation at nest, their reproduction did not benefit from magpie removal, even blackbird, which usually suffers from magpie predation (Groom 1993, Gregoire 2003).

If the number of banded postfledging songbirds is correlated to the number of young produced at nest (Peach et al. 1996, Bart et al. 1999), our conclusions are not consistent with expected positive effects of corvid control on nest success (Côte and Sutherland 1997, Newton 1998). Previous correlative studies have suggested predation by corvids negatively impacts the nest success rate of common passerines (Andren 1992, Timsit and Clergeau 1998, Paradis et al. 2000, Stoate and Szczur 2001). For instance, Paradis et al. (2000) showed a positive correlation between the nest failure rates of Turdidae (blackbird and song thrush [*Turdus philomelos*]) and corvid density (magpie and carrion crow). But as such studies have only been run in farmland and were unable to reject the confounding effects of habitat type and time variation on nest-failure rate, the conclusions warrant caution. In the case of blackbirds, the comparison of postfledging productivities between urban and nonurban sites would suggest the importance of habitat type on nest success in our study. Apparently, blackbird productivity in suburban habitats was lower than productivity observed in the close countryside. As magpie density was also much higher in urban parks, the lack of young blackbirds produced in urban parks could be interpreted as the consequence of magpie predation. But the absence of magpie removal effect on the number of blackbirds fledged in urban parks indicated that other environmental factors (i.e., quality of habitat and other predators present) would better explain the difference in blackbird productivity between urban and nonurban habitats rather than magpie density.

As we observed for blackbirds, the increase in the number of blue tit juveniles caught after magpie density reduction was unexpected because the blue tit nests in cavities and is thus protected from avian predation at nest. Consequently, the freedom from predation in fledged juveniles could better explain such an increase rather predation at nests, after magpie removal. Similarly, the marked increase in the number of long-tailed tit adults after magpie density reduction should be independent of nest predation. In a few cases, magpies prey on fledged juveniles and adult songbirds (Fernández-Juricic et al. 2004). Indeed, magpie is a non-specialized predator and is able to catch songbirds out of their nests, which can provide a supplementary source of protein for chicks. But attacks on adults are occasional and often unsuccessful, and thus they are unlikely to limit local songbird densities. Rather, magpie avoidance might explain the selection of areas of reduced magpie density by adult long-tailed tits and blue tits. Fledged juveniles and adults of these gregarious species usually gather for foraging in a group and may have switched from neighboring areas to the newly created magpie-free area. Yet we never observed movement of juveniles or ringed adults between control and removal plots during our 3-year study. Changes in the number of blue tits and long-tailed tits caught revealed that a few species of songbirds can react quickly to change in predator presence–absence. Further studies will be worth analyzing behavioral responses of songbirds to magpie presence and its consequences on prey habitat selection. If magpies could play a substantial role in the local distribution of tit species, other environmental factors may limit local tit densities much more. The blue tit produced more juveniles and was more abundant inside urban parks than in countryside, despite the negative effect of magpie presence in urban parks on this species. This observation might indicate that the pressure of magpie predation has a weak effect on tit densities relative to other environmental factors such as habitat quality or other predators.

Finally, we stressed the independence between the variation of songbird densities and the variation in young productivity in urbanized versus rural habitats. For instance, it is notable that low blackbird productivity in urban parks does not seem to affect the overall blackbird urban population, of which densities remain higher than in countryside. Because changes in songbird densities (i.e., between habitats) were not necessarily related to productivity variations (i.e., postfledging productivity estimator), potential effects of magpie predation on songbird densities would be thus minimized. The absence of relationship between songbird productivity and their densities highlights the need to advance our understanding of the roles of mechanisms that could compensate for reduction in blackbird productivity and regulate population densities.

The lack of magpie impact on songbird productivity in our study suggests that high magpie density does not alter the long-term persistence of the songbirds we studied. In the United Kingdom, large-scale monitoring confirmed that population trends of the 14 songbirds studied were not associated with magpie density changes (Gooch et al. 1991, Thomson et al. 1998). However, we urge caution in our conclusions; because the colonization of magpies is not finished in urban areas (Jerzak 2001), magpie density might increase in some European cities, inducing changes of interaction between songbirds and this predator and potential deleterious effects on the conservation of prey. Clearly, we required local studies before implementation of any management policies because generalization of our results about nest predators and young productivity may be false at the local management level. Future studies and policies will include long-term monitoring of prey and predator densities. Furthermore, because we studied the most abundant songbird species, we cannot reject the hypothesis that magpie presence may have caused the exclusion of more rare species.

MANAGEMENT IMPLICATIONS

In France, conservationists widely use predator control, aiming at increasing levels of prey populations. Despite very high densities of magpies in urban parks, we gave evidence that removal of this predator was ineffective to preserve population of common passerines. This would suggest that the risk induced by the presence of magpies is independent to its density. Hence, before any reduction of predator populations conservationists must carefully assess its impact. It would avoid either inefficiency of the control or persecuting predators for no reason. In the future, we recommend management policies include long-term monitoring of magpie–prey interactions during breeding season to detect potential changes in songbird responses to magpie predation.

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LITERATURE CITED

Alberti, M., J. M. Marzluff, E. Shulenberger, G. Bradley, C. Ryan, and C. Zumbrunnen. 2003. Integrating humans into ecology: opportunities and challenges for studying urban ecosystems. BioScience 53:1169–1179.

Andren, H. 1992. Corvid density and nest predation in relation to forest fragmentation: a landscape perspective. Ecology 73:794–804.

Balanca, G. 1984. Diet of a magpie (*Pica pica*) population. Gibier Faune Sauvage 3:37–61.

Bart, J., C. Kepler, P. Sykes, and C. Bocetti. 1999. Evaluation of mist-net sampling as an index to productivity in Kirtland's warblers. Auk 116: 1147–1151.

Batary, P., and A. Baldi. 2004. Evidence of an edge on avian nest success. Conservation Biology 18:389–400.

Bibby, C. J., N. D. Burgess, and D. A. Hill. 2001. Bird census techniques. Academic Press, London, United Kingdom.

Birkhead, T. 1991. The magpies. T&AD Poyser, London, United Kingdom.

Burke, D. M., K. Elliot, L. Moore, W. Dunford, E. Nol, J. Philips, S. Holmes, and K. Freemark. 2004. Patterns of nest predation on artificial and natural nests in forests. Conservation Biology 18:381–388.

Cézilly, F., A. Viallefont, V. Boy, and A. R. Johnson. 1996. Annual variation in survival and breeding probability in greater flamingos. Ecology 77:1143–1150.

Côte, I. M., and W. J. Sutherland. 1997. The effectiveness of removing predators to protect bird populations. Conservation Biology 11:395–405.

du Feu, C., and J. McMeeking. 2001. Does constant effort netting estimate juvenile abundance? Ringing and Migration 12:118–123.

Faaborg, J. 2004. Truly artificial nest studies. Conservation Biology 18:369–370.

Fernández-Juricic, E., J. Jokimäki, J. C. McDonald, F. Melado, A. Toledano, C. Mayo, M. Martín, I. Fresneda, and V. Martín. 2004. Effects of opportunistic predation on anti-predator behavioural responses in a guild of ground foragers. Oecologia 140:183–190.

Gooch, S., S. Baillie, and T. Birkhead. 1991. Magpie *Pica pica* and songbird populations. Retrospective investigations of trends in population density and breeding success. Journal of Applied Ecology 28:1068–1086.

Gregoire, A. 2003. Démographie et différenciation chez le Merle noir *Turdus merula*: liens avec l'habitat et les relations hôtes-parasites. Thesis, University of Dijon, Dijon, France. [In French.]

Gregory, R. D., and J. H. Marchant. 1995. Population trends of jays, magpies, jackdaws and carrion crows in the United Kingdom. Bird Study 43:28–37.

Groom, D. W. 1993. Magpie *Pica pica* predation on blackbird *Turdus merula* nests in urban areas. Bird Study 40:55–62.

Institut National de la Statistique et des Études Économiques. 1999. Recensement national de la population. <http://www.insee.fr>. Accessed 5 Jan 2005. [In French.]

Jerzak, L. 2001. Synurbanization of the magpie in the Palearctic. Pages 403–425 *in* J. M. Marzluff, R. Bowman, and R. Donnelly, editors. Avian ecology and conservation in an urbanizing world. Kluwer Academic, Norwell, Massachusetts, USA.

Jiguet, F. 2001. Programme STOC-EPS—bilan de la relance du réseau national en 2001. Ornithos 8:201–207. [In French.]

Jokimaki, J., and E. Huhta. 2000. Artificial nest predation and abundance of birds along an urban gradient. Condor 102:838–847.

Jokimaki, J., M.-L. Kaisanlahti-Jokimaki, A. Sorace, E. Fernandez-Juricic, I. Rodriguez-Prieto, and M. D. Jimenez. 2005. Evaluation of the "safe nesting zone" hypothesis across an urban gradient: a multi-scale study. Ecography 28:59–70.

Julliard, R., and F. Jiguet. 2002. Un suivi intégré des populations d'oiseaux communs en France. Alauda 70:137–147. [In French.]

Krebs, C. J. 2001. Ecology. Benjamin Cummings, San Francisco, California, USA.

Ligue pour Protection des Oiseaux. 2001. Suivi des populations de pies et de corneilles au Parc départemental de La Courneuve. Observatoire de la Biodiversité de Seine-Saint-Denis, Paris, France. [In French.]

Luginbuhl, J. M., J. M. Marzluff, J. E. Bradley, M. G. Raphael, and D. E. Varland. 2001. Corvid survey techniques and the relationship between corvid relative abundance and nest predation. Journal of Field Ornithology 72:556–572.

Marzluff, J. M. 2001. Worldwide urbanization and its effects on birds. Pages 19–47 *in* J. M. Marzluff, R. Bowman, and R. Donnelly, editors. Avian ecology and conservation in an urbanizing world. Kluwer Academic, Norwell, Massachusetts, USA.

Marzluff, J. M., R. B. Boone, and G. W. Cox. 1994. Native pest bird species in the West: why have they succeeded where so many have failed? Studies in Avian Biology 15:202–220.

McDonnell, M. J., and S. T. A. Pickett. 1990. Ecosystem structure and function along urban–rural gradients: an unexploited opportunity for ecology. Ecology 71:1232–1237.

Newton, I. 1998. Population limitation in birds. Academic Press, San Diego, California, USA.

Newton, I. 1999. Age ratio in bullfinch *Pyrrhula pyrrhula* population over six years. Bird Study 46:330–335.

Paradis, E., S. Baillie, W. J. Sutherland, C. Dudley, H. Q. P. Crick, and R. D. Gregory. 2000. Spatial synchrony in populations of birds: effects of habitat, population trend and spatial scale. Ecology 81:2112–2125.

Peach, W. J., S. T. Buckland, and S. R. Baillie. 1996. The use of constant effort mist-netting to measure between-year changes in abundance and productivity of common passerines. Bird Study 43:142–156.

Smith, A. P., and D. G. Quin. 1996. Patterns and causes of extinction and decline in Australian conilurine rodents. Biological Conservation 77:243–267.

Soh, M. C. K., N. S. Sodhi, R. K. H. Seoh, and B. W. Brook. 2002. Nest site selection of the house crow (*Corvus splendens*), an urban invasive bird species in Singapore and implications for its management. Landscape and Urban Planning 59:217–226.

Sorace, A. 2002. High density of bird and pest species in urban habitats and the role of predator abundance. Ornis Fennica 79:60–71.

Soulé, M. E., M. T. Bolger, A. C. Alberts, J. Wright, M. Sorice, and S. Hill. 1988. Reconstructed dynamics of rapid extinctions of chaparral-requiring birds in urban habitat islands. Conservation Biology 2:75–92.

Stoate, C., and J. Szczur. 2001. Could game management have a role in the conservation of farmland passerines? A case study from a Leicestershire farm. Bird Study 48:279–292.

Sukopp, H., M. Numata, and A. Huber. 1995. Urban ecology as the basis for urban planning. SPB Academic, The Hague, The Netherlands.

Svensson, L. 1992. Identification guide to European passerines. Svensson Lars, Stockholm, Sweden.

Thomson, D. L., R. E. Green, R. D. Gregory, and S. R. Baillie. 1998. The widespread declines of songbirds in rural Britain do not correlate with the spread of their avian predators. Proceedings: Biological Sciences 265: 2057–2062.

Timsit, O., and P. Clergeau. 1998. Corvid (Corvidae) densities and predation on artificial nests in relation to landscape structure. Gibier Faune Sauvage 15:151–166.

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