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DECADAL CHANGES IN URBAN BIRD ABUNDANCE IN SINGAPORE

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ABSTRACT. — Birds are one of the most cost-effective groups to survey for monitoring human impacts on faunal communities and are consequently the best studied taxonomic group in urban areas. Urban bird assemblages are typically dominated by a few pest species, and need to be appropriately managed to reduce the aesthetic costs and health risks they may pose in highly-populated areas. Studies were conducted in Singapore (Feb.2000 to Feb.2001) to provide recommendations to manage urban birds, in particular to control the population of two invasive alien bird species: the house crow (*Corvus splendens*) and the Javan myna (*Acridotheres javanicus*). We then re-surveyed the same sites 9 years later (Mar.2010 to Feb.2011) to compare the changes in the abundance of the 20 most common urban bird species in Singapore over the past decade. We also tested whether the decrease in house crow abundance was correlated with increases in abundance of its co-invasive, the Javan myna, or with the Asian koel (*Eudynamys scolopacea*), a brood parasite of the house crow, across sites. In addition, we investigated competition between two myna species by comparing whether declines in the abundance of the common myna (*Acridotheres trista*) were correlated with increases in the abundance of the Javan myna. Our results showed that a total of 14 species recorded a significant increase in abundance between the two surveys, two species significantly decreased, and four species had no significant change. There was also no significant correlation between all the bird abundances, although changes in bird abundances were significantly associated with certain changes in the urban environment such as spontaneous or cultivated green cover. We suggest that reduced density of house crow nests may actually result in increased vulnerability to, and hence success rate of, brood parasitism by the Asian koel, or there may be increased parasitism of other host species' nests. Meanwhile, competitive effects among the other birds may not be detectable at the scale of the transects used in our study.

KEY WORDS. — invasive species, pest bird control, urban avifauna, competitive release, co-invader, brood parasitism

INTRODUCTION

The area, number, and densities of human settlements are increasing around the world (United Nations Population Division, 2010). Therefore, it is increasingly important to understand how human activities in urbanised areas affect ecosystems, with urban habitats becoming increasingly relevant to biodiversity research. Birds are one of the best studied taxonomic groups in urban areas because they are ubiquitous, cost-effective to survey, and are highly visible (Chace & Walsh, 2006). They also perform important ecological functions such as seed dispersal and pest removal (Sekercioglu, 2006).

A few common patterns are emerging from research on urban bird assemblages. Species richness and abundance of exotic and generalist bird species increase with increasing urbanisation, while the reverse is often true for native and specialist birds (McKinney, 2002; Lim & Sodhi, 2004; Carbó-Ramírez & Zuria, 2011; MacGregor-Fors & Ortega-Álvarez, 2011). Bird communities are also increasingly dominated by a subset of species with increasing urbanisation. Among cities, bird communities are often highly homogenized (i.e., the same subset of species are found), especially in the highly urbanised centers (McKinney, 2006; Husté & Boulinier, 2011; MacGregor-Fors & Ortega-Álvarez, 2011). When widespread, highly mobile species congregate in high densities close to human habitations, they may create significant problems such as health risks. For example, migratory and urban birds were a source of worry for health authorities during the avian flu outbreak in recent years (Sodhi & Sharp, 2006).

A series of studies was conducted in Singapore to understand the behavioural ecology of urban birds, in particular to provide recommendations for effective population management of the two invasive alien pest species: the house crow (*Corvus splendens*) and the Javan myna (*Acridotheres javanicus*). The former arrived in Singapore possibly via spreading southwards from Port Klang in Peninsular Malaysia where it was introduced as a potential biological control for the clear wing hawkmoth (*Cephonodes hylas*) caterpillar plague on coffee plantations at the end of the 19th century or early 20th century (Soh et al., 2002; Brook et al., 2003; Lim et al., 2003; Sodhi & Sharp, 2006; Lim & Sodhi, 2009). Alternatively, the house crows could have arrived as stowaways on ships arriving from India and Sri Lanka where this species is native. This latter hypothesis was inferred from the establishment of the first crow colony around Singapore's downtown port in the 1940s (see Sodhi & Sharp, 2006; Lim, 2009a), while the former hypothesis may be doubtful due to the absence of house crows between Johor Bahru, Malaysia (a city just north of the causeway from Singapore) and Klang. The introduced population increased from hundreds in the 1960s to over a hundred thousand by the end of the 20th century (Brook et al., 2003; Lim et al., 2003). The Javan myna is indigenous to Java, Bali, and Sumatra, and arrived in Singapore through the pet bird trade since the 1920s (see Yap et al., 2002; Yap, 2003; Sodhi & Sharp, 2006). It subsequently experienced a population explosion rivaling that of the house crow, achieving a population size that numbered in the hundreds of thousands by the end of the 20th century (Lim et al., 2003). Both the house crow and the Javan myna congregate in communal roosts near human-inhabited areas. Consequently, the loud noise around these areas is considered a public nuisance, and the droppings a hygiene problem (Soh et al., 2002; Brook et al., 2003; Lim et al., 2003; Sodhi & Sharp, 2006). In addition, house crows are known to attack passers-by and mob other native birds (Soh et al., 2002; Brook et al., 2003; Sodhi & Sharp, 2006), while the Javan myna has been suspected to compete for nesting cavities with other secondary cavity nesters (Yap et al., 2002; Lim et al., 2003; Sodhi & Sharp, 2006).

A slew of measures were recommended for managing the populations of these two species. Brook et al. (2003) recommended a massive culling of at least 41,000 house crows in 2003, followed by the culling of approximately 250,000 birds within the next 10 years. In concert with other strategies such as nest destruction, and limitation of food supplies and nesting sites, the management aim was to bring the population density of the house crow to below 10 birds per km^2. Since both species are opportunistic feeders, refuse bins with lids, enclosed refuse centres, prompt clearing of food scraps at outdoor dining locations, and relocation of food stalls indoors were some of the recommendations put forward to reduce food availability to these two species (Soh et al., 2002; Yap et al., 2002; Lim et al., 2003; Sodhi & Sharp, 2006). For nesting, house crows appear to prefer tree species such as the yellow flame (*Peltophorum pterocarpum*), which has a spreading crown. On the other hand, the Javan myna prefers the angsana (*Pterocarpus indicus*) and sea apple (*Syzygium grande*), hence recommendations were to avoid planting of these tree species, especially in monospecific stands, while existing trees of these species should be pruned regularly (Soh et al., 2002; Yap et al., 2002). Since these studies were undertaken, the house crow population in Singapore has declined noticeably, presumably because the proposed measures were adopted, while the Javan myna population has increased (Lim & Lim, 2009).

Our study investigated changes in bird abundance in Singapore over a 10-year period by comparing our recent field surveys with those of Lim & Sodhi (2004). Some past studies cautioned that a sudden reduction in the size of the house crow population could have side effects such as the competitive release of the Javan myna, resulting in the latter's population explosion (Brook et al., 2003; Yap, 2003). We therefore also tested if the decline in house crow abundance was correlated with an increase in Javan myna abundance across individual survey sites. In addition, we tested for two correlations suggested by interspecific interactions with these two invasive birds: the Asian koel (*Eudynamys scolopacea*) is known to be a brood parasite of house crow nests (Sodhi & Sharp, 2006; Lim, 2009a), hence we hypothesized that the change in abundance of the Asian koel was positively correlated with the change in abundance of the house crow. Given that the common myna was suggested as less capable of exploiting ephemeral food sources in urbanised landscapes than the Javan myna (Lim et al., 2003; Sodhi & Sharp, 2006), hence we hypothesized a negative correlation in change in abundance between these two species. Given that Singapore's continually changing urban landscape may be a confounding factor, we controlled for changes in landscape variables between these two studies when testing for interspecific correlations.

MATERIAL AND METHODS

Study area and sites. — The Republic of Singapore (1°N, 103°E) consists of Singapore Island and 58 other smaller islands, and is separated from the southern tip of continental Asia by just about 700 m of sea at the narrowest point. The climate is equatorial, with mean daily temperatures between 23.9°C and 32.3°C and an average annual rainfall of 2,191 mm which generally occurs throughout the year, although the northeast monsoon winds at the end and beginning of each year bring heavier rainfall than the southeast monsoon winds in the middle of the year. Topographically, Singapore's landscape is relatively flat with the highest point at only 163 m above sea level. Once covered primarily in lowland evergreen rainforest, the city-state is heavily urbanised today, with a population of about 5.18 million in a combined land area of 714.3 km^2 (Singapore Department of Statistics, 2011).

All the sites in this study are located on Singapore Island. The original 30 sites utilised by Brook et al. (2003) and Lim et al. (2003) were selected by stratified random sampling. Ten transects were randomly selected in the north and south regions and five in the east and west regions of the island using grid squares in a street directory. Nature reserves containing mature or primary lowland rainforests were avoided as the studies focused on urban bird communities. The exact transects lines were located along accessible footpaths. We did not re-survey two transects for the following reasons. One of these transects ("Khatib B" in Brook et al. [2003] or N3 in Lim et al. [2003]) was not included in the later analysis by Lim & Sodhi (2004) and is now located in a restricted military area, while heavy housing construction was ongoing in the vicinity of the second transect ("Marina" in Brook et al. [2003] or S9 in Lim et al. [2003]). For the remaining 28 transects, we kept as much as possible to the same transect lines and methods for data collection as described in Lim & Sodhi (2004).

Bird surveys. — Each transect was 500 m long and 100 m wide. A single observer walked from one end of the transect to the other at an average speed of about 25 m per min (taking a total time of about 20–25 min per survey), counting and recording all birds heard or seen within 50 m of either side of the centre of the transect line. Birds that flew by without stopping within the transect boundaries were not counted. Surveys were conducted between 0700–1000 hours on days without strong wind or rain. In the original survey, six surveys were conducted every two months for each transect from 1 Feb.2000 to 20 Feb.2001. Similarly, in our re-survey, six surveys of each transect were conducted about every two months from 2 Mar.2010 to 28 Feb.2011. The observers in both sets of surveys were different: the original surveys were conducted by a pair of observers taking turns (H. C. Lim, M. C. K. Soh), while the re-surveys were all conducted by S. Rajathurai. To account for inter-observer variability, we only analysed the changes in abundance of the most common species (see *Data analysis*).

Landscape and environmental variables. — A circle of radius 250 m was drawn around the centre of each transect for the quantification of urban environmental variables. In the original studies (see Lim et al., 2003; Lim & Sodhi, 2004), 1:5,000 town planning maps were used to determine percentage of each land use and green cover. In this study we used footprint GIS layers of buildings obtained from the Urban Redevelopment Authority of Singapore and 0.5 m resolution GeoEye satellite images taken in Jun.2009. The area of different land uses were calculated using ArcGIS version 10 (ESRI, 2011). In both the original and the current studies, ground-truthing accompanied the use of maps and satellite imagery. The number of food centres, defined as a street-level premises that sold cooked food, was counted via a thorough search within the delimited circle area. The vegetation within each transect was characterised in five 100-m sections. Within each section, a circle of radius 20 m was placed randomly, and the following variable measured: the number of woody plants >4 m in height ('trees'), the average heights of four trees closest to the four cardinal directions ('tree height'), the percentage of ground covered by woody plants <4 m in height ('shrub cover'), and the percentage canopy openness measured by a spherical densiometer at the centre of that section ('canopy cover'). The value of each measurement was averaged across the five sections for each transect and used in subsequent analyses. For each land cover and environmental variable, the difference between the values in the original and re-measurements was calculated and used in the analysis. Distance to the nearest coast did not emerge as an important variable in the earlier analyses, while human population density and number of sites with exposed edible waste could not be re-measured with sufficient confidence, hence we did not include these variables in our analysis.

Data analysis. — We did not directly compare species richness and abundance between the original surveys and re-surveys because observer differences would be a major confounding factor. However, observer skill and experience would have a much less effect for detecting the most common bird species. We ranked the bird species by the total counts across all transects for the re-surveys, and first selected the most common species from the re-survey for comparing abundances observed between the two sets of surveys. We excluded the barn swallow (*Hirundo rustica*) and the Pacific swallow (*Hirundo tahitica*) as these species were excluded from the original studies (see Lim et al., 2003; Lim & Sodhi, 2004). We also did not include the zebra dove (*Geopelia striata*) as it was not encountered in the original surveys. The 18 most common species, in decreasing order of abundance in the re-surveys, were: Javan myna, rock pigeon (*Columba livia*), Asian glossy starling (*Aplonis panayensis*), Eurasian tree sparrow (*Passer montanus*), yellow-vented bulbul (*Pycnonotus goiavier*), olive-backed sunbird (*Nectarinia jugularis*), spotted dove (*Streptopelia chinensis*), black-naped oriole (*Oriolus chinensis*), common tailorbird (*Orthotomus sutorius*), scaly-breasted munia (*Lonchura punctulata*), common iora (*Aegithina tiphia*), pink-necked green pigeon (*Treron vernans*), house crow, common myna, brown-throated sunbird (*Anthreptes malaccensis*), scarlet-backed flowerpecker (*Dicaeum cruentatum*), Asian koel, and white-collared kingfisher (*Todiramphus chloris*). We included the white-throated kingfisher (*Halcyon smyrnensis*) for comparison to the white-collared kingfisher as it has similar feeding and nesting guilds, and included the baya weaver (*Ploceus philippinus*) which was the 11th most common species in the original surveys, for a total of 20 bird species. We stopped at a round number of 20 because we felt this set was sufficiently representative of the most commonly encountered bird species in Singapore (Table 1).

For each species in each transect, we fitted a simple regression model with the $\log_{10}$ of the abundance counts in the 12 surveys (i.e., six original, six re-surveys) as the response variable, and the type of study (before—original surveys; after—re-surveys) as the explanatory variable. Each survey is therefore taken as an individual observation. The slope of this linear model was then used as a measure of change in abundance for each transect. To determine if there was a net negative or positive change in abundance for each species, we conducted a non-parametric bootstrap re-sampling procedure and constructed a 95% confidence interval with 1,000 bootstrapped values (Davison & Hinkley, 1997).

To determine if the change in abundance of species was associated with others' across transects after controlling for land use changes at individual sites, we used the changes in abundance represented by the slopes for each transect, fitted as above, as a predictor in a multiple linear regression model after first controlling for covariates. To determine which environmental variables to use as covariates, we used backwards-stepwise selection to arrive at a model with the slope of all retained terms significant at the 5% level of significance.

All analyses were conducted using the statistical programming software R version 2.10.1 (R Development Core Team, 2009).

RESULTS

Fourteen of the 20 most common species increased significantly in abundance (Fig. 1). Only two species, the house crow and the common myna, significantly decreased in abundance. No significant change was observed for the abundances of the remaining species.

None of the changes in environmental variables was significantly associated with changes in house crow abundance. Changes in private low-rise housing cover and natural or semi-natural vegetation cover were retained in the final model for changes in Javan myna abundance (R^2 = 0.4465, F = 10.08, p-value < 0.001; Table 2). After controlling for these two variables, the change in abundance of the Javan myna was not significantly correlated with that of the house crow (mean slope b ± s.e. = 0.0889 ± 0.1159, t = 0.767, p-value = 0.451). Change in urban greenery cover was the only variable significantly associated with changes in Asian koel abundance (R^2 = 0.1488, F = 4.544, p-value = 0.043; Table 2). Controlling for this variable, the changes in abundance of koels and crows were not significantly correlated (b = 0.0208 ± 0.1138, t = 0.183, p-value = 0.857). Changes in tree height and canopy were retained as covariates of common myna abundance (R^2 = 0.3447, F = 6.576, p-value = 0.005; Table 2). Controlling for their covariates, the abundance changes of the two myna species were not significantly correlated (Pearson's r = 0.072, t = 0.3692, p-value = 0.715).

Even without controlling for environmental variables, there were no significant correlations between the house crow and the Javan myna (r = 0.112, t = 0.5765, p = 0.569) and the Asian koel (r = 0.101, t = 0.5153, p-value = 0.611), and between the Javan myna and the common myna (r = 0.114, t = 0.5839, p-value = 0.564).

DISCUSSION

Since most of the common bird species examined increased in abundance between the two surveys, we could not infer any consistent patterns associated with particular feeding or nesting guilds that could have conferred an advantage in Singapore's rapidly changing urban environment, but our classifications may have been too coarse or simplistic. Most of these common urban species, however, are omnivorous or granivorous and are either tree or shrub nesters, reflecting the opportunistic exploitation of urban resources (Lim & Sodhi, 2004). A recent study found that relative brain size is larger for passerine birds that are successful in urban areas (Maklakov et al., 2011; but see Kark et al., 2007), suggesting that behavioural traits such as adaptability can be important.

There are a few caveats to this study. Firstly, the confounding effect of utilising different observers in the two sets of surveys cannot be ignored, although limiting the comparisons to the most common species would have mitigated it. Secondly, a two-point comparison provided in this study does not constitute effective monitoring over time. The abundances of some species could be in decline before an anomalous spike in the year of re-surveys. A more robust conclusion on trends can only be drawn from regular and long-term re-surveys.

The annual bird censuses, for example, provide long-term nationwide data from which population trends and fluctuations have been inferred (Lim & Lim, 2009). The census data is a volunteer effort and has its own limitations, such as considerable variation in sampling effort and observer experience between places and years. Interestingly, most of the results in our two-study comparison agree with the trends stated by Lim & Lim (2009) albeit with some exceptions. For example, the spotted dove was suggested to have declined from 200 counts in 1997 to 104 counts in 2000 (Lim & Lim, 2009), but the most recent bird censuses show that counts have recovered to 210, 188, and 191 in the years 2008, 2009, and 2010, respectively (Lim, 2009b; Lim, 2010). Similarly, population estimates of the white-collared kingfisher plunged from 248 in 1996 to 97 in 2000 (Lim & Lim, 2009) but have since fluctuated (165 in 2008,131 in 2009, 146 in 2010; Lim, 2009b, Lim, 2010). Lim & Lim (2009) also suggest that the Eurasian tree sparrow population is still increasing, but numbers have in fact dropped from 87 in 1997 to 24 in

Table 1. Twenty bird species analysed in this study. Occurrence refers to the proportion of transects where the presence of the bird was detected. The statuses of these species were obtained from Lim (2009a).

					Original survey (2000–2001)		Re-survey (2010–2011)	
Species	Common name	Family	Status		Occurrence	Total count	Occurrence	Total count
Acridotheres javanicus	Javan myna	Columbidae	Exotic	Abundant	93%	1955	100%	3238
Columba livia	Rock pigeon	Passeridae	Exotic	Common	55%	1412	62%	1708
Aplonis panayensis	Asian glossy starling	Pycnonotidae	Native	Very Common	72%	548	97%	1406
Passer montanus	House sparrow	Sturnidae	Exotic	Very Common	76%	829	66%	981
Pycnonotus goiavier	Yellow-vented bulbul	Oriolidae	Native	Very Common	93%	427	97%	893
Nectarinia jugularis	Olive-backed sunbird	Nectariniidae	Native	Very Common	90%	435	100%	588
Streptopelia chinensis	Spotted dove	Columbidae	Native	Very Common	76%	196	93%	524
Oriolus chinensis	Black-naped oriole	Aegithinidae	Native	Very Common	93%	220	97%	492
Orthotomus sutorius	Common tailorbird	Cisticolidae	Native	Very Common	76%	105	100%	360
Lonchura punctulata	Scaly-breasted munia	Estrildidae	Native	Very Common	21%	81	45%	340
Aegithina tiphia	Common iora	Nectariniidae	Native	Very Common	59%	73	86%	304
Treron vernans	Pink-necked green pigeon	Columbidae	Native	Very Common	55%	135	72%	288
Corvus splendens	House crow	Sturnidae	Exotic	Very Common	93%	1982	72%	258
Acridotheres tristis	Common myna	Sturnidae	Native	Very Common	76%	372	66%	237
Anthreptes malaccensis	Brown-throated sunbird	Dicaeidae	Native	Very Common	38%	20	100%	208
Dicaeum cruentatum	Scarlet-backed flowerpecker	Dicaeidae	Native	Common	66%	75	86%	185
Eudynamys scolopacea	Asian koel	Cuculidae	Native	Very Common	55%	58	86%	152
Todiramphus chloris	White-collared kingfisher	Alcedinidae	Native	Very Common	48%	46	72%	129
Halcyon smyrnensis	White-throated Kingfisher	Alcedinidae	Native	Very Common	69%	58	62%	75
Ploceus philippinus	Baya weaver	Ploceidae	Native	Common	7%	299	21%	39

2004, hence the species did not qualify for the top 20 lists in recent bird censuses. Our results show a slight decrease between 2000–2001 and 2010–2011 although the change was not statistically significant. Our 20 bird species differs from the top 20 most abundant birds of Singapore indicated in Lim (2009a) as the latter was compiled from nationwide bird counts and included many shorebirds, while we were only concerned with the 20 most commonly-encountered birds in Singapore's urbanised areas. Lim (2009a) also compared the most abundant birds in the decade from 1996–2005 to the top three most abundant residents listed by Bucknill & Chasen (1927), namely the Eurasian tree sparrow, the yellow-vented bulbul, and the Oriental magpie robin (*Copsychus saularis*). The Oriental magpie robin has not qualified for any of the recent top 20 lists, and was suggested to have been a victim of competition with the Javan myna for secondary cavities to nest in (Huong & Sodhi, 1997; Sodhi & Sharp, 2006).

Although these results suggest that the abundance of urban bird species have increased over the past decade, we caution against interpreting this as strong evidence for a healthy urban ecological system since these species were already common prior to this census and may mean that the bird community may have become more uneven and will increasingly be dominated by a smaller subset of species. Further, many of these species are not native residents, and increasing dominance may imply that out-competition of the rarer native species is already occurring. Unfortunately, observer differences prevent comparisons on the abundances of the less common species. As the urban environment is hyperdynamic, we expect the bird communities to be dynamic as well. Hence, we reiterate the call for long term, comparable data to explore this dynamism in community structure.

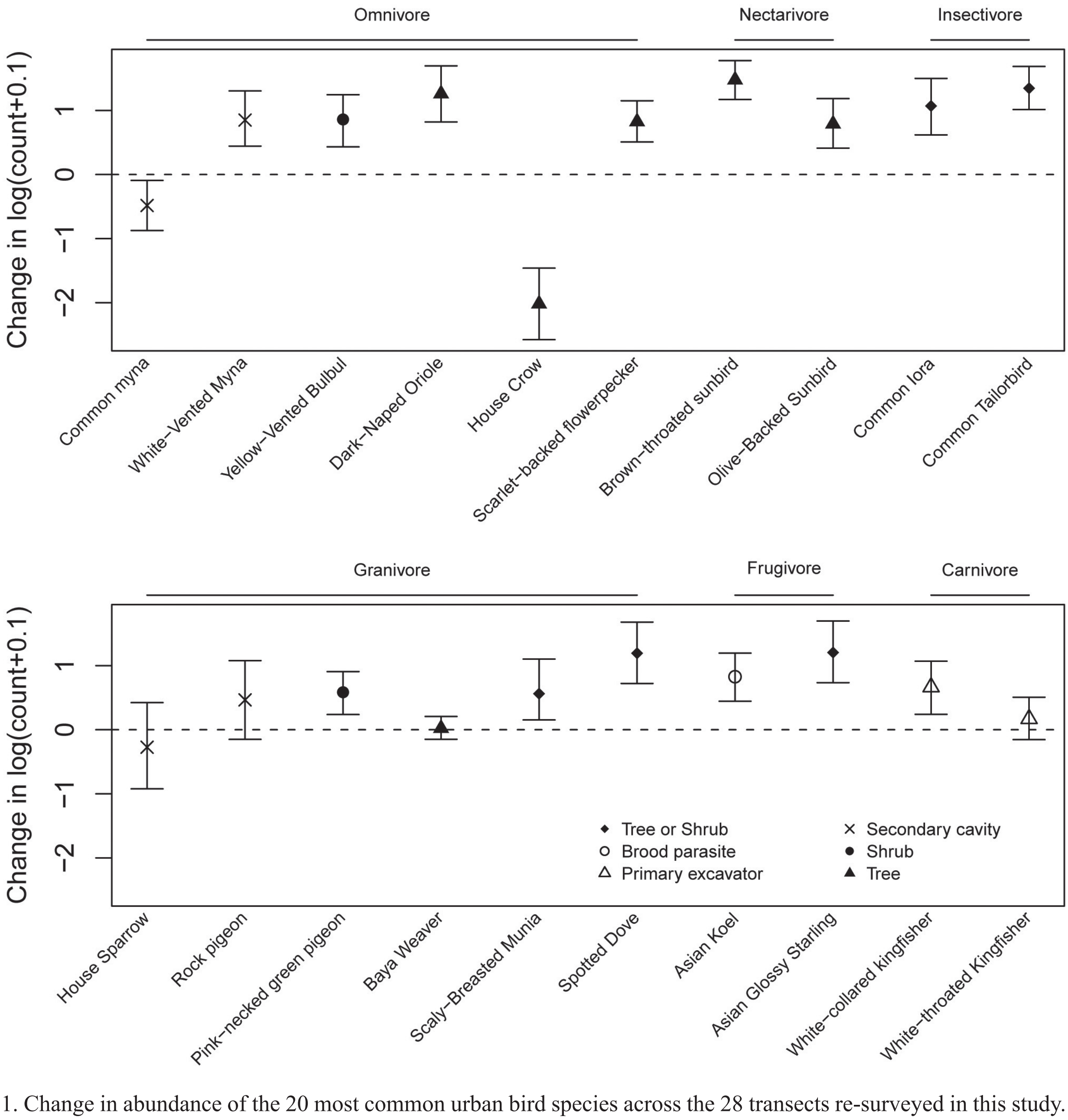

Fig. 1. Change in abundance of the 20 most common urban bird species across the 28 transects re-surveyed in this study. Error bars represent 95% bootstrapped confidence intervals; overall change is not significant when interval spans zero. Feeding and nesting guilds were adapted from Lim & Sodhi (2004).

Table 2. Environmental covariates retained in the final model for changes in Javan myna, common myna and Asian koel abundance (n = 28). Variable(s) refer to the change in these environmental and landscape values between 2000–2001 and 2010–2011.

Species	Variable(s)	Coefficient	t	p-value
Javan myna	Low-rise private housing	0.2718 ± 0.0096	2.827	0.009
	Natural/ semi-natural green cover	–0.0181 ± 0.0046	–3.903	<0.001
Common myna	Tree height	–0.0460 ± 0.0186	–2.471	0.021
	Canopy cover	0.0091 ± 0.0031	2.926	0.007
Asian koel	Urban greenery	0.0113 ± 0.0053	2.132	0.043

Observer differences did not account for non-significant inter-specific correlations in our study. Even if the re-survey observer detects birds systematically more frequently than the observers from the original survey, correlations would not have been masked. Instead, we offer other explanations. For example, the release of the Javan myna population from competition with house crows will not be confined to the spatial scale of transects used in our surveys, and is more likely to be observed over larger areas, and similarly for competition between the common and Javan mynas, because mynas are highly vagile. Lim & Sodhi (2004) also suggested that these two species, though both opportunistic feeders, are able to utilise other aspects of the urban environment differently. It is also possible that competition effects are weak in urban bird communities (Anderies et al., 2007), and this should be explored in future studies.

Contrary to the expectation that Asian koels would decrease in abundance with the large decline in the house crow population, there was instead a significant increase in abundance (Fig. 1). In Bangladesh, Begum et al. (2011) found that increasing distance to conspecific nests results in an increased chance of a house crow nest being parasitised by the Asian koel, and it was hypothesized that nesting in groups was a defence against brood parasitism. In Singapore, the drastic reduction in house crow population may have instead increased breeding success of Asian koels as the house crow nests are now more likely to be solitary and more vulnerable to brood parasitism. In addition, the Asian koels in Singapore could also be parasitising the nests of other species. The black-naped oriole, a former migrant that became resident in the 1920s (Lim, 2009a) and has been extremely successful at exploiting urban conditions (see Fig. 1), is a possible host for the Asian koel (Lowther, 2011). We recommend future research on the effects of shifts and switches in the host species of brood parasites on community structure and dynamics in further urban ecology research.

In all, the control of house crows in Singapore has been largely successful with minimal or no negative impacts. While culling played a major role, other factors such as Singapore's efficient municipal waste management is likely to have contributed. Conversely, we recorded an increase in the abundance of the Javan myna but we did not find any relationship to site-specific ecological release from competition with house crows. Rather, the moderately strong explanatory power of environmental variables suggests that the population increase of Javan mynas is a result of increasing urbanisation: occurrence of more private low-rise development and clearance of more spontaneous vegetation resulting in a strong increase in the myna population (Table 2). There was a recent proposal to release trained raptors in the evenings to frighten and deter Javan mynas from building communal nests along Orchard Road, a key retail street in Singapore (Lim, 2011). Although similar methods have been tried, for example, to reduce scavenging bird numbers on landfill sites (Baxter & Allan, 2006), and to deter pest birds from feeding on ripe grapes in vineyards (Kross et al., 2012), the long-term sustainability of such a measure has never been proven. Following the success on population control of the house crow based on previous local research, perhaps the authorities can consult the recommendations given in these studies (e.g. Yap et al., 2002; Lim et al., 2003; Sodhi & Sharp, 2006) before attempting other methods.

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