Distribution and abundance of introduced Common and Javan Mynas in metropolitan and suburban areas of Kuching, Sarawak, Borneo

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Summary. Counts of the invasive Common Myna *Acridotheres tristis* and Javan Myna *A. javanicus* were carried out in Kuching, the capital city of Sarawak, Borneo, and in surrounding suburbs, over a period of 30 months from July 2013 to December 2015. Ten areas were sampled each month using 3 km-long line transects. Combining all 30 months, a total of 3,913 mynas were counted, of which 75% were Common Mynas, and 25% Javan Mynas. Population densities were estimated at 0.78 and 0.72 individuals ha^{-1} for Common and Javan Mynas, respectively. The Common Myna was widely distributed in Kuching and suburbs of Kota Samarahan division, whereas the Javan Myna was confined to metropolitan Kuching. The distribution of these two species was thought to be influenced mostly by food and nest site availability.

Ringkasan. Penghitungan burung Kerak Ungu *Acridotheres tristis* yang dikenal invasif dan Kerak Kerbau *A. javanicus* dilaksanakan di Kuching, ibu kota Sarawak, Kalimantan (Borneo) dan di sekitar pinggiran kota selama lebih dari 30 bulan, dari Juli 2013 sampai Desember 2015. Sepuluh kawasan dijadikan sampel dan disurvei setiap bulan dengan metoda transek garis sepanjang tiga kilometer. Dari gabungan 30 bulan survei, terhitung total 3.913 burung kerak yang terdiri dari 75% Kerak Ungu dan 25% Kerak Kerbau. Kepadatan populasi diperkirakan 0,78 dan 0,72 individu per ha^{-1} untuk Kerak Ungu dan Kerak Kerbau, secara berurutan. Kerak Ungu tersebar secara luas di Kuching dan daerah pinggiran Kota Samarahan, sedangkan Kerak Kerbau menyebar terbatas sampai kota metropolitan Kuching. Diduga distribusi kedua spesies ini kebanyakan dipengaruhi oleh ketersediaan pakan dan lokasi untuk bersarang.

Introduction

Anthropogenic changes to natural landscapes typically devastate indigenous bird communities, yet benefit non-indigenous species (Hernández-Brito *et al.* 2014). In particular, urbanisation creates new habitat which can be successfully exploited by non-native species (Ward 1968; Lim & Sodhi 2004; Van Heezik *et al*. 2008). In Southeast Asia, the species that have benefitted most from urbanisation are the Eurasian Tree Sparrow *Passer montanus* and several species of mynas (Sodhi & Sharp 2006). In Borneo, the most common invasive species are the Common Myna *Acridotheres tristis* and Javan Myna *A. javanicus* (Myers 2009; Phillipps & Phillipps 2009). Mynas are well adapted to man-made habitats including cities, towns and cultivated areas (Yap & Sodhi 2004). They are also popular as pets due to their ability to mimic human speech (Feare & Craig 1998). Both species are opportunistic omnivores exploiting a variety of food sources, but especially human food wastes from rubbish dumps (Yap *et al*. 2002).

Originally from Uzbekistan and Iran in the west through the Indian sub-continent to southwest China in the east (Craig *et al.* 2017), the Common Myna has been widely introduced to Southeast Asia, including Malaysia (Wells 2007). The first known sighting of this species in Sarawak was at an army camp, 15 km south of Kuching, in 1994 (Smythies 1999). It is now a common species in Kuching and small towns (Yap & Sodhi 2004; Myers 2009; Phillipps & Phillipps 2009), including Serian and Kota Samarahan. The original range of the Javan Myna was from Java and Bali, Indonesia, but it has been widely introduced across Southeast Asia, including Sumatra, Borneo, the Lesser Sundas and the Thai-Malay Peninsula (Craig & Feare 2017). It was introduced to Singapore via the cage bird trade (Wang 2011). The Javan Myna was first recorded in Banjarmasin in 1978 (Mann 2008; Iqbal *et al.* 2013) and in Kuching during the mid-1980s, before the Common Myna (Smythies 1999). Despite its early introduction in Kuching, the Javan Myna is currently restricted to metropolitan Kuching. It seems that the Common Myna is dominant and could potentially out-compete the Javan Myna.

The International Union for the Conservation of Nature (IUCN) has recognised the Common Myna as one of only three birds among the 'World's 100 worst' invasive species, the others being the Red-vented Bulbul *Pycnonotus cafer* and Common Starling *Sturnus vulgaris* (Lowe *et al*. 2000). In Australia, Common Mynas threaten indigenous birds through aggressive competition for cavity nest sites and exclusion from their territories (Pell & Tidemann 1997; Grarock *et al*. 2012). Moreover, this species may affect human well-being through the spread of parasites and diseases, damage to agricultural crops and the noise and droppings they produce at their communal roosts (Feare & Craig 1998; Yap *et al.* 2002). Mynas also carry bird mites *Ornithonyssus bursa* and *Dermanyssus gallina* which have the potential to transfer to houses as these birds often nest in roofs. Bird mites can cause asthma and hay fever if inhaled (Yap *et al*. 2002). As mynas roost communally, their accumulated droppings may pose a threat to human health, and their calls may create disturbance in residential areas (Yap *et al*. 2002).

Although the Common Myna is considered a pest in Singapore (Yap & Sodhi 2004), there have been no reports of mynas becoming pests in Borneo. Nevertheless, it is important to monitor local populations to enable detection of large increases and mitigate against potential negative environmental impacts (Grarock *et al*. 2014). Thus, we began a study of these invasive mynas in Sarawak in 2015 (Rahman *et al.* 2015). The aim of this study was to determine the population density of Common and Javan Mynas in Kuching city and the adjacent suburban Kota Samarahan Division. Information on roost and nest-site selection was also recorded.

Study site and Methods

Study sites and censuses

The study was conducted in three metropolitan areas in Kuching and four suburban areas in Kota Samarahan from July 2013 to December 2015. The metropolitan areas consisted of high-rise, multi-storey buildings for commercial businesses, shopping centres, private apartments and condominiums. The suburban areas, by contrast, comprised low-rise (1–3 storey) residential and community buildings, recreational parks, and managed and unmanaged vegetation). Counts of mynas were conducted along ten line transects, comprising of five in each of the Kuching and Kota Samarahan Divisions (Fig. 1). Each transect was categorised according to landscape and land use types (Tables 1, 2).

Each line transects extended along both sides of the road for 3 km and was walked at a constant speed of 1.5 km h^{-1} to detect mynas. Each transect was surveyed twice in each month, once in the morning (07:00-10:00 hrs) and once in the late afternoon (16:00-19:00 hrs). The total sampling effort was 80 h per month. Binoculars were used to identify bird species and group size. Only birds observed along the line transects were recorded. When birds were sighted, a rangefinder (Truepulse 360b) was used to determine their distance (m) and angle (degrees) from the sighting point on the transect. Other data recorded were GPS coordinates (Table 2), number of individuals and nest sites. Foraging and roosting sites were noted but not quantified.

Figure 1. Map of study areas in Kuching and Kota Samarahan division, Sarawak. The transect location is indicated in the box. The large coloured circle indicates the capital of each division whereas the smaller circle is the district town in western Sarawak (sourced from clipart101.com).

Data analysis

Raw count data were log-transformed prior to statistical analysis (Fowler & Cohen 1990). Distance 6.2 was used to estimate bird densities using detection probabilities as a function of distance (Buckland *et al*. 1993, 2001). The detection function was fitted for uniform models with cosine and simple polynomial functions, as well as half-normal models with cosine and hermite polynomial expansion (Norvel *et al.* 2003). Model selection in Program Distance is based on an information-theoretic approach (Burnham and Anderson 2002) using Akaike's Information Criterion, AIC. A model is selected from an a priori set of candidate models to optimize the balance between precision and bias (Burnham and Anderson 2002). The detection function fitted for this study was a half-normal model with cosine expansion. Density estimates (individual ha^{-1}) are presented with standard errors (SE). Independent two-sample t-tests were used to compare the morning and afternoon observations. Calculations were performed using the PAST 3.11 statistical package (Hammer *et al.* 2001).

Table 1. Description of land use types represented on transects in Kuching and Kota Samarahan division.

Land use type	Code	Description
Private apartment	PRI	Private high-rise apartment and condominiums
House	HOU	Low-rise (≤ 3 surface storey) residential buildings
Commercial	COM	Buildings for commercial purposes; retails centres; shopping areas
Natural/ Semi-natural environment	NAT	Unmanaged vegetation; nature parks; unused ground left to generate
Institution, Community facilities and office	INS	Schools; sport facilities; civic and community buildings; army camp; office buildings, shop lots

Table 2. GPS coordinates of road transects in Kuching and Kota Samarahan division. Landscape: U, urban; S, suburban.

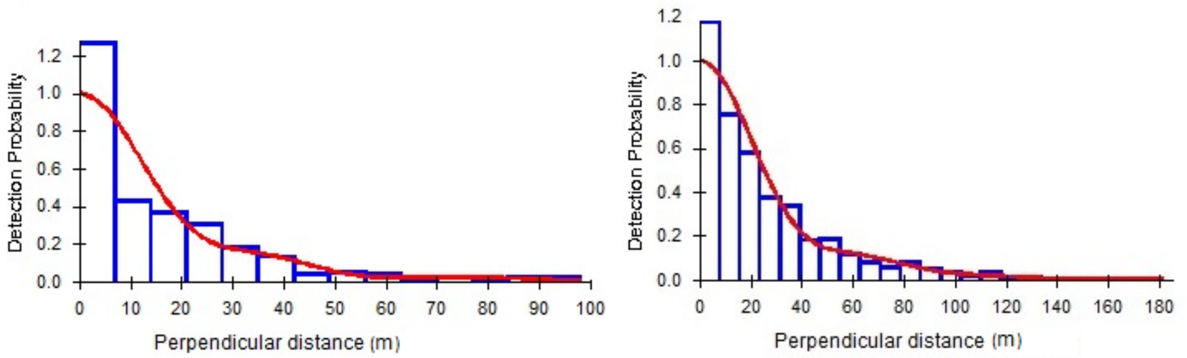
Transect No.	Location	GPS coordinates of start of transect	Elevation (m, asl)	Landscape type	Land use types*
1	Muara Tuang	01°27.7'N, 110°28.8'E	9	S	INS, NAT
2	Desa Ilmu	01°27.3'N, 110°26.9'E	12	S	HOU, INS, NAT
3	UNIMAS-Bunga Raya College	01°28.0'N, 110°26.2'E	18	S	INS
4	UNIMAS- Asset Unit	01°28.0'N, 110°25.3'E	15	S	INS
5	Tabuan Jaya- Jalan Song	01°31.3'N. 110°23.0'E	9	U	COM, HOU, INS, PRI
6	Tabuan Jaya-Stutong market	01°31.0'N, 110°22.2'E	9	U	COM, HOU, INS, PRI
7	Kuching Waterfront	01°33.5'N, 110°20.9'E	5	U	COM, INS, PRI,
8	Jalan Dato' Ajibah Abol	01°33.3'N, 110°20.8'E	8	U	COM, INS, NAT
9	Kenyalang Park-Spring Complex	01°32.1'N, 110°21.3'E	21	U	COM, HOU, PRI
10	Serian Town	01°10.6'N, 110°34.1'E	68	S	HOU, INS, NAT

*See Table 1 for explanation of acronyms

Results

Combining all 30 months, a total of 3,913 mynas were counted, of which 2,950 (75%) were Common Mynas, and 963 (25%) Javan Mynas. The two species had similar detection probability distributions yet the distance of detection differed slightly, that of the Javan Mynas declining beyond 10 m, while that of the Common Myna was still high at this distance (Fig. 2). The mean density of Common Mynas was significantly higher ($p=0.0032$) in the suburban Kota Samarahan (0.99±0.20 individuals ha^{-1}) than in Kuching city (0.57±0.05 ind. ha^{-1}) (Table 3). Javan Mynas were recorded only in metropolitan Kuching, where the estimated density was 0.72±0.09 ind. ha^{-1} (Table 3). Counts of Common Mynas were significantly higher in the morning (0.86±0.12 ind. ha^{-1}) than in the late afternoon (0.58±0.07 ind. ha^{-1}) ($t=-3.76$, $df=1$, $p=0.00019$). A similar trend was observed for the Javan Myna, with 0.79±0.11 ind. ha^{-1} in the morning and 0.61±0.08 ind. ha^{-1} in the afternoon ($t=-2.71$, $df=1$, $p=0.00727$).

Both species roosted communally in large trees with dense foliage, on roofs of shopping centres, and on air-vents on buildings. Foraging sites of both species included the rear of restaurants or cafés, roadside stalls, garbage dumps, short grass lawns, parking lots, pavements and home yards with pet food. Both species invariably built their nests in or on artificial structures that were attached to or part of buildings, but they differed somewhat in their preferred nest sites (Table 4). Common Mynas nested in a wide variety of sites (n=30), including inside and underneath old and abandoned air conditioner compressor units, underneath signboards, inside open roof gutters and holes on buildings, between pipes near ceilings, and in ceilings of compressor storage spaces. Javan Mynas, on the other hand, nested in only about half of the number of substrates (n=18) used by Common Mynas, preferring pipes and holes in buildings, and roof beams (Table 4).



(a) (b)

Figure 2. Detection probability (half normal) curves for (a) Javan Myna in Kuching, and (b) Common Myna in Kuching and Kota Samarahan (combined).

Table 3. Density estimates for Common and Javan Mynas in Kuching region (ME, metropolitan area; KS, Kota Samarahan)

Species	Variable	Density (birds ha^{-1})	Density at 95% confidence interval (birds ha^{-1})
Common Myna	Both (ME+KS)	0.78±0.10	0.60-1.01
	KS	0.99±0.20	0.67-1.48
	ME	0.57±0.05	0.48-0.67
	Morning (AM)	0.86±0.12	0.65-1.13
	Evening (PM)	0.58±0.07	0.44-0.74
Javan Myna	ME	0.72±0.09	0.56-0.92
	Morning (AM)	0.79±0.11	0.60-1.03
	Evening (PM)	0.61±0.08	0.46-0.80

ǂ Mean no. mynas ha^{-1}

Table 4. Nest sites of Common and Javan Mynas on buildings

Location	Common Myna	Javan Myna
Inside abandoned air conditioner of 4 level shop lot	4	–
Pipe near roof of 3 level shop lot	3	–
Underneath air conditioner of 3 level shop lot	2	–
Drain funnels of 3 level shop lot	2	–
Underneath signboard of 4 level shop lot	1	–
Pipe near ceiling of 4 level shop lot	1	–
Pipe hole of 4 level shop lot	1	4
Gutter and spout entrance of 4 level apartment/shop lot	3	3
Air vent of 4 level shop lot	3	3
Hole in ceilings of exterior house / shop lot	3	2
Compressor storage of 4 level shop lot	3	2
Roof beam of 3 level shop lot	4	4
Total	30	18

Discussion

This study provides the first estimates of density of an invasive bird species in the highly biodiverse island of Borneo. Our study shows that the Common Myna has successfully colonised both metropolitan and suburban areas around Kuching, whereas the Javan Myna is largely confined to urban areas. Using radio-telemetry, Kang (1992) showed that Javan Mynas flew 1.6 km, on average, between their feeding and roosting sites on the small island of Singapore. As observed elsewhere (Sarangi *et al*. 2014), both myna species in our study region typically roosted communally on buildings, which exist mostly in metropolitan Kuching. These human-made structures are high enough for them to avoid capture by ground predators, such as cats and dogs, and large enough to accommodate many hundreds of birds simultaneously.

The lower density of Common Mynas in metropolitan Kuching than in suburban Kota Samarahan may be related to the presence of Javan Mynas in metropolitan areas. The Javan Myna has successfully colonised the urban area of Kuching possibly because they arrived earlier than the Common Myna (Smythies 1999). In Singapore, the abundance of Javan Mynas was positively correlated with the size of food centres (Lim *et al.* 2003). In Peninsular Malaysia, the abundance of Common Mynas appeared to have been severely reduced by interspecific competition with Javan Mynas (Davison & Aik 2010; Lum *et al.* 2010). In Singapore, Lim *et al.* (2003) found Common Mynas were strongly associated with rural landscapes, especially agricultural areas. The clearing of forest and its replacement with suburban residences and parks with short-grass lawns, especially in Kota Samarahan, has created a substantial amount of foraging habitat for Common Mynas, which feed on earthworms and other ground-dwelling arthropods (Kang 1989). In addition, we frequently observed both species foraging near rubbish dumpsters, and on food scraps from roadside stalls, short grasses, parking lots, pavements and house lawns with dog food.

The two species had similar detection probability distributions yet differed slightly in their distance of detection (Fig. 2). Javan Mynas were mostly detected within 10m of the transect line, and rarely detected beyond 60m, whereas the probability of detecting Common Mynas declined gradually up to 120m. Both species are so well adapted to human activities that they were confiding and often observed less than 10m from the observer. The flight-initiation distance, which is the distance at which an animal moves away from an advancing intruder (Blumstein 2003), is expected to decrease in areas with high human density due to habituation (McGiffin *et al*. 2013).

One factor that potentially influences the distribution of the two mynas in the study area is nest site preference. Common Mynas are known to nest under metal roofs, and in gutter entrances, drain funnels, spouting and air vents (Counsilman 1971; Yap *et al*. 2002), all of which open to the outside. On the other hand, based on our observations, Javan Mynas appear to nest more often in enclosed spaces, such as inside pipes, ceiling vents and holes in buildings. This observation is supported by Yap *et al*. (2002) who found that this species nests in protected hollows found either naturally in trees or buildings. Being less specialised in their choice of nest sites, Common Mynas are thus able to exploit a wide variety of potential nest sites which can be found in both urban and suburban areas.

Both myna species are opportunistic omnivores, exploiting humans for leftover food (Lim & Sodhi 2004) and pet food. The higher density of Common Mynas in suburban Kota Samarahan may be partly due to the presence of open fresh-produce or "wet" markets where refuse is poorly managed. Additionally, these "wet" markets are surrounded by hawker stalls which provide another reliable and easily obtained source of food for mynas. Excess food is abundant after the wet markets close, with little or no proper disposal or cleaning program. The daily piling up of food wastes creates unhygienic conditions that attract more mynas to forage.

That counts of both Common and Javan Mynas were higher during the early morning than in the late afternoon is probably related to the availability of food wastes. The daily produce-markets operate early in the morning (07:00−09:00 hrs), allowing the birds to obtain food early in the day. The excess food from nearby stalls and markets provides additional foraging grounds.

Athough mynas are considered pests in Singapore (Yap & Sodhi 2004), they are not yet considered so in Sarawak. The droppings that these birds produce at their communal roosts may affect human health through the spread of parasites and diseases, and the noise at roosts may be irritating (Feare & Craig 1998; Yap *et al.* 2002). In Sarawak, communal roosts may yet prove to be a nuisance to the public, especially those in large trees with dense foliage. In Singapore, Soh *et al.* (2002) found that the Javan Myna roosted mainly in Angsana *Pterocarpus indicus* and Sea Apple *Syzygium grande*. Regularly trimming such trees and replacing them with less densely foliaged tree species could discourage these birds from roosting in areas where they are considered pests. More importantly, food availability of the two species could be reduced by educating the public to dispose of their food wastes in trash bins with lids, and promptly clear food scraps at outdoor dining locations, as well as relocating food stalls indoors (Soh *et al*. 2002; Yap *et al*. 2002).

Acknowledgements

We thank the Malaysian Ministry of Education for supporting this study with research grants FRGS/STWN/10(03)/988/2013/(29) and NRGS/2013/1088 (02), and Universiti Malaysia Sarawak (UNIMAS) for administrative support. Permission to undertake research was granted by the Sarawak Forestry Department under permit NCCD.907.4.4(JLD.10)-179. We are also very grateful for the reviews and edits of earlier versions of this manuscript by Richard Noske, Mustafa Abdul Rahman, Clive Mann and an anonymous reviewer, and Adam Supriatno for providing the Indonesian summary.

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