Status and roosting characteristics of Collared Crow *Corvus torquatus* at the Mai Po Nature Reserve, Hong Kong

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For unknown reasons, the number of Collared Crow *Corvus torquatus* communally roosting at Mai Po Nature Reserve has steadily increased between 2004 and 2013, and are higher in summer than the preceding winter. The Deep Bay population appears to be isolated and there is no evidence of recruitment locally or the population being supplemented by northern migrants in winter. Collared Crows form large pre-roost gatherings in several locations close to the final roost. When they depart to roost after sunset, they do so as a single species flock, showing a preference for dense stands of mangrove trees, probably *Kandelia obovata*, in the intertidal mangal (mangrove zone) as their final roost location. The majority of birds arrive from habitats to the south of the reserve, suggesting that the local population in Deep Bay is not homogeneous throughout the contiguous network of commercial fishponds. Fishponds are being ecologically degraded or lost over much of the Collared Crow's range, a result of development and agricultural intensification. Given the paucity of information about this species in most of its range, and that it is suspected to be in global decline, the Mai Po Nature Reserve and its environs are clearly an important site for this Near Threatened species.

INTRODUCTION

Collared Crow *Corvus torquatus* is a near-endemic to China, being resident in the south and east, reaching southern Hebei in the north-east, Gansu in the west and Yunnan and Hainan in the south-west (Cheng 1987, BirdLife International 2014). Its range extends to north Vietnam, and it is a vagrant to Taiwan (Brazil 2009, BirdLife International 2014). It is an uncommon and localised resident in the Hong Kong Special Administrative Region (Hong Kong), frequently encountered in the Deep Bay area (Carey *et al.* 2001).

The global population of the species is in decline (BirdLife International 2014), with a range contraction being reported by birdwatchers and field researchers across China (DJS pers. obs.). Loss of food supply owing to agricultural intensification and an associated overuse of pesticide are considered the major factors, although human persecution in some areas also occurs (dos Anjos *et al.* 2009, BirdLife International 2014). In recognition of reported population declines, a Near Threatened global status was assigned to Collared Crow in 2008 (BirdLife International 2014). In contrast to the global trend there appears to be a secure population in Hong Kong (Kilburn 2009), with an estimated 200 birds in 2007 (BirdLife International 2014).

Status in Hong Kong

Deep Bay, an eastern branch of the Pearl River estuary located at the north-west of Hong Kong (22.485°N 114.035°E), is the major area for Collared Crows (Carey *et al.* 2001, WWF-HK 2009a,b). During the day, this population disperses as individuals or small foraging groups throughout the area, with highest concentrations seen feeding on bunds within commercially managed fish ponds. Nearby, on the northern shoreline adjacent to the city of Shenzhen (22.518°N 114.002°E; Figure 1), the species is rarely recorded and occurs generally singly (J. Martinez verbally).

Away from Deep Bay, the other main area for the species is Shuen Wan near Tolo Harbour, north-east Hong Kong (22.452°N 114.201°E), with a maximum count of 71 pre-roosting birds in April 2011 (HKBWS 2013). Outside these areas, observations of Collared Crow typically involve no more than five birds. On Po Toi Island (22.167°N 114.252°E), a regularly watched site in southern Hong Kong, there is only a single record (G. Welch verbally). The species disappeared from a cluster of former haunts on Lantau Island following construction of Hong Kong International Airport (22.301°N 113.917°E) (Carey 2009).

Study area

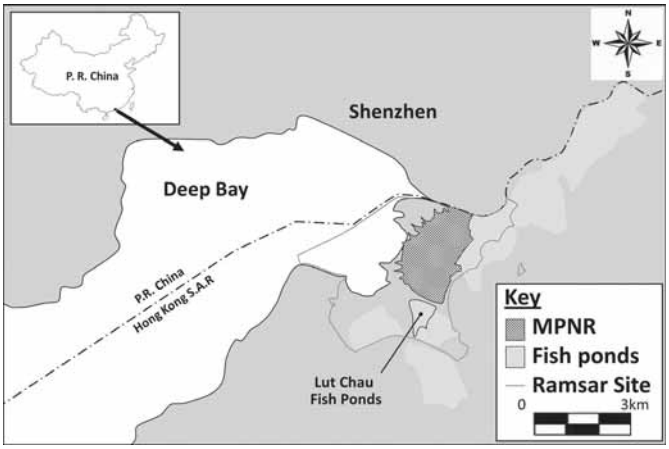
The study area is the Mai Po Nature Reserve (hereafter Mai Po), a 377 ha wetland located in the Mai Po Inner Deep Bay Ramsar Site (22.485°N 114.035°E) (Figure 1).

The interior of Mai Po is a mix of impounded brackish ponds (including traditionally managed shrimp ponds—locally called *gei wai*—and shallow water ponds with islands) and rain-fed ponds/marshes. The major vegetation types are mangal, composed predominantly of *Kandelia obovata*, and reedbed dominated by common reedgrass *Phragmites australis*. Open water covers 50.3% of the area (WWF-HK 2013).

Earth embankments (or bunds) between ponds and *gei wai* are typically lined with individual or small clusters of trees composed of chinaberry *Melia azedarach*, elephant's ear *Macaranga tanarius*, Chinese tallow tree *Sapium sebiferum* and several standing snags (dead trees), although recently disturbed areas are either bare ground or short grass, interspersed with snags.

The western part of Mai Po is a strip of mature intertidal mangal 500 1,000 m wide (Figure 3). Dominant species include *K. obovata*, spiny bear's breeches *Acanthus ilicifolius*, *Aegiceras comiculatum* and black mangrove *Avicennia marina* (WWF-HK 2013). A 3-m high immigration fence, constructed in the early 1960s between the impounded ponds and the intertidal mangal, controls human access to the intertidal area.

Figure 1. Map of Deep Bay showing the location of the study area.



Pre-roost and roost behaviour

Communal roosting by corvids is well documented (Cramp & Simmons 1977, Francis 1998, Everding & Jones 2004, dos Anjos *et al.* 2009, Seng 2009) and although it has been reported for Collared Crow (Carey *et al.* 2001, Wong & Young 2009, WWF-HK 2009a,b, 2011, 2013), we expand further here on a locally well-known Collared Crow roost.

The benefits of communal roosting are well described and include a decrease in the chance of predator approach going unobserved, some physical protection against adverse weather, the facilitation of the meeting and pairing of unrelated individuals and probably maximising the chances of finding rewarding food sites the next day (Moore & Switzer 1998, Dall 2002, dos Anjos *et al.* 2009). These 'information centres' have previously been attributed to both roost sites and breeding colonies (Zahavi 1971, Ward & Zahavi 1973, Sonerud *et al.* 2001, Wright *et al.* 2003, dos Anjos *et al.* 2009). It has been suggested that young corvids tend to follow older individuals and recruitment to the communal roost is common (dos Anjos *et al.* 2009).

Prior to roosting, many corvids often congregate at locations away from the final roost site, forming what is known as a pre-roost (Moore & Switzer 1998, Hansen *et al*. 2000, Everding & Jones 2004). These pre-roost gatherings have rarely been studied and their function is poorly understood;it has been suggested that pre-roost gatherings of corvids are not simply a consequence of many individuals approaching the same roost area but, like communal roosting, have a particular function (Moore & Switzer 1998, Hansen *et al*. 2000, Winiecki 2000).

Study objectives

The core part of this study was to look at the long-term population trend of Collared Crows roosting at Mai Po and to form a preliminary assessment of their roosting characteristics. This serves to build up the knowledge base to aid the conservation of this species elsewhere in its range and to generate information for management decisions at Mai Po.

Pre-roost and roost counts were considered the most appropriate way of gathering data to meet the study objectives. This paper does not attempt to explain the purpose of pre-roost or roost gatherings.

METHODS

Roost counts and observations

Counts and determination of both pre-roost and final roost locations commenced at least 60 minutes before sunset (as recorded by Hong Kong Observatory) and continued until birds had settled at the final roost site in Mai Po or light conditions inhibited counting. Following sunset, twilight provides between 20–50 minutes for observations, and in most cases crows would depart to roost within this time period.

A single observation point within an 800 m radius of the final roost was used during each survey; the position of this point was dependent on the location of the pre-roost site and a certain amount of flexibility was necessary throughout the counts. Observations were made with binoculars and naked eye. All birds seen arriving at the pre-roost location were counted and field notes kept of arrival direction (simply as the four cardinal points of the compass), local movements, habitat use, any noteworthy behaviour and association with other corvid species. A maximum count was derived from each survey sample; this was usually when birds finally departed to roost. However, when a final roost count could not be made, the maximum count from the survey was taken based on experience of pre-roost behaviour and confidence that the maximum count had already been attained. Counts were conducted seasonally between December 2004 and August 2013: four every winter (between December and February) and four every summer (between July and August), each count being approximately two weeks apart.

The final roost was determined to be the location where the birds that had departed from the pre-roost locations settled as a larger flock and ceased movements completely for the overnight roost. Pre-roost locations were deemed to be those areas where birds congregated in the 60-minute period prior to the final roost. Birds may be mobile at these pre-roost locations, but generally form a loose congregation whilst feeding or interacting with other individuals.

RESULTS

A total of 71 counts between December 2004 and August 2013 (one count in July 2005 was cancelled due to bad weather) recorded a maximum of 167 birds (18 July 2013) and a minimum of 31 birds (3 February 2005). During each survey, when roosting was recorded, there was only one final communal Collared Crow roost at Mai Po.

Total numbers roosting in both winter and summer periods increased over the eight-year study period at average annual rates of +9.6 and +8.6 individuals respectively. Winter mean count was 60.1 ± 22.2 birds (range 30–118, n = 36) and summer mean count was 100.0 ± 30.2 birds (range 32–167, n = 35). Differences between the winter and summer numbers were significant (one-way ANOVA $d.f.$ = 1, p<0.001) (Figure 2).

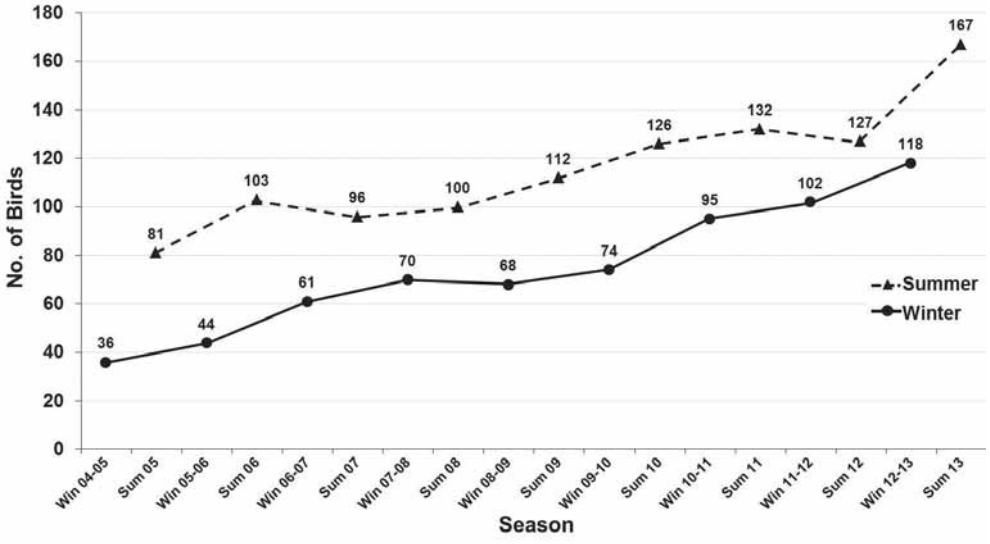


Figure 2. Maximum counts of Collared Crows roosting at Mai Po in summer and winter between 2004 and 2013.

Pre-roost gathering and communal roosting

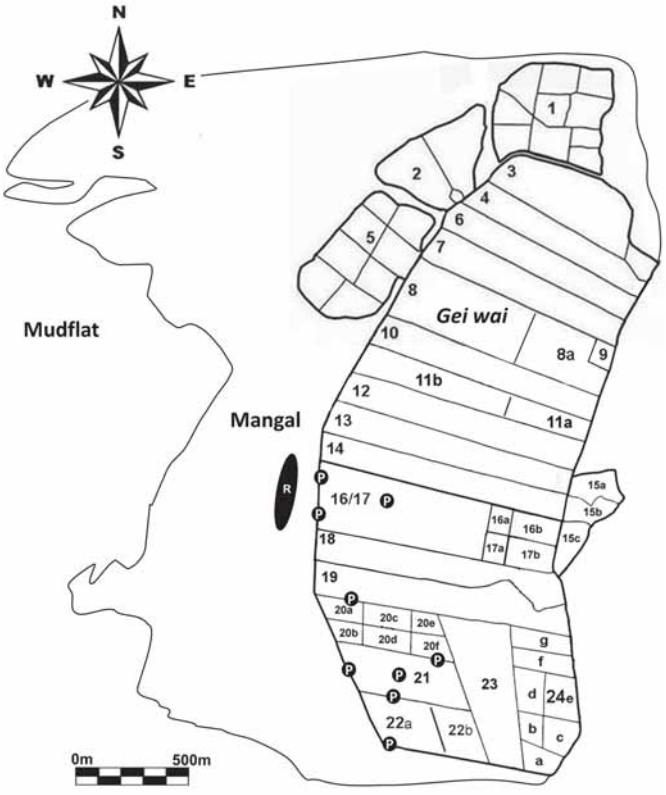
Individuals were often present at regular pre-roost locations before the start of the count. In the 60-minute period prior to sunset, pre-roosting birds arrived singly or in small groups of 2–10 birds. Birds typically congregated at the southern and south-western parts of Mai Po (Figure 3) and were observed both loafing and foraging on bunds or islands, or perched on snags or on branches of living trees devoid of, or with limited, foliage. All the pre-roost locations were within 150–950 m of the final roost site. Birds generally departed to the main night roost location as a single group led by several individuals that flew above the congregation, cawing and circling the pre-roost locations for several minutes. The lead birds would then drop into the final roost, followed by the main group, and did not re-emerge. Birds settled at the final roost on average 22.4 ± 9.3 minutes after sunset (range –6 to +45 minutes). Counts when final roost time could not be determined are excluded.

The final roost was located inside the intertidal mangal (Plate 3), with exceptions on eight counts (11.3% of total) when birds remained at the pre-roost locations and were not seen going into roost within the survey period. Given the strong site fidelity of the roosting crows for the intertidal mangrove zone, it is assumed on these occasions that the population entered the roost sometime after twilight. Whilst the final roost location within the wide belt of intertidal mangal could not be determined with precision, the same general area of dense mangal was utilised consistently (Figure 3).

Direction of arrival to pre-roost locations

Birds not already at pre-roost locations 30 minutes prior to sunset arrived either from the south (49.0% of the total number of birds) or from areas to the north and east of the study area (40.4%). Relatively few birds (10.6%) arrived from the west, i.e. over the intertidal mangal. The state of tides was not recorded, but given the low percentage of birds coming from the west tidal influence was believed to be minimal.

Figure 3. Pre-roost and final roost locations of Collared Crows at Mai Po. R = location of final roost; P = regular pre-roost locations; pond/*gei wai* numbers shown.



Association with other corvids

On nine occasions, Large-billed Crow *Corvus macrorhynchos* and House Crow *C. splendens* were recorded among pre-roosting Collared Crows. These individuals left the pre-roost locations earlier than the Collared Crow flock and in a different direction; none was seen to join the Collared Crow roost. Up to 74 Eurasian Magpie *Pica pica* roosted in a separate area of the intertidal mangal (KKSL pers. obs.) and were regularly observed at the same pre-roost locations used by Collared Crows.

DISCUSSION

Overall numbers

At Mai Po, numbers of Collared Crows observed gathering and going to roost within the intertidal mangal have steadily increased over the eight-year study period, reaching high counts of 167 in summer (2013) and 118 individuals in winter (2012/13).

Numbers were consistently higher in each summer period than the preceding winter period; this is assumed to be due to the recruitment of young birds following breeding success. Collared Crows commence breeding in early February with a clutch size of 2–6 eggs; young fledge at the end of March (dos Anjos *et al.* 2009). This corresponds to the winter/summer pattern seen in the roosting flock and perhaps the drop in winter numbers is a result of natural mortality. However, given the similarities in plumage of different-age birds and the varying light levels at survey times, it was difficult to identify the age-class structure within these pre-roost gatherings. Seasonal fluctuations in the number of individuals joining roosts are usual amongst communally roosting corvids, increasing in early summer and falling during autumn (dos Anjos *et al.* 2009). Preliminary findings from a study in progress confirm that this seasonal pattern is found in the Collared Crow roost at Mai Po.

The reason for this gradual population increase is not known. To the authors' knowledge there have been no significant changes to the habitats of, or management strategies at, Mai Po, and no apparent land use or habitat changes in the wider area during the study period. Given that lower numbers are seen in winter, there is no evidence to show that the winter population at Mai Po is supplemented by a winter influx of northern birds withdrawing southward to milder coastal areas of southern China, as reported by dos Anjos *et al.* (2009). In addition, our study in progress suggests it is unlikely that there is recruitment locally from populations outside Deep Bay. Further investigation is required to explain the shift of the population away from a state of equilibrium, as population density is determined by birth and death rates, and by immigration and emigration rates.

Pre-roost gathering and communal roosting

Pre-roost gatherings typically formed in open areas, usually on bare tree branches or snags but also on bare or sparsely vegetated islands and bunds; all appeared to be conspicuous from the air. The trigger for the final movement to roost is not known. Immediately prior to roosting, birds became vocal with constant movements and jostling by small groups between trees.

Birds departed to roost well after sunset, settling at the roost on average 22.4 ± 9.3 minutes post-sunset. Variation in settling times may be attributed to seasonality or local weather conditions. In addition, other parameters that may influence timing of roosting include the presence of security floodlights along the immigration fence, which are switched on around dusk with no discernible pattern, along with the periodic drain-down of ponds or *gei wai*, allowing birds to forage later into the evening.

All surveys at Mai Po recorded Collared Crows pre-roosting and roosting communally. Elsewhere in Hong Kong this species only appears to roost communally in the Plover Cove area (Carey

MARTIN HALE

Plate 1. Collared Crow *Corvus torquatus* gather at pre-roost on a snag (dead tree), Mai Po Nature Reserve, Hong Kong, September 2013**.**

MARTIN HALE

Plate 2. Collared Crow gather at pre-roost on a *Melia azedarach,* Mai Po Nature Reserve, Hong Kong, September 2013.

et al. 2001, HKBWS 2013). Observations in the wider environs of Hong Kong reveal this species is present in lower densities (singles or pairs) and it does not appear to roost communally as a single flock.

The intertidal mangal in Deep Bay is well documented as a favoured roost site for Collared Crows (WWF-HK 2009a,b, Wong & Young 2009, WWF-HK 2011,2013). This dense habitat type is in decline in southern China (UNEP 2008) and globally (UNEP 2010, AFCD 2011). The fact that Collared Crows choose to roost within intertidal mangal as opposed to stands of terrestrial mature trees which are present nearby, adds potential importance to the conservation of mangal for this species. Investigation of other roost sites is required.

The strip of mature intertidal mangal currently used by Collared Crows is not considered to be under any immediate threat. However, siltation (leading to colonisation by terrestrial climbing plants), annual defoliation of *A. marina* by the larvae of the moth *Nephopterix syntaractis*, and competition between native mangrove trees and the recently introduced exotic mangrove species *Sonneratia caseolaris* and *S. apetala* (AFCD 2011) could have implications for the Deep Bay Collared Crow population. Monitoring of these threats and their impact should be considered.

Direction of arrival to pre-roost locations

Birds tended to arrive at pre-roost gatherings from the south, suggesting that the local population in Deep Bay is not homogeneous throughout the wetlands. There are approximately 1,150 ha of fish pond habitat in Hong Kong (AFCD 2013). A larger area of suitable fish pond habitat is available to the north-east of Mai Po (Figure 1), but a larger proportion of the population arrives

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Plate 3. Intertidal mangal outside the immigration fence—the final roost location of the Collared Crows, Mai Po Nature Reserve, Hong Kong, December 2005.

from habitats in the south. It is not known why there should be such a preference for the habitats to the south of the roost site given the apparent similarities to other fish pond areas throughout the Deep Bay area. Further investigation into why specific areas are selected as foraging grounds is required.

Association with other corvids

Communal roosting involving different corvid species has been described previously (Francis 1998, Wright *et al.* 2000, dos Anjos *et al.* 2009) and Eurasian Magpies notably share pre-roost locations with the Collared Crows at Mai Po. However none was recorded going to the same final roost with the Collared Crows, indicating that roosting in a single monospecific flock is preferable. A single Collared Crow was observed at a pre-roost gathering of Large-billed Crows in southern Hong Kong, and presumably roosted as part of the flock (DJS pers. obs.).

Elsewhere in its range, Collared Crow is known to associate with Large-billed Crow (dos Anjos *et al.* 2009). Qu *et al*. (2005) described up to 20 Collared Crows roosting with other corvids over six consecutive winters in Henan province, China. These were in mixed flocks with Daurian Jackdaw *C. dauuricus* (1,000+), Eurasian Jackdaw *C. monedula* (500+), Rook *C. frugilegus* (4,000+) and Large-billed Crow (5,000+); numbers in parentheses indicate the maximum count over the study period, illustrating the low proportion of Collared Crows in these roosting flocks.

CONCLUSION

Given the paucity of information on the Collared Crow in most of its range (dos Anjos *et al.* 2009) and that it is believed to be in global decline (Kilburn 2009, BirdLife International 2014), Mai Po and its environs are clearly an important site for this Near Threatened species. The increase in the local population at Mai Po is encouraging, and it would appear the existing management and the current site condition are favourable for roosting Collared Crows. Further studies are required to establish the reasons behind the continued population growth at Mai Po. Furthermore, it is hoped that wider studies can be employed to reveal the factors affecting the population status and dynamics elsewhere in the region.

ACKNOWLEDGEMENTS

We thank Tommy K.C. Cheung and Roger H. Lee for their help in collecting data and WWF-HK for usage of its monitoring data and the Agriculture, Fisheries and Conservation Department of Hong Kong Special Administrative Region for its conservation work in the Ramsar site. Paul Leader provided

exhaustive comments on earlier drafts which greatly improved this manuscript and for which we are extremely grateful. We thank Martin Hale for allowing us to use his images.

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