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Commentary

Managing urban crow populations in Japan

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Abstract: Crow (*Corvus* spp.) populations are increasing globally. This is cause for concern because overabundant crow populations can damage agricultural crops, harm native wildlife, and become a nuisance in urban areas. In Japan, the carrion (*C. corone*) and large-billed crow (*C. macrorhynchos*) can cause damage to crops and livestock. This damage is predicted to increase in Japan with climate change, especially when precipitation increases, inducing landscape changes that may favor crow populations and activities. In Japan, the primary control method used to manage crow damage is the destruction of nests by a crow control officer who is employed by local municipalities. Herein, I describe how urban crow populations are currently managed in Japan. I also reviewed historical records of crow control and precipitation data from 2011–2016 for the Mombetsu City, located in northern Japan, to describe a potential relationship between increased precipitation and crow abundance and activities. Lastly, I provide recommendations for mitigating damage that may be caused by predicted increases in crow populations that may result because of climate change and changes in precipitation.

Key words: climate change, *Corvus corone*, *C. macrorhynchos*, crow control measure, crows, human activities, human–wildlife conflicts, Japan, urban areas, wildlife damage management

The carrion and large-billed crows (*Corvus corone* and *C. macrorhynchos,* respectively) are considered native species in Japan. Crows historically have been viewed favorably by most people in Japan and are considered to be wise birds, although they can also be a nuisance. Kojiki, among the most historical literature in Japan, written in 712, and Nihon Shoki (written in 720) said that a crow guided the way to the first Japanese emperor Jinmu in 663 B.C. (Ono 712, Toneri 720). The crow is also imprinted on the uniform of the national soccer team of Japan.

Crow (*Corvus* spp.) populations in Japan are increasing globally. Overabundant crow populations cause damage to agricultural crops, constitute a threat to human health and safety, and create nuisance problems in urban areas by damaging homes and buildings (Ministry of the Environment 2018). Crow damage to agricultural crops in Japan has been reported as early as the 1950s (Inukai et al. 1952). Previous studies have also documented the damage caused by crows in urban areas (Inukai et al. 1952, 1953; Pokorny et al. 2014). Crows also have been reported attacking humans (Grazio 1978). Although crows may cause damage, they are also an integral part of the ecosystem and their complete elimination may result in an imbalance. Pesendorfer et al. (2016) reported that crows play an important role in seed dispersal for large-seeded trees of conservation concern.

The increase in crow populations in Japan and worldwide has been attributed to urbanization (Marzluff et al. 2001, Ministry of the Environment 2018). Climate change has also been implicated in the corvid population increases in Africa (Madden et al. 2015). In Japan, warmer temperatures attributed to climate change will also be accompanied by increased rainfall. These environmental factors have also contributed to increased mosquito (*Culex* spp. and *Aedes* spp.) numbers, and importantly, increased incidences of West Nile virus (WNV; Bagar et al. 1993). Concomitantly, corvids, who are particularly susceptible to WNV, could also decline if climate change facilitates the spread of WNV. Some regional crow populations across the United States declined 45% since WNV was first introduced in 1999 (Foppa et al. 2011).

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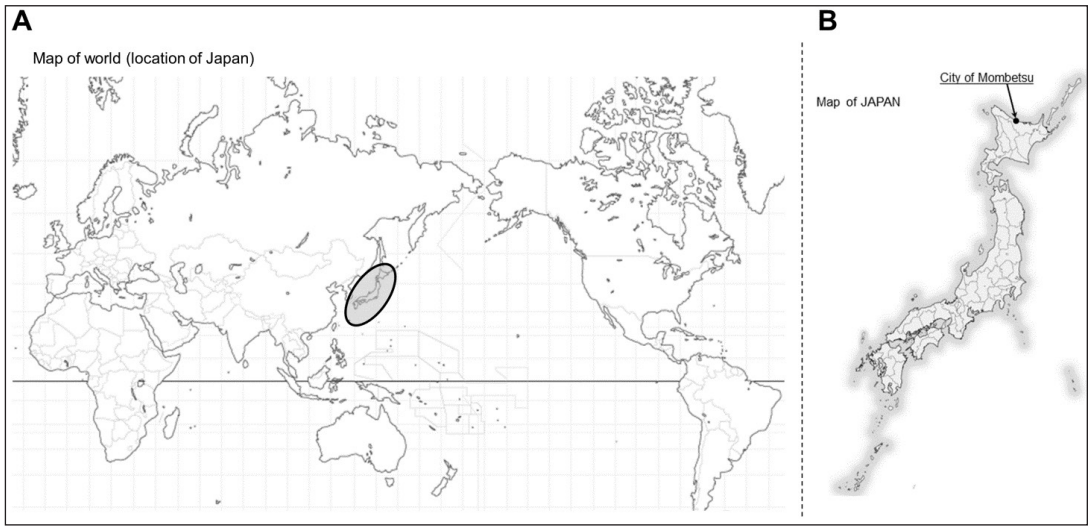

Figure 1. Location of Japan (map of world [A]). The City of Mombetsu is shown in the map of Japan (B).

Although reported incidences of WNV in Japan are low, the possibility that WNV will spread in Japan in the future is real. Thus, the possible consequences of WNV in Japan and its economy will need to be fully considered (Ministry of Health, Labour and Welfare 2019).

In Japan, all wild birds, including crows, are protected (Ministry of the Environment 2018). However, crows causing damage to crops, livestock, and those considered a nuisance can be controlled with the approval of the local municipality. Citizens impacted by crow damage may also ask city officials to control crows when they are affected.

Crow control program

The crow control officer program emerged in response to public concerns regarding bird and beast damage prevention (Ministry of the Environment 2018). Each municipality in Japan funds, hires, and trains their officers. Additionally, each municipality provides overall program approval and direction. For example, in Mombetsu City, crow control officers attempt to eliminate nests mainly in the residential areas of the downtown region (City of Mombetsu 2019*a*). In the city of Sapporo, officers do not attempt to remove random crow nests, but seek to reduce complaints from citizens who approach their section to notify them about the location of the nests (City of Sapporo 2019).

Because of concerns of the toxicant impact on nontarget species (Puttoo and Archer 2004), deterrents (Honda 2011), the crow control officers are the preferred damage reduction methods (Ministry of the Environment 2018). Oiling eggs is a potential strategy to reduce the population of birds (Christens et al. 1995, Pochop et al. 1998). However, this approach would not be popular in Japan, because of an emphasis placed on reducing the damage from nuisance crows and not wide-scale population reduction (Ministry of the Environment 2018).

When crow nests are destroyed by the crow control officer, the birds typically rebuild them, often in sites that are difficult for humans to access or locate such as in the tops of trees or hidden by leaves and branches. In Mombetsu City, crows commonly rebuild their nests before laying their eggs, but not after. Some people request that crow nests be destroyed even when they do not contain eggs or young; however, they are informed by the officers that the most appropriate time to destroy the nests is after the eggs have been laid (Ministry of the Environment 2018).

In Mombetsu City, the costs of the crow control program were included as the total maintenance cost of the environment for the city (City of Mombetsu, unpublished data). The estimated annual cost for crow control program for Mombestu is $300,000 USD. These costs include the salaries and equipment for 3 employees. I also researched the actual cost for a similar program in the city of Hirosaki, which has >170,000 inhabitants. Although

Hirosaki is much larger, the cost of the program was estimated at $70,000 USD (City of Hirosaki, unpublished data). These costs were included in the municipal budget of the local government. The costs are based on the taxes paid by citizens, such as resident tax according to income and local consumption tax.

Mombetsu City crow control officers are trained on-the-job. Section leaders or more experienced officers train younger officers. Because city officers are often rotated between several sections in city offices in Japan, the term of the crow control officer may be 2 or 3 years. New officers are required to study the manuals prepared by the Ministry of the Environment (2018).

Managers will need more information about crow ecology and population responses to changing environmental conditions to devise alternative strategies to mitigate the damage caused by overabundant crow populations. Given the projected increase in crow populations in response to the increased frequency of precipitation events in Japan, there is a need to better understand the potential effects of climate change on crow control activities.

In this case study, I summarize crow control program efforts conducted in Mombetsu City, located in northern Japan, from 2012–2016. I also summarize precipitation data from the same period for Mombetsu City and describe the relationship observed between precipitation, crow abundance and activities, and crow control efforts.

Study area

Mombetsu City is located in the northern part of the Okhotsk sub-prefecture in Hokkaido, Japan (Figure 1). The city has 23,000 inhabitants (City of Mombetsu 2019*b*). It has cold winters and warm summers, with an average temperature of 6.4 °C throughout the year. The daily maximum and minimum temperature is 10.1 °C and 2.7 °C, respectively.

The carrion and long-billed crow are common in the study area (Ministry of the Environment 2018). Both species have been reported to attack people. The carrion crow constructs its nests in broad-leaved trees and on electrical poles. The long-billed crow builds its nests in conifers. In residential areas, the streets are lined with many broad-leaved trees and there are several electrical poles.

In Mombetsu City (as in almost all of Hokkaido), it seldom snows in April compared to March (Japan Meteorological Agency 2018), and this is when crows start to construct their nests. The nesting period typically ends in late June to early July. The nesting season will likely be prolonged by climate change (Ministry of the Environment 2018).

Methods

To initiate crow control officer actions, citizens must first file a complaint with city offices. However, based on the complaints alone, there often is not enough information to determine the species involved. Because permission is needed to remove crows, I was able to determine almost all the cases where crows have been captured and killed and nests destroyed in the residential areas of Mombetsu City. Thus, the numbers of crow nests destroyed and nestlings removed reflect actual control efforts.

The crow nests I studied were collected and photographed by crow control officers of the environmental section in Mombetsu City (Figure 2). I used these photographs to verify crow numbers. The number of eggs destroyed and nestlings removed were recorded each time.

Crow nests were collected from the middle of May to June. Control activities are initiated when crows have laid their eggs. Generally, most crows in Mombetsu City lay only 1 clutch of eggs per year. I used this information to estimate the production of crow offspring. Because it has been suggested that crow abundance and nest removal trends might be related to weather, I compared nest removal rates to the number of rainy days and the amount of precipitation obtained from the Japan Meteorological Agency database. Study area precipitation data were obtained from Mombetsu City.

Data analysis

To describe the potential relationship between precipitation and crow abundance, I calculated the correlation efficiency between precipitation and rainy days and number of crows removed. Correlation coefficients for the data collected were calculated using the CORREL functions of Microsoft Excel 2011, respectively, as described previously (Yoda et al. 2017). I calculated *P*-values in Excel 2011.

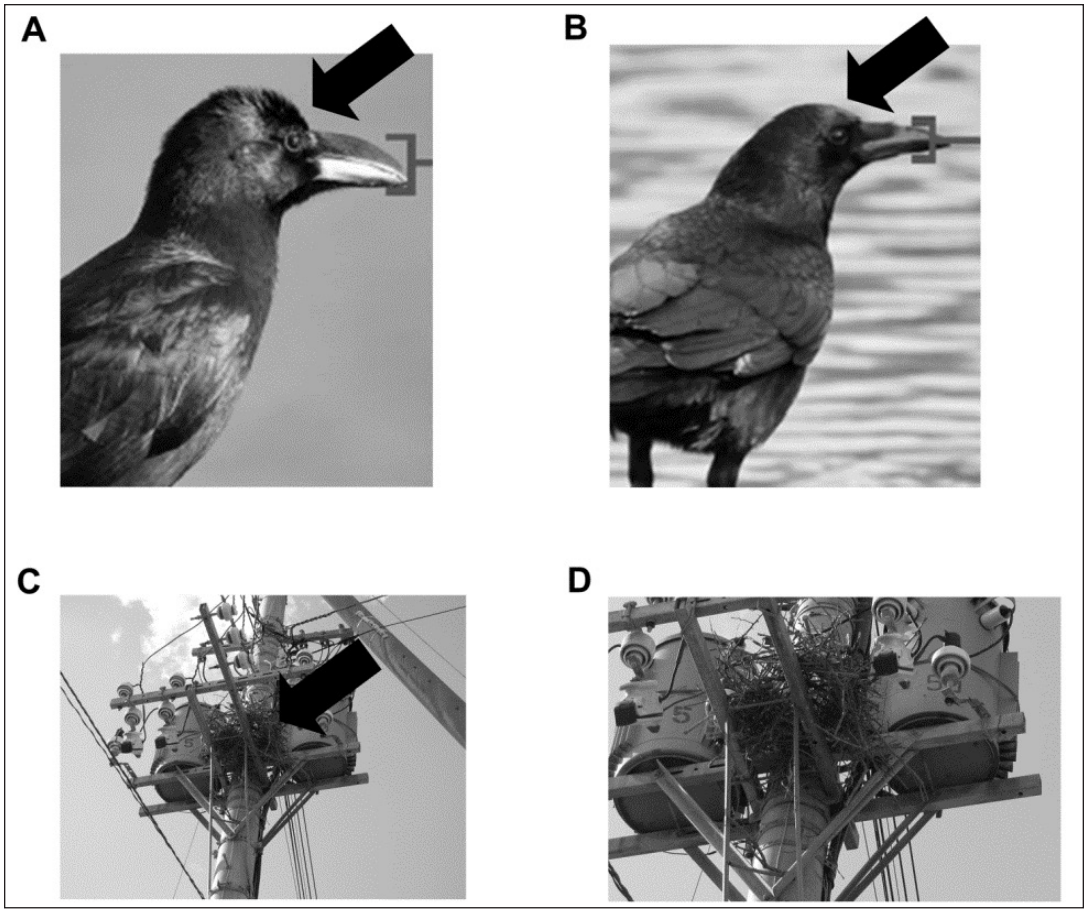

Figure 2. Images of crows with arrows indicating distinctive features of *Corvus macrorhynchos* (A) and *C. corone* (B) and their nest. Constructed nest by *Corvus* sp. at Mombetsu City, Japan (C) and its zooming view (D; *photos [A] and [B] courtesy of Seibutsu Moratoriamu and photos [C] and [D] courtesy of T. Yoda*).

Results

The number of eggs destroyed and nestlings killed varied annually (Figure 3). More crow nests were removed and the number of broken nests observed was higher when the precipitation was lower during the crow nesting season. Because citizens were keen to have nests destroyed at the earliest opportunity, the number of eggs destroyed each year is generally larger than the number of nestlings removed. This trend was observed for the years 2012, 2013, 2014, and 2016, although not for 2015. The numbers of both eggs and nestlings removed also varied annually.

The number of rainy days and the amount of precipitation were well fitted for the years 2012–2016, with a correlation coefficient (r) of 0.50. These trends are similar to the trends in the total number of broken eggs and nestlings killed (Figure 4). The correlation coefficients between the total number of broken eggs and nestlings killed and the amount of precipitation and the number of rainy days were r = 0.88 and r = 0.83 (each data point represents 5 observations). These correlation coefficients are important because when r is 0.83, it implies P>0.1, and when r is 0.88, it implies P>0.05 (as long as 5 observations were considered), respectively.

I also compared the number nests, eggs broken, and nestlings removed to weather data for the months of April and May (Figure 4). The trends of rainy days and precipitation were found to be similar to those eggs broken and nestlings removed (Figures 3, 4, and 5). The calculated correlation coefficients between total broken eggs and nestlings removed and precipitation and rainy days in April were r =

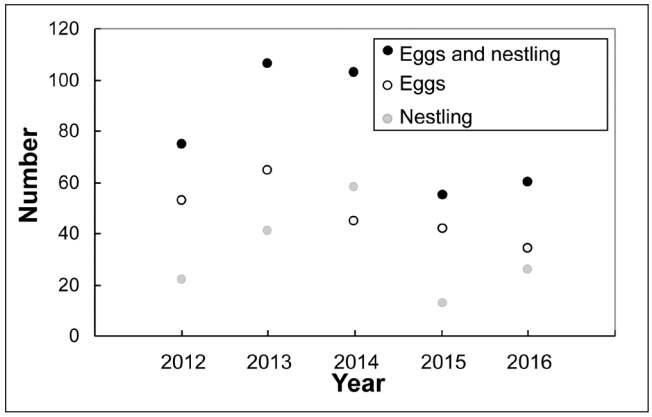

Figure 3. Number of carrion and long-billed crows (*Corvus corone* and *C. macrorhynchos*) removed over a 5-year period from 2012–2016, Mombetsu City, Japan. The number of crow's eggs removed (white), killed nestlings (gray), and both eggs and nestlings (black) are shown.

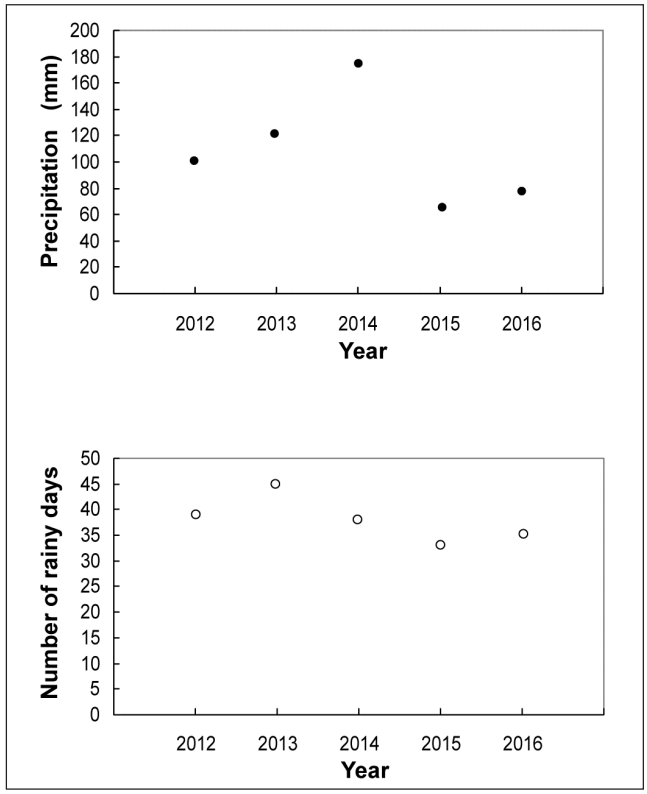

Figure 4. Amount of precipitation and number of rainy days from April to May for the years 2012–2016, Mombetsu City, Japan.

0.54 and $r = 0.50$, respectively, and in May were $r = 0.71$ and $r = 0.74$, respectively. (Notably, although each sample contained 5 observations, the coefficients did not differ enough to indicate a strong correlation; therefore, their values are used only for comparison.)

The number of eggs reported broken and nestlings removed was correlated with precipitation in the following descending order: total precipitation in April and May, total rainy days in April and May, rainy days in May, precipitation in May, precipitation in April, and rainy days of April. The correlation coefficients of both broken eggs and nestlings killed with precipitation and rainy days were $r = 0.80$ and $r = 0.77$, respectively. Although the trends were similar, these values were lower than those of April and May. All values of correlation coefficients for both rainy days and precipitation in February and March with both broken eggs and nestlings killed were found below 0.5.

Discussion

I examined the relationship between precipitation events and data on eggs broken and nestlings removed by crow control officers during the 5-year period from 2012–2016. The number of rainy days and the amount of precipitation were correlated with changes in the number of eggs broken and nestlings killed by city crow officers. Contrary to expectation, when precipitation was highest, the number of eggs, nests destroyed, and nestlings removed was also high. Initially, these findings seemed counterintuitive because increased precipitation could also disrupt nest construction and egg laying. However, the results could be explained by the fact that increased precipitation may also disrupt human activities (Horanont et al. 2013) and hence create conditions more favorable to crow nesting.

When there is substantial rain, the activities of both human and other animals that disturb crows during nest construction tend to be reduced. Consequently, crows were able to build their nests and raise their young, relatively undisturbed. An alternative explanation may be that rainy days allowed people to observe

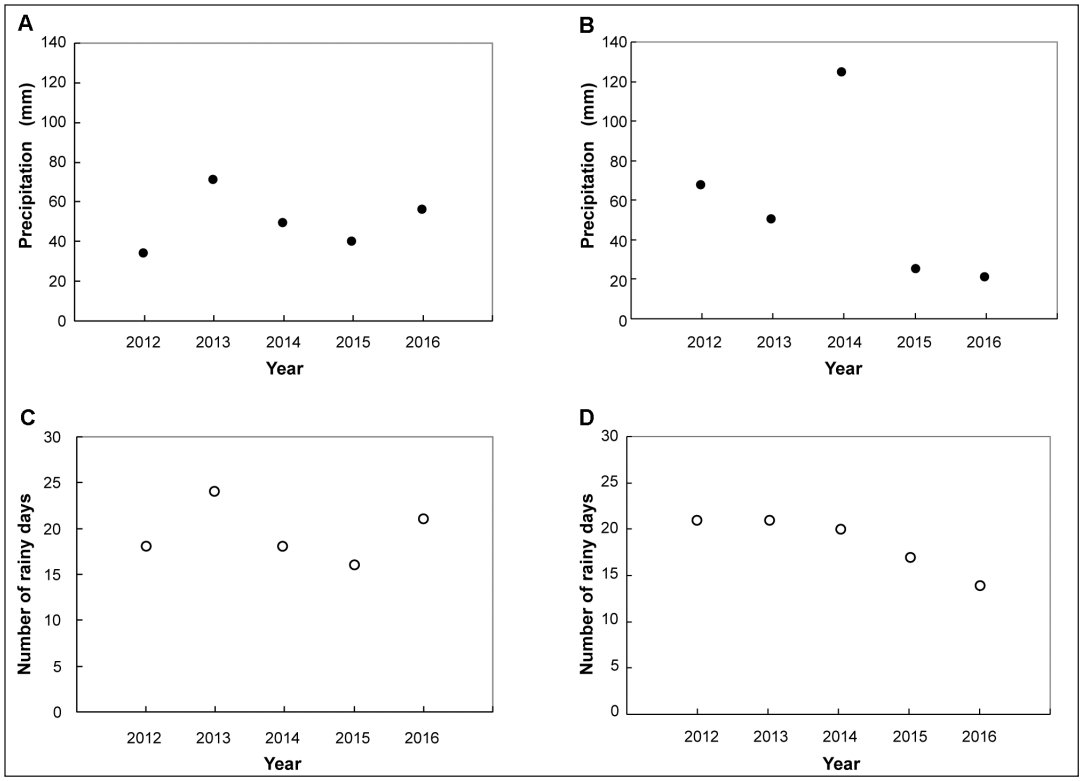

Figure 5. Precipitation levels in April (A) and May (B) and number of rainy days in April (C) and May (D) for the years 2012–2016, Mombetsu City, Japan.

and find crow nests near their homes more readily than during sunny weather when normal activities do not allow people the time to observe attentively. Then they can inform the authorities and request the destruction of the nests. A previous study showed that the number of observed crows was higher in rainy conditions than in dry conditions at the same location (Luginbuhl et al. 2001).

Although not all cases of crow nests and nestlings are reported to the city officers, the activities of crows causing annoyance to citizens were generally reported (Mombetsu City crow control officer, personal observation). But because the population of the city during the 5-year study period and the city response unit comprising 3 officers have remained the same, the observed data trends may be representative of the relationships between rainfall and crow activities.

It should, however, be emphasized that the data presented in this study are limited to Mombetsu City and represent only a 5-year period. Similar summarized data and research on crows for other cities in Japan may help to validate these observations.

Management implications

Because long-term data related to climate predictions are available from the Japan Meteorological Agency, it may be possible to devise measures to effectively control crows. For example, in response to the finding that crows are more active during rainy periods, crow control officers might be able to take appropriate measures to control crows, such as the preparation of tools, hiring additional section members, and cutting tree branches to disturb nest building.

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