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Corvid control in urban environments: a comparison of trap types

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Abstract. Corvids, mainly Hooded Crows (*Corvus cornix* L.) and Rooks (*Corvus frugilegus* L.) have colonised and spread in many European cities in recent decades. They are often considered as pests due to their noise, littering, aggression to humans and pets, and predation on birds of urban environments. Consequently, the control and/or management of corvids may become necessary in many cities in the future. The aim of this study was to compare the effectiveness of different trap types in catching crows and rooks in an urban environment. We experimentally tested four types of traps in the winter of 2014: bow net, Larsen trap, Swedish trap, and ladder entrance trap. As bait, we used bread, meat, fish, and live decoy birds. In 269 trap-days, we captured 23 Hooded Crows (with three birds recaptured 10 times), 34 Rooks (three recaptured 11 times), and 3 Magpies. The side-opening Larsen trap (0.46 captures/trap-day) and the ladder entrance trap (0.37) were the most effective. We caught only juvenile Hooded Crows, and both juvenile and adult Rooks, likely related to the wariness of adult crows. If a bird was captured in one type of trap, it was never recaptured in that type of trap. Our study suggests that trapping may be an effective way to catch crows and rooks and that some trap types may be more efficient than others. We present detailed guidelines for trapping, which will be useful in environmental management, urban planning and development, nature conservation and wildlife management.

Key words: city, *Corvus cornix*, *Corvus frugilegus*, human-wildlife conflict, Hooded Crow, Rook, mark-recapture.

Introduction

Birds possibly began to appear and settle near humans at the start of urbanization. Urbanization and birds colonising cities is still an active, even expanding, process today. A large city can be considered as a network of different urban habitat types with specific and characteristic species involved (Bezzel 1985). The composition of species is determined by the biotic and abiotic conditions of the city (Böhning-Gaese 1997, Roy et al. 1999).

Since the 1960s, Hooded Crows (*Corvus cornix* L.) appeared, colonised and spread in many European cities, e.g. in Finland (Vuorisalo et al. 2003), Hungary (Ujhelyi 2005; Juhász et al. 2009; Kövér et al. 2015), Norway (Parker 1985), Poland (Mazgajski et al. 2008) and Russia (Konstantinov et al. 1982; Korbut 1996). Several factors were proposed to explain this process, primarily including the availability of diverse food sources and nesting places in the cities (Vuorisalo et al. 2003), coupled with the habituation skills and ecological flexibility of Hooded Crows (Konstantinov et al. 1982; Von Busche 2001; Kövér et al. 2015). Cities also provide ample hiding places from predators (Vuorisalo et al. 2003). Human disturbance or hunting pressure outside or inside the cities can also be influential factors (Sorace 2001, Withey and Marzluff 2005, Jokimäki et al. 2016).

The first recorded nesting of Hooded Crows in Debrecen, our study area, is from the university botanical garden in 1959. The species was not reported for 20 years and reappeared as a nesting species only in 1972 (Fintha 1994) and then in 1979 (Juhász et al. 2009). The population became stable in the northern parts of the city (e.g. zoo, cemetery, sport complex) in the 1990s (Juhász 1999) and it started to spread to other parts of the city in the early 2000s. By 2013, the size of the birds' urban population has exceeded 100 nesting pairs (and 4 nests/km^2) and is still increasing linearly, with no sign of reaching carrying capacity (Juhász et al. 2009; Kövér et al. 2015).

The occurrence of corvids often results in concerns from inhabitants of the cities. Hooded Crows often search for food in trash cans, leaving trash scattered, can be vectors of diseases, and are also loud and can be aggressive to humans or pets (Vuorisalo et al. 2003; Szemadám 2006). Hooded Crows are fine predators and their primary prey are the eggs (Erikstad et al. 1982; Heubeck and Mellor 1994) or young (Schenk 1928; Edholm 1979) of Blackbirds (*Turdus merula*), several finches (Fringillidae), and pigeons and doves (Columbidae), but they are also known to effectively catch fish and frogs from ponds in city parks and hunt for small mammals such as moles (*Talpa europea*) and bats (e.g. *Nyctalus noctula*) (Kőszegfalvi 2008; LK, pers. obs.). Large numbers of Common Rooks (*Corvus frugilegus*) nesting in city parks also cause concern in several cities of the region (e.g. Satu Mare, Sfântu Gheorghe, Timișoara, Tîrgu Mureș) due to their noise and littering and there are several plans for controlling them (e.g. http://milvus.ro/pasari-protejate-expulzate-de-primaria-targu-mures/8222, foter.ro/cikk/20160219_a_varjak_miatt_megkoszapitanak_a_szatmari_kossuth_kertet).

All these increasing nuisances to humans and negative effects on the urban biota raise the possibility that the control or management of Hooded Crows is or will become necessary in Debrecen and in other European cities in the future (Parker 1985, Woodbury 1961, Moran 1991, Tsachalidis et al. 2006). One way of control and management is to catch crows by trapping and translocating them. Because corvids are highly intelligent and are often subjects of research studies, trapping is also of central importance in many research programmes, e.g. in mark-recapture studies based on individual marking. However, crows are really smart animals and thus can be difficult to catch (Bub 1995). The aim of our study thus was to test and compare the efficiency of different types of traps in capturing crows and other corvids in an urban habitat. We used various trap types to identify which traps were the most effective and we also aimed to gather experi-

ence important for the successful capture of crows that can be used both in urban and rural environments.

Materials and methods

Traps tested

We tested five kinds of four trap types: bow trap, Larsen trap, Swedish trap, ladder entrance trap. Two kinds of Larsen trap were used, one with a side-door and another with an upper door, which we will consider as two different kinds of trap. The details of each trap are given below.

Bow net (Fig. 1): This trap type consists of square-shaped or curved metal frames (minimum length for crows: 0.6 m) connected by a spring structure. This trap catches one bird at a time. The spring mechanism works at a high speed and needs great caution during operation. The trap is fixed with metal sticks, and its power and speed need to be tested before use. The activated trap needs to be covered with leaves, otherwise the crows will not go into it. The trap is set off automatically by the bird when it tries to take out the bait. The bait can vary (egg, meat, bread etc.) depending on the season. The trap needs to be frequently checked from a distance with binoculars and the bird caught should be taken out as soon as possible (Bub 1995).

Figure 1. A cat under the bow net.

Larsen trap (Fig. 2): This box-shaped trap was developed explicitly for crows by a Danish ranger in the 1950s. The wooden-frame box is covered by wire and has one holder and two catcher racks. The catcher rack's door closes upwards when a bird tries to sit on the half-sawn sitting stick. The trap has upper-door and side-door versions. Most often the trap uses live crows as decoys, which the other crows do not tolerate, especially during the nesting season when they are territorial. The foreign individual in the box trap is readily attacked by the crows, which can quickly get inside the trap by a spring door. However, the trap can be used in all seasons, but needs to be installed in places that crows commonly use. Alternatively, the trap can also be baited with food. The trap needs to be checked once a day, usually in the night-time. This trap type has been used successfully in Hungary before (Hajas 2009; Balogh 2011).

Swedish trap (Fig. 3): This trap has a trapezoid shape and three racks and works like a Larsen trap. The doors of the catcher rack are activated by a seesaw sitting stick. The only difference from the Larsen trap is that this trap is operated by gravity (Hajas 2009).

Ladder entrance trap (Fig. 4): This trap also hails from Scandinavia and although it was originally developed for decreasing the populations of Rooks (*Corvus frugilegus*), it can also be used to catch Hooded Crows and Magpies (*Pica pica*) with other baits. The trap looks like a large flight cage due to its size (2-4 m width, 2-5 m length, 2-3 m height) and has a ladder-like door on the top side, where crows at

Figure 2. Larsen trap (side-door version).

Figure 3. Swedish trap.

Figure 4. Ladder entrance trap.

tracted to the bait can jump (Bub 1995). The ladder gaps should be between 0.15-0.35 m. The trap can be used throughout the year, however, in the summer, it mostly catches juveniles. Trap success increases when snow is on the ground or food availability is limited. Proper baiting with bread, meat products, fish or using live birds as decoys can lead to high capture success. The trap should be checked in the early morning and in the evening to prevent the crows from recognising the researchers. This kind of trap has been used successfully in case of Hooded Crow in rural areas (Moran 1991) and in urban parks of Vienna (Austria), Sapporo (Japan) and in Debrecen (Hungary) before (Kövér et al. 2014).

Implementation of trapping

Trapping was carried out in two sequences from January 16 until January 31 in 2014 and from October 8, 2014 until January 8, 2015 in Debrecen, the second largest city in Hungary (c.a. 210 000 inhabitants). We conducted our study in winter because it is one of the best times to catch corvids due to the reduced availability of food sources (Bub 1995) and high numbers of resident and wintering crows in the city. In the nesting season, crows are rather territorial and show nest defence behaviour, which can be exploited in trapping, however, the chances of catching meaningfully large numbers of crows for the comparison of trap types are low relative to the amount of extra work of moving the traps. The study site was a large grassy area on the campus of the Faculty of Agriculture, Food Science and Environmental Management of the University of Debrecen (E-Hungary). A detailed, seven-year study of the recent colonisation and population increase of Hooded Crows in Debrecen (Kövér et al. 2015) showed that at least 4 pairs of Hooded Crows used the campus area for nesting. In addition, several pairs of other corvids such as Magpies (*Pica pica*) and Common Jays (*Garrulus glandarius*) breed on this campus and substantial numbers (up to several thousand; Veszelinov 2012) of Rooks (*Corvus frugilegus*) use it in the winter. During the periods of trapping, both resident and wintering Hooded Crows (few tens of individuals) and several hundreds of wintering Rooks used the campus area. Because trapping was conducted in the winter, no birds showed territorial or nest-defence behaviour.

We built two (side-door Larsen and ladder entrance) of the five kinds of traps and the other three were purchased from regular commercial suppliers (Ernst & Hajas Company). We designed our custom-built traps based on literature information and personal consultation with experienced experts on using the traps at University of Vienna (Austria) and Tokai University (Japan). The dimensions of our ladder entrance trap were 2×2×2.5m (W, L, H), with 0.16×0.2-m gaps between ladder steps. The ladder trap, the largest of the traps, hosted the decoy birds in bad weather, when the traps were not operated.

Traps were set 50 m apart from one another. The five traps were similarly close to a dog house, where food was permanently available for the crows. In each trap, we used baits and live Hooded Crows as decoy birds, except in the bow net trap. The success rate of capturing corvids is known to increase with the use of decoy birds (Moran 1991; Bub 1995). For bait and food for the decoy bird, we used bread, meat products, fish, kitchen leftovers, chitterlings (pork, rabbit), fruits, dog food (both dry and canned), and fresh water. We always checked traps after sunset in the dark. Birds caught were put in a cotton bag, marked with a metal/scheme ring and two colour rings on their legs for individual identification, and were released in the morning.

Results

In 269 trap-days, we captured corvid species 81 times (Hooded Crow: 33, Rook: 45, Magpie: 3), including 23 individuals of Hooded Crows (three birds were captured more than once, with a total of 10 recaptures) and 34 individuals of Rooks (11 recaptures) in addition to the 3 Magpies (no recaptures) (Table 1).

We also captured two Black Redstarts (*Phoenicurus ochruros*), two Great Tits (*Parus major*), and one Common Buzzard (*Buteo buteo*), all with the ladder entrance trap. In addition, two domestic cats (*Felis silvestris catus*) were caught by the bow net. After these incidents, we discontinued the use of this trap to avoid accidents with pets or children as the campus is used for recreational purposes by locals.

Of the remaining four trap types, the side-door version of the Larsen trap was the most effective (mean = 0.47, SD = 0.78, captures per trap-day, Table 1), followed by the ladder entrance trap (0.37 + 0.95), the Swedish trap (0.28 ± 0.60) and the upper-door Larsen trap (0.05 ± 0.29). The number of captures per day differed significantly among the trap types, both when all captures (Kruskal-Wallis, $H = 7.496$, $df = 3$, $p = 0.001$, n=81) and only new captures were analysed (n = 21 recaptures excluded; $H = 3.814$, $df = 3$, $p = 0.015$, $n = 60$). Pairwise Bonferroni-corrected Mann-Whitney tests showed significant ($p < 0.05$) differences in the number of captures per day between the ladder and the Larsen (upper-door) trap ($p = 0.023$) and between the Larsen (side-door) and the Larsen (upper-door) trap ($p = 0.0002$), and between the Swedish and Larsen (upper-door) trap ($p = 0.038$), whereas there was no difference between the ladder and the Larsen (side-door) traps ($p = 0.534$). The results were similar when recaptures (n = 21) were excluded, with the exception that the pairwise difference between the ladder and the Swedish trap was not significant (Bonferroni-corrected $p = 0.288$).

The age distribution of captured individuals showed differences between crows and rooks. All caught Hooded Crows were juveniles, whereas we caught both juvenile and adult Rooks (Table 2). Most individuals were caught only once. However, three Hooded Crows and three Rooks were recaptured a total of 21 times (Table 3). Trap-happiness occurred in one notorious trap-visitor Rook (recaptured 8 times) and in one Hooded Crow (5 times). This Hooded Crow was one of the first three caught, and one month passed between its capture and its first recapture. Then this bird was caught three times in four days.

Apart from the trap-happy Rook and one Hooded Crow (ID #5, Table 3), the trap type of the first capture differed from the trap type of the recapture. In other words, if a bird was captured in one type of trap, it was not recaptured in that type of trap, which suggests that crows and rooks, other than the trap-happy ones, actively avoided the traps they

Table 1. Number of captures in different trap types. The number of recaptures is given in parentheses.

Trap type	No. trap-days	Hooded Crow	Rook	Magpie	Total
Ladder trap	103	19 (6)	18 (4)	1	38 (10)
Larsen (side-door)	62	13 (4)	16 (6)	0	29 (10)
Larsen (upper-door)	60	0	1	2	3
Swedish	39	1	10 (1)	0	11 (1)
Bow net	5	0	0	0	0
Total		33 (10)	45 (11)	3	81 (21)

Table 3. Number of recaptures and trap type of first capture and recapture for individuals caught more than once.

Species	ID	No. recaptures	First captured by	Recaptured by		
				Ladder	Larsen (side)	Swedish
Hooded Crow	#1	5	Larsen (side-door)	5	0	0
Hooded Crow	#5	2	Ladder entrance	1	1	0
Hooded Crow	#7	3	Ladder entrance	0	3	0
Rook	#3	1	Ladder entrance	0	1	0
Rook	#9	8	Larsen (side-door)	4	4	0
Rook	#15	2	Ladder entrance	0	1	1

Table 2. Age distribution of the corvids captured.

Species	Juvenile	Adult	Unknown	Total
Hooded Crow	16	0	7	23
Rook	11	20	3	34
Magpie	2	0	1	3

had been caught in the first time.

Discussion

Our study provides three key results. First, our observations showed that Hooded Crows and Rooks, whose wariness to humans and the surroundings is well established (e.g. Clucas & Marzluff 2012), can be successfully captured by trapping. Our results suggested that trapping of Hooded Crows was most effective at capturing young, and probably inexperienced, individuals, while trapping effectively caught both adult and young Rooks. However, we cannot exclude the possibility that adult Hooded Crows can be captured by these traps because most of the individuals observed around the traps were juveniles of the year of study. Second, the most effective traps were the side-door version of the Larsen trap and the ladder trap, whereas the upper-door Larsen trap was less effective in capturing corvids. Therefore, we recommend the side-door Larsen and/or the ladder trap for capturing crows and rooks. Finally, although we originally initiated the study to catch Hooded Crows, we captured not only crows but also other corvids (Rooks and Magpie), indicating that these traps are effective for catching several species of corvids. Because the traps caught both adults and juveniles of the year of Rooks (Table 2), our results are particularly important for plans to control Rooks in several cities in E Hungary and NW Romania in and outside the breeding season.

Apart from these exact results, our study provided important practical knowledge in capturing corvids. First, when selecting the location, one has to choose sites where crows appear frequently. Most often, such places have reliable food sources such as rubbish-dumps, pens in zoos, parks with grassy areas and fruit-bearing trees, parking lots of shopping malls, or residential areas with open garbage cans or access to dogs' food. These permanent food sources facilitate the occurrence of corvids (Baltensperger et al. 2013), and thus can be also important in attracting them to and in the traps (Loretto et al. 2016). Our observations suggest that trapping at such "crow-sure" locations can lead to greater catching success.

Second, it may be difficult to capture birds in urban environments due the permanent presence of people, who might scare the birds away (Clucas & Marzluff 2012). In our study area (university campus with a large grass-covered open space not frequented by people), we could hide the traps and corvids could discover them without frequent interruptions by people. Other good options to set up traps are larger parks or areas in the outskirts of cities (cemeteries, trash depos etc.), e.g. as in Sapporo, Japan (Takenaka 2003).

Third, despite the relatively closed locality (campus) and our frequent checks of the traps, there were abuses from people and from small predators (cats, weasels) which tried to gain access to the decoy birds. Because the traps should be unattended during the day to attract corvids, they can be an easy target for vandalism or theft. To prevent this, information posts with a short explanation and contact information should be installed close to the traps and the traps should be locked (Clarin et al. 2014).

Fourth, the use of decoys (conspecific live bait birds) can also increase the attractiveness of the traps and some researchers argue that the use of a bait bird is necessary (Moran 1991; Bub 1995; Campbell et al. 2012, 2016). Although we did not experience differences in the number of corvids near traps with or without decoys in the field during our direct observations, it requires further systematic study to evaluate whether the use of decoys increases the success of capturing corvids. In addition, the vitality and behaviour of the decoy birds has a very important role of attracting the free birds into the trap. In recent years, the use of live-bait birds has been questioned on ethical grounds (Weatherhead & Greenwood 1981). To minimise stress to the bait birds, we used the same live birds as decoys throughout the trapping period and they were regularly changed among trap types, ensuring that these birds got used to our presence and handling. Because the calm behaviour of the decoy may reduce the wariness of the target wild individuals, we therefore suggest that it may be best to use hand-raised birds as decoys. We protected the decoy birds from the weather by fitting the traps with a roof or a windshield against wind, rain and snow. The traps often needed maintenance, most frequently the lubrication of the doors and locks (Bub 1995).

The age distribution of captured individuals showed differences between crows and rooks. This difference may be related to the gregariousness and nesting habits of the species. Hooded Crows mostly spend their time alone or in pairs and nest solitarily, whereas Rooks are more gregarious, move in groups and nest in colonies (Goodwin 1986). This is probably related to why adult Hooded Crows were more alert and wary of traps and that only inexperienced juveniles got into the traps. Moreover, we observed that the two species' behaviour during handling/ringing fit these expectations because while Rooks were fully calm, Hooded Crows vehemently hipped, clawed and tried to fly away all the time.

Fifth, we found that both crows and rooks can be effectively captured in the winter. During this period, corvids are not territorial and their space use depends mostly on the availability of food sources. In contrast, crows are territorial, aggressive and show nest defence during the breeding season. Trapping during the breeding period can thus mean that single crows may be caught more easily as they actively defend their nest from conspecifics and take more risks during this period (e.g. in Rooks: Green 1981, in Jackdaws: Greggor et al. 2016). In an extreme case, it is quite possible that during the breeding season, there would be smaller or no differences among the different types of traps in the success of capturing corvids. However, a study in the breeding season would also require a much higher effort to obtain a meaningful sample size for comparing trap types, e.g. in finding and monitoring nests, moving and setting the traps near the nests, controlling human use of nesting areas such as parks to reduce disturbance to the birds etc. Therefore, the efficacy of the different trap types in catching corvids in the breeding season remains open for further study.

In addition, our experience shows that the timing of trap checks is also important for successful captures. Corvids are wary and are known to recognise threats early and from a distance, especially from people (Marzluff et al. 2010). The learning of threats at the population level can happen really fast due to their quick social learning and rapid spreading of knowledge (Cornell et al. 2012), and their ability to distinguish people individually (Davidson et al. 2015). Considering these abilities of crows, we checked the traps only in the evening hours when it was dark in order to avoid being recognised by the crows.

Finally, although we did capture unintended animals (passerines, cats etc.) of minor conservation importance, trapping conducted outside the cities should consider that the traps will have a greater chance to capture birds and mammals of higher conservation importance. Another conservation-related issue is whether lethal methods should be used to control corvid numbers in urban environments. For example, Rook control by shooting outside the breeding season is planned in several cities and is surrounded by controversy between local people, authorities and conservationists (e.g. in Satu Mare in NW Romania, please see link above). Without the intention of taking sides in this issue and based on our experience with increasing numbers of crows in cities (e.g. Kövér et al. 2015), we can only point out that lethal control will provide a short-term, temporary solution at most because corvids will be quick to recolonise the former nesting areas from where they are extirpated. Felling the trees that provide nesting sites can lengthen the duration of this solution, however, this solution is also likely to reduce the recreation quality of city parks and zoos. Although Hooded Crows in the cities nest on high trees, they may also show a tendency to use smaller trees for nesting as the population increases (Kövér et al. 2015). Rooks are also known to use shorter trees for nesting (Kasprzykowski 2008), thus, they may occupy smaller trees if the larger ones are felled. We believe that corvid control requires longer-term solutions to work. For example, sources of corvid food such as trash bins should be mapped in the city and should be addressed e.g. by redesigning trash collecting bins in a way that prevents crows to gain access to trash. As another example, suitable nesting sites (groups of large trees) can be established for corvids on the outskirts of cities where they cause no problems (e.g. at field edges, near garbage dumps). These actions require careful planning and more resources than simple lethal control by shooting or trapping/killing but they represent long-term solutions to human-corvid conflicts. An ideal management thus should address the ultimate anthropogenic reasons for the problem (e.g. inadequate trash collection, inappropriate trash bins to keep out corvids, lack of nesting sites outside the city etc.) rather than employ lethal control methods for short-term solutions.

In conclusion, we found that the side-opening Larsen and the ladder entrance traps were the most effective in catching crows and rooks. These traps can thus be recommended for use in any research or conservation programmes in which Hooded Crows need to be captured e.g. for purposes of individual marking or translocation. The Swedish trap was less effective, while the bow net should not be used, in order to avoid the unintended capture of domestic animals or wildlife. Our results will be useful for city planners, urban developers, environmental management, nature conservation authorities, non-governmental conservation organisations, and researchers of corvid biology.

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