International Journal of Engineering and Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 10 Issue 8 Series II || August 2021 || PP 39-44

A Study on Avian Diversity: Impact of Urbanization

GEETIKA
Associate Professor (Zoology)
S.P.N.K.S. Govt (PG) College, Dausa Rajasthan.

Abstract-
Urban landscapes and habitats differ significantly from nonurban "natural" habitats. The transition of the land from natural green spaces to manmade constructions and impermeable surfaces is the primary difference. Birds must adapt to the new circumstances in order to survive in their urban habitat. Furthermore, urban growth has caused a highly fragmented landscape with isolated areas that are good for bird habitat surrounded by roads and structures that commonly operate as barriers, even for organisms that can move around like birds. With many species disappearing whenever a region is urbanized, these new conditions have drastically affected the avifauna, causing a considerable loss in local biodiversity. However, some species appear to flourish in urban environments, and these species frequently exhibit notable phenotypic variations (such as in behavior, physiology, and morphology) from their conspecifics in the countryside. Specific urban selection drivers like air pollution, artificial nighttime lighting, noise, various food types, various predation pressures, and human disturbances have all been connected to these phenotypic changes.
It is challenging to identify one urban characteristic as the primary driver of the disparity because multiple causes are frequently entangled. Urban habitats pose a serious danger to biodiversity, but they also provide an intriguing setting for research of population divergence, evolutionary responses, and ultimately speciation in the wild.
Keywords- *Anthropogenic, Environmental stress, Habitat fragmentation, Light at night ,Pollution etc*

I. Introduction

Since the beginning of human settlement, there has been extensive yet localized deforestation and damage of the land. A treeless Mediterranean environment that we are familiar with now was already created by the Romans, possibly at the expense of the local species at the time. Similar situations have occurred all throughout the world and throughout human history. However, urban human societies did not begin to dramatically expand globally until the Anthropocene. Beginning in the 1700s, Western industrialization led to the emergence of urbanization and urban sprawl, which significantly altered the landscape. Urbanization has an impact on all creatures, including birds, on a worldwide scale nowadays. However, emerging nations are still in the early stages of the industrial revolution; as a result, it is anticipated that the impact of global urbanization will grow. Likewise, current urban centers in western countries are expected to increase and intensify in the future as a result of the continuous growth of the human population.

Urbanization is seen as one of the biggest risks to biodiversity, especially the survival of many bird species, along with climate change. The biggest concern is probably habitat loss and fragmentation, which demands quick decisions about whether to migrate (if at all possible) to areas that are more suited or remain and adapt to the new circumstances. The process of urbanization itself has resulted in new urban settings, but this is not the only factor. Non-native plant species have also been planted in previously "green" areas, and mid-story canopies have been removed. Even though there are fewer bird species overall after a region becomes urbanized, many bird species appear to be in good health. In fact, birds are most likely the loudest and most noticeable animal species in urban environments. The urban species frequently take advantage of human-made resources such the high abundance of novel food sources and man-made nesting cavities, like nest boxes and spaces between roof tiles. Birds in temperate regions can also take advantage of the warmer weather brought on by the so-called "urban heat island" effect, which is brought on by the heat-absorbing qualities of impervious surfaces and structures as well as the scattering effects of air pollution, trapping heat irradiation within the atmosphere of the city. However, in hotter or tropical areas, the impact of urban heating on birds can be disastrous, causing heat stress and dehydration. Although farmlands and deforestation in sparsely populated areas are among the anthropogenic landscape changes that pose difficulties for birds, I will here concentrate mainly on the urbanization that is connected to the densification of people and human activity, i.e., cities. Up to 54% of the world's population now resides in cities. The greater the population density, the greater the requirement for infrastructure, buildings, and nighttime artificial lighting due to traffic-related air and noise pollution. Thus, the size of the human population is a reasonably accurate predictor of the effects on birds at the city level.

Animals Disappear from the City

The species that instantly disappear when a place becomes urbanized are known as urban avoiders. Ecological traits like poor natal dispersal, migration, fear of humans (far flight-initiation distance), insectivory, and/or low annual fecundity are typically used to describe these species.

On a global scale, this has resulted in a species homogenizing effect and an overall decrease in species richness in the metropolitan areas. Loss of habitat is the primary cause of this fall in avian biodiversity (i.e., the extinction of those species), and there is a definite inverse relationship between avian species density and urban land use. The number of native bird species will remain higher in cities that preserve the original vegetation composition and architectural styles than in those that do not. A megacity that has managed to preserve a sizable amount of bird biodiversity is Singapore. 36 bird species were found to be on the IUCN's global Red List for vulnerable species as a result of a global assessment of bird species across 54 cities, and 12 of those were found in Singapore.

Therefore, to prevent the homogeneity of species and preserve adequate habitats for them, cities like Singapore have a crucial conservation role in the future survival of these species. Urban city planners and conservationists have a crucial responsibility to sustain current biodiversity because urbanization will continue to rise along with the human population, making the urban threat to birds even more concerning in the future.

The species that disappear instantly as a result of urbanization can be recognized rather easily. Many species, nevertheless, have a slower reaction to urbanization, and as a result, their populations gradually dwindle. These species' identification can be more challenging and calls for extensive research on populations and their dynamics (such as dispersal, fecundity, and survival). It will be crucial for studies on population dynamics to (1) identify species for whom cities operate as ecological traps and (2) determine whether urban populations are sinks or sources of population.

Because they are less fit across their lifetimes than birds in nearby nonurban settings, both possibilities may lead to an impoverishment of urban bird populations. The persistence of the entire species may be affected if the urban environment serves as an ecological trap. An ecological trap works by luring and attracting birds to a certain place, as the name "trap" suggests. The city draws a lot of birds due to its greater abundance of resources (such as food and cavity-nesting bird nesting opportunities) and, in temperate climates, especially due to its milder winter environment in comparison to the nearby nonurban habitats. Because of these qualities, birds choose the city habitat over more natural habitats because they consider it to be a "high-quality" habitat. The population's general fitness in the urban environment is decreased by low nutritional content of food sources, exposure to high pollution levels, and a high incidence of collisions with cars and windows.

Therefore, if the ecological trap (city preference) is strong, the urban habitat will keep luring rural birds into the city where they will suffer the repercussions, ultimately lowering the species' chances of survival in the future. Depending on whether the urban population is a source or a sink in the source-sink scenario, the population could experience both positive and negative effects. Birds do not favor urban settings over nonurban habitats, nonetheless, if the urban population is a sink (rather than a trap). Instead, because there aren't enough open spaces in the natural habitat, surplus people can be compelled into the city. The effects on the species level, however, won't be as severe as with the ecological trap because the urban habitat is not desired. However, because the basis for that reasoning is the availability of natural habitats, the continued destruction of ecosystems and deforestation might have disastrous effects on source-sink dynamics throughout the urban and rural landscape.

Animals Prosper or Survive in the City

Some species thrive or survive in the city, despite the fact that many species disappear from metropolitan areas. The group of urban exploiters includes organisms that appear to thrive in cities. They have so heavily exploited the human resources that they now rely on them to keep population concentrations where they are. Many of the avian urban exploiters are invasive species, including Common Mynas Acridotheres tristis, House Sparrows, and Feral Pigeons. In actuality, compared to nonurban environments, urban regions have higher bird (or biomass) abundance per sampling unit. Many raptor species have benefited from this, and some of them, like the Great Horned Owl Bubo virginianus, Peregrine Falcon Falco peregrinus, and Black Sparrowhawks Accipiter melanoleucus, are now becoming more prevalent in metropolitan settings.

Large breeding distributions, a high propensity for dispersal, high rates of feeding innovation (novel ways of acquiring food), less fear of humans (short flight-initiation distance), and a life history with a high annual fecundity and high adult survival rate are characteristics of urban bird species. The bursa of Fabricius, a specialized organ in birds that is a part of the immune system, is larger in urban species, which suggests that they may be able to mount a stronger immune response than urban avoiders. Additionally, compared to urban avoiders, urban species have higher amounts of dietary antioxidants (vitamin E and carotenoids), which may aid them in more effectively combating oxidative pollution.

According to other studies, urbanization benefits omnivorous, granivorous, and cavity-nesting bird species, but it also relies on a region's climate and geography. These characteristics are typical of species that are frequently found in urban settings, although they do not necessarily indicate whether a particular species is an exploiter species or an adaptor species. Knowing whether a species is an adapter or an exploiter species can be crucial for understanding a species' adaptability to urbanization, the related urban stressors, as well as its dependence on humans. This is similar to the two situations above, the ecological trap and source-sink dynamic. Although the urban adapter species is not reliant on human resources, it is glad to do so occasionally.

We will examine both individual and population-level responses to urbanization, which ultimately offer a platform for selection to act upon and for population divergence to develop, potentially having consequences for sexually selected features and speciation.

Species Evolution

Real-time studies of evolution present an attractive potential in urban settings. Most animal species—if not all—display some phenotypic variation between their urban and nonurban counterparts. These phenotypic variations have been seen in a variety of aspects, including physiology, behavior, and morphology, and they may have an impact on life-history characteristics and, ultimately, fitness. These phenotypic changes have several, often difficult-to-distinguish drivers. Similarly, it is not always clear what mechanisms underlie the alterations or if "non-genetic" phenotypic plasticity or genetic divergence (described below) is to blame.

Phenotypic plasticity in this context refers to an organism's immediate reaction to a change in the environment, such as urbanization. In other words, a particular genotype will result in a distinct phenotype in an urban setting as opposed to a rural one. The phrase is a general term that refers to all phenotypic reactions, such as physiological acclimatization and learning. Some of these reactions can alter just once, then stay that way for the rest of a person's life, or they can alter constantly in response to environmental stimuli. Phentypic plasticity is referred to here as a "non-genetic" attribute, but plasticity itself can be an inherited trait. The degree of plasticity, or the capacity to change phenotypically, of a species or an individual depends significantly on the amount and timing of gene expression. Only one study has examined the transcriptomes of urban and rural birds to this point. It was discovered that the differentially expressed genes were involved in DNA methylation, innate and adaptive immunological responses, DNA repair, heavy metal detoxification, and fat metabolism.

Movement Obstacles Caused by the Urban Environment

For a population to diverge genetically, it must be reproductively isolated from other populations of the same species. Urban settings were not previously thought to be a barrier for nomadic species like birds. However, it has been shown that species with sedentary habits or restricted vagility—the capacity to move freely and migrate—are particularly vulnerable to habitat loss brought on by intensifying urbanization or urban sprawl. Therefore, populations get imprisoned. In fact, investigations of relatively sedentary species like the Wrentit Chamaea Fasciata have discovered considerable genetic divergence between urban and rural populations. But even the more mobile Song Sparrow Melospiza melodia exhibits a slight (but considerable) divergence. The degree of genetic structure is also correlated with the nature of cities and the level of urbanization (habitat fragmentation), in addition to dispersal capacity. The Great Tit, a species that is largely sedentary, has had varying degrees of success in various places.

The study may potentially show signs of selection on certain genomic areas, indicating that the urban environment does exert selective pressure on this widespread European species. Additionally, a small or big initial gene pool might serve as the foundation for the growth of a newly colonized metropolitan population. These reactions can alter once and then remain constant throughout a person's life or alter continuously in response to environmental cues if the urban population begins to increase. Phenotypic plasticity can be an inherited feature, despite the fact that I refer to it here as a "non-genetic" trait. The degree of plasticity, or the capacity to change phenotypically, of a species or an individual depends significantly on the amount and timing of gene expression. Only one study has examined the transcriptomes of urban and rural birds to this point. It was discovered that the differentially expressed genes were involved in DNA methylation, innate and adaptive immunological responses, DNA repair, heavy metal detoxification, and fat metabolism. Furthermore, DNA methylation patterns across urban and rural populations varied dramatically between two species of the well-known Darwin's finches, Geospiza sp. Although the functional importance of these mechanistic variations is still unknown, it is encouraging to discover variation in this area because it indicates that animals can adapt quickly to urbanization.

Movement Obstacles Caused by the Urban Environment

For a population to diverge genetically, it must be reproductively isolated from other populations of the same species. Urban settings were not previously thought to be a barrier for nomadic species like birds.

However, it has been shown that species with sedentary habits or restricted vagility—the capacity to move freely and migrate—are particularly vulnerable to habitat loss brought on by intensifying urbanization or urban sprawl. Therefore, populations get imprisoned. Indeed, research on relatively sedentary species like the Wrentit Chamaea fasciata has revealed significant genetic differences between urban and rural populations. But even the more mobile Song Sparrow Melospiza melodia exhibits a small (but considerable) difference. The degree of genetic structure is also correlated with the nature of cities and the level of urbanization (habitat fragmentation), in addition to dispersal capacity. The Great Tit, a species that is largely sedentary, has had varying degrees of success in various places.

The study may potentially show signs of selection on certain genomic areas, indicating that the urban environment does exert selective pressure on this widespread European species. Additionally, a small or big initial gene pool might serve as the foundation for the growth of a newly colonized metropolitan population. The founder effect, which causes fast population divergence, can occur if the urban population begins to expand from a small number of individuals who are extremely different from the surrounding populations. Urban environments may draw a particular type of people, such as those who are bolder and more explorative.

When compared to rural birds, the urban (from Barcelona) Great Tits exhibit the highest expression of genes linked to exploring activities. Therefore, genetic divergence as well as genetic diversity loss might occur more quickly as a result of the colonization of urban settings by a certain type of person as opposed to a trapped subset of the population. A popular method for determining the intensity of a genetic barrier is to study genetic diversity. It is hypothesized that isolated populations and populations exhibiting founder effects will have less genetic diversity than their conspecifics. In fact, this has been demonstrated in urban populations of several species, including

Instead of a single colonization event followed by local adaptation and dispersal (a leapfrog colonization model), the pattern of the genetic signals in the Blackbird study revealed that this species has colonized urban areas more than once (i.e., numerous independent founder effects). Genetic diversity is important since it can have a variety of detrimental effects. One illustration is the detrimental impact of inbreeding, which raises the risk of genetic illnesses and abnormalities. Populations with low genetic diversity are therefore more vulnerable to environmental changes since there is less variation for natural selection to operate on. It's interesting to note that the genetic diversity in the two Great Tit populations from Barcelona and Montpellier had different outcomes. In comparison to their respective rural populations, the genetic diversity of city birds was higher in Barcelona and lower in Montpellier, indicating that the population dynamics of this species differ in these two European cities.

In-City Drivers

Chemical pollution, noise, artificial light at night (ALAN), and human presence are at least four drivers (or environmental stress factors) that are specifically associated with urbanization and are common across all geographical zones. These four elements have prompted scientists to hypothesize that the selection pressures that metropolitan environments may impose are largely uniform.

Traffic creates the chemical pollutants that are common to metropolitan environments; the combustion of fossil fuels results in particularly high quantities of nitrogen oxides (NOx) and soot. These contaminants are particularly prevalent in many Chinese cities. However, the pollution levels in a typical Swedish city, which is located in a considerably less populous area, are also high enough to negatively affect both humans and birds. There are also numerous urban places that are heavily polluted with heavy metals; nevertheless, the differences between urban and rural sites in heavy metal pollution appear to be very variable, depending on local industry and history. For instance, in India, many of the polluting industries, such as those that manufacture metal and tan leather, are situated in rural regions, hence there are no variations in the incorporation of heavy metals into feathers between urban and rural inhabitants.

Therefore, compared to NOx and soot exposure, urban exposure to heavy metals is less closely connected to level of urbanization. In a city, it can be challenging to locate a quiet area. Constantly, airplanes take off, automobiles honk, sirens sound, and construction labor hammers away. Urban noise pollution is the collective term for this. Depending on the noise's volume, repetition rate, consistency, and duration, birds will react differently. Darkness is also uncommon in urban areas. The globe's illuminated urban hotspots are vividly visible in satellite photos taken at night. On the map, littoral hotspots include Europe, the United States (mid- to eastern sections), and Asia, particularly Japan and India. By contrast, northern South America, central Africa, Russia, and Australia still have very low levels of pollution. In addition to the phenotypic alterations that will be illustrated below, all three types of pollution—chemical, noise, and light—are associated with costs to an organism's health, reproduction, and/or survival.

The existence of people is the final urban general driver. Because they frequently contact with and are exposed to humans, urban birds must learn to deal with the threat that humans offer to them. Birds are likely to become anxious when they see people, especially during the breeding season. According on species, human

behaviors toward birds are also likely to vary. For instance, whereas larger species are fiercely scared away and even hunted in cities, smaller species are typically accepted to stay close. Additionally, human behavior toward birds depends on the situation; for instance, when actively feeding them,we want them close by, but when dining outside, we do not.

II. Discussion

In addition to the forces indicated above, a few more elements have been highlighted, including food quantity, infections, and predation. In contrast to the aforementioned factors, these appear to be more influenced by local conditions, geography, and culture. For instance, there are significant regional differences in the availability of food for urban birds. In western nations, supplemental bird feeding is highly frequent, whereas it is largely missing in eastern nations. As a result, urban birds in the west appear to have an abundance of food, whereas urban birds in the east may not (at least not from intentional feeding). Additionally, individuals in sparsely populated farmlands can significantly increase bird populations; as a result, food access is not necessarily directly correlated with urbanization. However, it is also expected that lower food diversity (such as in terms of grain and bug species) and inferior food quality from both anthropogenic and natural sources will apply to all cities. Pathogen diversity and abundance exhibit significant geographic heterogeneity, even within and between cities in the same region.

The two key factors influencing pathogen variety and abundance in the city are the climate and the existence of water bodies. However, due to larger bird concentrations and bird gatherings at feeding tables, disease transmission may be more rapid in urban locations.

Depending on the qualities of the city and the location, the pressure from predators may decrease or grow. One the one hand, compared to natural nonurban regions, urban areas are likely to have less natural predators (such as large mammals and raptors). On the other side, feral cats, American minks, and corvids are more prevalent. Likewise, many smaller raptors thrive in urban environments today, including Peregrine Falcons and Lesser Kestrels (Falco naumanni). Additionally, the presence of constructed nests appears to draw predators to urban locations substantially more than to rural ones. However, it was discovered through a comparison study of several urban species that the feathers of urban birds were harder to pluck (i.e., an anti-predation response), which was explained by lower natural selection pressures brought on by predation in urban habitats. Although the presence of these final three variables varies significantly between cities, they are probably important contributors to population-level alterations in phenotypic features.

Phenotypic Responses and Changes Caused by Urban Life

We do not plan to discuss all phenotypic variations or drivers. In reality, it is frequently unknown or challenging to isolate a specific driver from the vast pool of potential urban variables responsible for a phenotypic alteration. As a result, rather than focusing on specific factors, many studies of phenotypic alterations link urbanization in general. Both population-level genetic pool changes and an individual's "nongenetic" reactions (phenotypic plasticity) may contribute to the observed phenotypic alterations. It should be highlighted that these two sources of variance at the population level are not antagonistic. In reality, a genetic alteration can result in a shift in phenotypic plasticity, and shifts in phenotypic plasticity might result in a new phenotype that will be subject to sexual and natural selection, altering the genetic makeup of future generations.

III. Conclusion

The avifauna has undergone enormous alteration as a result of urbanization. In response to urbanization, species have fled, disappeared, flourished, and transformed. It is obvious that urbanization poses a serious threat to biodiversity and the continued existence of many bird species, and it is not anticipated that urbanization will slow down any time soon, quite the contrary. Therefore, city planners and conservationists have a significant task ahead of them. If the urban green space areas are managed well through the planting of native flora and increased complexity, and if they improve the urban green space or prevent construction in important locations, their efforts could really have significant positive effects on the bird community. Many legislative measures are being made to lessen the effects of the various pollution sources, such as the use of electric vehicles and LED lights that can be dimmed or turned off during sensitive times, which will likely also have a favorable impact on species that live in cities. There is still much to learn about the adaptability of urban bird species to urbanization and how flexible these species may be in their stress resistance responses to a variety of stressors before they cross a threshold and experience a population crash. Future research will look at whether urbanization offers a chance for species radiation or if it will continue to be a place where species are eliminated and bred to be the same.

References

[1]. Andersson MN, Wang H-L, Nord A et al (2015) Composition of physiologically important fatty acids in great tits differs between urban and rural populations on a seasonal basis. Front Ecol Evol 3:93. https://doi.org/10.3389/fevo.2015.00093

[2]. Aronson MFJ, La Sorte FA, Nilon CH et al (2014) A global analysis of the impacts of urbanization on bird and plant diversity reveals key anthropogenic drivers. Proc R Soc Lond B 281:20133330. https://doi.org/10.1098/rspb.2013.3330

[3]. Audet J-N, Ducatez S, Lefebvre L (2016) The town bird and the country bird: problem solving and immunocompetence vary with urbanization. Behav Ecol 27:637–644. https://doi.org/10.1093/beheco/arv201

[4]. Badyaev AV, Young RL, Oh KP et al (2008) Evolution on a local scale: developmental, functional, and genetic bases of divergence in bill form and associated changes in song structure between adjacent habitats. Evolution 62:1951–1964. https://doi.org/10.1111/j.1558-5646.2008.00428.x

[5]. Binkowski LJ, Meissner W (2013) Levels of metals in blood samples from Mallards (Anas platyrhynchos) from urban areas in Poland. Environ Pollut 178:336–342

[6]. Björklund M, Ruiz I, Senar JC (2010) Genetic differentiation in the urban habitat: the great tits (Parus major) of the parks of Barcelona city. Biol J Linn Soc 99:9–19. https://doi.org/10.1111/j. 1095-8312.2009.01335.

[7]. Blair RB (1996) Land use and avian species diversity along an urban gradient. Ecol Appl 6:506–519. https://doi.org/10.2307/2269387

[8]. Bonier F (2012) Hormones in the city: endocrine ecology of urban birds. Horm Behav 61:763–772. https://doi.org/10.1016/j.yhbeh.2012.03.016

[9]. Bonnington C, Gaston KJ, Evans KL (2015) Ecological traps and behavioural adjustments of urban songbirds to fine-scale spatial variation in predator activity. Anim Conserv 18:529–538. https://doi.org/10.1111/acv.12206

[10]. Boonekamp JJ, Bauch C, Mulder E et al (2017) Does oxidative stress shorten telomeres? Biol Lett 13:20170164. https://doi.org/10.1098/rsbl.2017.0164

[11]. Bosse M, Spurgin LG, Laine VN et al (2017) Recent natural selection causes adaptive evolution of an avian polygenic trait. Science 358:365–368. https://doi.org/10.1126/science.aal3298

[12]. Chace JF, Walsh JJ (2006) Urban effects on native avifauna: a review. Landsc Urban Plan 74:46–69. https://doi.org/10.1016/j.landurbplan.2004.08.007

[13]. Chamberlain DE, Gough S, Vaughan H et al (2007) Determinants of bird species richness in public green spaces. Bird Study 54:87–97. https://doi.org/10.1080/00063650709461460

[14]. Chamberlain DE, Cannon AR, Toms MP et al (2009) Avian productivity in urban landscapes: a review and meta-analysis. Ibis 151:1–18. https://doi.org/10.1111/j.1474-919X.2008.00899.

[15]. Charmantier A, Demeyrier V, Lambrechts M et al (2017) Urbanization is associated with divergence in pace-of-life in great tits. Front Ecol Evol 5:53. https://doi.org/10.3389/fevo.2017.

[16]. Clergeau P, Croci S, Jokimäki J et al (2006) Avifauna homogenization by urbanization. Analysis at different European latitudes. Biol Conserv 127:336–344. https://doi.org/10.1016/j.biocon.2005.

[17]. Delaney KS (2014) Landscape genetics of urban bird populations. In: Gil D, Brumm H (eds) Avian urban ecology. Oxford University Press, Oxford, pp 143–154

[18]. Delaney KS, Riley SPD, Fisher RN (2010) A rapid, strong, and convergent genetic response to urban habitat fragmentation in four divergent and widespread vertebrates. PLoS One 5:e12767. https://doi.org/10.1371/journal.pone.0012767

[19]. Evans KL, Gaston KJ, Sharp SP et al (2009b) Effects of urbanisation on disease prevalence and age structure in blackbird Turdus merula populations. Oikos 118:774–782. https://doi.org/10.1111/j.1600-0706.2008.17226.

[20]. Grimm NB, Faeth SH, Golubiewski NE et al (2008) Global change and the ecology of cities. Science 319:756–760

[21]. org/10.1007/s00442-013-2663-2Manjula M, Mohanraj R, Devi MP (2015) Biomonitoring of heavy metals in feathers of eleven common bird species in urban and rural environments of Tiruchirappalli, India. Environ Monit Assess 187:267. https://doi.org/10.1007/s10661-015-4502-

[22]. McKinney ML (2002) Urbanization, biodiversity, and conservation. Bioscience 52:883–890. https://doi.org/10.1641/0006-3568(2002)052[0883:ubac]2.0.co;2

[23]. Møller AP, Tryjanowski P, Díaz M et al (2015) Urban habitats and feeders both contribute to flight initiation distance reduction in birds. Behav Ecol 26:861–865. https://doi.org/10.1093/beheco/arv024