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Abstract: Worldwide, urbanization is recognized as a leading cause of species extinction because of its role in rapid and permanent habitat loss and fragmentation. This study investigates how habitat fragmentation caused by urbanization and transportation corridors affects the movements—and ultimately, the occurrence—of songbirds within a human-impacted landscape.

In spring and summer 2005, I used audio playbacks to measure the willingness of birds to cross small-scale features such as roads, railways, rivers, and transportation bridges over riparian corridors within the urban landscape of Calgary, Alberta, Canada. Preliminary results indicate a negative correlation between the likelihood of forest-dependent birds crossing roads, rivers, and bridges over riparian corridors and the width of the gap in vegetation associated with these features. In contrast, railways appeared to be highly permeable for forest birds, probably due to their relatively narrow width.

This study is still in its earliest stages. Subsequent phases of the project include: (1) using translocations to measure the permeability of larger-scale elements of the landscape such as freeways and neighbourhoods of various ages and densities, (2) developing individual-based, spatially explicit models aimed at depicting functional landscape connectivity among the city's natural areas, and (3) exploring the relationship between landscape connectivity and bird species occurrence within these natural areas.

Background and Purpose

In fragmented landscapes, biodiversity is often dependent on habitat connectivity because without it, the exchange of genes and individuals is constrained and small, isolated populations become at greater of risk of extinction (Soule 1986). Movement is a process of central importance to the persistence of species in fragmented landscapes because it underlies dispersal and colonization (Belisle and Desrochers 2002).

In the past decade, a limited number of studies have attempted to elucidate the effects of linear features and gaps between habitat patches on the movement of birds. Taped playbacks of mobbing calls have been successfully used to lure birds across selected small-scale features such as roads or meadows (Rail et al. 1997, Desrochers and Hannon 1998, St. Clair et al. 1998, Belisle and Desrochers 2002, St. Clair 2003). In larger-scale experiments, territorial birds have been translocated and their return trip documented (Belisle and St. Clair 2001). Both playback and translocation techniques have made it possible to standardize the motivation of birds to cross different landscape elements so that their permeability can be quantified and compared.

The primary purpose of this research project is to investigate how habitat fragmentation caused by urbanization and transportation corridors affects the movements—and ultimately, the occurrence—of songbirds within a human-impacted landscape. The study is being carried out in Calgary, Canada's fastest growing city.

Methods

I used an audio recording of a Black-capped Chickadee (*Poecile atricapillus*) and a Red-breasted Nuthatch (*Sitta canadensis*) to lure birds across selected small-scale features of the urban landscape and thus assess their willingness to cross these features. Each trial involved attracting birds to an origin speaker and then to a destination speaker located on either side of a potential barrier. Immediately upon turning the origin tape off, the destination tape was turned on and the response of each bird noted. A response was considered positive if a bird moved from the origin to the destination within six minutes from the time the destination tape was turned on.

This year's playback experiments, conducted from May 2 to August 26, 2005, focused on four features: (1) roads of varying widths and traffic volumes, (2) railways (including transit lines), (3) transportation bridges over riparian corridors, and (4) rivers. Each trial across a feature was paired with a control trial conducted in similar habitat conditions, but in continuous forest cover.

Preliminary Results

Only data collected during the breeding season (May 2 to June 15, 2005) have been analyzed thus far. During this time, a total of 325 birds responded to playback experiments in 103 separate trials. Black-capped Chickadees were the most common species to respond, representing 63% of the total responses. Only chickadees and nuthatches were included in the analyses, as they were the only family groups represented by a sample size of at least 25 individuals. Logistic regression showed that the probability of chickadees and nuthatches crossing roads quickly decreased as the trial distance exceeded 30 m. At 50 m, these birds were 60% less likely to cross roads than they were to travel through continuous forest. At 80 m, this difference increased to 80%.

A similar, but slightly less pronounced, pattern was found for bridges over riparian corridors and rivers. In contrast, chickadees and nuthatches were equally as likely to move across railways as they were through continuous forest.

Discussion

These preliminary results suggest that gap width is one of the most important factors affecting the willingness of forest-dependent birds to cross features in the urban context. For most features, as the gap in vegetation increased, the likelihood of a positive response decreased. The high permeability of railways was likely due to their narrow width, which resulted in a vegetation gap of less than 20 m.

Vegetation height also appeared to be a key factor affecting movement, particularly in relation to bridges and roads. The presence of tall trees on either side of a bridge appeared to facilitate movement as birds typically attempted to cross over the structure, from treetop to treetop. Chickadees and nuthatches almost never flew under a bridge. Tall trees on either side of busy roads also appeared to make it easier for these birds to cross above moving traffic.

Next Steps

In the next several months, I will conduct multivariate analyses to better elucidate the factors affecting the permeability of urban features to the movements of forest-dependent songbirds. I will then compare the breeding-season playback data to more recently collected post-fledging data to examine seasonal differences in movement behavior. Playback experiments will also be conducted in winter 2006 to further explore seasonal-movement patterns.

Because the spatial scale of playback experiments is constrained by the distance at which sound will carry, starting in spring 2006 I will use translocations to assess the permeability of larger landscape features such as freeways or residential neighborhoods of different ages and densities. Each translocation experiment will consist of capturing a territorial male bird in a mist net, moving it a distance of 200 m to 2 km and documenting its return trip to its home territory. Using these empirical data, I will then determine functional landscape connectivity among natural areas through the use of individual-based movement modeling within a GIS environment.

A final component of the project will be to examine the relationship between functional landscape connectivity and species occurrence. To this end, breeding bird surveys are being conducted over multiple years to determine the presence or abundance of bird species within selected natural areas. Through regression analysis, I will then explore how functional connectivity and patch-specific attributes (such as area and habitat quality) affect the composition of songbird communities within the city's natural areas.

Significance

Through the use of playbacks and translocations this study will provide novel, empirically-based information on the permeability of urban-landscape elements (including transportation corridors) to the movement of birds. Anticipated applications of the study's results include the development of guidelines aimed at facilitating the movements of songbirds across transportation corridors and urban areas, as well as the identification of priorities for restoration or preservation of habitats important to the movements of songbirds.

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Biographical Sketch: Marie holds a master's degree in environmental design (environmental science) from the University of Calgary, in addition to undergraduate degrees in education and engineering. In fall 2004, she undertook a Ph.D. in ecology at the University of Alberta. Her research focuses on the movements of songbirds in the urban landscape of Calgary, Alberta and is supported by several prestigious scholarships including a National Science and Engineering Research Council Postgraduate Scholarship and an Alberta Ingenuity Studentship Award.

Marie has over 11 years of teaching experience, including almost five years as an instructor of biology, ecology, environmental science, physical geography, and geology at Mount Royal College and the University of Lethbridge. She has also worked part-time as a wildlife consultant over the past several years, focusing on the effects of human activities and facilities on the movements of wildlife. Her most important contributions include modeling wildlife-movement corridors for elk, bighorn sheep and grizzly bears in the Radium Hot Springs area in southeastern British Columbia (her master's work), and developing a management strategy aimed at facilitating movements of large- to mid-sized mammals in the Lake Louise area in Banff National Park. Most recently, in 2004 she co-authored a report addressing the effects of exclusionary fencing on the movements of mammals in the Lake Louise area of Banff National Park, Alberta.

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