Landscape and Urban Planning 122 (2014) 29–40

Contents lists available at ScienceDirect

Landscape and Urban Planning

journal homepage: www.elsevier.com/locate/landurbplan

Research Paper

# Using urban forest assessment tools to model bird habitat potential

Susannah B. Lerman[a,b,*], Keith H. Nislow[a], David J. Nowak[c], Stephen DeStefano[d], David I. King[a], D. Todd Jones-Farrand[e]

[a] Northern Research Station, USDA Forest Service, Amherst, MA, USA
[b] Department of Environmental Conservation, University of Massachusetts, Amherst, MA, USA
[c] Northern Research Station, USDA Forest Service, Syracuse, NY, USA
[d] U.S. Geological Survey, Massachusetts Cooperative Fish and Wildlife Research Unit, University of Massachusetts, Amherst, MA, USA
[e] Central Hardwoods Joint Venture, US Fish & Wildlife Service, Columbia, MO, USA

## HIGHLIGHTS

- The i-Tree wildlife tool assesses the bird habitat potential within the urban forest.
- The i-Tree wildlife tool evaluates habitat improvement plans.
- The i-Tree wildlife tool provides detailed information of habitat requirements.

## ARTICLE INFO

*Article history:*
Received 4 January 2013
Received in revised form 23 October 2013
Accepted 24 October 2013
Available online 3 December 2013

*Keywords:*
Habitat models
Urban biodiversity
i-Tree
Management
Suitability index

## ABSTRACT

The alteration of forest cover and the replacement of native vegetation with buildings, roads, exotic vegetation, and other urban features pose one of the greatest threats to global biodiversity. As more land becomes slated for urban development, identifying effective urban forest wildlife management tools becomes paramount to ensure the urban forest provides habitat to sustain bird and other wildlife populations. The primary goal of this study was to integrate wildlife suitability indices to an existing national urban forest assessment tool, i-Tree. We quantified available habitat characteristics of urban forests for ten northeastern U.S. cities, and summarized bird habitat relationships from the literature in terms of variables that were represented in the i-Tree datasets. With these data, we generated habitat suitability equations for nine bird species representing a range of life history traits and conservation status that predicts the habitat suitability based on i-Tree data. We applied these equations to the urban forest datasets to calculate the overall habitat suitability for each city and the habitat suitability for different types of land-use (e.g., residential, commercial, parkland) for each bird species. The proposed habitat models will help guide wildlife managers, urban planners, and landscape designers who require specific information such as desirable habitat conditions within an urban management project to help improve the suitability of urban forests for birds.



## 1. Introduction

The modification and destruction of wildlife habitat within urban areas via the replacement of forest cover and native vegetation with lawns, buildings, roads, and other impervious surfaces poses one of the greatest threats to bird populations on a global scale (Czech, Krausman, & Devers, 2000). Replacing native vegetation with ornamentals is one of the forms that habitat alterations take in the urban environment, and these esthetically pleasing landscapes are often at odds with ecological function (Lerman, Turner, & Bang, 2012). Thus, wildlife management tools aimed at assessing and improving urban habitat have an important role to play in reversing the loss of urban biodiversity.

Urban and community areas in the conterminous United States on average have 35% tree cover (Nowak & Greenfield, 2012), though the resulting urban landscape is a mix of contiguous (e.g., forest stands in parks or vacant areas) and fragmented (e.g., isolated trees along streets and in private yards) cover. Over the next 50 years, it is estimated that 118,300 km$^2$ of forested lands in the US will be consumed by urbanization (Nowak & Walton, 2005). Nonetheless, the urban forest provides essential ecosystem services that sustain environmental quality and human health (Nowak & Walton,

* Corresponding author at: Northern Research Station, USDA Forest Service and Department of Environmental Conservation, 160 Holdsworth Way, University of Massachusetts, Amherst, MA 01354, USA. Tel.: +1 413 545 5447.
*E-mail addresses:* slerman@cns.umass.edu (S.B. Lerman), knislow@fs.fed.us (K.H. Nislow), dnowak@fs.fed.us (D.J. Nowak), sdestef@eco.umass.edu (S. DeStefano), dking@fs.fed.us (D.I. King), david.jones-farrand@fws.gov (D.T. Jones-Farrand).

0169-2046/$ – see front matter © 2013 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.landurbplan.2013.10.006

2005). In particular, trees and other urban vegetation help mitigate the urban heat island effect through evapotranspiration and by providing shade, and they reduce air pollution through carbon sequestration (Akbari, Pomerantz, & Taha, 2001). Furthermore, the urban forest provides wildlife habitat resources including food, and nest and roosting sites for birds, mammals, and insects. And finally, the urban forest provides opportunities for urbanites to connect with the natural world (Miller, 2005). Currently we lack methods for a rapid assessment of the habitat potential of the urban forest (Shanahan, Possingham, & Martin, 2011). Therefore designing effective urban habitat assessment tools that can assist with the reconciliation between urban development and wildlife habitat becomes paramount to ensure that conservation efforts and plans for enhancing and protecting the urban forest will lead to sustainable bird and other desirable wildlife populations.

Few North American federal and Non-governmental Organization (NGO) programs have targeted improvement plans in urban habitats. The North American Landbird Conservation Plan (NALCP; Rich et al., 2004) aims to create and conserve landscapes that sustain bird populations. The NALCP calls for a thorough examination into how birds respond to and tolerate different land uses, including suburban areas, and recognizes the imminent threat of urbanization to most of the primary bird habitats in North America. Other than encouraging bird-friendly urban planning, the NALCP primarily characterizes urban areas as a threat to bird populations on a national scale without acknowledging the many opportunities for promoting conservation initiatives in urban and suburban landscapes (Goddard, Dougill, & Benton, 2010). The U.S. Fish and Wildlife Service's Urban Bird Treaty program (U.S. Fish and Wildlife Service, 2012) provides competitive challenge grants to individual cities for promoting education, hazard reduction, and habitat improvement projects aimed at supporting native urban bird populations. The National Wildlife Federation and the National Audubon Society have programs aimed at creating and certifying wildlife habitats in residential gardens and schoolyards with their respective Certified Wildlife Habitat and Healthy Yards programs. Although effective and innovative at the site level, these programs do not include management or monitoring programs for urban bird populations at regional scales. Recently Partners in Flight (PIF; an international cooperative effort that partners federal, state and local government agencies, NGOs, academia, and private landowners to conserve species at risk) recognized the extent of urban areas and the negative impact of urbanization on bird populations (Berlanga et al., 2010), though currently, PIF does not focus efforts toward conserving or enhancing urban habitats (Watts, 1999).

Scientists have studied urban bird populations since the 1970s (e.g., Emlen, 1974), however, our understanding of urban habitat and bird relationships trails behind that of habitat relationships in wildlands, thus hindering effective regional conservation plans aimed at improving bird habitat within the urban forest. Studying bird habitat relationships date back to the early 1900s (e.g., Adams, 1935; Grinnell, 1917; Lack, 1933). This research and other seminal works provided the foundation for understanding the habitat requirements for sustaining bird populations and have guided conservation planning, such as the NALCP (Fitzgerald et al., 2009). To date, the majority of urban bird studies conduct a bird monitoring protocol to document distribution patterns, measure habitat features at local and landscape scales, and design statistical models to identify the habitat features that relate to and influence patterns of bird abundance (Chace & Walsh, 2006). In addition, many urban bird studies correlate bird distribution with habitat features measured along an urban to rural gradient, within different land-use categories, or between urban and wildland sites (Beissinger & Osborne, 1982; Blair, 1996; Clergeau, Savard, Mennechez, & Falardeau, 1998; Croci, Butet, & Clergeau, 2008; Crooks, Suarez, & Bolger, 2004; DeGraaf & Wentworth, 1986; Emlen, 1974; Gering & Blair, 1999; Lerman & Warren, 2011; Melles, 2005). Additional variables identified as important in influencing urban bird populations include household density, human activities, and socio-economics (Fernandez-Juricic, 2000; Kinzig, Warren, Martin, Hope, & Katti, 2005; Lerman & Warren, 2011; Strohbach, Haase, & Kabisch, 2009).

Although these and other studies provide a solid foundation for understanding how birds respond to conditions within a particular city, they lack a means for non-specialists to apply these findings to conservation planning and management. In an effort to provide such tools, Tirpak and colleagues and Jones-Farrand and colleagues modeled how patch and landscape habitat features influence suitability for birds at an ecoregional scale (Tirpak, Jones-Farrand, Thompson, Twedt, & Uihlein, 2009; Jones-Farrand et al., 2011). Using the USDA Forest Service national forest census program Forest Inventory and Analysis (FIA) datasets, they described the forest structure and composition in the central and south-central U.S. and constructed Habitat Suitability Index (HSI) models that quantitatively relate forest characteristics to the abundance of forty bird species of conservation concern. They validated the models with Breeding Bird Survey data by testing whether the predicted suitability of landscapes based on the FIA and other data accorded with presence and relative abundance of a particular species (Tirpak, Jones-Farrand, Thompson, Twedt, Baxter, et al., 2009). These models have tremendous management potential in that they can assess the suitability at an ecoregional scale by leveraging existing forest and bird monitoring programs. Further, they assess habitat in terms of manageable characteristics such that they can be used to guide management prescriptions and predict the response of birds to various management scenarios.

Here we introduce the approach of integrating two existing bird habitat models (e.g., Tirpak, Jones-Farrand, Thompson, Twedt, Baxter, et al., 2009) and developing seven new models using the same model building procedure, and integrate these models into an urban forest assessment tool to evaluate the potential of the urban forest for supporting breeding bird populations, while also providing a platform for generating habitat improvement plans. This study aims to describe and validate the habitat models, and to demonstrate their applicability for improving urban bird diversity. Specifically we (1) identified the vegetation composition, configuration, and landscape features associated with the presence of a suite of representative bird species based on an extensive literature review, (2) quantified the characteristics of urban forests in ten northeastern cities using datasets from the i-Tree urban forest assessment program (Nowak et al., 2008), (3) modeled the habitat suitability for the representative bird species in urban forest monitoring plots, validated the models, and compared habitat suitability among ten cities and different land uses, and (4) tested whether habitat suitability changed over time for two cities for which we had habitat data for two points in time.

## 2. Methods

### 2.1. Study area

This study assesses the habitat potential for ten northeastern U.S. cities (Baltimore, MD, Boston, MA, Jersey City, NJ, Moorestown, NJ, New York, NY, Philadelphia, PA, Scranton, PA, Syracuse, NY, Washington D.C., and Woodbridge, NJ). These cities were selected because they had available urban forest data from i-Tree, and had a wide range of population sizes (19,000 – 8.4 million). Cities ranged from small municipalities such as Moorestown, NJ to large metropolitan areas such as Boston and Philadelphia, and thus were representative of urban areas in the region.