

Title: Influences of habitat fragmentation and hurricane damage on wintering songbirds in Belize

Abstract: Many Nearctic-Neotropic migrant songbirds are experiencing long-term population declines in North America. These declines have been associated with habitat fragmentation on both the breeding and wintering grounds. However, landscape-level responses to habitat fragmentation by migratory songbirds during the winter period are not as thoroughly understood. In addition, research linking the landscape level to responses other than species richness or abundance is relatively rare and nearly nonexistent during winter. To accomplish this goal, I conducted point counts in forested habitats affected by fragmentation (i.e., orange-grove development, residential development) and natural heterogeneity (i.e., low-intensity hurricane damage, high-intensity hurricane damage, and riparian openings) in central Belize to survey total abundance, individual abundance, and species richness of migratory songbirds. Both richness and total abundance were highest in riparian habitat, followed by residential openings. In addition, 12 species responded to habitat differences, with most species more abundant at either residential sites (e.g., Hooded Warbler) or riparian (river) openings (e.g., Baltimore Oriole). Only one species, the Orchard Oriole, showed significant differences between survey years; it was not detected during the 2013 season. Information from this study will be valuable to elucidate differences among species and habitats for migrants during winter to help in overall conservation of songbirds. Specifically, future work will also explore foraging behavior of migrants could help conservation biologists quantify overall habitat quality as it affects population declines of migratory songbirds.

Background

Habitat fragmentation has been studied primarily during the breeding season, even though impacts on the wintering grounds may be more substantial; Sherry and Holmes (1996) have called for research in different habitats in the tropics to better understand Nearctic-Neotropic migratory songbirds. Habitat fragmentation has been implicated in population declines of migratory songbirds and determining causes of these declines is an ongoing goal of conservation biologists. Habitat fragmentation at a landscape scale has not been emphasized in analyses of wintering migrants; however, this analysis may add a considerable level of explanation that has eluded researchers in the conservation of northeastern songbirds.

In the central Cayo District of Belize, habitat fragmentation takes the form of residential (especially lodge) development, agricultural development, and orange-grove establishment. Habitat fragmentation may contrast sharply with habitat heterogeneity, the natural habitat variation found in a region. In Belize, tree-fall gaps and riverine openings form a habitat mosaic, with variation from large-scale disturbance. Specifically, Hurricane Richard struck Belize during November 2010, creating swaths of downed overstory trees and lush regrowth. Despite the interplay of habitats from hurricane damage, research has focused on immediate impacts on bird communities (e.g., Johnson and Winker 2010). In contrast, my research will compare habitat use by birds in sites that are fragmented and heterogeneous, particularly focusing on habitat structural damage in an area that has relatively high biodiversity potential in Belize (Fig. 1).

In addition to habitat use, foraging behavior is a good index to evaluate effects of fragmentation compared to habitat heterogeneity, because it may reflect levels of food available for an insectivorous songbird (Graber and Graber 1983). Higher rates of attacks on insect prey have a positive correlation with higher prey density (Lyons 2005), and attack rates along with insectivore density indicate optimal habitat (Wolda 1990). Wintering warblers may exhibit strong levels of intraspecific competition which may limit populations (Sherry and Holmes 1996); this competition would be evidenced in differences in foraging behavior, in addition to differences in abundance at these sites. Furthermore, wintering migrant abundance in the tropics tracked arthropod prey abundance well in diverse habitats and may serve as an index to habitat quality (Johnson and Sherry 2001).

Objectives: My objectives for this project were to: 1) determine relative abundance of specific migratory songbirds at sites that have been fragmented (lowland tropical forest adjacent to orange groves and residential development) or that exhibit natural heterogeneity (low-intensity and high-intensity hurricane damage and riparian openings) during winter 2012-2013 in Belize; 2) compare foraging behavior of abundant insectivorous warbler species (American Redstart, Black-and-White Warbler, Black-throated Green Warbler, Chestnut-sided Warbler, Hooded Warbler, Magnolia Warbler, Wilson's Warbler); and 3) determine the relative influence of different landscape and site characteristics as they influence songbird abundance and foraging success. These focal species were selected because they are abundant in Belize during winter, they are typically conspicuous foragers and flock members, and their populations are exhibiting different trends in New England (Sauer et al. 2014).

Progress

Avian surveys – With generous funding from the Nuttall Ornithological Club, we completed our second field season from 27 December 2012-15 January, following the same methods as the previous year. A 30-m fixed-radius point count was used to survey songbirds. My students and I visited each point three times, recording all migratory songbirds seen or heard during 5 minutes. For every observation, we recorded species, type of observation (singing, calling, or visual), presence of a mixed foraging flock, vertical height, and location within forest structure. Observations began at sunrise and concluded 4 hours later.

Vegetation and Landscape Analyses – During this visit, we completed vegetation analysis at all 35 survey points. Vegetation variables have not yet been compared to bird survey data; however, after we complete landscape analysis (see below), we will work on this statistical comparison. We attempted to collect landscape data upon our return from available online land cover maps, but Belize does not have fine-scale supportive GIS data available at present.

Preliminary Results

We recorded an average of 3.9 species at all sites combined, with an average of 6.1 individuals per site. We found a total of 215 individuals and 22 species of migrants during 2013. During the second field season, the most abundant species were Hooded Warbler (38 individuals), Magnolia Warbler (33 individuals), and American Redstart (20 individuals). Both abundance and richness were highest in river and residential sites, with the second year following the pattern identified the first year nearly exactly (Fig. 2), illustrating the value of a second year of data to corroborate patterns. In total, 12 species were differentially detected in habitats, whereas only one species (Orchard Oriole) differed by year (more abundant during 2012 and not detected during 2013). In particular, Black-and-white Warbler, Chestnut-sided Warbler, and Hooded Warbler were most abundant in residential habitat (Fig. 3), whereas nine species, including Yellow Warbler, Gray Catbird, and Baltimore Oriole, were more commonly found in riparian habitat (Fig. 4).

Products

Even though this project is not fully complete and the data are not thoroughly analyzed, I have already presented this research at multiple conferences and at three invited talks. In addition, I anticipate at least two papers coming from this research. After completing data collection and

analysis during spring 2017, I will begin preparing a manuscript on the main project for submission to the Wilson Journal of Ornithology or Condor. I also intend to publish a second paper on foraging behavior in either Journal of Field Ornithology or Caribbean Naturalist. The Nuttall Ornithological Club will be mentioned prominently in the acknowledgement section of these papers.

Future Research

Foraging behavior – I will be returning to Belize during 20 February – 5 March 2017 to finalize all data collection for this project. I had anticipated conducting foraging behavior and analysis to finish data collection during the 2013 field season. However, students were not as adept at collecting these data as I had anticipated, and I elected to have them help with bird surveys and vegetation data collection instead. So overall, the number of birds that were followed for behavioral analysis was not as high as I wished, and another field season will be required. Behavioral characteristics will include: 1) successful or unsuccessful attack; 2) foraging method (i.e., foliage gleaning, bark gleaning, or aerial attack); 3) relative prey size; 4) foraging substrate; 5) number of hops on one branch; 6) number of flights between branches; 7) number of vocalizations; and 8) number of individuals within the flock.

Landscape analysis – With limited fine-scale satellite imagery of Belize to use in GIS analyses, to complete this project, I will also take my Unmanned Aerial Vehicle (Phantom 4 Drone) to Belize during 2017 to take aerial images of the sites. Images will be collected and analyzed using Pix4D software to establish location of hurricane damage and extent of forest cover and fragmentation. Students will then help me to analyze these data using GIS software.

Statistical Analysis – The last component of this project that I will complete during 2017 is statistical analysis using software programs Minitab and R. I intend to fully analyze the vegetation and landscape measures that affect both bird variables and behavior variables. Given the trends I've already identified in this project, I anticipate publishing this work immediately.

Significance

Results from this study will provide a measure of habitat quality for migrating birds in different landscapes. With persistent and growing fragmentation through residential and agricultural development in Belize, birds will continue to be influenced by human impacts. This research

considers bird responses at multiple scales (habitat and landscape) and at a variety of levels (richness, abundance, and behavior) during an under-represented season. Flather and Sauer (1996) noted that Nearctic-Neotropical migrants are more sensitive to habitat fragmentation than other migratory guilds during the breeding season, which is suggestive that this group may also respond to fragmentation during other seasons. The comparison to natural heterogeneity will allow me to understand this more nuanced perspective for a group that is experiencing population declines.

References

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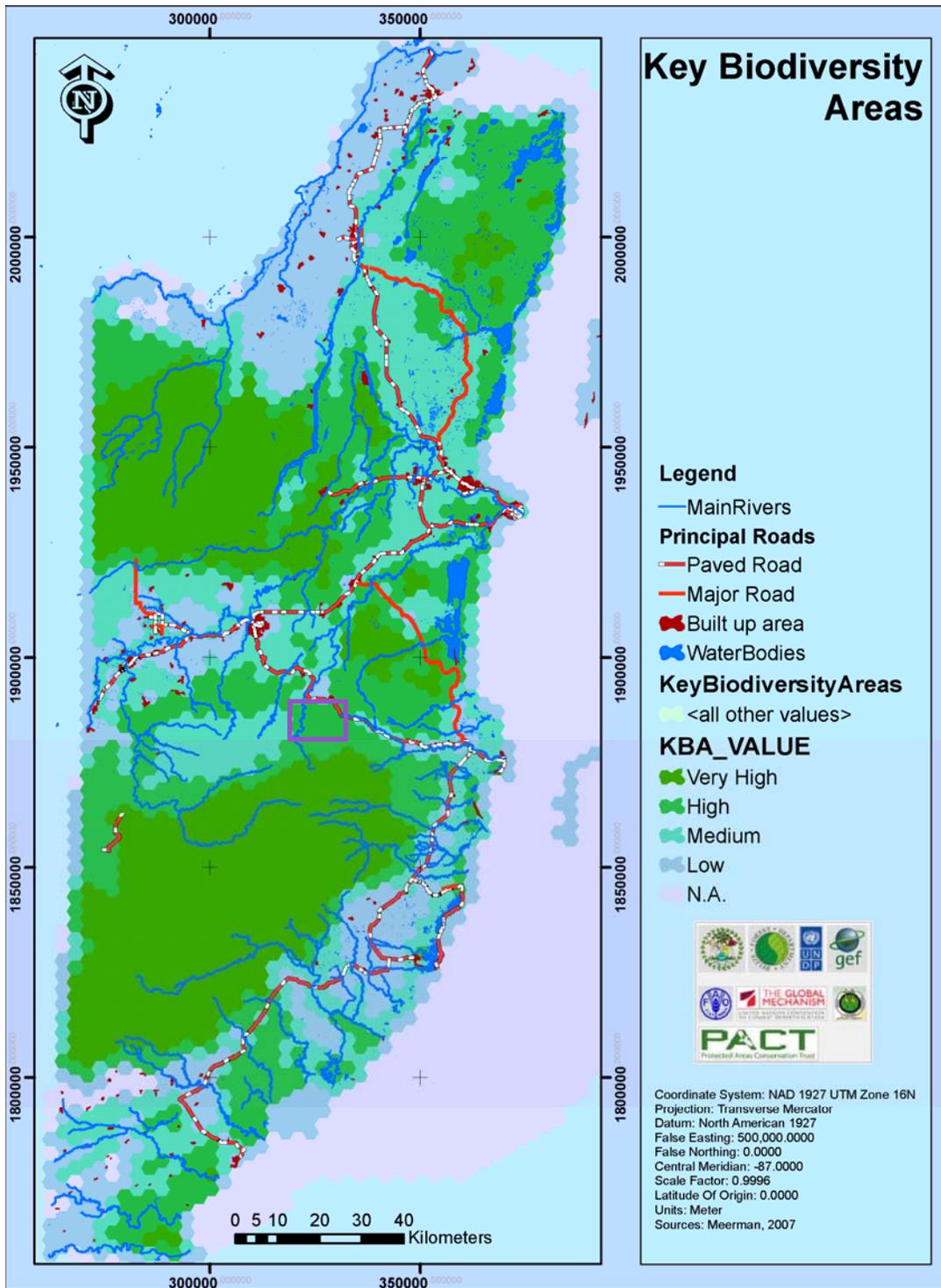


Figure 1. High levels of biodiversity potential at the bird study sites in central Belize. The violet rectangle in the middle of the image bounds the study sites for this project.

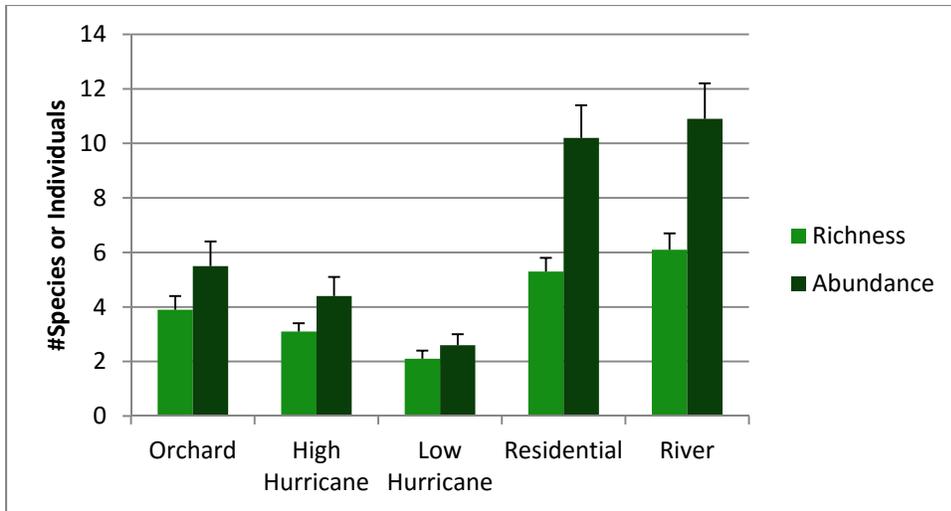


Figure 2. Average species richness and average total abundance (+/- standard error) of migrants in five habitat types in central Belize during 2012-2013 winter seasons combined. Significantly more species and individuals were detected in river sites, followed by residential sites, compared to other habitats.

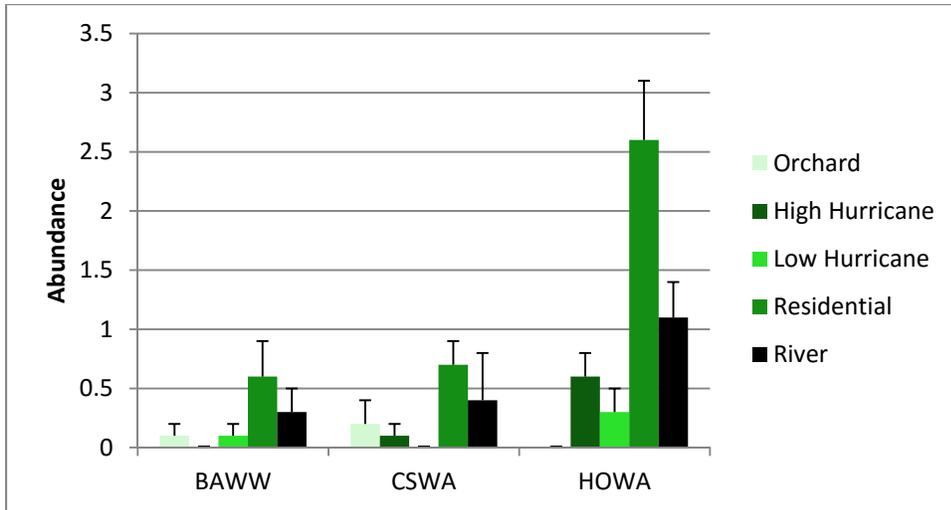


Figure 3. Average abundance of three migratory bird species (BAWW = Black-and-white Warbler; CSWA = Chestnut-sided Warbler; HOWA = Hooded Warbler) significantly detected more commonly in residential habitat compared to other habitats during winter seasons 2012-2013 in central Belize.

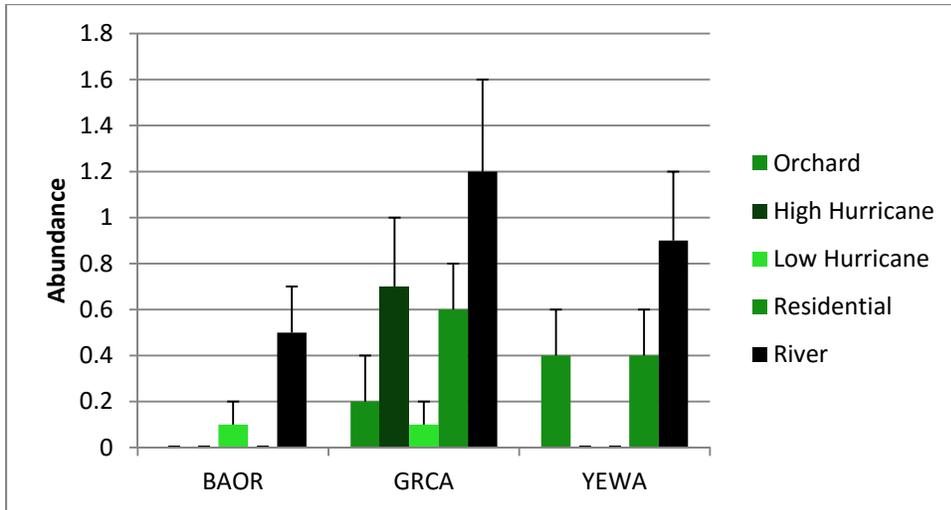


Figure 4. Average abundance of three migratory bird species (BAOR = Baltimore Oriole; GRCA = Gray Catbird; YEWA = Yellow Warbler) significantly detected more commonly in river habitat compared to other habitats during winter seasons 2012-2013 in central Belize.