



Hurricane Katrina impacts the breeding bird community in a bottomland hardwood forest of the Pearl River basin, Louisiana

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ABSTRACT

We monitored breeding bird communities and vegetation both before and after Hurricane Katrina category 2 winds severely damaged extensive bottomland hardwood forest of the Pearl River basin, south Louisiana. Many trees were felled by wind, most others were stripped of leaves and branches, and the canopy opened considerably (57%). Blackberry thickets sprouted and expanded to cover almost all of what was previously a patchily open forest understory. The bird community changed distinctively following the hurricane, driven primarily by increased density of species that prefer dense understory (regenerating) habitat. Individual species that increased significantly in density included one year-round resident, Carolina wren, and five breeding migrants, white-eyed vireo, Swainson's warbler, Kentucky warbler, hooded warbler, and yellow-breasted chat. These patterns were predictable responses to the opened canopy and increased density of understory vegetation. However, over three years following the storm, most species, especially canopy breeders, showed no distinct numerical response to the hurricane, which suggests that the initial bird community was resistant to hurricane disturbance. Only one species, Acadian flycatcher, declined significantly after the hurricane, presumably because of loss of its preferred open understory breeding and feeding habitat. Our results thus document and reinforce the important role hurricanes play along the Gulf coast in structuring forest bird communities by altering understory habitat. We expect habitat changes will continue as invasive plant species further change forest community structure, and as large storms increase in frequency in relation to global climate change. Thus, we also expect continued changes to the bird community, which may include additional future declines.

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1. Introduction

Hurricanes have relatively large annual impact areas and economic costs relative to most other types of natural disturbance (Dale et al., 2001). As a result of habitat disturbance, hurricanes also have strong effects on animal communities in forested ecosystems (reviewed by Michener et al., 1997). For example, in the Caribbean, frequent hurricanes are an important force structuring forest bird communities (Wunderle et al., 1992; Wunderle, 1995). The impact of hurricanes on animal communities depends on geographic location, and severity and extent of storm damage, among other factors. Post-hurricane conditions, such as drought or fire events, and the timing of storms in relation to breeding and migration also influence community response (Lynch, 1991; Waide, 1991). As with any disturbance, the response of individual species to hurricanes is not uniform (Rittenhouse et al., 2010a),

and disturbance-dependent species can even benefit (Greenberg and Lanham, 2001; Tejeda-Cruz and Sutherland, 2005). In some cases, bird communities are only minimally affected or rebound quickly following hurricanes (Waide, 1991; Murphy et al., 1998; Tejeda-Cruz and Sutherland, 2005; Yaukey, 2008). Surprisingly, little recent research addresses the effects of hurricanes on forest bird communities along the northern Gulf of Mexico, where hurricanes are frequent and have strong influences on coastal forest composition and structure (Williams et al., 1999). However, following Hurricane Katrina, radar tracking of habitat use indicated that for several weeks migratory songbirds avoided the most severely impacted forests as well as high quality stopover habitat (bottomland hardwood forest) in favor of not only less disturbed, but also typically less preferred habitat (intensively managed pine), before densities among habitats returned to typical patterns (Barrow et al., 2007). Following Hurricane Rita in southwest Louisiana, arthropod abundance had increased after one year, but food availability for birds was lower in severely damaged forest than in lightly damaged forest because of reduced foraging substrate (Dobbs et al., 2009). In urban and suburban New Orleans, all of the most common bird

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species experienced severe declines, some for just months and others lasting for more than a year (Yaukey, 2008). At a regional scale, Rittenhouse et al. (2010a) compared community similarity before and after four hurricanes that made landfall along the Gulf and Atlantic coasts of the United States. They found that similarity of bird communities in the first year following hurricanes was lower for all species combined as well as for species nesting in the mid-story or canopy, and changes to community diversity persisted for at least five years. Nonetheless, few before–after reports document how these recent Gulf Coast hurricanes impact forest bird breeding community composition, especially in relation to plant community changes.

We studied the response of a bottomland hardwood bird community to Hurricane Katrina, which passed directly over our study site in the Pearl River basin with category 2 wind speeds (Fig. 1). We compared habitat and avian communities in the Pearl River before and after the hurricane. We expected that the severe habitat changes caused by the hurricane (Chambers et al., 2007) would lead to (1) increased density of avian species that prefer dense understory habitat created by loss of canopy cover, and (2) decreased density of avian species that prefer open understory, closed canopy forest. Because the hurricane occurred in the middle of the autumn migration period, we also expected the hurricane to have strongest negative effects on resident species, which would have been more exposed to the short-term habitat changes such as defoliation.

2. Methods

2.1. Study area

We surveyed forest habitat structure and bird communities non-continuously beginning in 1996 and continuing through 2008 within the 14,750 ha Bogue Chitto National Wildlife Refuge of the Pearl River basin of Louisiana (30°27'13"N, 89°44'56"W). Surveys were conducted during 5 years before (1996–1999, 2003) and 3 years following Hurricane Katrina (2006–2008). The Pearl River basin contains one of the few large intact bottomland hardwood forests in the region, with large areas protected by state and federal refuges and a relatively natural hydrology including periodic freshwater flooding. Within the Pearl River basin, the study site is located north (upriver) of the marshes and cypress-dominated forests that include the state-managed Pearl River Wildlife Management Area, where much of post-Katrina remote sensing and forest-based research has occurred (Chambers et al., 2007; Wang and Xu, 2008). The Bogue Chitto study area is dominated by bottomland hardwood forest including sweetgum (*Liquidambar styraciflua*), water oak (*Quercus nigra*), overcup oak (*Quercus lyrata*), green ash (*Fraxinus pennsylvanica*), red maple (*Acer rubrum*), water hickory (*Carya aquatica*), and American elm (*Ulmus americana*). The bottomland forest in our study area is interspersed with lower elevation, and more frequently inundated, sloughs of bald cypress (*Taxodium distichum*) and water tupelo (*Nyssa aquatica*). Midstory and shrub species include American hornbeam (*Carpinus caroliniana*), possumhaw (*Ilex decidua*), elderberry (*Sambucus canadensis*), and blackberry (*Rubus* sp.). Vines common at all levels of the forest include muscadine (*Vitis rotundifolia*) and poison ivy (*Toxicodendron radicans*), Virginia creeper (*Parthenocissus quinquefolia*), and trumpet creeper (*Campsis radicans*). The study area was harvested for timber through the 1960s. In 1996, approximately half of our 45 ha study site (in randomly located 1.87 ha blocks) was subjected to a midstory thinning treatment by using herbicide injections and no removal of treated trees. As the dominant midstory species, American hornbeam was targeted, but all species were treated. This treatment was intended to increase understory stem density and enhance habitat for migratory songbird species that prefer dense

understory. Preliminary analysis of bird density (unpublished data) showed no significant effects of this treatment on any species, and thus we have pooled all sampling locations for analysis here. The effects of Hurricane Katrina on canopy cover and basal area did not differ between treated and control plots. Since the treatment had much the same effect on vegetation as Hurricane Katrina—namely opening up the understory for re-vegetation—it may have impacted the plot-wide bird data we report.

Hurricane Katrina passed over Bogue Chitto on August 29, 2005. Bottomland hardwood forests including the study site here were highly, but patchily impacted by the hurricane (Chapman et al., 2008; Wang and Xu, 2008). In the months after the hurricane, forests responded to the damage by leafing out and growing relatively late into the autumn season (Ramsey et al., 2009). Thus, the vegetation regenerated considerably before the following avian breeding season.

2.2. Habitat assessment

To assess changes to the forest structure and community, we measured forest canopy cover, basal area of trees, and density of live stems, including blackberry stem density. Canopy cover was measured using line-intercept (1996–1999) and visual estimation (2003–2008; Jones and Robertson, 2001). For 1996–1999, basal area was estimated with 10 factor prism counts centered on each 1.87 ha plot (1996–1999; $N=24/\text{year}$). In 2003 and 2006 we estimated basal area with fixed plot (0.008 ha) measurements of diameter at breast height (DBH) repeated at the same randomly located sites ($N=12$). Within the same fixed plots ($N=12$), we measured density of live stems <1 cm DBH, and calculated density of blackberry and other stems.

2.3. Bird community surveys

Observers experienced with all the local birds by both sight and vocalization surveyed all forest birds using 5 minute fixed radius (50 m) point counts twice annually: (1) in May, well after migrant and resident birds had begun breeding (mid-late April), and (2) in early-mid June, near the end of the migratory period for forest birds in the study region (Hamel et al., 1996). Our goal was to survey both migrant and resident birds that were breeding or attempting to breed in the study area. Although we may have included in our counts some migrants, we suspect they made up a relatively small proportion of the total birds surveyed. In each round of sampling, we surveyed 24 uniformly spaced points (137 m apart) each centered on one of the 1.87 ha blocks within the single 45 ha site. Although these points are relatively close, they are independent given our fixed radius sampling design. Surveys were conducted at the same 24 locations in 5 non-continuous years before the hurricane, and in 3 continuous years following the hurricane. Point counts were conducted by the primary author (2003, 2006–2008) or by trained ornithologists contracted by USFWS through Louisiana State University (1996–1999). The same two field technicians conducted the counts for 3 of those 4 years (1996–1998). At each count, bird locations were recorded on spot-map sheets and later classified into 10 m distance annuli. To improve accuracy of distance estimates, 25 m annuli were flagged in the four cardinal compass directions at each point count location.

2.4. Statistical analysis

We tested for differences in canopy cover caused by the hurricane using a two-sample Student's *t*-test (two-tailed) with years as replicates. For basal area, blackberry density, and density of other understory stems we had a single year of data before (2003) and after (2006) from repeated plots; thus, we analyzed pre

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