

Search Efforts for Ivory-billed Woodpecker in South Carolina

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Abstract - Following the reported rediscovery of *Campephilus principalis* (Ivory-billed Woodpecker) in Arkansas, we initiated searches in South Carolina in February 2006, with additional searches in the winter and spring of 2006–2007 and 2007–2008, concentrating in the Congaree, Santee, and Pee Dee river basins. We accrued a cumulative total of 8893 survey hours. We found suggestive evidence in the form of visual and acoustic encounters, but failed to document conclusive evidence. Based on our search results, we believe it is unlikely that a population of Ivory-billed Woodpeckers persists in Congaree National Park and found limited evidence for their presence on other public lands in South Carolina. However, we cannot rule out the possibility that a small, nomadic population persists in the state.

Introduction

Campephilus principalis (L.) (Ivory-billed Woodpecker) once occurred throughout the southeastern United States in mature bottomland hardwood forests and, according to some accounts, in upland pine and the ecotone between these habitats (Jackson 2004, Tanner 1942). In the 19th century, its population began to decline, largely due to habitat destruction that was locally exacerbated by over-hunting (Jackson 2002, 2004; Tanner 1942; USFWS 2010). The bird's range continued contracting through the early part of the 20th century, and by 1926, many authorities considered the bird extirpated from the continental United States (Jackson 2002). In the late 1930s, Tanner (1942) documented the existence of a small population of Ivory-billed Woodpeckers in Madison Parish, LA and believed that populations existed in the Santee Swamp of South Carolina and the Suwanee and Big Cypress regions of Florida, based on habitat conditions and local sightings. Additional populations may have also existed in the Southeast (Jackson 2004), because Tanner's surveys were not exhaustive. Continued habitat destruction and possibly hunting led to the decline and assumed extinction of these populations, with the last

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widely accepted observation of an Ivory-bill Woodpecker in the United States from the Singer Tract in Louisiana in 1944 (Tanner 1942).

Despite the scientific community's conclusion that the bird was extirpated from the United States, unverified sight records continued throughout the latter part of the 20th century, with reported sightings in several states in its former range (Gallagher 2005, Steinberg 2008). In 2005, the Cornell Lab of Ornithology announced the discovery of a single male Ivory-billed Woodpecker from the Cache River of Arkansas (Fitzpatrick et al. 2005), although this claim has been challenged (Sibley et al. 2006). Following this announcement, the United States Fish and Wildlife Service supported search efforts across the historic range of the Ivory-billed Woodpecker to determine its current status. In South Carolina, work began in 2005 with the creation of the South Carolina Ivory-billed Woodpecker Working Group (SCIBWWG), a partnership of 16 federal and state agencies and private organizations. This working group coordinated the search effort within South Carolina.

The last generally accepted sighting of the bird in South Carolina was in 1938 by Murray and Sanders on Wadmacon Island (Jackson 2002, 2004; Post and Gauthreaux 1989). Several unverified, but credible sightings of Ivory-billed Woodpeckers have occurred to the present day, with clusters of sightings occurring in Congaree National Park, the Wambaw Creek Wilderness, and the Pee Dee River Basin (SCIBWWG 2006), suggesting that a population could have persisted into the early 21st century. Thus, the primary objective of our study was to determine if a population of Ivory-billed Woodpeckers persists in South Carolina and, if so, to collect conclusive evidence.

Field-Site Descriptions

Our searches encompassed 3 major river basins in South Carolina, including the Congaree, Santee, and Pee Dee. Our efforts focused where concentrations of credible but unverified sightings had occurred (SCIBWWG 2006) and where mature bottomland hardwood forest continuously dominate the landscape (Fig. 1).

Congaree

Congaree National Park protects approximately 10,927 ha of forested floodplains containing internationally significant ecological resources. The floodplain forest in this park contains the largest intact tract of old-growth bottomland forest (approximately 4452 ha) in North America (Davis 2003) and represents one of the last, best examples of an ecosystem that once covered more than 4 million ha along river floodplains in the southern United States. Congaree National Park is part of the South Atlantic Coastal Plain Biosphere Reserve, a Globally Important Bird Area, and a congressionally designated wilderness. The unique forests and relatively unaltered ecological conditions are dependent upon the natural seasonal flow regimes in the streams and floodwaters that enter the park. This floodplain forest is dominated by *Taxodium distichum* (L.) Rich. (Bald Cypress), *Nyssa aquatica* L. (Water Tupelo),

Liquidambar styraciflua L. (Sweetgum), *Pinus taeda* L. (Loblolly Pine), *Quercus* spp. (oak), *Fraxinus* spp. (ash), and *Ulmus* spp. (elm). Congaree National Park contains one of the tallest broad-leaved forests in North America, with the canopy height averaging 40–50 m in old-growth areas (Jones 1997). Over 500 vascular plant species, including more than 80 native species of trees, have been documented in the Park (Gaddy et al. 2000).

Santee

Francis Marion National Forest (FMNF) in Berkeley and Charleston counties in South Carolina occupies approximately 106,028 ha in the coastal plain of South Carolina and is one of the most biologically and ecologically diverse forested landscapes in the Southeast (USDA 1996). The forest boundary is formed by the Santee River to the north, the Intracoastal Waterway to the southeast, and Lake Moultrie and Cooper River to the west (USDA 1996). The FMNF is comprised of several different landforms, ranging from swamps, floodplains, and stream terraces to side slopes and xeric ridges. The FMNF contains over 30 different natural communities ranging from a dry *Pinus palustris* Mill. (Longleaf Pine) and *Quercus laevis* Walter (Turkey Oak) woodland to clay-based Carolina

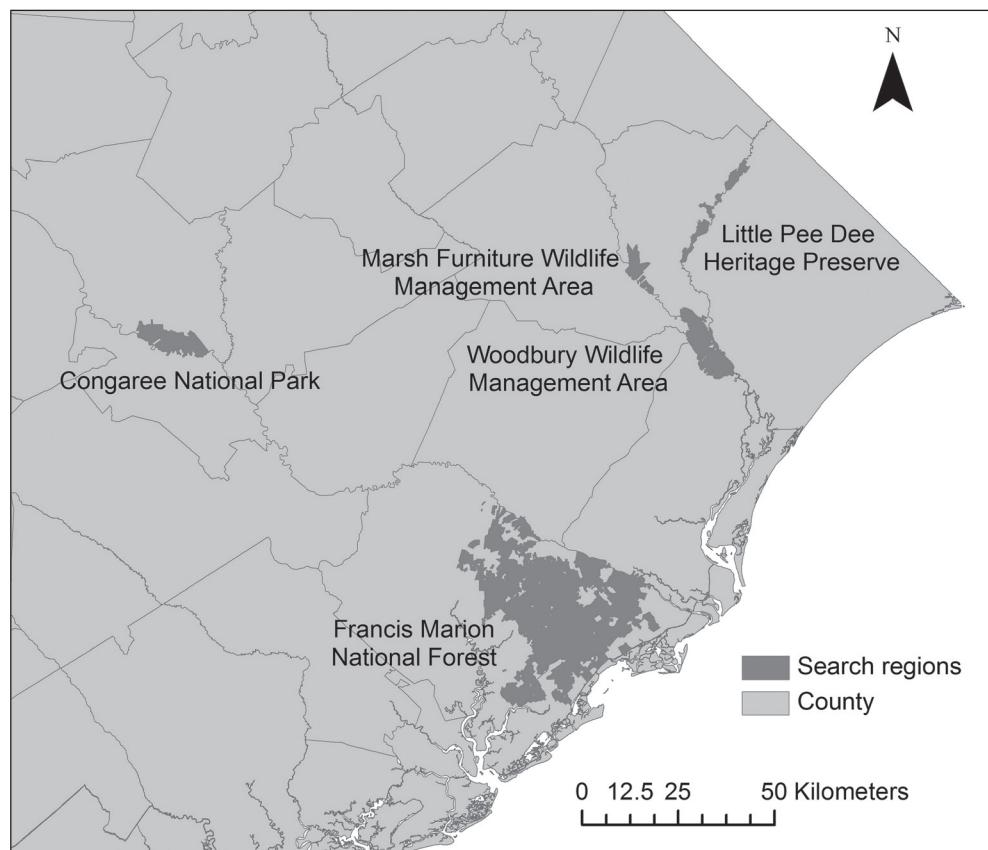


Figure 1. Public lands in South Carolina where searches occurred for Ivory-billed Woodpeckers over 3 field seasons.

bay wetlands (USDA 1996). There are approximately 451 km of perennial streams and 60,703 ha of palustrine, riverine, lacustrine, and estuarine wetlands on the FMNF (USDA 1996).

Pee Dee

Little Pee Dee Heritage Preserve consists of 4 distinct tracts (Little Pee Dee, Ward, Tilghman, and Dargan) in Horry and Marion counties. The total acreage of all 4 tracts is 3350 ha, with the majority in the Dargan and Little Pee Dee tracts (Dozier and Stowe 1999). Each tract is adjacent to the Little Pee Dee River, a black-water river system, and contains representative floodplain forests comprised of Bald Cypress, Water Tupelo, *Nyssa biflora* Walt. (Swamp Tupelo), and *Acer rubrum* L. (Red Maple) that are seasonally inundated by the river (Dozier and Stowe 1999). The midstory and forest floor are vegetatively sparse due to long periods of deep flooding (Dozier and Stowe 1999). Each tract also contains bottomland hardwood forests that were heavily logged in the 1950s, but today are dominated by a well-developed canopy of *Quercus nigra* L. (Water Oak), *Quercus lyrata* Walter (Overcup Oak), *Quercus phellos* L. (Willow Oak), Sweetgum, *Carya aquatica* (Michx. f.) Nutt. (Water Hickory), and Loblolly Pine (Dozier and Stowe 1999). Uplands are dominated by Longleaf Pine on xeric sand ridges with a midstory primarily of Turkey Oak, *Quercus virginiana* Small (Live Oak), and *Diospyros virginiana* L. (Persimmon) (Dozier and Stowe 1999).

The Marsh Furniture Wildlife Management Area (WMA) comprises 3464 ha in Marion County, SC. The property is bounded to the west by the Great Pee Dee River, a red-water river system, and includes bottomland hardwood, isolated freshwater wetlands, and extensive pine and mixed pine-hardwood forests (SCDNR 2010). The hardwood stands are in the river flood plain, and species composition includes oak, *Carya* spp. (hickory), *Nyssa* spp. (gum), ash, *Acer* spp. (maple), and *Taxodium* spp. (cypress) (SCDNR 2010). Various early successional hardwoods such as *Populus* spp. (cottonwood), *Salix* spp. (willow), Sweetgum, and *Liriodendron* spp. (poplar) are prevalent especially within recent hardwood clearcuts (SCDNR 2010). Pine areas are dominated by plantation and naturally regenerating Loblolly Pine (SCDNR 2010).

The 10,387-ha Woodbury WMA is managed for pine and hardwood timber production. The area is bounded by the Great Pee Dee River to the west and Little Pee Dee River to the east resulting in both black- and red-river floodplain communities, with similar vegetation to the Little Pee Dee Heritage Preserve and Marsh Furniture WMA, respectively. Between the river systems are uplands dominated by *Pinus* spp. (pine) (SCDNR 2009).

Methods

Our search efforts occurred from February to April of 2006 (Year 1), November 2006 to May 2007 (Year 2), and November 2007 to May 2008 (Year 3). Search seasons occurred when the majority of broadleaf trees were leafless, allowing for better visibility across the floodplain. Our search methods included

2 approaches: active ground searches by observers and passive techniques using autonomous recording units (ARUs).

Active ground searches included “exploratory” and “patch” searches. Observers were not required to stay within defined areas for “exploratory” searches, but covered large regions relatively quickly to determine whether an area warranted a more systematic survey, such as “patch” searching. “Patch” searching was conducted in regions where observers recorded double knocks or “kent” calls and large cavities, with measurements consistent with historical Ivory-billed Woodpecker cavities, were found. In contrast to “exploratory”, “patch” searching required observers to move within defined areas that averaged 202-ha. Table 1 provides the type of searching conducted in each region.

We conducted “patch” searching in Congaree National Park during all field seasons and in the FMNF in Year 3. The strategy for “patch” searching varied slightly for each field season. In Year 1 and 2, two to four observers searched 202-ha patches for at least 3 days (Cooper et al. 2006). In Year 3, we created a 400-m grid within patches for Congaree National Park and the FMNF. The grid allowed for more systematic surveys. Observers began at a grid point at sunrise and remained stationary for at least 2 hours. After the stationary watch, observers freely searched the 400-m x 400-m grid cell located immediately to the east for approximately 4 hours.

During all search activities, all observers continually watched and listened for the presence of Ivory-billed Woodpeckers and looked for large cavities and bark scaling (indicative of woodpecker foraging). When cavities were located, observers photographed and categorized them based on overall size and shape according to a scale developed by the Cornell Lab of Ornithology (2007a) ($A \geq 10 \times 12 \text{ cm}$, $B \geq 8 \times 9 \text{ cm}$, or $C \leq 8 \times 9 \text{ cm}$). During Year 3, observers watched 79 “A” cavities in Congaree National Park and 12 in the FMNF for 90 min each (i.e., 60 min before and 30 min after sunset) for at least 1, and up to 4, evenings. Observers also noted “tight-bark” scaling, indicative of feeding activity by large-bodied woodpeckers. “Tight bark” is defined as bark that cannot be pried loose with the fingertips (Cornell Lab of Ornithology 2007a). If feeding sign qualified as “tight

Table 1. Survey effort for Ivory-billed Woodpeckers in several regions of South Carolina during 3 field seasons.

River basin/region	Year	Survey type	Survey hr
Congaree			
Congaree National Park	2006	Patch	1633
	2006–2007	Patch	3839
	2007–2008	Patch	2590
Santee			
Francis Marion National Forest	2006–2007	Exploratory	124
	2007–2008	Exploratory/patch	134/221
Pee Dee			
Woodbury Wildlife Management Area	2006–2007	Exploratory	193
	2007–2008	Exploratory	49
Marsh Furniture Wildlife Management Area	2007–2008	Exploratory	31
Little Pee Dee Heritage Preserve	2007–2008	Exploratory	79

bark” scaling, observers used the absence or pattern of small excavations into the exposed wood layer to categorize it as type “A” or “B”, using the Cornell Lab of Ornithology (2007a) guidelines.

During the search seasons in all regions, observers broadcast characteristic sounds of Ivory-billed Woodpeckers, either double knocks or “kent” calls (Allen and Kellogg 1937, Tanner 1942) with the intention of eliciting a response from a bird. The methods varied slightly each year. Beginning in Year 1, observers used CD players and small speakers to broadcast “kent” calls recorded from Ivory-billed Woodpeckers in the Singer Tract, LA (Allen and Kellogg 1937), along with recorded *Campephilus pollens* (Bonaparte) (Powerful Woodpecker) double knocks 2 to 3 times daily. Powerful Woodpecker double knocks were chosen, because they probably closely resemble those of an Ivory-billed Woodpecker, of which there are no known recordings. Prior to beginning a broadcast, observers notified all other observers in the field via two-way radios. The lack of success, as well as conversations with other researchers (Martjan Lammertink, Cornell Lab of Ornithology, Ithaca, NY, pers. comm.), suggested that this method might not be effective at eliciting a response from a woodpecker. In Year 2, we discontinued the use of recorded double knocks and “kent” calls. In Year 3, we developed devices to manually create double knocks (Cornell Lab of Ornithology 2007a), which had the advantage of broadcasting over larger areas than recordings. A double-knock session consisted of 7 double knocks spaced 10 sec apart, followed by a 5-min pause, and then 7 more double knocks spaced 10 sec apart. Double knock sessions were alternated between observers and conducted every hour on the hour from sunrise until mid-afternoon for the entire field season.

In addition to observers, we placed autonomous recording units (ARUs) at locations where past visual or acoustic encounters had been reported. We programmed ARUs to record for 4 hours beginning at sunrise and 4 hours before sunset for a total of 8 hours each day. We deployed units for 2-wk periods during the search season. ARUs were sent to the Cornell Lab of Ornithology for analysis using automatic signal detection and interactive sound-visualization tools provided by the XBAT software system. All potential Ivory-billed Woodpecker detections (i.e., “kent” calls or double knocks) were reviewed by 1 or more bird-sound experts with careful attention to surrounding acoustic context. Potential vocalizations or double knocks were classified into 4 categories using a ranking system developed by Rohrbaugh (2006). We deployed 2 ARUs in Year 1, 13 in Year 2, and 15 in Year 3. We placed all units in Congaree National Park with the exception of 1 unit in the FMNF in Year 2. In addition, 17 ARUs deployed in 2004 and 2005 in Congaree National Park for bird and amphibian acoustic surveys and soundscape monitoring were reviewed for potential Ivory-billed Woodpecker sounds.

During all field seasons, we placed time-lapse trail cameras (RECONYX™ PM35T25) near type “A” and “B” bark scaling and cavities to determine the species feeding and roosting, respectively. With the exception of 1 camera deployed on a cavity in the Woodbury WMA, all were deployed in Congaree National Park.

For bark scaling, we programmed cameras to record images every 12 sec from sunrise to sunset. We programmed cameras on cavities to record images every 4 sec for 30 min before and 60 min after sunrise, and 60 min before and 30 min after sunset. We reviewed all photographs from these deployments for use by Ivory-billed Woodpeckers. We deployed cameras on 8, 43, and 93 bark-scaled trees and cavities in Year 1, Year 2, and Year 3, respectively.

Results

From February 2006 to May 2008, we accrued a total of 8893 survey hours searching 9185 ha in South Carolina. Of this total, 8062 survey hours occurred in Congaree National Park, 479 survey hours in the FMNF, and 352 survey hours on public and private land in the Pee Dee River Basin (Table 1). Approximately 6755 ha of Congaree National Park (including all 4452 ha of old growth), 1686 ha of the FMNF, 377 ha of the Little Pee Dee Heritage Preserve, 179 ha of the Marsh Furniture WMA, and 188 ha of the Woodbury WMA were searched. Forty-six observers participated in Year 1, 42 in Year 2, and 36 in Year 3. The majority of these individuals were trained, unpaid volunteers.

Observers located 83 “A” and 205 “B” cavities in all search regions. In addition, they recorded 149 trees with “tight bark” scaling; 68 of these categorized as “A” and 79 as “B” scaling (Table 2). Ninety-one “A” and “B” cavities were watched by single observers for 90 min at sunset for roosting birds. No Ivory-billed Woodpeckers were encountered during cavity watches; however, observers noted a variety of other woodpecker species using the cavities, including *Dryocopus pileatus* (L.) (Pileated Woodpecker).

Observers reported several acoustic encounters, the majority in Congaree National Park. In Year 1, observers reported 5 acoustic encounters. Three of the encounters were single “kent” calls, 1 was a series of 2 “kent” calls, and 1 included several double knocks heard in series (number unspecified). In Year 2, observers reported 15 “kent” call encounters, 12 of which were a series of 2 to 12 calls. Additionally, observers reported 13 double-knock encounters, 5 of which were a series of 2. One of the single double knocks occurred shortly after an observer completed a double-knock session. In Year 3, observers reported 4 “kent” call encounters, with 3 to 6 “kent” calls during each encounter. Observers also reported 13 double-knock encounters, 6 of which were a series of 2 to 5 double knocks. Additionally, 4 of the double-knock encounters occurred shortly after a

Table 2. Number of “A” and “B” cavities and bark scaling found per region during 3 field seasons in South Carolina.

Region	Cavity		Bark scaling	
	“A”	“B”	“A”	“B”
Congaree National Park	76	189	67	65
Francis Marion National Forest	5	10	1	7
Woodbury Wildlife Management Area	0	3	0	2
Marsh Furniture Wildlife Management Area	2	1	0	1
Little Pee Dee Heritage Preserve	0	2	0	4

double-knock session. Finally, in the FMNF, observers reported 2 double-knock encounters. In both cases, the observer reported 2 double knocks in series.

In addition to acoustic encounters, a few visual encounters were reported from Congaree National Park, although all were brief views by single observers. These visual encounters did not provide enough diagnostic field marks to completely rule out other species. In Year 1, four observers reported 7 visual encounters, all of which were brief fly-bys. In Year 2 and 3, single brief visual encounters were reported.

Trail cameras produced approximately 3 million images over the 3 field seasons, requiring approximately 850 person hours to review. After close examination of these images, no Ivory-billed Woodpeckers were noted; however, Pileated Woodpecker, *Picoides pubescens* (L.) (Downy Woodpecker), *Picoides villosus* (L.) (Hairy Woodpecker), *Melanerpes carolinus* (L.) (Red-bellied Woodpecker), *Strix varia* Barton (Barred Owl), and *Sciurus carolinensis* Gmelin, 1788 (Eastern Gray Squirrel) were photographed using cavities. These species in addition to *Melanerpes erythrocephalus* (L.) (Red-headed Woodpecker), *Buteo lineatus* (J.F. Gmelin) (Red-shouldered Hawk), *Thryothorus ludovicianus* (Latham) (Carolina Wren), *Meleagris gallopavo* L. (Wild Turkey), and *Turdus migratorius* L. (American Robin) were documented on bark scaling.

ARUs deployed in Congaree National Park recorded several double knocks and “kent” calls ranked as plausible Ivory-billed Woodpecker using criteria outlined in Rohrbaugh (2006), with no likely alternative apparent in the context of the recording (Table 3). Additionally, 1 unit in the FMNF in Year 2 recorded for 113 hours with no recorded Ivory-billed Woodpecker sounds.

Discussion

Over 3 field seasons in South Carolina, the majority of reported encounters and recorded events occurred in Congaree National Park. All ARU double-knock events were single occurrences, although observers reported double knocks in series, as well as responses to playback sessions. Unfortunately, there are no recordings of the observer-reported events. All “kent” calls were reported by observers, with the exception of 1 event on an ARU in Year 2. Although many of the encounters were reported by experienced personnel, a number of unrelated phenomena have been shown to sound similar to Ivory-billed Woodpecker double knocks and “kent” calls (Cornell Lab of Ornithology 2007b, Rohrbaugh and Rosenberg 2006).

Table 3. Number of units, total recorded time, and type and number of detected sounds on autonomous recording units (ARUs) for 5 years in Congaree National Park.

Year(s)	No. of units	No. of recorded hr	Single double knock	Single “kent” call
2004	5	1114	0	0
2005	12	3493	0	4
2006	2	335	2	0
2006–2007	12	1495	3	1
2007–2008	15	1583	4	0

Of the possible alternate explanations for double knocks, it is unlikely that distant gunshots, duck wing collisions, or vehicles crossing bridges could have been the origin in Congaree National Park. Hunting is illegal within Park boundaries, and all reported encounters occurred at least 1.5 km from a road. However, we cannot completely rule out gunshot sounds, which can travel several kilometers, and hunting does occur on Congaree's west boundary. We believe it is also unlikely, but cannot completely exclude the possibility, that our reported double knocks originated from duck wing collisions, because observers reported that they did not see or hear ducks during Ivory-billed Woodpecker encounters. Finally, we also cannot rule out that the double knocks did not originate from other woodpeckers, such as Pileated Woodpeckers, which are abundant in the national park. However, it is unlikely for Pileated Woodpeckers to respond to observer-broadcasted double knocks or to produce a series of double knocks. Additionally, it would be unlikely that double knocks from a Pileated Woodpecker would be independent of other sounds, such as drumming or calling.

Verifying potential Ivory-billed Woodpecker "kent" calls is also problematic. There are many other possible explanations for "kent" calls, including creaking and rubbing trees, squirrels, and other bird species (Cornell Lab of Ornithology 2007b). We were not able to rule out these alternative possibilities, especially since recordings were not available in most cases.

After 3 field seasons, we do not have photographs or videos of an Ivory-billed Woodpecker, and all sightings were based on impressions without definite descriptions of field marks. Overall, our sighting evidence is limited and inconclusive. This limited sighting evidence in Congaree National Park could be due to the lack of Ivory-billed Woodpeckers or the difficulty of observing birds in a 40–50-m-high canopy.

We believe two conclusions could be drawn from the search effort in South Carolina. The first possibility is that Ivory-billed Woodpeckers are extirpated from Congaree National Park and possibly from South Carolina. We believe that this is a strong possibility, since there are alternate explanations for the evidence observed (Cornell Lab of Ornithology 2007b, Rohrbaugh and Rosenberg 2006). Specifically, the bark scaling could be the result of other foraging woodpecker species. On a few occasions, observers noted Pileated Woodpeckers creating "tight bark" scaling. Cavities resembling Ivory-billed Woodpecker cavities could also have been created by the weathering of small cavities, squirrels, or other woodpeckers. Additionally, we cannot rule out that the sound and visual evidence came from sources other than an Ivory-billed Woodpecker. Finally, this conclusion would agree with recent analyses by Gotelli et al. (2011) and Solow et al. (2012), which suggest that Ivory-billed Woodpeckers probably went extinct no later than 1980 or 1988, respectively.

The alternate possibility is that Ivory-billed Woodpeckers persist in South Carolina, and our search effort was unable to obtain conclusive proof in the form of a video or photograph. If Ivory-billed Woodpeckers do persist in South Carolina, we believe that they would have to persist in very low densities, be highly nomadic, and very elusive. Ivory-billed Woodpeckers by some accounts

were never common and finding one took great effort (Allen and Kellogg 1937, Tanner 1942); thus, they may have always persisted in low densities. Establishing that Ivory-billed Woodpeckers are nomadic, moving frequently between ephemeral sources of food is difficult, because there is little documentation of this life-history characteristic. However, nomadic behavior has been documented in several other species of woodpeckers (Block and Brennan 1987, Dixon and Saab 2010, Pierson et al. 2010, Smith et al. 2000). Thus, it remains possible that Ivory-billed Woodpeckers frequently shifted their home ranges in response to food availability, which would make them difficult to locate. Finally, there is some debate as to how vocal and secretive the species is. Tanner (1942) suggested that they were highly vocal and not elusive; however, Allen and Kellogg (1937) suggest that the species was quiet and shy. This contradiction is currently unresolvable; however, we believe that persistence would require an elusive and quiet bird.

Our efforts cannot completely rule out the possibility that a small, nomadic population persists in South Carolina, because it is difficult to conclusively prove the expiration or extinction of a species. However, we believe it is unlikely that a population of Ivory-billed Woodpeckers persists in Congaree National Park due to the absence of firm results despite persistent search efforts for 3 years. Additionally, we found no evidence for their presence on other public lands in the state, although the search effort was not as intensive in these areas.

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