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Photo: Eduardo Iñigo-Elias

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Distribution and abundance of the Giant Kingbird (*Tyrannus cubensis*) in eastern Cuba

Carlos Peña[1,2], Elier Córdova[1,3], Lee Newsom[4], Nils Navarro[5], Sergio Sigarreta[1,6], and Gerardo Begué[7]

Abstract The endemic Giant Kingbird (*Tyrannus cubensis*) is a poorly understood and incompletely documented member of the Cuban avifauna. The bird's distribution formerly encompassed the Bahamas and Turks and Caicos Islands, but it has been extirpated from that portion of its former range and is now considered Endangered in Cuba. We collected and examined data on the species' distribution, relative abundance, habitat preferences, food resources, and reproductive biology in eastern Cuba. This entailed systematic searches in the study area, as well as more intensive sampling in three known locations using a series of line transects oriented along forest conservation gradients to determine relative abundance and habitat preferences of the species. Vegetation variables including canopy height, ground cover, canopy cover, and foliage density were estimated in sections of the transects. The Giant Kingbird was found to be most abundant in secondary rainforest at Monte Iberia, with 4.0 individuals/km. The most important vegetation variables associated with the bird's presence were canopy height and foliage density. Important plant food resources were royal palm (*Roystonea regia*), yamagua (*Guarea guidonia*), jubabán (*Trichilia hirta*), ayúa (*Zanthoxylum martinicense*), and caimitillo (*Chrysophyllum oliviforme*). We recorded 14 localities for the Giant Kingbird, demonstrating that the species has a broader distribution than had been previously thought.

Keywords biodiversity hotspots, Caribbean avifauna, Giant Kingbird, Greater Antilles tyrannids, *Tyrannus cubensis*, wildlife conservation

Resumen Distribución y abundancia del Pitirre Real (*Tyrannus cubensis*) en el este de Cuba—El tiránido endémico Pitirre Real (*Tyrannus cubensis*) es un miembro de la avifauna cubana poco conocido e insuficientemente documentado. La distribución de esta especie abarcó anteriormente las Bahamas y las Islas Turcas y Caicos; pero ha sido extirpado de ese área de su rango de distribución anterior y ahora se considera En Peligro en Cuba. Recolectamos y examinamos datos sobre la distribución, abundancia relativa, preferencias de hábitat, recursos alimentarios y biología reproductiva de la especie en el este de Cuba. Esto implicó búsquedas sistemáticas en el área de estudio; así como un muestreo más intensivo en otras tres localidades conocidas utilizando una serie de transectos lineales orientadas a lo largo de gradientes de conservación forestal para determinar la abundancia relativa y las preferencias de hábitat de la especie. En dichos transectos se estimaron variables de la vegetación, incluyendo la altura y cobertura del dosel, la cobertura del suelo y la densidad del follaje. Se encontró que el Pitirre Real era más abundante en el bosque lluvioso secundario en Monte Iberia, con 4,0 individuos/km. Las variables de vegetación más importantes asociadas con la presencia de esta especie fueron la altura del dosel y la densidad del follaje. La palma real (*Roystonea regia*), la yamagua (*Guarea guidonia*), el jubabán (*Trichilia hirta*), la ayúa (*Zanthoxylum martinicense*) y el caimitillo (*Chrysophyllum oliviforme*) fueron elementos vegetales importantes en la dieta de esta especie. Se registraron 14 localidades para este tiránido; lo cual demuestra que la especie tiene una distribución más amplia de lo que se había pensado anteriormente.

Palabras clave avifauna del Caribe, conservación de la vida silvestre, Pitirre Real, puntos calientes de biodiversidad, tiránidos de las Antillas Mayores, *Tyrannus cubensis*

Résumé Répartition et abondance du Tyran géant (*Tyrannus cubensis*) dans l'est de Cuba—Le Tyran géant (*Tyrannus cubensis*) est une espèce endémique de Cuba mal connue et sur laquelle il existe peu d'informations. La répartition de cet oiseau comprenait autrefois les Bahamas et les îles Turques et Caïques, mais il a disparu de cette partie de son ancienne aire de répartition et est maintenant considéré comme En danger à Cuba. Nous avons recueilli et examiné des données sur la répartition, l'abondance relative, les préférences en matière d'habitat, les ressources alimentaires et la biologie de la reproduction de l'espèce dans l'est de Cuba. Cela a impliqué des recherches systématiques dans la zone d'étude, ainsi qu'un échantillonnage plus intensif dans trois secteurs où l'espèce est connue,

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en utilisant une série de transects en ligne orientés par rapport aux gradients de conservation de la forêt, afin de déterminer l'abondance relative de cet oiseau et ses préférences en matière d'habitat. Les variables relatives à la végétation, incluant la hauteur de la canopée, le recouvrement du sol, la couverture de la canopée et la densité du feuillage, ont été estimées dans les sections des transects. Le Tyran géant s'est révélé être le plus abondant dans la forêt tropicale secondaire à Monte Iberia, avec 4,0 individus/km. Les variables relatives à la végétation les plus importantes associées à la présence de l'oiseau étaient la hauteur de la canopée et la densité du feuillage. Les principales ressources alimentaires végétales étaient *Roystonea regia*, *Guarea guidonia*, *Trichilia hirta*, *Zanthoxylum martinicense*, et *Chrysophyllum oliviforme*. Nous avons relevé 14 localités où le Tyran géant était présent, démontrant que l'espèce a une répartition plus large qu'on ne le pensait auparavant.

Mots clés avifaune des Caraïbes, conservation de la faune sauvage, hotspots de biodiversité, Tyran géant, tyrannidés des Antilles, *Tyrannus cubensis*

The Tyrannidae family includes over 400 species, all of which are confined to the Western Hemisphere, principally Central and South America (Clements *et al.* 2017). The family is well represented in Cuba with 18 species, including the Giant Kingbird (*Tyrannus cubensis*; Fig. 1), the largest representative of the group in the Antilles (Raffaele *et al.* 1998). The species was considered common in Cuba in the 19th century, according to the German naturalist J.C. Gundlach (Gundlach 1876, Suárez 1998), although presently it is listed as Endangered (González Alonso 2012, BirdLife International 2017). The Giant Kingbird once also inhabited the southern Bahamas and the Turks and Caicos Islands (Great Inagua and the Caicos group, respectively; Fig. 2a), but it appears to have been extirpated from this part of its former range (BirdLife International 2017). It also occurred in the northern Bahamas (Abaco Island) during the Pleistocene (Steadman *et al.* 2015). The species is now restricted to the Cuban archipelago where it is represented by relatively small and isolated populations spanning the length of the country (Fig. 2b).

Presently the Giant Kingbird is known from three specific locations in the western part of Cuba (Fig. 2b): La Güira on the Guanahacabibes Peninsula (Península de Guanahacabibes, Pinar del Río Province, the westernmost point on the main island); along the Santa Fe River (Río Santa Fé) on the Isle of Youth (Isla de la Juventud, formerly known as the Isle of Pines or Isla de Pinos); and Matanzas Province, specifically the Zapata coastal wetland (Ciénaga de Zapata), including Treasure Lagoon (Laguna del Tesoro) (Garrido and Kirkconnell 2000, González Alonso 2012). The species has also been recorded in two locations in the central portion of the island: Sancti Spíritus Province and Sierra de Najasa (La Belén, Camagüey Province) (Fig. 2b; Garrido and Kirkconnell 2000, González Alonso 2012). Finally, in eastern Cuba, the Giant Kingbird has been reported from Cabo Cruz in the southeast (Granma Province), the Gibara area on the north coast (Holguín Province), and the mountainous terrain along the northeastern sector of the island (i.e., the Nipe-Sagua-Baracoa mountain range, Holguín and Guantánamo Provinces) (Fig. 2b; Garrido and Kirkconnell 2000, González Alonso 2012). The last of these locations represents about 85% of the species' potential range in eastern Cuba.

Fig. 1. Giant Kingbird at El Zapote in the Cuchillas del Toa ecozone. Photograph by Nils Navarro.

The Giant Kingbird is one of the least studied members of the Cuban avifauna, resulting in a general paucity of data regarding its habitat requirements, population size, distribution, and behavioral characteristics (Raffaele *et al.* 1998, Suárez 1998). A rapid biological assessment conducted in February 2004 in Alejandro de Humboldt National Park (hereafter AHNP), which lies within our main study area in the northeastern mountains, identified the Giant Kingbird as a priority for conservation initiatives (Farnsworth *et al.* 2005). Recent studies by Cuban biologists have sought to address this situation by examining the feeding and reproductive biology of the species in Sierra de Najasa in central Cuba (Regalado 2004), and the distribution, abundance, and diversity of bird communities, including the Giant Kingbird, around Ojito de Agua in the northeastern mountain region noted above (González Alonso *et al.* 2007). The species appears to prefer open forest with tall trees in mountain areas, as well as riparian forests and generally the ecotones along forest edges (Regalado 2004). The Giant Kingbird is a member of the perching insectivorous guild (Kirkconnell *et al.* 1992), however it is known to have a mixed feeding strategy, relying on large insects, small vertebrates, and seasonally available fruit (Raffaele *et al.* 1998, Regalado 2004). The breeding season is March–June, and nests are positioned on horizontal branches of larger trees (Kirkconnell *et al.* 1992, Garrido and Kirkconnell 2000, Regalado 2004).

Our study addressed the need for more detailed information on the Giant Kingbird to aid in its ongoing conservation, focusing in particular on the mountainous terrain of the northeastern portion of the main island (Fig. 3). Specifically, the main goal of this study was to clarify the presence, ecology, and distribution

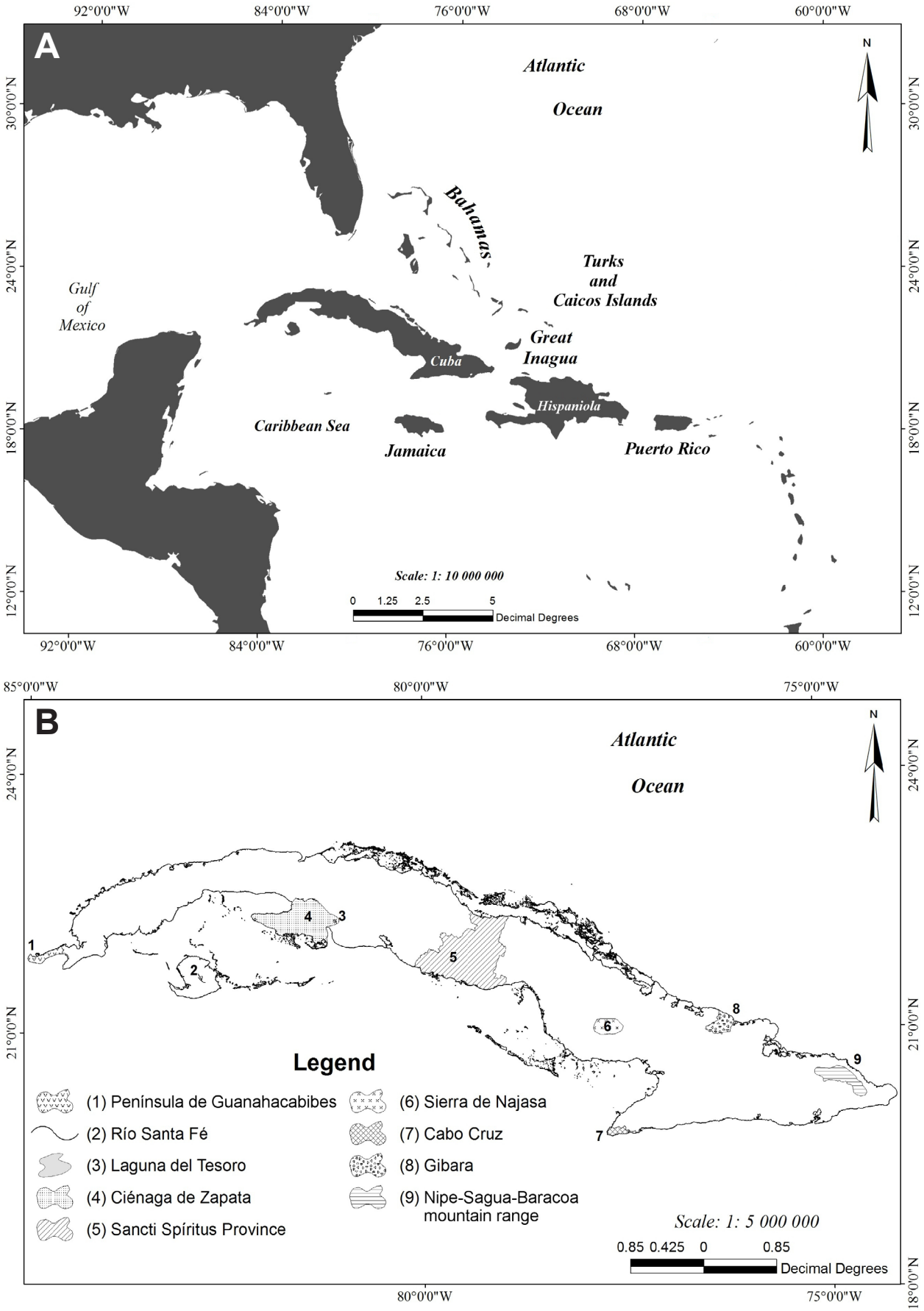

Fig. 2. (a) Map of the Caribbean including Cuba, the Bahamas, and Turks and Caicos archipelagos, and (b) map of Cuba showing the general locations of recent and currently known Giant Kingbird populations.

of the species in the higher terrain of the Nipe-Sagua-Baracoa mountain range. This included revisiting Ojito de Agua, as well as expanding on the surveys by Farnsworth *et al.* (2005) within AHNP and incorporating some of the surrounding terrain along the perimeter of the park. We also re-examined the Gibara location—an area situated farther west along the north coast (Figs. 2 and 3)—to ascertain whether the historically recorded population there still existed. We present new data on the Giant Kingbird, including distributional information, relative abundance measurements, floristic composition and vegetation structure of occupied habitats, insights into its feeding behavior, and aspects of its reproductive biology.

Methods

Study Area

Our research encompassed two main study locations: Gibara on the north coast, and the Nipe-Sagua-Baracoa mountain range in the northeast, specifically the mountainous terrain spanning from just west of the Mayarí River to the Maisí Plateau (Meseta de Maisí) in the east (Fig. 3). The Gibara locality was chosen because of relatively recent sightings near Cantimplora, including collection (May 1975) of a specimen that is preserved at the Museum of Natural History "Joaquín Fernández de La Vara" in Gibara (Wiley *et al.* 2008). The primary study location, the Nipe-Sagua-Baracoa mountain range, also included some more recent sightings in and around AHNP (Farnsworth *et al.* 2005, González Alonso *et al.* 2007). The third eastern locality with prior records for the species, Cabo Cruz, in the extreme southeast, was not included in our study due to distance, inaccessibility, and the lack of recent sightings.

The mountainous primary study location encompasses two other national parks, the Pico Cristal and Mensura-Piloto, in addition to AHNP. AHNP was designated a UNESCO World Heritage Site in 2001 (UNESCO World Heritage Centre 2017), and is part of the larger Cuchillas del Toa UNESCO-MAB Biosphere Reserve (2,083 km²), which encompasses much of the Sagua-Baracoa mountains (between the Sagua de Tánamo and Yumurí Rivers; Fig. 3). AHNP spans 721 km² and lies approximately 50 km northeast of the city of Guantánamo and 35 km northwest of the town of Baracoa in Holguín and Guantánamo Provinces. The park is one of Cuba's most important strictly protected areas (Category II, World Conservation Union, IUCN) due to its historical

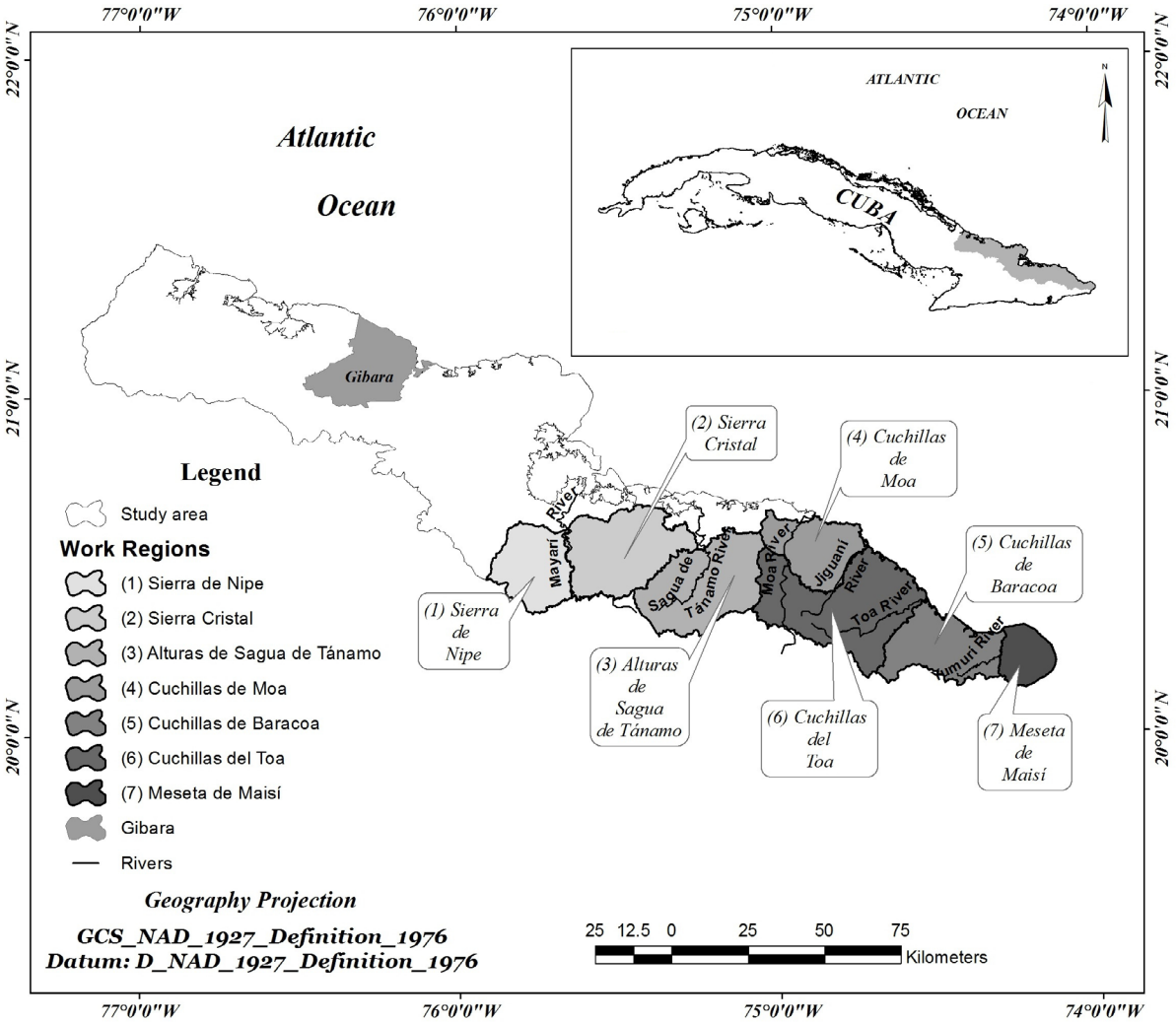

Fig. 3. Study area including Gibara and seven ecozones in the Nipe-Sagua-Baracoa mountain range of eastern Cuba (following Acevedo 1983) selected for survey of Giant Kingbird populations.

ecology and potential significance as a Pleistocene refugium, its unique habitats, and its inherent biodiversity (UNESCO World Heritage Centre 2017). Pico Cristal National Park lies to the west, in the Sierra Cristal mountain range (between the Sagua de Tánamo and Mayarí Rivers), and Mensura-Piloto National Park is farther west in the Sierra de Nipe mountain range, just beyond the Mayarí River (Fig. 3); both are in Holguín Province (Mayarí municipality). Collectively, this mountainous ecosystem, including the three parks and the Cuchillas del Toa Biosphere Reserve that encompasses AHNP, harbors the country's highest levels of plant and animal species richness and endemism, and represents the largest protected remnant of Cuba's montane ecosystems (Le Saout *et al.* 2013, UNESCO World Heritage Centre 2017).

Our research in this mountain region was structured around the seven broad physiographic and ecological zones, or "ecozones", that were originally defined for the area by Acevedo (1983): Sierra de Nipe, Sierra Cristal, Alturas de Sagua de Tánamo, Cuchillas de Moa, Cuchillas del Toa, Cuchillas de Baracoa, and Meseta de Maisí. These ecozones run west to east and are circumscribed and separated from one another by the lower elevation valleys and drainages of the Mayarí, Sagua de Tánamo, Moa, Jiguaní, Toa, and Yumurí Rivers (Fig. 3). Within the Sierra de Nipe and Sierra Cristal ecozones, the Sierra de Nipe-Cristal massif, specifically the high-elevation terrain west of the Sagua de Tánamo River (Fig. 3), has a combined total area of 3,600 km² (Acevedo 1983) and is characterized by very high floristic endemism (Borhidi 1996). This is particularly true of the montane pine forest dominated by Cuban pine (*Pinus cubensis*) and the sclerophyllous montane shrubwoods (charrascales) associations on serpentine substrates (Borhidi 1996). The Sierra de Nipe and Sierra Cristal ecozones have similar vegetation largely because of the shared presence of the pine forest and serpentine soils (Acevedo 1983). Semi-deciduous tropical forest and rainforest associations are also present. Average annual rainfall totals are relatively high and may exceed 1,800 mm in Sierra de Nipe and 2,200 mm in Sierra Cristal (Acevedo 1983). Mensura-Piloto National Park is in the Sierra de Nipe ecozone while Pico Cristal National Park is in the Sierra Cristal ecozone. The most recent Giant Kingbird sightings for this general area are La Zoilita in 1986 and Nipe Plateau in 1998 (Abreu *et al.* 1989, Mazar Barnett and Kirwan 1999).

East of the Sagua de Tánamo River, the mountainous terrain between the Sagua de Tánamo and Yumurí Rivers encompasses four ecozones (Fig. 3). These extend across Holguín and Guantánamo Provinces for a combined area of 5,750 km² (Acevedo 1983). The core of AHNP lies within the Cuchillas del Toa ecozone, but the park also spans parts of the three other ecozones (Fig. 3). Annual rainfall totals along the northern coast are around 1,800 mm, decreasing to about 800 mm or less toward the Maisí Plateau (Borhidi 1996). Along the southern coast the average annual rainfall is generally quite low (< 600 mm), but may exceed 3,400 mm at higher elevations in the Moa and Toa mountain ranges (Acevedo 1983). The prevailing vegetation in this portion of our primary study area includes tropical rainforest, semi-deciduous forest, seasonal evergreen forest, pine woodland, and charrascales (Borhidi 1996). Although this area has phytogeographic similarities with the Sierra de Nipe and Sierra Cristal ecozones to the west, it is outstanding for the large numbers of local endemics (Borhidi 1996). Prior records of Giant Kingbird exist for this eastern sector in AHNP (the Cuchillas de Moa and Cuchillas del Toa ecozones; Fig. 3). Twelve Giant Kingbird pairs were detected at Monte Iberia about a decade ago during a rapid biological inventory (Farnsworth *et al.* 2005); subsequently, González Alonso *et al.* (2007) reported the bird's relative abundance at Ojito de Agua (see below). In addition, during searches for the Ivory-billed Woodpecker (*Campephilus principalis bairdii*), the first author observed a couple of Giant Kingbirds at La Melba in 1986, and one individual was seen in the same general area in 2007. Finally, Ernesto Reyes detected one individual at Mina Las Merceditas in 2009 (pers. comm. to CP).

Species Search and Monitoring

We conducted systematic searches of particular localities and probable habitats for the Giant Kingbird, taking into account our prior field experience in the montane forests of eastern Cuba and drawing on previously published research emphasizing the species' distribution and habitat requirements (Garrido and Kirkconnell 2000, Farnsworth *et al.* 2005, González Alonso 2012). Our surveys around Gibara (Fig. 3, Appendix 1) took place during 2–9 November 2010 and 1–8 March 2011. Our main goal was to confirm whether this population still existed. We divided the area into two blocks and established a pair of 2-km north-south transects within each block, with the distance between transects being > 200 m. We surveyed each transect over a period of four consecutive days between the hours of 0600 and 1000, with one observer responsible for each transect. Additionally, we scanned other nearby locations for the presence of Giant Kingbirds during the survey period.

Our search and census in the mountainous terrain east of Gibara was organized by the seven ecozones described above (Fig. 3). Details of the main survey locations are summarized in Appendix 1. The surveys spanned daylight hours (between 0600 and 1600) over 7–10 consecutive days per visit. Visits occurred during May and June 2008; March, April, May, and August 2009; and March, May, and June 2010.

The search effort in the westernmost Sierra de Nipe ecozone (Fig. 3) began with surveys conducted during 15–23 August 2009. Specific locations included the terrain along the Piloto River, the centrally located Pinares de Mayarí Plateau, and around Cayo Rey (in the southwest). During 22–28 March 2010, additional searches were carried out at La Güira de Sierra de Nipe (in the southeast) and along the Naranjo River.

The study sites within the adjacent Sierra Cristal ecozone (Fig. 3) were located within Pico Cristal National Park. The specific locations we surveyed were La Güira de Sierra Cristal (in the northeast), Paraíso (in the southwest), and La Zoilita (in the northwest). Our surveys at the first two locations were conducted from 15 to 24 June 2010, and in La Zoilita from 20 to 27 May 2008.

We established sets of four 2-km transects at 4–5 sites within each of the four centrally located ecozones to search for Giant Kingbird: Cuchillas de Baracoa (3–9 June 2008), Alturas de Sagua de Tánamo (1–7 March 2009), Cuchillas de Moa (1–8 April 2009), and Cuchillas del Toa (2–8 May 2010) (Fig. 3, Appendix 1). These searches were based in part on some of the prior records of sightings. The rapid biological inventory (Farnsworth *et al.* 2005) focused on the Cuchillas de Moa and Cuchillas del Toa ecozones,

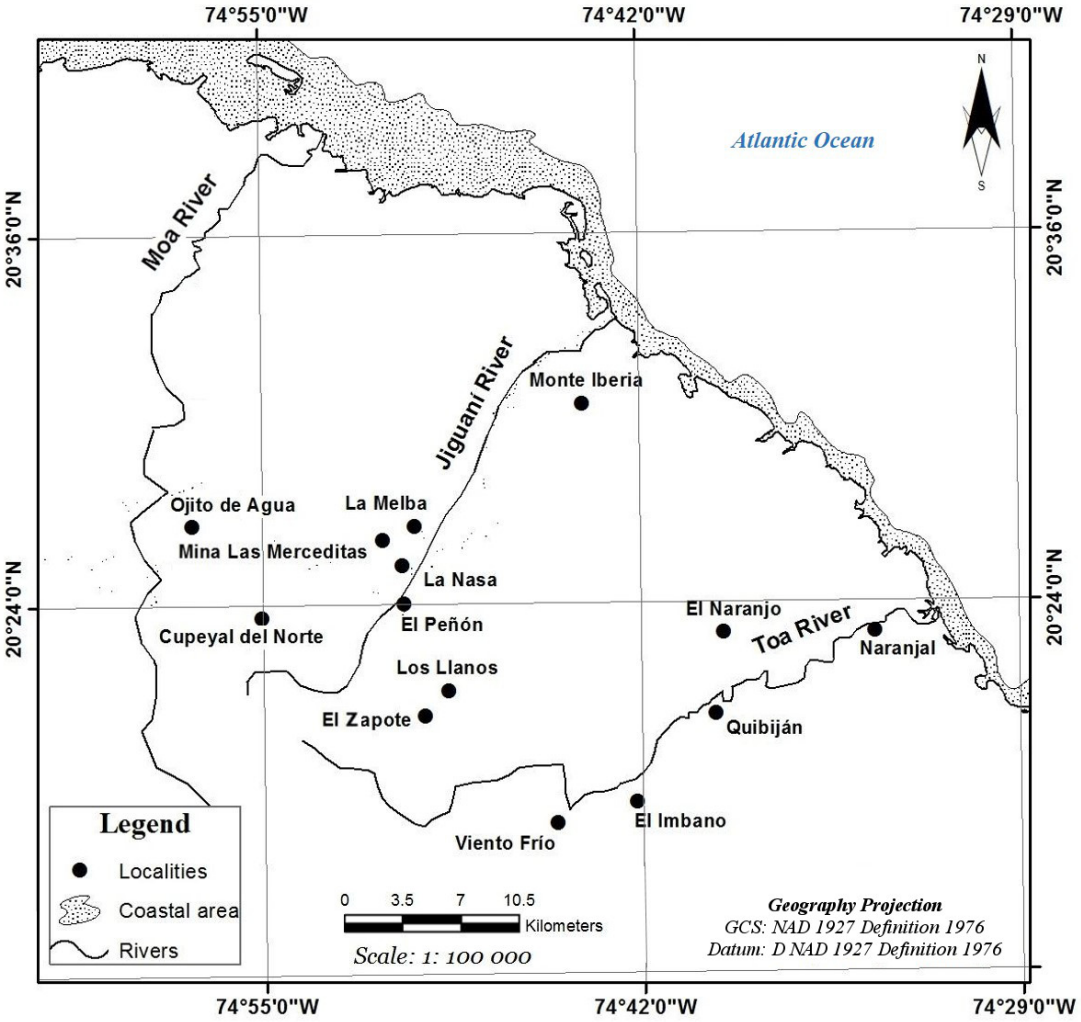

Fig. 4. Spatial distribution of the 14 localities for the Giant Kingbird recorded during 2008–2010 in the Sagua-Baracoa mountains (Cuchillas de Moa, Cuchillas del Toa, and Cuchillas de Baracoa ecozones), Nipe-Sagua-Baracoa mountain range.

visiting four potential localities within AHNP and spanning 4 days per ecozone. Our surveys expanded on this baseline by encompassing eight sites within the park boundaries associated specifically with these two ecozones, plus another located in the adjacent Cuchillas de Baracoa ecozone (Appendix 1). This included revisiting the original four locations from the rapid biological inventory and adding four more within the Cuchillas de Moa and Cuchillas del Toa ecozones, and Quibiján in the Cuchillas del Baracoa ecozone (Appendix 1). Our surveys also occurred over a longer sampling interval of 7–8 days per ecozone.

The transects included one oriented parallel to a river or stream and three that were positioned farther away, separated from one another by a distance > 200 m, with one observer per transect and making short forays away from the path at intervals of 100–150 m. The surveys were conducted using the same transects during four consecutive days, between the hours of 0600 and 1000. The search efforts also incorporated limited surveys and inspections of areas in proximity to each survey site.

We also undertook more intensive sampling in three representative sites—La Melba in the Cuchillas de Moa ecozone, Monte Iberia in the Cuchillas del Toa ecozone, and Quibiján in the Cuchillas de Baracoa ecozone (Fig. 4)—to estimate the relative abundance of Giant Kingbirds. These sites represent separate sampling units but incorporate a similar range of habitats and share the same history of natural- and human-induced disturbances. At these three locations, we took into account forest condition, i.e., the conservation or successional status of the habitat on a gradient from essentially intact to progressively more disturbed forest. This included submontane seasonal rainforest (hereafter referred to as rainforest), degraded rainforest, and fully secondary rainforest at the La Melba and Quibiján locations, and rainforest, degraded evergreen forest, and secondary rainforest at Monte Iberia. Transects were stratified to reflect the relative disturbance levels mentioned above and the forest ecological gradients (Blondel 1976). We divided each sampling unit into three blocks and established one 2-km transect within each of the blocks, ensuring again that all transects were separated by a distance > 200 m from the adjacent block.

These transect surveys were carried out during the Giant Kingbird's nesting season (March–June), specifically during 21–29 June 2008 at Quibiján, 28 April to 6 May 2009 at La Melba, and 25 May to 3 June 2010 at Monte Iberia. Surveys were conducted on three occasions along each transect on alternate days between the hours of 0600 and 1000 for Quibiján and La Melba,

and between 0600 and 1200 for Monte Iberia, with one observer per transect. The surveys began from the opposite ends of each transect each time, and birds were counted by moving slowly at speeds of approximately 10 m/min. The characteristics of the terrain and vegetation precluded the possibility of surveying perfectly linear transects.

We recorded feeding and nesting activities during focal observations and surveys to determine food preferences and nesting behaviors. Feeding patterns were based on visits to fruiting plants and fruit consumption or clear efforts to do so. We also considered previous observations made by a team member (GB) who works in AHNP.

To associate specific vegetation characteristics with the habitat requirements of the Giant Kingbird, we established circular plots of 22.4 m diameter (0.04 ha) in which we recorded five vegetation variables: diameter at breast height, canopy height, percent canopy cover, percent ground cover, and foliage density at 0–0.3 m, 0.3–1 m, 1–2 m, and 2–3 m height (James and Shugart 1970, Noon 1981). We sampled the vegetation at both positive points, i.e., the sections of transects where the species was observed or heard, as well as negative points, where it was unrecorded, to evaluate the differences in habitat (Bibby *et al.* 1998). The approximate heights and vegetation strata at which individual birds were observed perching or feeding were also recorded. To avoid disturbing the birds, the vegetation was sampled after bird surveys were completed at a given site. Geographical Information Systems, specifically ArcGIS version 9.1 (Esri, Redlands, CA, USA) and the modules ArcMap, ArcToolbox, and ArcCatalog on a cartographic base to a scale of 1:250,000 and 1:100,000 were used for digital cartography.

Results

Giant Kingbird Sightings and Habitat in Northeastern Cuba

Our surveys in the Gibara area occurred near Cantimplora, Gibara municipality, close to the northern coast of Holguín Province (Fig. 3). Unfortunately, the original semi-deciduous forest vegetation has been eliminated or considerably reduced since the 1970s sightings. Most of the terrain has been converted to agroecosystems, with small isolated patches of low-stature secondary regrowth. We found no Giant Kingbirds and conclude that it is unlikely that any population persists in this locality.

Despite a relatively recent published record for Giant Kingbird on the Nipe Plateau (Sierra de Nipe ecozone; Fig. 3; Mazar Barnett and Kirwan 1999), repeated searches of this location by other ornithologists covering a variety of habitats (Navarro Pacheco *et al.* 1997, Sánchez *et al.* 1998, Peña Rodríguez *et al.* 1999) have turned up no additional sightings. Likewise, our efforts in this ecozone were unsuccessful. Assuming the observers were correct in their identification, the lack of any further sightings suggests that it is unlikely that any Giant Kingbird populations persist in this zone.

In the Sierra Cristal ecozone (Fig. 3) researchers previously focused their attention on the La Zoilita mountain range (Abreu *et al.* 1989, Fa *et al.* 2002), and Abreu *et al.* (1989) reported having observed one bird in June 1986 on the way to Mosca Verde, about 6 km to the southeast of La Zoilita. Although our search efforts paid special attention to this location, we were unable to find any Giant Kingbirds there. Regalado (2004) pointed out that the Naranjo River, La Güira de Sierra Cristal, and Paraíso are the locations where the most recent Giant Kingbird sightings have occurred in this sector; however, he also emphasized that these records require confirmation, since in the field many ornithologists and birdwatchers mistake the Loggerhead Kingbird (*Tyrannus caudifasciatus*) for the Giant Kingbird. Our survey results for all locations in this ecozone were negative.

Moving farther east, our search and survey in the Alturas de Sagua de Tánamo ecozone (Fig. 3) took place in the Castro, La Maltina, Calabaza de Sagua, Naranjo Agrio, and El Sopo localities. Although no individuals were sighted in this ecozone, the Castro locality seems to have potential habitat for the Giant Kingbird based on previous information about its habitat preferences and on observations made in the remaining three ecozones (see below).

Our first positive sightings of Giant Kingbird occurred in the Cuchillas de Moa ecozone, east of the Moa River (Fig. 3). Here individuals were observed at five locations: La Melba, La Nasa, Mina Las Merceditas, Cupeyal del Norte, and Ojito de Agua (Fig. 4). Farther east, in the adjacent Cuchillas del Toa ecozone between the Jiguaní and Toa Rivers (Fig. 3), the species was detected at five more locations: El Peñón, Los Llanos, El Zapote, El Naranjo, and Monte Iberia (Fig. 4). At El Zapote, one bird was sighted frequently and mainly in taller trees in secondary rainforest. Finally, farther east in the Cuchillas de Baracoa ecozone (Fig. 3), positive sightings were recorded at another four locations: Naranjal (beside the Toa River), Quibiján, El Imbano, and Viento Frío (Fig. 4). Although our current search efforts did not extend farther east to the Meseta de Maisí ecozone on the Maisí Plateau (Fig. 3), we note the lack of historical records of sightings in that area as well as our prior personal experiences on the plateau, during which no Giant Kingbirds were encountered.

Relative Abundance

The highest relative abundance values for Giant Kingbird obtained in our study correspond with the secondary rainforest habitat at the Monte Iberia locality, with 4.0 individuals/km. By comparison, we recorded 1.0 individual/km in the degraded evergreen forest located within this same general area, and no individuals were encountered in the undisturbed rainforest. We discovered that one of the best locations to observe this bird is at the base of the plateau in a mosaic of coffee (*Coffea arabica*) plantations and generally disturbed forests, the latter including royal palm or palma real (*Roystonea regia*) and cultivated cacao (*Theobroma cacao*). We encountered about eight pairs including a nesting pair in this area. In February 2004, Farnsworth *et al.* (2005) observed a pair feeding on the fruits of a royal palm in this same location. We also encountered the Giant Kingbird at El Alto de Esteban (within the Monte Iberia locality; Fig. 4) in habitat characterized by the presence of majagua (*Hibiscus elatus*), coconut (*Cocos nucifera*), and guárano (*Cupania glabra*) trees.

Very generally, our census suggests that the relative abundances of Giant Kingbird in the Quibiján and La Melba survey areas are consistent with our observations at Monte Iberia. At Quibiján, 2.0 individuals/km were documented in secondary rainforest, and 1.0 individual/km in the degraded rainforest. No individuals were observed in the preserved primary rainforest.

Just as at Monte Iberia, one of the most productive areas for observation of the species proved to be open patches of vegetation, sometimes mixed with cultivation, specifically on the elevated terrain adjacent to the Quibiján River and immediate vicinity. The relative abundance tended to be slightly lower in the La Melba survey area, with 1.5 individuals/km in the secondary rainforest and 0.5 individuals/km in degraded rainforest. Once again, no individuals were observed in the intact rainforest. Consistent with the other two locations, Giant Kingbird was found to be most frequent at La Melba in disturbed forest edges (e.g., a small rise before arriving at the local village; along the route to a sawmill; generally, around the Nando family property; in the vicinity of the forest observation tower; and in El Acana, which is about 3 km from the forest biological station). Our surveys thus revealed similar trends in presence and abundance in relation to the forest conservation gradients at the three intensive survey localities.

Relationship with Vegetation Structure and Composition

The positive detection points in the three more intensively sampled sites were associated with disturbed forests. The vegetation in these plots was characterized by forest gaps, relatively tall trees, foliage density ranging from 54% to 88% cover, and ground cover ranging from 73% to 83% (Table 1). These data contrast strongly with the corresponding negative points data for which the foliage density values and the percent ground cover were comparatively low, and the canopy was not as tall (Table 1).

Feeding Behavior

The Giant Kingbird is a member of the perching insectivorous guild, which typically perch on exposed branches for long periods, waiting for flying insects to catch, and often return to the same perch (Kirkconnell *et al.* 1992). However, it was occasionally observed capturing prey very near the ground in dense herbaceous vegetation. We observed that the bird's early morning foraging activities occurred mainly in the foliage, whereas in the afternoon the birds shifted to foraging in the upper dry twigs of taller trees, allowing it to exploit different vegetative strata and take full advantage of the areas characterized by intermediate succession processes.

We also observed Giant Kingbirds feeding on the fruits of 12 different tree species during this study (Table 2). Five of these—royal palm, yamagua (*Guarea guidonia*), jubabán (*Trichilia hirta*), ayúa (*Zanthoxylum martinicense*), and caimitillo (*Chrysophyllum oliviforme*)—were most commonly observed as food resources, thus they appear to be more heavily relied upon relative to the other fruits, based on our direct observations. Considering plant-bird dispersal mutualisms, many of the trees we identified as food sources display signaling colors or other features that attract birds (Table 3; Stiles 1982, Janson 1983, Janzen 1983, Kricher 1999, Schmidt and Schaefer 2004, Schaefer *et al.* 2007, Amsberry and Steffen 2008, Guerra and Pizo 2014). The fruits of some trees are red or yellow (e.g., ateje [*Cordia collococca*] and wild fig or jagüey hembra [*Ficus aurea*]), while others have contrasting black or blue areas (e.g., caimitillo), or seeds with red arils or other brightly colored components (Table 3). Two members of the mahogany family (Meliaceae)—yamagua and jubabán—are examples of the latter, having similarly sized woody capsules that enclose two to four seeds with red arils (Table 3). Several species have seeds that are characterized by high lipid content (Max Rubner-Institut 2011), which is another bird attractant (Guerra and Pizo 2014, Olson 2014). These include ayúa; najesí (*Carapa guianensis*), another member of the mahogany family which has a comparatively large brown capsule with several small lipid-rich seeds (Kleiman and Payne-Wahl 1984, Taylor 1996, Guerra and Pizo 2014); and guamá (*Lonchocarpus domingensis*) and chicharrón (*Terminalia intermedia*) (Guerra and Pizo 2014). Notably, najesí was found to be relatively more abundant at the Monte Iberia site.

Reproductive Biology of the Giant Kingbird

Data on the reproductive activity of the Giant Kingbird were recorded from three inactive nests at La Melba and two active ones at Monte Iberia. The nests were located in relatively dense vegetation with more canopy cover, offering an appropriate refuge and sufficient microclimatic conditions for incubation. In the first location, a nest was built during two consecutive years (2006 and 2007) in the same ayúa tree at 13 m height. The third nest was constructed in 2008 in this same vegetation patch, in a najesí tree at 14 m height. This might indicate a certain fidelity

Table 1. Averages of vegetation structure variables per intensive search locality. Positive points: locations where the Giant Kingbird was recorded. Negative points: locations where the Giant Kingbird was not recorded.

	Positive Points			Negative Points		
Variables	La Melba (*n* = 6)	Monte Iberia (*n* = 9)	Quibiján (*n* = 4)	La Melba (*n* = 6)	Monte Iberia (*n* = 8)	Quibiján (*n* = 6)
Diameter at breast height (cm)	31.2	37.0	32.8	23.3	29.0	28.2
Mean canopy height (m)	13.8	17.9	14.5	10.0	11.8	10.5
Percent canopy cover	33.5	43.8	35.7	72.9	78.7	79.4
Percent ground cover	82.5	72.7	80.0	33.8	32.7	34.5
Foliage density (percent cover)						
0–0.3 m	72.5	87.5	71.4	52.3	57.6	41.8
0.3–1 m	71.8	84.5	73.6	47.8	60.0	43.9
1–2 m	63.7	73.5	59.8	41.3	42.7	41.0
2–3 m	56.5	65.0	53.8	40.5	36.9	38.7

Table 2. Fruiting phenology of the tree species observed as food resources for the Giant Kingbird in eastern Cuba (sources: Roig 1965, Albert 2005, Beurton 2008).

		Fruit Availability											
Plant Species	**Scientific Name**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
royal palm	*Roystonea regia*	X	X	X	X	X	X	X	X	X	X	X	X
ateje	*Cordia collococca*				X	X							
chicharrón[a]	*Terminalia intermedia*				X	X						X	X
guamá	*Lonchocarpus domingensis*				X	X	X						
najesí	*Carapa guianensis*			X	X	X	X	X	X	X	X		
yamagua	*Guarea guidonia*	X	X	X	X	X	X	X	X	X	X	X	X
jubabán	*Trichilia hirta*	X	X	X	X	X	X	X	X				X
jagüey hembra	*Ficus aurea*								X	X	X		
nabaco	*Faramea occidentalis*							X	X	X			
ayúa	*Zanthoxylum martinicense*		X	X	X	X	X	X	X	X	X	X	X
guárano	*Cupania glabra*				X	X							
caimitillo	*Chrysophyllum oliviforme*	X	X	X	X	X	X	X	X	X	X	X	X

[a]endemic

to the same nesting site, which could have practical implications for Giant Kingbird conservation. All the nests were built on horizontal branches and were protected by dense foliage.

In Monte Iberia, where observations were made from 0600 to 1200, a nest was noted at 22 m height in an ocuje (*Calophyllum utile*) patch. Protected by the foliage, the nest was in the process of being fabricated, with both the female and male equally involved in its construction as well as in territorial defense. The second nest in this area was located just west of a local spot named La Guanábana, 17 m high in the canopy of a jobo tree (*Spondias mombin*). Although the sides were protected, the nest was exposed from above. Due to the height, it was not possible to determine the number of nestlings, which must have been present based on the parents' behavior. We observed that the female and the male alternated feeding the nestlings, with intervals of 5, 7, 27, 15, 23, and 30 min. The birds used the lower forest strata around the nest to capture insect prey and search for edible fruit, foraging generally within a distance up to about 400 m from the nest, depending on the availability of food resources.

The adults were observed perching near the nest during the midday hours, generally at distances that varied between about 20 cm and 1 m, from which they emitted calls at regular intervals. They occasionally left to expel possible predators from their territory, comprised of a defensive radius of about 40–60 m. These behaviors seem to indicate that parental care in this nesting stage is constant and serves to counter or minimize predation of eggs and nestlings. The female and male are equally effective at nest defense.

Among the potential predators detected during our observations were the Cuban Crow (*Corvus nasicus*) and the American Kestrel (*Falco sparverius*), the first being more aggressive. Pre-

Table 3. Fruit characteristics of plant taxa ingested by the Giant Kingbird in eastern Cuba (sources: Little and Wadsworth 1964, Howard 1974–1989, Little *et al.* 1974, Correll and Correll 1982, Liogier 1985–1997, Acevedo-Rodríguez 1996, Albert 2005).

			Fruit Characteristics			
Plant Species	**Scientific Name**	**Family**	**Type**	**Diameter**	**Color**	**Seeds**
royal palm	*Roystonea regia*	Arecaceae	drupe-like	2 cm	purple-black	1; black
ateje	*Cordia collococca*	Boraginaceae	drupe	8–10 mm	red	1
chicharrón	*Terminalia intermedia*	Combretaceae	dry drupe	—	brown	1; 2 wings
guamá	*Lonchocarpus domingensis*	Fabaceae	legume	10 cm x 2.0–2.5 cm	brown	4–7; flat, 10 mm
najesí	*Carapa guianensis*	Meliaceae	woody capsule	7–10 cm	brown	2–4; angular
yamagua	*Guarea guidonia*	Meliaceae	dry capsule	1.5–1.9 cm	brown	2–4; ovoid, red aril
jubabán	*Trichilia hirta*	Meliaceae	woody capsule	10–15 mm	brown	2–4; 6–8 mm long, red aril
jagüey hembra	*Ficus aurea*	Moraceae	fig, achene	6–15 mm	red or yellow	1; minute
nabaco	*Faramea occidentalis*	Rubiaceae	drupe	8–10 mm	black	1; brown
ayúa	*Zanthoxylum martinicense*	Rutaceae	follicle	4–6 mm	brown	1; black, shiny, 3–4 mm
guárano	*Cupania glabra*	Sapindaceae	woody capsule	1–2 cm	brown	brown, fleshy orange base
caimitillo	*Chrysophyllum oliviforme*	Sapotaceae	berry	1 cm	blue or blackish	1; brown

dation by the Barn Owl (*Tyto alba*) could not be witnessed by our team since the observations took place during daylight hours. However, analysis of owl pellets has revealed the presence of skeletal remains from Gray Kingbird (*Tyrannus dominicensis*), Loggerhead Kingbird, and Cuban Pewee (*Contopus caribaeus*) (Arredondo Antúnez and Chirino Flores 2002). The Giant Kingbird thus might also constitute part of the owl's diet.

The Giant Kingbird did allow other bird species to get close to the nest, among which were noted the following: Cuban Trogon (*Priotelus temnurus*), Black-whiskered Vireo (*Vireo altiloquus*), Gray Kingbird, Cuban Blackbird (*Dives atroviolaceus*), West Indian Woodpecker (*Melanerpes superciliaris*), and Cuban Oriole (*Icterus melanopsis*). Any concern for protection of the nest against human intruders was practically nonexistent.

Discussion

Previously, the Giant Kingbird's distribution in eastern Cuba was assumed to have been restricted primarily to the Cuchillas de Moa and Cuchillas del Toa ecozones and immediate environs (Suárez 1998, Farnsworth *et al.* 2005, Gonzalez Alonso *et al.* 2007). The results of this study demonstrate that the bird's range is more extensive, encompassing more of the Cuchillas del Toa, as well as the adjacent Cuchillas de Baracoa ecozone farther east. Our data also suggest that populations of the Giant Kingbird in eastern Cuba are restricted primarily to AHNP and its buffer zones (Quibiján and Viento Frío) in the Sagua-Baracoa mountains (Fig. 5). This range encompasses territory within Holguín and Guantánamo Provinces, with the species' populations distributed mostly within the forested watersheds of three rivers, namely the Moa, Jiguaní, and Toa. Altogether, we documented 14 localities for the species, including reconfirming the presence of Giant Kingbirds at Ojito de Agua, Monte Iberia, La Melba, and Mina Las Merceditas. Of these locations with positive sightings, the most important appear to be La Melba, Monte Iberia, Naranjal, Quibiján, Ojito de Agua, and El Zapote. Some of these locations are very close together (Fig. 4), but they are distinguished here because they serve as reference points for future research.

Although a member of the perching insectivorous guild, our research also corroborated frugivory for the species. We identified 12 exploited plant species, half of which (royal palm, jubabán, jagüey hembra, ateje, chicharrón, and guamá) were previously noted by other researchers (Kirkconnell *et al.* 1992, Regalado 2004). The most important tree species on which Giant Kingbirds feed appear to be royal palm, yamagua, jubabán, ayúa, and caimitillo, based on our direct observations. This is supported also by tree phenology, these taxa having relatively longer periods of fruit availability and specific adaptations for bird dispersal mutualisms (Tables 2 and 3). We also note that wild figs (*Ficus* spp.; e.g., jagüey hembra) are generally known to be keystone species for tropical frugivores (Lee *et al.* 2014), even though they appear to play a lesser role in the Giant Kingbird's diet.

Giant Kingbirds were relatively more abundant in secondary rainforest habitat, which appears to offer critical nesting and food resources, especially in conjunction with forest ecotones (natural gaps) or the transition zones between preserved for-

Fig. 5. Quibiján locality. One of the localities where Giant Kingbirds were observed in the Cuchillas de Baracoa ecozone. Photograph by Carlos Peña.

est and open (deforested) areas, including human plantations. Our assessment of Giant Kingbird habitat is consistent with that described by Regalado (2004), showing strong similarities. Readily available in this type of habitat is a range of trees representing food resources for the species, particularly najesí, guárano, yamagua, and royal palm, which were especially abundant at Monte Iberia. In addition, taller tree canopy height (generally exceeding 13 m) appears to be an important vegetation predictor of Giant Kingbird presence, i.e., habitat use, based on our observations and the descriptions of Johannes Gundlach (1876), who stated that this species inhabits woods and fields that preserve taller trees. These findings are consistent with other research in the Neotropics, for example in Costa Rica (Frishkoff *et al.* 2014), where it was recently reported that diversified agricultural systems may help buffer against extreme loss of avian phylogenetic diversity.

The greater abundance values associated with the secondary rainforest habitat at the Monte Iberia locality as compared with Quibiján and La Melba could be influenced by the taller canopy height compared with the secondary regrowth found in the other two areas, as well as by the particular mosaic of agricultural plots, palm trees, and patches of secondary rainforest found there, providing for the abundance of food sources mentioned above. Moreover, a previous study by González Alonso *et al.* (2007) conducted in the Ojito de Agua locality, one of the locations where we also recorded the Giant Kingbird (Fig. 4), found the birds to be relatively abundant. Thus, Ojito de Agua might be considered along with Monte Iberia as the locations of two of the most important populations in the Nipe-Sagua-Baracoa mountain range of eastern Cuba.

Research has demonstrated that habitat fragmentation affects different species in different ways (Laurance 2010), causing some to decline sharply or to disappear in fragments while others may remain stable, and still others may increase. Our data suggest that the Giant Kingbird's apparent ability to take advantage of forest gaps and disturbed edges has benefited it and enabled its survival in eastern Cuba. Nevertheless, we documented the loss of the isolated Giant Kingbird population near Gibara. The bird's range is also shrinking elsewhere on the island outside of our study area (Sancti Spíritus and Pinar del Río Provinces), where the fragmentation of its habitat is greater and populations are more isolated (BirdLife International 2017).

The German naturalist Johannes Gundlach (1876) observed in the late 19th century that the species was not rare in Cuba and was associated with woodlands and fields that preserved tall trees. Following from this and taking into account our results on the bird's reproductive biology, feeding habits, and the vegetation structure of its habitat, we surmise that the removal of the taller trees that provide Giant Kingbirds with edible fruits and suitable nesting places could be one of the main factors underlying their decline in many places on the island. Overall, our results suggest that the conservation issue that most affects the Giant Kingbird population is forest conversion, especially clear cutting for diverse uses, including agricultural development.

We have attempted to clarify the population distribution of the Giant Kingbird in eastern Cuba, along with collecting data on aspects of its behavioral ecology and conservation. Much is yet to be learned about the species' population spatial structure and metapopulation dynamics, as well as other behavioral aspects and the role of external influences that may have important consequences for long-term viability. Other questions regarding the present and recent distribution of the Giant Kingbird need to be resolved. For example, the origin, relative isolation, and cause for disappearance of the birds previously observed near Cantimplora remain uncertain. To some extent these questions may be addressed through genetic analysis of the specimen curated at the Museum of Natural History "Joaquín Fernández de La Vara" in Gibara.

Habitat conversion has been shown to be a critical factor underlying biodiversity losses worldwide (Le Saout *et al.* 2013, Lee *et al.* 2014). Our recommendations therefore for the Giant Kingbird, and by extension, for Cuban forest and wildlife management in general, are first and foremost to control deforestation and further anthropogenic degradation of natural forest habitats, including those undergoing natural succession. It is conceivable that the Giant Kingbird, given its apparent dispersal mutualism with a dozen types of fruit, may facilitate some natural forest regeneration and habitat recovery (Robinson and Handel 1993, Fraser 2009). Moreover, the species interaction may be integral to the survival of endemic plant taxa, including Endangered species such as chicharrón (Areces-Mallea 1998), one we recorded as a food resource for the Giant Kingbird. Other Cuban avifauna, including threatened species, feed on some of these same plants and might benefit from Giant Kingbird seed dispersal. For example, the White-crowned Pigeon (*Patagioenas leucocephala*) consumes large quantities of jubabán and guárano fruit (Godínez 1993), and the Cuban Parakeet (*Psittacara euops*) relies heavily on ayúa, at least during the reproductive season (50% of the feeding observations; García 2009).

Control plans need to be established for introduced mammals, particularly black rats (*Rattus rattus*; Farnsworth *et al.* 2005), that prey on bird populations. The Giant Kingbird is also not familiar to local people due to its resemblance to other tyrannids and its low population numbers, even when it inhabits the vegetation immediately surrounding human homes and settlements. In view of these issues, we suggest that an environmental education project be instituted in the different sectors of the national park and extended to local communities. The primary objective would be to convey the importance and needs of the Giant Kingbird, including mitigating clear cutting of trees and shrubs important to its diet and reproduction. This initiative could be augmented by some selective reforestation involving direct sowing of seeds from species important to the Giant Kingbird, some of which can be raised and sourced from seed nurseries.

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Appendix 1. Giant Kingbird survey sites in eastern Cuba. AHNP: locality within Alejandro de Humboldt National Park (X); Method: search and census method; TF: transects with short forays; T: transects; Giant Kingbird: Giant Kingbird detected (X).

					Relative Abundance (individuals/km)		
Site	Geographic Coordinates	AHNP	Method	Giant Kingbird	Secondary Forest	Disturbed Forest	Preserved Forest
Gibara							
Cantimplora	21°02'58.71"N, 76°11'40.07"W		TF				
Sierra de Nipe							
Piloto River	20°26'45.14"N, 75°47'26.33"W		TF				
Pinares de Mayarí Plateau	20°31'31.08"N, 75°46'46.41"W		TF				
Cayo Rey	20°28'21.15"N, 75°45'42.85"W		TF				
La Güira de Sierra de Nipe	20°26'45.83"N, 75°40'46.11"W		TF				
Naranjo River	20°28'10.84"N, 75°41'54.48"W		TF				
Sierra Cristal							
Paraíso	20°28'10.84"N, 75°41'54.48"W		TF				
La Güira de Sierra Cristal	20°35'33.73"N, 75°21'45.93"W		TF				
La Zoilita	20°32'43.11"N, 75°32'05.55"W		TF				
Alturas de Sagua de Tánamo							
Castro	20°31'14.01"N, 75°05'10.83"W	X	TF				
La Maltina	20°24'35.98"N, 75°14'10.04"W		TF				
Calabaza de Sagua	20°27'28.79"N, 75°21'02.29"W		TF				
Naranjo Agrio	20°27'58.99"N, 75°16'39.75"W		TF				
El Sopo	20°26'20.83"N, 75°15'35.20"W		TF				
Cuchillas de Moa							
La Melba	20°27'15.07"N, 74°48'05.33"W	X	TF-T	X	1.5	0.5	0.0
La Nasa	20°25'16.21"N, 74°50'11.10"W	X	TF	X			
Mina Las Merceditas	20°26'05.47"N, 74°50'51.86"W	X	TF	X			
Cupeyal del Norte	20°23'35.46"N, 74°55'02.14"W	X	TF	X			
Ojito de Agua	20°26'35.90"N, 74°57'24.79"W	X	TF	X			
Cuchillas del Toa							
El Peñón	20°24'01.38"N, 74°50'08.63"W	X	TF	X			
Los Llanos	20°21'11.20"N, 74°48'37.75"W		TF	X			
El Zapote	20°20'22.99"N, 74°49'26.66"W		TF	X			
El Naranjo	20°23'01.34"N, 74°39'10.67"W	X	TF	X			
Monte Iberia	20°30'27.23"N, 74°43'57.70"W	X	TF-T	X	4.0	1.0	0.0
Cuchillas de Baracoa							
Naranjal	20°23'00.53"N, 74°33'56.83"W		TF	X			
Quibiján	20°20'22.18"N, 74°39'26.74"W	X	TF-T	X	2.0	1.0	0.0
El Imbano	20°17'24.27"N, 74°41'23.01"W		TF	X			
Viento Frío	20°16'51.63"N, 74°44'57.16"W		TF	X			

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