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Inventory of birds in different plant formations in the protected area Martín Infierno Cave, south-central Cuba

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Photo: Christoph Moning

Inventory of birds in different plant formations in the protected area Martín Infierno Cave, south-central Cuba

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Abstract Martín Infierno Cave is a 430-ha Cuban protected area best known for its cave system, which contains the largest stalagmite in the world. From a speleological standpoint, the area has been well studied; however its above-ground habitats are much less documented, and the fauna not at all. The objective of our work was to compile a list of birds, by habitat, identified throughout this protected area, to lay the groundwork for subsequent avian studies, and ultimately a more informed management and conservation plan for the site. We recorded 72 species, belonging to 17 orders and 32 families. Of these species, 13 are endemic to Cuba and 4 are categorized as Endangered or Vulnerable. The most species of birds (55) were recorded within the evergreen mesophyll forest plant formation. The Order Passeriformes and the Family Parulidae represented the greatest number of species recorded, with 33 and 11, respectively.

Keywords Cuba, birds and plant formations, Martín Infierno Cave, protected area

Resumen Inventario de aves en diferentes formaciones vegetales del área protegida Cueva Martín Infierno, de la región sur-central de Cuba • Martín Infierno es un área protegida cubana de 430 ha, conocida principalmente por su sistema cavernario, en el cual se encuentra la estalagmita más grande del mundo. Desde el punto de vista espeleológico, este sitio ha sido bien estudiado; sin embargo, sus hábitats sobre la superficie están mucho menos documentados, y su fauna aún no ha sido investigada. Por ello el objetivo de este trabajo fue elaborar la primera lista de aves de la Cueva Martín Infierno, como el primer paso para futuros estudios sobre este grupo zoológico en el lugar. Este estudio inicial ayudará a allanar el camino para el manejo y conservación de las aves en esta área protegida recientemente establecida. La avifauna registrada está compuesta por 72 especies, pertenecientes a 17 órdenes y 32 familias. Entre ellas, 13 son endémicas y cuatro están categorizadas con algún grado de amenaza. La formación vegetal con el mayor número de especies detectadas fue el bosque siempreverde mesófilo (55 especies). La familia con mayor número fue Parulidae (11) y el orden con más especies fue Passeriformes (33).

Palabras clave área protegida, aves y formaciones vegetales, Cuba, Cueva Martín Infierno

Résumé Inventaire des oiseaux dans différentes formations végétales de l'aire protégée de la grotte Martín Infierno dans le sud de la région centrale de Cuba • La grotte Martín Infierno est une aire protégée cubaine de 430 hectares, surtout connue pour son système souterrain qui contient la plus grande stalagmite du monde. D'un point de vue spéléologique, la zone a été bien étudiée, mais ses habitats de surface sont beaucoup moins documentés et sa faune sauvage ne l'est pas du tout. L'objectif de notre travail était de dresser une liste des oiseaux identifiés dans les différents habitats de cette aire protégée, afin de jeter les bases pour des études ultérieures de l'avifaune et, finalement, pour un plan de gestion et de conservation du site bien informé. Nous avons inventorié 72 espèces, appartenant à 17 ordres et 32 familles. Parmi ces espèces, 13 sont endémiques de Cuba et 4 sont classées dans les catégories En danger ou Vulnérable. La plupart des espèces d'oiseaux (55) ont été mentionnées dans la formation végétale de la forêt mésophylle à feuilles persistantes. L'Ordre des Passeriformes et la Famille des Parulidae étaient les plus représentés avec respectivement 33 et 11 espèces.

Mots clés aire protégée, Cuba, grotte Martín Infierno, oiseaux et formations végétales

The National System of Protected Areas of Cuba comprises

211 managed and legally protected areas in eight categories (CNAP 2013). Six of these protected areas are in the Guamuhaya Mountains (Ruiz 2015), one of the biodiversity hotspots in Cuba. Most studies in this region have focused on the flora, including the works of Ricardo *et al.* (1998, 1999), but few studies have investigated the fauna. Studies on the birdlife in other areas of this region have been carried out in the Yaguanabo Valley

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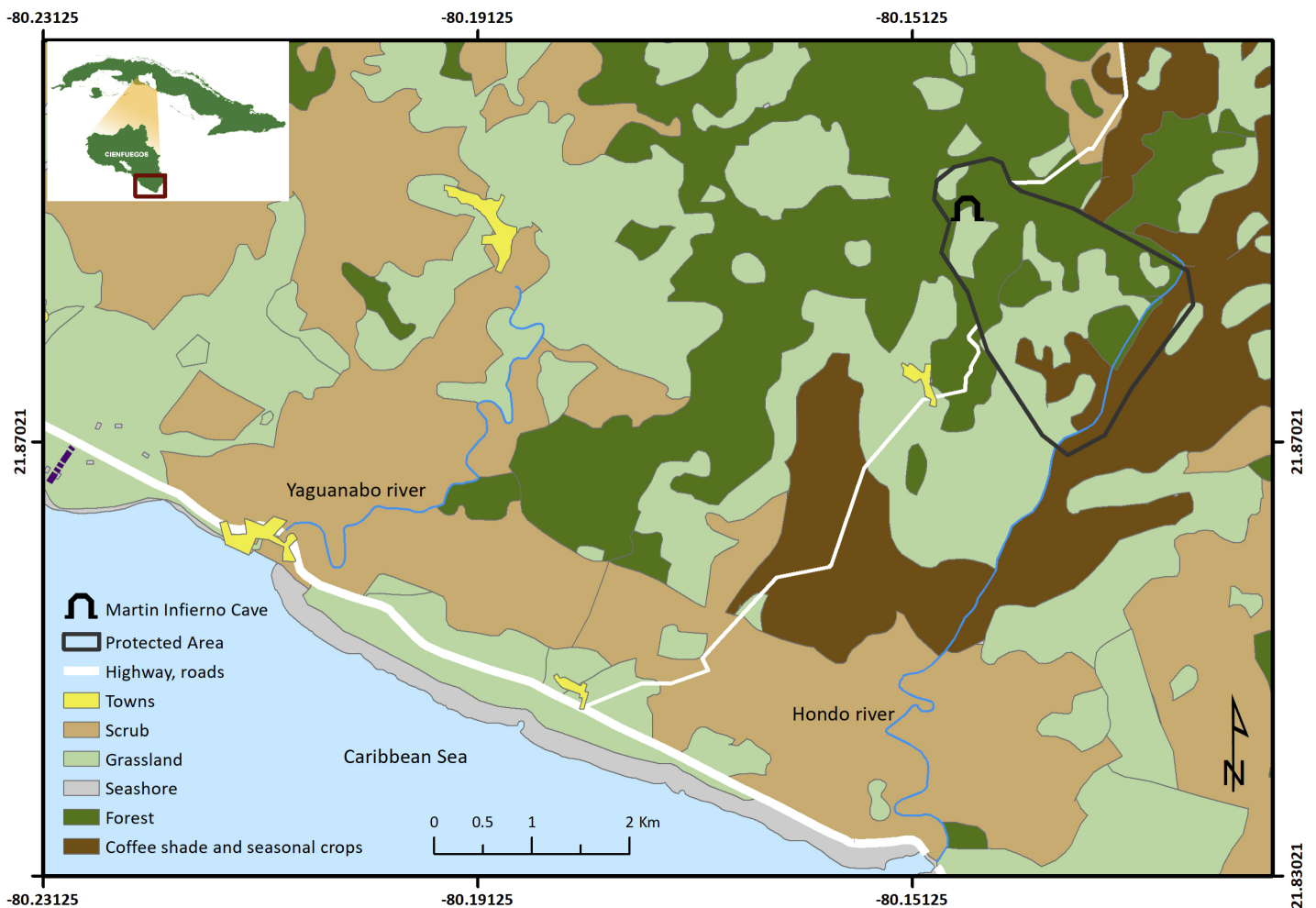


Fig. 1. Geographic location of the protected area Martín Infierno Cave in the Guamuha Mountains, south-central Cuba. We conducted avian surveys across four vegetation types within the protected area: grassland, gallery forest, evergreen mesophyll forest, and secondary vegetation and crops. The forest shown on the map includes both sampled forest types. Coffee shade and seasonal crops were included in the secondary vegetation and crops category.

(Ledesma 2011, Águila, 2012) and in Topes de Collantes (Ayala 1989, Sánchez 2005). Other protected areas in the same region, such as Aguacate-Boca de Carreras, do not yet have faunal inventories. Martín Infierno Cave—a protected area in the Guamuha Mountains established in 2019—is known primarily for the Martín Infierno cave, which contains the largest stalagmite in the world. The protected area is managed by the Cienfuegos Botanical Garden, and the few studies undertaken here, which have focused on the floral and vegetal formations, have been biodiversity studies to aid implementation of the management plan (León 2013). The aim of this study was to compile the first list of the birds and their associated habitats to further the conservation of birds in the protected area.

Methods

The protected area Martín Infierno Cave is located at 560 m above sea level on the southern part of Trinidad Heights, Guamuha Mountains, Cienfuegos province, Cuba (21°53'43.9"N, 80°08'49.8"W; Fig. 1). The 430-ha protected area is a limestone massif consisting of rocks from the Jurassic Period. The cave is 776 m long and contains 6 chambers (Nuñez 1990). The climate

is tropical humid with two seasons: dry and rainy. Vegetation in the protected area is composed of a mosaic of different formations with some endemic species of flora, such as *Coccothrinax crinita brevicrinis* and *Erythrina elenae* (León 2013).

We conducted line transect surveys in March, May, September, and November of 2012–2014 within four plant formations in the protected area: secondary vegetation and crops, gallery forest, grasslands, and evergreen mesophyll forest. These categories are based on the classification of Cuban plant formations of Capote and Berazain (1984). For the secondary vegetation and crops category, we included coffee shade plantations and other seasonal crops associated with them. Secondary vegetation and crops are characterized largely by the degradation of natural vegetation; trees and shrubs are dispersed, and vines are abundant. The gallery forest, at the border of the rivers, consisted of trees 15–20 m tall, with vines and epiphytes in the shrubs and trees. *Panicum maximum* is the predominant species of the grassland, which is heavily influenced by livestock. The semideciduous mesophyll forest consists of trees 25 m tall and a lower stratum dominated by deciduous shrubs.

Our sampling consisted of transects at existing and new

census routes in the protected area as well as of observation points inside the cave, as birds are known to use caves for refuge, resting, and nesting (Montes 2019). Transects in secondary vegetation and crops took place along two existing unpaved paths that were each ~3 m wide and 1 km long; transects in the other vegetation types (gallery forest, grasslands, and evergreen mesophyll forest) were new, with each route ~2 m wide and extending 2 km long through the bush. All routes were drawn to avoid obstacles in the field but to stay within the vegetation type. We sampled five days in every month for a total of 60 sampling days throughout the 3-yr study period. Each census was 6 hours and split between morning (0700–1100) and late afternoon (1600–1800), as these are the periods of greatest bird detectability. We worked in teams of two observers in each census for a total of 180 observer-hours in each of the four vegetation types. We used 8×42 binoculars and recorded each species that we saw or heard. We assigned threat criteria to each species using the criteria proposed by Navarro (2021).

Observations inside the cave were made in the 4 chambers that connect to both cave entrances: the north entrance Chamber, Camp Chamber, Dolina del Cafetal Chamber, and Baseball Field Chamber. We were unable to monitor the other 2 chambers. Observations in the cave took place during the morning (0600–0900) and evening (1840–1940), for a total of 240 hours of observation.

Results

We compiled the first list of birds for the Martín Infierno Cave protected area, consisting of 17 orders, 32 families, and 72 species (Appendix 1), representing 18.14% of Cuban bird species (397 species; Navarro 2021). Passeriformes was the most represented order of all recorded birds, with 33 species, 11 of which are in Parulidae. We identified 13 endemic species and 4 threatened species (2 Endangered and 2 Vulnerable). Forty-six species (63.89%) are present in the area year-round, 4 are partial migrants, 15 are transient and winter residents, 3 are transient and summer residents, 2 are transient and partial migrants, 1 is a winter resident, and 1 is a summer resident. We recorded 47 species in the gallery forest, 49 in the secondary vegetation, 15 in the grassland, and 55 in the evergreen mesophyll forest. Evergreen mesophyll forest and gallery forest had the greatest number of unique species (7 species each), followed by secondary vegetation and crops (5 species), and then grassland (1 species). Five of the endemic species were found exclusively in evergreen mesophyll forest (Appendix 1). Four of the species found in secondary vegetation are introduced, including Helmeted Guineafowl (*Numida meleagris*), Red Junglefowl (*Gallus gallus*), Muscovy Duck (*Cairina moschata*), and Wild Turkey (*Meleagris gallopavo*). Helmeted Guineafowl were also present in the grassland and in or near backyards of the local community. Another introduced species detected, Shiny Cowbird (*Molothrus bonariensis*), is considered naturalized in Cuba (Navarro 2021).

We observed six species nesting in the rocky wall of the cave entrance or inside the cave, in the area with natural light or semi-darkness: Cave Swallow (*Petrochelidon fulva*; 29 nests), Barn Owl (*Tyto alba*; 2 nests), Bare-legged Owl (*Margarobyas*

lawrencii; 1 nest), Cuban Parakeet (*Psittacara euops*; 9 nests), Scaly-naped Pigeon (*Patagioenas squamosa*; 2 nests), and Cuban Blackbird (*Ptiloxena atroviolacea*; 2 nests). Of these cave-dwellers, Barn Owl and Bare-legged Owl were nesting in March, while the other species were nesting in May. We also recorded these species in the gallery forest, secondary vegetation, and evergreen mesophyll forest.

Discussion

In Cuba, previous studies have examined the composition of avifauna in different protected areas (Fong *et al.* 2005a, 2005b, Kirkconnell *et al.* 2005, Maceira *et al.* 2005, 2006, Díaz *et al.* 2006); however, the results of these studies cannot be compared with those obtained in Martín Infierno because their methods and objectives were different. Furthermore, these protected areas differ in key characteristics, such as altitude, area, plant formations, climate, and relief—all of which influence the composition and abundance of their fauna. Compared with other protected areas in the Guamuha Mountains, Martín Infierno Cave has fewer species (72) than Topes de Collantes (145; eBird 2020), but more than Yaguanabo Valley (40; Águila 2012). These three areas are geographically close and contain similar plant formations, although Topes de Collantes is much larger. In the recently established Aguacate-Boca de Carreras Protected Area, no studies have examined the birds or other fauna because the conservation focus is the native flora, so studies have been focused on vegetation.

Significantly, the 13 endemic species in Martín Infierno Cave represent almost half of Cuba's 27 endemic species (Garrido and Kirkconnell 2010). Although this is fewer than the 16 reported from Topes de Collantes (eBird 2020), it is more than in the Yaguanabo Valley (8; Águila 2012). Gray-fronted Quail-Dove (*Geotrygon caniceps*) has not been reported from any of the other nearby protected areas. In fact, this is the first report for this species for Cienfuegos province and the Guamuha Mountains. According to eBird records, the closest locality where this species has been observed is Trinidad, approximately 20 km from Martín Infierno (Garrido and Kirkconnell 2010, Navarro 2015, eBird 2020).

Of particular interest are our observations of the six species nesting in the rocky wall of the cave. Although most of these have previously been reported nesting in rocky substrate (Silva 1988, Peris and Llanes 1998, Cañizares and Berovides 2008, Montes and García 2010, Montes *et al.* 2016), these species are more commonly cavity nesters. Scaly-naped Pigeon has never been recorded nesting on rocky substrate. Nesting in the cave could be a strategy to avoid predation (Marín and Stiles 1992, Mínguez and Oro 2003, Mínguez 2006) or an ecological adaptation to the karst environment (Mancina and García 1997). However, it could also be caused by the shortage of nest sites due to the loss of trees. This could especially be the case for Scaly-naped Pigeon, as the other five species we found nesting in the rocky wall of the cave use a wider assortment of nesting sites, including human construction as well as tree cavities and caves. Because the vegetation around this area has been significantly degraded, mainly by cattle ranching and forest fires, this site could be an important refuge for birds in the area. Additionally, it is important to note that the four introduced species detect-

ed in the secondary vegetation, grassland, and in or near backyards of the local community have an economic purpose as a food source.

There are two major conservation concerns in the study area. One is the illegal trapping of birds, especially Western Spindalis (*Spindalis zena*), Cuban Bullfinch (*Melopyrrha nigra*), Yellow-faced Grassquit (*Tiaris olivaceus*), and Cuban Grassquit (*Phonipara canora*), for the caged bird market—all species we recorded in the Martín Infierno Cave protected area. The other is the persecution of raptors, especially Gundlach's Hawk (*Accipiter gundlachi*) and Red-tailed Hawk (*Buteo jamaicensis*), which are hunted because they harass and depredate farmed birds. Gundlach's Hawk, an endemic evaluated as Critically Endangered (Navarro 2021, IUCN 2014), is the species of greatest concern in the area. This conflict between humans and birds of prey occurs throughout the world (Price and Nickum 1995, Fernández-García *et al.* 2015), and Cuba is no exception.

These problems must be considered by future managers of the protected area and solutions must be used to develop environmental education and management strategies to change people's perception of these birds. Conservation authorities should consider Gundlach's Hawk as a flagship species and establish conservation priorities in the area through education activities with local communities. One strategy could be engaging local communities in celebrating World Migratory Bird Day.

The Guamuhaya Mountains are one of the biodiversity hotspots on the island of Cuba; however, most studies in this area have focused on flora and only few have concentrated on the avifauna. Further studies, building on our preliminary assessment, should help to define conservation priorities and create new management tools, especially in protected areas, to promote conservation of the region's avifauna.

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Title Page Illustration

Gray-fronted Quail-Dove (*Geotrygon caniceps*) at Refugio de Fauna Bermeja, Matanzas, Cuba, on 6 Mar 2018. Photographed by Christoph Moning.

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Appendix 1. Birds of the protected area Martín Infierno Cave. Conservation and resident status according to Navarro (2021): * = Endemic, LC = Least concern, EN = Endangered, NT = Near Threatened, VU = Vulnerable, Int = Introduced, Nat = Naturalized, YR = Year-round, T = Transient, PM = Partial Migrant, WR = Winter Resident, SR = Summer Resident.

Scientific Name	Common Name	Habitat				Threat Status	Resident Status
		Grassland	Gallery Forest	Secondary Vegetation, Crops	Evergreen Mesophyll Forest		
Order Anseriformes							
Family Anatidae							
<i>Cairina moschata</i>	Muscovy Duck			X		Int	YR
Order Galliformes							
Family Numididae							
<i>Numida meleagris</i>	Helmeted Guineafowl						
Family Phasianidae							
<i>Meleagris gallopavo</i>	Wild Turkey						
<i>Gallus gallus</i>	Red Junglefowl						
Order Columbiformes							
Family Columbidae							
<i>Patagioenas squamosa</i>	Scaly-naped Pigeon		X		X	LC	YR
<i>Columbina passerina</i>	Common Ground Dove	X	X	X	X	LC	YR
<i>Geotrygon montana</i>	Ruddy Quail-Dove				X	LC	YR
<i>Geotrygon caniceps</i> *	Gray-fronted Quail-Dove				X	VU	YR
<i>Zenaida asiatica</i>	White-winged Dove		X		X	LC	PM
<i>Zenaida macroura</i>	Mourning Dove		X	X	X	LC	YR
Order Cuculiformes							
Family Cuculidae							
<i>Crotophaga ani</i>	Smooth-billed Ani	X		X		LC	YR
<i>Coccyzus merlini</i>	Great Lizard-Cuckoo			X	X	LC	YR
Order Caprimulgiformes							
Family Caprimulgidae							
<i>Chordeiles gundlachii</i>	Antillean Nighthawk	X		X	X	LC	SR
Family Apodidae							
<i>Cypseloides niger</i>	Black Swift	X	X	X	X	LC	YR
<i>Streptoprocne zonaris</i>	White-collared Swift	X	X	X	X	LC	YR
Family Trochilidae							
<i>Riccordia ricordii</i>	Cuban Emerald		X	X	X	LC	YR
Order Gruiformes							
Family Aramidae							
<i>Aramus guarauna</i>	Limpkin		X			LC	YR
Order Charadriiformes							
Family Charadriidae							
<i>Charadrius vociferus</i>	Killdeer	X				LC	YR
Family Jacanidae							
<i>Jacana spinosa</i>	Northern Jacana						
Order Pelecaniformes							
Family Ardeidae							
<i>Ixobrychus exilis</i>	Least Bittern		X			LC	T, PM
<i>Egretta caerulea</i>	Little Blue Heron		X			LC	T, PM
<i>Bubulcus ibis</i>	Cattle Egret	X		X		LC	PM
<i>Butorides virescens</i>	Green Heron		X			LC	PM

Appendix 1 cont.

Scientific Name	Common Name	Habitat				Threat Status	Resident Status
		Grassland	Gallery Forest	Secondary Vegetation, Crops	Evergreen Mesophyll Forest		
Order Cathartiformes							
Family Cathartidae							
<i>Cathartes aura</i>	Turkey Vulture	X		X	X	LC	PM
Order Accipitriformes							
Family Accipitridae							
<i>Accipiter gundlachi</i> *	Gundlach's Hawk				X	EN	YR
<i>Buteo jamaicensis</i>	Red-tailed Hawk	X		X	X	LC	YR
Order Strigiformes							
Family Tytonidae							
<i>Tyto alba</i>	Barn Owl	X		X	X	LC	YR
Family Strigidae							
<i>Margarobyas lawrencii</i> *	Bare-legged Owl				X	LC	YR
<i>Glaucidium siju</i> *	Cuban Pygmy-Owl				X	LC	YR
Order Trogoniformes							
Family Trogonidae							
<i>Priotelus temnurus</i> *	Cuban Trogon		X		X	LC	YR
Order Coraciiformes							
Family Todidae							
<i>Todus multicolor</i> *	Cuban Tody		X	X	X	LC	YR
Order Piciformes							
Family Picidae							
<i>Sphyrapicus varius</i>	Yellow-bellied Sapsucker		X	X	X	LC	T, WR
<i>Xiphidiopicus percussus</i> *	Cuban Green Woodpecker		X	X	X	LC	YR
<i>Melanerpes superciliaris</i>	West Indian Woodpecker		X	X	X	LC	YR
<i>Colaptes auratus</i>	Northern Flicker		X	X	X	LC	YR
Order Falconiformes							
Family Falconidae							
<i>Falco sparverius</i>	American Kestrel	X		X	X	LC	YR
<i>Falco columbarius</i>	Merlin	X		X	X	LC	T, WR
Order Psittaciformes							
Family Psittacidae							
<i>Amazona leucocephala</i>	Cuban Parrot		X		X	VU	YR
<i>Psittacara euops</i> *	Cuban Parakeet		X		X	EN	YR
Order Passeriformes							
Family Tyrannidae							
<i>Contopus caribaeus</i>	Cuban Pewee		X	X	X	LC	YR
<i>Myiarchus sagrae</i>	La Sagra's Flycatcher		X	X	X	LC	YR
<i>Tyrannus dominicensis</i>	Gray Kingbird		X	X	X	LC	YR
<i>Tyrannus caudifasciatus</i>	Loggerhead Kingbird		X	X	X	LC	T, SR
Family Vireonidae							
<i>Vireo gundlachii</i> *	Cuban Vireo		X	X	X	LC	YR
<i>Vireo altiloquus</i>	Black-whiskered Vireo		X	X	X	LC	T, SR

Appendix 1 cont.

Scientific Name	Common Name	Habitat				Threat Status	Resident Status
		Grassland	Gallery Forest	Secondary Vegetation, Crops	Evergreen Mesophyll Forest		
Family Hirundinidae							
<i>Petrochelidon fulva</i>	Cave Swallow		X	X	X	LC	T, SR
Family Polioptilidae							
<i>Polioptila caerulea</i>	Blue-gray Gnatcatcher			X		LC	T, WR
Family Mimidae							
<i>Dumetella carolinensis</i>	Gray Catbird		X	X	X	LC	T, WR
<i>Mimus polyglottos</i>	Northern Mockingbird		X	X	X	LC	YR
Family Turdidae							
<i>Turdus plumbeus</i>	Red-legged Thrush		X	X	X	LC	YR
Family Spindalidae							
<i>Spindalis zena</i>	Western Spindalis		X	X	X	LC	YR
Family Teretistridae							
<i>Teretistris fernandinae</i> *	Yellow-headed Warbler				X	LC	YR
Family Icteridae							
<i>Sturnella magna</i>	Eastern Meadowlark	X		X		LC	YR
<i>Icterus melanopsis</i> *	Cuban Oriole		X	X	X	LC	YR
<i>Agelaius humeralis</i>	Tawny-shouldered Blackbird		X		X	LC	YR
<i>Molothrus bonariensis</i>	Shiny Cowbird			X		Nat	YR
<i>Ptiloxena atroviolacea</i> *	Cuban Blackbird		X	X	X	LC	YR
<i>Quiscalus niger</i>	Greater Antillean Grackle			X	X	LC	YR
Family Parulidae							
<i>Seiurus aurocapilla</i>	Ovenbird				X	LC	T, WR
<i>Parkesia motacilla</i>	Louisiana Waterthrush		X			LC	T, WR
<i>Mniotilta varia</i>	Black-and-white Warbler		X	X	X	LC	T, WR
<i>Geothlypis trichas</i>	Common Yellowthroat		X	X	X	LC	T, WR
<i>Setophaga ruticilla</i>	American Redstart		X	X	X	LC	WR
<i>Setophaga tigrina</i>	Cape May Warbler		X	X	X	LC	T, WR
<i>Setophaga americana</i>	Northern Parula		X		X	LC	T, WR
<i>Setophaga caerulescens</i>	Black-throated Blue Warbler		X	X	X	LC	T, WR
<i>Setophaga palmarum</i>	Palm Warbler		X	X	X	LC	T, WR
<i>Setophaga discolor</i>	Prairie Warbler		X			LC	T, WR
<i>Setophaga virens</i>	Black-throated Green Warbler		X	X	X	LC	T, WR
Family Thraupidae							
<i>Tiaris olivaceus</i>	Yellow-faced Grassquit	X	X	X	X	LC	YR
<i>Melopyrrha nigra</i>	Cuban Bullfinch		X	X	X	NT	YR
<i>Phonipara canora</i> *	Cuban Grassquit		X		X	LC	YR