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Birds of a Severely Hurricane-Damaged Atlantic Coast Rain Forest in Nicaragua[1]

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ABSTRACT

On 22 October 1988 Hurricane Joan severely damaged 500,000 ha of lowland tropical rain forest in southeastern Nicaragua near Bluefields. An expedition in February 1989 detected virtually no birds in formerly forested sites, although standing trunks that had been snapped were resprouting and the forest appeared to be recovering. In March 1990 I observed birds along rivers and at a secondary forest site and surveyed and mist-netted birds at three sites reported to be largely mature forest before they were damaged by the hurricane. I recorded a total of 161 species throughout the hurricane-damaged region. In seven days at the regenerating forest sites, I recorded 113 species of birds, a species richness comparable to undamaged lowland forest I visited six months later near the Río Santa Cruz, Nicaragua. Mist net capture rates at the damaged sites suggested overall bird abundance similar to that of a comparable lowland rain forest at La Selva, Costa Rica, but the typical habitats of mist-netted frugivores differed significantly between the two areas: the hurricane-damaged sites had proportionately fewer captures of species typical of the forest interior. Most of the birds encountered in the hurricane-damaged forest were species typical of forest edge, forest canopy, and second-growth habitats; only 19 species were birds typical of the forest interior, and only two were exclusively so. Woodcreepers, forest antbirds, and furnariids, families characteristic of lowland rain forest, were notably absent or under-represented. Overall forest structure appeared to be important in determining the species composition of the reappearing bird community.

RESUMEN

El 22 de octubre de 1988, el huracán Juana provocó daños severos en 500,000 ha de un bosque muy húmedo tropical bajo al sureste de Nicaragua cerca Bluefields. Una expedición en febrero de 1989 casi no detectó pájaros en áreas previamente con bosque, a pesar de que los troncos de árboles partidos, que aún permanecían de pie, tenían rebrotes y el bosque aparentaba estar en recuperación. En marzo de 1990, yo observé pájaros a lo largo del río y en un lugar de bosque secundario y examiné y atrapé pájaros con redes en tres lugares que se habían reportado mayormente como bosque maduro antes de ser dañados por el huracán. Se registró un total de 161 especies a través de la región dañada por el huracán. En siete días en los lugares de bosque en recuperación, se registraron 113 especies de pájaros, una riqueza de especies comparable al bosque bajo no dañado que visité seis meses después cerca del Río Santa Cruz, Nicaragua. La tasa de captura en redes en los lugares afectados sugiere una abundancia de pájaros en general similar a la de un bosque muy húmedo tropical bajo en La Selva, Costa Rica, pero el ambiente típico donde se encuentran los frugívoros capturados, fue significativamente diferente entre las dos áreas: los lugares afectados por el huracán tuvieron proporcionalmente menos capturas de especies típicas del interior del bosque. La mayoría de los pájaros encontrados en el bosque afectado por el huracán fueron especies típicas del borde del boque, el dosel y ambientes de crecimiento secundario: sólo 19 especies fueron pájaros típicos del interior del bosque, y sólo dos lo eran exclusivamente. Familias características de bosque muy húmedo bajo, como los trepadores, hormigueros, y horneros estuvieron notablemente ausentes o con poca representación. La estructura general del bosque aparentemente es importante para determinar la composición de especies en la comunidad de pájaros que reaparece.

HURRICANE JOAN HIT THE CARIBBEAN COASTAL city of Bluefields, Nicaragua, on 22 October 1988 with winds gusting to 290 km/hr (Cortes & Fonseca 1988). The storm severely damaged 500,000 ha of lowland tropical rain forest centered on a line from Bluefields to Rama, 50 km inland. Fewer than 20 percent of the trees in this region were left standing, and what had been canopy was strewn on the ground as a deep and tangled litter (Yih *et al.* 1989, 1991; Boucher 1989).

One of the more spectacular effects of the hurricane that was mentioned repeatedly by local residents was the virtual absence of birds in the days following the storm and for several months afterward. In February 1989, in two weeks of field work at widely scattered sites throughout the region of damage, Yih *et al.* (1989) sighted only about 20 doves, 3 parrots, 2 toucans, 7 kingfishers, 5 flycatchers, and several groups that were more common: egrets, herons, and vultures. All of these were

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seen either along waterways or in agricultural areas. Alerted to the scarcity of birds, members of the expedition watched and listened intently for them in forest study areas. They heard none and saw only a single *Amazilia* hummingbird (Boucher 1989).

This study documents the presence of birds in the Bluefields region 16.5 months after Hurricane Joan. Unfortunately, there are no comparable baseline data available describing the avifauna prior to the hurricane. The only recent study is that of Howell (1957) from a second-growth forest 16 km W of Rama. Previous studies (Nutting 1884, Richmond 1894, Rendahl 1919) are all based on collections made in the 19th century. The fact that so little is currently known about the avifauna of southeastern Nicaragua is particularly lamentable because its forests comprise the largest tract of extant lowland tropical rain forest in all of Central America and therefore deserve the special concern of responsible ecologists, naturalists, and conservationists worldwide.

STUDY SITES AND METHODS

I visited the Bluefields, Nicaragua region 5–18 March 1990 as a member of an international team studying the regeneration of the hurricane-damaged forest. I recorded all birds sighted in transit on the waterways, but primary observations were concentrated at three forests and one second-growth study site.

Las Delicias (12°18′N, 83°52′W, elev. 30–60 m), about 17 km NW of Kukra Hill, was visited 6–9 March. La Fonseca (12°16′N, 83°58′W, elev. 20–40 m), visited 16–18 March, is 12 km W of Las Delicias and about 3 km E of the agricultural cooperative Carlos Fonseca on the Río Kama. La Bodega (11°52′N, 83°58′W, elevation 10–20 m), visited 11–14 March, is located 500 m from the bank of the Río Kukra about 33 km by river from its mouth on Bluefields Bay. All three forest sites were primarily mature *terra firme* rain forest before the hurricane, but La Bodega differs in its proximity to the river and its inclusion of seasonally inundated *Pterocarpus* swamp. At Las Delicias and La Bodega, 80.5 percent of the trees were severely damaged (snapped = 53.2%, windthrown = 27.3%) by the hurricane, but by February 1989, 77 percent were resprouting from the base of fallen trunks or by epicormic branching. Tree seedling species composition was similar to that of adults (Yih *et al.* 1991, Vandermeer *et al.* 1990b). By March 1990 the overall death rate of adult trees was estimated at 45 percent, including those directly killed by the hurricane (Vandermeer *et al.* 1990a). A fourth site, El Kama, visited on 6 March and again 15–17 March, is situated on the W bank of the Río Kama, approximately 5 km S of La Fonseca. It comprises a mosaic of river edge, pasture, agricultural fields, low scrub, young second growth, and older second growth.

At each site, with binoculars or by voice, I identified birds during all daylight hours and recorded vocalizations for later identification, confirmation, or to lure birds into view with playback. I walked on whatever trails were available, penetrating the forest wherever possible. The forest "interior" (a euphemism, since there was no canopy) was extremely difficult to reach due to the ubiquitous litter of fallen trunks and limbs, the dense tangle of vines, and new sprouting vegetation. For estimates of avian abundance, I opened between three and seven 2.6 × 12 m mist nets from ≈0600 to ≈1000 hr on the second and third mornings at each forest site (only one morning at La Fonseca). I used mostly 36 mm mesh nets with one 30 mm or 71 mm net set along existing or modified trails. I checked nets every 30 minutes and color-banded resident birds or feather-clipped migrants and hummingbirds to identify recaptured individuals.

Mist net capture rates were compared with those of Levey (1988a, b) at La Selva, a lowland rain forest in Costa Rica 180 km to the south. I also compared the species list from my study with birds which I recorded over a similar period of 7 days (30 August to 5 September 1990) at La Lupe (11°7′N, 84°22′W, elev. 80–160 m), a site 110 km SW of Bluefields near the Río Santa Cruz, 12.5 km NNE of El Castillo, Río San Juan, Nicaragua. La Lupe was not damaged by the hurricane and comprises mostly mature *terra firme* rain forest selectively logged in 1985–86, patches of uncut primary forest, and forest edge and second growth. In overall structure it resembles mature rain forest, since the crowns of many of the large trees (*e.g.*, *Dipteryx panamensis*) have been left intact, but it also shares some characteristics with the hurricane-damaged forest, notably an understory littered with fallen branches and dense new vegetation. To compare distributions of birds by typical habitats, I used the classification in Stiles (1983) for La Selva. Species that were listed as occurring in several habitats were placed in mutually exclusive categories based on the most mature forest category in which they are typically found, in the order: mature forest interior, interior of old second growth, forest canopy, forest edge, young second growth, and scrub and pasture.

RESULTS

In the 12 field and travel days of the study, I recorded 161 species of birds in the region (Appendix A). The total for all terrestrial habitats, excluding aquatic birds, was 130 species over 8.5 days. Excluding species seen in transit, at the second growth site of El Kama, and at or above a forest pond at La Bodega, I recorded 105 terrestrial species in the recovering forest over a 7-day period. Using identical observation methods, I recorded 112 nonaquatic species over 7 days in undamaged rain forest at La Lupe (T. Will, pers. obs.). Excluding migrants and transients from both lists (since the surveys were done at different times, March *vs.* September), the comparison is 90 species in the hurricane-damaged forest *vs.* 98 at the undamaged site. If more open pasture habitat is included, there were 130 species at the hurricane-damaged sites compared with 122 at La Lupe (109 *vs.* 107, respectively, without migrants). Thus, depending on whether more open habitats and/or migrants are included, the hurricane-damaged sites near Bluefields appear from 6.5 percent richer in bird species to 8.2 percent less rich than a similarly surveyed, undamaged forested area. The distribution of species (migrants excluded) typical of mature forest/old second-growth interior, forest canopy, forest edge, and young second growth/pasture was similar at both sites (test of independence, $\chi^2_3 = 6.24$, $P > .05$).

Of the 105 nonaquatic species at the three forest sites, 19 (18%) were birds typically found in the interior of tropical forest ("Fi" in Appendix A). Of these, only Slaty-breasted Tinamou and Song Wren are more or less birds of the forest interior exclusively (they also are found in closed canopy old second growth). The other 17 species are also often found at the forest edge (including light gaps), in older second growth, or in tree plantations. Of the 105 forest site species, 21 (20%) were birds of open pasture, low scrub, and young second growth—not at all typical of forest. Thirty-six (34%) of the forest site species were birds typical of the forest canopy. With the exception of Great Green Macaw, all of these are also commonly found in other habitats, notably forest edge, old second growth, and tree plantations. An additional 24 species (23%) were typical of forest edge, including light gaps of various ages, but not of forest canopy; many of these are also found in older second growth and tree plantations. The distribution of species typical of mature forest/old second-growth interior, forest canopy, forest edge, and young second growth/pasture found at the three forest sites differed significantly from that found at the predominantly second-growth/pasture site of El Kama (test of independence, $\chi^2_3 = 9.57$, $P < .025$); El Kama had proportionately fewer forest interior and more young second-growth/pasture species.

At the three hurricane-damaged forest sites, I captured a total of 52 individuals of 30 species in 113.5 net-hours, an average of 0.458 birds per net-hour (numerals in Appendix A). In lowland rain forest at La Selva, Costa Rica, Levey (1988a) captured an average of 0.237 birds per net-hour in forest gaps over all months of the year (0.195 in gaps and intact forest combined). Because tropical bird abundance can vary considerably from month to month (Karr 1976, Levey 1988b), it is more enlightening to compare only March captures, where the Levey (1988b) data were available only for frugivores in intact forest, mature forest gaps, and second growth. I used Levey's (1988b) dietary classification for my captures (Appendix A) and recorded 0.282 frugivore captures per net-hour as compared with 0.125 for the Levey (1988b) study in March at La Selva. Although there are differences in habitat, in the magnitude of the studies (114 *vs.* $\approx$1042 March net-hours), and in the duration of net set (until $\approx$1000 *vs.* $\approx$1400 hr) that make comparison less than ideal, the contrast provides no evidence of low overall bird abundance in the hurricane-damaged Nicaraguan forest. However, the distributions of number of frugivore captures typical of mature forest/old second-growth interior, forest canopy/edge, and young second growth were significantly different between La Selva and the hurricane-damaged sites (test of independence, $\chi^2_2 = 13.3$, $P < .005$). Frugivores typically found in the forest interior were proportionately less abundant while edge and scrub birds were more abundant in the Nicaraguan forest samples.

DISCUSSION

Sixteen months after Hurricane Joan, neither overall bird species richness nor abundance appeared to be unusually depressed at study sites in the damaged Nicaraguan rain forest—a situation radically different from the virtual absence of birds reported four months after the hurricane by Yih *et al.* (1989). Although none of the researchers on the February 1989 expedition were trained ornithologists, they all were ecologists or naturalists with much tropical experience. Their perceptions should not be taken lightly, especially as the scarcity of birds was a common theme among local residents, many of whom were quite familiar with the local avifauna

and capable of identifying many birds to species both visually and by vocalization. But without evidence of massive mortality or displacement or comparable mist net sampling in the months immediately following the forest destruction, it is not possible to assess the magnitude of the direct effects of the hurricane on the avifauna. Birds may have been killed outright by the high winds and debris or blown away—or many birds may have survived the storm and concentrated in local patches, singing less and remaining inconspicuous in the tangles of fallen debris.

The fact that the hurricane damaged so vast an area coupled with the relative abundance of birds detected 16.5 months later suggests that many birds probably did survive the storm and afterward wandered locally as regenerating patches of forest became available. Similar strong hurricanes in forests of Jamaica (J. Wunderle, pers. comm.), Mexico, and Puerto Rico appear to have resulted in little direct mortality of birds, but drastic declines in populations of nectarivores and frugivores in Mexico after Gilbert (Lynch 1991) and in Puerto Rico (Waide 1991) and the Virgin Islands (Askins & Ewert 1991) after Hugo, suggest that loss of food resources results in subsequent local movement. The data from this study also suggest that birds reappear as food resources become available in the regenerating forest. Yih *et al.* (1991) found virtually no pioneer tree species in the forest study sites in February 1989, but by March 1990 bird-dispersed species like *Cecropia* and fruiting shrubs were common on several of the transects (Vandermeer *et al.* 1990a)—along with the frugivorous birds that were so conspicuously absent a year before.

The reappearance of birds in the Nicaraguan hurricane-damaged forest seems to be closely linked to the availability of structurally suitable habitat. The first species to become conspicuous after the hurricane were birds of less damaged agricultural zones and waterways (Yih *et al.* 1989). By March 1990 the regenerating forest sites resembled expanses of dense second-growth understory, but they differed from young secondary forest in having a tree species composition similar to that of mature forest (Yih *et al.* 1991) and in the presence of numerous large resprouting trunks which nonetheless lacked the spreading crowns of mature forest trees. Thus, it is not too surprising that most of the birds noted on the regenerating sites were species typical of forest canopy, forest edge, and second-growth sites and that there were proportionately more net captures of frugivores typical of forest edge and young second-growth habitats than at La Selva. Lynch (1991) noted a similar influx of field- and shrub-associated species in Mexico after Hurricane Gilbert. In the distribution of species by typical habitats, the Nicaraguan hurricane-damaged forest sites were similar to selectively logged forest at La Lupe, but they still had proportionately more species typical of the forest interior and fewer species typical of scrub and young second-growth habitats than the largely second-growth site of El Kama. Intermediate in structure and tree species composition between mature forest and second growth, the hurricane-damaged forest sites in March 1990 appeared to support an avifauna intermediate between one characteristic of mature rain forest and one characteristic of second-growth forest. This suggests an hypothesis of close linkage between overall forest structure and the species composition of the bird community. As the forest continues to regenerate (Vandermeer *et al.* 1990a), forest interior birds should become more evident. This prediction assumes that there was sufficient variation in the extent of hurricane damage throughout the region to have provided the necessary refugia to sustain populations of the more uncommon forest species.

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Appendix A

Species of birds noted in the vicinity of Bluefields, Nicaragua, 5–18 March 1990. Birds seen along waterways are indicated under RIOS; those recorded at El Kama are listed under KAMA. The three forest sites of Las Delicias, La Fonseca, and La Bodega are designated as DEL, FON, and BOD, respectively. Numerals in the columns indicate mist-net captures.

Scientific name[a]	English common name[a]	Habitat[b]	Diet[c]	RIOS	KAMA	Forest sites[d]		
						DEL	FON	BOD
Crypturellus soui	Little Tinamou	Fe, S	F/G		x	fc	x	fc
Crypturellus boucardi	Slaty-breasted Tinamou	Fi, oS	F/G			x		
Pelecanus occidentalis	Brown Pelican	A	P	fc				
Phalacrocorax olivaceus	Olivaceous Cormorant	A	P	fc				
Anhinga anhinga	Anhinga	A	P	fc				
Fregata magnificens	Magnificent Frigatebird	A	P	fc				
Tigrisoma mexicanum	Bare-throated Tiger-Heron	A	Pr					(x)
*Nycticorax nycticorax***	Black-crowned Night-Heron**	A	Pr		x			
Bubulcus ibis	Cattle Egret	P	I	c	x			
*Butorides striatus***	Green-backed Heron**	A	Pr	fc				(x)
*Egretta caerulea**	Little Blue Heron*	A	P	vc				(x)
*Egretta tricolor**	Tricolored Heron*	A	P	c				
*Egretta thula**	Snowy Egret*	A	P	c				
*Casmerodius albus***	Great Egret**	A	Pr	vc				
*Ardea herodias**	Great Blue Heron*	A	Pr	fc				(x)
Mycteria americana	Wood Stork	A	P	vc	x			(fc)
Ajaia ajaja	Roseate Spoonbill	A	P, I	x				(x)
Cairina moschata	Muscovy Duck	A	G	x				(x)
Cathartes aura	Turkey Vulture	O	C	c	c	c	c	c
Coragyps atratus	Black Vulture	O	C, Fp	c	c	c	c	c
*Pandion haliaetus**	Osprey*	A	P	fc				
Elanoides forficatus°*	American Swallow-tailed Kite°	O	Pr	x	x	x		x
Elanus caeruleus	Black-shouldered Kite	P	Pr	x			x	
Harpagus bidentatus	Double-toothed Kite	Fc, Fe	Pr			x		
Leucopternis semiplumbea	Semiplumbeous Hawk	Fi, Fe, oS, Fp	Pr		x			x
Leucopternis albicollis	White Hawk	Fc, Fe	Pr		x			
Buteogallus anthracinus	Common Black-Hawk	Fe	Pr	x				x
Buteo nitidus	Gray Hawk	Fe	Pr	x				
Buteo magnirostris	Roadside Hawk	yS	Pr		x			
*Buteo platypterus**	Broad-winged Hawk*	Fe	Pr			x		
Spizaetus tyrannus	Black Hawk-Eagle	Fe, S	Pr		x			
Herpetotheres cachinnans	Laughing Falcon	Fe, S, Fp	Pr					x
*Falco sparverius**	American Kestrel*	P	Pr		x			

Appendix A

Continued.

Scientific name[a]	English common name[a]	Habitat[b]	Diet[c]	RIOS	KAMA	Forest sites[d] DEL	FON	BOD
Ortalis cinereiceps	Gray-headed Chachalaca	yS	Fh					x
Penelope purpurascens	Crested Guan	Fi, Fe, oS, Fp	Fh					x
Laterallus albigularis	White-throated Crake	A, P	I, G		x			
Heliornis fulica	Sungrebe	A	I, Pr	fc				
Jacana spinosa	Northern Jacana	A, P	I, Pr, G	fc				
*Actitis macularia**	Spotted Sandpiper*	A	I, Pr	fc				
*Larus atricilla**	Laughing Gull*	A	Pr	c				
*Sterna maxima**	Royal Tern*	A	P	fc				
Columba speciosa	Scaled Pigeon	Fc, Fe, Fp	Fh		fc		fc	fc
Columba nigrirostris	Short-billed Pigeon	Fc, Fe, oS, Fp	Fh			x		
Columbina talpacoti	Ruddy Ground-Dove	P	F/G		x			
Claravis pretiosa	Blue Ground-Dove	P, yS	G		fc		fc 2	
Leptotila cassinii	Gray-chested Dove	Fe, oS, Fp	F/G				x	x
Ara ambigua	Great Green Macaw	Fc	Fh			x		
Aratinga finschi	Crimson-fronted Parakeet	P	Fh	fc		c	c	fc
Aratinga nana	Olive-throated Parakeet	Fe, oS, Fp	Fh		fc	fc	fc	fc
Brotogeris jugularis	Orange-chinned Parakeet	P, yS	F/G		fc	fc		x
Pionopsitta haematotis	Brown-hooded Parrot	Fc, Fe, S, Fp	F/G	x		fc		
Pionus senilis	White-crowned Parrot	Fc, Fe, S, Fp	F/G	x	fc		x	
Amazona autumnalis	Red-lored Amazon	Fc, Fe, Fp	F/G		c	c	fc	fc
Amazona farinosa	Mealy Amazon	Fc, Fe, Fp	F/G		fc	c		fc
Piaya cayana	Squirrel Cuckoo	Fe, yS, Fp	I			fc 1	x	fc
Crotophaga sulcirostris	Groove-billed Ani	P, yS	I, Fp	c	c			fc 1
Tapera naevia	Striped Cuckoo	P	I		x			
Otus guatemalae	Vermiculated Screech-Owl	Fi, Fe	I			x		x
Pulsatrix perspicillata	Spectacled Owl	Fi, Fe, Fp	Pr					x
Ciccaba virgata	Mottled Owl	Fe, oS, Fp	Pr		x			
Nyctibius grandis	Great Potoo	Fc, Fe	I			x		
*Chordeiles acutipennis***	Lesser Nighthawk**	P	I	fc				
Nyctidromus albicollis	Pauraque	P, yS	I		c	c	fc	fc
Chaetura cinereiventris	Gray-rumped Swift	O	I	fc	fc	fc		fc
Glaucis aenea	Bronzy Hermit	Fe, yS	N		fc		fc 2	
Phaethornis longuemareus	Little Hermit	Fi, Fe, oS	N			fc 2		
Florisuga mellivora	White-necked Jacobin	Fi, Fe, oS, Fp	N			x		
Thalurania colombica	Crowned Woodnymph	Fi, Fe, S, Fp	N		x	fc 1		

Appendix A

Continued.

Scientific name[a]	English common name[a]	Habitat[b]	Diet[c]	RIOS	KAMA	Forest sites[d] DEL	FON	BOD
Hylocharis eliciae	Blue-throated Goldentail	Fe, oS	N					1
Amazilia tzacatl	Rufous-tailed Hummingbird	yS	N			fc 1	fc 2	fc 2
Trogon massena	Slaty-tailed Trogon	Fc, Fe, oS, Fp	Fp			x	x	
Trogon melanocephalus	Black-headed Trogon	Fc, Fe, oS	Fp		x		x	
Ceryle torquata	Ringed Kingfisher	A	P	c				(x)
*Ceryle alcyon**	Belted Kingfisher*	A	P	fc				
Chloroceryle amazona	Amazon Kingfisher	A	P	c				
Chloroceryle americana	Green Kingfisher	A	P	fc				
Chloroceryle aenea	American Pygmy Kingfisher	A, Fi, Fe	P					1
Electron platyrhynchum	Broad-billed Motmot	Fc, Fe, oS	Fp			x		
Baryphthengus martii	Rufous Motmot	Fc, Fe, oS	Fp			fc	x	
Bucco macrorhynchos	White-necked Puffbird	Fc, Fe, oS	I, Pr			x		
Pteroglossus torquatus	Collared Aracari	Fc, Fe, oS, Fp	Fp	x		x		
Ramphastos sulfuratus	Keel-billed Toucan	Fc, Fe, oS, Fp	Fp		x	fc	x	x
Ramphastos swainsonii	Chestnut-mandibled Toucan	Fc, Fe, oS, Fp	Fp	x	x	fc		x
Melanerpes pucherani	Black-cheeked Woodpecker	Fc, Fe, oS, Fp	I, Fp		x			x
Dryocopus lineatus	Lineated Woodpecker	Fe, oS	I		x			
Campephilus guatemalensis	Pale-billed Woodpecker	Fc, Fe, oS, Fp	I			x		x
Dendrocincla fuliginosa	Plain-brown Woodcreeper	Fi, Fe	I				x	
Cymbilaimus lineatus	Fasciated Antshrike	Fe, S, Fp	I		x			
Taraba major	Great Antshrike	yS	I		x	x	x	
Thamnophilus doliatus	Barred Antshrike	yS	I		x	x	x	
Thamnophilus punctatus	Slaty Antshrike	Fi, Fe, oS, Fp	I			fc	fc	fc
Cercomacra tyrannina	Dusky Antbird	Fe, oS	I			x		x
Myrmeciza exsul	Chestnut-backed Antbird	Fi, Fe, oS	I			fc	fc	fc
Hylophylax naevioides	Spotted Antbird	Fi, Fe	I				x	
Tityra semifasciata	Masked Tityra	Fc, Fe, oS, Fp	Fp		x	fc	x	x
Carpodectes nitidus	Snowy Cotinga	Fc, Fe, Fp	Fh		x	x	x	x
Pipra mentalis	Red-capped Manakin	Fi, Fe, oS	Fh			c 2	fc 1	fc 1
Manacus candei	White-collared Manakin	Fe, oS	Fh		fc	fc 1		c 1
Colonia colonus	Long-tailed Tyrant	Fc, Fe, Fp, P	I		x			
Tyrannus tyrannus†	Eastern Kingbird†	Fe, oS, Fp	Fp		x			
Tyrannus melancholicus	Tropical Kingbird	P, yS	Fp	c	fc			
Megarhynchus pitangua	Boat-billed Flycatcher	Fc, Fe, oS, Fp	Fp		x		x	
Attila spadiceus	Bright-rumped Attila	Fc, Fe, oS, Fp	Fp	x	x	fc	fc	fc

Appendix A

Continued.

Scientific name[a]	English common name[a]	Habitat[b]	Diet[c]	RIOS	KAMA	Forest sites[d] DEL	FON	BOD
Myiozetetes similis	Social Flycatcher	P, yS	Fp	fc	fc			
Pitangus sulphuratus	Great Kiskadee	P	Fp	c	fc			
Rhytipterna holerythra	Rufous Mourner	Fc, Fe, oS, Fp	Fp				1	
*Myiarchus crinitus**	Great Crested Flycatcher*	Fc, Fe, oS, Fp	Fp		x	x		x
Myiarchus tuberculifer	Dusky-capped Flycatcher	Fe, oS, Fp	Fp		x		1	x
Contopus cinereus	Tropical Pewee	P, yS	I		x			
Oncostoma cinereigulare	Northern Bentbill	Fe, oS	I				x	
Elaenia flavogaster	Yellow-bellied Elaenia	P, yS	Fp		x		x	
Mionectes oleagineus	Ochre-bellied Flycatcher	Fi, Fe, oS, Fp	Fp			1		
Progne subis†	Purple Martin†	O	I	x				
Progne chalybea	Gray-breasted Martin	P	I	fc	fc	fc	c	
Tachycineta albilinea	Mangrove Swallow	A	I	vc				
Cyanocorax morio	Brown Jay	yS	Fp			x		
Thryothorus thoracicus	Stripe-breasted Wren	Fe, oS, Fp	I					x
Thryothorus nigricapillus	Bay Wren	Fe, oS	I		fc		x	fc
Troglodytes aedon	House Wren	yS	I		fc	fc	fc	
Cyphorhinus phaeocephalus	Song Wren	Fi, oS	I					x
*Dumetella carolinensis**	Gray Catbird*	yS	Fp		x		fc 2	fc 1
Turdus grayi	Clay-colored Robin	P, yS	Fp		fc			
*Hylocichla mustelina**	Wood Thrush*	Fi, Fe, oS	Fp					1
Polioptila plumbea	Tropical Gnatcatcher	Fc, Fe, oS, Fp	I		fc	fc	c	c
Ramphocaenus melanurus	Long-billed Gnatwren	Fe, oS	I			1		
Vireolanius pulchellus	Green Shrike-Vireo	Fc, Fe, Fp	Fp		x			
*Vireo flavifrons**	Yellow-throated Vireo*	Fc, Fe, oS, Fp	I			x		
Vireo olivaceus†	Red-eyed Vireo†	Fc, Fe, oS, Fp	Fp		x		fc	
Hylophilus decurtatus	Lesser Greenlet	Fc, Fe, oS, Fp	Fp		fc	fc	fc	c
*Vermivora pinus**	Blue-winged Warbler*	yS	I				x	
*Vermivora peregrina**	Tennessee Warbler*	Fe, yS, Fp	Fp			1		
*Dendroica petechia**	Yellow Warbler*	P, yS	I		fc			
Dendroica cerulea†	Cerulean Warbler†	Fc, Fe, Fp	I		x			
*Dendroica pensylvanica**	Chestnut-sided Warbler*	Fc, Fe, S, Fp	Fp		fc		fc 1	
*Seiurus aurocapillus**	Ovenbird*	Fe, oS	I					1
*Seiurus noveboracensis**	Northern Waterthrush*	Fe, S	I			1		
*Oporornis formosus**	Kentucky Warbler*	Fi, Fe, oS	I			1		1
Geothlypis poliocephala	Gray-crowned Yellowthroat	P, yS	Fp				x	

Appendix A

Continued.

Scientific name[a]	English common name[a]	Habitat[b]	Diet[c]	RIOS	KAMA	Forest sites[d] DEL	FON	BOD
Psarocolius montezuma	Montezuma Oropendola	Fc, Fe, oS, Fp	Fp			fc	fc	
Cacicus uropygialis	Scarlet-rumped Cacique	Fc, Fe, Fp	Fp			fc	fc	fc
Quiscalus mexicanus	Great-tailed Grackle	P	Fp	c				
*Icterus spurius**	Orchard Oriole*	S	Fp		x			
Icterus dominicensis	Black-cowled Oriole	Fe, S, Fp	Fp		x			x
*Icterus galbula**	Northern Oriole*	Fe, S, Fp	Fp		fc			fc
Tangara larvata	Golden-hooded Tanager	Fc, Fe, S	Fp		fc			fc
Dacnis cayana	Blue Dacnis	Fc, Fe, Fp	Fp			fc	x	
Thraupis abbas	Yellow-winged Tanager	S, Fp	Fp		x			
Ramphocelus passerinii	Scarlet-rumped Tanager	S	Fp	fc	c	c 2	c	c 1
*Piranga rubra**	Summer Tanager*	Fc, Fe, oS, Fp	Fp		x			x
Habia fuscicauda	Red-throated Ant-Tanager	Fe, oS	Fp					1
Saltator coerulescens	Grayish Saltator	yS	Fp		x			
Caryothraustes poliogaster	Black-faced Grosbeak	Fe, oS, Fp	F/G		x		fc	fc 1
Pitylus grossus	Slate-colored Grosbeak	Fc, Fe, Fp	F/G			1		
Cyanocompsa cyanoides	Blue-black Grosbeak	Fe, oS	F/G			1	1	
*Passerina cyanea**	Indigo Bunting*	yS	F/G		x			
Sporophila schistacea	Slate-colored Seedeater	yS	G	fc	c		fc	
Sporophila aurita corvina	Variable Seedeater	P, yS	F/G		fc			
Oryzoborus funereus	Thick-billed Seed-Finch	yS, Fe	F/G		fc		fc 2	
Volatinia jacarina	Blue-black Grassquit	P, yS	F/G		fc		fc 2	
Arremon aurantiirostris	Orange-billed Sparrow	Fi, Fe, oS	F/G		x	x		
Arremonops conirostris	Black-striped Sparrow	yS, P	F/G		c	c 3	fc	c 1
Total species			161	48	78	62	54	65
Total less aquatic species			130		76	62	54	57
Total number of mist-net captures			52			20	17	15
Mist-net hours			113.5			28	31.5	54
Number of captures per net-hour			0.458			0.714	0.540	0.278
Frugivores per net-hour			0.282			0.429	0.349	0.167

[a] Status: * = North American wintering migrant; ** = resident population + migrants; † = North American transients; ° = resident population migrating south. Taxonomic order and nomenclature based on Stiles & Skutch (1989).

[b] Typical habitat based on Stiles (1983) for La Selva, Costa Rica: Fi = forest interior, Fc = forest canopy, Fe = forest edge, including light gaps, Fp = tree (*e.g.*, cacao) plantations, arboretums, etc.; oS = old second growth, with a more or less distinct canopy; yS = young second growth or low scrub; S = second growth in general; P = pastures and other open habitat; A = aquatic habitat; O = aerial, ranging above various habitats.

[c] Diet classification after Levey (1988b) and Stiles & Skutch (1989): P = piscivore; Pr = predator (mainly of vertebrates); C = carrion; I = insectivore; Fh = heavy frugivore, Fp = partial frugivore (omnivore), F/G = frugivore/granivore; G = granivore; N = nectarivore.
[d] Relative abundance of records: vc = very common, >30 individuals noted daily; c = common, 10–30 individuals noted daily; fc = fairly common, 3–10 individuals noted daily (or <30 individuals recorded once); x = present, or recorded infrequently. Numerals indicate mist-net captures. () = aquatic species excluded from certain analyses.