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Avian biodiversity in a pasture-dominated ecosystem

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Abstract Burgeoning human populations have created many challenges for conservation of biodiversity, as ever-larger areas of land are converted to agricultural and other forms of production. Protected reserves alone are not sufficient to sustain biodiversity in a world of increasing human needs, so it is necessary to understand the extent to which biodiversity can exist within highly altered, agricultural ecosystems. From 11 May to 8 August 2013, bird diversity was surveyed at an agricultural site on Hispaniola, utilized mainly for pasture, and the population and regeneration potential of the royal palm (*Roystonea borinquena*), a key nest tree species for two abundant bird species, was assessed. The site harbored 33 bird species including 32 resident species (about one-third of Hispaniola's low-elevation resident land bird species), of which 5 are endemic to Hispaniola. Two of these endemic species, the Palmchat (*Dulus dominicus*) and the Hispaniolan Woodpecker (*Melanerpes striatus*), were the predominant species present. Seventy-six percent of species at this site showed an association with trees. The royal palm occurred mainly in wooded riparian corridors, but showed little ability to colonize pastures, suggesting possible declines in future overall tree density at this site. Ensuring adequate tree recruitment is crucial to maintaining biodiversity in agricultural and grazing zones.

Keywords biodiversity, deforestation, *Dulus dominicus*, *Melanerpes striatus*, *Roystonea borinquena*

Resumen Biodiversidad aviar en un ecosistema dominado de pastizal—El crecimiento de las poblaciones humanas ha generado muchos desafíos para la conservación de la biodiversidad, ya que cada vez una mayor cantidad de terrenos son transformados para la agricultura y otras formas de producción. Las áreas protegidas no son suficientes por sí solas para sostener la biodiversidad en un mundo con necesidades humanas crecientes, por eso es necesario entender el grado en que la biodiversidad puede existir en ecosistemas agrícolas altamente transformados. Desde el 11 de mayo al 8 de agosto de 2013 se muestreó la diversidad de aves en un sitio agrícola de La Española utilizado principalmente para el pastoreo. También se evaluó la población y el potencial regenerador de la palma real (*Roystonea borinquena*), una especie de árbol clave para la nidificación de dos especies muy abundantes. El sitio albergó 33 especies de aves, incluyendo 32 especies residentes (cerca de un tercio de las especies de aves terrestres de zonas bajas de La Española), de las cuales cinco son endémicas de La Española. Dos de estas especies endémicas, la Sigua Palmera (*Dulus dominicus*) y el Carpintero de La Española (*Melanerpes striatus*) fueron las especies predominantes. Setenta y cinco por ciento de las especies de este sitio mostraron una asociación con los árboles. La palma real se encontró principalmente en los corredores boscosos ribereños, pero mostró poca habilidad para colonizar pastos, lo que sugiere posibles disminuciones en la densidad total de árboles en el futuro. Asegurar un adecuado reclutamiento de árboles es crucial para mantener la biodiversidad en las zonas agrícolas y de pastoreo.

Palabras clave biodiversidad, deforestación, *Dulus dominicus*, *Melanerpes striatus*, *Roystonea borinquena*

Résumé Diversité de l'avifaune dans un écosystème dominé par le pâturage—L'augmentation de la population humaine entraîne de nombreux défis pour la conservation de la biodiversité, des zones de plus en plus vastes étant transformées pour l'agriculture et pour d'autres formes de production. Les espaces protégés ne sont pas suffisants pour maintenir la biodiversité dans un monde où les besoins de l'homme sont en constante augmentation. Il est ainsi nécessaire de comprendre comment la biodiversité peut persister au sein d'écosystèmes agricoles hautement altérés. Du 11 mai au 8 août 2013, la diversité de l'avifaune a été étudiée à Hispaniola sur une zone agricole utilisée principalement pour le pâturage. La population et le potentiel de régénération du Palmier royal de Porto Rico (*Roystonea borinquena*), une espèce d'arbre clé pour la nidification de deux espèces d'oiseaux abondantes, ont été évalués. Le site abritait trente-trois espèces d'oiseaux dont trente-deux espèces résidentes (environ un tiers des espèces résidentes d'oiseaux terrestres de basse altitude à Hispaniola), dont cinq espèces endémiques d'Hispaniola. Deux de ces espèces endémiques, l'Esclave palmiste (*Dulus dominicus*) et le Pic d'Hispaniola (*Melanerpes striatus*), étaient prédominantes. Soixante-seize pour cent des espèces de ce site étaient associées aux arbres. Le Palmier royal de Porto Rico était principalement présent dans les corridors de ripisylve, mais montrait peu de capacité à coloniser les pâturages, ce qui indique un risque de baisse de la densité des arbres sur ce

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site dans le futur. Il est donc essentiel de veiller à ce que la régénération de ce palmier soit suffisante pour que la biodiversité se maintienne dans les zones agricoles et pastorales.

Mots clés biodiversité, déforestation, *Dulus dominicus*, *Melanerpes striatus*, *Roystonea borinquena*

Burgeoning human populations have created many challenges to conserving biodiversity, as land-use decisions often result in the conversion of natural ecosystems to specialized human uses (e.g., Terborgh 1992, Vandermeer and Perfecto 2005). Western ideas of conservation often focus on setting aside reserves where hunting and land clearing are prohibited (e.g., Pasquier 1980). Such reserves are an indispensable part of conservation strategy in tropical forested landscapes, because a 90% reduction in forest cover in such a region can result in a 50% loss of biodiversity (Terborgh 1992), and the effects of deforestation on biodiversity can persist for decades after the landscape appears stabilized (Hansen *et al.* 2005). But a balanced approach is needed. Reserves alone are not sufficient, because land uses outside protected areas can reduce the viability of such reserves (e.g., humans living adjacent to protected areas may enter reserves in search of economic opportunities; Vandermeer and Perfecto 2005). Areas used for agricultural production can also be part of an overall conservation strategy. Many species can sustain themselves in highly altered ecosystems dominated by human activity, and some grazing areas have similar avian diversity to protected areas without grazing (Hansen *et al.* 2005).

A sustainable conservation strategy must include consideration of conditions in the places where people live. Such consideration must involve assessment of biodiversity that includes highly altered ecosystems, including those impacted by agricultural practices such as growing regions for coffee (*Coffea* spp.; e.g., Perfecto *et al.* 1996, Wunderle and Latta 1998, Wunderle 1999, Carlo *et al.* 2004) and cacao (*Theobroma cacao*; e.g., Rice and Greenberg 2000), as well as lands that have been converted to pastures for grazing livestock. Pasture, in particular, has long been a dominant land use in the Neotropics (Gumbs 1981), but although there have been studies of abandoned pastures reverting to forest (e.g., Guevara *et al.* 1986, Zimmerman *et al.* 2000, Myster 2003), there has been a dearth of biodiversity research that includes actively grazed pasture lands in tropical regions. Studies of abandoned pastures have found low tree recruitment in these habitats, and have sought to identify the causes (Zimmerman *et al.* 2000, Myster 2003). Some suggested causes are competition from herbaceous vegetation, seed and seedling predation, lack of seed dispersal, and hotter and drier conditions relative to forest (Zimmerman *et al.* 2000). In active pastures, the activities of cattle (e.g., trampling of vegetation, soil compaction, creation of hummocks, and deposition of dung) have also been cited as possible factors inhibiting tree regeneration (Myster 2003).

The present study sought to document the extent to which bird species utilize pasture-dominated, agricultural ecosystems, and the sustainability of royal palm (*Roystonea borinquena*) tree cover in such ecosystems. Across different habitats present on the site, I documented 1) avian species diversity, 2) overall density of vegetation cover, and 3) regeneration of royal palm.

Methods

The north coast of Espaillat Province, Dominican Republic, is in the "Partly Evergreen Hardwood" zone of Durland (1922). Little of the original forest remains in the region, which is now largely devoted to agriculture and ranching. Finca Cambium (hereafter Cambium; 19°36'03"N, 70°10'45"W), a 48.5 ha agricultural estate approximately 3 km inland at elevations ranging from 29 to 76 m above sea level, was chosen as a study site because it is typical of this broader landscape, consisting of 66% pasture, 33% certified organic cacao, and < 1% of *conuco* (i.e., mixed crops), gardens, and houses. It is traversed by the Río Magante and several intermittent tributary streams, with remnant riverine forest along the banks. The riparian corridors, both the Río Magante and its tributary streams, sustain the only remnants of original forest retaining their original multilayered structure. Cacao plantations are shaded with a diversity of forest tree species, but lack understory structure. The pastures are *Roystonea-Samanea* pasture (Borhidi 1988), consistent with the partly evergreen forest zone. In all three of these habitats, royal palm is an abundant tree species. This species is a national symbol of the Dominican Republic, with many uses (Horst 1997) and a close association with the Palmchat (*Dulus dominicus*), the national bird of the country. Palmchats build large communal nests of sticks on the massive infructescences of royal palms (Bond 1985). Hispaniolan Woodpeckers (*Melanerpes striatus*) excavate nesting cavities in this tree species also (Selander 1966).

From 11 May to 8 August 2013, I conducted bird surveys in all four habitat types at Cambium: pastures, cacao plantations, *conuco* and gardens, and riparian corridors. I conducted area searches (adopted from Ralph *et al.* 1993) consisting of 31 observation days separated by a mean of 2.1 days (minimum = 0, maximum = 4 for the first 1.5 months, with three gaps of 7 days each in the second 1.5 months). The search time for each observation day was lengthened to 120 min to increase the encounter probability of secretive species in heavily forested habitat (Dieni and Jones 2002). Observation days reflected the relative proportions of the different habitats: two-thirds of observation days were conducted in pastures and one-third in cacao plantations and riparian corridors. *Conuco* was not systematically searched, but observations were made while passing through. Additionally, I conducted walking transects along public roads extending into the area surrounding Cambium on 12 observation days. During observation days, I recorded visual and auditory observations of birds in each habitat type. Bond (1985) was used for identification, and Spanish common names were updated according to the recommendations of the Sociedad Español de Ornitología (Bernis *et al.* 1994a, 1994b, 1996, 1998, 2000, 2001, 2002, De Juana *et al.* 2004, 2005, 2010, 2012). I constructed a species accumulation curve for Cambium. I did not attempt to estimate abundances, because birds were not individually marked, so it is likely some individuals were counted more than once.

From 24 July to 1 August 2013, I censused colony trees of Hispaniolan Woodpeckers throughout Cambium, noting nest tree species, whether the colony occupied one or two trees, whether the nest trees were living or dead, and whether the colony was active or abandoned.

Since royal palm provides crucial nesting habitat for several bird species, I counted the number of palms of this species in each delineated pasture, and classified them as juvenile (not yet of reproductive age), mature (fruiting), or dead trees. Stumps were counted as dead trees because they represent a loss of reproductive individuals, and because dead palms are seen by local people as a valuable resource and are often quickly cut down. Palms in the riparian corridors were not counted because this was not intended to be a complete census, but rather, an assessment of regeneration in the pasture habitat.

To sample seedling recruitment of the royal palm, I randomly selected two fruiting trees in each of five pastures distributed across Cambium (i.e., 10 trees total). At distances of 5 and 10 m from each tree along a randomly selected azimuth, a 1 m^2 quadrat was placed, the nearest corner placed at the measured distance, and the nearest and furthest corners aligned along the selected azimuth, for a total of 20 quadrats. I counted the number of palm seedlings in each quadrat, and percent cover, summed to 100, of each of the following classes: bare soil, cattle path, grass/forb, shrub, woody debris, tree seedling < 2 m height (other than royal palm), exposed root, liana, leaf litter, and rock. For comparison, I used the same protocol to sample seedling recruitment in the riparian corridors. Statistical analyses were carried out using Microsoft Excel 2007 (Microsoft Corporation, Redmond, WA, USA).

Results

Thirty-three bird species were observed at Cambium (Table 1). Seventy-six percent of the species at Cambium (25 species) were observed within the first 11 observation days (Fig. 1). Seventy-five percent of pasture species (18 of 24) were likewise detected within the first 11 observation days, and all by the 23rd observation day (Fig. 1). Finally, for woodland species (i.e., cacao and riparian), 74% (14 of 19) had also been detected by the 11th observation day (Fig. 1).

Of the 33 species observed at Cambium, 32 were resident species (Table 1), representing 25% of the resident avian diversity of Hispaniola. Excluding seabirds and shorebirds from consideration, I detected 28% of Hispaniola's resident land bird diversity at Cambium. Excluding high altitude specialists, I found 35% of the island's total low-elevation resident land bird diversity at Cambium. Five species observed (15%) were endemic to Hispaniola (Table 1), and an additional six species (18%) were endemic to the West Indies.

The majority of the species present (73%; 24 of 33), including 3 of the 5 Hispaniola endemics, were observed utilizing the pasture habitat at least part of the time, and 14 species (42%) were observed exclusively in pastures (Table 1). Five species—three from the family Ardeidae, the Spotted Sandpiper (*Actitis macularius*), and the Scaly-Breasted Munia (*Lonchura punctulata*)—were seen exclusively in riparian corridors (Table 1). All other species utilized two or more habitat types. Of the 14 species observed only in pastures, 8 species were observed only in the open, either on the ground, perching on fence posts or wires, or engaging in aerial foraging without alighting (Table 1). None of these eight species were Hispaniola endemics. Of the species using pastures at least part of the time, 67% (16 of 24) used the relict trees (Table 1). Only two species were observed using both the relict trees and the open ground: the Common Ground-Dove (*Columbina passerina*) and the Mourning Dove (*Zenaida macroura*) (Table 1), both of which occur in non-forested habitats in mainland North America.

The Palmchat was by far the most frequently seen: three times as many observations as the next most frequent species. This was largely due to its occurrence in flocks in all habitat types where trees were present, and most likely the same individuals were observed on multiple days and at multiple locations. Two other Hispaniola endemics, the Hispaniolan Woodpecker and the Broad-billed Tody (*Todus subulatus*), were also frequently seen. The only non-endemic of comparable frequency was the Cattle Egret (*Bubulcus ibis*), a globally widespread species generally associated with concentrations of large livestock, and it was observed exclusively in the open pastures (Table 1).

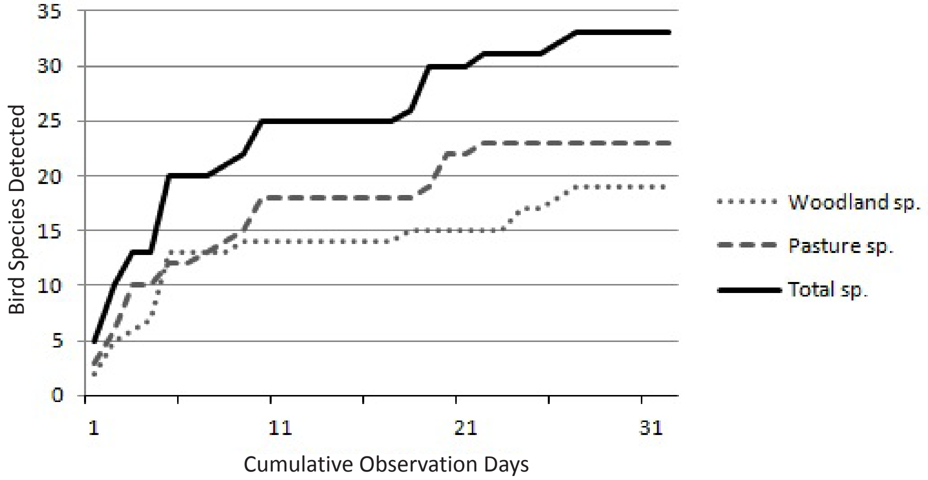

Fig. 1. Species accumulation curve for bird species observed from 11 May to 8 August 2013 at Finca Cambium, Hispaniola.

Table 1. Bird species observed at Finca Cambium from 11 May to 8 August 2013, and listed in order of first observation. Habitat type abbreviations are: PT = Pasture Relict Trees, PO = Pasture Open Area, C = Cacao Plantation, G = Gardens and *Conuco*, R = Riparian Corridor.

Rank	Scientific Nam	English Name	Spanish Name	Habitats Used
1	*Dulus dominicus**	Palmchat	Sigua Palmera	PT,C,G,R
2	*Melanerpes striatus**	Hispaniolan Woodpecker	Carpintero de La Española	PT,C,G,R
3	*Bubulcus ibis*	Cattle Egret	Garcilla Bueyera	PO
4	*Todus subulatus**	Broad-billed Tody	Barrancolí Picogrueso	C,G,R
5	*Butorides virescens*	Green Heron	Garcita Verdosa	R
6	*Patagioenas squamosa*	Scaly-naped Pigeon	Paloma Isleña	PT,C
7	*Quiscalus niger*	Greater Antillean Grackle	Zanate Antillano	PT,R
8	*Coereba flaveola*	Bananaquit	Platanero	PT,C,G,R
9	*Ploceus cucullatus*	Village Weaver	Tejero Común	PT,C,G
10	*Tachornis phoenicobia*	Antillean Palm-Swift	Vencejito Antillano	PO
11	*Crotophaga ani*	Smooth-billed Ani	Garrapatero Aní	PT
12	*Coccyzus longirostris**	Hispaniolan Lizard-Cuckoo	Cuco Lagartero de La Española	C,G
13	*Icterus dominicensis**	Hispaniolan Oriole	Turpial de La Española	PT,C
14	*Turdus plumbeus*	Red-legged Thrush	Zorzal Patirrojo	C,G,R
15	*Cathartes aura*	Turkey Vulture	Aura Gallopavo	PO
16	*Egretta thula*	Snowy Egret	Garceta Nívea	R
17	*Zenaida macroura*	Mourning Dove	Zenaida Huilota	PT,PO,C,G
18	*Anthracothorax dominicus*	Antillean Mango	Mango Antillano	PT,C,G,R
19	*Tyrannus dominicensis*	Gray Kingbird	Pitirre Abejero	PO
20	*Mimus polyglottos*	Northern Mockingbird	Sinsonte Norteño	PO
21	*Colinus virginianus*	Northern Bobwhite	Colín de Virginia	PO
22	*Falco sparverius*	American Kestrel	Cernícalo Americano	PT, R
23	*Charadrius vociferus*	Killdeer	Chorlo Gritón	PO
24	*Nyctanassa violacea*	Yellow-crowned Night-Heron	Martinete Coronado	R
25	*Mellisuga minima*	Vervain Hummingbird	Colibrí Zumbadorcito	PT
26	*Tiaris olivaceus*	Yellow-faced Grassquit	Semillero Olivaceo	PT
27	*Chordeiles gundlachii*	Antillean Nighthawk	Añapero Querequeté	PO
28	*Columbina passerina*	Common Ground-Dove	Columbita Común	PT,PO
29	*Patagioenas leucocephala*	White-crowned Pigeon	Paloma Coronita	PT
30	*Zenaida asiatica*	White-winged Dove	Zenaida Aliblanca	PT
31	*Vireo altiloquus*	Black-whiskered Vireo	Vireo Bigotudo	C,R
32	*Actitis macularius***	Spotted Sandpiper	Playero Manchado	R
33	*Lonchura punctulata*	Scaly-breasted Munia	Capuchino Punteado	R

*endemic to Hispaniola
**winter migrant

Three exotic species were infrequently observed: Village Weaver (*Ploceus cucullatus*), introduced from Africa; Northern Bobwhite (*Colinus virginianus*), introduced from North America; and Scaly-breasted Munia, introduced from tropical Asia. The Scaly-breasted Munia was the last species added to the accumulation curve (Table 1).

There were 14 colonies of Hispaniolan Woodpecker, of which 7 were active and 7 abandoned. All colonies occurred in royal palms, but one woodpecker was observed attempting to excavate a cavity in a *Cocos nucifera*. Eleven colonies occupied one tree each, and the remaining three occupied two trees each. Ten colonies were solely in living trees, the remaining four occupying at least one dead tree—in one case, the colony occupied one living and one dead tree. There were also five possible aborted nesting attempts, where the partially excavated cavities were too small for woodpeckers to occupy. One apparently abandoned colony was in a juvenile palm, with all other colonies in adult palms. In addition, one active colony in a single, living palm was located outside the boundaries of Cambium, but near enough that the birds would have included part of Cambium in their foraging territory; this foraging territory would have included one of the abandoned colonies within Cambium.

There were 38 juvenile, 325 adult, and 22 dead royal palms detected in the delineated pastures. However, 18 of the juveniles were in a single pasture in the extreme northwest end of Cambium. This pasture bordered a cacao plantation outside Cambium, but like the other pasture sites, was not near unaltered forested habitat.

Pastures contained significantly fewer seedlings than riparian areas (t-test, $t = -5.49$, $p < 0.001$). In the pastures, only 2 of the 20 quadrats had one seedling each, for an average of 0.1 seedlings per quadrat (SD = 0.3). Conversely, in the riparian corridors,

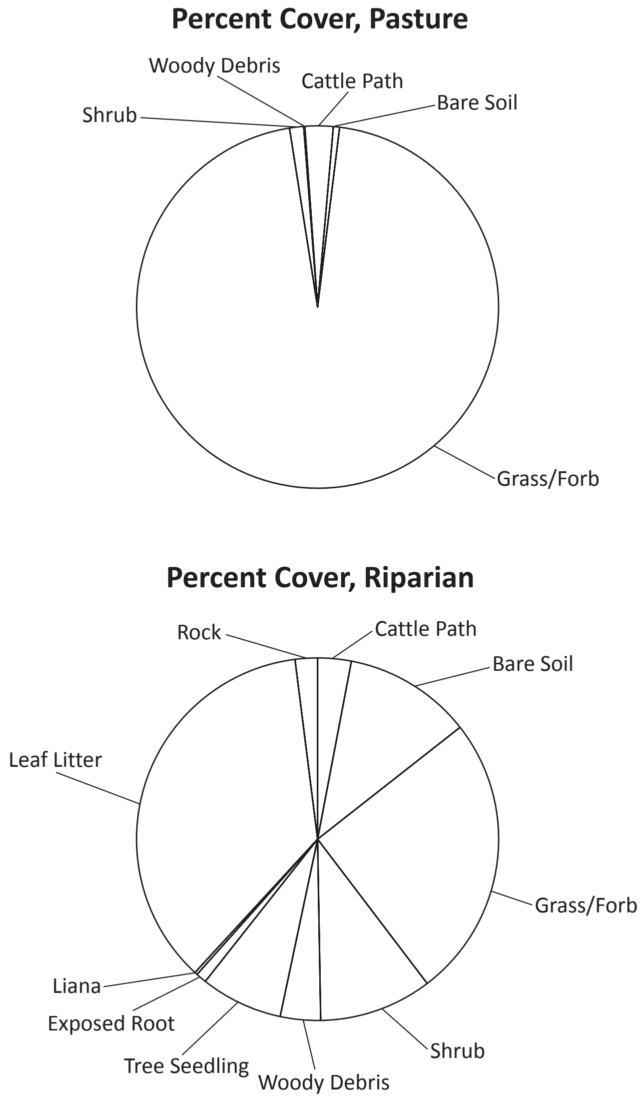

Fig. 2. Percent cover by class in pasture and riparian corridor.

the number of seedlings per quadrat ranged from 0 to 10, with a mean of 4.1 (SD = 3.2). In the pastures, grass/forb cover averaged 95% (SD = 10), with the remaining 5% divided among cattle path, shrub, bare soil, and woody debris (Fig. 2). This treatment was zero-inflated due to true zeros (Martin *et al.* 2005). Cover in the riparian corridors included all 10 cover classes, of which the 3 most prevalent were leaf litter (36%, SD = 29), grass/forb (25%, SD = 29), and bare soil (12%, SD = 23) (Fig. 2). Grass/forb cover was significantly higher in pastures relative to riparian corridors (t-test, $t = 10.06$, $p < 0.001$). Cattle path was 3% in both pastures and riparian corridors, and not significantly different between treatments (t-test, $t = -0.16$, $p = 0.9$). Because these were the only substantial cover classes in the pastures, it was not feasible to compare the other cover classes between treatments.

Discussion

This study was conducted in late spring and summer, when Neotropical migrants are on their temperate North American nesting grounds. It is likely that diversity would be somewhat higher in fall and winter, when migrants return (Latta *et al.* 2003). The Spotted Sandpiper, first observed on 1 August, was the first of these returning migrants.

Cambium harbors about one-third of Hispaniola's total low-elevation resident land bird diversity. The majority of Hispaniola endemics are highland species (Bond 1985, Latta *et al.* 2003). Considering only the relatively fewer low-elevation endemics, endemics made up a higher percentage of Cambium's resident avifauna relative to the island as a whole.

The majority of the birds at Cambium are either early successional or generalist species, utilizing a variety of habitats including open pasture. This would explain why all native birds observed in this study are listed as Least Concern by the International Union for Conservation of Nature (IUCN), with the exception of the White-crowned Pigeon (*Patagioenas leucocephala*), which is Near Threatened (IUCN 2015). It is also consistent with Rice and Greenberg (2000), who found that shade cacao, although harboring more bird species than most tropical agriculture types, was dominated by forest generalists and early successional species, some of which require forest in addition to cacao for long-term survival. Also, in comparing four natural habitat types, Latta *et al.* (2003) found that species richness was lowest in the habitat with the simplest vegetation structure. Nevertheless, one-third of low-elevation resident land bird species is a considerable number, and suggests that, alongside protected areas for habitat specialists, agricultural landscapes can be a viable component of a balanced biodiversity conservation strategy.

A few species at Cambium may have benefited from deforestation. Turkey Vultures (*Cathartes aura*), for example, seem to have been rare vagrants on Hispaniola until the extensive deforestation of the 1800s, but have since become permanently established (Santana C. *et al.* 1986). Likewise, Common Ground-Doves, White-winged Doves (*Zenaida asiatica*), and Mourning Doves all flourish in agricultural regions (Rivera-Milan 1992). None of these are of high conservation concern, and the majority of bird species in the region are still dependent on the presence of trees for nesting and feeding. The Palmchat usually nests in royal palm (Bond 1928), and in one study, Palmchats and Hispaniolan Orioles (*Icterus dominicensis*) were found to be present only where the royal palm was present (Wunderle and Latta 1998). Likewise, Hispaniolan Woodpeckers also prefer royal palms for nesting (Selander 1966). Since abandoned woodpecker colonies in this study were as numerous as active colonies, it is likely that these birds periodically shift locations. Isolated pasture trees may also serve as "stepping stones," allowing forest species to reach and utilize smaller shade plantations they otherwise could not (Wunderle 1999).

In this study, 58% of the species utilizing pastures were observed in the relict trees, but not on the ground. In addition, 18% of the species at Cambium were found exclusively in wooded habitats (i.e., cacao plantations and riparian corridors). Furthermore, combining all species found in association with trees (i.e., relict trees, cacao plantations, or riparian corridors) at least part of the time, 76% of the avifauna at Cambium may be tree dependent. However, this study suggests that royal palm regeneration in pasture habitat is less robust than in other disturbed habitats. Although the number of juvenile royal palms past the seedling stage in the pastures at Cambium approximately equals that of dead trees, notable numbers of seedlings were found only in the narrow riparian corridors. It is possible that these juveniles were established before the land was cleared. Royal palm is the only palm on Hispaniola that regularly re-establishes itself in disturbed habitats (Henderson *et al.* 1990), yet the dearth of seedlings in the actively grazed pastures relative to riparian corridors suggests that it is not regenerating in pasture habitat. Of the possible reasons for the lack of recruitment, the activities of cattle (i.e., trampling, soil compaction, and deposition of dung; Myster 2003) seem unlikely in this case, since cattle path was a similar percentage of cover in pastures and riparian corridors, and dung piles were present in both habitat types also. Although competition from herbaceous vegetation has not been ruled out due to the significantly higher grass/forb cover in the pastures, a likely explanation is the hotter, drier conditions of pastures relative to riparian corridors (Zimmerman *et al.* 2000). Borhidi (1988) found that royal palms are not true savannah palms, but forest palms, with seedlings that require shade to germinate, and Gutiérrez and Jiménez (2007) found that seedlings of another royal palm species grew best under intermediate levels of shade, rather than full sun or complete shade.

Simply prohibiting the felling of trees is not enough to ensure sustainable habitat; there must also be the right conditions for seedling recruitment. Research in other regions has found that stands of unpalatable vegetation can serve as refugia for tree seedlings in grazed lands, and that the first year of a seedling's life is the most critical for establishment and survival (Van Uytvanck *et al.* 2008). This question should be addressed in Neotropical systems also. One possible solution is to replace conventional open pastures with sylvopastoral systems, in which cattle grazing occurs in a matrix of fodder shrubs and sheltering trees (Calle *et al.* 2012). In landscapes like that of the north coast of Hispaniola, ensuring adequate tree recruitment in pasture lands is essential to supporting a diversity of bird life even as grazing continues.

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