A COMPARISON OF AVIAN COMMUNITIES IN PRIMARY AND SECONDARY FOREST AT FOUR SITES IN COSTA RICA

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Abstract. Tropical habitats support a high diversity of birds. We hypothesized that differences in elevation, climate, forest structure and resource availability would lead to differences in bird community structure among different sites in Costa Rica. We also hypothesized that high habitat heterogeneity and primary production in secondary forests would lead to greater numbers of species and individuals in secondary than in primary forests. Using a point-count technique, we surveyed the number of species and individuals of birds in both primary and secondary forest at four different sites in Costa Rica, ranging from tropical dry forest to montane cloud forest to lowland rain forests. Only two sites, however, differed significantly in the number of species and individuals observed per sample point: La Selva (lowland rain forest) had significantly more species and individuals than did Monteverde (montane cloud forest). In addition, all sites, except Monteverde, had more species and individuals in secondary forest. Secondary forest thus appears to be particularly important in maintaining high avian diversity in Costa Rica.

INTRODUCTION

The broad range of forest types in Costa Rica supports a high diversity of birds. Differences in elevation, moisture level, canopy height, density of understory vegetation and food resource productivity may lead to differences in bird community structure among the different forest types. We surveyed bird communities at four sites representing four forest types (tropical dry forest, montane cloud forest, Pacific lowland rain forest and Caribbean lowland rain forest), expecting to find differences in overall community structure among these sites.

We also surveyed bird communities in primary and secondary forest at each site. Secondary forest structure is probably more heterogeneous than primary forest structure due to greater variation in type and amount of disturbance. Since there are more niches in more heterogeneous habitats, we hypothesized that there would be more species in secondary compared to primary forest. Secondary forest tends to have higher productivity and, therefore, higher amounts of food production than primary forest, so we further hypothesized that there would be more individuals in secondary than in primary forest. Because Costa Rica contains a large proportion of secondary forest relative to primary forest, it is important to investigate differences in bird communities between these two habitats.

METHODS

In January and February 1995, we surveyed bird species richness and abundance in primary and secondary forest at four sites in Costa Rica. We used a point-sampling technique with observation points spaced 50 m apart. After arriving at each point, we waited one minute to allow birds to return to normal activity before starting our survey. We then recorded all birds observed during an eight minute interval within an approximately 25 m radius. We did not include birds flying over the canopy.

At Palo Verde National Wildlife Refuge, we sampled 10 secondary forest points off the Bagaces road and 21 primary forest points on the Sendero Mirador. At Estacion Biologica de Monteverde, we sampled 10 secondary forest points on the Caribbean side of the continental divide and 21 primary forest points on the Pacific side. At Estacion Biologica Sirena in Corcovado National Park, we sampled 15 secondary forest points along Sendero Sirena and 20 primary forest points along secondary forest points along Sendero Tres Senderos Ollas and Skyway. At La Selva Biological Station, we sampled 10 Rios and 20 primary forest points along Caminos Experimental Sur and Circular Cercano.

Secondary forest at Palo Verde had small trees and a dense understory full of woody plants (canopy height≈8 m), while primary forest had wider trees and smaller understory plants (canopy height≈12 m). Monteverde secondary forest was almost monospecific (canopy height≈10 m), while primary forest contained various large trees with high epiphyte loads (canopy height≈16 m). Secondary forest at Corcovado contained primarily balsa in an open canopy and *Heliconia* spp. in the understory (canopy height≈15 m), while primary forest had a denser canopy and small trees in the understory (canopy height≈22 m). La Selva secondary forest had a densely packed understory with scattered tall emergent trees (canopy height≈12 m), while primary forest had more emergent trees in a denser canopy (canopy height≈19 m).

TABLE 1. Differences in the mean number of individuals (±1 SE) observed per point in primary and secondary forest at four sites in Costa Rica. * = significantly different.

Site	Primary	Secondary	t	df	P
Palo Verde	1.10±0.28	4.40±0.52	6.07	29	<0.001*
Monteverde	1.05±0.36	0.80±0.51	0.40	29	0.695
Corcovado	1.40±0.43	2.47±0.62	1.28	23	0.214
La Selva	1.70±0.46	7.00±2.00	-3.44	28	0.002*
All Sites	1.29±0.19	3.53±0.60	-4.22	115	<0.001*

TABLE 2. Differences in the mean number of species (± 1 SE) observed per point in primary and secondary forest at four sites in Costa Rica. * = significantly different.

Site	Primary	Secondary	t	df	P
Palo Verde	0.90±0.22	2.80±0.20	5.49	29	<0.001*
Monteverde	1.00±0.32	0.50±0.27	0.99	29	0.332
Corcovado	1.20±0.29	1.73±0.38	0.94	23	0.358
La Selva	1.30±0.28	3.20±0.68	-3.06	28	0.005*
All Sites	1.08±0.15	2.02±0.25	-3.45	115	0.001*

RESULTS

We found significantly more individuals and more species in secondary forest per sample point at two sites (Palo Verde and La Selva) and for all sites combined (Tables 1, 2). We found a significant difference between the sites in number of individuals and species observed per sample point ($F\text{-ratio}_{individuals}=3.826$, df=3, P=0.012; $F\text{-ratio}_{species}=2.933$, df=3, P=0.037). Based on a Tukey means comparison test, there were significantly fewer species and individuals observed per sample point at Monteverde than at La Selva ($P_{individuals}=0.006$, $P_{species}=0.022$). All other differences between sites were not significant.

DISCUSSION

As predicted, overall we found a greater number of species and individuals in secondary versus primary forest. Since secondary forest is usually caused by several types and degree of disturbance, it often contains forest patches in different stages of succession. This greater patchiness in secondary forests probably results in greater habitat heterogeneity, providing more niches that support more species. In addition, secondary forests, with larger numbers of smaller plants, tend to have higher productivity than primary forests. Higher amounts of food production

in secondary forests may in turn support a larger number
of individuals .

Another difference between secondary and primary forests is the higher frequency of mixed species flocks in primary forests (Holmes, pers. comm.). Since we sampled for a maximum of 15 points and 2.5 hours in the primary forest at each site, our observations may have excluded large numbers of species and individuals traveling in a clump. Thus, there may actually be higher richness and abundance than our data suggests. For example, we encountered one mixed species flock in the primary forest at Monteverde, which resulted in the higher average number of species and individuals per sample point compared to secondary forest (Tables 1,2). At all other sites, where we encountered no mixed species flocks, the average number of species and individuals per point was higher in the secondary forest. Therefore, more intensive sampling is probably needed to document these community patterns more accurately.

Also, birds may be easier to see in secondary than in primary forests. Most of the birds we observed were in the canopy, which was lower and more open in the secondary forests we sampled. Additionally, our inexperience in identifying birds, especially by their sounds, almost certainly reduced the effectiveness and accuracy of our censuses.

We expected to see greater differences in bird communities between sites, but our limited sampling and inexperience probably limited our ability to detect these differences.

Monteverde and La Selva were the only sites which differed significantly in observed numbers of species and individuals. Monteverde, the only high elevation site in our study, had significantly fewer species and individuals than La Selva, the site with the greatest species richness and abundance. The lower temperatures at higher elevations may limit the number of bird species and individuals that can survive at Monteverde.

Future studies should investigate the differences between primary and secondary forests that may explain the observed differences in bird richness and abundance. We suggest expanding sampling to include mist-netting to get better estimates of diversity of understory birds. If bird diversity truly is higher in secondary forests, then both primary and secondary forests need to be considered in conservation efforts.

LITERATURE CITED

Hartshorn, G. S. 1983. Plants , Introduction. Pages 119-125 *in* D. H. Janzen, editor. Costa Rican Natural History. University of Chicago Press, Chicago, USA.

APPENDIX: SPECIES LIST

Palo Verde

Primary

Common Name	Scientific Name	Number Observed
1. Brown-crested Flycatcher	Myiarchus tyrannulus	3
2. Plain chachalaca	Ortalis vetula	1
3. Blue-crowned Motmot	Momotus momota	1

Secondary

Common Name	Scientific Name	Number Observed
1. White-fronted Parrot	Amazona albifrons	3
2. Streaked-backed Oriole	Icterus pustulatus	2
3. Bare-throated Tiger Heron	Tigrisoma mexicanum	2
4. Great Crested Flycatcher	Myiarchus crinitus	1
5. Tropical Kingbird	Tyrannus melancholicus	1
6. Blue-throated Goldentail	Hylocharis eliciae	1
7. Roadside Hawk	Buteo magnirostris	1

Monteverde

Primary

Common Name	Scientific Name	Number Observed
1. Common Bush Tanager	Chlorospingus ophthalmicus	3
2. Black Guan	Chamaepetes unicolor	1
3. Emerald Toucanet	Aulacorhynchus prasinus	1

Secondary

Common Name	Scientific Name	Number Observed
1. Slate-throated Redstart	Myioborus miniatus	1

Corcovado

Primary

Common Name	Scientific Name	Number Observed
1. Clay-colored Robin	Turdus grayi	1
2. Orange-billed Sparrow	Arremon aurantiirostris	1
3. Chestnut-mandibled Toucan	Ramphastos swainsonii	1
4. Rufous Piha	Lipaugus unirufus	1
5. Blue-crowned Manakin	Pipra coronata	1

Secondary

Common Name	Scientific Name	Number Observed
1. Scarlet Macaw	Ara macao	9
2. Long-tailed Hermit	Phaethornis superciliosus	3
3. Short-billed Pigeon	Columba nigrirostris	3
4. Blue-crowned Manakin	Pipra coronata	1
5. Riverside Wren	Thryothorus semibadius	1
6. Black-hooded Antshrike	Thamnophilus bridgesi	1
7. Chestnut-mandibled Toucan	Ramphastos swainsonii	1

La Selva

Primary

Common Name	Scientific Name	Number Observed
1. Dusky-faced Tanager	Mitrospingus cassinii	5
2. Montezuma's Oropendola	Psarocolius montezuma	5
3. Olive-throated Parakeet	Aratinga nana	2
4. Great Currasow	Crax rubra	1
5. Broad-billed Motmot	Electron platyrhynchum	1
6. Yellow-billed Cacique	Amblycercus holosericeus	1
7. Short-billed Pigeon	Columba nigrirostris	1
8. Long-tailed Hermit	Phaethornis superciliosus	1
9. Slaty-tailed Trogon	Trogon massena	1

Secondary

Common Name	Scientific Name	Number Observed
1. Montezuma's Orependula	Psarocolius montezuma	18
2. Oranged-chinned Parakeet	Brotogeris jugularis	6
3. Chestnut-sided Warbler	Dendroica pensylvanica	5
4. Collared Aracari	Pteroglussus torquatus	4
5. White-fronted Parrot	Amazona albifrons	2
6. Rufous-tailed Hummingbird	Amazilia tzacatl	2
7. Broad-billed Motmot	Electron platyrhynchum	2
8. White-breasted Wood Wren	Henicorhina leucosticta	1
9. White-collared Manakin	Manacus candei	1
10. Purple-crowned Fairy	Heliothryx barroti	1
11. Chestnut-mandibled Toucan	Ramphastos swainsonii	1