A COMPARATIVE STUDY OF BIRD SPECIES RICHNESS ACROSS FIVE COSTA RICAN SITES

SARA C. GOODWIN, KARL R. KROENLEIN, ADAM J. SIEGEL, EMILY B. SOHN, ANDREW C. TOLONEN AND ANTHA N. WILLIAMS

Abstract. The abundance and diversity of birds in Costa Rica is consistent with trends toward increased species diversity in the Neotropics. One factor contributing to this bird diversity is the wide range of habitats found across Costa Rica. In five forest sites that differed greatly with respect to climate, vegetation, and elevation, we found a total of 544 individuals and 49 taxa of birds. At every site we found more individuals in open forest than in closed forest. Because of the heterogeneity of forest structure and diversity of food resources, a greater number of niches are found in open and edge forest. The greater visibility in such forest may also have contributed to greater bird diversity in the open forest habitats. The high elevation site of Cerro de la Muerte had the most individuals and taxa observed possibly due to the widespread flowering and fruiting that occurred at that site and to the multi-species flocks observed there.

Key Words: tropical birds, species richness

INTRODUCTION

Costa Rica hosts a broad range of forest types and an amazing diversity of bird species. The highly diverse assemblages of birds in the tropics may be due in part to the large degree of habitat heterogeneity across multiple forest types. Different forest types offer birds different kinds of food and nest sites and variation in the distribution of these resources may lead to increased niche differentiation and higher species diversity.

We surveyed birds in five Costa Rican forests: tropical dry forest, sub-montane cloud forest, high elevation montane forest, Pacific lowland wet forest and Caribbean lowland wet forest. We hypothesized that these habitats would support both different numbers of birds and different bird species.

At each site, we surveyed birds in two habitat types: forest interior and forest edge habitat. Forest interiors were well-developed, while edge habitats ranged from open fields to slightly developed successional plots. The edge habitats tended to be more heterogeneous than the forest interiors. A heterogeneous habitat may contain more potential niches for birds to occupy. Further, edge zones have greater productivity, and hence more available food for birds. For these reasons, we hypothesized that the avian community would be more diverse in the edge habitat and that the total number of birds observed would be greater in the edge zones.

METHODS

In January and February, 1997, we surveyed bird communities at five sites in Costa Rica: lowland deciduous dry forest (3-183 m) at Palo Verde National Wildlife Refuge, premontane forest (1200-1800 m) at Monteverde, montane forest (3000 m) near Cerro de la Muerte, Pacific coast lowland rainforest (0-40 m) at Corcovado National Park, and Atlantic slope lowland rainforest (29-100 m) at La Selva Biological Station. At each site we sampled two forest types differing in structural complexity, one open and one closed.

In three groups of two people, we made observations at every site using a point-sampling technique. Each pair sampled five observation points 100 m apart in each habitat for a total of 30 observation intervals in each habitat. At each point, after allowing one minute of acclimation time to reduce the effects of human arrival, we recorded all birds seen or heard over a 10 min interval. However, sound-only records were not included in totals and analyses. We included birds flying overhead if they could potentially forage in the area and we identified each bird. For analysis, the birds were categorized into general taxonomic groups (hummingbirds, tanagers, raptors, etc.).

RESULTS

In all five sites, there was a trend toward more individuals in the edge habitat than in the forest interior (Table 1, Fig. 1). However, a student's t-test revealed these differences in that the number of birds were statistically significant at only two sites, Palo Verde and Cerro. When all sites were combined, there were more birds in the edge habitat than in the forest interior (Table 1).

These trends were similar when comparing taxa across sites. Although only Palo Verde showed a significant difference in the number of taxa between habitats, there were generally more taxa found in the edge habitat than in the forest interior at all sites (Table 2, Fig. 1).

Using a two-way analysis of variance, we found a significant difference in the number of individuals and taxa observed per sampling event at each of the individual sites ($F_{individuals}=6.78$, $df=149$, $P<0.001$; $F_{taxa}=8.43$, $df=149$, $P<0.001$, Fig. 2). Cerro had significantly more individual birds and taxa per sampling event than La Selva, Corcovado and Monteverde, based on Tukey-Kramer means comparison test ($P<0.05$). The number of individual birds and taxa were also significantly different between Monteverde and Palo Verde. We observed a total of 544 individuals and 49 taxa at all five sites.

DISCUSSION

We expected to see differences in species richness between the five sites (Palo Verde, Monteverde, Cerro, Corcovado and La Selva) correlated with the diversity of vegetation and variation in climates. In particular, the greater abundance of birds at Cerro probably reflects the high abundance of flowering and fruiting plants in the edge and early successional forest at this site. The greater number of individuals and taxa observed in the edge than the forest is likely due to the heterogeneity and range of micro-habitats offered by such environments.

Another possible contributor to differences in species richness and abundance across habitats and sites could be observer biases. Individual variation in the identification skills of observers can bias site and habitat comparisons. Moreover, it is likely that individual identification skills and general bird finding skills improved over time, which could have lead to greater abundances and more species observed at sites sampled later in the program.

It is also possible that the consistently higher bird richness found in edge sites could result from such systematic differences in the efficiency of bird observation. Birds are frequently heard but not seen in a dense, forest canopy, while in open early successional habitats, birds are much more easily observed. This difference in observer sighting is pronounced in sampling new sites and new species where bird calls and behaviors are unfamiliar.

The third potential source of bias in bird observation is the variation in canopy structure between sites. Certain sites, like Monteverde, had an overall denser canopy structure than sites such as Cerro and Palo Verde. This could significantly alter the capabilities of the observers between sites. In a further study, this comparison could be strengthened and deepened by sampling more points and by training the observers more thoroughly. The inclusion of mist netting could increase the numbers of birds found at each site.

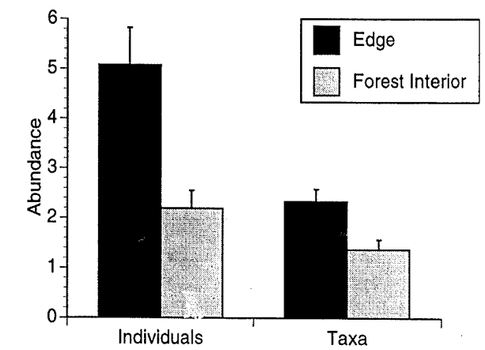

FIG. 1. Differences in the mean numbers of individuals and taxa observed between closed and open forests across five sites in Costa Rica. N=15 point samples for both habitat types. Abundance is the number of individuals or taxa per transect.

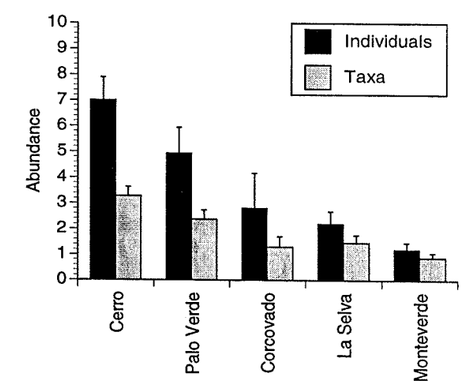

FIG. 2. Differences in the mean number of individuals and taxa between five sites in Costa Rica in both closed and open forests. N=15 point samples. Abundance is the number of individuals or taxa per transect.

Table 1: Differences in the mean (± SE) number of individuals observed per sampling event in closed and open forest at five sites in Costa Rica. *=P<0.005.

Site	Closed	Open	t	df	P
Palo Verde	2.13±0.58	7.73±1.65	3.19	28	0.004*
Monteverde	1.07±0.37	1.33±0.39	0.49	28	0.63
Cerro	4.80±1.30	9.20±0.94	2.74	28	0.011*
Corcovado	1.47±0.62	4.13±2.68	0.97	28	0.34
La Selva	1.47±0.45	2.93±0.58	1.53	28	0.14
All Sites	2.19±0.36	5.07±0.75	3.47	148	0.0007*

Table 1: Differences in the mean (± SE) number of taxa observed per sampling event in closed and open forest at five sites in Costa Rica. *=P<0.005.

Site	Closed	Open	t	df	P
Palo Verde	1.47±0.34	3.27±0.55	2.80	28	0.009*
Monteverde	0.66±0.19	1.07±0.30	1.13	28	0.27
Cerro	2.80±0.66	3.73±0.33	1.27	28	0.21
Corcovado	0.93±0.39	1.67±0.72	0.89	28	0.38
La Selva	1.00±0.28	1.93±0.48	1.68	28	0.10
All Sites	1.37±0.19	1.93±0.48	3.04	148	0.003*