

## **Testing Hypotheses of Bird Extinctions at Rio Palenque, Ecuador, with Informal Species Lists**

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### **Supporting Information**

**Appendix S1.** Criteria for hypothesis tests presented in Table 1.

1) **Trophic level hypothesis** -Using broad categories commonly applied to tropical forest bird communities (Pearson 1977, 1982), we assigned the most common trophic type used by each forest-associated species. Although some species opportunistically eat foods from other trophic levels, for instance insectivorous flycatchers occasionally eat fruit; we only assigned the general category of feeding when the mixture of trophic levels used was a consistent one. The categories from lowest to highest trophic level were: fruit and/or seeds, nectar, insects, generalist, carnivore/predator.

2) **Social dependence hypothesis** - We categorized each bird species as using one of four types of specialized behavior that dealt primarily with breeding and socialization. These four categories were: colonial species that are usually found together in intraspecific flocks and often nest in social units; flocks of mixed species that regularly move through the canopy, mid-levels or undergrowth of the forest together as a loose but cohesive unit; leking species in which males gather together and display to attract females for mating; solitary species that show little behavioral specialization and are normally alone or associate only with a mate. Additional

categories of specialized behaviors that deal primarily with feeding are included in the following tests.

3) **Body size hypothesis** - Because accurate weights for many tropical bird species are not available, we used mean body length (tip of bill to tip of tail) as a representative of body size. These measurements are readily available from field guides and numerous scientific studies.

4) **Foraging specialization hypothesis** - The six categories we tested here are arranged from most specialized to least specialized. Army ant following species range from obligate to opportunistic. They rely to varying degrees on insects that flee from columns of attacking army ants on or near the ground. Many species rarely or occasionally use these fleeing insects as a source of food. We included in this category only those bird species that regularly follow army ants and obtain a significant part of their diet in this manner. Trunk or branch creeping to search for insects on these substrates is another highly specialized form of foraging that usually entails many morphological and behavioral adaptations. Predatory pouncing behavior is typical of carnivorous bird species and involves considerable specialization. Hovering, or flying out from a perch to snatch prey from leaves and other substrates is a moderately specialized behavior. Sallying out from a perch to catch flying prey also involves moderate levels of specialization. Gleaning insects or fruits from vegetation usually is the least specialized foraging behavior encountered in tropical forests.

5) **Light level hypothesis** - Forest floor specialists and species adapted to the understory will have higher incidences of local extinction in the forest patch (Hanski 1982) Many if not most

bird species in tropical forests are physiologically and behaviorally specialized to occupy relatively narrow vertical and sunlight-affected strata (Pearson 1971). The categories are arranged from the highest level of sunlight to the most shaded and darkest forest niches generally used by each species: forest edge; canopy levels; subcanopy and mid-story levels; undergrowth and forest floor; some species regularly use a broad range of vertical strata.

6) **Species range hypothesis** - The MapView 5 software program (Golden Software, Inc.) was used to calculate the total area (km<sup>2</sup>) of the geographical range of each species. In addition to the Birds of Ecuador field guide, we used range maps in bird field guides for Colombia (Hilty & Brown 1986), Venezuela (Hilty 2003), Mexico and Central America (Howell & Webb 1995), South America (Ridgley & Tudor 1989,1994; Schulenberg et. al 2007) to establish the entire ranges of these bird species.

7) **Biogeographic source hypothesis** - We assume that Tumbesian species are generally better adapted to drier and more open forests than are Chocó species. In addition, higher altitude species tend to have smaller ranges and be at the extremes of their ranges at lower altitudes. In addition they are likely less well-adapted to survive changes here than are low altitude-adapted species (Mehlman 1997).

## **Literature Cited**

Hanski, I. 1982. Dynamics of regional distribution: the core and satellite species hypothesis.

Oikos **38**:210-221.

Hilty, S. L. 2003. Birds of Venezuela, 2nd edition. Princeton University Press, Princeton, New

Jersey.

Hilty, S. L., and W. L. Brown. 1986. A guide to the birds of Colombia. Princeton University

Howell, S. N. G., and S. Webb. 1995. A guide to the birds of Mexico and northern

Central America. Oxford University Press, New York.

Mehlman, D. W. 1997. Change in avian abundance across the geographic range in response to environmental change. *Ecological Applications* **7**:614-624.

Pearson, D.L. 1971. Vertical stratification of birds in a tropical dry forest. *Condor* **73**:46-55.

Pearson, D.L. 1977. A pantropical comparison of bird community structure on six low-land forest sites. *Condor* **79**:232-244.

Pearson, D.L. 1982. Historical factors and bird species richness. Pages 441-452 in G. T. Prance, editor. *Biological diversification in the tropics*. Columbia Press, New York.

Ridgley, R. S., and G. Tudor. 1989. *The birds of South America, Vol. 1: The oscine passerines*. University of Texas Press, Austin.

Ridgley, R. S., and G. Tudor. 1994. *The birds of South America, Vol. 2: The suboscine passerines*. University of Texas Press, Austin.

Schulenberg, T. S., D. F. Stotz, D. F. Lane, J. P. O'Neill, and T. A. Parker, III. 2007. *Birds of Peru*. Princeton University Press, Princeton, New Jersey.