

# Effects of habitat disturbance on the territorial response of the Gray-breasted Wood-Wren, *Henicorhina leucophrys*.

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## ABSTRACT

Habitat fragmentation and disturbance have become integral aspects of the neotropical landscape, impacting a variety of ecological factors. Here I attempt to quantify the relationship of bird territory size and habitat disturbance by observing the effects of habitat disturbance on avian response to conspecific playback in the Gray-breasted Wood-wren, *Henicorhina leucophrys*. Mean distance traveled to follow playback increased along a gradient of increasing disturbance ( $F = 4.435$ ,  $p\text{-value} = .0165$ ,  $s.d. = 27.256$ ; 47.283; 49.094). Edge habitat birds showed significantly greater response than birds in primary and secondary growth ( $p\text{-values} = 0.0051$ ; 0.0479). Variation in response also differed between habitats. These results may be due to a variety of factors that varying along a disturbance gradient, including prey abundance, predation risks, structural characteristics, and territory shape and distribution.

## RESUMEN

Fragmentación de hábitat y alboroto han llegado a ser los aspectos integrantes del paisaje de neotropical, impresionando una variedad de factores ecológicos. Aquí procuro cuantifica la relación del tamaño del territorio de pájaro y alboroto de hábitat observando los efectos de alboroto de hábitat en la respuesta aviar a la repetición del conspecific en el troglodito de breasted Gris de Madera, leucophrys de Henicorhina. La distancia mala viajó para seguir repetición aumentada por un declive de alboroto creciente ( $F = 4.435$ , el valor  $P = .0165$ ,  $s. d. = 27.256$ ; 47.283; 49.094). Bordee pájaros de hábitat la respuesta que pájaros apreciablemente más grande mostrada en el crecimiento primario y secundario (los valores  $P = 0.0051$ ; 0.0479). La variación en la respuesta difirió también entre hábitats. Estos resultados pueden estar debido a una variedad de los factores que variando por un declive de alboroto, inclusive la abundancia de presa, los riesgos de la rapiña, características estructurales, y la forma del territorio y la distribución.

## INTRODUCTION

Human land use in the Tropics alters landscape structure and impacts a wide variety of factors important to ecosystem function (Noble and Dirzo 1997). Many studies have addressed this issue in evaluations of biodiversity and species interactions (Armenteras et al. 2003; Ayyad 2003). Petchey et al. (1999) have shown that global warming affects extinction rates depending on tropic position. Vitosek et al. (1997) have described in detail human influences on ecosystems through land transformation, ocean and biogeochemical function and biotic changes. Many questions, however, remain as to the effects of habitat disturbance on animal behavior. Birds have been

used extensively as indicator species, providing insight in to ecosystem function (Browder et al. 2002; Paillisson et al. 2002; Eens et al. 1999). Birds are ideal indicator species because of their abundance in pristine as well as disturbed habitats (Crooks et al. 2003), and easily observable behavior.

Species interactions may be potentially altered by habitat disturbance, as well. The structural characteristics of different forest types, such as tree density, may cause auditory degradation of intruder song. Certain habitat types may make birds more vulnerable to intruders because the ability of the defender to monitor its territory is negatively affected by sound degradation and absorption by the understory. Habitats of differing disturbance levels may also support different abundances of prey. For instance, Coleoptera abundance has been shown to be highest in secondary growth areas of lower montane rain forests in Costa Rica (Stumpf 2001). Landscape fragmentation and vegetative characteristics also may impact territory partitioning and breeding habitats. Based upon observed movement patterns, Imbeau and Desrochers (2002) speculate that continuous forest may provide better breeding habitats for the three-toed woodpecker than shredded forests.

Habitat disturbance has many potential impacts on avian species. Microclimatic conditions on fragment edges are altered in terms of wind, temperature, moisture, biomass and carbon gradients (Laurence et al.1997; Baldissera et al. 2003). Therefore, birds may change their foraging, reproductive, and anti-predator strategies. Changes in vegetation form and growth are potential factors affecting reproductive activity. Further, Conner and Perkins (2003) found that habitat fragmentation might cause avian population decline due to increased nest predation. If inadequate understory cover is available, or if the ecological conditions of altered habitat are beneficial to an invasive high order consumer, predation risk for birds may increase.

With habitat disturbance possibly altering multiple conditions influential to avian ecology, it may be inferred that these changes impact avian behavior. Disruption or anthropogenically-induced changes to habitats may alter interspecific as well as intraspecific interactions. These effects may alter bird habitat preference, in turn impacting territorial behavior. Changes in bird territoriality could serve as an indicator of the degree to which habitat disturbance affects avian population ecology. In this study I attempt to quantify the territorial response of a common Costa Rican wren species, *Henicorhina leucophrys* (Gray-breasted Wood-wren). Three habitat types of varying disturbance are evaluated: primary forest, secondary forest, and edge habitats. I expect to find a difference in the level of territorial response along this disturbance gradient.

## **METHODS**

### **Study Site**

Experiments were conducted from 16 October to 12 November 2003 at Estación Biológica de Monteverde, Reserva Bosque Nuboso de Monteverde, Centro de Educación Creativa, the property of Arnoldo Beche and the property of Martha Campbell. Elevations ranged from 1400 m to 1800 m, coinciding with the upper

limits of the lower montane moist forest, as well as lower montane wet forest (1470 m to 1600 m) and lower montane rain forest (1600 m to the upper limits of the Cordillera de Tilarán) (Haber 2000). Habitat types examined were primary forest, secondary forest, and edge habitats. Primary forest had a closed canopy up to 40 m high, shaded understory, low-density understory vegetation, as well as occasional large trees. The secondary forest examined was consistent with relatively long time periods since disturbance, with a more open canopy than primary, denser understory vegetation, and smaller tree heights (canopy generally did not exceed 20 m). Edge habitats reflected well-defined boundaries such as roadsides and pastures, both borders of secondary growth. Each habitat type possessed consistent structural characteristics among all respective study sites.

### **Natural History of *Henicorhina leucophrys***

*Henicorhina leucophrys* is an understory insectivore of highland forests, ranging from C Mexico to W Ecuador and N Bolivia. They are understory birds that usually forage in pairs or family groups, and are well adept at disappearing into surrounding foliage. The song is a flowing melody of warbles and whistles lacking a set pattern, while the scold call is a continuous harsh, rasping churr. This species is monogamous and territorial year-round, nesting from March to June (Stiles and Skutch 1989). It is active throughout the day. *H. leucophrys* is abundant above 1400 m in Monteverde, Costa Rica.

### **Aggressiveness and Territoriality in *Henicorhina leucophrys***

Conspecific playback was used to assess aggressiveness and territoriality in *Henicorhina leucophrys*. Fotheringham et al. (1997) found that territorial male wood warblers (Parulinae) respond aggressively to conspecific song playback. It was assumed that monogamous and territorial birds such as *H. leucophrys* will respond in a similar fashion. Aggressiveness and territoriality are a single measure, reflected by the distance of the response to the playback. If the playback accurately mimics an intruder, then birds with larger territories should respond (follow the moving playback) longer distances. Both song and scold calls were played (Ross et al. 1997) on a continuous playback loop using an Aiwa CSD-TD49 compact disc player while walking forest and edge trails. When an individual, pair, or group was spotted foraging or observed responding to the playback, the initial point of observation was marked. The distance to the point at which the individual(s) no longer followed or turned around was measured with measuring tape to the nearest tenth of a meter. The individual or group responding to a given playback was treated as a single datum, regardless of size.

Because territories are likely to be irregularly shaped, the linear distance measured with playback is not likely to reflect territory size directly (as in the diameter of a circle). However, the linear distance measured should reflect relative territory size, as randomly cutting a large irregular shape will generally yield a larger linear measure than randomly cutting a smaller irregular shape (Fig.1). Therefore, longer linear distances should indicate larger territories.

## RESULTS

### Aggressiveness and Territoriality in *Henicorhina leucophrys*

The distances *Henicorhina leucophrys* were willing to follow playback varied by habitat (one-way ANOVA,  $F=4.435$ ,  $n=57$ ,  $p=0.0165$ ) (Fig. 2). Birds in primary forest followed playback relatively short distances,  $59.7 \text{ m} \pm 27.256 \text{ m}$  ( $n = 20$ ). Secondary forest birds, on the other hand, traveled distances of  $71.558 \text{ m} \pm 47.283 \text{ m}$  ( $n = 19$ ). Edge birds had the greatest distance of response,  $99.539 \text{ m} \pm 49.094 \text{ m}$  ( $n = 18$ ).

Fisher's PLSD post hoc tests showed a significant difference between distances observed across habitat type. Primary forest distances were significantly smaller than edge distances (mean difference =  $-11.858$ ,  $p\text{-value} = 0.0051$ ). Secondary forest distances were also significantly smaller than edge (mean difference =  $-27.981$ ,  $p\text{-value} = 0.0479$ ). No statistically significant difference was seen between primary and secondary forest birds.

Equality of Variance F-test likewise showed difference in the variation of response and habitat type. The variation in following distance increased with disturbance. Primary forest birds followed the most consistently (variance =  $742.874$ , ranging from  $25.7 \text{ m}$  to  $134.0 \text{ m}$ ). Secondary forest birds showed a higher range than primary (variance =  $2235.665$ , ranging from  $10.5 \text{ m}$  to  $174.0 \text{ m}$ ). Edge birds showed the least consistency (variance =  $2410.205$ , ranging from  $39.0 \text{ m}$  to  $179.3 \text{ m}$ ).

### Behavioral Observations

During playback experiments, several behaviors became apparent. First, the number of *Henicorhina leucophrys* foraging together (and therefore responding to the playback), was highly variable, from one to six individuals. This trend was observed across all habitat types. Second, the type of vocal response of foraging birds groups was inconsistent. For instance, the first individual may begin with a scold call, while the second responds with song. Later, a third scolding individual may begin to follow. The inconsistency in vocal response showed no observable pattern, and was present in all habitat types. Finally, the type of call was more diverse than simple song and scold. A third call type, as well as possibly a fourth was heard. These calls, while similar to the song, had distinctly different arrangement of notes and tones.

## DISCUSSION

Habitat differences resulted in two different responses to conspecific playback in *Henicorhina leucophrys*. First, response to playback increased in linear distance as habitat disturbance increased. Second, the variation of the distances recorded in each habitat also increased with disturbance. Primary and secondary forest responses did not differ significantly from each other. However, significant differences were seen between edge habitats and both primary and secondary forest. These data may be interpreted as a smaller territory size being an indicator of preferred habitat, because defending smaller areas is less costly. Simply, a bird will expend less energy in territory defense if its requirements can be met in a smaller area than in a larger one. Factors such as prey abundance, predation risk, habitat structure and territory shape and distribution may explain these trends.

Prey abundance may be a contributing factor to the significant difference in territorial response in edge habitats. Higher levels of intraspecific competition may lower arthropod abundance if richness indices decrease in fragmented habitats. Baldissera et al. (2003) found higher web spider species richness from pasture to forest interior in a southern Brazilian study site. Defense of a larger area may indicate insect prey is more vulnerable to edge effects and is more limited compared with pristine habitats. Microclimatic changes including soil moisture could be used to promote this hypothesis. Simply, if prey abundance decreases, territories will increase in size and be more actively defended.

Occasionally responding individuals would cross open roadside gaps smaller than 10 m. No individuals were observed following the playback into open areas such as pasture. This behavior suggests that understory vegetation is an important factor influencing *H. leucophrys* natural history, perhaps because it provides cover from predators. If this were the case, edge habitats with a more open understory would be less desirable than secondary growth forests, for example. Greater territory size along edges may be an indicator of higher predation rates on these areas if bird densities are lower.

Patterns of territoriality may be further explained by forest consistency. Primary growth habitats showed a lower standard deviation than secondary and edge sites. Less fragmentation and disturbance may promote a more consistent distribution of particular types of forest vegetation that increase *H. leucophrys* fitness by providing greater abundance of invertebrate prey or shelter and support for nests. Temperate vegetation in the United Kingdom has been shown to affect food supply and predation risk in the Dartford warbler (van der Berg et al. 2001). While acoustic long-distance signals have shown avian response difference across multiple levels of degradation (Naguib 1999), it is unlikely this variable influenced the data. Degradation may affect the number of playback responses, however this study does not account for response frequency. The close proximity of the playback device to all responding birds (often less than 10 m) leads me to believe that distances measured were not affected by degradation.

Larger edge territories suggest that *H. leucophrys* abundance declines sharply on pasture boundaries and roadsides. This distribution could be explained by envisioning preferred breeding sites being tightly clustered in the interior of forest patches. Older, more established adult individuals may occupy these territories, while young fledglings or weaker individuals defend the less preferred edge territories. These younger or less fit birds may occupy edge areas temporarily, waiting for an opportunity take over a more desirable territory.

The possibility also exists that assumptions made as to the shape and distribution of *H. leucophrys* territories were erroneous. Habitats with more consistent abiotic conditions such as primary and secondary forests may be more desirable, and result in a tighter packing of territories. Edge areas would then have more elongated shapes as they frame the larger area of the forest patch (Fig. 3). Playback experiments conducted while walking on the borders of edge habitats would then measure the distance of the two farthest boundary points. If this is the case, the distance of territorial response measured may not accurately reflect the area of that territory.

While clear trends exist in the playback response of *H. leucophrys* across habitat type, the implications of these findings are only speculative at this point. Studies in this area would benefit from more precise territory size estimations. Tagging individuals and GPS mapping would certainly shed light on changing behavior patterns along a disturbance gradient. Experiments attempting to further quantify *H. leucophrys* territoriality would benefit from recording countersinging, the vocal response of a bird to a territory intruder. Hyman (2003) used playback procedures to evaluate the degree of aggressiveness of the countersinging

response in Carolina wrens (*Thryothorus ludovicianus*), using rate of song to measure of aggressiveness. The study indicated perceptual representation of differences in the distance of a sound source, a concept that could be applied across a disturbance gradient. Further studies of bird territoriality may serve as indications of disturbance severity and ecosystem health, however improved methodology and understanding of avian behavior will be required.

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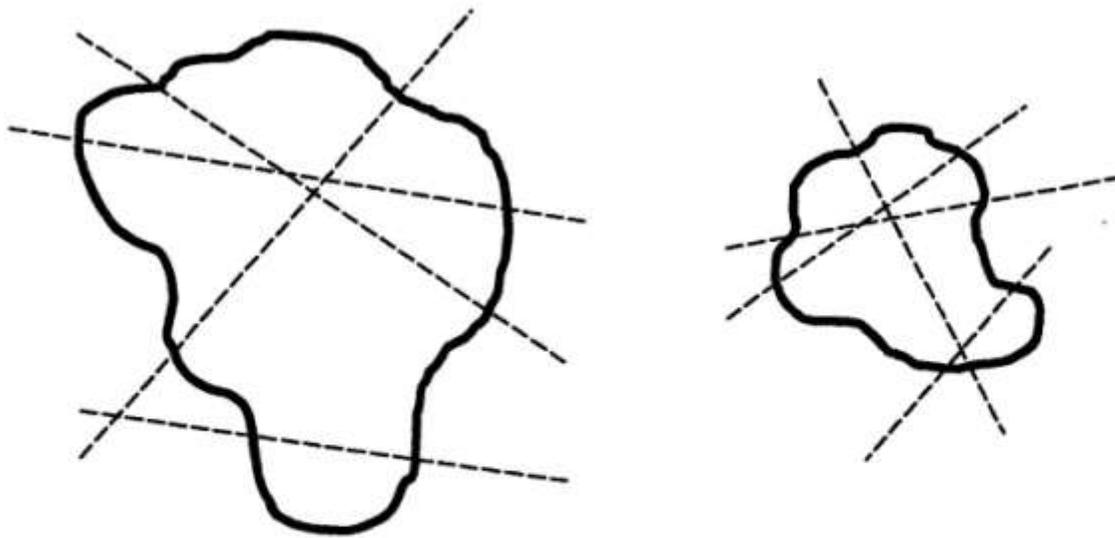


Figure 1. Random transects run in the larger area yield larger mean distances than random transects run in the smaller area. Linear distances act as indicators of territory size.

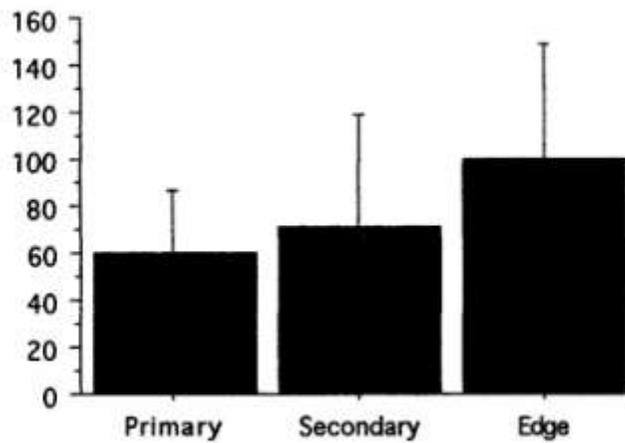


Figure 2. ANOVA results. Habitat type is graphed against distance of playback response in meters (m), with standard deviation.

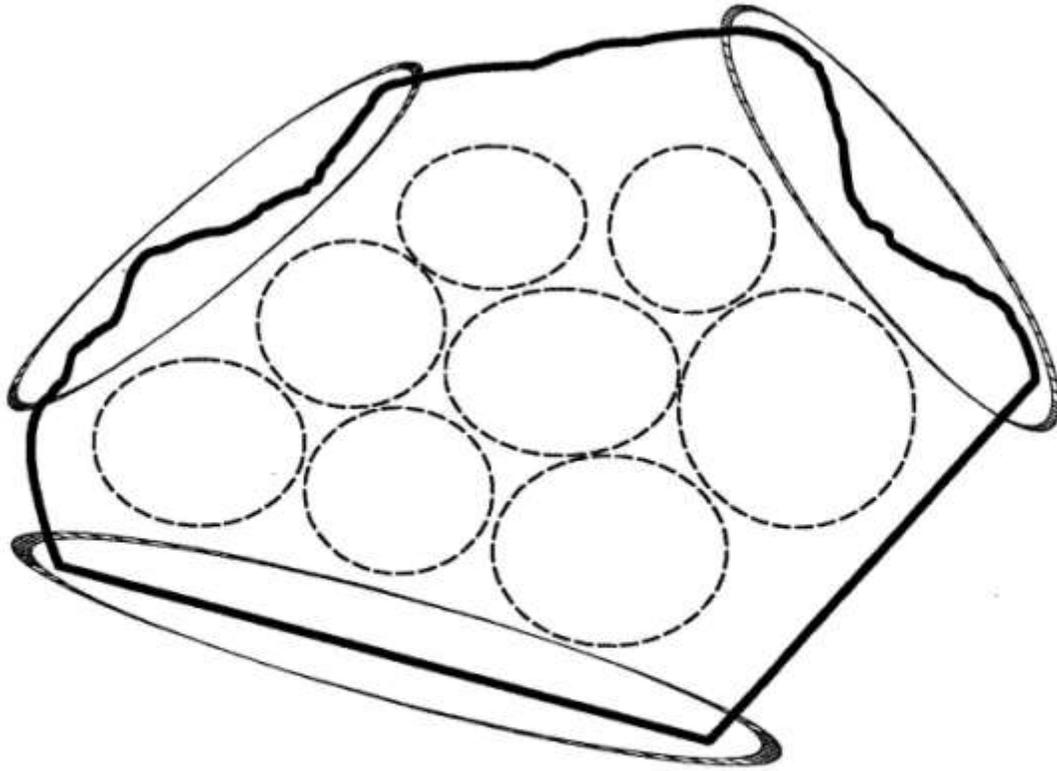


Figure 3. A theoretical forest patch. Dashed circles represent primary, secondary forest territories, unaffected by edge effects. Areas outlined in blue represent edge territories. If elongated edge territories frame the forest patch, then responses to playback measured as the farthest linear distance may inaccurately describe territory size.