

HABITAT SELECTION BY BLACKBURNIAN WARBLERS WINTERING IN COLOMBIA

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Abstract.—We compared habitat characteristics in plots used by Blackburnian Warblers (*Dendroica fusca*) to randomly selected paired plots in a high Andean native secondary forest in Colombia. Density of trees in all diameter-at-breast-height (dbh) categories, density of snags, and density of native trees and shrubs were higher on the bird-centered plots. Percent vegetation cover (0–1 m, 1–2 m and 2–3 m above the ground) was lower at bird-centered plots. Blackburnian Warblers avoided non-native trees species, represented mainly by *Eucalyptus globulus* in the study area, and preferred native tree species. They preferred the higher part of trees in the middle and high dbh classes. They avoided the smallest dbh size class (3–8 cm dbh). Management for conservation of Blackburnian Warbler wintering habitat should emphasize maintenance of relatively mature native forests. Conversion of native forests to non-native tree species will reduce the amount of suitable Blackburnian Warbler habitat.

SELECCIÓN DE HÁBITAT POR INDIVIDUOS DE *DENDROICA FUSCA* QUE PASAN EL INVIERNO EN COLOMBIA

Sinopsis.—Comparamos las características del hábitat en parcelas utilizadas por la reinita *Dendroica fusca* con áreas seleccionadas al azar en bosque nativo secundario de las alturas de los Andes, en Colombia. La densidad de los árboles en todas las categorías de altura al nivel del pecho (DBH), densidad de tocones, y la densidad de árboles nativos y arbustos fueron mayores en las parcelas en donde se encontraron las aves. El porcentaje de cobertura (0–1 m, 1–2 m y 2–3 m sobre el suelo) fue menor en las parcelas utilizadas por las aves. Las reinitas evitaron las especies de árboles que no eran nativas, representadas principalmente por *Eucalyptus globulus* en el área de estudio, y prefirieron las especies nativas. Hubo preferencia por la parte más alta de los árboles y por árboles con DBH entre las clasificaciones de altos y medianos. Evitaron vegetación con un DBH bajo (3–8 cm). El manejo dirigido a la conservación de esta reinita, en los lugares en donde ésta pasa el invierno, debe ir dirigido al mantenimiento de bosques nativos relativamente maduros. El cambio de bosque nativo por especies introducidas reducirá la cantidad de hábitat adecuado para esta especie de pájaro.

Blackburnian Warblers winter from Costa Rica to Peru and Bolivia (Stiles and Skutch 1989) with the majority of the species' population wintering in the northern Andes in South America (Whitney 1994). Although Breeding Bird Survey data do not show significant declines for Blackburnian Warbler numbers in North America (Sauer and Droege 1992, Robbins et al. 1989), Robbins et al. (1992a:560) noted "any bird species limited to the foothill forests of the eastern Andes should now be considered threatened because of habitat loss and fragmentation." In the northern Andes in Colombia the rate of forest loss has been about 820,000 ha/year (Hartshorn 1992). Diamond (1991) predicted that 34% of the Blackburnian Warbler's winter habitat would disappear between 1985 and 2000. Reforestation programs account only for 2500 ha/year (Cartón de

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Colombia in Cavelier 1995). Usually introduced species of pine (*Pinus patula*) and cypress (*Cupressus lucitanica*) are used for reforestation; native species are rarely used (Cavelier 1995).

Because the majority of Blackburnian Warblers winter in the northern Andes, forest loss and conversion may have a serious impact on their population. However, little is known about specific habitat needs of this species in winter. In this study we compared habitat characteristics in plots used by Blackburnian Warblers with that in randomly selected paired plots in a High Andean native secondary forest in Colombia. Our objectives were to characterize the vegetation structure of the areas used by the birds, evaluate preferences for certain habitat features, and to provide specific recommendations for management.

STUDY AREA

We conducted the study at Finca Los Amarillos, located in the Municipio de San Francisco, Departamento de Cundinamarca, in the Eastern Andes of Colombia, South America (4°53'N, 74°17'W). Los Amarillos contains approximately 80 ha of forests and 130 ha of pasture lands. It is surrounded by farms of the same type, producing a landscape of fragments of different sizes of native and cultivated forests, pasture lands, and agricultural lands. Elevation ranged from 2700–2900 m and temperatures from 0–28 C throughout the year. Forests in Los Amarillos were all second growth. Approximately 40–50% of the forests contained planted eucalyptus (*Eucalyptus globulus*), with some *Pinus patula* and *Acacia* spp. The remainder was native forest averaging 12 m in height and dominated by trees in Melastomaceae, Myrsinaceae, and of the genera *Chusquea* and *Cyathea*.

METHODS

Field sampling was conducted between September 1993 and May 1994. Blackburnian Warblers were located by walking randomly within the study area until a mixed-species flock was found. When we encountered a flock, the number of Blackburnian Warblers, a list of the other species, and the number of individuals of each species in the flock were recorded. For the first Blackburnian Warbler seen in the flock, we recorded the bird's relative position in the tree (top, middle, or lower third), the tree species, the tree's diameter at breast height (dbh), and the tree's estimated height (0–5, 6–10, 11–15, 16–20, and >20 m). Each flock was observed until no more new species of birds were seen.

The location of the first Blackburnian Warbler seen served as the center of a 0.04-ha circular plot within which the following habitat characteristics were recorded: shrub density (total number of stems <3 cm dbh in 2 arm-width transects across the plot), average maximum and mean canopy height categories (1–5, 6–10, 11–15, 16–20, 21–25, >25 m), % tree canopy cover, % ground cover, general habitat configuration (forest fragment, line of trees, solitary tree in a pasture), understory foliage volume (% vegetation density) 0–1, 1–2, and 2–3 m above ground measured

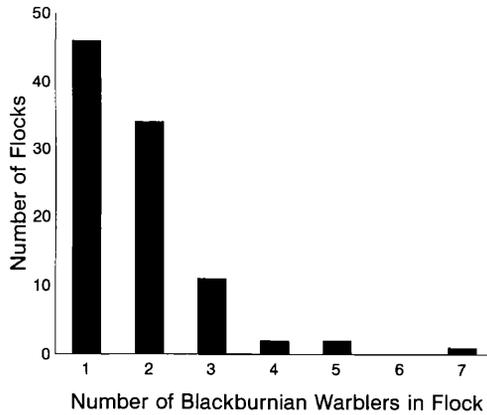


FIGURE 1. Number of Blackburnian Warblers in 96 mixed species flocks, Colombia, September 1993–May 1994.

with a density board, and tree density (#/ha) by taxa and dbh category (3–8, 9–15, 16–23, 24–38, 39–53, 54–69, 70–84, >85 cm dbh). Habitat sampling procedures followed Noon (1981). We recorded the same set of variables at a randomly selected paired plot. The center of the random plots was determined using a random distance (30 to 60 m) and bearing relative to the center of the bird-plot.

We used paired-sample tests to compare bird-centered and random plots. We compared vegetation characteristics using Wilcoxon signed-rank tests for continuous variables and Chi-square tests of homogeneity for categorical data. Assuming that a relationship exists between the presence of a species and certain characteristics of habitat (Rotenberry 1981), we assume that the variables exhibiting differences between the bird-centered and random plots may be useful in identifying habitat characteristics important to the species. We used Chi-square goodness of fit tests to quantify whether Blackburnian Warblers have a preference for native or non-native tree species, for specific dbh tree classes, or for a certain tree height. We used Spearman-rank correlations to quantify the association between flock size and selected habitat features. Significance was set at 0.05 for all analyses.

RESULTS

Blackburnian Warblers were first seen in the study area on 29 Sep. 1993 and last observed on 15 Apr. 1994. We saw 96 flocks with Blackburnian Warblers during the study; 92 of the flocks consisted of >1 species. The number of Blackburnian Warblers per flock varied from 1–7 individuals; the most common numbers were 1 and 2 (Fig. 1). The number of warblers in each flock was relatively uniform throughout the period (means for 2-wk intervals ranged from 1.0–2.5 Blackburnian Warblers per flock).

In general, bird-centered plots had a greater density of trees, shrubs,

TABLE 1. Comparison of mean vegetation characteristics at 55 bird-centered and random paired plots for Blackburnian Warblers in Colombia, September 1993–May 1994.

Variable	Type of plot				<i>P</i> ^a
	Bird-centered		Random		
	\bar{x}	SE	\bar{x}	SE	
% vegetation density 0–1 m	18	3.4	34	4.7	<0.01
% vegetation density 1–2 m	25	3.7	37	4.5	0.02
% vegetation density 2–3 m	29	3.7	45	4.5	<0.01
% tree canopy cover	73	3.8	67	3.9	0.18
% ground cover	42	4.7	51	4.8	0.14
Tree dbh (cm)	14	1.4	15	1.3	0.37
No. stems <3 cm dbh/ha	28,790	3161	24,810	3783	0.09
No. trees 3–8 cm dbh/ha	1086	108	733	101	<0.01
No. trees 9–15 cm dbh/ha	630	47	428	45	<0.01
No. trees 16–23 cm dbh/ha	202	17	185	23	0.19
No. trees 24–38 cm dbh/ha	89	10	69	10	0.07
No. trees 39–53 cm dbh/ha	45	7	28	5	0.02
No. trees 54–69 cm dbh/ha	18	4	14	4	0.39
No. trees 70–84 cm dbh/ha	10	3	9	2	0.65
No. trees >84 cm dbh/ha	20	5	8	2	0.03
No. trees 9–38 cm dbh/ha	921	62	682	67	<0.01
No. trees 39–84 cm dbh/ha	74	10	51	8	0.03
No. native trees and shrubs/ha	1659	151	1059	105	<0.01
No. non-native trees and shrubs/ha	284	43	305	56	1.00
No. snags/ha	130	18	54	12	<0.01

^a Significance level for Wilcoxon signed-rank tests for differences between bird centered and random plots.

and snags than the random sites (Table 1). Percentage vegetation density <3 m tended to be lower at bird-centered plots (Table 1). Densities of Brunelliaceae, Clusiaceae, Cunoniaceae, Piperaceae, Rubiaceae, *Schefflera* spp., Solanaceae, and Winteraceae also were higher for the bird-centered plots (Table 2). There was no significant difference for maximum ($\chi^2 = 3.5$, $df = 4$, $P = 0.48$) and mean ($\chi^2 = 3.66$, $df = 4$, $P = 0.45$) canopy height between bird-centered and randomly selected paired plots. There was no correlation between flock size and percent vegetation density 0–1 m, 1–2 m, and 2–3 m, shrub density, percent canopy cover, percent ground cover or any of the dbh tree classes (absolute correlations <0.1, all $P > 0.10$).

Blackburnian Warblers were observed both in the large forest fragments and in small or linear patches such as fencerows, hedgerows, or riparian borders. They never were observed in solitary trees in pasture lands or in pine plantations. Blackburnian Warblers preferred native trees and avoided non-native trees (Fig. 2). They avoided trees in the 3–8 cm dbh class and preferred or selected trees in the 9–38, 39–84 and >85 cm dbh classes (Fig. 2). Blackburnian Warblers were observed most commonly in the upper third of tree canopies (Fig. 3).

TABLE 2. Mean density of trees and shrubs at 55 bird-centered and random paired plots for Blackburnian Warblers in Colombia, September 1993–May 1994.

	Type of plot				P ^a
	Bird centered		Random		
	\bar{x}	SE	\bar{x}	SE	
No. Brunelliaceae/ha	87	18.4	35	8.2	<0.01
No. Chlorantaceae/ha	73	23.8	39	14.6	0.06
No. Clusiaceae/ha	90	27.2	29	9.9	<0.01
No. Cunoniaceae/ha	107	19.9	52	12.2	<0.01
No. Ericaceae/ha	33	15.7	21	10.3	0.35
No. Piperaceae/ha	22	10.9	2	1.6	0.04
No. Rubiaceae/ha	59	22.5	21	9.1	0.03
No. <i>Schefflera</i> /ha	30	12.1	20	9.4	0.03
No. Solanaceae/ha	99	22.6	49	31.1	<0.01
No. Winteraceae/ha	68	19.8	19	7.6	<0.01

^a Significance level for Wilcoxon signed rank tests for differences between bird centered and random plots.

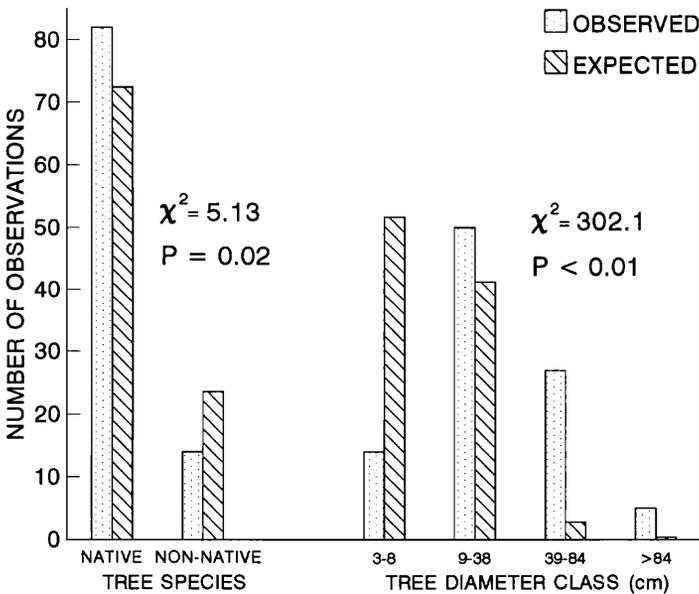


FIGURE 2. Relative use of trees by Blackburnian Warblers for foraging and availability by species and diameter class, Colombia, September 1993–May 1994. The data represent 96 foraging observations.

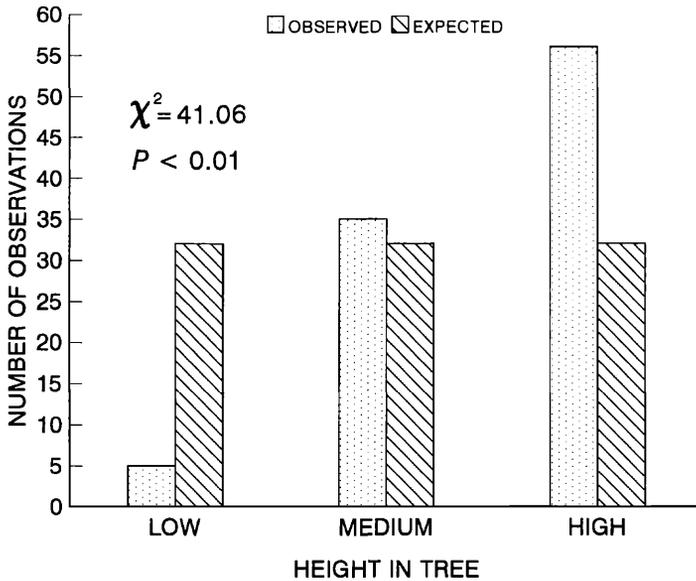


FIGURE 3. Frequency of observations of Blackburnian Warblers at different relative heights in trees, Colombia, September 1993–May 1994.

DISCUSSION

The Blackburnian Warbler was the most common migrant species at Los Amarillos (De La Zerda Lerner 1995), as well as at other places in Colombia (Miller 1963, Chipley 1976, Hilty 1980, Johnson 1980, Hilty and Brown 1986). In Colombia, Blackburnian Warblers have usually been seen with mixed-species flocks (Chipley 1976, Johnson 1980); we saw the same pattern. Chipley (1976) found Blackburnian Warblers to be more gregarious before spring migration than during the earlier part of the season on his study area in Colombia. This is the part of the season when the birds have to feed more efficiently to accumulate the energy necessary for migration. At Los Amarillos, the number of Blackburnian Warblers in the flocks throughout the season was relatively uniform. Before spring migration, I. Jiménez (pers. comm.) observed flocks with 40–50 Blackburnian Warblers in San Antonio del Tequendama southwest of Bogotá and L. M. Renjifo (pers. comm.) observed flocks of 20–25 Blackburnian Warblers in the central Andes. We believe Blackburnian Warbler density was not high enough at Los Amarillos to produce such large flocks.

Habitat used by the Blackburnian Warblers at Los Amarillos.—Habitat preferred by the Blackburnian Warblers in Los Amarillos can be characterized as a native second-growth forest with a relatively high density of trees >3 cm dbh, and a relatively low percentage of vegetation density from 1–3 m above the ground (Table 1). Blackburnian Warblers avoided non-native trees (Fig. 2), represented mostly by *Eucalyptus* spp. at Los

Amarillos (De La Zerda 1995). Habitats with non-native trees, mainly *Cupressus* spp., *Eucalyptus* spp., and *Acacia* spp., were used by the Blackburnian Warblers, but the birds appeared to prefer locations with native trees. Blackburnian Warblers were never seen in the pine plantation on the study area indicating that Blackburnian Warblers likely were also avoiding this cover type.

Reforestation in Colombia usually is done with *Pinus patula* and *Cupressus lucitanica* (Cavelier 1995). More animal and plant species can be found associated with eucalyptus than with pine plantations in Colombia (De La Zerda Lerner, pers. obs.). We can assume that selected tree species are providing the birds something that the non-selected trees are not providing (Rotenberry 1981). Food availability may be the most limiting factor in winter survival of neotropical migrants (Sherry and Holmes 1996). We believe that food may be more abundant in native trees. Holloway et al. (1992) found a reduction in insect diversity as tropical forests were converted to tree plantations. Native species that have evolved within an area have naturally associated insects, larvae, and other plants (epiphytes). Introduced plant species on the other hand, may not provide as much suitable substrate for invertebrate species.

Blackburnian Warblers selected for higher shrub density at Los Amarillos, which may be related to prey abundance, as suggested in other studies (Steele 1992). The preference that Blackburnian Warblers showed for a high density of trees also can be related to their feeding habits. Blackburnian Warblers forage in the outer leaves and twigs of trees and shrubs (Chipley 1980, Keast 1980, Stiles and Skutch 1989, De La Zerda Lerner 1995) mainly on insects and some fruit (Hilty 1980, Willis 1980, Curson et al. 1994). At Los Amarillos, a higher density of some fruit-producing shrubs (Chlorantaceae, Rubiaceae, Ericaceae) was seen in bird-plots (Table 2). However, we did not see any Blackburnian Warblers feeding on fruit in trees or shrubs; they always appeared to be seeking insects on twigs and leaves.

Although we did not census Blackburnian Warblers, we gained the impression that the number of mixed flocks and Blackburnian Warblers seen inside the larger forest patches was higher than the number seen outside the forest in smaller patches and lines of trees (71 observations were in fragments and 23 in lines of trees; De La Zerda Lerner 1995). This may indicate that some of the resident species and Blackburnian Warblers preferred larger forest fragments. Robbins et al. (1992b) found some Neotropical migrant species using isolated forest fragments as well as tree plantations in the Neotropics.

In Los Amarillos, Blackburnian Warblers showed a preference for the middle and upper levels of the vegetation (Fig. 3). This observation agrees with observations of Chipley (1980) and Ridgely and Gaulin (1980) in Colombia and Keast (1980) in Panama. Willis (1980), also in Panama, reported the Blackburnian Warblers to be common at all levels but that they preferred the upper levels when at low densities. During September and from late April to early May when densities are low, Blackburnian

Warblers preferred the higher levels of the vegetation (Chipley 1976, 1980). The fact that at Los Amarillos Blackburnian Warblers used the upper levels of trees during the whole season may indicate densities were relatively low.

Conservation and management implications.—We have identified some habitat features apparently important for Blackburnian Warblers on the wintering grounds. This information can be used to identify areas that might be considered for protection for Blackburnian Warblers and other species that may be associated with them in winter.

In Colombia, resident and migrant birds, as well as wildlife in general, will benefit from protecting Andean forests. We believe the most significant result we report was the avoidance of plantations of non-native tree species. Clearly, as forests are cut for various purposes, their replacement with plantations will result in less suitable habitat for wintering Blackburnian Warblers and perhaps other Neotropical migrants. We suggest that reforestation with native tree species and maintenance of native habitats should be a priority (Sherry and Holmes 1996).

ACKNOWLEDGMENTS

We appreciate the assistance of the Friedmann family on the study site and professional input of L. Rosselli and G. Stiles while in the field. This manuscript was improved by reviews of C. Haas, J. Fraser, and C. Adkisson and by two anonymous reviewers.

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Received 30 Sep. 1996; accepted 19 Feb. 1997.