Bird Conservation International (1995), 5:251-277 Cambridge University Press

doi:10.1017/S0959270900001039

Bird Conservation International (1995) 5:251-277

Bird faunas of the humid montane forests of Mesoamerica: biogeographic patterns and priorities for conservation

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Summary

The distribution of 335 species of birds in 33 islands of humid montane forest in Mesoamerica is summarized, and patterns of distribution, diversity and endemism are analysed. The montane forests of Costa Rica and western Panama far exceed other habitat islands considered for species-richness, richness of species endemic to Mesoamerica, and richness of species ecologically restricted to humid montane forests. Other regions, such as the Sierra Madre del Sur of Guerrero and Oaxaca, the Los Tuxtlas region of southern Veracruz and the mountains of Chiapas and Guatemala, also hold rich and endemic avifaunas. Based on patterns of similarity of avifaunas, the region can be divided into seven regions holding distinctive avifaunas (Costa Rica and western Panama; northern Central America and northern Chiapas; southern Chiapas; eastern Mexico north of the Isthmus of Tehuantepec; Sierra Madre del Sur; interior Oaxaca; and Transvolcanic Belt and Sierra Madre Occidental), which serve as useful guides for the setting of priorities for conservation action.

Se resumen las distribuciones de 335 especies de aves en 33 islas de bosque húmedo de montaña en Mesoamérica, y se analizan patrones de distribución, diversidad y endemismo. Los bosques montanos de Costa Rica y del oeste de Panamá tienen la más alta riqueza de especies, riqueza de especies endémicas a Mesoamerica, y riqueza de especies ecologicamente restringidas a bosque húmedo de montaña. Otras regiones, tales como la Sierra Madre del Sur de Guerrero y Oaxaca, la región de Los Tuxtlas y las montañas de Chiapas y Guatemala, también tienen avifaunas ricas en especies y en endémicas. Basado en patrones de similitud de avifaunas, se puede dividir Mesoamerica en siete regiones que tienen avifaunas distintas (Costa Rica y el oeste de Panamá; el norte de Centroamérica y el norte de Chiapas; el sur de Chiapas; el este de México; la Sierra Madre del Sur; el interior de Oaxaca; y el Eje Neovolcánico y la Sierra Madre Occidental), las cuales pueden servir como guias en el establecimiento de prioridades para la conservación.

Introduction

Tropical forests are rapidly disappearing from the face of the earth, and with them are vanishing multitudes of species of plants and animals that depend on them for food and shelter. Reductions in forest cover in this century are frighteningly large, and have accelerated greatly in recent years owing to expanding human populations, worsening economic situations, and improved technology for forest removal. For this reason, tropical forests have become the focus of intense interest from conservationists working to avoid large-scale loss of biological diversity (Sarukhán and Dirzo 1992).

In spite of the interest in preserving tropical forest biodiversity, the geographic distribution of that diversity is still largely unknown (Peterson *et al.* 1993). That is, for most taxonomic groups, very little is known about distributional limits of species, patterns of species-richness, or patterns of distribution of unique or endemic forms (Soulé 1990, Escalante-Pliego *et al.* 1993, Peterson *et al.* 1993). Birds are an important group for such studies because their taxonomy is well known, and because inventory methods are well developed, permitting detailed inferences from distributional data (e.g. ICBP 1992). Among the purposes of this paper, therefore, are to summarize the current knowledge of the distribution of birds in one habitat type – humid montane forests – in Mesoamerica, to analyse that information with regard to biogeographic patterns, and to begin to outline strategies for conservation action.

Humid montane forests in Mesoamerica

For this paper, we define humid montane forest as middle-to-high elevation tropical forest that receives strong input of moisture from rain, fog, and clouds. This definition includes true cloud-forest, which is a dense mixture of temperate and tropical broad-leaved tree species with many epiphytes and tree ferns, as well as humid pine–oak forest. Tree species characteristic of northern Mesoamerican cloud-forests include members of the genera *Quercus, Juglans, Podocarpus,* and especially *Liquidambar* (east) and *Chiranthodendron* (west; Rzedowski 1986). Many genera and species of trees in eastern Mexican cloud-forests are also found in the eastern United States, probably indicating an ancient moist forest connection between the two regions (Martin and Harrell 1959). Humid pine–oak forests grade into true cloud-forests, and share with them structural features such as the abundance of tree ferns and epiphytes (Rzedowski 1986). Faunas of the two habitat types, when in contact, are almost identical (Navarro-Sigüenza 1992, Torres-Chávez 1992), and therefore are considered together herein (Escalante-Pliego *et al.* 1993, Peterson *et al.* 1993).

Humid montane forests are found in broken strings along both coastal slopes of Mesoamerica. This distribution makes intuitive sense: coastal mountains intercept moisture from clouds rolling in off the ocean. These forests are better developed in the east, where climatic conditions are more moist. The degree of development of cloud-forests in a particular region also depends on factors such as soil type and predominant weather patterns, but especially on the presence of high or steeply ascending mountains close to the coast. Hence, the geographic distribution of the habitat is everywhere fragmented and local (Figure 1).

The dominant geographic features in Mexico are coastal ranges ("cordilleras") and interior basins. The western cordillera consists of the Sierra Madre Occidental in the north-west, part of the Transvolcanic Belt from Jalisco south to Michoacán, the Sierra Madre del Sur of Oaxaca and Guerrero, and the Sierra Madre de Chiapas. The eastern cordillera includes the Sierra Madre Oriental in the north-east; part of the Transvolcanic Belt in Hidalgo, Puebla, and Veracruz;

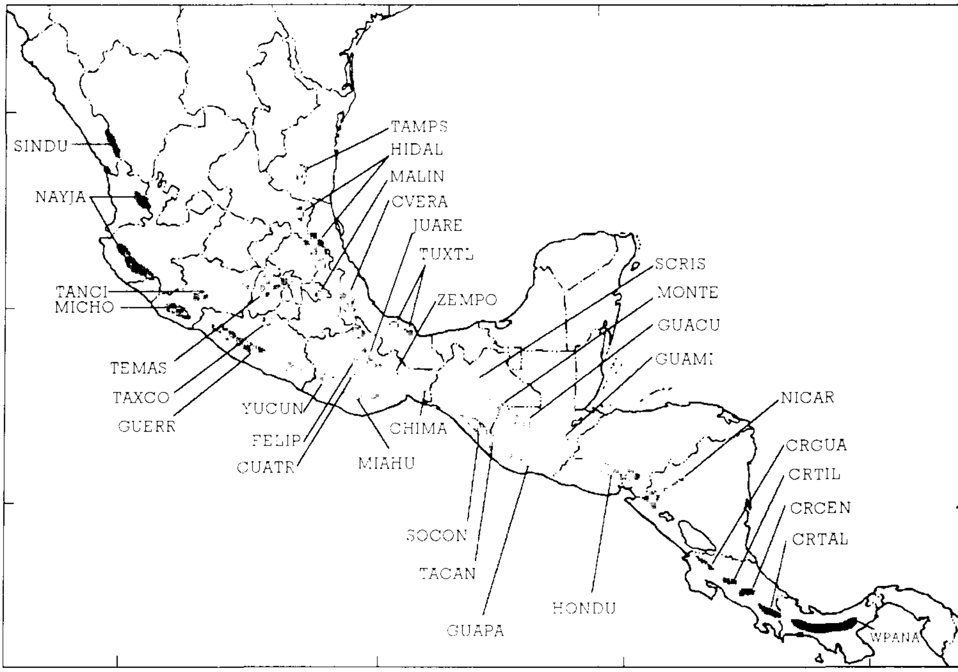

Figure 1. Map of the distribution of patches of humid montane forest in Mesoamerica, showing those included in this study and several that are yet to be studied.

the Nudo de Zempoaltépetl of Oaxaca; and the Sierra Norte de Chiapas. Separating these two mountain chains are arid interior basins including the Chihuahuan Desert, Valle de Tehuacán, Valle de Oaxaca, and the interior basins of Chiapas. Farther south, in southern Central America, the topography is often more simple, with one central cordillera and lowlands along both coasts.

An east–west transect across Mexico at almost any latitude therefore crosses a remarkably consistent set of vegetation types. First, one encounters wet tropical habitats in the Atlantic coastal lowlands. On the coastal slope of the first range of mountains is a narrow band of cloud-forest, and above that a band of humid pine–oak forest: these two habitats are the focus of the present paper. At the highest elevations, alpine pine–fir forest is found. In the interior basins, dry pine–oak forest, desert, or deciduous tropical scrub prevails. Descending the western slope, the same sequence of habitats is found, from alpine pine–fir forest through humid pine–oak and cloud-forest down to lowland tropical forests. However, because climates of the western lowlands are often less humid than those of the eastern slope, the west-slope tropical forests rarely approach the lush, evergreen quality of the east slope, and indeed are in many cases wholly or partly deciduous. Much of the geography of habitats in the country can be understood on the basis of this simplified scheme. Distributions of vegetation types in Central America are similar, except that in many areas the dry interior basins are lacking, and humid montane forest is therefore more continuous (Long 1995).

Mesoamerican humid montane forest avifaunas

The birds of humid montane forests in Mesoamerica represent a surprisingly diverse aggregation of species, and rank high among habitats in Mexico in total species-richness (Navarro-Sigüenza 1992, Escalante-Pliego *et al.* 1993, Peterson *et al.* 1993, Long 1995). Among the birds present are species commonly associated with lowland rainforests (e.g. Ornate Hawk-eagle *Spizaetus ornatus*, Ochre-bellied Flycatcher *Mionectes oleagineus*), as well as species typical of high-elevation, alpine forests (e.g. Sharp-shinned Hawk *Accipiter striatus*, Golden-crowned Kinglet *Regulus satrapa*). Also present, and perhaps most interesting, are many species and genera that are restricted to the humid montane forest zone, such as toucanets of the genus *Aulacorhynchus*, several rare and endangered guans (genera *Penelopina*, *Oreophasis*, and *Chamaepetes*), and jays of the genus *Cyanolyca*.

This variety suggests several ideas about why humid montane forests hold such diverse avifaunas (Escalante-Pliego *et al.* 1993). One possibility is that they represent a meeting ground between habitats, and their avifaunas largely consist of mixtures of both lowland and highland elements. A second view is that Mesoamerica as a whole represents an area of overlap between two faunas – those of North and South America – and that its richness results from the intermixture of the two geographically separated avifaunas. A final possibility is that substantial diversification has occurred *in situ*, and that the increased diversity of humid montane forests results from speciation and diversification of bird taxa in humid montane forests. It should be noted that these three explanations are not mutually exclusive, and that one, two, or all three may actually have played roles in the development of the humid montane forest avifauna.

Hence, a second set of objectives for this study is to lay a basis for a more thorough understanding of the historical processes that generated the diverse humid montane forest avifauna. Detailed analyses of patterns of distribution, diversity, and endemism can reveal hints as to the history of the region and its biota. Later, combining these results with hypotheses of the history of particular taxa – phylogenetic hypotheses – detailed historical explanations can potentially be developed.

Methods

We gathered data on the distribution of bird species in 33 isolated patches of humid montane forest in Mesoamerica (Figure 1), defined here as the region lying between the Río Bravo (U.S.A.–Mexico border) and the Isthmus of Panama. Forest patches were chosen to represent as much as possible regions of continuous humid montane forest without major interruptions such as deep river valleys or desert basins. Some patches had to be eliminated from consideration owing to insufficient data; for example, the Sierra Mazateca of northern Oaxaca was not considered because nothing whatsoever was known of its avifauna (Binford 1989; results of surveys are currently in preparation). Obviously, because humid montane forest is by nature fragmented, our "patches" really represent systems of related patches of different sizes; badly needed are surveys in tiny and remote humid montane forest patches. Because of the concentration of our field surveys in the northern part of the study area (Mexico), more detailed analysis was possible within Mexico than in the mountain systems in Central America; regardless, cloud-forest patches appear to be more continuous in Central America (ICBP 1992, Long 1995), making a coarser-grained view appropriate. Detailed analyses of the extent and condition of individual forest patches, as well as analyses of species-area relationships, must await detailed study of satellite imagery from the region.

Three hundred and thirty-five bird species were included in the database for this study, based on the taxonomy of the American Ornithologists' Union (AOU 1983), with minor amendments to reflect more recent taxonomic opinion (Appendix 1). We used brackets [ ] to indicate the superspecies relationships of differentiated allopatric forms that would be considered semispecies (AOU 1983) or phylogenetic species (Cracraft 1983, McKitrick and Zink 1988). To restrict the analysis to taxa that actually breed in the study areas, we eliminated all species that occur only as migrants, vagrants, or winter residents (Remsen 1994). A few species, which have broad geographic distributions but occur in humid montane forests only marginally throughout much of their ranges, such as Scrub Jays *Aphelocoma coerulescens*, are included in the data matrix only where they range broadly into that habitat.

To focus the study on inhabitants of humid montane forests, we excluded species not living *within* the forest, for example, swallows that hunt for food above the canopy; families of birds that were thus eliminated include Hirundinidae and Alcedinidae. Based on descriptions of distributions (AOU 1983) and habitat use (see references), we described each species as occurring farther north ($N = 1$), farther south ($S = 1$), higher ($A = 1$), or lower ($B = 1$) in the altitudinal sequence of habitats. We define species occurring neither farther north nor farther south ($N + S = 0$) as endemic to Mesoamerica, and species occurring neither higher nor lower in the altitudinal sequence of habitats ($A + B = 0$) as ecologically restricted to humid montane forests.

A wide variety of sources (e.g. Friedmann *et al.* 1950, Miller *et al.* 1957, Wetmore 1965–1984, AOU 1983, Stiles and Skutch 1989) was used to make the database reflect the known distributions of species as completely as possible. In addition, we consulted taxonomic treatments for many groups, faunal lists for numerous localities, and specimen data from several North American museum collections. For each definite record, a "1" indicating presence was entered in the appropriate cell of the data matrix; absences were entered as "0". Because, in many cases, existing inventories for particular montane forest habitat islands were incomplete, we also included a "probable" occurrence category: if a species occurred in habitat islands both north and south of an island in question, and if particuliar habitat requirements were met, then an "X" was entered in the appropriate cell of the data matrix. Later, we tested the validity of these distributional assumptions by alternatively setting all $X = 1$ (assumptions correct) or all $X = 0$ (assumptions incorrect), and reanalysing the data.

A variety of approaches was employed to understand geographic patterns in the dataset. Species-richness and levels of endemism were assessed by simple counts of occurrences at each locality. Phenetic analyses of similarity among avifaunas of different localities were conducted by calculating Simpson's Index of Faunal Similarity, and then using the unweighted pair-group method of analysis (routines in SYSTAT, version 3.1) to produce dendrograms. Reanalysing the data under the two distributional assumptions mentioned above had no qualitative effect on patterns detected, and so only the results based on the most complete information (assumption $X = 1$) are presented herein.

Results

Patterns of species-richness and endemism

Species-richness of birds in the humid montane forest islands in Mesoamerica showed a broadly increasing trend from north to south (Table 1, Figure 2a). Forest islands in northern and central Mexico generally held 100 bird species or fewer, those in Chiapas and northern Central America 150–180 species, and those of Costa Rica and western Panama 180–201 species. Hence, the coarsest-scale trend was one of elevated species-richness in the southernmost montane forest islands.

Exceptions to this trend included montane forest islands in the interior and those that are geographically isolated from the main mountain masses of Mesoamerica. For example, the forest islands in the interior of Mexico in the Transvolcanic Belt and central Oaxaca (Table 1, Figure 2a) held substantially fewer species than adjacent forest islands on the coastal slopes. Similarly, the isolated humid montane forests of the Los Tuxtlas region of south-eastern Veracruz held relatively few bird species (Andrle 1967). Surveys in small and isolated habitat islands in southern Mesoamerica would provide an important test of the generality of this result.

In all, 145 species of birds that occur in humid montane forests are endemic to Mesoamerica (i.e. $N + S = 0$). Patterns of species-richness among endemics of Mesoamerica were generally similar to patterns of species-richness in the region (Table 1, Figure 2b): northernmost forest islands contained few Mesoamerican endemics, whereas Central American forest islands, especially those of Costa Rica and western Panama, were extremely rich in such species. These patterns were apparent regardless of whether they were based on raw numbers of endemic species or on the percentage of endemism relative to the total species-richness at the site.

Patterns of distribution of habitat-restricted species

A total of 147 species occur in Mesoamerica that are ecologically restricted to humid montane forests (i.e. $A + B = 0$). These species are narrowly restricted to the humid forest band at middle elevations (1,000–1,800 m in Mexico). Geographic patterns of richness of these taxa were generally similar to those of species-richness: a broad trend of increasing numbers from north to south (Table 1, Figure 2c). Especially notable was the virtual absence of ecologically restricted species in the marginal northernmost forest islands in northern, central and western Mexico.

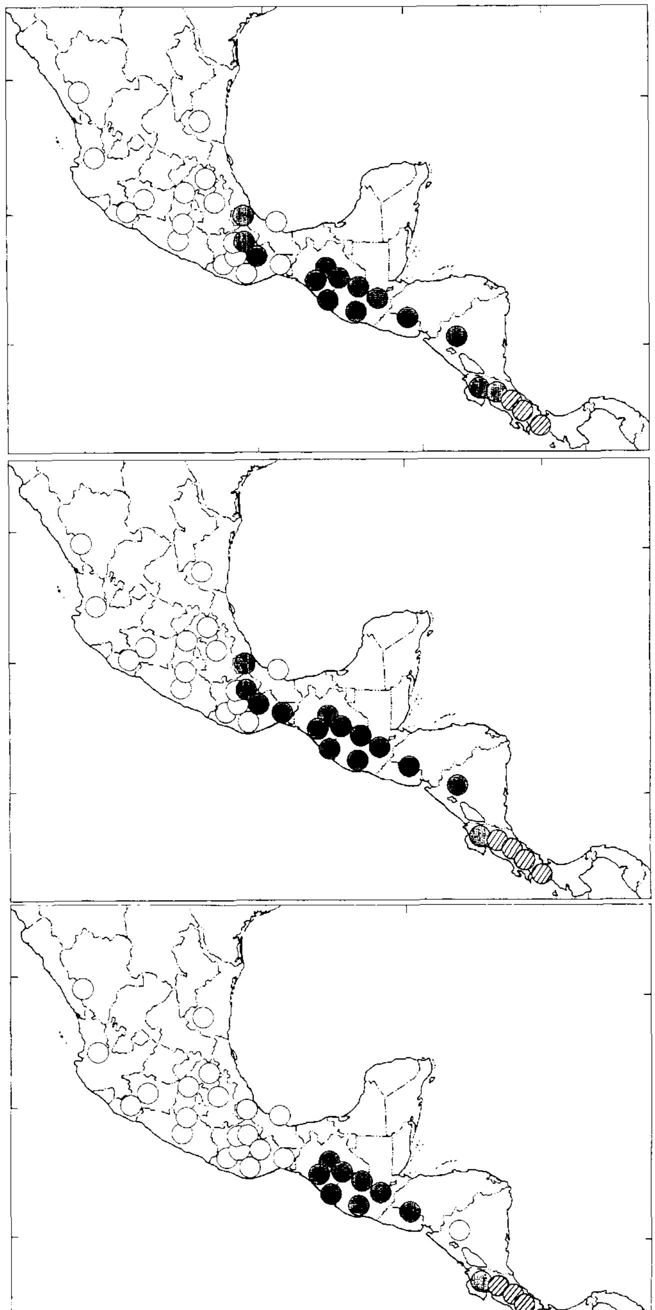

Figure 2. Distribution of species-richness of birds in the humid montane forests of Mesoamerica. Top: species-richness (white, 72–99; light grey, 100–136; dark grey, 145–178; cross-hatched, 195–200 species). Middle: richness of species endemic to Mesoamaerica (white, 3–11; light grey, 12–25; dark grey, 26–39; cross-hatched, 40–57 species). Bottom: richness of species restricted to humid montane forests (white, 7–15, light grey, 16–27; dark grey, 36–62; cross-hatched, 79–102 species).

Table 1. Summary of species-richness, richness of species ecologically restricted to humid montane forests, richness of species endemic to the humid montane forests of Mesoamerica, and richness of narrow endemics (at scales of 1–2 patches, 1–5 patches, and 1–10 patches), of 33 humid montane forest patches in Mesoamerica. Xo and X1 represent the two different assumptions made regarding completeness of inventories in each forest patch. Totals refer to numbers in each category in Mesoamerica as a whole.
See Appendix 2 for patch names.

	Species-richness		Ecolog. restricted		Endemic		Narrow endemics		
Patch	*Xo*	*X1*	*Xo*	*X1*	*Xo*	*X1*	*1–2*	*1–5*	*1–10*
Eastern Mexico									
TAMPS	79	103	13	14	8	8	0	0	0
HIDAL	100	136	23	27	12	15	1	1	2
CVERA	139	175	36	41	20	23	1	2	4
TUXTL	82	104	18	24	11	14	2	2	3
CUATR	42	72	8	10	4	5	0	0	1
JUARE	125	154	34	38	20	22	0	1	3
FELIP	78	104	15	17	7	9	0	1	2
ZEMPO	71	154	21	36	12	20	0	1	3
SCRIS	81	165	36	51	27	36	0	1	14
MONTE	34	166	17	51	12	36	0	1	14
Western Mexico									
SINDU	36	95	4	10	3	4	1	1	1
NAYJA	71	122	12	17	9	9	1	1	2
MICHO	78	113	9	14	5	8	0	0	1
GUERR	111	133	25	27	15	15	1	2	3
YUCUÑ	68	103	15	16	6	6	1	2	2
MIAHU	99	124	23	24	12	12	1	2	3
CHIMA	97	120	32	36	21	22	0	0	4
SOCON	79	155	44	56	30	37	0	2	14
TACAN	65	156	36	57	27	38	0	2	15
Transvolcanic Belt, Mexico									
TANCI	58	93	8	11	4	5	0	0	0
TEMAS	57	91	7	11	4	6	0	0	1
TAXCO	54	80	7	7	4	4	0	0	0
MALIN	14	74	0	7	0	3	0	0	0
Central America									
GUAPA	145	178	52	58	36	38	0	3	16
GUACU	88	183	40	59	30	39	0	2	16
GUAMI	95	181	38	58	26	38	0	1	15
HONDU	173	183	60	62	38	39	1	2	16
NICAR	91	147	26	43	20	23	1	2	6
CRGUA	130	145	53	58	26	28	0	18	20
CRTIL	159	170	74	79	38	40	0	28	30
CRCEN	193	195	96	97	54	54	0	41	43
CRTAL	190	195	97	99	56	56	3	43	45
WPANA	188	200	97	102	56	57	6	45	47
TOTALS	335		147		101		14	61	78

Of the ecologically restricted species, more than two-thirds (101 species) are also geographically restricted to Mesoamerica (i.e. N + S + A + B = 0). This assemblage of species is found nowhere in the world but in Mesoamerican humid montane forests, and might be taken as a set of species that evolved *in situ*. These species are of special interest in conservation planning because of their extreme vulnerability to destruction of humid montane forests in a limited region.

Narrow endemics

Species with extremely restricted distributions, "narrow endemics", are important features in studies of biological diversity and endemism. Of the 335 species included in this study, 101 were endemic to Mesoamerican humid montane forests. Of these species, eight (7.9%) were restricted completely to a single forest island; 14 (13.9%) were found in one or two islands; and 61 (60.4%) were found in fewer than five islands of montane forest. Hence, extreme geographic restriction is common among the endemic birds of humid montane forests in Mesoamerica.

The geographic distribution of these restricted-distribution species was focused in but a few zones (Figure 3). Species with geographic ranges of but one or two forest islands were concentrated in the Los Tuxtlas region of south-eastern Veracruz, the mountains of western Mexico, and especially in south-easternmost Costa Rica and western Panama. Each of these areas represents a mountain massif holding forests which were probably isolated from other humid montane forests since before the Pleistocene (Martin and Harrell 1959, Graham 1993), providing the isolation necessary for speciation to take place. Expanding the scale of endemism to include species with geographic ranges of five or fewer forest islands, the pattern was similar, although forest islands in north-eastern Mexico also appeared as hotspots, and the importance of the Costa Rican and Panamanian islands became much more emphasized. Expanding the scale still more, say, to ranges of up to 10 forest islands, emphasized Chiapas, Guatemala, Costa Rica and western Panama greatly, and de-emphasized the importance of forest islands farther north. Hence, the geographic patterning of endemism is very much a function of the spatial scale at which endemism is defined.

Patterns of similarity among avifaunas

Analyses of similarity among avifaunas of different forest islands (Figure 4) revealed clear geographic patterns. The avifaunas of the mountains of Costa Rica and western Panama were very different from those of forest islands farther to the north. The avifaunas of the forest islands of eastern Mexico north of the Isthmus of Tehuantepec were all very similar to one another, and as a unit were most similar to those of Chiapas and northern Central America (within which the mountains of southern Chiapas segregated as a distinct entity). Three forest islands, the Chimalapas region of eastern Oaxaca, the Los Tuxtlas region of south-eastern Veracruz, and the mountains of Nicaragua, clustered loosely together, which, at least in the case of the latter island, makes no clear geo-

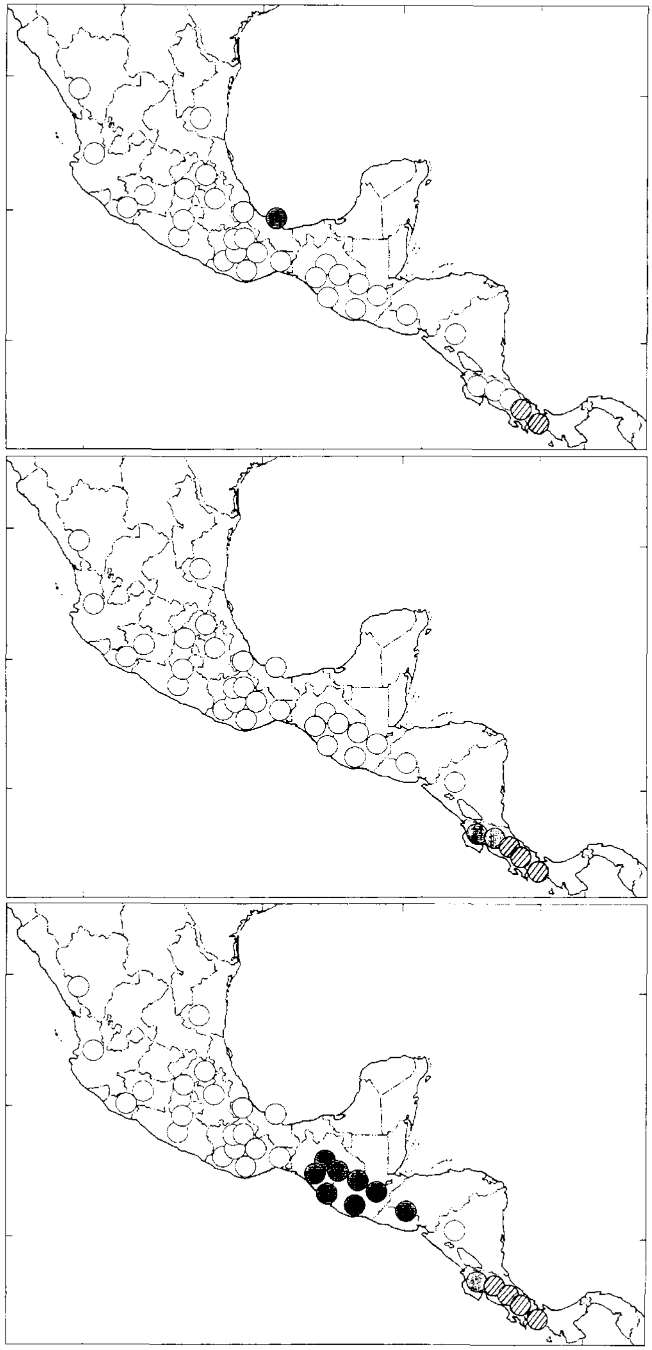

Figure 3. Distribution of richness of species of restricted geographic distribution (narrow endemics) in Mesoamerica, under different definitions of endemism. Top: 1–2 forest patches (white, 0; light grey, 1; dark grey, 2; cross-hatched, 3–6 species). Middle: 1–5 forest patches (white, 0; light grey, 1–3; dark grey, 18–28; cross-hatched, 41–45 species). Bottom: 1–10 forest patches (white, 0; light grey, 1–6; dark grey, 14–20, cross-hatched, 30–47 species).

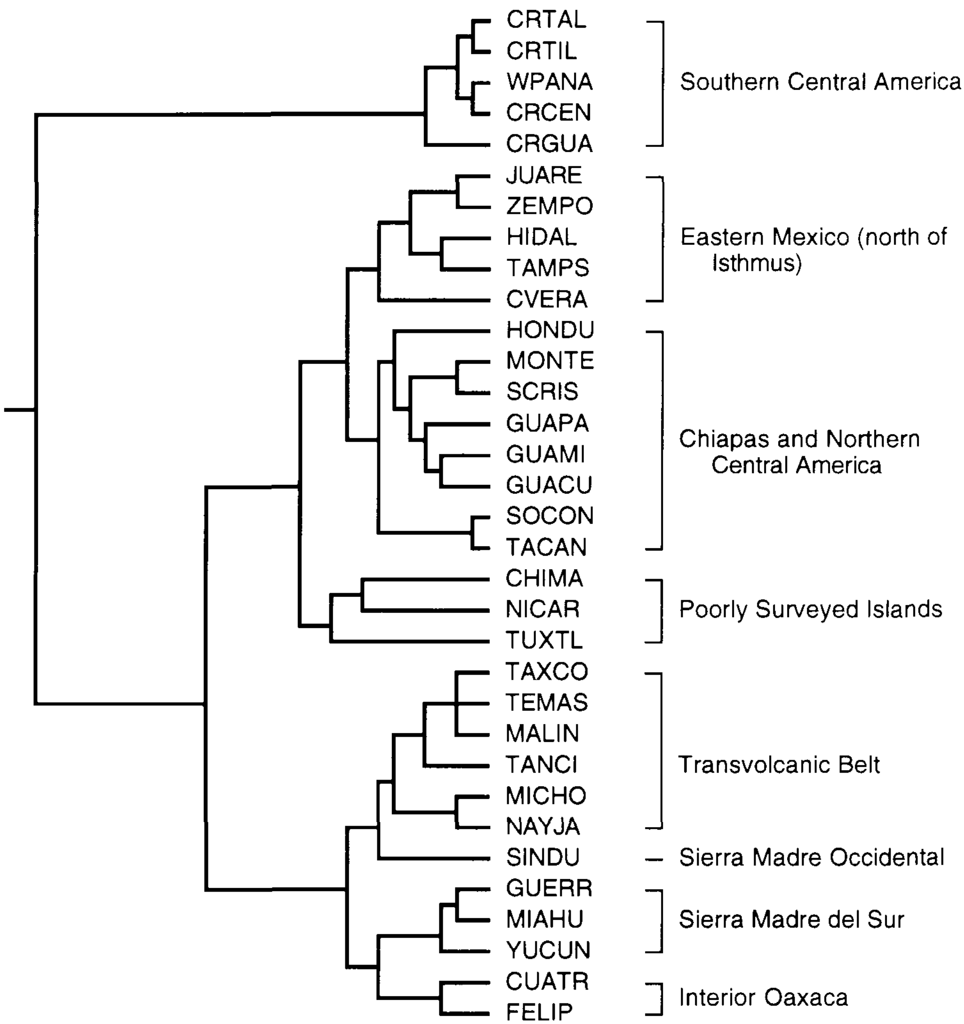

Figure 4. Patterns of similarity among the avifaunas of patches of humid montane forest in Mesoamerica, based on UPGMA analyses of Simpson's Index of faunal similarity.

graphic sense, although given their low level of similarity, they could perhaps be considered as three separate entities; perhaps they grouped together because their avifaunas are depauperate and/or poorly known. Finally, the forest islands of the Transvolcanic Belt and Sierra Madre Occidental of central and western Mexico (within which can be seen three geographic groupings: the Sierra Madre Occidental, the mountains along the coast from Michoacán to Nayarit, and the interior portion of the Transvolcanic Belt) and the mountains of southern Mexico west of the Isthmus of Tehuantepec (within which can be discerned a Sierra Madre del Sur group and an interior Oaxaca group) each formed units, and grouped together form a more inclusive unit separate from that of eastern Mexico and northern Central America. Hence, most forest islands included in

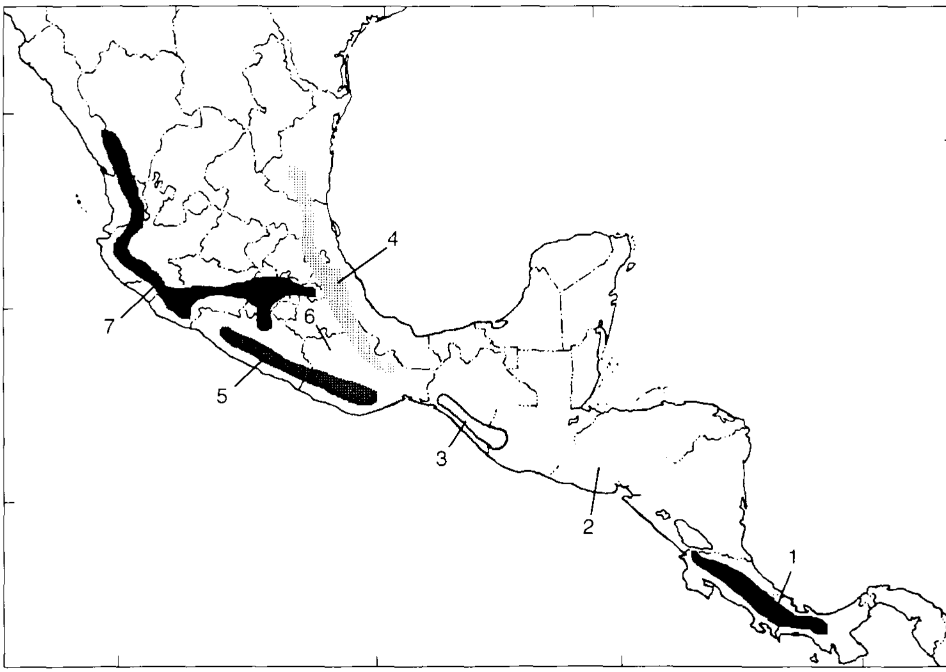

Figure 5. Biogeographic units based on patterns of similarity of avifaunas in the humid montane forests of Mesoamerica (numbers are equivalent to those on opposite page).

this study fell into distinct geographic units, and biogeographic entities were thereby easily delineated (Figure 5).

Discussion

Geographic patterns in distribution of species

The avifauna of the humid montane forests of Mesoamerica is distributed unevenly. A general trend of increasing diversity from north to south across the study area was found, with the southernmost islands holding about twice as many species as the northernmost. Also, patches of humid montane forest isolated from the main cordilleras had considerably fewer species than central patches. All of these patterns were perhaps expected given the ease of colonization of central as compared with peripheral forest patches, long-term stability and integrity of forest patches, patterns of complexity of plant communities, and the broad-scale trend of increasing diversity at lower latitudes.

More interesting were the geographic patterns of distribution of species endemic to Mesoamerican humid montane forests. By far the greatest concentration of endemic species in the region was in south-eastern Costa Rica and western Panama. This result would seem surprising in view of the geographic proximity of the cloud-forests of eastern Panama and the Andes of South America; however, as has been appreciated by other authors (e.g. Wetmore 1965–1984, ICBP 1992, Long 1995), many species have their geographic distributions restricted to a tiny area very close to a barrier that separates the Mesoamerican and South American faunas. Such a concentration, with essentially no introgression from forms to the east, suggests that the Isthmus of Panama has constituted an extremely strong barrier to dispersal, that colonization events in either direction have been rare, and that connections of humid "montane" forest across the Isthmus were probably never established during the climatic fluctuations of the late Pleistocene glaciations.

Biogeographic boundaries

The analyses presented herein, especially the cluster analyses of avifaunal similarity (Figure 4), allowed detailed and quantitative identification of biogeographic regions (Figure 5). The analyses presented above clearly identified seven geographic clusters with characteristic avifaunas. In the list that follows, endemic species are listed, and selected species having distributions almost limited to the region are given in parentheses.

(1) Costa Rica and western Panama: e.g. *Pselliophorus* spp., *Pyrrhura hoffmani*, *Parula gutturalis* and *Troglodytes ochraceus*, among others.
(2) Northern Central America and northern Chiapas: *Lampornis sybillae*, *Otus barbarus* and *Cyanocorax melanocyaneus*.
(3) Southern Chiapas: (*Tangara cabanisi*) and (*Oreophasis derbianus*).
(4) Eastern Mexico north of the Isthmus of Tehuantepec: *Dendrortyx barbatus*, (*Cyanolyca nana*) and (*Rhynchopsitta terrisi*).
(5) Sierra Madre del Sur: *Eupherusa poliocerca*, *E. cyanophrys*, *Cyanolyca mirabilis*, (*Nyctiphrynus mcleodii*) and (*Cypseloides storeri*).
(6) Interior Oaxaca: (*Cyanolyca nana*).
(7) Transvolcanic Belt and Sierra Madre Occidental: *Cyanocorax dickeyi*, *Thalurania ridgwayi*, (*Streptoprocne semicollaris*), (*Rhynchopsitta pachyrhyncha*), (*Cardellina rubrifrons*) and (*Atlapetes virenticeps*).

Each of these regions is faunistically distinctive from other such regions.

Of great interest to biogeographers is the historical pattern of interconnections among areas. This pattern could be represented as a tree showing the history of connection and isolation of different forest patches. The hierarchical pattern of similarity resulting from these analyses is as follows: (Costa Rica and western Panama, ((eastern Mexico, (northern Central America and Chiapas, southern Chiapas)), (Transvolcanic Belt and Sierra Madre Occidental, (Sierra Madre del Sur, interior Oaxaca)))) (Figure 4). Although this pattern was detected by phenetic analyses, to the degree that avifaunal similarity reflects historical relationship, we can take it as a preliminary hypothesis of historical relationships among cloud-forest areas for later testing based on phylogenetic studies.

Endemism and speciation

By inspecting patterns of distribution of endemic species, regions that may be foci of differentiation and speciation may be identified. For example, the Costa Rica and western Panama area has many endemic species that appear to have differentiated and speciated *in situ*. Other areas that represent potential foci of differentiation and speciation include the Los Tuxtlas region of south-eastern Veracruz and the Sierra Madre del Sur of Guerrero and Oaxaca. Detailed phylogenetic studies of individual taxa are needed to clarify the historical processes that underlie these distributional patterns.

Although the high endemism in the Costa Rica/Panama area has been well appreciated (Wetmore 1965–1984, Stiles and Skutch 1989, ICBP 1992), elevated endemism in the two Mexican regions has gone relatively underappreciated (but see ICBP 1992, Long 1995). In 1988–1989, when three of us wrote a summary of patterns of avian diversity in Mexico (Escalante-Pliego *et al.* 1993), we knew of but one species endemic to the Los Tuxtlas region, the hummingbird *Campylopterus excellens*. Since that time, however, we have come to appreciate the distinctiveness of three other taxa: the quail-dove *Geotrygon carrikeri*, which is recognizable as a species separate from the southern *G. lawrencii* based on characters of plumage and morphology (Peterson 1993); the bush-tanager *Chlorospingus [ophthalmicus] wetmorei*, which is distinctive in genetic characters (Peterson *et al.* 1992); and the brush-finch *Atlapetes [brunneinucha] apertus*, which is readily distinguishable on the basis of plumage characters. Recognition of these forms as separate species of course depends on the species concept used; nevertheless, they are diagnosable forms and represent units of biological diversity distinct from other populations currently placed in the same species. Hence, the Los Tuxtlas region actually holds a number of endemic taxa, although the first impression was to the contrary; assessment of its importance as a centre of endemism if all near-species-level differentiates were recognized, however, must await future analyses (Navarro-Sigüenza and Peterson in prep.).

The Sierra Madre del Sur of Guerrero and Oaxaca (in some taxa extending north-west to Michoacán, Jalisco and Nayarit) is still more striking in its richness of endemic species, the distinctiveness of many of which has also been underappreciated. Taxa occurring in humid montane forests in the region include the newly described swift *Cypseloides storeri* (Navarro-Sigüenza *et al.* 1992), the hermit hummingbird *Phaethornis [superciliosus] mexicanus* (R. C. Banks pers. comm.), the extremely rare hummingbird *Lophornis brachylopha* (Banks 1990), the hummingbirds *Thalurania ridgwayi* (Jalisco and Nayarit only: Escalante-Pliego and Peterson 1992), *Eupherusa poliocerca**, *E. cyanophrys**, and *Lampornis [amethystinus] margaritae* (Torres-Chávez *et al.* in prep.), the toucanet *Aulacorhynchus [prasinus] wagleri* (Benítez-Díaz *et al.* in prep.), the woodpecker *Piculus auricularis** (Baptista 1978), the antpitta *Grallaria [guatimalensis] ochraceiventris* (Peterson *et al.* in prep.), the jays *Cyanolyca mirabilis** and *Aphelocoma [unicolor] guerrerensis* (Peterson 1992), and the bush-tanager *Chlorospingus [ophthalmicus] albifrons* (asterisks indicate recognition by AOU 1983). Hence, of the 13 species or near-species-level differentiates in humid montane forests in the region, only four were fully recognized by the AOU (1983). The majority are presently under study by ourselves and our students, based on a variety of morphological characters, investigations that are revealing more striking levels of endemism than previously appreciated (Peterson and Navarro-Sigüenza in prep.). The importance of the mountains of western Mexico as a centre of avian endemism has also been pointed out by ICBP (1992) and Long (1995).

Viewed more generally, in the context of the question posed in the Introduction, the surprising biological diversity of the humid montane forests of

Mesoamerica has a complicated history. Some taxa have clearly entered the region from north or south (see examples in Introduction), but fully 101 of the 335 species (30.1%) seem to have speciated *in situ* in Mesoamerican humid montane forests. Hence, all three general explanations may have played important roles in the diversification of the birds of the humid montane forests of Mesoamerica (Escalante-Pliego *et al.* 1993).

Priorities for conservation action

An important reason for conducting studies such as this is to aid the design of optimal strategies for conserving biological diversity. In the present case, the avifaunas of humid montane forests are in trouble because the habitat is increasingly endangered. Humid montane forests are cleared for lumber and paper pulp interests, planting coffee, corn, and other agricultural products, or for grazing cattle or goats. In some cases, the destruction is absolute (e.g. clear-cutting of forests); in other cases, it is gradual, such as through the grazing of cattle within forests, which causes a slow degradation of forest quality. The end result, however, is much the same: a place uninhabitable by animals and plants requiring native forest cover.

Given that money and opportunities for conservation action are limited, careful design of a strategy for conserving maximally the biological diversity of these forests is critical. A common approach is to focus on species of particular interest: for the present study, candidates might include the Horned Guan *Oreophasis derbianus* and Resplendent Quetzal *Pharomachrus mocinno*, both of which are large, attractive, endangered, and endemic to Mesoamerican humid montane forest. Nevertheless, as we have demonstrated in these analyses, the set of species potentially threatened in Mesoamerican humid montane forests is much more inclusive, and we therefore believe that efforts to preserve maximally the biological diversity of the region must instead be focused at the level of communities.

An exciting result that has emerged in the past decade is the remarkable coincidence in patterns of diversity and endemism among different taxonomic groups in Mesoamerica (see, e.g., Peterson *et al.* 1993, Ramamoorthy *et al.* 1993, Vázquez-García 1995). Patterns being concordant among many taxa, optimal conservation strategies should also generally coincide, because endemic forms are concentrated in the same areas. Given that birds are such a well-known group in terms of distribution and diversity, analyses of patterns of avian diversity are critical to the establishment of conservation priorities. The biogeographic regions delimited above are a good first step. Viable reserves should be established in each of the seven regions: (1) Costa Rica and western Panama, (2) northern Central America and northern Chiapas, (3) southern Chiapas, (4) eastern Mexico north of the Isthmus of Tehuantepec, (5) Sierra Madre del Sur, (6) interior Oaxaca, and (7) Transvolcanic Belt and Sierra Madre Occidental. Preservation of examples of each of these regions would protect the great majority of endemic montane forest birds in Mesoamerica.

Unfortunately, not all seven areas are currently under protection. Those areas that are currently protected more or less adequately (i.e. excluding areas under decree as protected areas but not in actuality receiving any protection) are (1)

Costa Rica and western Panama (e.g. Parque Nacional La Amistad), (2) northern Central America and northern Chiapas (e.g. Parque Nacional Lagunas de Montebello), (3) southern Chiapas (Reserva de la Biósfera El Triunfo), and (7) Transvolcanic Belt (e.g. Parque Nacional Pico de Tancítaro, Parque Nacional Lagunas de Zempoala) and Sierra Madre Occidental (e.g. Reserva de la Biósfera "Sierra de Manantlán"). The remaining areas – (4), (5) and (6) – remain completely unprotected. We list (4) as unprotected in spite of the existence of the Reserva de la Biósfera "El Cielo" in Tamaulipas, because that mountain range is too far north to hold many of the species characteristic of that region.

Focusing on the 101 bird species endemic to Mesoamerican humid montane forests, the existing reserve system misses completely seven of these species: *Cyanocorax dickeyi* of the Sierra Madre Occidental of Sinaloa and Durango; the Bearded Wood-partridge *Dendrortyx barbatus* of Hidalgo, San Luis Potosí and northern Puebla and Veracruz; the Dwarf Jay *Cyanolyca nana* presently restricted to Cerro San Felipe of central Oaxaca; the Blue-capped Hummingbird *Eupherusa cyanophrys* of the Sierra de Miahuatlán of southern Oaxaca; the White-tailed Hummingbird *E. poliocerca*; the White-throated Jay *Cyanolyca mirabilis* of the Sierra Madre del Sur of Guerrero and Oaxaca; and the Green-breasted Mountain-gem *Lampornis sybillae* of Nicaragua and Honduras. Five of these species – *Dendrortyx barbatus, Cyanolyca nana, C. mirabilis, Eupherusa cyanophrys,* and *E. poliocerca* – have already been identified as threatened with global extinction (Collar *et al.* 1992). Hence, clear priorities in the situation of new reserves include these areas, especially the Sierra Madre del Sur of Guerrero and Oaxaca, where three of these species remain unprotected (not to mention 10 additional forms presently under study, as mentioned above).

An ideal, if perhaps impractical, plan for the conservation of humid montane forest avifaunas would be the establishment of protected areas in each forest island, given that avifaunas of different islands within regions, although similar, are not identical. For areas in which political instability is a concern, binational protected areas may potentially buffer unique habitats against the whims of human matters (consider, for example, the destruction of forest areas in northern Chiapas in 1994 and 1995). More than anything, conservation of montane forest areas in Mesoamerica must adopt a two-pronged approach: (1) emergency protection of even the smallest patches of forest in critically endangered areas (e.g. forests in north-eastern Mexico, which are threatened with total eradication), and (2) identification and protection of the largest and most complete areas, which may permit the long-term preservation of entire ecosystems without substantial losses due to area effects (e.g. Sierra de Juárez, Oaxaca, where 300,000+ ha of montane forest remain almost untouched). Our hope is that information and analyses presented herein will serve to focus such efforts more precisely, and allow conservation planners to make optimal use of their resources. We can make available electronic copies of the data matrix so as to permit further analysis and interpretation of the information presented herein.

Acknowledgements

We thank a great many people for their help with this project over the past 14 years. First and foremost, thanks to our many students who in the course of their studies have dedicated hundreds of hours to the work in field, library, museum, and laboratory needed to assemble this database. We thank our dear friends, Claudia Abad de Navarro, Carlos Cordero, Livia León-Paniagua, and Rosa M. Salazar for their friendship, help, and encouragement during this project. Several colleagues have offered helpful comments on the manuscript, including Mark Robbins, Oliver Komar and an anonymous reviewer. For access to specimens, we thank the curators of the Field Museum of Natural History, American Museum of Natural History, and University of Michigan Museum of Zoology. Funding was provided by the National Geographic Society, National Science Foundation, Dirección General de Asuntos del Personal Académico, CONACyT, PADEP, and the Field Museum of Natural History.

Appendix 1. Summary of known distributions of birds in patches of humid montane forest in Mesoamerica.

For each patch, occurrence of species is indicated as 0, absent; x, not definitely known to occur, but likely on biogeographic grounds; and 1, definitely occurs. "HAB" = habitat use: A, occurs in habitats above humid montane forests; and B, occurs in habitats below humid montane forests. "GEO" = extent of geographic range: N, occurs farther north than the northern limit of humid montane tropical forests as defined for the purposes of this paper; and S, occurs south or east of the Isthmus of Panama. "TV Belt" = the Transvolcanic Belt of central Mexico. Forest islands are numbered as in Appendix 2.

	HAB		GEO		Mexico			
					East slope	West slope	TV Belt	Central America
	A	B	N	S				
Abeillia abeillei	0	0	0	0	0 0 1 0 0 1 0 x 1 x	0 0 0 0 0 0 1 1 x	0 0 0 0	1 x x 1 1 0 0 0 0 0
Acanthidops bairdii	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Accipiter bicolor	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	1 x x x x 1 1 1 1 1
Accipiter gentilis	1	0	1	0	0 1 0 0 0 0 0 0 0 0	1 0 0 1 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Accipiter striatus	1	0	1	1	x 1 0 0 0 0 1 0 0 x	0 1 0 1 0 0 1 1 1	1 0 0 0	1 1 1 1 1 0 0 0 0 0
Aegolius acadicus	1	0	1	0	0 0 1 0 0 0 1 x 0 0	0 x 0 0 0 0 1 0 0	1 0 0 1	0 0 0 0 0 0 0 0 0 0
Aegolius ridgwayi	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 1	0 0 0 0	1 x x 1 0 0 0 1 1 1
Aeronautes saxatalis	1	0	1	0	x 1 x 0 0 0 0 0 0 0	x 0 1 1 0 0 0 0 1	1 0 1 0	1 x x 1 0 0 0 0 0 0
Amaurospiza concolor	0	0	0	1	0 0 0 0 0 0 0 x 0 0	0 1 0 1 0 1 0 1 0	0 0 0 0	0 0 0 1 1 1 1 1 1 1
Amazilia beryllina	1	1	0	0	0 0 1 x 1 0 1 1 1 x	x 1 1 1 x 1 0 x x	1 1 1 x	1 x 1 1 0 0 0 0 0 0
Amazilia candida	0	1	0	0	0 1 1 1 0 1 0 x 1 1	0 0 0 0 0 0 x 0 0	0 0 0 0	1 x x 1 0 0 0 0 0 0
Amazilia cyanocephala	1	1	0	0	1 1 1 x 0 1 1 1 1 x	0 0 0 0 0 0 1 x x	0 0 0 0	1 1 1 1 1 0 0 0 0 0
Amazilia tzacatl	0	1	0	1	1 x x 1 x 1 x x x x	0 0 0 0 0 0 x x x	0 0 0 0	1 x x 1 1 1 1 1 1 1
Amazona finschi	0	1	0	0	0 0 0 0 0 0 0 0 0 0	x x x x 1 1 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Anabacerthia variegaticeps	0	1	0	1	0 0 0 1 0 1 0 1 x 1	0 0 0 1 x 1 1 1 1	0 0 0 0	1 1 1 1 x 1 1 1 1 1
Aphelocoma coerulescens	1	0	1	0	0 0 0 0 1 0 1 0 0 0	0 0 0 0 0 0 0 0 0	0 0 1 1	0 0 0 0 0 0 0 0 0 0
Aphelocoma ultramarina	1	0	1	0	1 1 0 0 0 0 0 0 0 0	0 1 0 0 0 0 0 0 0	1 1 1 x	0 0 0 0 0 0 0 0 0 0
Aphelocoma unicolor	0	0	0	0	0 1 1 0 0 1 0 1 1 1	0 0 0 1 0 0 0 1 1	0 0 0 0	1 1 1 1 0 0 0 0 0 0
Aratinga holochlora	1	0	1	0	1 1 1 x x x x x x x	x x x x x x 0 0 0	0 0 0 0	1 x x 1 1 0 0 0 0 0
Aratinga strenua	0	1	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 x x	0 0 0 0	1 0 0 1 x 0 0 0 0 0
Asio stygius	0	1	0	1	0 0 1 0 0 0 0 0 0 0	x 1 0 1 0 0 0 0 1	0 0 0 0	x x x x x 0 0 0 0 0
Aspatha gularis	0	0	0	0	0 0 0 0 0 0 0 0 1 x	0 0 0 0 0 0 1 1 1	0 0 0 0	1 1 1 1 0 0 0 0 0 0
Atlapetes albinucha	0	0	0	0	0 x 1 0 0 1 0 1 1 1	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Atlapetes brunneinucha	0	0	0	1	1 1 1 1 1 1 1 1 1 1	0 0 0 1 1 1 1 1 1	0 0 0 0	1 1 1 1 x 1 1 1 1 1
Atlapetes gutturalis	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1 1	0 0 0 0	1 1 1 1 x 1 1 1 1 1
Atlapetes pileatus	1	0	1	0	1 1 1 0 x x 1 1 0 0	1 1 1 1 x 1 0 0 0	1 1 1 x	0 0 0 0 0 0 0 0 0 0
Atlapetes virenticeps	1	0	1	0	0 0 0 0 0 0 0 0 0 0	x 1 1 0 0 0 0 0 0	1 1 1 x	0 0 0 0 0 0 0 0 0 0
Atthis ellioti	0	0	0	0	0 0 0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 1 x	0 0 0 0	1 1 x 1 0 0 0 0 0 0
Atthis heloisa	1	0	0	0	1 x 1 0 1 1 1 1 0 0	x 1 1 1 1 1 0 0 0	x 1 1 x	0 0 0 0 0 0 0 0 0 0
Attila spadiceus	0	1	0	1	0 0 1 1 0 x 0 x x x	x x 1 1 x x x x x	1 1 x x	1 x 1 1 1 1 1 1 1 x

Appendix 1 (*cont.*)

	HAB		GEO		Mexico			
	A	B	N	S	East slope	West slope	TV Belt	Central America
Aulacorhynchus prasinus	0	0	0	0	0 1 1 1 0 1 0 X 1 X	0 0 1 1 1 1 1 1 1	0 0 0 0	1 1 1 1 1 1 1 1 1 1
Automolus ochralaemus	0	1	0	1	0 0 1 1 X 1 X X X X	0 0 0 0 0 0 0 0 0	0 0 0 0	1 X X 1 1 1 1 1 1 1
Automolus rubiginosus	0	0	0	1	0 X 1 0 0 1 0 1 X X	0 0 0 1 1 1 0 1 1	0 0 0 0	1 1 1 1 X 0 0 0 1 1
Basileuterus belli	1	0	0	0	1 1 1 1 0 1 1 1 1 X	1 1 1 1 1 1 1 1 X	1 1 0 X	1 1 1 1 0 0 0 0 0 0
Basileuterus culicivorus	0	1	0	1	1 1 1 1 0 1 0 1 X X	0 1 X 1 1 1 1 X X	0 0 0 0	1 X X 1 X 1 1 1 1 1
Basileuterus melanogenys	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Basileuterus tristriatus	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Bolborhynchus lineola	0	0	0	1	0 0 1 0 0 1 0 X 1 X	0 0 0 X 0 0 0 1 X	0 0 0 0	1 X X 1 X 1 1 1 1 1
Buteo jamaicensis	1	1	1	1	1 1 1 X X X X 1 X X	X 1 1 1 X X 1 1 X	1 X X 1	1 1 X 1 1 1 1 1 1 1
Campephilus guatimalensis	0	1	0	0	1 1 1 1 0 1 0 X 1 X	X X 1 1 X X 1 X X	1 0 0 0	1 X X 1 1 1 1 1 1 1
Campylopterus curvipennis	0	1	0	0	1 1 1 0 0 1 0 1 X X	0 0 0 0 0 0 0 0 0	0 0 0 0	X X X 1 0 0 0 0 0 0
Campylopterus excellens	0	1	0	0	0 0 0 1 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Campylopterus hemileucurus	0	1	0	0	0 0 1 1 0 1 0 1 X X	0 0 0 1 0 0 1 1 1	0 0 0 0	1 1 1 1 1 1 1 1 1 1
Campylopterus rufus	0	0	0	0	0 0 0 0 0 0 0 0 X X	0 0 0 0 0 0 1 1 X	0 0 0 0	1 X X 1 0 0 0 0 0 0
Campylorhamphus pusillus	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Campylorhynchus megalopterus	1	0	0	0	0 0 1 0 0 1 1 1 0 0	0 1 1 0 0 0 0 0 0	1 1 1 0	0 0 0 0 0 0 0 0 0 0
Campylorhynchus zonatus	0	1	0	1	0 1 1 1 0 1 0 X 1 1	0 0 0 0 0 0 1 X 1	0 0 0 0	1 1 1 1 1 1 1 1 1 1
Caprimulgus ridgwayi	0	1	1	0	0 0 0 0 0 0 0 0 0 0	X 1 X X X 1 X X X	X 0 0 0	X X X 1 X 0 0 0 0 0
Caprimulgus saturatus	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Caprimulgus vociferus	1	1	1	0	X X 1 X 1 1 1 X X 1	X 1 1 1 1 1 1 X X	1 1 1 X	1 1 1 1 0 0 0 0 0 0
Cardellina rubrifrons	1	0	1	0	0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Carduelis atriceps	1	0	0	0	0 0 0 0 0 0 0 0 1 X	0 0 0 0 0 0 0 X X	0 0 0 0	1 X 0 0 0 0 0 0 0 0
Carduelis notata	1	0	1	0	1 1 1 0 1 0 1 1 X X	1 1 1 1 1 1 1 X 1	1 1 1 X	1 1 1 1 1 0 0 0 0 0
Carduelis pinus	1	0	1	0	0 X 1 0 0 0 0 0 1 X	X X 0 0 0 0 0 0 0	X X 0 1	0 X X 0 0 0 0 0 0 0
Carduelis xanthogastra	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Catharus aurantiirostris	0	1	0	1	X 1 1 0 0 1 1 1 X X	1 1 1 1 1 1 1 X 1	X 1 X X	1 X X 1 1 X 1 1 0 1
Catharus dryas	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 1 1	0 0 0 0	1 1 1 1 0 0 0 0 0 0
Catharus frantzii	0	0	0	0	0 0 1 0 0 1 1 1 1 X	0 1 0 1 0 1 1 1 1	1 0 0 0	1 1 1 1 X 1 1 1 1 1
Catharus fuscater	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Catharus gracilirostris	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Catharus mexicanus	0	0	0	0	1 1 1 1 0 1 0 0 1 X	0 0 0 0 0 0 1 X X	0 0 0 0	X 1 1 1 X 1 1 1 1 1
Catharus occidentalis	1	0	1	0	0 0 1 0 0 1 1 1 0 0	0 1 1 1 1 1 0 0 0	1 1 1 X	0 0 0 0 0 0 0 0 0 0
Catherpes mexicanus	1	0	1	0	1 1 1 X X X X X X 0	X X 1 X X X 0 0 0	X X X X	0 0 0 0 0 0 0 0 0 0
Certhia familiaris	1	0	1	0	X X X 0 1 1 1 X 1 X	1 X 1 1 0 1 0 X 1	1 X X 1	1 1 1 1 1 0 0 0 0 0
Chaetura vauxi	0	1	1	1	1 1 X 1 X X X X 1 X	1 1 1 1 X 1 1 X X	X X X X	1 1 1 1 X 1 1 1 1 1
Chamaepetes unicolor	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Chlorophonia callophrys	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Chlorophonia occipitalis	0	0	0	0	0 0 1 1 0 1 0 X 1 X	0 0 0 0 0 0 1 1 1	0 0 0 0	1 X X 1 1 0 0 0 0 0
Chlorospingus canigularis	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 0 1
Chlorospingus ophthalmicus	0	0	0	1	0 1 1 1 0 1 0 1 1 1	0 0 0 1 1 1 1 1 1	0 0 0 0	1 1 1 1 X 1 1 1 1 1
Chlorospingus pileatus	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Ciccaba virgata	0	1	0	1	1 1 1 1 X X X X X X	1 X X 1 X X X X X	0 X 1 0	1 1 X 1 1 1 1 1 1 1
Cinclus mexicanus	1	0	1	0	0 0 1 0 0 0 1 X 0 0	X X X 1 0 1 0 0 0	1 1 0 0	1 1 X 1 1 1 1 1 1 1
Claravis mondetoura	0	0	0	1	0 1 1 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 1	0 0 0 0	1 X 1 1 X 1 1 1 1 1
Coccothraustes abeillei	0	0	0	0	1 1 1 X 0 1 0 X X 1	X 1 X 1 0 0 0 1 1	X X 1 0	1 1 1 1 0 0 0 0 0 0
Coccothraustes vespertinus	1	0	1	0	0 X 1 0 0 0 1 0 0 0	X X X 0 0 0 0 0 0	X X 0 0	0 0 0 0 0 0 0 0 0 0
Colaptes auratus	1	0	1	0	X 1 1 X 1 1 1 1 1 X	X X 1 1 1 1 X X X	1 X 1 X	1 1 1 1 0 0 0 0 0 0
Colibri delphinae	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 X 1 X 1 1 1 1 1
Colibri thalassinus	0	1	0	1	0 1 X 0 1 1 1 1 1 X	0 X 1 1 0 1 1 1 X	1 1 1 0	1 1 X 1 X X 1 1 1 1
Columba fasciata	1	0	1	1	X X X 0 1 1 1 X 1 X	X 1 1 1 1 1 1 1 X	X X X X	1 1 1 1 1 1 1 1 1 1
Columba subvinacea	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Contopus lugubris	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Contopus ochraceus	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Contopus pertinax	1	0	1	0	1 1 1 0 1 1 1 X X X	1 1 1 1 1 1 1 X X	1 1 X X	1 1 1 1 1 0 0 0 0 0
Cotinga amabilis	0	1	0	0	0 0 0 1 0 1 0 X X X	0 0 0 0 0 0 0 0 0	0 0 0 0	X X X 1 X 1 1 1 1 0
Cotinga ridgwayi	0	1	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 1 1
Cranioleuca erythrops	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Crax rubra	0	1	0	1	X X X 1 X 1 X X X X	0 0 0 0 0 0 1 X X	0 0 0 0	X X X 1 1 1 1 1 1 1

Appendix 1 (*cont.*)

	HAB	GEO	Mexico			
	A B	N S	East slope	West slope	TV Belt	Central America
Crypturellus cinnamomeus	0 1	0 0	1 1 1 1 0 0 X X X X	1 X X 1 X X 1 1 X	0 0 0 0	1 X X 1 1 1 0 0 0 1
Cyanerpes cyaneus	0 1	0 1	0 X X 1 0 1 0 X X X	0 0 0 0 0 0 0 0 0	0 0 0 0	1 X 1 1 1 1 1 1 1 X
Cyanocitta stelleri	1 0	1 0	0 X 1 0 1 1 1 1 1 X	1 X 1 1 1 1 0 X 1	1 X X X	1 1 X 1 1 0 0 0 0 0
Cyanocompsa parellina	0 1	0 0	1 1 1 1 0 0 0 1 X X	X X X X 1 1 1 X 1	0 0 0 0	X X X 1 1 0 0 0 0 0
Cyanocorax dickeyi	0 0	0 0	0 0 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Cyanocorax melanocyaneus	0 0	0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	1 X 1 1 1 0 0 0 0 0
Cyanocorax yncas	0 1	0 1	1 1 1 1 0 X 0 X 1 1	0 1 1 1 X 1 1 1 X	0 0 0 0	1 X X 1 0 0 0 0 0 0
Cyanolyca argentigula	0 0	0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Cyanolyca cucullata	0 0	0 0	0 1 1 0 0 1 0 1 1 1	0 0 0 0 0 0 1 1 1	0 0 0 0	1 1 1 1 1 0 1 1 1 1
Cyanolyca mirabilis	0 0	0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 1 1 1 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Cyanolyca nana	0 0	0 0	0 0 1 0 0 1 1 1 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Cyanolyca pumilo	0 0	0 0	0 0 0 0 0 0 0 0 1 1	0 0 0 0 0 0 0 1 1	0 0 0 0	1 1 1 1 0 0 0 0 0 0
Cyclarhis gujanensis	0 1	0 1	1 1 1 1 0 X 0 X 1 X	0 0 0 0 0 0 1 X X	0 0 0 0	1 X X 1 1 X 1 1 1 1
Cypseloides cherriei	0 0	0 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 X
Cypseloides cryptus	0 0	0 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 X 0 1 1 1 1 X
Cypseloides niger	0 0	1 0	0 0 1 0 0 1 1 0 0 0	X X X 0 0 1 0 X X	X 0 0 X	X X X 1 X X X 1 1 X
Cypseloides rutilus	0 0	0 1	0 0 1 X 0 1 0 1 1 X	X 1 0 0 1 1 1 X X	0 X 0 0	X X X 1 X X X 1 1 1
Cypseloides storeri	0 1	0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 1 0 0 0 0 0	X 0 0 0	0 0 0 0 0 0 0 0 0 0
Dactylortyx thoracicus	0 0	0 0	1 X 1 X X X X X 1 X	0 1 X 1 0 0 1 1 X	0 0 0 0	1 1 X 1 0 0 0 0 0 0
Dendrocincla anabatina	0 1	0 0	0 1 X 1 0 1 0 X X X	0 0 0 0 0 0 0 0 0	0 0 0 0	X X 1 1 1 0 X X 1 1
Dendrocincla homochroa	0 1	0 1	0 0 0 0 0 1 0 1 X X	0 0 0 0 0 0 1 X X	0 0 0 0	1 X X 1 X 1 X X 1 1
Dendrocolaptes picumnus	0 1	0 1	0 0 0 0 0 0 0 0 1 1	0 0 0 0 0 0 0 0 0	0 0 0 0	X X 1 1 X 0 0 1 1 1
Dendroica graciae	1 0	1 0	0 0 1 0 1 0 X 0 X 1	X X 1 1 1 1 1 X 1	X X X X	1 X 1 1 1 0 0 0 0 0
Dendrortyx barbatus	0 0	0 0	0 1 1 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Dendrortyx leucophrys	0 0	0 0	0 0 0 0 0 0 0 0 1 X	0 0 0 0 0 0 0 X X	0 0 0 0	1 1 X 1 1 0 0 1 1 0
Dendrortyx macroura	0 0	0 0	0 0 1 0 1 1 1 1 0 0	0 1 X 1 0 1 0 0 0	0 1 0 0	0 0 0 0 0 0 0 0 0 0
Diglossa baritula	1 0	0 0	0 X 1 0 1 1 1 1 1 X	0 1 X 1 1 1 1 X 1	1 1 1 X	1 X X 1 0 0 0 0 0 0
Diglossa plumbea	0 0	0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Doricha eliza	0 1	0 0	0 0 1 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Doricha enicura	0 0	0 0	0 0 0 0 0 0 0 0 X X	0 0 0 0 0 0 0 X X	0 0 0 0	1 X X 1 0 0 0 0 0 0
Doryfera ludoviciae	0 0	0 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Dryocopus lineatus	0 1	0 1	1 1 X 1 0 1 0 X 1 X	X X 1 X X X 1 X X	0 0 0 0	1 X X 1 1 1 1 1 1 1
Dysithamnus mentalis	0 1	0 1	0 0 0 0 0 0 0 0 0 X	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 1 0 1 1 1 1 1
Elaenia frantzii	0 0	0 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	1 X X 1 1 1 1 1 1 1
Electron carinatum	0 0	0 0	0 0 0 X 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 X X 1 1 1 1 0 0 0
Elvira chionura	0 0	0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 1 1
Elvira cupreiceps	0 0	0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 0 0
Empidonax affinis	1 0	0 0	0 0 1 0 0 1 1 0 0 0	X 1 1 1 0 1 0 0 0	X 1 X 1	0 0 0 0 0 0 0 0 0 0
Empidonax albigularis	0 1	0 0	0 1 1 1 X X X 1 X X	1 X X X X X X X 1	X X X X	1 X X 1 1 0 0 1 0 1
Empidonax atriceps	0 0	0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Empidonax difficilis	1 0	1 0	1 1 1 0 X 1 1 1 0 0	1 1 1 1 X 1 0 0 0	1 1 1 X	0 0 0 0 0 0 0 0 0 0
Empidonax flavescens	0 0	0 0	0 0 0 1 0 0 0 0 1 1	0 0 0 0 0 0 1 1 1	0 0 0 0	1 1 1 1 1 1 1 1 1 1
Ergaticus ruber	1 0	1 0	0 X 1 0 X 1 1 1 0 0	X 1 1 1 1 1 0 0 0	1 1 1 X	0 0 0 0 0 0 0 0 0 0
Ergaticus versicolor	0 0	0 0	0 0 0 0 0 0 0 0 1 1	0 0 0 0 0 0 0 X 1	0 0 0 0	1 1 1 0 0 0 0 0 0 0
Eubucco bourcierii	0 1	0 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Eugenes fulgens	1 0	1 0	1 1 1 0 1 1 1 1 1 X	1 1 1 1 1 1 1 1 1	1 1 1 X	1 1 1 1 X 0 0 1 1 1
Eupherusa cyanophrys	0 0	0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 1 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Eupherusa eximia	0 0	0 0	0 0 X 0 0 1 0 X X 1	0 0 0 0 0 0 1 X X	0 0 0 0	X X X 1 1 1 1 1 1 1
Eupherusa nigriventris	0 0	0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Eupherusa poliocerca	0 0	0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 1 1 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Euphonia anneae	0 1	0 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Euphonia elegantissima	0 1	0 0	1 1 1 X 1 1 1 X 1 X	X 1 X X 1 1 1 X X	X 1 X X	1 1 X 1 X X X 1 1 X
Euphonia hirundinacea	0 1	0 0	1 1 1 1 0 1 0 X X X	0 0 0 0 0 0 0 0 0	0 0 0 0	1 X 1 1 1 1 1 1 1 1
Formicarius analis	0 1	0 1	0 0 1 1 0 1 0 X 1 X	0 0 0 0 0 0 0 0 0	0 0 0 0	0 1 1 1 1 1 1 1 1 1
Formicarius rufipectus	0 1	0 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Geothlypis nelsoni	1 0	1 0	1 1 1 0 X 1 1 1 0 0	0 0 0 0 1 1 0 0 0	0 1 0 1	0 0 0 0 0 0 0 0 0 0
Geotrygon albifacies	0 0	0 0	0 1 1 0 0 1 X 1 X X	0 0 0 1 0 1 1 1 X	0 0 0 0	1 1 1 1 1 0 0 0 0 0
Geotrygon chiriquensis	0 0	0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1

Appendix 1 (*cont.*)

	HAB		GEO		Mexico			
					East slope	West slope	TV Belt	Central America
	A	B	N	S				
Geotrygon costaricensis	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Geotrygon carrikeri	0	0	0	1	0 0 0 1 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Geotrygon lawrencii	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Glaucidium gnoma	1	0	1	0	X X X 0 0 1 1 0 X X	X 1 1 1 1 1 0 X X	1 1 1 X	X X X 1 0 0 0 0 0 0
Glaucidium jardinii	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Glaucidium minutissimum	0	1	0	1	1 X X X 0 X 0 1 X X	X 1 X 1 X X X X X	0 0 0 0	1 X X 1 X X X 1 X X
Grallaria guatimalensis	0	0	0	1	0 1 1 1 0 0 1 X X X	0 X X 1 1 1 1 1 X	0 1 0 0	1 1 1 1 X 1 1 1 1 1
Habia fuscicauda	0	1	0	1	1 1 1 1 0 1 0 X X X	0 0 0 0 0 0 0 0 0	0 0 0 0	0 X X 1 1 1 1 1 1 1
Habia rubica	0	1	0	1	1 X 1 1 0 1 0 X X X	0 1 X X X X X X X	0 0 0 0	1 X X 1 X 1 1 1 X 1
Haplospiza rustica	0	0	0	1	0 0 1 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 1	0 0 0 0	0 0 0 1 0 0 1 1 1 1
Harpyhaliaetus solitarius	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 0 0	0 0 1 0	0 0 X 1 0 X X 1 1 1
Heliodoxa jacula	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Heliomaster longirostris	0	1	0	1	0 0 1 1 0 1 0 X X X	0 0 0 1 0 1 1 X X	0 0 0 0	X 0 0 1 X 1 1 1 1 1
Henicorhina leucophrys	0	0	0	1	0 1 1 0 0 1 1 1 1 1	0 1 1 1 1 1 1 1 1	1 0 0 0	1 1 1 1 X 1 1 1 1 1
Henicorhina leucosticta	0	1	0	1	0 1 X 1 0 1 0 X X X	0 0 0 0 0 0 1 X X	0 0 0 0	1 1 1 1 1 1 1 1 1 1
Hylocharis leucotis	1	1	1	0	0 1 1 0 1 1 1 1 1 X	X 1 1 1 1 1 1 X 1	1 1 1 X	1 1 1 1 1 0 0 0 0 0
Hylomanes momotula	0	0	0	1	0 0 0 1 0 1 0 X X X	0 0 0 0 0 0 X X X	0 0 0 0	1 X X 1 X 1 0 0 0 1
Icterus graduacauda	1	1	1	0	1 1 X 0 1 1 0 1 0 0	0 1 1 1 1 1 0 0 0	0 X 0 0	0 0 0 0 0 0 0 0 0 0
Junco phaeonotus	1	0	1	0	X X 1 0 0 1 1 1 1 X	1 X 1 1 1 1 0 X 1	1 1 0 1	1 1 0 0 0 0 0 0 0 0
Lampornis amethystinus	0	0	0	0	1 1 1 1 1 1 1 1 1 X	0 1 1 1 0 1 0 1 1	1 1 1 X	1 1 1 1 0 0 0 0 0 0
Lampornis calolaema	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 0
Lampornis cinereicauda	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 1 1
Lampornis castaneoventris	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 1
Lampornis clemenciae	0	1	1	0	X X 1 0 1 0 1 X 0 0	X X 1 1 1 1 0 0 0	1 1 1 1	0 0 0 0 0 0 0 0 0 0
Lampornis sybillae	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 1 1 0 0 0 0 0
Lampornis hemileucus	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 X
Lampornis viridipallens	0	0	0	0	0 0 0 0 0 0 0 0 1 X	0 0 0 0 0 0 1 1 1	0 0 0 0	1 1 1 1 0 0 0 0 0 0
Lamprolaima rhami	0	0	0	0	0 0 X 0 1 1 1 1 1 X	0 0 0 1 0 1 0 1 1	0 X 0 0	1 1 1 1 0 0 0 0 0 0
Lepidocolaptes affinis	0	0	0	1	1 1 1 1 1 1 1 1 1 1	0 0 0 1 1 1 1 1 1	0 0 0 0	1 1 1 1 X 1 1 1 1 1
Lepidocolaptes leucogaster	0	1	0	0	0 0 X 0 0 1 1 0 0 0	X 1 1 X 1 1 0 0 0	X 1 1 0	0 0 0 0 0 0 0 0 0 0
Leptopogon amaurocephalus	0	1	0	1	0 0 0 1 0 1 0 X X X	0 0 0 0 0 0 0 0 0	0 0 0 0	X X 1 1 X 1 1 1 X 1
Leptopogon superciliaris	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Leptotila verreauxi	0	0	0	1	1 1 1 1 X X 1 X X 1	X X 1 X X X 1 1 X	X X 1 X	1 X X 1 1 1 1 1 1 1
Leucopternis albicollis	0	0	0	1	0 0 X 1 0 1 0 1 X X	0 0 0 0 0 0 X X X	0 0 0 0	X X X 1 1 1 1 1 1 1
Leucopternis princeps	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Lophostrix cristata	0	1	0	1	0 0 X X 0 X 0 X X X	0 0 0 0 X X X X X	0 0 0 0	X X X 1 X 1 1 1 1 1
Lophotriccus pileatus	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Loxia curvirostra	1	0	1	0	X X X 0 1 0 1 0 1 X	1 1 1 1 0 1 1 X X	X X X X	X X X 1 1 0 0 0 0 0
Lysurus crassirostris	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Margarornis rubiginosus	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Megarynchus pitangua	0	1	0	1	1 1 1 1 X X X X X X	X X X X X 1 1 1 X	X X X X	1 X X 1 1 1 1 1 1 1
Melanerpes formicivorus	1	1	1	1	1 1 1 0 1 1 1 1 1 X	X 1 1 1 1 1 1 1 X	1 1 1 X	1 1 1 1 1 X 1 1 1 1
Melanotis caerulescens	0	1	1	0	1 1 1 0 1 1 1 1 0 0	1 1 1 1 1 1 0 0 0	1 1 1 X	0 0 0 0 0 0 0 0 0 0
Melanotis hypoleucus	0	0	0	0	0 0 0 0 0 0 0 0 1 1	0 0 0 0 0 0 0 1 1	0 0 0 0	1 1 1 X 0 0 0 0 0 0
Micrastur ruficollis	0	1	0	1	0 1 1 1 0 1 0 X X X	0 0 1 0 0 1 1 X X	0 0 0 0	X X 1 1 X 1 1 1 1 1
Microcerculus marginatus	0	1	0	1	0 0 0 0 0 0 0 0 X 1	0 0 0 0 0 0 0 0 0	0 0 0 0	X X X 1 X 1 1 1 X 1
Mionectes oleagineus	0	1	0	1	0 0 1 1 0 1 0 X X X	0 0 0 0 0 0 0 0 0	0 0 0 0	1 1 X 1 X 1 1 1 1 X
Mitrephanes phaeocercus	0	0	0	1	1 1 1 0 1 1 1 1 1 X	1 1 1 1 1 1 X 1 X	1 1 1 X	1 1 1 1 1 1 1 1 1 1
Momotus momota	0	1	0	1	1 1 1 1 0 1 0 X X X	0 0 0 0 0 0 1 X X	0 0 0 0	1 1 1 1 1 1 1 1 1 1
Myadestes melanops	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Myadestes occidentalis	1	0	0	0	1 1 1 0 1 1 1 1 1 X	1 1 1 1 1 1 1 1 1	1 1 1 X	1 1 1 1 0 0 0 0 0 0
Myadestes unicolor	0	0	0	0	0 1 1 1 0 1 0 1 1 1	0 0 0 0 0 0 1 1 1	0 0 0 0	0 1 1 1 1 0 0 0 0 0
Myiarchus tuberculifer	1	1	1	1	1 1 1 1 0 1 1 X 1 X	X X 1 1 1 1 1 X X	1 1 1 X	1 1 1 1 1 1 1 1 1 X
Myiobius sulphureipygius	0	1	0	1	0 0 1 1 0 1 0 X X X	0 0 0 0 0 0 0 0 0	0 0 0 0	X X 1 X 1 1 1 1 1 1
Myioborus miniatus	1	0	1	1	0 1 1 1 1 1 1 1 1 1	X 1 1 1 1 1 1 1 1	1 1 1 X	1 1 1 1 X 1 1 1 1 1
Myioborus pictus	1	0	1	0	1 1 1 X X 1 X X 1 1	X 1 1 1 X X X 1 1	1 1 1 X	1 1 1 1 1 0 0 0 0 0
Myioborus torquatus	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Myiodynastes hemichryseus	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1

Appendix 1 (*cont.*)

	HAB		GEO		Mexico			
	A	B	N	S	East slope	West slope	TV Belt	Central America
Myiodynastes luteiventris	0	1	1	0	1 1 1 X 0 X 0 X X X	X X X X X X 1 X X	0 0 0 0	1 X X 1 X 1 1 1 0 0
Myiopagis viridicata	0	1	0	1	X X 1 1 X 1 X X X X	X 1 1 1 X X X X X	X 1 1 X	1 X X 1 1 1 1 1 1 1
Myrmeciza immaculata	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Myrmotherula schisticolor	0	1	0	1	0 0 0 0 0 0 0 0 X 1	0 0 0 0 0 0 0 X 1	0 0 0 0	0 X X 1 X 1 1 1 1 1
Nothocercus bonapartei	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 0 1 1 1
Nyctidromus albicollis	0	1	1	1	1 1 1 1 X X X X X X	X 1 X X X X 1 1 X	X 0 0 0	X X 1 1 1 1 1 1 1 1
Nyctiphrynus mcleodii	0	1	0	0	0 0 0 0 0 0 0 0 0 0	0 1 0 0 0 1 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Odontophorus guttatus	0	0	0	0	0 0 X 1 0 X 0 X X X	0 0 0 0 0 0 1 X X	0 0 0 0	1 X X 1 1 X X 1 1 1
Odontophorus leucolaemus	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Oreophasis derbianus	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1 1	0 0 0 0	1 0 0 0 0 0 0 0 0 0
Otus barbarus	0	0	0	0	0 0 0 0 0 0 0 0 X X	0 0 0 0 0 0 0 0 0	0 0 0 0	0 1 0 0 0 0 0 0 0 0
Otus choliba	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 1 X X 1 1 1 1
Otus clarkii	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Otus flammeolus	1	0	1	0	0 0 1 0 0 0 0 0 0 0	0 1 1 1 0 0 0 0 0	X 1 1 X	X 0 0 0 0 0 0 0 0 0
Otus guatemalae	0	1	1	1	1 X 1 X X X X X 1 X	X X 0 0 0 0 0 0 0	0 0 0 0	0 X X 1 X 1 1 1 1 1
Otus trichopsis	1	0	1	0	X X 1 0 0 0 1 0 0 0	0 X 1 X 1 1 0 0 0	1 1 X X	1 1 X 1 0 0 0 0 0 0
Pachyramphus aglaiae	0	1	1	0	1 1 1 1 X X 1 X X X	X 1 X X X X 1 1 X	X 1 1 X	1 X X X X 1 0 0 0 0
Pachyramphus albogriseus	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Pachyramphus major	0	0	0	0	1 1 1 1 0 1 0 X X X	1 1 1 1 0 1 1 1 1	0 0 0 0	1 1 1 1 1 0 0 0 0 0
Pachyramphus versicolor	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Panterpe insignis	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Panyptila sanctihieronymi	0	1	0	0	0 0 0 0 0 0 0 0 0 0	0 0 1 X 1 1 1 1 0	X 0 0 0	1 X X 1 0 0 0 0 0 0
Parula gutturalis	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Parula pitiayumi	0	1	0	1	1 1 0 0 0 0 0 0 0 0	X X 0 1 0 0 0 1 0	0 0 0 0	1 X 1 1 X 1 1 1 1 1
Parula superciliosa	0	0	0	0	1 1 1 0 1 1 1 1 1 X	1 1 1 1 1 1 X 1 1	1 1 1 X	1 1 1 1 1 0 0 0 0 0
Parus sclateri	1	0	1	0	0 0 1 0 0 1 1 0 0 0	X X 1 1 0 1 0 0 0	1 1 X 1	0 0 0 0 0 0 0 0 0 0
Penelope purpurascens	0	1	0	1	1 1 X 1 0 1 0 1 1 X	1 1 1 1 0 1 1 1 X	0 0 0 0	X X X 1 X 1 1 1 1 1
Penelopina nigra	0	0	0	0	0 0 0 0 0 0 0 0 1 X	0 0 0 0 0 0 1 1 1	0 0 0 0	1 1 X 1 1 0 0 0 0 0
Peucedramus taeniatus	1	0	1	0	1 X 1 0 1 1 1 0 X X	1 X 1 1 0 1 0 X X	1 X X 1	1 1 1 1 1 0 0 0 0 0
Pezopetes capitalis	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Phaethornis guy	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Phaethornis longuemareus	0	1	0	1	0 0 1 1 0 1 0 X X X	0 0 0 0 0 0 0 0 0	0 0 0 0	X X X 1 1 1 1 1 1 1
Phaethornis superciliosus	0	1	0	1	0 0 X 1 0 1 0 X X X	0 1 X 1 1 1 X X X	0 0 0 0	X X X X 1 1 1 1 1 1
Phainoptila melanoxantha	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Pharomachrus mocinno	0	0	0	0	0 0 0 0 0 0 0 0 1 1	0 0 0 0 0 0 1 1 X	0 0 0 0	1 1 1 1 1 0 1 1 1 1
Pheucticus chrysopeplus	0	1	0	0	0 0 0 0 0 0 0 0 0 0	X X X 1 X X X 1 1	0 X 0 0	1 X X 0 0 0 0 0 0 0
Pheucticus melanocephalus	0	1	1	0	1 1 X 0 0 1 1 X 0 0	X X 1 1 1 1 0 0 0	1 1 1 X	0 0 0 0 0 0 0 0 0 0
Pheucticus tibialis	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Philydor rufus	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Phyllomyias burmeisteri	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Phylloscartes superciliaris	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 X 1
Piaya cayana	0	1	0	1	1 1 1 1 X X X X X X	X X 1 1 X X 1 X X	1 1 1 X	1 1 1 1 1 1 1 1 1 1
Picoides villosus	1	0	1	0	X 1 1 0 1 1 1 1 1 X	X X X 1 1 1 1 1 X	1 1 1 X	1 1 X 1 1 X 1 1 1 1
Piculus auricularis	0	1	0	0	0 0 0 0 0 0 0 0 0 0	1 1 X 1 1 1 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Piculus rubiginosus	0	1	0	0	1 1 X 1 X 1 X X 1 X	0 0 0 0 0 0 1 X X	0 0 0 0	1 1 1 1 1 1 1 1 1 1
Pionopsitta haematotis	0	1	0	1	0 0 0 1 0 1 0 1 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 X X 1 1 1 1 1 1 1
Pionus senilis	0	1	0	0	1 1 X X 0 X 0 X X X	0 0 0 0 0 0 1 X X	0 0 0 0	0 X 1 1 1 1 1 1 1 1
Pipilo erythrophthalmus	1	1	1	0	1 1 1 0 1 1 1 1 1 1	1 1 1 0 1 1 0 X 1	0 1 1 1	1 1 0 0 0 0 0 0 0 0
Pipilo ocai	1	0	0	0	0 0 1 0 1 1 1 1 0 0	0 1 X 1 1 1 0 0 0	1 0 0 0	0 0 0 0 0 0 0 0 0 0
Pipra pipra	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Piranga bidentata	0	0	0	0	1 X 1 0 0 1 0 0 1 X	0 1 1 1 1 1 1 1 1	1 1 1 X	1 1 1 1 X X X 1 1 1
Piranga erythrocephala	1	0	1	0	0 0 0 0 0 X 1 1 0 0	1 1 1 1 1 1 0 0 0	X 1 X X	0 0 0 0 0 0 0 0 0 0
Piranga flava	1	1	1	0	X X 1 X 1 1 1 1 X X	1 X 1 1 1 1 1 1 X	1 1 1 X	X 1 1 1 1 1 1 1 1 1
Piranga leucoptera	0	1	0	1	1 1 1 1 0 1 0 X X X	0 0 0 0 0 0 1 1 X	0 0 0 0	1 X X 1 1 1 1 1 1 1
Platyrinchus cancrominus	0	1	0	0	0 0 X 1 0 1 0 X X X	0 0 0 0 0 0 0 0 0	0 0 0 0	1 X X 1 1 1 0 0 0 0
Platyrinchus mystaceus	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Premnoplex brunnescens	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Procnias tricarunculata	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 1 1 1 1 1 1 1
Pselliophorus tibialis	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1

Appendix 1 (*cont.*)

	HAB		GEO		Mexico			
	A	B	N	S	East slope	West slope	TV Belt	Central America
Pselliophorus luteoviridis	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 1
Pseudocolaptes lawrencii	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Ptilogonys caudatus	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Ptilogonys cinereus	1	0	1	0	1 1 1 0 1 1 1 1 1 X	1 X 1 1 1 1 0 1 X	1 1 1 X	1 1 X 0 0 0 0 0 0 0
Pyrrhura hoffmanni	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 1 1
Ramphocelus sanguinolentis	0	1	0	0	0 0 1 1 0 1 0 X X X	0 0 0 0 0 0 0 0 0	0 0 0 0	X X X X 1 1 1 1 1 1
Regulus satrapa	1	0	1	0	0 0 0 0 0 0 1 0 X X	0 0 X 1 0 0 0 X 1	1 X X X	X 1 X 0 0 0 0 0 0 0
Rhynchocyclus brevirostris	0	1	0	1	0 0 1 1 0 1 0 0 X X	0 0 0 1 1 1 1 X X	0 0 0 0	1 1 1 1 1 1 1 1 1 1
Rhynchopsitta pachyrhyncha	0	0	1	0	0 0 0 0 0 0 0 0 0 0	X X 0 0 0 0 0 0 0	1 0 0 0	0 0 0 0 0 0 0 0 0 0
Rhynchopsitta terrisi	1	0	1	0	1 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Ridgwayia pinicola	1	0	1	0	0 X 1 0 X X 1 X 0 0	X 1 1 1 X 1 0 0 0	X X X X	0 0 0 0 0 0 0 0 0 0
Sayornis nigricans	1	1	1	1	1 1 1 X X X X X X 1	1 X X X X X X X X	X X X X	1 1 1 1 1 1 1 1 1 1
Sclerurus albigularis	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Sclerurus mexicanus	0	0	0	1	0 0 1 X 0 1 0 0 X X	0 0 0 0 0 0 1 1 0	0 0 0 0	1 1 1 1 X 1 1 1 1 1
Scytalopus argentifrons	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Selasphorus ardens	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 1
Selasphorus flammula	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Selasphorus platycercus	1	0	1	0	X X X 0 X X X 1 X X	1 X 1 1 X X X X X	X X 1 X	1 X X 0 0 0 0 0 0 0
Selasphorus scintilla	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Semnornis frantzii	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Serpophaga cinerea	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Sitta carolinensis	1	0	1	0	X X X 0 1 0 1 0 0 0	X X 1 1 1 1 0 0 0	X X X X	0 0 0 0 0 0 0 0 0 0
Sitta pygmaea	1	0	1	0	X X 1 0 0 0 0 0 0 0	X X 1 0 0 0 0 0 0	X X X X	0 0 0 0 0 0 0 0 0 0
Sittasomus griseicapillus	0	1	0	1	1 1 X 1 0 1 0 0 1 X	0 1 1 1 0 1 1 X X	0 0 0 0	1 X 1 1 X 1 1 1 1 1
Spizaetus ornatus	0	1	0	1	1 X X 1 X 1 X X X X	0 0 0 1 0 0 0 0 0	0 0 0 0	X X X 1 X 1 1 1 1 1
Streptoprocne semicollaris	0	1	0	0	0 0 0 0 0 0 0 0 0 0	X X 1 1 0 0 0 0 0	X X 0 0	0 0 0 0 0 0 0 0 0 0
Streptoprocne zonaris	0	1	0	1	1 1 1 1 0 1 1 1 1 X	0 0 0 X 1 1 1 X 1	X 0 1 0	1 1 1 1 1 1 X 1 1 1
Strix fulvescens	0	0	0	0	0 0 0 0 0 0 0 0 1 X	0 0 0 0 0 0 0 1 1	0 0 0 0	1 1 1 1 0 0 0 0 0 0
Strix varia	1	0	1	0	0 X X 0 0 0 1 0 0 0	0 X X 1 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Syndactyla subalaris	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Tangara cabanisi	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1 1	0 0 0 0	1 0 0 0 0 0 0 0 0 0
Tangara dowii	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Tangara gyrola	0	1	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Tangara icterocephala	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Terenura callinota	0	0	0	1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Thalurania ridgwayi	0	1	0	0	0 0 0 0 0 0 0 0 0 0	0 1 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 0 0 0
Thamnophilus doliatus	0	1	0	1	1 1 1 1 0 1 0 X X 1	0 0 0 0 0 0 1 1 X	0 0 0 0	1 X X 1 X 1 1 1 1 1
Thraupis abbas	0	1	0	0	1 1 1 1 0 1 0 X 1 X	0 0 0 0 0 0 1 X 1	0 0 0 0	1 X 1 1 1 0 0 0 0 0
Thripadectes rufobrunneus	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Thryothorus maculipectus	0	1	0	0	1 1 1 1 0 1 0 1 1 X	0 0 0 0 0 0 0 X X	0 0 0 0	1 X 1 1 1 0 0 0 0 0
Thryothorus modestus	0	1	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 X X X	0 0 0 0	1 X X 1 X 1 1 1 1 1
Thryothorus rufalbus	0	1	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1 1	0 0 0 0	X X X X X 0 0 0 0 0
Tityra semifasciata	0	1	0	1	1 1 1 1 0 1 0 X X X	X X X 1 X 1 1 X X	0 0 0 0	1 1 1 1 1 1 1 1 1 1
Tolmomyias sulphurescens	0	1	0	1	0 0 1 1 0 1 0 X X X	0 0 0 0 0 0 1 X X	0 0 0 0	1 X 1 1 X 1 1 1 1 1
Touit costaricensis	0	1	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Toxostoma ocellatum	0	1	0	0	0 0 1 0 0 0 1 0 0 0	0 0 0 0 1 0 0 0 0	0 X 1 X	0 0 0 0 0 0 0 0 0 0
Troglodytes brunneicollis	0	0	1	0	X 1 1 1 1 1 1 1 0 0	X X 1 1 1 1 0 0 0	1 1 1 X	0 0 0 0 0 0 0 0 0 0
Troglodytes ochraceus	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 1 1 1 1
Troglodytes rufociliatus	0	0	0	0	0 0 0 0 0 0 0 0 1 X	0 0 0 0 0 0 0 1 1	0 0 0 0	1 1 1 1 1 0 0 0 0 0
Trogon aurantiiventris	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Trogon collaris	0	1	0	1	0 1 1 1 0 1 0 0 X X	0 0 0 1 1 1 1 1 X	0 0 0 0	1 X 1 1 1 0 0 1 1 1
Trogon elegans	1	0	1	0	1 1 X 0 0 0 0 1 X X	1 1 1 X 0 1 0 1 X	X X 0 0	1 X 1 1 X 1 0 0 0 0
Trogon mexicanus	1	0	1	0	1 1 1 0 1 1 1 1 1 X	1 1 1 1 1 1 0 1 X	1 1 1 0	1 1 1 1 0 0 0 0 0 0
Turdus assimilis	0	1	0	1	1 1 1 1 0 1 1 1 X 1	1 1 1 1 1 1 1 1 1	1 1 1 0	1 X X 1 1 1 1 1 1 1
Turdus grayi	0	1	0	1	1 1 1 1 0 1 0 0 1 X	0 0 0 0 0 0 1 1 X	0 X 0 0	1 X 1 1 1 1 1 1 1 X
Turdus infuscatus	0	0	0	0	1 1 1 1 0 1 1 1 1 X	0 0 0 1 1 1 1 1 1	0 0 0 0	1 1 1 1 0 0 0 0 0 0
Turdus migratorius	1	0	1	0	X 1 1 0 1 1 1 1 0 0	X X 1 1 1 1 0 0 0	X 1 X 1	0 0 0 0 0 0 0 0 0 0
Turdus nigrescens	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Turdus plebejus	0	0	0	0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 1 1	0 0 0 0	1 1 1 1 1 1 1 1 1 1

Appendix 1 (*cont.*)

			Mexico			
	HAB	GEO	East slope	West slope	TV Belt	Central America
	A B	N S				
Turdus rufitorques	0 0	0 0	0 0 0 0 0 0 0 0 1 1	0 0 0 0 0 0 0 X 1	0 0 0 0	1 1 1 1 0 0 0 0 0 0
Tyto alba	1 1	1 1	X X 1 1 X X X X X X	X X X 1 X X 1 X X	X X X 1	1 X 1 X X 1 1 1 1 1
Veniliornis fumigatus	0 1	0 1	1 1 X 1 X 1 X X X X	0 X X 1 X X X 1 X	0 X 0 0	X X X 1 1 1 1 1 1 1
Vireo brevipennis	0 1	0 0	0 0 1 0 0 0 0 X 0 0	0 1 0 0 1 1 0 0 0	0 0 1 0	0 0 0 0 0 0 0 0 0 0
Vireo carmioli	0 0	0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 0 0 1 1 1
Vireo huttoni	1 0	1 0	X X 1 0 1 1 1 1 1 1	1 1 1 1 1 1 X 1 1	1 X 1 X	1 1 1 0 0 0 0 0 0 0
Vireo leucophrys	0 0	0 1	1 1 1 0 0 X 0 X 1 X	0 0 0 0 0 0 1 X X	0 0 0 0	X X X 1 X 0 1 1 1 1
Vireo solitarius	1 0	1 0	X X 1 0 1 0 1 X X X	0 X 1 1 1 1 1 X X	1 1 1 X	1 1 1 1 0 0 0 0 0 0
Vireolanius melitophrys	0 1	0 0	0 1 1 0 0 0 1 X X X	0 1 1 1 1 1 0 X X	1 1 1 0	1 0 0 0 0 0 0 0 0 0
Xiphocolaptes promeropirhynchus	0 1	0 1	0 1 X X 0 1 1 1 1 1	0 0 0 1 0 1 0 0 0	0 0 0 0	0 X X 1 1 X X 1 1 1
Xiphorhynchus erythropygius	0 0	0 1	0 1 X 0 0 1 0 X 1 X	0 0 0 1 0 0 1 1 X	0 0 0 0	1 X 1 1 1 1 1 1 1 1
Xiphorhynchus flavigaster	0 1	0 1	1 1 1 1 X X X X 1 X	X 1 X X X X 1 X X	0 0 0 0	1 X 1 1 1 X 0 0 0 0
Zeledonia coronata	0 0	0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	0 0 0 0	0 0 0 0 0 1 1 1 1 1
Zimmerius vilissimus	0 1	0 1	0 0 0 0 0 0 0 0 X X	0 0 0 0 0 0 0 1 X	0 0 0 0	1 1 1 1 X 1 1 1 1 X

Appendix 2. Descriptions of the 33 humid montane forest patches included in this study.

HPO, humid pine-oak forest; CF, cloudforest. General references are listed in the Methods section; here listed as references are major sources that provided numerous records for particular islands.

Abbreviation	Name	Habitat	References
Eastern Mexico			
1. TAMPS	Tamaulipas and Nuevo León	HPO, CF	Harrell (1951)
2. HIDAL	N Veracruz, Hidalgo, SLP	HPO, CF	Sutton and Burleigh (1940), Lowery and Newman (1949)
3. CVERA	Central Veracruz	HPO, CF	Chapman (1898), Navarro-Sigüenza *et al.* (1991)
4. TUXTL	Los Tuxtlas, Veracruz	CF	Wetmore (1943), Andrle (1967)
5. CUATR	Sierra de Cuatro Venados, Oaxaca	HPO	Binford (1989), Rowley (1984)
6. JUARE	Sierra de Juárez, Oaxaca	HPO, CF	Binford (1989), Torres-Chávez (1992)
7. FELIP	Cerro San Felipe, Oaxaca	HPO	Binford (1989)
8. ZEMPO	Cerro de Zempoaltépetl, Oaxaca	HPO, CF	Binford (1989)
9. SCRIS	San Cristóbal de las Casas, Chiapas	HPO, CF	Alvarez del Toro (1980)
10. MONTE	Lagunas de Montebello, Chiapas	HPO, CF	Alvarez del Toro (1980)
Western Mexico			
11. SINDU	Sinaloa and Durango	HPO	–
12. NAYJA	Nayarit and Jalisco	HPO	Escalante-Pliego (1988), Schaldach (1963)
13. MICHO	Coastal Michoacán	HPO	–
14. GUERR	Sierra de Atoyac, Guerrero	HPO, CF	Navarro-Sigüenza (1986, 1992)
15. YUCUÑ	Sierra de Yucuñacua, Oaxaca	HPO	Binford (1989)

Appendix 2 – (*cont.*)

Abbreviation	Name	Habitat	References
16. MIAHU	Sierra de Miahuatlán, Oaxaca	HPO	Binford (1989), Rowley (1966)
17. CHIMA	Los Chimalapas, Oaxaca	HPO, CF	Binford (1989)
18. SOCON	Sierra de Soconusco, Chiapas	HPO, CF	Parker *et al.* (1976), Alvarez del Toro (1980)
19. TACAN	Volcán de Tacan	HPO, CF	Alvarez del Toro (1980)
Transvolcanic Belt, Mexico			
20. TANCI	Cerro de Tancítaro, Michoacán	HPO, CF	Blake and Hanson (1942)
21. TEMAS	Temascaltepec, México	HPO	Ornelas *et al.* (1988)
22. TAxCO	Sierra de Taxco, Guerrero	HPO	Morales-Pérez and Navarro-Sigüenza (1992)
23. MALIN	Volcán La Malinche	HPO	–
Central America			
24. GUAPA	Pacific slope, Guatemala	HPO, CF	Griscom (1932), Land and Wolf (1961)
25. GUACU	Sierra de los Cuchumatanes, Guatemala	HPO, CF	Griscom (1932), Land and Wolf (1961)
26. GUAMI	Sierra de las Minas, Guatemala	HPO, CF	Griscom (1932), Land and Wolf (1961)
27. HONDU	Honduras and El Salvador	HPO, CF	Monroe (1968), Thurber *et al.* (1987)
28. NICAR	Nicaragua	HPO, CF	–
29. CRGUA	Cordillera de Guanacaste, Costa Rica	HPO, CF	Slud (1964), Stiles and Skutch (1989)
30. CRTIL	Cordillera de Tilarán, Costa Rica	HPO, CF	Slud (1964), Stiles and Skutch (1989)
31. CRCEN	Cordillera Central, Costa Rica	HPO, CF	Slud (1964), Stiles and Skutch (1989)
32. CRTAL	Cordillera de Talamanca	HPO, CF	Slud (1964), Stiles and Skutch (1989)
33. WPANA	Western Panama	HPO, CF	Wetmore (1965–1984)

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