Technical Report

Status and Ecology of the Cerulean Warbler *Dendroica cerulea* in Northwestern Ecuador

Contract no. MBP-CERW-20050810

Quito, 30 May 2006

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SUMMARY

With the intention to clarify the status and ecology of the threatened Nearctic-Neotropical migrant Cerulean Warbler *Dendroica cerulea* in northwestern Ecuador, we studied a total of six transects at three study sites within the Cotacachi-Cayapas Ecological Reserve and its vicinity from Dec. 2005 to Feb. 2006. The transects covered an altitudinal range from 475-555 m in the Estero Pindiupi area, 1085-1180 m at the Río Negro Chico, and 1180-1370 m in the Río Pachamama valley. All transects had a length of 1200 m and were located inside forest, wherever possible. They were surveyed according to the optimized transect mapping protocol for monitoring studies, an audio-visual method consisting of 24 samples carried out from pre-dawn to after-dusk periods, with highest effort during early morning hours. During transect mapping surveys a total of 241 avian species were recorded with an effort of 295 h, completed in 48 man-days. Taking into account also a published bird list for the Río Negro Chico area and non-standardized observation hours in various types of forest and non-forest habitats at least 315 species are known to occur at our study sites. Not less than 57 avian taxa are considered endemics and 20 threatened or near-threatened on the global scale, including the Near Threatened Neotropical migrant Olive-sided Flycatcher *Contopus cooperi*. Although, we intensively searched mixed-species flocks and performed playback trials with prerecorded Cerulean Warbler vocalizations at all transects, we failed to detect the species in the scope of the study. However, we report on the observation of two Cerulean Warblers, which were found on 11 Nov. 2005 by B. Palacios in Pichincha Province at an altitude of 950 m. Furthermore, we present arguments why future searches of the Cerulean Warbler in the Chocó region should focus on forest edges and semi-open habitats rather than on continuous forest.

INTRODUCTION

The Cerulean Warbler *Dendroica cerulea* breeds preferably in mature deciduous forest and occasionally in mixed stands in southeastern North America, from the lower Great Lakes, southern Quebec and New England south to northern Louisiana and Georgia (Curson et al. 1994). It winters in western South America, from northern Colombia and Venezuela south to southern Peru and western Bolivia, mainly in premontane and montane forests between 500 and 2000 m. In Ecuador most records are obtained between 500 and 1400 m and sightings from the lowlands are usually attributed to transient individuals (e.g., Ridgely & Greenfield 2001). In recent decades, *D. cerulea* has undergone a steep population decline on its breeding grounds (e.g., Robbins et al. 1992) and it is now regarded Vulnerable on the global level (BirdLife International 2004). Furthermore, there is some evidence that the bottleneck controlling population size in this species lies in the wintering grounds and not in the breeding area (Rappole 1995, Table 9.3). Its preference for tall foothill forest in a restricted altitudinal range and its characteristic to accompany mixed-species flocks, do in fact indicate a rather narrow ecological niche-widths within South America. Therefore, studies

on the status and ecology of the Cerulean Warbler in the non-breeding season are of growing importance. In Ecuador, the species is believed to winter manly along the eastern slope of the Andes. However, there are also some recent records from the western slope in Pichincha Province, mirroring the increased observation intensity in this region (Ridgely & Greenfield 2001). Thus, it seems possible that the premontane forests to the north, particularly those of Esmeraldas Province, might be a more important wintering ground for this species than previously thought. Because the altitudinal range between 500 and 1,400 m remains poorly studied north of the Mindo area, we concentrated our survey efforts on the Cotacachi-Cayapas Ecological Reserve, the largest protect area in western Ecuador, and its vicinity.

STUDY AREA

We surveyed a total of six transects, each 1200 m long, at three sites in the typical altitudinal range of wintering Cerulean Warblers (*cf.* Appendix 1):

1. Estero Pindiupi, Cotacachi-Cayapas Ecological Reserve, Esmeraldas Province

Base camp:		00˚40'41"N, 78˚53'28"W; 430 m (Appendix 4; Fig. 3)
Transect PIN1:	start:	00˚40'31"N, 78˚52'31"W; 475 m
	end:	00˚40'02"N, 78˚52'19"W; 540 m
Transect PIN2:	start:	00˚40'02"N, 78˚52'19"W; 540 m
	end:	00˚39'42"N, 78˚51'56"W; 555 m

The area of Estero Pindiupi, a confluent of the Río San Miguel in the upper Río Cayapas drainage, is located within the largest and most important protected area of western Ecuador, the Cotacachi-Cayapas Ecological Reserve (243 638 ha; altitudinal range 80-4900 m). To our knowledge this was the first standardized bird survey carried out in the area. We studied two transects in continuous primary forest on a ridge in the Andean foothills. Due to the topographical conditions and limited time it resulted impossible to establish two independent transects. Instead, PIN2 was the continuation of PIN1 along a newly established trail of a length of 2400 m. On the basis of climate data published by Cañadas (1983) and Lanfer (1995), we estimate that the mean annual rainfall varies between about 3000-4000 mm and mean annual temperatures between 23-24° C. According to the map presented in Dodson & Gentry (1991), which was based on the classification scheme of Holdridge (1967), and the corresponding bio-climatic map for Ecuador (Cañadas 1983), the area might be located in the 'premontane wet forest' life zone. The observed bird community composition does support this assessment. According to Sierra *et al.* (1999) the natural formation of Estero Pindiupi is 'foothill evergreen forest'.

2. Río Pachamama, El Cristal, Esmeraldas Province

Base camp: 00˚50'19"N, 78˚31'35"W; 1360 m (Appendix 4; Fig. 6)

Transect RPM1: start: 00˚50'19"N, 78˚31'37"W; 1370 m

end: 00˚49'59"N, 78˚32'00"W; 1245 m

Transect RPM2: start: 00˚50'01"N, 78˚32'03"W; 1240 m

end: 00˚50'01"N, 78˚32'36"W; 1180 m

The valley of the Río Pachamama, a confluent of the Río Negro Chico, is located in the buffer zone north of the Cotacachi-Cayapas Ecological Reserve, and belongs to the community of El Cristal, south of Lita. Two transects were established, RPM1 along the Río Pachamama valley and RPM2 on a ridge between Río Pachamama and Río Negro Chico. Topography, rivers, and various pastures were the main factors that influenced the final transect routes. RPM1 was located entirely within forest, while RPM2 intersected various small cattle pastures. The distance between the end of RPM1 and start of RPM2 was only about 90 m. We estimate that the mean annual rainfall in the valley is well over 4000 mm and mean annual temperatures between 21-22° C. Thus, the area belongs to the 'premontane pluvial forest' life zone *sensu* Holdridge (1967). According to Sierra *et al.* (1999) the site is located in the transition zone between 'foothill evergreen forest' and 'montane cloud forest'.

3. Río Negro Chico, Alto Tambo county, Esmeraldas Province

Base camp: 00˚50'02"N, 78˚32'41"W; 1130 m (Appendix 4; Fig. 8)

Transect RNC1: start: 00˚50'09"N, 78˚32'52"W; 1120 m

end: 00˚50'22"N, 78˚33'24"W; 1085 m

Transect RNC2: start: 00˚50'09"N, 78˚32'51"W; 1125 m

end: 00˚49'50"N, 78˚32'28"W; 1180 m

The basis camp of the third study site was located just about 160 m from the end of transect RPM1 at the southern bank of the Río Negro Chico, a confluent of the Río Negro in the upper Río Santiago drainage. A preliminary bird survey was carried out in the area in 1993/94 (Gregory 1997). Our transects RNC1 and RNC2 were located entirely within forest. However, independence of the transects could not be achieved, due to a loop of the Río Negro Chico to the northwest of RNC1 and a large pasture to the southeast of PIN2. The distance between the start of RNC1 and start of RPM2 was only about 40 m. With a mean annual rainfall of approx. 4000 mm and mean annual temperatures between 22-23° C, the area lies in the 'premontane pluvial forest' life zone (Holdridge 1967). The corresponding natural formation is 'foothill evergreen forest' (Sierra *et al.* 1999).

METHODS

1. Transect establishment and characterization

The 1200 m long transects were marked with conspicuous distance markers, each 25 m apart, on both sides of the path. Their orientation and altitude was measured and the geographic coordinates of the initial and final points determined with a Ground Positioning Satellite (GPS) equipment (see above). The orientation of the transects was determined with a compass.

2. Transect mapping surveys

We surveyed the entire bird communities, using the optimized "Multi Time-window Transect Mapping" (MTW) protocol for monitoring studies (Jahn *accepted manuscript*). This standardized audio-visual method allows the detection of species that have their activity peaks at different periods of the day. All transect were surveyed with a set of 24 samples. In the case of transect RNC2 a total of six samples had to be repeated due to rain. The surveys were carried out from pre-dawn to after-dusk periods, with highest effort during early morning hours. For each sample period the mean observer speed was adapted to the activity level of the birds. For optimal efficiency, transects were sampled on the way out as well as on the way back. The transects in the Estero Pindiupi area and Río Pachamama valley were alternately surveyed by OJ and PMV. This was not possible at Río Negro Chico, where OJ arrived some days later than PMV due to a tropical illness. PIN1 and PIN2 were studied from 4 to 11 December 2005. The effort for PIN1 was 2893 min (48.2 h), equaling 241.1 min per 100 m section. The corresponding figures for PIN2 were 2915 min (48.6 h) and 242.9 min, respectively. RPM1 and RPM2 were surveyed between 14 and 22 January 2006. In the case of RPM1 the effort was 2857 min (47.6 h), or 238.1 min per 100 m transect. RPM2 was studied for 2941 min (49.0 h), which corresponds to 245.0 min per 100 m. RNC1 was exclusively surveyed by PMV, from 18 to 25 February, for 2548 min (42.5 h) or 212.3 min per 100 m transect. . In the case of RNC1, PMV performed 8 and OJ 16 valid samples, plus 6 samples that had to be repeated, between 24 February and 2 March. The effort for valid surveys at RNC2 was 2768 min (46.1 h) or 230.7 min per 100 m section. Taking into account the samples that had to be repeated due to rain the total effort for RNC2 increases to 3555 min (59.3 h), equaling 296.3 min per 100 m.

Because migratory species are often underdetected in audio-visual surveys due to their silent and elusive behavior (e.g., Rappole et al. 1998, Blake & Loiselle 2001, Jahn accepted manuscript), we actively searched each canopy and subcanopy flock for the presence of *Dendroica cerulea* and other migrants.

3. Playback trials

We broadcasted pre-recorded songs and calls of Cerulean Warblers (Borror & Gunn 1985) with the aim to increase the probability to detect them. On average the vocalizations were broadcasted every

100 m along the transect routes with a total effort of several hours per transect. Playback trials were carried out on 9 December, 24 January, and 26 February at the transects at Estero Pindiupi, Río Pachamama, y Río Negro Chico, respectively.

4. Habitat characterization

Visible limits between distinct habitats types (e.g., forest, non-forest), changes in topography (e.g., banks, cliffs, gullies), large treefall gaps, and streams were noted. We also measured habitat characteristics, such as canopy cover, basal area of trees ≥10 cm DBH, tree height, as well as the average height of the vegetation strata (herbs, shrub level, subcanopy, canopy) at 16 randomly selected 5-m radius plots per transect.

5. Data analysis

Until now, only a small part of the field data could be analyzed due to time restraints. Although, all field data are completely digitized already, the transect mapping results for Río Pachamama and Río Negro Chico still have to be corrected and completed with help of the tape recordings made during the transect mapping surveys. In consequence, the results presented for these study areas have to be regarded as preliminary, including the descriptive statistics on endemic and threatened species. However, we made some headway with the transect mapping data for Pindiupi, where we determined species accumulation graphs for transects PIN1 and PIN2, and used *EstimateS* 6.0b (Colwell 2000; see also Colwell & Coddington 1994) to extrapolate total species richness. We computed seven nonparametric estimators (ACE [Abundance-based Coverage Estimator]: Chao *et al.* 1993, Chazdon *et al.* 1998; ICE [Incidence-based Coverage Estimator]: Lee & Chao 1994, Chazdon *et al.* 1998; Chao 1: Chao 1984, 1987; Chao 2: Chao 1984, 1987; Jackknife 1: Burnham & Overton 1978, 1979; Heltshe & Forrester 1983; Smith & van Belle 1984; Jackknife 2: Burnham & Overton 1978, 1979; Smith & van Belle 1984; Palmer 1991; Bootstrap: Smith & van Belle 1984) and two Michaelis Menten (MM) statistics that extrapolate species accumulation curves (MMRuns and MMMean: Raaijmakers 1987). ACE and Chao 1 are abundance-based models, whereas all other nonparametric estimators are based on the presence/absence (incidence) of species in the samples; see Colwell (2001) for equations and further details. The equations for the Michaelis-Menten richness estimators are stated in Raaijmakers (1987): MMRuns computes estimates for each pooling level of each randomization run, and then averages over randomization runs, whereas MMMean calculates estimators only once for the mean species accumulation curve (Colwell 2001); see Colwell & Coddington (1994) and Keating & Quinn (1998) for discussions and evaluations of these methods. We used the following settings to compute the statistics with *EstimateS*: (a) number of sample order randomizations= 50; (b) arbitrarily chosen random seed= 42 (allows us to obtain precisely the same results when repeating the procedure for the same data sets); (c) randomize samples without replacement (ensures that the final value for the averaged, random-order species

accumulation curve matches precisely the total number of observed species); (d) Chao 1 and Chao 2 bias correction 'on'; see Colwell (2000) for details; (e) upper abundance limit for rare or infrequent species (needed for coverage-based estimators, i.e. ACE and ICE)= 10 (recommended default); (f) individual shuffling 'off' (this experimental tool allows the removal of effects of patchiness of distribution, which was not an objective of our analysis). The estimators were computed for the raw data of each complete survey of transect PIN1 and PIN2 and for the pooled data sets of both transects. However, at least two samples are required for the calculation of incidence-based estimators, in contrast to abundance-based statistics. As a result, only ACE and Chao 1 could be computed for all data sets.

Using *EstimateS* 6.0b (Colwell 2000) we also determined diversity indexes Fisher's α, Shannon's *H'*, and Simpson's *D*, according to the equations stated in Magurran (1988) and Hayek & Buzas (1996); see Colwell (2001) for details. For the comparison of bird diversity between transects PIN1 and PIN2, we computed four similarity indices, two qualitative (incidence-based) indices (Jaccard and Sørenson I) and two quantitative (abundance-based) indices (Sørenson II and Morisita-Horn), according to the equations in Magurran (1988: 95), using *EstimateS* 6.0b (*cf.* Colwell 2001).

The estimation of absolute population densities and bird biomass for PIN1 and PIN2 according to the methods described in Jahn (*accepted manuscript*), as well as the analysis of bird data for the other transects, will carried out during the coming months. Likewise, until now, we have not had the time to analyze the habitat data.

RESULTS

Cerulean Warbler-specific findings. – Although, we surveyed three sites for *c*. 100 h each, and in addition carried out playback trials with prerecorded vocalizations, we did not detect any Cerulean Warblers in the scope of our fieldwork. However, *c*. 70 km south of our study area, an experienced birding guide, Byron Palacios, observed two individuals of *Dendroica cerulea* on 11 November 2005 from the old Milpe – Los Bancos road in Pichincha Province (00˚04'N, 78˚59'W; 950 m). He observed one male and a female, moving independently from each other, while accompanying the same mixed-species flock. It is unclear if these individuals represented migrating or wintering birds (Appendix 1). Another Cerulean Warbler was reportedly seen in December 2005 or January 2006 in semi-open habitat at Jocotoco's Río Canandé Reserve (350 m), Esmeraldas Province (Francisco Sornoza Molina, pers. com.). Unfortunately, I heard about this observation just a few days before submitting the report, too late to contact the person who made the observation.

Tab. 1: Observed and estimated species richness, and number of birds recorded during standardized transect-mapping surveys at PIN1 and PIN2. Abbreviations used: **(a) data set:** PIN1= transect PIN1; PIN2= transect PIN2; PIN1&PIN2= 'independent' data sets of both transect**;** PIN1+PIN2= pooled data set; **(b) field data:** N_{ds}= number of data sets used for the calculation of the species richness estimators; S_{obs}= number of species observed; N_b= number of birds recorded (raw MTW data, which include an unknown number of repeatedly observed individuals); **(c) species richness estimator:** see methods for details.

	Field data [b]			Species richness estimator [c]								
Data set [a]	**N_{ds}**	**S_{obs}**	**N_b**	**ACE**	**ICE**	**Chao1**	**Chao2**	**Jack1**	**Jack2**	**Bootstrap**	**MMRuns**	**MMMean**
PIN1	1	142	3635	149.0		152.2 ±8.6		142.0		142.0		
PIN2	1	139	3440	145.0		144.1 ±4.6		139.0		139.0		
PIN1&PIN2	2	159	7075	171.0	189.0	168.3 ±7.0	164.4 ±3.0	177.5 ±1.5	177.5	168.3	183.1	183.0
PIN1+PIN2	1	159	7075	171.0		168.3 ±7.0		159.0		159.0		

The bird community of Estero Pindiupi. – In the standardized transect-mapping study of PIN1, we recorded 3635 birds, representing 142 species, with 2671 separate observations. Note that the figures on observed birds and records include, as always in mapping surveys according to the MTW protocol, an unknown number of repeated registrations of some individuals (Jahn *accepted manuscript*). Two additional species were recorded during non-standardized observation hours (Appendix 2). At PIN2 we recorded 3440 birds, representing 139 species, with a total of 2582 separate records. Again, two additional species were detected apart of our transect mapping surveys. Species accumulation was very similar for both transects, with curves flattening out after about 25 h of surveying or 2000 'birds recorded' (Appendix 3, Fig. 1a and Fig. 1b). For PIN1 and PIN2 together we noted 159 species in the standardized study (Tab. 1 and Tab. 2), 122 (76.7 %) of which were recorded at both transects (Tab. 3). Sampling was almost complete, as demonstrated by the species accumulation graphs, with only 7 (4.4 %) species added after 50.0 h or 4000 'birds recorded' (Appendix 3, Fig. 2a and Fig. 2b). Using the incidence-based statistics MMRuns and MMMeans, which were shown to produce the most accurate estimations in previous studies (Jahn *accepted manuscript*), total richness was *c*. 183 core species during the survey period (Tab. 1).

Tab. 2: Diversity indices according to the observed species richness and number of birds recorded during standardized transect-mapping surveys at PIN1 and PIN2. Values represent ⨿ (*alpha*) diversity as the transects were located within homogenous habitat. Abbreviations used: **(a) data set:** see Tab. 1; **(b) field data:** N_{ds}= number of data sets used for the calculation of the diversity indices; S_{obs}= number of species observed; N_b= number of birds recorded; **(c) diversity index:** see methods.

	Field data [b]			Diversity index [c]		
Data set [a]	**N_{ds}**	**S_{obs}**	**N_b**	**Alpha**	**Shannon**	**Simpson**
PIN1	1	142	3635	29.43 ±1.17	4.23	44.88
PIN2	1	139	3440	29.07 ±1.17	4.31	52.02
PIN1&PIN2	2	159	7075	28.88 ±0.99	4.31	49.11
PIN1+PIN2	1	159	7075	28.88 ±0.99	4.31	49.11

Tab. 3: Similarity coefficients comparing diversity between transects and observers. Based on 'birds recorded' during transect-mapping surveys. Abbreviations used: **(a) data set:** PIN1= transect PIN1; PIN2= transect PIN2; Observer 1= OJ; Observer 2= PMV **(b) field data:** S_{obs}= number of species observed in samples 1 and 2; shared S_{obs} 1&2= number of species shared; **(c) shared S_{est} 1&2:** coverage-based estimator for shared species; see methods for details; **(d) similarity coefficients:** see methods for details.

Data set [a]		Field data [b]				Similarity coefficient [d]			
						(qualitative)		(quantitative)	
1	2	S_{obs} 1	S_{obs} 2	Shared S_{obs} 1&2	Shared S_{est} 1&2 [c]	Jaccard	Sørenson I	Sørenson II	Morisita-Horn
PIN1	PIN2	142	139	122	124.7	0.77	0.87	0.80	0.95
Observer 1	Observer 2	153	135	129	141.0	0.81	0.90	0.81	0.95

That is, we detected *c*. 87 % of the core species present in the transect areas. Taking also into account non-standardized observations we recorded a total of 182 species in the larger area of Estero Pindiupi, which includes the area between the base camp and the transects. As expected on the basis of the species accumulation graphs (Appendix 3, Fig. 1a and Fig. 1b), diversity indices were very similar for both transects (Tab. 2), although, similarity coefficients indicate that their diversity was not identical (Tab. 3). Similarity coefficients and the number of shared species for the observer-specific results, that is the data each observer collected alternately at both transects, were slightly higher than for the particular transects.

Preliminary results for Río Pachamama and Río Negro Chico. – We recorded at least 84 bird species at RPM1 and 100 at RPM2 (Appendix 2). Taking into account all observations made in the area of the community of El Cristal, which includes mostly deforested areas at the outskirts of the village (pastures, mixed-culture plantations, sugar cane monocultures etc.) and selectively logged forest in the Cordillera del Lacha up to 1700 m above sea level, we detected a total of 177 species. At RNC1 we noted at least 73 and at RNC2 99 bird taxa. Considering non-standardized observations, we noted a total of 125 species in the area of Río Negro Chico. This number includes 13 species that Gregory (1997) reported for the same area, but which were not detected during our surveys.

Endemic and threatened species. – In the three study areas together 315 bird species are known to occur (Appendix 2), at least 302 of which were recorded in the scope of the Cerulean Warbler Project and 241 during standardized transect-mapping surveys. A total of 57 (18.0 %) taxa are considered endemics, with 46 restricted to the Chocó region *sensu* Stattersfield (1998) and/or Ridgely & Greenfield (2001). The latter authors listed nine additional species as endemics of the western Andean slope and two for the Tumbesian region. The number of endemic avian taxa was very similar for the three sites studied, with 33 each in the areas of Estero Pindiupi and Río Negro Chico and 32 in the community of El Cristal. The proportion of endemic species of total species richness was 22.2 % (n= 32) at PIN1, 19.9 % (28) at PIN2, 27.4 % (23) at RPM1, 24.0 % (24) at RPM2, 31.5 % (23) at RNC1, and 27.3 % (27) at RNC2.

We recorded 20 species considered threatened or near-threatened on the global scale (Appendix 2). Three are listed as Endangered: *Penelope ortoni, Ara ambiguus*, and *Vireo masteri*; six as Vulnerable: *Micrastur plumbeus, Odontophorus melanonotus, Glaucidium nubicola, Cephalopterus penduliger, Dacnis berlepschi*, and *Chlorospingus flavovirens*; and the remaining eleven as Near Threatened: *Leucopternis plumbeus, Nyctiphrynus rosenbergi, Capito squamatus, Semnornis ramphastinus, Veniliornis chocoensis, Campephilus gayaquilensis, Margarornis stellatus, Pittasoma rufopileatum, Contopus cooperi, Tangara johannae*, and *Iridosornis porphyrocephala* (BirdLife International 2004). The number of threatened and near-threatened species was 13 in the area of Estero Pindiupi, 9 in the community of El Cristal and 10 in the area of Río Negro Chico.

The Chocó Vireo *V. masteri* is a species new to Ecuador, which was first discovered by B. Palacios a few kilometers southeast of Alto Tambo on 16 September 2004. We found at least 15 territories of this species along the transect routes at Río Pachamama and Río Negro Chico (Jahn et al. in revision). The recently described species was previously known only from two localities in western Colombia (Salaman & Stiles 1996, BirdLife International 2000, 2004).

Nearctic-Neotropical migrants. – We recorded seven Neartic-Neotropical migrant species, six of which were detected during transect mapping surveys: *Contopus sordidulus, Contopus cooperi, Empidonax virescens, Vireo olivaceus, Catharus ustulatus*, and *Piranga rubra*. *Contopus cooperi* is regarded Near Threatened on the global level (BirdLife International 2004). The single New World Warbler in this group, *Dendroica fusca*, was exclusively noted during non-standardized observation hours in semi-open habitat. Five Nearctic-Neotropical migrants were recorded in the area of Estero Pindiupi, three in the community of El Cristal and two in the area of Río Negro Chico.

DISCUSSION

The status of the Cerulean Warbler in northwestern Ecuador. – Considering that we failed to detect any wintering New World warbler species with an effort of roughly 300 h of standardized transect mapping surveys, it seems likely that continuous Chocóan forest is only of minor importance as a wintering habitat for this bird group. Although, Jahn (*accepted manuscript*) pointed out that migrants are easily overlooked in transect mapping surveys, those boreal winter visitants that establish and defend feeding territories are regularly detected, e.g., *Contopus sordidulus, Contopus cooperi, Empidonax virescens, Vireo olivaceus, Catharus ustulatus*, and *Piranga rubra*. In the particular case of the Cerulean Warbler, we also tried to provoke a reaction by broadcasting prerecorded vocalizations along our transect routes, without getting any response. Furthermore, we intensively searched all mixed-species bird flocks during our surveys, also without success. However, we still believe that *Dendroica cerulea* regularly winters in small numbers on the

western Andean slope, but likely not in continuous forest. Instead it is likely, that in the Chocó region, Cerulean Warblers might prefer forest edges and mixed-culture plantations in the vicinity of forest as a wintering habitat. Interestingly, several species that winter in a similar altitudinal range like *Dendroica cerulea* (500-1400 m) are more common on the eastern slope than on the western slope of the Andes, i.e., Blackburnian Warbler *Dendroica fusca* (900-2800 m) and Canada Warbler *Wilsonia canadensis* (500-2000 m). This might have biogeographical reasons (e.g., centers of speciation, traditional migration routes and wintering grounds), as well as ecological reasons. The premontane pluvial forests (*sensu* Holdridge 1967) of the western Andean slope grow mostly on poor soils, where nutrients are leached out due to the extremely high annual precipitation, especially in the Colombian Chocó region. The canopy of these forests is quite open, big trees are rare and palms and epiphytes are dominant elements. At our study sites endemic species accounted for 20 to 32 % of the entire bird communities, indicating that unique environmental conditions select for special adaptations. Considering that the climatic and ecological conditions are even more extreme in the Colombian Chocó, stretching for approx. 700 km from northwestern Colombia (Cordoba Dept.) south to northwestern Ecuador, it might be disadvantageous for some Nearctic-Neotropical migrants to winter on the western Andean slope. Those species that do winter in the Chocó might prefer forest edge habitats to continuous forest, as the former offer broader ecological niche-widths. In concordance with this hypothesis, the two Cerulean Warblers reported by B. Palacios and the individual recorded at Río Canandé (F. Sornoza M. pers. com.) were observed at the edge of secondary forest in a fragmented landscape. The single New World warbler, Blackburnian Warbler, detected in our study was also noted in a semi-open habitat mosaic. In conclusion, we likely focused our surveys on the wrong habitat (continuous primary forest).

Importance of the study areas for conservation. – The high proportion of endemic and threatened bird species at all three study sites underlines their importance for conservation. However, their forest ecosystems are severely threatened by various human activities. The forest in the Río Pachamama valley is so poor in timber tree species that local people consider to convert it into cattle pastures. In recent years, several pastures were already established and the pressure to clear-cut more forest is growing as illegal settlers threaten to occupy any 'unproductive' land in the region. The situation is slightly different in the Río Negro Chico area, where the land was recently purchased by an Ecuadorian foundation that plans to implement forest management plans. Park rangers regularly patrol the area so that invasions are less likely. However, it seems possible that natural forest cannot be profitably managed, that is, intensive forestry techniques might be used in the future, which could include the planting of exotic timber tree species. Hunting pressure is increasing and populations of large mammal species are obviously diminished already. Although, Estero Pindiupi is located inside the Cotacachi-Cayapas Ecological Reserve hunting pressure from the reserve's periphery is reportedly growing. Furthermore, two communities from the Río

Cayapas have occupied parts of the reserve and some others plan to do so in the future. If the Ecuadorian government is not able or willing to stop this development the very integrity of the largest and most important protected area in western Ecuador is at stake.

Effectiveness and efficiency of transect mapping in bird surveys. – The fact that we recorded 159 bird species in homogenous habitat (continuous primary forest on a ridge without streams) in the Estero Pindiupi area, with a survey effort of only 14 man-days (96.8 h), demonstrates the superiority of the new MTW monitoring protocol. In a similar Chocóan premontane forest at Patio (500 m), Junín, Nariño Dept., southwestern Colombia, Salaman and coworkers recorded 141 avian taxa with a 5-fold study effort (70 man-days), using mist-netting and non-systematic observations (Salaman 1994). In the latter study, a mist-netting effort of 44,708 MNH (=Mist-Net Hours), corresponding to a survey period of at least 2 to 4 weeks, revealed the presence of 80 species, that is only 50 % of the species richness recorded in our standardized transect mapping study. Although, other time-efficient bird survey methods do exist, namely the 'random walk' method (Fjeldså 1999, Herzog *et al.* 2002), we have to emphasize that these methods produce only species lists and rough estimates of relative abundance and total species richness when used in combination with 5-, 10- or 20-species lists. In contrast, transect mapping allows the estimation of absolute abundance, population densities and biomass with a fieldwork effort of approx. one week per transect. Furthermore, MTW survey data can be geo-referenced with minimal effort. Incidence-based statistics (i.e., MMRuns and MMMeans) produce accurate estimations of total richness with as few as two transects surveyed according to the optimized MTW protocol for monitoring studies. However, for monitoring purposes it should be taken into account that species richness and composition changes in time due to seasonal movements of some species. In addition, the asynchronous breeding of many tropical bird taxa means, that different territories of the same species have unequal chances of being detected at any given moment. Some other tropical species tend to reproduce during periods when most other species do not breed. In conclusion, when time and budget allows, at least two complete MTW monitoring surveys per year and transect should be carried out (Jahn *accepted manuscript*).

CONCLUSION

During the survey period, *Dendroica cerulea* was definitely present in western Ecuador, although, we failed to detect the species in the scope of our fieldwork at three study sites within continuous Chocóan premontane forest. Future studies in search of the Cerulean Warbler in northwestern Ecuador should focus on forest edges and habitat mosaics of mixed-culture plantations (i.e., cocoa) and forest fragments, because some Nearctic-Neotropical migrant species, particularly New World Warblers, seem to prefer such habitats to continuous forest in that region.

ACKNOWLEDGMENTS

We thank THE NATURE CONSERVANCY for funding the study (project: MBP-CERW-20050810), Fundación Kumanii for logistical help during our field trip to the Cotacachi-Cayapas Ecological Reserve in November and December 2005, the Ministry of the Environment (MAE= Ministerio del Ambiente del Ecuador), Esmeraldas, for issuing the research permit (no. 011-IC-FAU-MA), the FUNDACIÓN PARA EL DESARROLLO FORESTAL and the community of El Cristal for permission to work on their land, Dr. Jhanira Regalado Bolaños for assisting us in the characterization of the transects and their habitats in the Río Negro Chico area, Byron Palacios for providing us with the data on his observation of two Cerulean Warblers in November 2005, and the many field assistants for their much needed help, which made our work in extremely remote areas possible. O. Jahn would like to thank THE BREHM FUNDS FOR INTERNATIONAL BIRD CONSERVATION for additional funding in the preparation phase of the project and during the first fieldtrip in December 2005.

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Appendix 1: Deliverable data from survey for Cerulean Warbler in non-breeding period.

A) Study sites without Cerulean Warbler records.

I. For each site searched:	**1. Transect PIN1 (length 1200 m)**
A. Survey date and time	4 to 11 December 2005 (effort: 48.2 h)
B. Geographic Location:	
Site Name, Province, Nation	Estero Pindiupi, Cotacachi-Cayapas Ecological Reserve, Esmeraldas Province, Ecuador
GPS location:	
Type of GPS unit used	Garmin: GPS 12, software 4.53; Personal Navigator
UTM coordinates, in WGS84 datum	transect start: 17N0737302; UTM0072807 (3 Dec. 2005) transect end: 17N0736596; UTM0073413 (3 Dec. 2005)
Location accuracy, in m	± 10 m
Percent slope at the location, to the nearest percent	0 to 23 (range of variation along the transect line)
Aspect of the slope to the nearest ten degrees (N=0°, S=180°, etc.)	variable
Elevation in m	475 to 540 m

I. For each site searched:	**2. Transect PIN2 (length 1200 m)**
A. Survey date and time	4 to 11 December 2005 (effort: 48.6 h)
B. Geographic Location:	
Site Name, Province, Nation	Estero Pindiupi, Cotacachi-Cayapas Ecological Reserve, Esmeraldas Province, Ecuador
GPS location:	
Type of GPS unit used	Garmin: GPS 12, software 4.53; Personal Navigator
UTM coordinates, in WGS84 datum	transect start: 17N0736596; UTM0073413 (3 Dec. 2005) transect end: 17N0736214; UTM0074310 (3 Dec. 2005)
Location accuracy, in m	± 10 m
Percent slope at the location, to the nearest percent	0 to 22 (range of variation along the transect line)
Aspect of the slope to the nearest ten degrees (N=0°, S=180°, etc.)	variable
Elevation in m	540 to 555 m

I. For each site searched:	**3. Transect RPM1 (length 1200 m)**
A. Survey date and time	14 to 22 January 2006 (effort: 47.6 h)
B. Geographic Location:	
Site Name, Province, Nation	Río Pachamama, El Cristal, Esmeraldas Province, Ecuador
GPS location:	
Type of GPS unit used	Garmin: GPS 12, software 4.53; Personal Navigator
UTM coordinates, in WGS84 datum	transect start: 17N0774997; UTM0092408 (14 Jan. 2006) transect end: 17N0774273; UTM0091789 (14 Jan. 2006)
Location accuracy, in m	± 10 m
Percent slope at the location, to the nearest percent	0 to 23 (range of variation along the transect line)
Aspect of the slope to the nearest ten degrees (N=0°, S=180°, etc.)	variable
Elevation in m	1245-1370 m

I. For each site searched:	**4. Transect RPM2 (length 1200 m)**
A. Survey date and time	14 to 22 January 2006 (effort: 49.0 h)
B. Geographic Location:	
Site Name, Province, Nation	Río Pachamama, El Cristal, Esmeraldas Province, Ecuador
GPS location:	
Type of GPS unit used	Garmin: GPS 12, software 4.53; Personal Navigator
UTM coordinates, in WGS84 datum	transect start: 17N0774209; UTM0091850 (14 Jan. 2006) transect end: 17N0773180; UTM0091859 (12 Jan. 2006)
Location accuracy, in m	± 10 m
Percent slope at the location, to the nearest percent	0 to 26 (range of variation along the transect line)
Aspect of the slope to the nearest ten degrees (N=0°, S=180°, etc.)	variable
Elevation in m	1180-1240 m

I. For each site searched:	**5. Transect RNC1 (length 1200 m)**
A. Survey date and time	18 to 25 Feb. 2006 (effort: 42.5 h)
B. Geographic Location:	
Site Name, Province, Nation	Río Negro Chico, Alto Tambo county, Esmeraldas Province, Ecuador
GPS location:	
Type of GPS unit used	Garmin: GPS 12, software 4.53; Personal Navigator
UTM coordinates, in WGS84 datum	transect start: 17N0772681; UTM0092083 (17 Feb. 2006) transect end: 17N0771683; UTM0092489 (17 Feb. 2006)
Location accuracy, in m	± 10 m
Percent slope at the location, to the nearest percent	0 to 30 (range of variation along the transect line)
Aspect of the slope to the nearest ten degrees (N=0°, S=180°, etc.)	variable
Elevation in m	1085-1120 m

I. For each site searched:	**6. Transect RNC2 (length 1200 m)**
A. Survey date and time	24 Feb. to 2 Mar. 2006 (effort: 59.3 h)
B. Geographic Location:	
Site Name, Province, Nation	Río Negro Chico, Alto Tambo county, Esmeraldas Province, Ecuador
GPS location:	
Type of GPS unit used	Garmin: GPS 12, software 4.53; Personal Navigator
UTM coordinates, in WGS84 datum	transect start: 17N0772714; UTM0092106 (28 Feb. 2006) transect end: 17N0773426; UTM0091503 (2 Mar. 2006)
Location accuracy, in m	± 10 m
Percent slope at the location, to the nearest percent	0 to 30 (range of variation along the transect line)
Aspect of the slope to the nearest ten degrees (N=0°, S=180°, etc.)	variable
Elevation in m	1125-1180 m

B) Additional study site were the Cerulean Warbler was recorded (B. Palacios *pers. com.*).

I. For each site searched:	
A. Survey date and time	11 November 2005 (12:45)
B. Geographic Location:	
Site Name, Province, Nation	Old Milpe – Los Bancos road, Pichincha Province, Ecuador, Ecuador
GPS location:	
Type of GPS unit used	not available
UTM coordinates, in WGS84 datum	
Location accuracy, in m	not available (± 2000 m)
Percent slope at the location, to the nearest percent	not available
Aspect of the slope to the nearest ten degrees (N=0°, S=180°, etc.)	not available
Elevation in m	950 m
II. For each site at which Cerulean Warblers were located:	
A. Survey date and time	11 November 2005 (12:45)
B. Number of Cerulean Warblers located	2
C. Gender and age	1 male; 1 female (age unknown)
D. Habitat	edge of secondary forest fragments in a habitat mosaic of forest fragments and pastures at a roadside

APPENDIX 2

Bird species of three study areas in the Ecuadorian Chocó: endemism, global threat status, and status of confirmation: Preliminary list of bird species recorded at three sites between Nov. 2005 and Mar. 2006 (see chapter "study areas" for details). Some additional species (n= 13) listed by Gregory (1997) for the area of the Río Negro Chico are included. In the case of uncertain records the species have been taken into account only if their occurrence in the study area is likely. Abbreviations used: **(a) EBA** (endemic bird area): Cho1= Chocó EBA 041 *sensu* Stattersfield *et al.* (1998); Cho2= Chocó lowlands; additional endemic species listed by Ridgely & Greenfield (2001); Tum1= Tumbesian region EBA 045 *sensu* Stattersfield *et al.* (1998); Tum2= Tumbesian lowlands; additional endemic species listed by Ridgely & Greenfield (2001); wAnd2= western Andean slope; additional endemic species listed by Ridgely & Greenfield (2001b); **(b) World** (threat status): international threat status categories (IUCN 2001; BirdLife International 2004): NT= Near Threatened; DD= Data Deficient; VU= Vulnerable; EN= Endangered; CR= Critically Endangered; **(c) study area 1**: Estero Pindiupi area, Cotacachi-Cayapas Ecological Reserve, Esmeraldas ; PIN1: transect Pindiupi 1; PIN2: transect Pindiupi 2; Est. Pindiupi= all species recorded during standardized and non-standardized surveys; **(d) study area 2**: community of El Cristal, Esmeraldas; RPM1: transect Río Pachamama 1; RPM2: transect Río Pachamama 2; El Cristal= all species recorded during standardized and non-standardized surveys within the limits of the community of El Cristal; **(e) study area 3**: Río Negro Chico area, Alto Tambo county; Esmeraldas; RNC1: transect Río Negro Chico 1; RNC2: transect Río Negro Chico 2; Río Negro Chico= included are all species we recorded during standardized and non-standardized surveys, additional taxa listed by Gregory (1997) area marked with an asterisk (*) ; **(f) status of confirmation**: mentioned for each transect and study area; 1= confirmed record (i.e., sound recordings); 2= confirmable record; e.g., identification of sound recordings need further confirmation; 3= unconfirmable record; e.g., sight and/or acoustical records without any confirmable documentation like sound recordings or photos; 4= uncertain record; e.g., unconfirmable sight records of species that may be difficult to identify in the field, species not seen well enough to assure the correctness of identification with certainty, etc.; […]= species exclusively recorded during non-standardized observations at the transects:

		Status		Study area 1			Study area 2			Study area 3		
Scientific name	**English name**	**EBA**	**World**	**PIN1**	**PIN2**	**Est. Pindiupi**	**RPM1**	**RPM2**	**El Cristal**	**RNC1**	**RNC2**	**Río Negro Chico**
Tinamidae (3)	**Tinamous (3)**											
Tinamus major	Great Tinamou			1	1	1						
Crypturellus berlepschi	Berlepsch's Tinamou	Cho1		1	1	1						
Crypturellus soui	Little Tinamou				3	3						
Ardeidae (1)	**Herons and allies (1)**											
Tigrisoma fasciatum	Fasciated Tiger-Heron						3		3			3
Cathartidae (2)	**American Vultures (2)**											
Coragyps atratus	Black Vulture								3			
Cathartes aura	Turkey Vulture								3			
Accipitridae (9)	**Hawks and allies (9)**											
Chondrohierax uncinatus	Hook-billed Kite					3						
Elanoides forficatus	Swallow-tailed Kite					3			3			
Harpagus bidentatus	Double-toothed Kite			3		3						4*
Ictinia plumbea	Plumbeous Kite					3						
Leucopternis plumbeus	Plumbeous Hawk		NT	1	1	1						

		Status		Study area 1			Study area 2			Study area 3		
Scientific name	**English name**	**EBA**	**World**	**PIN1**	**PIN2**	**Est. Pindiupi**	**RPM1**	**RPM2**	**El Cristal**	**RNC1**	**RNC2**	**Río Negro Chico**
Leucopternis princeps	Barred Hawk			1		1		3	3	2	3	2
Buteo magnirostris	Roadside Hawk							1	1		1	1
Spizaetus tyrannus	Black Hawk-Eagle			1	1	1						
Spizaetus ornatus	Ornate Hawk-Eagle			1	1	1	1	1	1	1	1	1
Falconidae (6)	**Falcons and allies (6)**											
Ibycter americanus	Red-throated Caracara			1	1	1				3	1	1
Micrastur ruficollis	Barred Forest-Falcon			2	2	2						3*
Micrastur plumbeus	Plumbeous Forest-Falcon	Cho1	VU	1	1	1	2	2	2	3	2	3
Micrastur semitorquatus	Collared Forest-Falcon			1	1	1						
Herpetotheres cachinnans	Laughing Falcon					3						
Falco rufigularis	Bat Falcon				[3]	3			3			
Cracidae (3)	**Curassows and allies (3)**											
Penelope ortoni	Baudó Guan	Cho1	EN	1	1	1					1	1
Penelope purpurascens	Crested Guan			3	3	3						
Chamaepetes goudotii	Sickle-winged Guan								3			
Odontophoridae (3)	**New World Quails (3)**											
Odontophorus erythrops	Rufous-fronted Wood-Quail			1	1	1						4*
Odontophorus melanonotus	Dark-backed Wood-Quail	Cho1	VU				3	3	3	1	1	1
Rhynchortyx cinctus	Tawny-faced Quail			1	1	1						
Rallidae (2)	**Rails and allies (2)**											
Laterallus albigularis	White-throated Crake								3			
Amaurolimnas concolor	Uniform Crake					3						
Columbidae (6)	**Pigeons and Doves (6)**											
Patagioenas subvinacea	Ruddy Pigeon			1	1	1			3			
Patagioenas plumbea	Plumbeous Pigeon								3			
Patagioenas goodsoni	Dusky Pigeon	Cho1		1	1	1						
Leptotila pallida	Pallid Dove	Cho2							3			
Geotrygon purpurata	Indigo-crowned Quail-Dove	Cho2		3	3	3				3		3
Geotrygon montana	Ruddy Quail-Dove			1		1						
Psittacidae (8)	**Parrots and allies (8)**											
Ara ambiguus	Great Green Macaw		EN	1	1	1	1		1			3*
Pyrrhura melanura	Maroon-tailed Parakeet			3		3	1	1	1	1	1	1
Bolborhynchus lineola	Barred Parakeet						3		3			

		Status		Study area 1			Study area 2			Study area 3		
Scientific name	**English name**	**EBA**	**World**	**PIN1**	**PIN2**	**Est. Pindiupi**	**RPM1**	**RPM2**	**El Cristal**	**RNC1**	**RNC2**	**Río Negro Chico**
Touit dilectissimus	Blue-fronted Parrotlet			3	1	1		3	3	1	3	1
Pionopsitta pulchra	Rose-faced Parrot	Cho1		1	1	1					3	3
Pionus menstruus	Blue-headed Parrot			3	3	3		4	4			
Pionus chalcopterus	Bronze-winged Parrot			1	1	1	3	3	3		1	1
Amazona farinosa	Mealy Amazon			1	1	1						
Cuculidae (4)	**Cuckoos and Anis (4)**											
Piaya cayana	Squirrel Cuckoo			3		3		3	3			
Piaya minuta	Little Cuckoo							1	1			
Crotophaga ani	Smooth-billed Ani								3			
Tapera naevia	Striped Cuckoo							4	4			
Strigidae (6)	**Typical Owls (6)**											
Megascops centralis	Chocó Screech-Owl			1	1	1						
Glaucidium nubicola	Cloud-forest Pygmy-Owl	wAnd2	VU				1		1	1		1
Glaucidium griseiceps	Central American Pygmy-Owl				1	1						
Lophostrix cristata	Crested Owl					3						
Pulsatrix perspicillata	Spectacled Owl			3		3						
Strix virgata	Mottled Owl			1	1	1	1	1	1			4*
Nyctibiidae (1)	**Potoos (1)**											
Nyctibius griseus	Gray Potoo			1		1						
Caprimulgidae (3)	**Nightjars and Nighthawks (3)**											
Lurocalis semitorquatus	Short-tailed Nighthawk						1	1	1		3	3
Nyctidromus albicollis	Pauraque					3						
Nyctiphrynus rosenbergi	Chocó Poorwill	Cho1	NT	1	1	1						
Apodidae (3)	**Swifts (3)**											
Streptoprocne zonaris	White-collared Swift						3		3			
Chaetura spinicaudus	Band-rumped Swift					3		3	3	3	3	3
Panyptila cayennensis	Lesser Swallow-tailed Swift					3			3			
Trochilidae (25)	**Hummingbirds (25)**											
Threnetes ruckeri	Band-tailed Barbthroat			3	3	3						
Phaethornis yaruqui	White-whiskered Hermit	Cho2		1	1	1			3	3	3	3
Phaethornis syrmatophorus	Tawny-bellied Hermit						1	1	1	1	1	1
Phaethornis striigularis	Stripe-throated Hermit			3		3					3	3

		Status		Study area 1			Study area 2			Study area 3		
Scientific name	**English name**	**EBA**	**World**	**PIN1**	**PIN2**	**Est. Pindiupi**	**RPM1**	**RPM2**	**El Cristal**	**RNC1**	**RNC2**	**Río Negro Chico**
Eutoxeres aquila	White-tipped Sicklebill			3	3	3	3	3	3	3	1	1
Androdon aequatorialis	Tooth-billed Hummingbird			1	1	1						
Doryfera ludovicae	Green-fronted Lancebill											3*
Florisuga mellivora	White-necked Jacobin					3			3			
Popelairia conversii	Green Thorntail					3						
Thalurania fannyi	Green-crowned Woodnymph			1	1	1					1	1
Amazilia tzacatl	Rufous-tailed Hummingbird								3			
Amazilia franciae	Andean Emerald								3		2	2
Amazilia rosenbergi	Purple-chested Hummingbird	Cho1		1	1	1						
Chalybura urochrysia	Bronze-tailed Plumeleteer			1	1	1						
Urosticte benjamini	Purple-bibbed Whitetip	Cho1					3		3			
Heliodoxa imperatrix	Empress Brilliant	Cho1					3		3			3*
Heliodoxa jacula	Green-crowned Brilliant				3	3					3	3
Urochroa bougueri	White-tailed Hillstar						3	3	3		3	3
Coeligena wilsoni	Brown Inca	Cho1		3		3	1	1	1	1	1	1
Boissonneaua flavescens	Buff-tailed Coronet							3	3			
Boissonneaua jardini	Velvet-purple Coronet	Cho1					3	3	3		3	3
Ocreatus underwoodii	Booted Racket-tail								3			
Aglaiocercus kingi	Long-tailed Sylph						4		3			
Aglaiocercus coelestis	Violet-tailed Sylph	Cho1					1	1	1		3	3
Heliothryx barroti	Purple-crowned Fairy			3		3						
Trogonidae (5)	**Trogons and Quetzals (5)**											
Pharomachrus auriceps	Golden-headed Quetzal						3	1	1	1	1	1
Trogon comptus	Chocó Trogon	Cho1		1	1	1	3	3	3	1	1	1
Trogon chionurus	Western White-tailed Trogon			1	1	1						
Trogon collaris	Collared Trogon			1	1	1	1	1	1	1	1	1
Trogon rufus	Black-throated Trogon			[3]		3						
Alcedinidae (1)	**Kingfishers (1)**											
Chloroceryle inda	Green-and-rufous Kingfisher					3						
Momotidae (2)	**Motmots (2)**											
Electron platyrhynchum	Broad-billed Motmot			1	1	1	3	3	3	3	3	3
Baryphthengus martii	Rufous Motmot			1	1	1						

		Status		Study area 1			Study area 2			Study area 3		
Scientific name	**English name**	**EBA**	**World**	**PIN1**	**PIN2**	**Est. Pindiupi**	**RPM1**	**RPM2**	**El Cristal**	**RNC1**	**RNC2**	**Río Negro Chico**
Galbulidae (2)	**Jacamars (2)**											
Galbula ruficauda	Rufous-tailed Jacamar				3	3						
Jacamerops aureus	Great Jacamar			3	3	3						
Bucconidae (3)	**Puffbirds (3)**											
Nystalus radiatus	Barred Puffbird				1	1				3		3
Malacoptila panamensis	White-whiskered Puffbird			1	1	1						
Micromonacha lanceolata	Lanceolated Monklet			3		3						
Capitonidae (3)	**New World Barbets (3)**											
Capito squamatus	Orange-fronted Barbet	Cho1	NT	3	3	3						
Eubucco bourcierii	Red-headed Barbet								3			
Semnornis ramphastinus	Toucan Barbet	Cho1	NT					3	3	1	1	1
Ramphastidae (4)	**Toucans (4)**											
Aulacorhynchus haematopygus	Crimson-rumped Toucanet						3	3	3		1	1
Pteroglossus erythropygius	Pale-mandibled Araçari	Cho2		1	1	1						
Ramphastos brevis	Chocó Toucan	Cho1		1	1	1						
Ramphastos swainsonii	Chestnut-mandibled Toucan			1	1	1						
Picidae (8)	**Woodpeckers and Piculets (8)**											
Piculus rubiginosus	Golden-olive Woodpecker						4	4	3		1	1
Piculus litae	Lita Woodpecker	Cho1		1	1	1						
Celeus loricatus	Cinnamon Woodpecker			1	1	1						
Veniliornis fumigatus	Smoky-brown Woodpecker						1	1	1	1	1	1
Veniliornis chocoensis	Chocó Woodpecker	Cho1	NT								4	4
Veniliornis dignus	Yellow-vented Woodpecker						3	1	1	1	3	1
Campephilus gayaquilensis	Guayaquil Woodpecker	Tum2	NT	3	3	3						
Campephilus haematogaster	Crimson-bellied Woodpecker			1	1	1		2	2			
Furnariidae (13)	**Ovenbirds (13)**											
Synallaxis brachyura	Slaty Spinetail								3			
Cranioleuca erythrops	Red-faced Spinetail						1	1	1	1	1	1
Pseudocolaptes johnsoni	Pacific Tuftedcheek	wAnd2					1	1	1	1	1	1
Margarornis stellatus	Star-chested Treerunner	Cho1	NT						3			
Premnoplex brunnescens	Spotted Barbtail						1	1	1	1	1	1
Syndactyla subalaris	Lineated Foliage-gleaner											4
Anabacerthia variegaticeps	Scaly-throated Foliage-gleaner						3	1	1	1	1	1

		Status		Study area 1			Study area 2			Study area 3		
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Hyloctistes virgatus	Western Woodhaunter			1	1	1						
Philydor rufus	Buff-fronted Foliage-gleaner						1	1	1	1	1	1
Automolus rubiginosus	Ruddy Foliage-gleaner					3					3	3
Thripadectes ignobilis	Uniform Treehunter	Cho1					1	1	1	1	1	1
Xenops minutus	Plain Xenops			1	1	1						
Sclerurus mexicanus	Tawny-throated Leaftosser			1	1	1			3			3*
Dendrocolaptidae (6)	**Woodcreepers (6)**											
Dendrocincla fuliginosa	Plain-brown Woodcreeper			1	1	1		1	1	1	1	1
Glyphorynchus spirurus	Wedge-billed Woodcreeper			1	1	1	1	1	1	1	1	1
Dendrocolaptes sanctithomae	Northern Barred-Woodcreeper			1	3	1						
Xiphorhynchus lachrymosus	Black-striped Woodcreeper				3	3						
Xiphorhynchus erythropygius	Spotted Woodcreeper			1	1	1	1	1	1	1	1	1
Campylorhamphus pusillus	Brown-billed Scythebill			1	1	1	3	1	1	1	1	1
Thamnophilidae (20)	**Typical Antbirds (20)**											
Cymbilaimus lineatus	Fasciated Antshrike					3						
Taraba major	Great Antshrike								3			
Thamnophilus unicolor	Uniform Antshrike						1	1	1		1	1
Thamnophilus atrinucha	Western Slaty-Antshrike					3						
Thamnistes anabatinus	Russet Antshrike			1	1	1						
Dysithamnus puncticeps	Spot-crowned Antvireo			1	1	1						
Myrmotherula ignota	Moustached Antwren			1	1	1						
Myrmotherula pacifica	Pacific Antwren								3			
Myrmotherula fulviventris	Checker-throated Antwren			1	1	1						
Myrmotherula axillaris	White-flanked Antwren			1	1	1						
Myrmotherula schisticolor	Slaty Antwren			1	1	1	1	1	1	1	1	1
Microrhopias quixensis	Dot-winged Antwren			1	1	1						
Terenura callinota	Rufous-rumped Antwren						1	3	1	1	1	1
Hylophylax naevioides	Spotted Antbird			1	3	1						
Pyriglena leuconota	White-backed Fire-eye				1	1						
Myrmeciza immaculata	Immaculate Antbird			1	1	1	1	1	1	1	1	1
Myrmeciza exsul	Chestnut-backed Antbird			1	1	1						
Myrmeciza nigricauda	Esmeraldas Antbird	wAnd2		1	1	1	1	1	1	1	1	1

		Status		Study area 1			Study area 2			Study area 3		
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Gymnopithys leucaspis	Bicolored Antbird			1	1	1						
Phaenostictus mcleannani	Ocellated Antbird			1	1	1						
Formicariidae (6)	**Antthushes and Antpittas (6)**											
Formicarius nigricapillus	Black-headed Antthrush			1	1	1					2	2
Formicarius rufipectus	Rufous-breasted Antthrush						1	1	1		1	1
Pittasoma rufopileatum	Rufous-crowned Antpitta	Cho1	NT	1		1				1	2	1
Grallaria haplonota	Plain-backed Antpitta						1	1	1			
Hylopezus perspicillatus	Streak-chested Antpitta			1	1	1						
Grallaricula flavirostris	Ochre-breasted Antpitta						1	1	1			3*
Rhinocryptidae (2)	**Tapaculos (2)**											
Scytalopus vicinior	Nariño Tapaculo	Cho1							3			
Scytalopus chocoensis	Chocó Tapaculo	wAnd2		1	1	1	1	1	1	1	1	1
Tyrannidae (46)	**Tyrant Flycatchers (46)**											
Phyllomyias cinereiceps	Ashy-headed Tyrannulet						3	3	3			
Zimmerius chrysops	Golden-faced Tyrannulet			1	1	1			3			
Ornithion brunneicapillus	Brown-capped Tyrannulet			1	1	1						
Camptostoma obsoletum	Southern Beardless-Tyrannulet								3			
Tyrannulus elatus	Yellow-crowned Tyrannulet								3			
Myiopagis viridicata	Greenish Elaenia				3	3			3			
Elaenia flavogaster	Yellow-bellied Elaenia								3			
Serpophaga cinerea	Torrent Tyrannulet											3
Mionectes striaticollis	Streak-necked Flycatcher											4*
Mionectes olivaceus	Olive-striped Flycatcher			1	1	1	3	3	3	1	1	1
Leptopogon superciliaris	Slaty-capped Flycatcher			1	1	1						
Pseudotriccus pelzelni	Bronze-olive Pygmy-Tyrant						1	1	1	1	1	1
Myiornis atricapillus	Black-capped Pygmy-Tyrant			1	1	1						
Lophotriccus pileatus	Scale-crested Pygmy-Tyrant								3			
Todirostrum nigriceps	Black-headed Tody-Flycatcher			1	1	1						
Todirostrum cinereum	Common Tody-Flycatcher								3			
Rhynchocyclus fulvipectus	Fulvous-breasted Flatbill						3		3		3	3
Tolmomyias flavotectus	Yellow-margined Flatbill			1	1	1	4		4			
Platyrinchus coronatus	Golden-crowned Spadebill			1	1	1						
Myiotriccus ornatus	Ornate Flycatcher			1	1	1	1	1	1	1	1	1

		Status		Study area 1			Study area 2			Study area 3		
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Terenotriccus erythrurus	Ruddy-tailed Flycatcher			1	1	1						
Myiobius sulphureipygius	Sulphur-rumped Flycatcher			3	3	3						
Myiobius villosus	Tawny-breasted Flycatcher						3	3	3	3	3	3
Myiophobus phoenicomitra	Orange-crested Flycatcher	wAnd2					3	1	1	1	1	1
Myiophobus fasciatus	Bran-colored Flycatcher								3			
Mitrephanes phaeocercus	Common Tufted-Flycatcher			1	1	1						
Contopus sordidulus	Western Wood-Pewee			1	1	1	1	1	1		3	3
Contopus fumigatus	Smoke-colored Pewee								3			
Contopus cooperi	Olive-sided Flycatcher		NT		1	1						
Empidonax virescens	Acadian Flycatcher			1	1	1						
Colonia colonus	Long-tailed Tyrant			1	1	1						
Attila spadiceus	Bright-rumped Attila								3			
Rhytipterna holerythra	Rufous Mourner			1	1	1				1		1
Myiarchus tuberculifer	Dusky-capped Flycatcher								3			
Myiozetetes cayanensis	Rusty-margined Flycatcher								3			
Myiozetetes granadensis	Gray-capped Flycatcher									3		3
Conopias albovittatus	White-ringed Flycatcher			1	1	1						
Myiodynastes maculatus	Streaked Flycatcher			3	1	1						
Myiodynastes chrysocephalus	Golden-crowned Flycatcher						3	1	1	1	1	1
Legatus leucophaius	Piratic Flycatcher								3			
Tyrannus melancholicus	Tropical Kingbird							1	1		3	3
Tyrannus niveigularis	Snowy-throated Kingbird	Tum2		3	3	3						
Pachyramphus cinnamomeus	Cinnamon Becard			1	1	1		1	1	3	3	3
Pachyramphus albogriseus	Black-and-white Becard				3	3	3		3			
Platypsaris homochrous	One-colored Becard			3	3	3						
Tityra semifasciata	Masked Tityra							3	3			3*
Cotingidae (6)	**Cotingas (6)**											
Pipreola riefferii	Green-and-black Fruiteater								3			
Pipreola jucunda	Orange-breasted Fruiteater	Cho1					1	1	1	1	1	1
Ampelioides tschudii	Scaled Fruiteater						3		3		3	3
Lathria cryptolophus	Olivaceous Piha						3		3		3	3
Lipaugus unirufus	Rufous Piha			1	1	1						

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Carpodectes hopkei	Black-tipped Cotinga			[3]		3						
Cephalopterus penduliger	Long-wattled Umbrellabird	Cho1	VU	1	1	1		3	3	3	1	1
Pipridae (8)	**Manakins (8)**											
Pipra mentalis	Red-capped Manakin				3	3						
Lepidothrix coronata	Blue-crowned Manakin			1	1	1						
Masius chrysopterus	Golden-winged Manakin							3	3		1	1
Manacus manacus	White-bearded Manakin				[3]	3						
Machaeropterus deliciosus	Club-winged Manakin	Cho1							3			3*
Chloropipo holochlora	Green Manakin			1	1	1						
Schiffornis turdinus	Thrush-like Schiffornis			1	1	1				1	1	1
Sapayoa aenigma	Broad-billed Sapayoa			1	1	1						
Vireonidae (6)	**Vireos and allies (6)**											
Cyclarhis nigrirostris	Black-billed Peppershrike						1	1	1	1	1	1
Vireolanius leucotis	Slaty-capped Shrike-Vireo			1	1	1						
Vireo olivaceus	Red-eyed Vireo				3	3						
Vireo masteri	Chocó Vireo	Cho1	EN				1	1	1	1	1	1
Hylophilus decurtatus	Lesser Greenlet			1	1	1						
Hylophilus ochraceiceps	Tawny-crowned Greenlet			1	1	1						
Turdidae (7)	**Thrushes (7)**											
Myadestes ralloides	Andean Solitaire						3		3	1	1	1
Cichlopsis leucogenys	Rufous-brown Solitaire						3	3	3	1	1	1
Entomodestes coracinus	Black Solitaire	Cho1						1	1			3
Catharus dryas	Spotted Nightingale-Thrush			2		2						
Catharus ustulatus	Swainson's Thrush										3	3
Turdus obsoletus	Pale-vented Thrush						1	3	1	1	3	1
Turdus daguae	Dagua Thrush			3	3	3						
Cinclidae (1)	**Dippers (1)**											
Cinclus leucocephalus	White-capped Dipper								3			3
Hirundinidae (4)	**Swallows and Martins (4)**											
Progne chalybea	Gray-breasted Martin					3						
Notiochelidon cyanoleuca	Blue-and-white Swallow								3			
Neochelidon tibialis	White-thighed Swallow								3			
Stelgidopteryx ruficollis	Southern Rough-winged Swallow								3			

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Troglodytidae (11)	**Wrens (11)**											
Campylorhynchus zonatus	Band-backed Wren						1	3	1		1	1
Odontorchilus branickii	Gray-mantled Wren			1	1	1						
Cinnycerthia olivascens	Sepia-brown Wren						1	1	1	1	1	1
Thryothorus nigricapillus	Bay Wren				3	3		1	1		3	3
Thryothorus leucopogon	Stripe-throated Wren			1	1	1						
Troglodytes aedon	House Wren								3			
Troglodytes solstitialis	Mountain Wren						1	1	1	1	1	1
Henicorhina leucosticta	White-breasted Wood-Wren			1	1	1						
Henicorhina leucophrys	Gray-breasted Wood-Wren						1	1	1	1	1	1
Cyphorhinus phaeocephalus	Song Wren					3						
Microcerculus marginatus	Southern Nightingale-Wren			1	1	1						
Polioptilidae (2)	**Gnatcatchers and Gnatwrens (2)**											
Microbates cinereiventris	Tawny-faced Gnatwren			1	1	1				2	2	2
Polioptila schistaceigula	Slate-throated Gnatcatcher			1	1	1						
Parulidae (7)	**New World Warblers (7)**											
Parula pitiayumi	Tropical Parula				3	3						
Dendroica fusca	Blackburnian Warbler								3			
Geothlypis semiflava	Olive-crowned Yellowthroat							1	1			
Myioborus miniatus	Slate-throated Whitestart								3			
Basileuterus chlorophrys	Chocó Warbler	wAnd2		1	1	1	1	1	1	1	1	1
Basileuterus tristriatus	Three-striped Warbler						1	3	1	2		2
Basileuterus fulvicauda	Buff-rumped Warbler					3	3	3	3			
Thraupidae (41)	**Tanagers and allies (41)**											
Coereba flaveola	Bananaquit			1	1	1			3			
Cyanerpes caeruleus	Purple Honeycreeper			1	3	1						
Chlorophanes spiza	Green Honeycreeper				3	3						
Dacnis berlepschi	Scarlet-breasted Dacnis	Cho1	VU	2		2						
Diglossopis caerulescens	Bluish Flowerpiercer							4	4			
Diglossopis indigotica	Indigo Flowerpiercer	Cho1			1	1	1	1	1	1	1	1
Erythrothlypis salmoni	Scarlet-and-white Tanager	Cho1		1	1	1						
Pipraeidea melanonota	Fawn-breasted Tanager								3			
Chlorophonia flavirostris	Yellow-collared Chlorophonia	Cho1		1		1	3	1	1		3	3

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Euphonia xanthogaster	Orange-bellied Euphonia			1	1	1	1	1	1	1	1	1
Euphonia minuta	White-vented Euphonia			1		1						
Euphonia fulvicrissa	Fulvous-vented Euphonia			3		3						
Chlorochrysa phoenicotis	Glistening-green Tanager	Cho1					1	1	1	1	1	1
Tangara rufigula	Rufous-throated Tanager	wAnd2						1	1	1	1	1
Tangara palmeri	Gray-and-gold Tanager	wAnd2		1	1	1						
Tangara arthus	Golden Tanager								3		3	3
Tangara florida	Emerald Tanager			3		3						
Tangara icterocephala	Silver-throated Tanager							3	3			
Tangara parzudakii	Flame-faced Tanager								3	1	1	1
Tangara nigroviridis	Beryl-spangled Tanager							3	3			
Tangara larvata	Golden-hooded Tanager								3			
Tangara johannae	Blue-whiskered Tanager	Cho1	NT	3	3	3						
Tangara gyrola	Bay-headed Tanager								3			
Tangara lavinia	Rufous-winged Tanager			1	1	1						
Iridosornis porphyrocephala	Purplish-mantled Tanager	Cho1	NT						3			
Anisognathus notabilis	Black-chinned Mountain-Tanager	Cho1										3
Bangsia rothschildi	Golden-chested Tanager	Cho1		1	1	1						
Bangsia edwardsi	Moss-backed Tanager	Cho1					1	1	1	1	1	1
Tersina viridis	Swallow Tanager								3			
Thraupis episcopus	Blue-gray Tanager								3			
Thraupis palmarum	Palm Tanager							3	3			
Ramphocelus icteronotus	Yellow-rumped Tanager							1	1		3	3
Piranga rubra	Summer Tanager			3		3			3			
Chlorothraupis olivacea	Lemon-spectacled Tanager	Cho2		1	3	1						
Chlorothraupis stolzmanni	Ochre-breasted Tanager	wAnd2		1	1	1	1	1	1	1	1	1
Mitrospingus cassinii	Dusky-faced Tanager					3						
Tachyphonus rufus	White-lined Tanager								3			
Tachyphonus delatrii	Tawny-crested Tanager			1	1	1						3*
Heterospingus xanthopygius	Scarlet-browed Tanager	Cho2		1	1	1						
Chlorospingus semifuscus	Dusky Bush-Tanager	Cho1					3	3	3			
Chlorospingus flavovirens	Yellow-green Bush-Tanager	Cho1	VU	1		1						
Chlorospingus flavigularis	Yellow-throated Bush-Tanager						1	1	1	1	1	1

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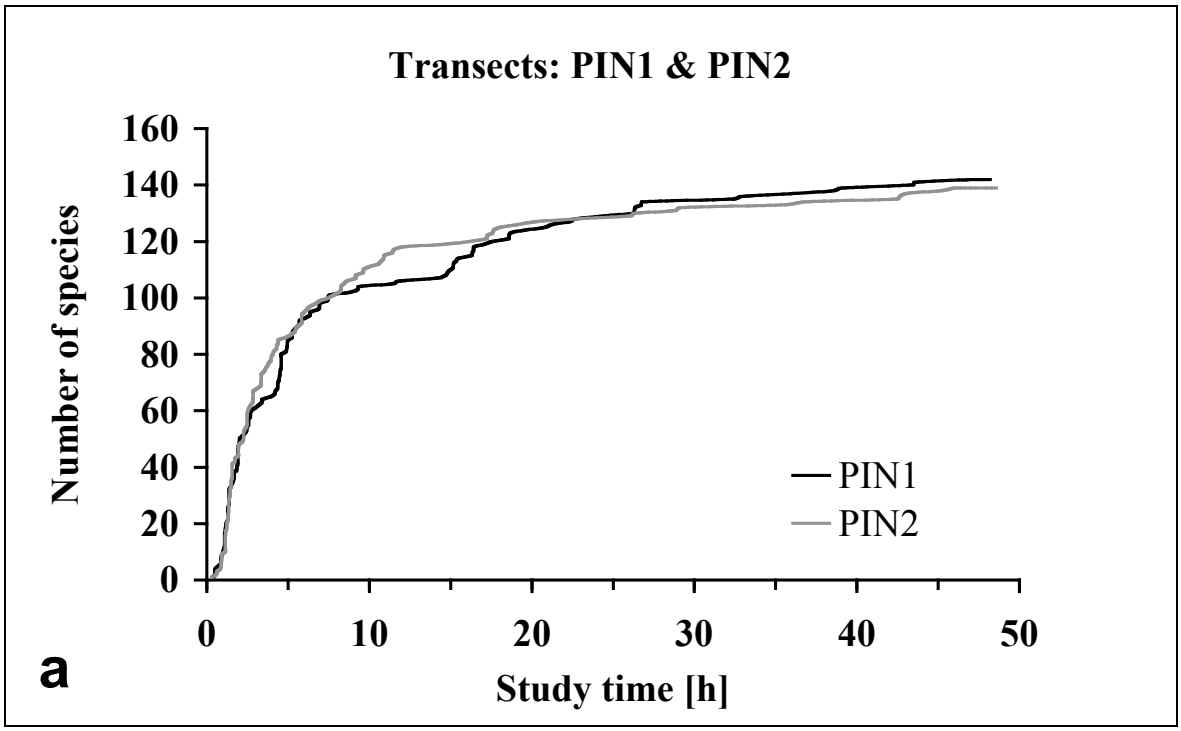
Cardinalidae (3)	**Cardinals and allies (3)**											
Saltator maximus	Buff-throated Saltator								3			
Saltator atripennis	Black-winged Saltator							1	1		3	3
Saltator grossus	Slate-colored Grosbeak			1	1	1		3	3	1	1	1
Emberizidae (10)	**Emberizine Finches (10)**											
Volatinia jacarina	Blue-black Grassquit								3			
Tiaris olivaceus	Yellow-faced Grassquit								3			
Tiaris obscurus	Dull-colored Grassquit								3			
Oryzoborus angolensis	Lesser Seed-Finch								3			
Sporophila corvina	Variable Seedeater							3	3			
Sporophila nigricollis	Yellow-bellied Seedeater								3			
Atlapetes tricolor	Tricolored Brush-Finch						3	1	1	3		3
Buarremon brunneinucha	Chestnut-capped Brush-Finch						1	1	1	1	1	1
Lysurus castaneiceps	Olive Finch						3	1	1		1	1
Arremonops conirostris	Black-striped Sparrow								3			
Icteridae (1)	**American Orioles and allies (1)**											
Cacicus microrhynchus	Scarlet-rumped Cacique				3	3		3	3	1	1	1
Number of species	**315**	**57**	**20**	**144**	**141**	**182**	**84**	**100**	**177**	**73**	**99**	**125**

APPENDIX 3



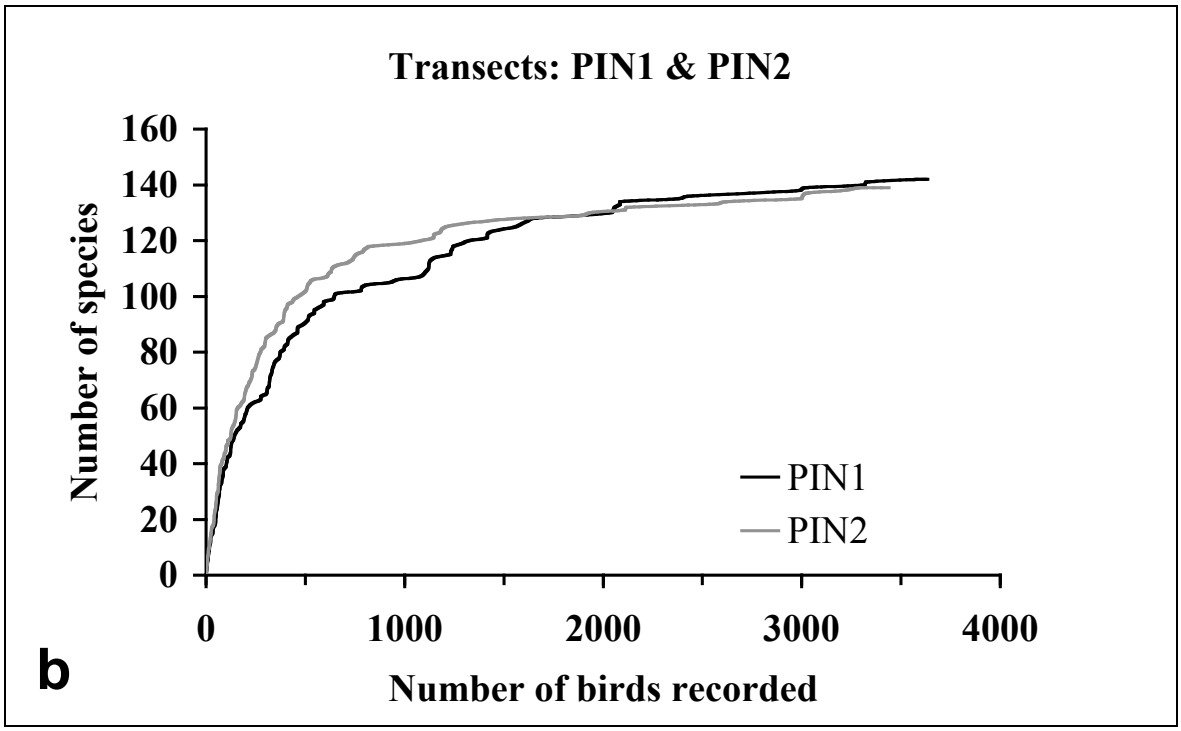
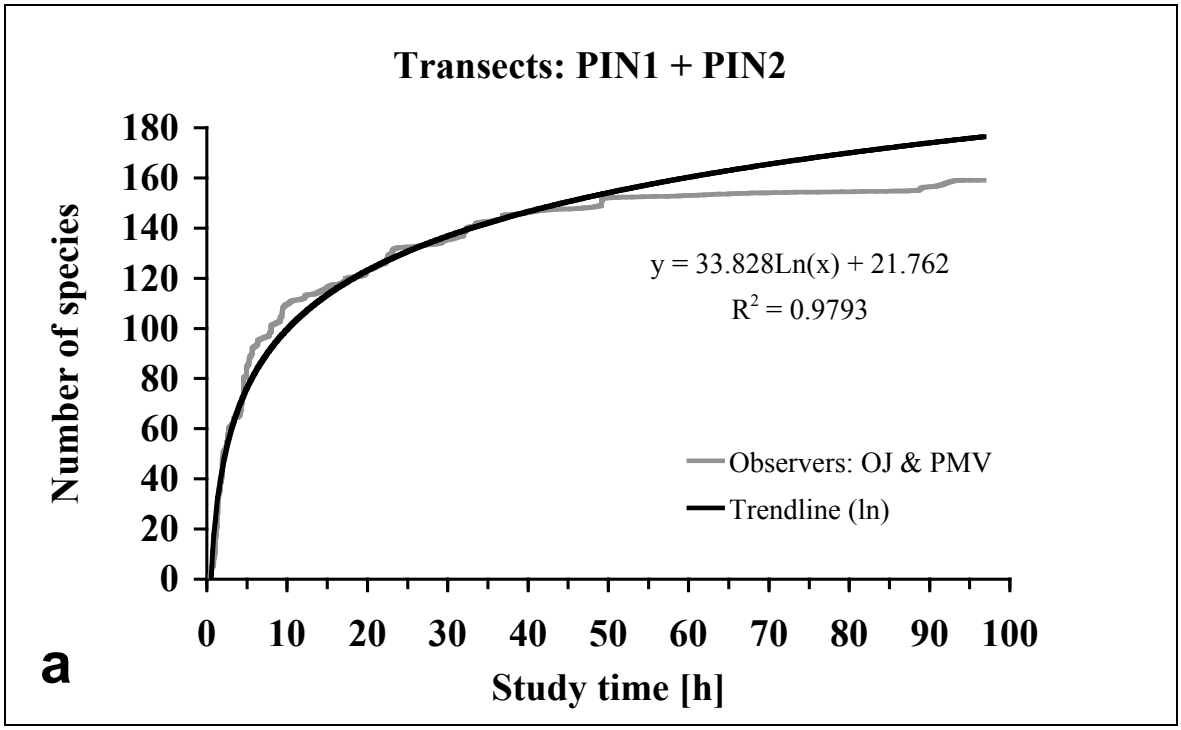


Fig. 1: Comparison of species accumulation during standardized transect-mapping (MTW) surveys at transects PIN1 and PIN2, Estero Pindiupi area, Cotacachi-Cayapas Ecological Reserve; (a) number of species *versus* study time, and (b) number of species *versus* number of 'birds recorded' (raw data, which include an unknown number of repeatedly observed individuals).



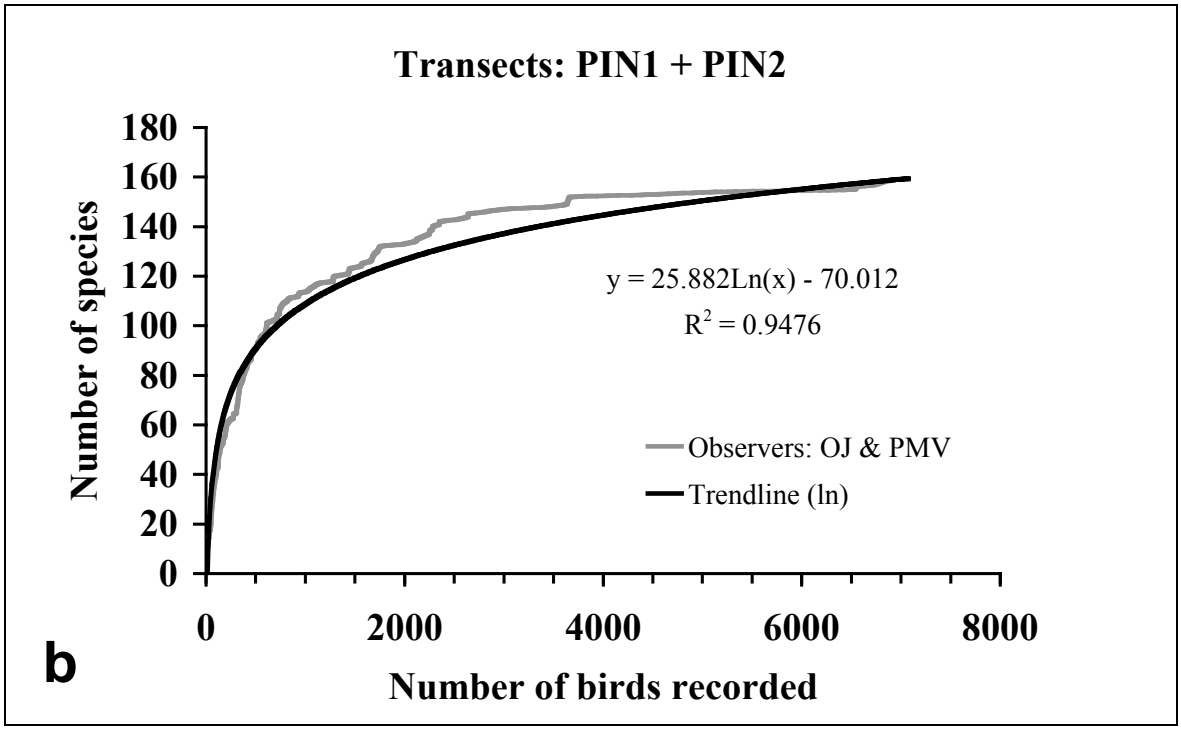


Fig. 2: Species accumulation according to the pooled transect-mapping (MTW) data for transects PIN1 and PIN2, Estero Pindiupi area, Cotacachi-Cayapas Ecological Reserve; (a) number of species *versus* study time, and (b) number of species *versus* number of 'birds recorded'. In both cases a log normal function fits the accumulation curves best.

APPENDIX 4

Fig. 3: The principal researchers, Olaf Jahn (second row, first from left) and Patricio Mena Valenzuela (first row, fourth from left), and their local assistants after arrival at the base camp at Estero Pindiupi inside the Cotacachi-Cayapas Ecological Reserve; altitude: 430 m; 30 Nov. 2005.

Fig. 4: Base camp at Estero Pindiupi inside the Cotacachi-Cayapas Ecological Reserve; altitude: 430 m; Dec. 2005.

Fig. 5: Horse transport of field equipment and food from the community of El Cristal to the base camp in the Río Pachamama valley; Cordillera del Lacha; altitude: *c*. 1700 m; 10 Jan. 2006.

Fig. 6: Base camp at the Río Pachamama; altitude: 1360 m; Jan. 2006.

Fig. 7: Arrival at the base camp after a long horse transport of field equipment and food from the community of El Cristal to the Río Negro Chico; altitude: *c*. 1130 m; 15 Feb. 2006.

Fig. 8: Base camp at the Río Negro Chico; altitude: 1130 m; Feb. 2006.