

Round River Conservation Studies



Integrated Conservation Project: Birds and Habitats



Lomas del Sierpe Report

Costa Rica

January, 2018

Executive Summary

The Osa Peninsula of Costa Rica, despite its limited geographic area, harbors a staggering array of avian diversity, including several endemic and/or threatened species. Round River Conservation Studies (RRCS) has operated a student-based conservation program on the Osa since 2016. Between February and July, 2017, RRCS conducted bird playback and point count surveys on Osa Conservation's (OC) Lomas del Sierpe property, with the goal of comparing avian composition and species' densities to previous work done by OC from 2010-13.

The low and relatively open canopy of its secondary forest, and associated visibility of a wide variety of species, make Lomas well suited for bird observation. Species of note documented in this study include a pair of Royal Flycatchers, Yellow-billed Cotinga, Collared Forest-Falcon (dark morph), Striped Woodhaunter, Great Antshrike, and Turquoise Cotinga. Leks of Stripe-throated Hermit, Long-billed Hermit, Bronzy Hermit, Blue-throated Goldentail, and Red-capped Manakin were common and easily visible from trails. All four species of Trogon that occur on the Peninsula were remarkably easy to find.

Using playback surveys, we recorded four of five species of concern, including Black-cheeked Ant-tanager, Baird's Trogon, Wood Thrush, and Kentucky Warbler, and estimated occupancy rates for these. Due to unforeseen difficulties with sample size, we were unable to estimate detection probabilities for species recorded during point counts; instead we used minimum known densities and Leavelle's detection probabilities to estimate densities for 24 bird species that were observed more than 10 times. Several understory insectivores (a guild of birds undergoing population declines throughout the tropics) appear to be abundant at Lomas del Sierpe, while Great Curassow, Crested Guan, and Great Tinamou (large-bodied species targeted by hunters and also undergoing global population declines) were observed with relative frequency. We provide methodological recommendations that deal with wide ranging and patchily distributed species in hopes of optimizing data collection for future surveys.

Introduction

Quantifying bird populations can provide valuable information on species richness, population trends (including for sensitive and/or vulnerable species), and changes in habitat quality and availability over time. Bird populations are typically measured using either density (the number of individual birds per hectare) or occupancy (the probability a given site is occupied), which are estimated by systematically looking and listening for birds at a number of points or transects within a site. Playbacks of vocalizations are also occasionally used to locate quieter,

less conspicuous species. One important concept in quantifying populations is detection probability, or the probability that a bird, given it is present, is detected by an observer. For example, a study comparing birds in open and forested habitats may find more birds in open habitats simply because birds are easier to see and hear. Detection probability accounts for the ability of the observer to detect birds, allowing for more precise comparisons.

Round River Conservation Studies (RRCS) is a U.S.-based 501(c)(3) organization that employs the principles of conservation biology to formulate strategies that provide our partner communities, organizations, and governments with a well-founded, scientific basis for their long-term conservation efforts. RRCS, in partnership with Osa Conservation (OC), has operated a student-based conservation program in Costa Rica since 2016, with efforts focused on the Osa Peninsula.

Between 2010 and 2013, Karen Leavelle in conjunction with OC completed a baseline avian monitoring study at OC's Lomas del Sierpe, Piro, and other properties, with objectives of inventorying all landbird species and identifying habitat and elevation associations.

Our study builds on these previous efforts, and is intended to make current our understanding of bird populations at Lomas del Sierpe.

Methods

From February 19-24, 2017, RRCS staff and students conducted four-minute playback surveys for "species of conservation concern" (using Leavelle (2013) as a reference) - Black-cheeked Ant-tanager, Baird's Trogon, Wood Thrush, Kentucky Warbler, and Yellow-billed Cuckoo - at 11 points (200m apart) across the southern trail system at Lomas del Sierpe. In addition, from July 8-14, 2017, we performed point counts for the full assemblage of birds, visiting 19 points (250m apart) three times a piece. Only birds within a 100m radius were recorded. A Zoom H2N recorder was used at all points, allowing for postliminary identification of any missed species.

All data were modeled using the package 'Unmarked' in R to estimate densities for species with >10 detections (those with fewer detections had high error surrounding their estimates) and occupancy rates for all species. Initially, we were unable to generate detection probabilities because Unmarked could not accurately estimate maximum likelihoods with our small sample ($n=19$); therefore, we counted the number of individuals encountered at each point, summed these across points, and divided by the total area sampled (i.e., minimum density). We then used Leavelle's detection probabilities to extrapolate densities from these estimates, and make them somewhat comparable to her own. This method is not as precise as

Leavelle's, whose sampling effort was greater - she walked four transects four times each at Lomas and visited 58 points three times each at Piro - but it does provide a reasonable point of comparison.

Figure 1. Map of the Osa Peninsula and locations of Lomas del Sierpe (pink) and Piro (yellow)



Figure 2. Map of 10 sites at Lomas del Sierpe where species of concern playback surveys were conducted in February of 2017

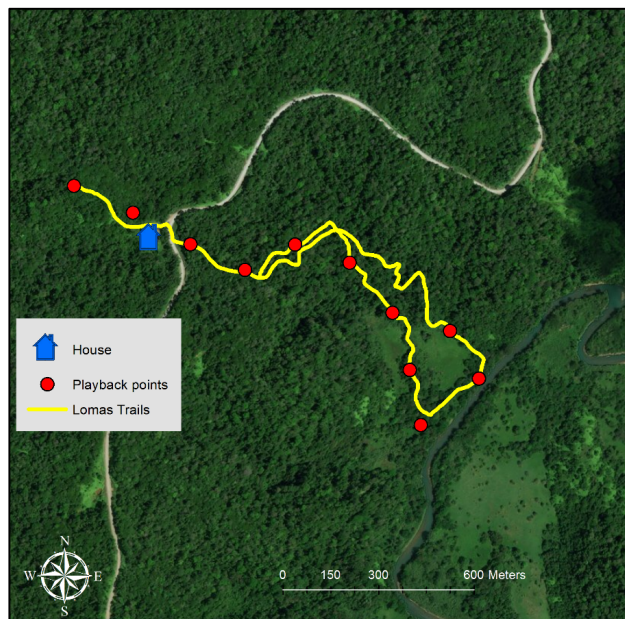
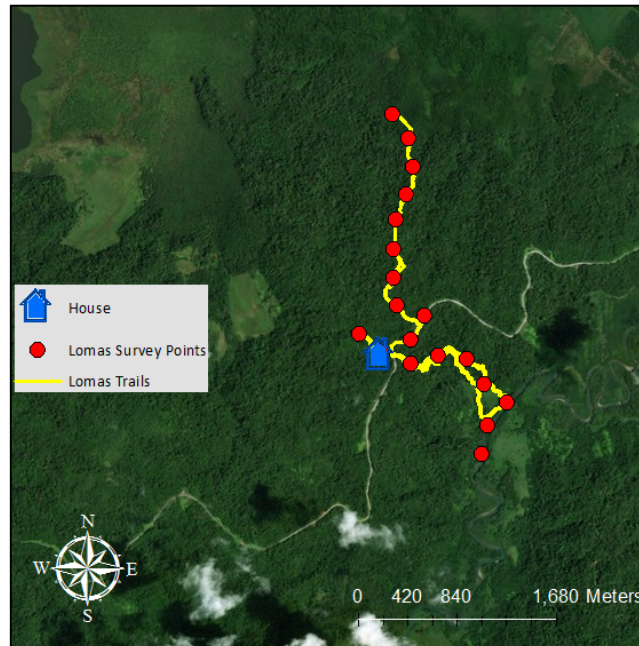


Figure 3. Map of 19 sites at Lomas del Sierpe where point count surveys were conducted in July of 2017



Results

In February of 2017, we encountered four of the five species surveyed for, with only the elusive Yellow-billed Cuckoo going undetected. We observed four individual Kentucky Warbler located in the dense vegetation of the flatland near the Esquinas River, at least eight Baird's Trogon, one Wood Thrush, and at least four groups of Black-cheeked Ant-tanager. Playback was extremely effective for Kentucky Warbler and Wood Thrush, who remained quiet and were never otherwise detected. We several times observed the same Baird's Trogon following us between consecutive points, and so estimated its occupancy using every other point (500m apart) to ensure different individuals were being counted (Table 1).

In July of 2017, we detected 114 species during point count surveys. For 24 species we made enough observations (>10) to estimate densities (Table 2). Including birds observed incidentally, we recorded 26 species not previously reported by Leavelle at Lomas. Several species (e.g., Black-cheeked Ant-tanager and Great Curassow) that were readily observed in February were not readily observed in July (likely because breeding season had passed by July), meaning that densities for these species are likely much higher than what we report. The highest-density species during 2017 point counts were Chestnut-backed Antbird, Yellow-throated Toucan, Scarlet-rumped Cacique, Red-lored Parrot, Cocoa Woodcreeper, and Short-billed Pigeon, all whose approximate densities were above one individual per hectare.

Table 1. Detection probability and occupancy for five species of concern determined using playback surveys. Baird's Trogon* reflects the corrected methodology of using data from every other point

Species	Detection Probability	Occupancy
Black-cheeked Ant-Tanager	0.255	0.284
Kentucky Warbler	0.899	0.273
Baird's Trogon	0.375	1
Baird's Trogon*	0.540	0.820
Wood Thrush	0.316	0.120
Yellow-billed Cuckoo	0	N/A

Table 2. Densities for all species with >10 detections (unless ** noted), estimated by summing the minimum number of individuals present divided by the total area sampled (i.e., minimum density) and employing detection probability estimates from Leavelle (2013)(* denotes estimate derived from Piro)

Species	Total # of individuals detected on all visits	Minimum # of individuals present	Minimum density (individuals /ha)	Leavelle detection probability	Density (this study)	Lomas density (2013)	Piro density (2010-2012)
Baird's Trogon	22	16	0.268	0.63	0.425	0.154	-
Black-faced Antthrush	28	18	0.302	0.502*	0.601	-	0.132
Black-hooded Antshrike	31	22	0.369	0.495	0.745	0.608	0.746
Black-striped Woodcreeper	13	10	0.168	0.679	0.247	0.419	0.563
Blue-black Grosebeak	15	11	0.184	0.352*	0.524	-	0.083
Cherrie's Tanager	10	7	0.117	0.359	0.327	0.781	-
Chestnut-backed Antbird	37	25	0.419	0.215	1.948	2.700	3.960
Cocoa Woodcreeper	10	9	0.151	0.132*	1.142	-	0.878
Golden-naped Woodpecker	13	11	0.184	0.541	0.341	0.334	-
Great Tinamou	20	13	0.218	0.438*	0.497	-	0.068
Little Tinamou	11	10	0.168	0.427*	0.392	-	0.091
Long-billed Hermit	25	15	0.251	0.579	0.434	1.943	-
Pale-billed Woodpecker**	8	8	0.134	0.37*	0.362	-	0.161
Red-capped Manakin	21	13	0.218	0.443	0.492	2.018	2.550
Red-lored Parrot	18	17	0.285	0.225*	1.266	-	-
Riverside Wren	17	8	0.134	0.556	0.241	0.415	0.566
Rufous Piha	22	16	0.268	0.644	0.416	0.339	0.339
Scarlet-rumped Cacique	56	34	0.570	0.439	1.297	0.973	-
Short-billed Pigeon	24	15	0.251	0.234*	1.074	-	0.254
Slaty-tailed Trogon	17	13	0.218	0.286*	0.761	-	0.207
Streak-chested Antpitta	10	8	0.134	-	-	-	-
Tropical Gnatcatcher	15	10	0.168	0.541	0.310	0.769	1.701
White-tipped Dove	12	5	0.084	-	-	-	-
Yellow-throated Toucan	12	11	0.184	0.112*	1.645	-	0.761

Discussion

Species Trends (2013-17)

Although our methodologies and analyses differed somewhat from previous work at Lomas del Sierpe and are based on limited samples (and, therefore, minor differences in species composition and densities cannot be used to infer trends directly), a few broad patterns did emerge.

Several understory insectivores (a guild of birds undergoing population declines throughout the tropics) are apparently abundant at Lomas. Streak-chested Antpitta was one of our 25 most common species, even though Leavelle did not detect them with enough regularity at Lomas to estimate densities. The same is true for Black-faced Antthrush.

Great Curassow, Crested Guan, and Great Tinamou are large-bodied game species that are often poached illegally, and their populations are declining globally (IUCN 2017). Leavelle did not detect Great Curassow at Lomas, and she did not detect Guan nor Tinamou with enough frequency to estimate densities. On the other hand, we observed at least three pairs of Great Curassow and one Curassow nest, two groups (totaling at least nine individuals) of Crested Guan, and a minimum density of Great Tinamou higher than those estimated at Piro. These evidence suggest that measures to control illegal poaching at Lomas have been effective.

Black-bellied wrens are associated with dense, shrubby lowlands and were found by Leavelle in the flat reforestation plots near the Esquinas River. We, however, did not detect a single individual of this loud and distinctive species, which leads us to consider the possibility that this habitat has changed (succeeded) enough in just three years to exclude this species.

Trogon species appear to be much more common at Lomas than Piro, as noted by Leavelle (2013). In that study, Baird's Trogon density at Piro was incalculably low while Slaty-tailed Trogon density was very low. We found both species to be fairly abundant at Lomas. Anecdotally, Black-throated and Gartered Trogons are also much more frequently encountered at Lomas than Piro, based on several hikes taken at the same time of year by C. Smith (RRCS), although neither Leavelle nor this study generated enough data to estimate densities.

Black-cheeked Ant-tanager, an endangered endemic, had only a single individual observed at Lomas in 2013. Meanwhile, we observed at least four groups in February, 2017 while surveying the same areas, suggesting that this endangered species may be increasing in abundance.

Birdwatching

The list of bird species recorded at Lomas del Sierpe now stands at 160, including several rare to the Peninsula or with IUCN status. One of the greatest strengths of Lomas as a birding destination is, perhaps surprisingly, its second growth forest. Second growth tends to be species rich, especially for latitudinal migrants (Blake et al. 2001). RRCS surveyed several other locations of interest for bird tourism throughout the Peninsula in 2017, and the birds at Lomas in its open, low-medium canopy forest were by far the easiest to observe. The station itself sits on a prominent hill, providing excellent birding opportunities throughout the day.

Many hard-to-find species, including Turquoise Cotinga, Yellow-billed Cotinga, Blue Dacnis, Shining Honeycreeper, and Red-legged Honeycreeper, and our largest mixed species flock (with around 35 spp.) were observed from the Lomas station. Aracari, Toucans, Guans, Baird's Trogon, Collared Forest-falcon, and Pale-billed Woodpecker all have resident pairs or groups with territories right around the station. The large Porterweed (*Stachytarpheta* sp.) bushes surrounding the station had over 10 species of hummingbird visiting, including the rare White-crested Coquette and vagrants like the Snowy-bellied Hummingbird. Royal Flycatchers are highly sought after by birdwatchers and are difficult to find on the Peninsula; the presence of a known pair that regularly responded to playback (n=3 of 3) is rare, and would likely be of great interest to birding tours. Other rarities include the Striped Woodhaunter, Striped Coquette, Great Antshrike, and Blue-headed Parrot. Adjacent to the large Red-capped Manakin lek near the viewing platform, there are also leks of Blue-crowned Manakin, Piha, and Long-billed, Bronzy, and Stripe-throated Hermit, which are all easily viewable.

Methodological Considerations

The best time to initiate point counts on the Osa Peninsula appears to be sometime in February or March, when weather has sufficiently dried and birds are moving into full breeding season, yet migrants are still present. In July we did not detect Black-cheeked Ant-tanager, Great Curassow, White-whiskered Puffbird, or Royal Flycatcher, birds which were vocal and found regularly in February. Similarly, there were significantly more Red-capped and Blue-crowned Manakins at leks in February as compared to July (although in July they were still active). Most migrants have left by mid-April, meaning a good portion of the bird community is not available to count thereafter.

Whether to use points or transects is a highly debated topic in bird research. We found that points spread 250m apart missed a large number of individuals, especially those species with clumped distributions (such as ones that lek). Several of our points were located over 50m from

Hummingbird or Manakin leks, making it impossible to get accurate counts. Transect surveys allow observers to get close or move around to better observe leks and therefore more accurately record numbers of individuals, and are also more likely to encounter clumped species.

One of the most important methodological considerations for point counts is whether to use a method that accounts for detection probability. Detection probability on many of Leavelle's counts ranged between 30-50%, while our detection probabilities generally ranged from 15-50%. Detection probability is important if densities are being directly compared between locations or studies. Point count methods that incorporate detection probability include: distance sampling (estimating detection probability using a curve based on distance from a center line), double observer (which requires two observers standing at the same point at the same time to try to match individual birds), time of detection (which divides a single visit into several intervals and records whether a bird is detected during each interval), and repeated counts (either repeating the same count several times on a single visit or repeatedly visiting the same point; Alldredge et al. 2008; Alldredge et al. 2007). These methods may also be combined.

There are two parts to detection probability: the probability that a bird is available for detection and, given it is available, its probability of being detected. Considering the large number of species in our study area that were in mixed species flocks or moved around home ranges much larger than our count radius, assuming all birds were available for detection is unrealistic. In theory, this eliminates distance sampling and double observer counts (which assume all individuals living within a count radius are available for detection), while time of detection is impossible to accomplish for high numbers of detections or flocks containing many individuals of the same species. Widely spaced, repeated counts over several visits is, thus, probably the most robust method available.

The radius at which to limit detections is another important factor. We sampled for six days, four hours per day, and encountered 352 individuals of 85 species at 50m, and 754 individuals of 113 species at 100m. Although estimating birds at 100m is less accurate than 50m, our experience doing playback surveys was that 100m could be used reliably, with observers concurring on whether birds were "in" or "out" at this distance. Estimating exact distances, nevertheless, resulted quite difficult due to the hilly terrain and dense vegetation, suggesting a fixed-radius "in" or "out" approach might be most accurate. Alldredge et al. (2008) drew the same conclusion, even for experienced observers. However, fixed radius counts or transects cannot incorporate detection probability without multiple visits or observers, so lumping birds

into distance bins (e.g., 0-10m, 10-25m, 25-50m, 50-75m, 75-100m) would be an important part of this study design, with four distance bins being the recommended minimum number (L. McNew, personal communication, Nov. 5, 2017). Leavelle uses a protocol which limits detections to 50m and requires estimating the exact distance to each bird, which may not be as accurate as hoped, but avoids binning (which some authors suggest against, though many use in practice). Restricting counts to 50m (with perhaps 10m bins) increases the accuracy of counts (compared to 100m), but decreases the sample size.

For the sorts of models used to analyze count data (N-mixture models), the number of points visited is the effective sample size. Thus, this study, with 19 points (albeit visited 3 times each) had a sample size of 19; for this reason, our models did not converge. At least 30 points are recommended to use this methodology (returning to each site multiple times) for density estimation, at least for the ~25 most common species. If time and space are limited (as in this study), **we believe the most efficient method for collecting future data is using transect distance counts**. Transects maximize the number of birds encountered, while distance sampling allows for incorporation of detection probability. With distance sampling, sample size is the number of detections, not the number of sites, which potentially allows for a much larger sample size than what we utilized.

There are species which are noteworthy for their violation of analytical assumptions. We were told that Scarlet-rumped Caciques often followed observers, and although we did not witness this behavior, their high detection and occupancy rates are likely a byproduct of this. Parakeets and Parrots range widely in flocks and, along with Toucans, are attracted to individual fruiting trees, often moving long distances in between them. It is impossible to know whether we double counted flocks or individuals between points, even within a single day, and whether we counted birds that only transiently occupy the study area, which limits our confidence in the accuracy of estimates for these species.

Conclusions

Lomas del Sierpe harbors a high diversity of birds, with 160 species now documented (only 15 less than Piro), including many rare species. The ease of viewing speaks highly to Lomas' potential as a birdwatching destination. The clearest population trends observed in this study suggest that Black-cheeked Ant-tanager and understory insectivores (Antthrush and Antpitta) may be increasing at Lomas, while commonly-hunted species such as Great Curassow, Crested Guan, and Great Tinamou may be increasing. We suggest future counts use transects of 50 or

100m radius, binning observations into at least four distance bins or using distance to each individual if this can accurately be estimated.

References

Allredge, M.W., Pacifici, K., Simons, T.R. and Pollock, K.H. 2008. A novel field evaluation of the effectiveness of distance and independent observer sampling to estimate aural avian detection probabilities. *Journal of Applied Ecology*, 45(5): 1349-1356.

Allredge, M.W., Pollock, K.H., Simons, T.R., Collazo, J.A. and Shriner, S.A. 2007. Time-of-detection method for estimating abundance from point-count surveys. *The Auk*, 124(2): 653-664.

Blake, J.G., and Loiselle, B.A. 2001. Bird assemblages in second-growth and old-growth forests, Costa Rica: perspectives from mist nets and point counts. *The Auk*, 118: 304-326.

IUCN 2017. *The IUCN Red List of Threatened Species. Version 2017-3*.
<http://www.iucnredlist.org>. Accessed on December 24th, 2017.

Leavelle, K.M. 2013. Avian inventory and monitoring report Lomas de Sierpe, Área de Conservación Osa.

McNew, L. Professor at Montana State University Ecology Department. Personal Communication. November 5th, 2017.

Appendix 1. Occupancy estimates for species with >10 detections, reflecting the probability a bird was present within a 100m radius while observing for 10 minutes. Top AIC model reflects results from a simple model set used to generate the most parsimonious model explaining occupancy for each species. Null=no covariates; Time of day=time from onset of surveys (+ indicates birds occurred later in the day; - indicates earlier in the day); Road=distance to road (as a metric of habitat fragmentation; - indicates birds occurred closer to the road); (River) indicates the species was only found near the Esquinas River

Species	Occupancy	SE	Detection Probability	SE	Top AIC Model
Baird's Trogon	0.999	0.034	0.351	0.064	Null
Black-faced Antthrush	0.872	0.148	0.463	0.097	Null
Black-hooded Antshrike	0.998	0.089	0.404	0.074	Null
Black-striped Woodcreeper	0.765	0.303	0.275	0.124	Null
Blue-black Grosebeak	0.811	0.259	0.320	0.119	Null
Cherrie's Tanager	0.413	0.169	0.382	0.153	Null
Chestnut-backed Antbird	1	0.013	0.439	0.066	Null
Cocoa Woodcreeper	0.994	0.208	0.141	0.055	Null
Golden-naped Woodpecker	0.984	0.418	0.196	0.099	Null
Great Tinamou	0.688	0.156	0.459	0.110	Time of Day (+)
Little Tinamou	0.594	0.472	0.177	0.152	Null
Long-billed Hermit	0.768	0.249	0.320	0.119	Null
Pale-billed Woodpecker	0.999	0.026	0.105	0.040	Null
Red-capped Manakin	0.413	0.169	0.382	0.153	Null
Red-lored Parrot	0.994	0.208	0.141	0.055	Null
Riverside Wren	0.266	0.102	0.793	0.110	Null
Rufous Piha	0.474	0.136	0.518	0.125	Null
Scarlet-rumped Cacique	0.886	0.093	0.634	0.079	Time of Day (-)
Short-billed Pigeon	0.614	0.138	0.543	0.110	Null
Slaty-tailed Trogon	0.889	0.287	0.296	0.112	Road (-)
Streak-chested Antpitta	0.653	0.337	0.242	0.137	Null
Tropical Gnatcatcher	0.551	0.184	0.382	0.133	Null
White-tipped Dove	0.158	0.084	0.888	0.107	Null (River)
Yellow-throated Toucan	0.862	0.698	0.150	0.132	Null

Appendix 2. List of resident and migrant bird species documented at Lomas del Sierpe, 2010-2017 (including by OC). Status represents the likelihood of birds being encountered in 2017: C=common (likely to locate in a 4 hr. walk); U=uncommon (likely to take 2-3 days to locate); R=rare (likely to take >5 days to locate). 2010-13 and 2017 represent whether the species was recorded by Leavelle (2010-13) or RRCS (2017), respectively. Species identified as priority/indicator species by Leavelle are labeled as follows: VU=vulnerable; NT=near threatened; EN=Endangered; Highlighted species are those which were first identified during this study

Common Name	Family	Scientific Name	Status	2010-13	2017	2017 Notes
Amazon Kingfisher	Alcedinidae	Chloroceryle amazona	U		Y	
Baird's Trogon (NT)	Trogonidae	Trogon bairdii	C	Y	Y	
Bananaquit	Parulidae	Coereba flaveola	C	Y	Y	
Bicolored Antbird	Thamnophilidae	Gymnopithys leucaspis	U	Y	Y	
Black Swift	Apodidae	Cypseloides niger	U	Y		
Black Vulture	Cathartidae	Coragyps atratus	C	Y	Y	Incidental at station
Black-bellied Wren	Troglodytidae	Thryothorus fasciatoventris	R*	Y		
Black-cheeked Ant-Tanager (EN)	Thraupidae	Habia atrimaxillaris	U	Y	Y	4 groups
Black-crowned Tityra	Tityridae	Tityra inquisitor	U	Y	Y	Incidental at station
Black-faced Antthrush	Formicariidae	Formicarius analis	C	Y	Y	
Black-hooded Antshrike	Thamnophilidae	Thamnophilus bridgesi	C	Y	Y	
Black-striped Sparrow	Emberizidae	Arremonops conirostris	C	Y	Y	
Black-striped Woodcreeper	Furnariidae	Xiphorhynchus lachrymosus	C	Y	Y	
Black-throated Trogon	Trogonidae	Trogon rufus	C	Y	Y	
Blue Dacnis	Thraupidae	Dacnis cayana	U	Y	Y	Incidental at station
Blue Ground-Dove	Columbidae	Claravis pretiosa	C	Y	Y	
Blue-black Grosbeak	Cardinalidae	Cyanocopsa cyanoides	C	Y	Y	
Blue-crowned Manakin	Pipridae	Pipra coronata	C-U	Y	Y	
Blue-gray Tanager	Thraupidae	Thraupis episcopus	C	Y	Y	
Blue-headed Parrot	Psittacidae	Pionus menstruus	R		Y	Incidental at station
Blue-throated Goldentail	Trochilidae	Hylocharis eliciae	U		Y	Lek by station
Boat-billed Flycatcher	Tyrannidae	Megarhynchus pitangua	C	Y	Y	
Bright-rumped Attila	Tyrannidae	Attila spadiceus	C	Y	Y	
Bronzy Hermit	Trochilidae	Glaucis aenea	C	Y	Y	
Brown-hooded Parrot	Psittacidae	Pionopsitta haematotis	U	Y	Y	
Buff-rumped Warbler	Parulidae	Myiothlypis fulvicauda	U		Y	
Buff-throated Foliage-gleaner	Furnariidae	Automolus ochrolaemus	U	Y		
Buff-throated Saltator	Cardinalidae	Saltator maximus	C	Y	Y	

Charming Hummingbird	Trochilidae	Amazilia decora	C	Y	Y	
Cherrie's Tanager	Thraupidae	Ramphocelus costaricensis	C	Y	Y	
Chestnut-backed Antbird	Thamnophilidae	Myrmeciza exsul	C	Y	Y	
Cocoa Woodcreeper	Furnariidae	Xiphorhynchus susurrans	C	Y	Y	
Collared Forest-Falcon	Falconidae	Micrastur semitorquatus	U	Y	Y	Pair, including dark morph female heard regularly from station
Common Tody-Flycatcher	Tyrannidae	Todirostrum cinereum	C		Y	
Common Pauraque	Caprimulgidae	Nyctidromus albicollis	U	Y	Y	Heard at night near station
Common Potoo	Nyctibiidae	Nyctibius griseus	R		Y	Heard at night near station
Costa Rican Swift	Apodidae	Chaetura fumosa	U	Y	Y	
Crested Guan	Cracidae	Penelope purpurascens	U	Y	Y	
Crested Owl	Strigidae	Lophotrix cristata	R	Y	Y	Incidental by waterfall
Crimson-fronted Parakeet	Psittacidae	Aratinga finschi	C	Y	Y	
Crowned Woodnymph	Troglodytidae	Thalurania colombica	U	Y	Y	
Dot-winged Antwren	Thamnophilidae	Microrhophias quixensis	U	Y	Y	
Double-toothed Kite	Accipitridae	Harpagus bidentatus	R	Y		
Dusky-capped Flycatcher	Tyrannidae	Myiarchus tuberculifer	C	Y	Y	
Elegant Euphonia	Fringillidae	Euphonia elegantissima	R	Y		
Fiery-billed Aracari	Ramphastidae	Pteroglossus frantzii	C	Y	Y	
Gartered Trogon	Trogonidae	Trogon caligatus	C	Y	Y	
Golden-crowned Spadebill	Tyrannidae	Platyrinchus coronatus	U	Y		
Golden-hooded Tanager	Thraupidae	Tangara larvata	C	Y	Y	Often at station
Golden-naped Woodpecker	Picidae	Melanerpes chrysauchen	C	Y	Y	
Gray Hawk	Accipitridae	Asturina nitidus	R	Y		
Gray-chested Dove	Columbidae	Leptotila cassini	C	Y	Y	
Gray-cowled Wood-Rail	Rallidae	Aramides cajanea	C	Y	Y	Incidental by Esquinas River
Gray-headed Kite	Accipitridae	Leptodon cayanensis	R	Y		
Gray-headed Tanager	Thraupidae	Eucometis penicillata	U	Y		
Great Antshrike	Thamnophilidae	Taraba major	R		Y	2 pair by Esquinas River
Great Blue Heron	Ardeidae	Ardea herodias	R	Y		
Great Curassow (VU)	Cracidae	Crax rubra	U		Y	3 pair observed, including 2 depredated

						eggs on trail
Great Kiskadee	Tyrannidae	Pitangus sulphuratus	C	Y	Y	
Great Tinamou	Tinamidae	Tinamus major	C	Y	Y	
Green Honeycreeper	Thraupidae	Chlorophanes spiza	C	Y	Y	
Green Kingfisher	Alcedinidae	Chloroceryle americana	C		Y	
Green Shrike-Vireo	Vireonidae	Vireolanius pulchellus	U	Y	Y	
House Wren	Troglodytidae	Troglodytes aedon	C	Y	Y	
King Vulture	Cathartidae	Sarcoramphus papa	R	Y	Y	Incidental from station
Laughing Falcon	Falconidae	Herpetotheres cachinnans	U	Y	Y	Incidental near station
Lesser Greenlet	Vireonidae	Hylophilus decurtatus	C	Y	Y	
Lesson's Motmot	Momotidae	Momotus lessonii	U	Y	Y	
Lineated Woodpecker	Picidae	Dryocopus lineatus	U	Y	Y	
Little Tinamou	Tinamidae	Crypturellus soui	C	Y	Y	
Long-billed Gnatwren	Sylviidae	Ramphocaenus melanurus	R	Y		
Long-billed Hermit	Trochilidae	Phaethornis longirostris	C	Y	Y	
Long-billed Starthroat	Trochilidae	Heliomaster longirostris	R	Y		
Long-tailed Woodcreeper	Furnariidae	Deconychura longicauda	R	Y	Y	
Marbled Wood-Quail	Odontophoridae	Odontophorus gujanensis	U	Y	Y	
Masked Tityra	Tityridae	Tityra semifasciata	C	Y	Y	Often at station
Mealy Parrot	Psittacidae	Amazona farinosa	C	Y	Y	
Northern Barred-Woodcreeper	Furnariidae	Dendrocolaptes sanctithomae	C	Y	Y	
Northern Bentbill	Tyrannidae	Oncostoma cinereigulare	U	Y	Y	
Northern Schiffornis	Tyrannidae	Schiffornis veraepacis	R		Y	
Northern Scrub-Flycatcher	Tyrannidae	Sublegatus arenarum	R	Y		
Ochre-bellied Flycatcher	Tyrannidae	Mionectes oleagineus	U	Y	Y	
Orange-billed Sparrow	Emberizidae	Arremon aurantirostris	C	Y	Y	
Orange-chinned Parakeet	Psittacidae	Brotogeris jugularis	C	Y	Y	
Orange-collared Manakin	Pipridae	Manacus aurantiacus	R	Y		
Ornate Hawk-Eagle	Accipitridae	Spizaetus ornatus	R		Y	Hunting Guans on north transect
Oropendola sp.	Icteridae	Psarcolius sp.	R		Y	Nest found near Esquinas River
Pale-billed Woodpecker	Picidae	Campephilus guatemalensis	C		Y	Pair by station evicted Golden-naped Woodpeckers from nest

Palm Tanager	Thraupidae	Thraupis palmarum	C	Y	Y	
Paltry Tyannulet	Tyrannidae	Zimmerius vilissimus	C	Y	Y	
Piratic Flycatcher	Tyrannidae	Legatus leucophaeus	C	Y	Y	
Plain Antvireo	Thamnophilidae	Dysithamnus mentalis	R		Y	
Plain Wren	Troglodytidae	Thryothorus modestus	U	Y	Y	
Plain Xenops	Furnariidae	Xenops minutus	U	Y	Y	
Purple-crowned Fairy	Trochilidae	Heliodytes barroti	R	Y	Y	
Red-billed Pigeon	Columbidae	Patagioenas cayennensis	R		Y	
Red-capped Manakin	Pipridae	Pipra mentalis	C	Y	Y	
Red-crowned Woodpecker	Picidae	Melanerpes rubricapillus	U	Y		
Red-legged Honeycreeper	Thraupidae	Cyanerpes cyaneus	U	Y	Y	
Red-lore Parrot	Psittacidae	Amazona autumnalis	C	Y	Y	
Red-rumped Woodpecker	Picidae	Veniliornis kirkii	R		Y	
Riverside Wren	Troglodytidae	Thryothorus semibadius	C	Y	Y	
Roadside Hawk	Accipitridae	Buteo magnirostris	C	Y	Y	
Rose-throated Becard	Tityridae	Pachyramphus aglaiae	R	Y		
Royal Flycatcher	Tyrannidae	Rhynchocyclus brevirostris	U		Y	Pair observed near Esquinas River: N8° 45.636' W83° 17.289'
Ruddy Quail-Dove	Columbidae	Geotrygon montana	C	Y	Y	
Rufous Mourner	Tyrannidae	Rhytipterna holerythra	U	Y	Y	
Rufous Piha	Cotingidae	Lipaugus unirufus	C	Y	Y	
Rufous-tailed Jacamar	Galbulidae	Galbula ruficauda	U	Y	Y	
Rufous-winged Woodpecker	Picidae	Piculus simplex	U	Y	Y	Incidental near Esquinas River
Scale-crested Pygmy-Tyrant	Tyrannidae	Lophotriccus pileatus	U	Y	Y	
Scaly-breasted Wren	Troglodytidae	Microcerculus marginatus	U	Y	Y	
Scarlet Macaw	Psittacidae	Ara macao	C	Y	Y	
Scarlet-rumped Cacique	Icteridae	Cacicus uropygialis	C	Y	Y	
Shining Honeycreeper	Thraupidae	Cyanerpes lucidus	U	Y	Y	
Short-billed Pigeon	Columbidae	Patagioenas nigrirostris	C	Y	Y	
Slaty Spinetail	Furnariidae	Synallaxis brachyura	R	Y		
Slaty-tailed Trogon	Trogonidae	Trogon massena	C	Y	Y	
Snowy-bellied Hummingbird	Trochilidae	Amazilia edward	R		Y	1 visual at station's Porterweed shrubs
Social Flycatcher	Tyrannidae	Myiozetetes similis	C	Y	Y	
Southern Rough-winged Swallow	Hirundinidae	Stelgidopteryx ruficollis	U	Y		

Spectacled Owl	Strigidae	Pulsatrix perspicillata	R		Y	Heard at night near station
Spot-crowned Euphonia	Fringillidae	Euphonia imitans	U	Y	Y	
Spotted Woodcreeper	Furnariidae	Xiphorhynchus erythropygius	U	Y	Y	
Squirrel Cuckoo	Cuculidae	Piaya cayana	U	Y	Y	
Streaked Flycatcher	Tyrannidae	Myiodynastes maculatus	U	Y	Y	Incidental by Esquinas River
Striped Owl	Strigidae	Pseudoscops Clamator	U	Y		
Striped Woodhaunter	Furnariidae	Hyloctistes subulatus	R		Y	Pair observed on north transect
Stripe-throated Hermit	Trochilidae	Phaethornis striigularis	C	Y	Y	
Sulphur-bellied Flycatcher	Tyrannidae	Myiodynastes luteiventris	U	Y		
Swallow-tailed Kite	Accipitridae	Elanoides forficatus	U	Y	Y	Incidental from station
Tawny-winged Woodcreeper	Furnariidae	Dendrocincla anabatina	U	Y	Y	
Thick-billed Seed-Finch	Emberizidae	Oryzoborus funereus	U	Y	Y	
Thrush-like Schiffornis	Tityridae	Schiffornis turdinus	R	Y		
Tropical Gnatcatcher	Sylviidae	Polioptila plumbea	C	Y	Y	
Tropical Kingbird	Tyrannidae	Tyrannus melancholicus	C	Y	Y	
Turkey Vulture	Cathartidae	Cathartes aura	C	Y	Y	Incidental near station
Turquoise Cotinga (VU)	Cotingidae	Cotinga ridgwayi	R	Y	Y	Incidental from station
Variable Seedeater	Emberizidae	Sporophila americana	C	Y	Y	
Violet Sabrewing	Trochilidae	Campylopterus hemileucurus	R	Y		
Violet-headed Hummingbird	Trochilidae	Klais guimeti	U		Y	
Wedge-billed Woodcreeper	Furnariidae	Glyphorhynchus spirurus	U	Y	Y	
White-crested Coquette	Trochilidae	Lophornis adorabilis	U		Y	Incidental from station
White-crowned Parrot	Psittacidae	Pionus senilis	U	Y		
White-lined Tanager	Thraupidae	Tachyphonus rufus	U	Y	Y	Incidental from station
White-necked Jacobin	Trochilidae	Florisuga mellivora	U		Y	Incidental from station
White-necked Puffbird	Bucconidae	Notharchus macrorhynchos	U	Y	Y	Incidental from far canopy tower
White-shouldered Tanager	Thraupidae	Tachyphonus luctuosus	U	Y		
White-throated Shrike-Tanager	Thraupidae	Lanio leucothorax	U	Y		
White-throated Thrush	Turdidae	Turdus assimilis	U	Y		
White-tipped Dove	Columbidae	Leptotila verreauxi	C	Y	Y	
White-vented Euphonia	Fringillidae	Euphonia minuta	U		Y	
White-winged Becard	Tityridae	Pachyramphus polychopterus	U	Y		

Wood Thrush	Turdidae	Hylocichla mustelina	R	Y	Y	
Yellow Tyrannulet	Tyrannidae	Capsiempis flaveola	R		Y	
Yellow-billed Cotinga (EN)	Cotingidae	Carpodectes nitidus	R		Y	Female or juvenile male seen from station in mixed spp. flock
Yellow-crowned Euphonia	Fringillidae	Euphonia luteicapilla	U	Y		
Yellow-green Vireo	Vireonidae	Vireo flavoviridis	U	Y		
Yellow-headed Caracara	Falconidae	Milvago chimachima	U		Y	
Yellow-olive Flycatcher	Tyrannidae	Tolmomyias sulphureus	U	Y		
Yellow-throated Toucan	Ramphastidae	Ramphastos ambiguus	C	Y		