Monitoring Key Biodiversity Indicator Species in Southwestern El Salvador: Changes in Bird Populations during Five Years in the Apaneca Biological Corridor

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Contents

Abstract

One of the primary purposes of biodiversity conservation programs is to maintain stable populations of both threatened and non-threatened species. Knowing the current status of bird populations through long term monitoring projects is vital in determining population trends over time, evaluating the success of existing conservation programs, as well as identifying conservation priorities. Five years ago, the virtual absence of abundance information for forest bird species in El Salvador inspired the development of the Permanent Bird Monitoring Program. Since the Program's inception, data have been collected for 151 species across the southwestern Apaneca region of El Salvador. Monitoring was conducted at three monitoring stations, which covered three habitat types: dry forest (El Imposible), cloud forest (Los Volcanes), and shade grown coffee plantation (Finca Nuevos Horizontes). Linear regression was used to evaluate temporal trends over a 5 year period for 87 species that have each been detected at least 10 times in the monitoring stations. Analysis of data resulting from this program has identified 22 declining species, and 1 increasing species. The dry forest site of El Imposible contained the most stable bird populations (90% stable), while the cloud forest populations of Los Volcanes were found to be intermediately so (79% stable), and the coffee plantation site was found to have the least stable populations (69% stable). Insectivore and neotropical migratory species appear to be suffering the worst declines. Of the neotropical migratory species found to be in decline in El Salvador, six were also found to be experiencing declines in their North American breeding grounds. In addition to providing base knowledge of the status of bird populations, this analysis will permit more accurate evaluations of threatened status in future reevaluations of national Red List status for El Salvador birds.

Introduction

In the species-rich tropics large percentages of deforestation and forest fragmentation have caused increased concern for the condition of remaining habitat and the species that live there. High rates of forest conversion, mainly for agriculture and urban development, are occurring in Mexico, Central America, and the Caribbean. Land resources are especially scarce in the densely populated country of El Salvador, where little natural forest cover remains.

Long-term species monitoring has been used extensively in North America and Europe as a litmus test for conservation success (Peach 1996, Sauer 2008), however it has not yet been put to use widely in the tropics and especially Central America. The status of bird populations is often used as an indicator of ecosystem health (Morrison 1986, Hutto 1998). Knowledge of the direction, magnitude, and location of changes in bird populations is essential to prioritize the focus of conservation efforts. Many studies have shown the neomigratory species that migrate from South and Central America to North America to breed are experiencing severe declines (Robbins et al. 1989, Askins et al. 1990, Finch 1991, State of the Birds 2009). Conversion of the land from forests to an increasingly agricultural and urban landscape is adversely affecting both resident and migratory bird species.

El Salvador is often overlooked as an important area of biodiversity conservation because of its small size, extensive deforestation (18% forest cover remaining), and extremely dense human population. For these reasons combined with political instability (a civil war which lasted from 1980-1992) it has in the past been avoided by most foreign ecological researchers, and local biological expertise has been slow to develop. However, in the past decade, environmental awareness and education on the importance of conservation, has grown in large part due to the efforts of SalvaNATURA and the Ministry of the Environment.

Biodiversity can be related to a diversity of habitats (Hamilton et al. 1964, Johnson 1975). El Salvador has a diverse mosaic of habitats, caused by the volcanic geography of the region and an elevational range between 0-2730 m. Currently 508 species of birds have been identified in El Salvador, which makes conserving its remaining natural habitats an important part of overall biodiversity conservation in the Central American region (Komar 1998).

The purpose of this study is to determine changes in bird populations in El Salvador under the auspices of SalvaNATURA in collaboration with USAID's Improved Management and Conservation of Critical Watersheds (IMCW) Project. SalvaNATURA, founded 14 years ago, is El Salvador's largest non-profit conservation organization. SalvaNATURA works with both governmental and private entities to protect and restore natural areas. The organization has developed a unique co-management system with governmental institutions, including the Ministry of the Environment, to manage the natural areas of El Salvador such as, El Imposible, Los Volcanes, and Montecristo National Parks.

USAID's Improved Management and Conservation of Critical Watersheds (IMCW) Project has supported SalvaNATURA's permanent bird monitoring program at El Imposible and Los Volcanes National Parks since the inception of the IMCW's Project activities in December 2006. The relative abundance of key species, including migratory bird species and indicator species for high quality habitats (such as the locally threatened Northern Bentbill, *Oncostoma cinereigulare*) have been monitored monthly through this program, generating the first estimates of population trends in El Salvador for 87 terrestrial bird species, and gathering additional data (potentially useful in future analyses) for another 95 bird species. Furthermore, during the first and second years of the Project, staff and consultants have provided hands-on field training in bird identification, bird monitoring techniques, and data analysis techniques for eight local

university biology students as well as for parks staff, SalvaNATURA science staff, and members of local communities near the monitoring stations, thereby strengthening national capacity for monitoring biodiversity. The local university students include four students from the University of El Salvador, School of Biology who have been hired by SalvaNATURA as monitoring and/or inventory technicians, another earning social service credit, and three additional volunteer biology students.

By analyzing population changes over the five year study period and across the three study sites, I have examined where population sizes are changing, by how much they are changing, which particular species are in need of most attention, and what habitats exhibit the most diversity and/or stability. The results from this analysis will lead to future research, examining the cause of certain species' decline/increase and determining conservation priorities and strategies. Herein, I present an analysis of five years of monitoring data for bird populations at three sites in the Apaneca corridor, including monitoring stations at El Imposible National Park, Los Volcanes National Park, and an Izalco coffee plantation located in the buffer zone of the latter park.

North American Connection

Analyses of data from the North American Breeding Bird Survey (BBS) indicate that populations of many species of Neotropical-wintering migratory birds, which breed in North America during the summer months have declined over the past three decades (Robbins et al. 1989, Terborgh 1989, Peterjohn and Sauer 1993, Pardiek and Sauer 2000). In response to these declines, major conservation efforts such as the Neotropical Migratory Bird Conservation Initiative, Partners in Flight (PIF); the North American Bird Conservation Initiative (NABCI); and the Neotropical Migratory Bird Conservation Act (NMBCA) were established. While these programs have been

major steps forward, they have been held back by a lack of information concerning causes of declines that may originate in the neotropics.

The permanent monitoring project established by SalvaNATURA is a cooperative effort with the MoSI (Monitoreo de Sobrevivencia Invernal) Project; an international project begun in the winter of 2002-03. The purpose of this international effort is to assess habitat-specific overwintering survival of Neotropical Migratory landbirds. The MoSI project is being conducted in conjunction with the MAPS (monitoring avian productivity and survivorship) project, so that data from the wintering grounds can be compared to that of the breeding grounds, and better management programs can be created to better protect birds in both ranges. MAPS is a cooperative effort among public agencies, private organizations, and individual bird banders in the U.S. and Canada to operate a network of over 500 standardized, constant effort mist-netting and bird-banding stations during the breeding season. The monitoring goals of MoSI are to provide estimates of habitat, age, and annual and seasonal (overwintering) survival rates, population sizes, and population trends. Recent evidence suggests that population declines in many Neotropical-wintering migratory landbird species may be in part caused by habitat loss and degradation on their wintering grounds. Such habitat loss and degradation can lower overwintering survival rates and cause surviving birds to leave their wintering grounds in poor physical condition, leading to high mortality during spring migration and low breeding productivity. Large-scale, long-term data on winter demographic parameters of these species and linkages between those parameters and winter habitat characteristics are urgently needed to understand the population dynamics of these migratory landbirds and guide management and conservation efforts for them. The MoSI (Monitoreo de Sobrevivencia Invernal) Program was established to fill this data gap.

Description of Bird Monitoring Stations

The three stations are located in Apaneca region of southwestern El Salvador, within the El Imposible and Los Volcanes national parks (Fig. 1). Each station occupies an area within a patch of homogeneous habitat larger than 12 (ha), following the Institute for Bird Population protocol. In reality, each station occupies 6–8 ha within much larger patches of homogeneous habitat, ranging from 70 to 900 ha.

Figure 1. Location of monitoring sites in the Apaneca region of El Salvador.

Table 1. Habitat type of study sites

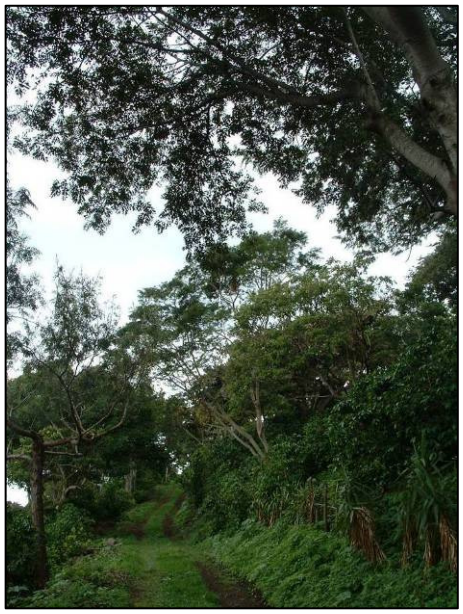
Site	Habitat Type
Nuevos Horizontes	Certified Shade Coffee Plantation
El Imposible	Dry Forest
Los Volcanes	Cloud Forest

The **El Imposible station** (Fig. 2) is located in second-growth semi-deciduous woodland, formerly occupied by a traditional rustic coffee plantation (with abundant native shade trees) abandoned in 1974. The altitude is 750 m above sea level, and the habitat patch, roughly estimated to be 200 ha in size, is contiguous with extensive natural forest of nearly 5000 ha.

Figure 2**.** Walter Thurber research cabin, at El Imposible National Park, used by SalvaNATURA biologists as the base station for bird monitoring.

Figure 3. Biologists processing birds at the Los Volcanes cloud forest monitoring station. Photos by Lety Andino/ SalvaNATURA Archive.

Los Volcanes cloud forest station is located in Sector Los Andes, Parque Nacional Los Volcanes. This cloud forest patch was part of a 900-ha cloud forest until October 2005, when an explosive eruption altered much of the volcano's cloud forest. Remarkably, the monitoring parcel was largely unaffected, and still is part of a homogeneous patch of several hundred hectares. The midpoint altitude is approximately 2100 m above sea level. The monitoring parcel contains steep terrain on the upper north-facing slope of the Santa Ana volcano, 1.5 km from the summit crater (Fig. 3).



The coffee plantation station at **Finca Nuevos Horizontes** in the Izalco municipality (Fig. 4) is found within the buffer zone of Los Volcanes National Park at 1150 m above sea level. Coffee is cultivated in the understory, beneath the shade of diverse species of trees and over ashy soil formed by the eruptions of the Izalco volcano. Use of agrochemicals is moderate.

Figure 4. Shaded Coffee Plantation.Photo by Jesse Fagan/SalvaNATURA Archive.

Methods

Since the establishment of the bird monitoring stations in November 2003, the Monitoreo de Sobrevivencia Invernal (MoSI) protocol has been used for bird capture and data collection; in cooperation with the Institute for Bird Populations (IBP). The protocol consists of visiting each station once each month for the duration of three days, and opening a set of 16 standard, 36 mm mesh, black nylon, 12-m long mist nets. The nets are open for approximately 400 net-hours ((number of nets) x (number of hours each day)x (number of days)) each month at each station

(Desante et. al 2007). Factors such as weather sometimes limit the number of net hours available during each netting effort. Because of this the number of captures is adjusted to reflect the number of captures expected in a 400 net-hour effort. The nets are located in the same places each month (Fig. 5). One exception to the MoSI protocol is that the nets are operated every month of the year, not just in the winter months (Desante et. Al 2007). The nets are kept open all day, from dawn to dusk, and are checked hourly to avoid trapped birds suffering from exposure to excessive sun, rain, or predators (Figs. 6 and 7). The trapped birds are identified and processed: data on weight, wing-chord length, age, sex, molt, and breeding condition are recorded. Migratory birds are marked with a uniquely-numbered aluminum leg band, and resident birds are marked with numbered plastic leg bands (Figs. 8 and 9). The birds are then released.

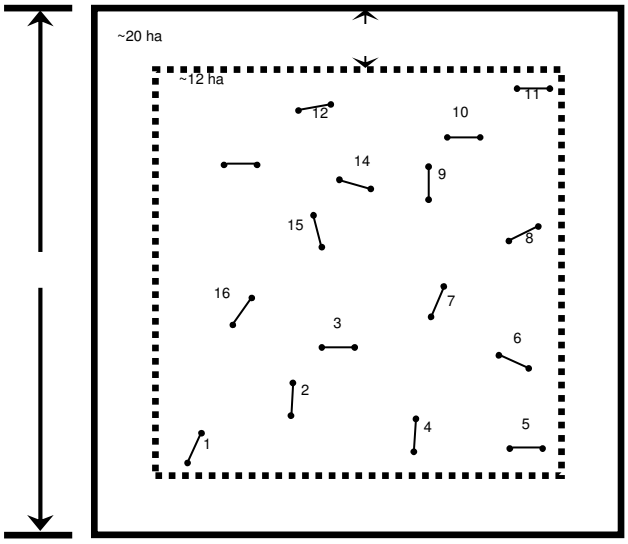


Figure 5. Example of net distribution as described in the Institute for Bird Populations protocol, covering 12 ha within a homogeneous vegetation patch of at least 20 ha.

Figure 6. Long-tailed Manakin (*Chiroxiphia linearis*) trapped in a mist net at El Imposible monitoring station. Photo by Peter Pyle/ SalvaNATURA Archive.

Figure 7. A student volunteer of the bird monitoring project extracts a bird from a mist net at El Imposible National Park. Photo by Jorge Jiménez/ SalvaNATURA Archive.

Figure 8. A migratory bird with an aluminum leg band. Photo by Peter Pyle/ SalvaNATURA Archive.

Figure 9. Long-tailed Manakin (*Chiroxiphia linearis*)*, a resident bird, with a plastic numbered leg band.* Photo by Peter Pyle/ SalvaNATURA Archive.

Analyses

Monthly detections (birds caught in the mist nets per 400 net hours) for each bird species detected at least ten times over the five years, were analyzed as response variables against a temporal trend. If captured ten or more times at one site, species were also analyzed at the site level. The response variables (number of captures) were deseasonalized using time series decomposition in order to control for the influence of seasonality on capture rates during different seasons of the year.

Additional response variables were formed by grouping species with similar life history traits, migrants, residents; and feeding guilds, nectarivores, insectivores, frugivores, granivores, omnivores, carnivores. Very few species in the study have both long-distance migratory and resident populations, and these were generally treated as migrants. They include Brown-crested Flycatcher (*Myiarchus tyrannulus*), Yellow-green Vireo (*Vireo flavoviridis*) and Sulphur-bellied Flycatcher (*Myiodynastes luteiventris*). However, some resident species in El Salvador were only present at some sites in the non-breeding season, and may be in fact local migrants, perhaps altitudinal migrants. These were treated as residents, and include Slate-throated Redstart (*Myioborus miniatus*) and Fan-tailed Warbler (*Euthlypis lachrymosa*) which seem to winter in the coffee plantation. For assignation of migratory/resident status and feeding guild see Appendix A.

When species were combined for analysis, their counts were first standardized so that all species were treated on a similar scale. Thus, rare species with just a few detections per year contributed to the group on the same scale as abundant species with dozens or hundreds of detections per year. The counts were standardized by dividing the monthly detection rate (birds per 400 net hours) by the overall average detection rate (birds per 400 net hours) for the species over the 5-year study period.

The temporal predictor variable was simply the scale 1–60, representing the maximum of 60 monthly pulses in the study. The division of data into years was as follows. For resident species, data from March through February represented one complete year. Since the study began in November of 2003, the first year of data was assembled from just four monthly monitoring pulses. For migrants, a complete year was formed by data from July through June. Migrants have been recorded in every month except June, but the great majority of migrants are recorded from September to April. Some migratory species are strictly transients and detected during just one or two months of the year.

Statistical tests

I used Minitab software to perform the decomposition and linear regression to evaluate temporal trends. Time series decomposition analysis using an additive type model was used to remove peaks and troughs in the data caused by seasonality for each species. The deseasonalized data for each species captured more than ten times over the five years was analyzed using linear regression where the response variable was the number of captures per pulse over the study period. P-values were generated and species for which regression results exhibited a p-value under the threshold of 0.05 were considered to have a statistically significant increasing or decreasing trend. In some cases response variables were log-transformed in order to increase linearity and homogenize variance.

Many studies have used regression as a means of analyzing population trends (Silkey et al. 1999, Dunn et al. 1997); however most have used multiple regression because environmental factors such as moon cycle and weather data were incorporated into the model. Environmental data were not included in this study, which is why we chose to use simple linear regression on data

where seasonality has been removed, based on the recommendations of a consulting statistician (Martin Jones Ph.D. College of Charleston. pers comm. June 2008).

Results and Discussion

In the three sites combined, 151 bird species were detected in the mist-net arrays with a total of 7778 captures during four years. Many were too rare for individual analysis, but 87 species were each detected ten or more times, and were analyzed for temporal trends. Of the species analyzed, 61 were permanent residents and 26 were long-distance (Nearctic-Neotropical) migrants. Twenty-two species (25%, table 2) had declining trends, whereas only one species (1%) had an increasing trend. The remaining 74% of the 87 species analyzed were considered to have stable populations.

Table 2. Species with site-level declining trends during 2003–2008.

English name	Scientific name	Sites where decline noted	Degree of confidence*
Rufous-capped Warbler	*Basileuterus rufifrons*	Coffee Plantation	Moderate
Violet Sabrewing	*Campylopterus hemileucurus*	Coffee Plantation & Dry Forest	Low
Rufous Sabrewing	*Campylopterus rufus*	Coffee Plantation	High
Ruddy-capped Nightingale-Thrush	*Catharus frantzii*	Cloud Forest	Low
Swainson's Thrush**	*Catharus ustulatus*	Coffee Plantation	Low
Blue Bunting	*Cyanocompsa parellina*	Dry Forest	Moderate
Willow Flycatcher**	*Empidonax traillii*	Coffee Plantation	Low

English name	Scientific name	Sites where decline noted	Degree of confidence*
Fan-tailed Warbler	*Euthlypis lachrymosa*	Dry Forest	Moderate
Worm-eating Warbler**	*Helmitheros vermivorum*	Cloud Forest	Moderate
Green-throated Mountain-gem	*Lampornis viridipallens*	Cloud Forest	High
White-tipped Dove	*Leptotila verreauxi*	Coffee Plantation	Low
Black-and-white Warbler**	*Mniotilta varia*	Cloud Forest	Low
Slate-throated Redstart	*Myioborus miniatus*	Cloud Forest	Low
Golden-olive Woodpecker	*Colaptes rubiginosus*	Coffee Plantation	Low
Ovenbird**	*Seiurus aurocapilla*	Coffee Plantation	Low
Spot-breasted Wren	*Thryothorus maculipectus*	Coffee Plantation	High
Plain Wren	*Thryothorus modestus*	Coffee Plantation	Moderate
Banded Wren	*Thryothorus pleurostictus*	Dry Forest	High
House Wren	*Troglodytes aedon*	Coffee Plantation	Low
Tennessee Warbler**	*Vermivora peregrina*	Coffee Plantation	Low
Yellow-green Vireo***	*Vireo flavoviridis*	Coffee Plantation	Low
Wilson's Warbler**	*Wilsonia pusilla*	Coffee Plantation	Moderate

*Levels of confidence: High, Probability (P)<0.001; Moderate, P<0.01; Low, P<0.05

**Migratory species that breed in North America and winter in Central or South America.

***This species has both long-distance and resident populations, and was treated here as a migrant.

The only increasing species was the White-throated robin (*Turdus assimilis*). Of the 22 declining species, 14 were resident and 8 were migratory. In the dry forest of El Imposible 15% of the resident species (4 of 27) showed declines including one nectarivorous hummingbird species, the Violet Sabrewing (*Campylopterus hemileucurus)*. In the cloud forest of Los Volcanes, 21% of resident species (4 of 19), including one nectarivorous hummingbird, the Green-throated Mountain-gem (*Lampornis viridipallens*), and 20% of migratory species (2 of 10) showed declines, whereas 1 resident frugivore, the White-throated Robin (*Turdus assimilis*) increased. The coffee finca had the least stable community, with 29% of residents (8 of 27) and 29% of migrants (7 of 21) exhibiting declines.

Only three species found to be in decline in this study are considered endangered or threatened in El Salvador. The Ruddy-capped Nightingale-thrush has endangered status in the national Red List for El Salvador; it's decreasing trend can be seen below (Fig 10). When combined by residency status, only migratory species were found to be exhibiting a significant decreasing temporal trend (Fig. 11). When species were broken down into feeding guilds and the detections within a feeding guild were combined, only insectivorous species showed a significant trend (Fig 12).

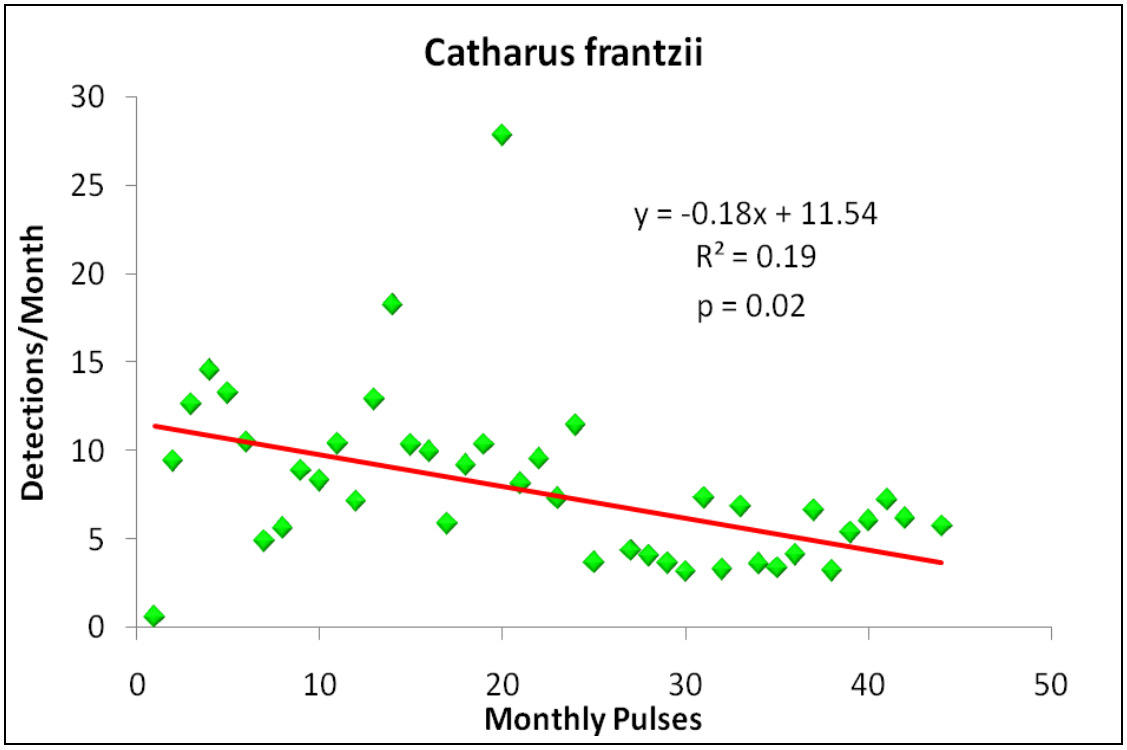


Figure 10. Significant decreasing trend of the Ruddy-capped Nightingale-Thrush, which is endangered in El Salvador.

The three monitoring stations covered very different habitats (Table 1), located at different. There was little overlap in the species monitored, and most declines or increases were detected at just one monitoring station (Table 2).

Some forest bird species were found moving through the coffee farm monitoring station in very low densities. At the coffee plantation, a large number of species that were rarely captured were presumed to be dispersing between local forest fragments. Common forest species like Long-tailed Manakin (*Chiroxiphia linearis*), Greenish Elaenia (*Myiopagis viridicata*), and Blue Bunting (*Cyanocompsa parellina*) were captured just once or twice over the four year period at the coffee plantation monitoring station.

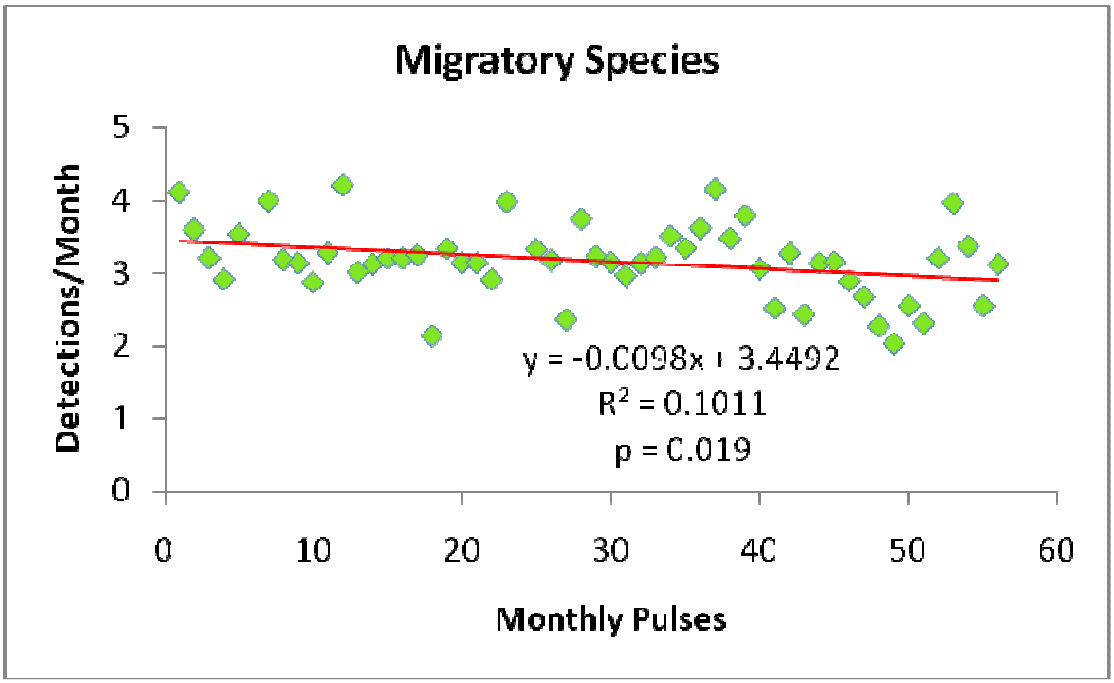


Figure 11. When all sites are combined migratory species show a significant decreasing temporal pattern. The x-axis represents the monthly pulses over the 5 year study period; the y-axis represents a standardized monthly capture rate.

The most stable community was at El Imposible National Park, where 90% of species appeared stable. El Imposible had no increases and four declines (Table 3). In the cloud forest site at Los Volcanes National Park, 79% of species appeared stable. The coffee plantation (a shaded, Rainforest Alliance Certified plantation) exhibiting the least stable community, had one increasing species and fourteen declining species, but 69% of species appeared stable. Thus, the dry forest site (El Imposible) had the most stable bird community, whereas the coffee plantation (Finca Nuevas Horizontes) was least stable. Los Volcanes was intermediate (Fig. 13).

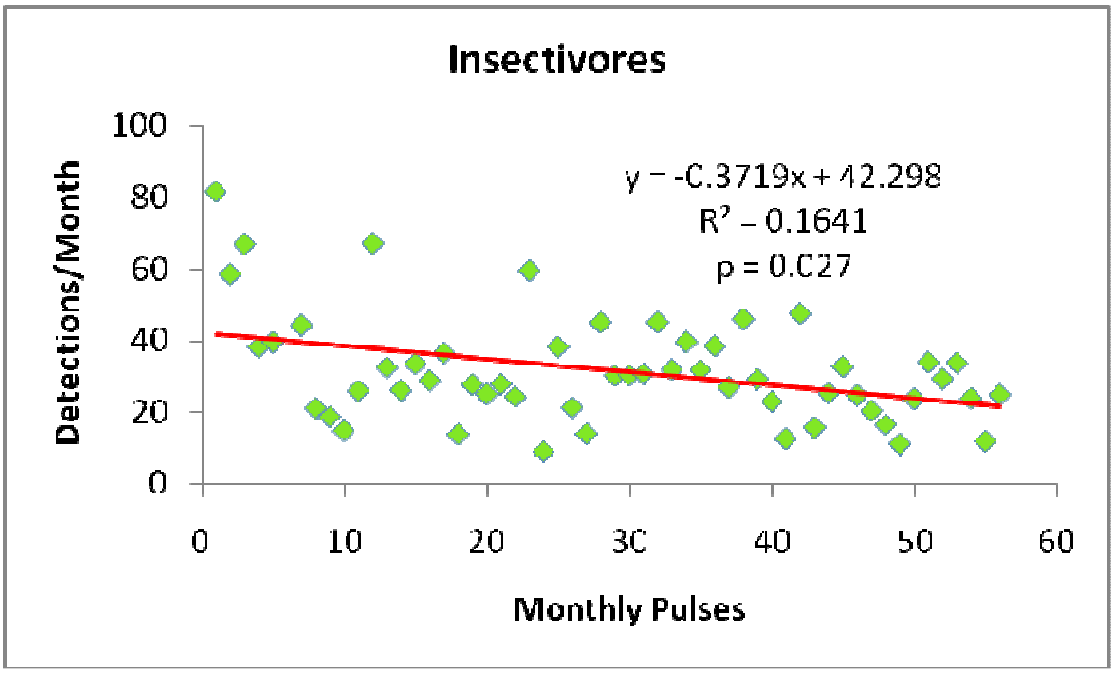


Figure 12. Decreasing trend of insectivores (data were log transformed to increase normality)

Table 3. Five year regression results per site.

Site	Species detected	Species with ≥10 detections	Declining species	Increasing species	Stable species
Shaded coffee plantation (Izalco)	116	50	14 (28%)	1 (2%)	35 (69%)
Dry Forest (El Imposible)	89	40	4 (10%)	0 (0%)	36 (9%)
Cloud Forest (Los Volcanes)	75	29	5 (17%)	1 (4%)	23 (79%)

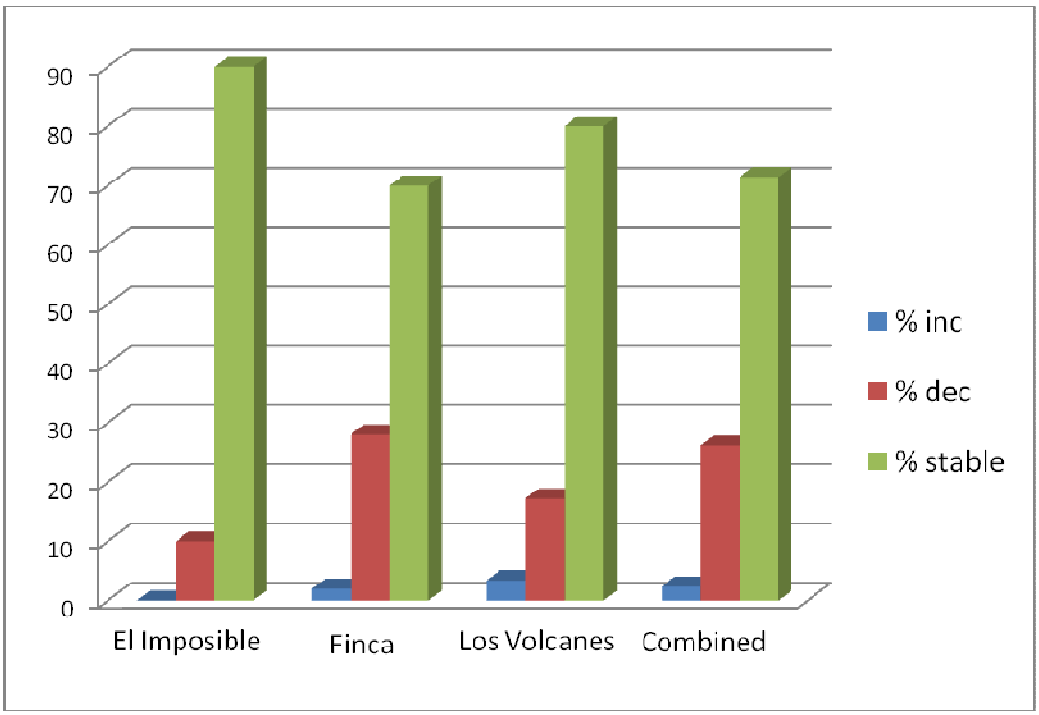


Figure 13. Figure 1. Relative stability of bird communities monitored over 2003–2008 in El Imposible and Los Volcanes national parks, El Salvador.

Table 4. Temporal trends (and estimated probabilities for tests of null hypothesis) in feeding guilds, 2003–2007, at El Salvador bird monitoring stations.

Guild	Three sites combined	Coffee	Dry Forest	Cloud Forest
Nectarivore	Stable	Stable	Stable	Decreasing ($p = 0.002$)
Insectivore	Decreasing ($p=0.027$)	Decreasing ($p =0.003$)	Stable	Decreasing ($p < 0.001$)
Frugivore	Stable	N/A	Stable	Stable
Granivore	Stable	Stable	Stable	Stable
Omnivore	Stable	Stable	Stable	Stable
Carnivore	N/A	Stable	N/A	N/A

El Imposible monitoring station

At El Imposible's dry forest monitoring site, 88 bird species and 3173 individual detections were logged in the mist nets over the five-year study. Of the four declining species, three are resident species and one is a resident hummingbird species. Two of the four species are insectivores, one is a granivorous species, and the other is a nectarivore (Table 5).

Insectivorous species on a whole are not declining significantly at El Imposible, however, two of the four declining species are resident insectivores, and they are exhibiting decreasing trends at the other two sites. This suggests that insectivores are not doing very well across the region. The supply of insects may be decreasing as well due to the warming effects of climate change. It has been recently discovered that tropical invertebrates are very physiologically sensitive to temperature changes, and face a high risk of extinction due to climate change (Deutsch et al. 2008).

Community turnover is a natural process that is likely to be more rapid in fragmented habitats where extinction probabilities are higher (MacArthur & Wilson 1967). In El Salvador, we think of the forest at El Imposible as an extensive patch, but on a regional scale it is a fairly small patch, which may have relatively high community turnover rates. Though it was found to be the most stable monitoring site, expanding the size of El Imposible National Park would be a logical recommendation, in order to increase the forest patch size, lower local extinction probabilities, and increase community stability further. Another option is to improve the management of the buffer zone and surrounding watersheds, such that the effective size of the conservation unit is increased.

Table 5. What species are declining or increasing at El Imposible monitoring station?

Species	Scientific Name	Status	Declining or Increasing?	Degree of confidence*
Violet Sabrewing	*Campylopterus hemileucurus*	Resident Nectarivore	Declining	Low p = 0.04
Blue Bunting	*Cyanocompsa parellina*	Resident	Declining	Moderate p = 0.015
Fan-tailed Warbler	*Euthlypis lachrymose*	Resident	Declining	Moderate p = 0.005
Banded Wren	*Thryothorus pleurostictus*	Resident	Declining	High p = 0.000

*Levels of confidence: High, P<0.001; Moderate, P<0.01; Low, P<0.05.

Izalco monitoring station

At the Finca Nuevos Horizontes (Izalco) coffee plantation, 109 bird species were detected in the mist-net arrays a total of 2512 times during four years. Many were too rare for individual analysis, but 51 species were each detected 10 or more times, and were analyzed for temporal trends. Fourteen species (28%) had declining trends, whereas only one species (2%) had increasing trends (Table 6). The remainder (69%) was considered to have stable populations. The 14 declining species included half migrants and half resident species; nine of which are are insect eaters, two are omnivores, one is granivorous, and two are nectar-feeding hummingbird. The one increasing species is the slate-throated redstart, which is an insect-eating altitudinal migrant at Los Volcanes, and is also showing a declining trend at that site. It does not breed at the Finca, but its increasing presence here maybe an indication that it has to leave the forest of Los Volcanes to find food sources.

The bird community at the Izalco coffee plantation appeared to be the least stable bird community. This brings to question some of the conservation strategies that have promoted shade-grown coffee as a quality habitat for birds, especially migratory birds. However many forest birds were found in the plantation, which means it does provide some kind of habitat for these species, even if it is just for forage or stopover purposes. The question remains whether

migratory birds prefer certified shade-grown coffee plantations over other kinds of coffee plantations (Komar 2006b).

The monitoring results at the coffee plantation detected a large number of species that were only captured once or twice, and which are not breeding at the plantation but rather visiting briefly or just passing through. For example, in Table 9 below, several species captured just once or twice at the plantation (i.e., mean monthly detections over four years of just 0.03 or 0.06) are common species at El Imposible (compare with Table 7). Examples include species like Long-tailed Manakin (*Chiroxiphia linearis*), Greenish Elaenia (*Myiopagis viridicata*), and Blue Bunting (*Cyanocompsa parellina*). This result supports the hypothesis that the shaded coffee plantations contribute to the functionality of a biological corridor (Komar 2007).

Table 6. What species are declining or increasing at the coffee plantation monitoring station?

Species	**Scientific Name**	**Status**	**Decline or Increasing?**	**Degree of confidence***
Ovenbird	*Seiurus aurocapilla*	Migrant	Declining	Low p = 0.031
Swainson's Thrush	*Catharus ustulatus*	Migrant	Declining	Low p = 0.037
Willow Flycatcher	*Empidonax traillii*	Migrant	Declining	Low p = 0.029
Slate-throated redstart	*Myioborus miniatus*	Migrant	Increasing	Low p = 0.014
Tennessee Warbler	*Vermivora peregrine*	Migrant	Declining	Low p = 0.022

Species	Scientific Name	Status	Decline or Increasing?	Degree of confidence*
Yellow-green Vireo	*Vireo flavoviridis*	Migrant	Declining	Low p = 0.019
Wilson's Warbler	*Wilsonia pusilla*	Migrant	Declining	Moderate p = 0.006
Violet Sabrewing	*Campylopterus hemileucurus*	Resident Nectarivore	Declining	Low p = 0.018
Rufous-capped Warbler	*Basileuterus rufifrons*	Resident	Declining	Low p = 0.014
Rufous Sabrewing	*Campylopterus rufus*	Resident	Declining	Moderate p = 0.001
White-tipped Dove	*Leptotila verreauxi*	Resident	Declining	Low p = 0.05
Golden-olive Woodpecker	*Piculus rubiginosus*	Resident	Declining	Low p = 0.037
Spot-breasted Wren	*Thryothorus maculipectus*	Resident	Declining	High p = 0.000
Plain Wren	*Thryothorus modestus*	Resident	Declining	Moderate p = 0.008
House Wren	*Troglodytes aedon*	Resident	Declining	Low p = 0.016

*Levels of confidence: High, P<0.001; Moderate, P<0.01; Low, P<0.05

Los Volcanes monitoring station

Figure 17. The Green-throated Mountain-gem (*Lampornis viridipallens*), a resident hummingbird found in El Salvador's few cloud forest patches, appeared to be declining at Los Volcanes National Park. Photo: Tom Jenner/Archive SalvaNATURA.

At the monitoring station in Sector Los Andes, Los Volcanes National Park, 72 bird species were detected in the mist-net arrays a total of 2941 times during four years. Many were too rare for individual analysis, but 29 species were each detected 10 or more times, and were analyzed for temporal trends. Five species (17%) had declining trends, whereas only one species (4%) had an increasing trend. The remaining species (79%) were considered to have stable populations (Table 7).

The bird community at the cloud forest in Los Volcanes National Park was second most stable with five species presenting a statistically significant decline, and one species exhibiting an increase (Table 7). In 2005 the volcano experienced a major volcanic explosion, which destroyed parts of its forests, but did not directly affect the monitoring parcel. The explosion was expected to influence its bird populations, and these analyses suggest that species are presenting short-term effects (SalvaNATURA, unpublished data). Nectarivores and insectivores appeared to have a declining trend, which could be due to impacts on vegetation from the ash cloud and poisonous gases released by the volcano into the atmosphere. The lack of a large response from

the bird community may be due to the fact that the species present are already adapted to frequent disturbances. Alternatively, longer-term data sets may be required to detect impacts of such events.

The bird community at this cloud forest station is likely to be threatened over the long-term by climate change. Global warming is expected to lead to drier conditions in Central America in coming decades, further degrading the cloud forest ecosystem. A longer-term data set is necessary to detect any related declines (or increases). Exacerbating global climate shifts, is the extensive deforestation in the lowlands of El Salvador which has probably led to drier conditions in the cloud forest in recent years (Lawton et al. 2001).

Table 7. What species are declining or increasing at Los Volcanes monitoring station?

Species	**Scientific Name**	**Status**	**Decline or Increasing?**	**Degree of confidence***
Green-throated Mountan gem	*Lampornis viridipallens*	Resident Nectarivore	Decreasing	High p = 0.000
Ruddy-Capped Nightingale Thrush	*Catharus frantzii*	Resident	Decreasing	Low p = 0.021
Slate-throated Redstart	*Myioborus miniatus*	Resident	Decreasing	Low p = 0.011
White-throated Robin	*Turdus assimilis*	Resident	Increasing	Low p = 0.034
Worm-eating Warbler	*Helmitheros vermivorum*	Migrant	Decreasing	Moderate p = 0.01
Black-and-White Warbler	*Mniotilta varia*	Migrant	Decreasing	Low p = 0.016

*Levels of confidence: High, P<0.001; Moderate, P<0.01; Low, P<0.05.

Bird Populations in North America

A recent *State of the Birds* report (2009) has announced that out of the 800 bird species found in the US, 67 are federally listed as endangered or threatened, and an additional 184 are species of conservation concern. Several factors have been used to explain these decreases in North American birds that have actually been observed since the late 1970s including: habitat loss and fragmentation on breeding grounds; increased nest predation and parasitism, which may be intensified by increased fragmentation; and deforestation and habitat in the neotropical wintering grounds. It is difficult to determine which of these factors has the greatest consequence on avian population declines as all of them mostly likely have had some influence. In an analysis of Breeding Bird Survey (BBS) data (1968-1987) by Bohning-Gaese et al. (1993) on populations of small, insectivorous, passerine species it was found that predation on breeding grounds in North America has been more influential on the decline of migratory songbirds than has deforestation on the wintering grounds in the neotropics.

Six out of eight neomigratory species found to be declining in El Salvador, were also found to be declining on their North American breeding grounds (table 8), when results from this study were compared to results from a 2004 report by Partners in Flight (Rich et al. 2004).

Swainson's Thrush *Catharus ustulatus*

The historic breeding range of Swainson's Thrush extends from west of the Cascades and the Sierra Nevada from Juneau, AK, south to San Diego Co., CA (Bent 1963). Although this bird is not listed nationally as vulnerable or threatened, the USDA Forest Service identified the Swainson's Thrush as one of two priority landbird species for monitoring in the Sierra Nevada (Small 1998). It is insectivorous and constructs open nests in shrubs of the understory of boreal forests.

Willow Flycatcher *Epidonax trailli*

Breeds throughout the United States and southern Canada. Its IUCN designation is Least Concern, however, the southwestern subspecies is in decline and is listed as an Endangered Species, and the other two subspecies are identified as State Threatened. The Willow Flycatcher is insectivorous and nests in low shrubs near water. The Flycatcher is also parasitized by the Brown-headed Cowbird (Sedgwick 2000).

Worm-eating Warbler *Helmitheros vermivorum*

Breeds in the Eastern US, forages in the understory, and has an open nest on the ground. The IUCN status is Least Concern. Threats include forest fragmentation in breeding and wintering grounds, and parasitism by the Brown-headed Cowbird (Hanners 1998).

Black and White Warbler *Mniotilta varia*

Breeds in mature and second-growth deciduous forests of the eastern US, eastern, and Midwestern Canada. The Black and White Warbler is insectivorous (foraging by creeping along bark of tree trunks) and nests on the ground. Its IUCN status is Least Concern, but is threatened by forest fragmentation and nest parasitism by Brown-headed Cowbirds.

Tennessee Warbler *Vermivora peregrine*

Breeds throughout Canada and the very northern border of the US. They nest in open nests, which are build on the floor of boreal forests in forest gaps where there are dense shrubs and small trees. Tennessee Warblers are insectivores, foraging in the foliage of trees and shrubs and also occasionally consumes nectar by pecking at the base of flowers (Rimmer, C. and K. Mcfarland 1998).

Yellow-green Vireo *Vireo flavoviridis*

Breeds throughout Mexico and in southern Texas; this bird constructs a hanging nest in branches of a tree about 1-3m above the ground. This species is also insectivorous, gleaning insects from the foliage of shrubs and trees. Its IUCN status is Least Concern, however not much is known about the status of

this species of vireo because it does not breed extensively in North America, and so has not been examined by most avian conservation initiatives.

Table 8. Migratory bird trends in El Salvador compared to trends reported in North America.

Species	**Scientific Name**	**Trend in El Salvador (this study)**	**Population trends in North America***	**Population Size (Rich et al. 2004)**
Swainson's Thrush	*Catharus ustulatus*	Decline	Decline (mostly breeds in boreal forests)	100 million
Willow Flycatcher	*Empidonax traillii*	Decline	Decline	3.3 million
Worm-eating Warbler	*Helmitheros vermivorum*	Decline	Decline	750,000
Black and White Warbler	*Mniotilta varia*	Decline	Decline	14 million
Tennessee Warbler	*Vermivora peregrine*	Decline	Suspected decline; breeds in boreal forests	62 million
Yellow green Vireo	*Vireo flavoviridis*	Decline	Decline	2 million

*Population trend over 30 years (source Rich et al. 2004, based mostly on Breeding Bird Survey data)

All of these birds are insectivorous open nesting species that rely on riparian woodland for breeding and wintering. This may make them particularly vulnerable in the face of forest fragmentation and habitat loss, and also very susceptible to nest parasitism by the Brown-headed Cowbird.

Conclusions

Limitations of this study

Long-term monitoring of wild bird populations is rarely funded by or linked to short-term development and conservation projects like USAID's 3-yr IMCW project. Nonetheless, the present analysis demonstrates that such short-term projects can both benefit from and contribute to long-term biodiversity monitoring projects in useful ways. Data from long-term projects such as the Permanent Bird Monitoring Program are necessary to evaluate many conservation policy issues that will be difficult, expensive, or impossible to evaluate on a short-term basis, such as effects of climate change on wildlife populations, or effectiveness of biological corridors in improving effective sizes of protected areas. To the benefit of the monitoring effort, short-term funds can be invaluable for maintaining long-term projects, or for carrying out periodic analysis of long-term data sets. Meanwhile, the short-term projects benefit from the long-term data collection effort. Even short-term results are demonstrating the utility of environmental policy decisions such as working simultaneously to conserve a variety of habitats across a landscape, or promoting the certification of farms that contribute local movement corridors for forest animals. So while this study is the first long term avian monitoring program and is great progress for the region, the time frame under which the current data was collected (5 years) is still relatively short compared to other long term studies such as the Breeding Bird Survey in North America (Sauer et al. 2008). It is the goal of SalvaNATURA to continue and expand the program in order to monitor the effects of landscape change and/or conservation projects. SalvaNATURA continues to seek funding so that this project will continue to monitor the status of avian populations in El Salvador.

Limitations regarding methodology in obtaining population abundance estimates using mist-netting efforts are similar to the bias that occurs when counts are obtained using visual and aural methods

(Dunn and Ralph 2004). Mist-nets are particularly good at capturing birds that fly within 2-3 m of the ground, excluding some species at least for the most part, which is why number of captures are used to measure relative abundance over time rather than population estimates. These types of biases can be somewhat controlled for by standardizing efforts, but error still occurs due to slight differences in net height, tension, and location. Also birds can take on different behaviors in slightly different habitats, which means that comparing species abundance between sites can contain error and is almost impossible to control for (Remson 1996).

Conservation Implications

1. Migratory bird species from North America, are of great conservation concern across the hemisphere, and use El Salvador habitats for both wintering and as stopover sites. Many of these species are showing severe declines on the El Salvador wintering grounds. Nonetheless, indicators of habitat quality for migratory birds at the monitoring stations suggest that both natural forest and shaded coffee plantations provide high quality habitats for migratory birds and therefore contribute to their conservation.

2. There is little overlap in the species that live in the three principal habitats monitored (dry forest, cloud forest, shaded coffee plantation). This supports the concept of a watershed (multi-ecosystem) approach to biodiversity conservation, and the need to monitor multiple habitat types present in the landscape.

3. Forest birds were found moving through the coffee farm monitoring station, supporting the hypothesis that shaded coffee farms can function as dispersal corridors and contribute to conservation of various forest bird species.

4. The bird monitoring station at El Imposible National Park detected that the dry forest bird community is relatively stable (compared to cloud forest and coffee plantation bird communities), which illustrates that protection efforts are working.

5. Many of the species with severe declines in the three different study areas are not currently recognized as threatened in El Salvador, most likely due to lack of current monitoring data; this study's results will permit more accurate evaluations of threatened status in future reevaluations of National Red List status for El Salvador birds. Conservation policy should establish priorities for threatened (declining) species.

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Appendix A. 87 Species evaluated for temporal trends during five years of monitoring.

Species	Scientific Name	Residence Status	Feeding Guild	Total detection Coffee Plantation	Total Detection El Imposible	Total detection Los Volcanes	Total detections 3 sites combined
Berylline Hummingbird	Amazilia beryllina	Resident	Nectarivore	31.6	55.0	4.1	90.7
Cinnamon Hummingbird	Amazilia rutila	Resident	Nectarivore	22.0	2.0	0.0	23.9
Ruby-throated Hummingbird	Archilochus colubris	Migrant	Nectarivore	31.4	2.0	0.0	33.5
Rufous-capped Warbler	Basileuterus rufifrons	Resident	Insectivore	174.5	167.2	0.0	341.7
Violet Sabrewing	Campylopterus hemileucurus	Resident	Nectarivore	41.5	42.8	10.1	94.3
Rufous Sabrewing	Campylopterus rufus	Resident	Nectarivore	36.9	0.0	21.7	58.6
Swainson's Thrush	Catharus ustulatus	Migrant	Omnivore	232.5	614.1	164.9	1011.6
Long-tailed Manakin	Chiroxiphia linearis	Resident	Frugivore	3.1	368.5	0.0	371.7
Bushy-crested Jay	Cyanocorax melanocyaneus	Resident	Omnivore	11.1	3.1	0.0	14.2
Blue Bunting	Cyanocompsa parellina	Resident	Granivore	0.9	181.3	1.0	183.3
Rufous-browed Peppershrike	Cyclarhis gujanensis	Resident	Omnivore	16.0	11.5	0.0	27.5

Species	Scientific Name	Residence Status	Feeding Guild	Total detection Coffee Plantation	Total Detection El Imposible	Total detection Los Volcanes	Total detections 3 sites combined
Magnolia Warbler	Dendroica magnolia	Migrant	Insectivore	26.1	25.5	0.0	51.6
Townsend's Warbler	Dendroica townsendi	Migrant	Insectivore	3.6	0.0	7.1	10.7
Black-throated Green Warbler	Dendroica virens	Migrant	Insectivore	32.3	0.0	1.0	33.4
Mountain Elaenia	Elaenia frantzii	Resident	Omnivore	5.7	0.0	198.7	204.4
Alder Flycatcher	Empidonax alnorum	Migrant	Insectivore	8.8	2.7	0.0	11.5
Yellow-bellied Flycatcher	Empidonax flaviventris	Migrant	Insectivore	15.2	7.3	1.0	23.5
Least Flycatcher	Empidonax minimus	Migrant	Insectivore	40.9	29.2	0.0	70.0
Willow Flycatcher	Empidonax traillii	Migrant	Insectivore	58.1	8.9	0.0	67.0
Magnificent Hummingbird	Eugenes fulgens	Resident	Nectarivore	1.0	0.0	132.5	133.5
Turquoise-browed Motmot	Eumomota superciliosa	Resident	Omnivore	26.7	4.0	0.0	30.7
Fan-tailed Warbler	Euthlypis lachrymosa	Resident	Insectivore	23.3	205.6	1.0	230.0
Worm-eating Warbler	Helmitheros vermivorum	Migrant	Insectivore	7.2	29.0	75.0	111.2

Species	Scientific Name	Residence Status	Feeding Guild	Total detection Coffee Plantation	Total Detection El Imposible	Total detection Los Volcanes	Total detections 3 sites combined
Blue-throated Goldentail	Hylocharis eliciae	Resident	Nectarivore	1.0	9.6	2.5	13.1
Wood Thrush	Hylocichla mustelina	Migrant	Omnivore	0.0	3.0	10.3	13.4
Baltimore Oriole	Icterus galbula	Migrant	Omnivore	2.1	0.0	11.5	13.6
Bar-winged Oriole	Icterus maculialatus	Resident	Omnivore	21.1	1.9	2.1	25.1
Streak-backed Oriole	Icterus pustulatus	Resident	Omnivore	45.5	2.0	0.0	47.5
Yellow-breasted Chat	Icteria virens	Migrant	Omnivore	10.2	1.0	0.0	11.2
Green-throated Mountain-gem	Lampornis viridipallens	Resident	Nectarivore	0.9	0.0	517.8	518.7
Spot-crowned Woodcreeper	Lepidocolaptes affinis	Resident	Insectivore	1.4	0.0	27.5	29.0
White-tipped Dove	Leptotila verreauxi	Resident	Granivore	32.3	47.7	2.0	82.0
Black-and-white Warbler	Mniotilta varia	Migrant	Insectivore	21.2	45.1	21.0	87.4
Blue-crowned Motmot	Momotus momota	Resident	Omnivore	58.0	72.0	0.0	130.0
Slate-throated Redstart	Myioborus miniatus	Resident	Insectivore	14.7	0.0	268.8	283.5
Dusky-capped Flycatcher	Myiarchus tuberculifer	Resident	Insectivore	9.0	8.2	5.0	22.2

Species	Scientific Name	Residence Status	Feeding Guild	Total detection Coffee Plantation	Total Detection El Imposible	Total detection Los Volcanes	Total detections 3 sites combined
Greenish Elaenia	Myiopagis viridicata	Resident	Insectivore	1.0	36.1	0.0	37.1
Northern Bentbill	Oncostoma cinereigulare	Resident	Insectivore	1.7	56.6	0.0	58.2
MacGillivray's Warbler	Oporornis tolmiei	Migrant	Insectivore	33.9	0.0	10.0	43.9
Painted Bunting	Passerina ciris	Migrant	Granivore	72.2	27.1	2.0	101.4
Indigo Bunting	Passerina cyanea	Migrant	Granivore	42.9	26.8	3.1	72.8
Rose-breasted Grosbeak	Pheucticus ludovicianus	Migrant	Omnivore	23.6	0.0	4.8	28.4
Golden-olive Woodpecker	Piculus rubiginosus	Resident	Insectivore	31.8	1.0	0.0	32.8
Flame-colored Tanager	Piranga bidentata	Resident	Omnivore	3.3	0.0	7.7	10.9
Western Tanager	Piranga ludoviciana	Migrant	Omnivore	28.1	39.0	0.0	67.1
Eye-ringed Flatbill	Rhynchocyclus brevirostris	Resident	Insectivore	0.0	7.4	63.1	70.6
Ovenbird	Seiurus aurocapilla	Migrant	Insectivore	72.6	108.9	60.5	241.9
Spot-breasted Wren	Thryothorus maculipectus	Resident	Insectivore	48.3	13.7	4.0	65.9

Species	Scientific Name	Residence Status	Feeding Guild	Total detection Coffee Plantation	Total Detection El Imposible	Total detection Los Volcanes	Total detections 3 sites combined
Plain Wren	Thryothorus modestus	Resident	Insectivore	40.7	8.1	2.6	51.4
Rufous-and-white Wren	Thryothorus rufalbus	Resident	Insectivore	1.2	75.8	0.0	77.1
Yellow-olive Flycatcher	Tolmomyias sulphurescens	Resident	Insectivore	8.7	65.0	0.0	73.7
House Wren	Troglodytes aedon	Resident	Insectivore	40.2	0.0	3.0	43.2
Elegant Trogon	Trogon elegans	Resident	Frugivore	4.0	25.5	0.0	29.5
White-throated Robin	Turdus assimilis	Resident	Omnivore	11.5	4.9	132.5	148.9
Clay-colored Robin	Turdus grayi	Resident	Omnivore	96.7	141.6	0.0	238.3
Tennessee Warbler	Vermivora peregrina	Migrant	Insectivore	319.5	28.5	44.6	392.6
Yellow-green Vireo	Vireo flavoviridis	Migrant	Omnivore	26.5	153.1	0.0	179.5
Warbling Vireo	Vireo gilvus	Migrant	Insectivore	10.7	30.0	0.0	40.7
Blue-headed Vireo	Vireo solitarius	Migrant	Insectivore	11.2	12.9	11.3	35.5
Canada Warbler	Wilsonia canadensis	Migrant	Insectivore	80.6	6.9	6.4	93.9
Wilson’s Warbler	Wilsonia pusilla	Migrant	Insectivore	147.3	6.5	214.7	368.6

Species	Scientific Name	Residence Status	Feeding Guild	Total detection Coffee Plantation	Total Detection El Imposible	Total detection Los Volcanes	Total detections 3 sites combined
Ivory-billed Woodcreeper	Xiphorhynchus flavigaster	Resident	Insectivore	12.7	52.4	0.0	65.1
Emerald-chinned Hummingbird	Abeillia abeillei	Resident	Nectarivore	0.0	0.0	12.3	12.3
Blue Seedeater	Amaurospiza concolor	Resident	Granivore	0.0	14.2	0.0	14.2
Rufous-naped Wren	Campylorhynchus rufinucha	Resident	Insectivore	36.9	0.0	0.0	36.9
Lesser Goldfinch	Carduelis psaltria	Resident	Granivore	13.6	0.0	0.0	13.6
Ruddy-capped Nightingale-Thrush	Catharus frantzii	Resident	Omnivore	0.0	0.0	356.8	356.8
Green Violet-ear	Colibri thalassinus	Resident	Nectarivore	0.0	0.0	22.3	22.3
Ruddy Woodcreeper	Dendrocincla homochroa	Resident	Insectivore	0.0	55.9	0.0	55.9
Cinnamon-bellied Flowerpiercer	Diglossa baritula	Resident	Nectarivore	0.0	0.0	32.9	32.9
Yellowish Flycatcher	Empidonax flavescens	Resident	Insectivore	0.0	0.0	104.4	104.4

Species	Scientific Name	Residence Status	Feeding Guild	Total detection Coffee Plantation	Total Detection El Imposible	Total detection Los Volcanes	Total detections 3 sites combined
Yellow-throated Euphonia	Euphonia hirundinacea	Resident	Frugivore	0.0	16.6	0.0	16.6
White-faced Quail-Dove	Geotrygon albifacies	Resident	Granivore	0.0	0.0	14.3	14.3
Ferruginous Pygmy-Owl	Glaucidium brasilianum	Resident	Carnivore	11.5	0.0	0.0	11.5
Scaled Antpitta	Grallaria guatimalensis	Resident	Insectivore	0.0	0.0	19.2	19.2
Red-crowned Ant-Tanager	Habia rubica	Resident	Omnivore	0.0	13.3	0.0	13.3
Lesser Greenlet	Hylophilus decurtatus	Resident	Insectivore	0.0	25.4	0.0	25.4
Golden-fronted Woodpecker	Melanerpes aurifrons	Resident	Omnivore	21.9	0.0	0.0	21.9
Prevost's Ground-Sparrow	Melozone biarcuata	Resident	Granivore	21.7	0.0	0.0	21.7
Ochre-bellied Flycatcher	Mionectes oleagineus	Resident	Insectivore	0.0	72.3	0.0	72.3
Brown-backed Solitaire	Myadestes occidentalis	Resident	Frugivore	0.0	0.0	103.1	103.1

Species	Scientific Name	Residence Status	Feeding Guild	Total detection Coffee Plantation	Total Detection El Imposible	Total detection Los Volcanes	Total detections 3 sites combined
Rose-throated Becard	Pachyramphus aglaiae	Resident	Omnivore	10.2	0.0	0.0	10.2
Crescent-chested Warbler	Parula superciliosa	Resident	Insectivore	0.0	0.0	117.3	117.3
Long-billed Gnatwren	Ramphocaenus melanurus	Resident	Insectivore	0.0	10.5	0.0	10.5
Black-headed Saltator	Saltator atriceps	Resident	Omnivore	40.2	0.0	0.0	40.2
Banded Wren	Thryothorus pleurostictus	Resident	Insectivore	0.0	16.5	0.0	16.5
Black Robin	Turdus infuscatus	Resident	Omnivore	0.0	0.0	64.0	64.0

Appendix B. Mean monthly detections (birds detected per 400 net hours) by year at El Imposible (dry forest) monitoring station. These measures were regressed against season in order to identify temporal trends (given only for species with 10 or more detections). Percent average decline over the 5 year study period also given (negative values indicating a decline and positive values indicating an increase).

Species	Scientific Name	2003-04	2004-05	2005-06	2006-07	2007-08	Average % decline	Trend Coefficent (R^2)	P value
Banded Wren	Thryothorus pleurostictus	0.63	0.45	0.28	0.13	0.07	-42.01	27.40	0.00
Fan-tailed Warbler	Euthlypis lachrymosa	6.25	5.53	3.46	2.45	2.33	-20.74	14.90	0.01
Blue Bunting	Cyanocompsa parellina	4.28	3.93	3.85	2.61	1.93	-17.07	11.50	0.02
Violet Sabrewing	Campylopterus hemileucurus	1.38	1.15	0.65	0.52	0.53	-19.28	8.00	0.04
Bright-rumped Attila	Attila spadiceus	0.21	0.16	0.04	0.00	0.07	-66.89		
Wood Thrush	Hylocichla mustelina	0.14	0.13	0.04	0.00	0.00	-58.90		
Willow Flycatcher	Empidonax traillii	0.50	0.29	0.08	0.08	0.00	-52.33		
Bushy-crested Jay	Cyanocorax melanocyaneus	0.00	0.09	0.13	0.04	0.00	-39.99		
Northern Barred-Woodcreeper	Dendrocolaptes sanctithomae	0.17	0.10	0.09	0.09	0.00	-37.28		
Painted Bunting	Passerina ciris	0.76	0.71	0.60	0.29	0.13	-31.95		

Species	Scientific Name	2003-04	2004-05	2005-06	2006-07	2007-08	Average % decline	Trend Coefficent (R^2)	P value
Canada Warbler	Wilsonia canadensis	0.00	0.17	0.29	0.13	0.00	-27.95		
Yellow-bellied Flycatcher	Empidonax flaviventris	0.25	0.12	0.12	0.09	0.07	-25.58		
Ovenbird	Seiurus aurocapilla	3.19	2.68	2.05	1.62	1.00	-24.68		
Tennessee Warbler	Vermivora peregrina	1.13	0.50	0.36	0.51	0.27	-22.66		
White-throated Robin	Turdus assimilis	0.00	0.00	0.16	0.21	0.07	-19.07		
Worm-eating Warbler	Helmitheros vermivorum	0.99	0.43	0.38	0.48	0.40	-14.84		
Northern Bentbill	Oncostoma cinereigulare	1.54	1.26	0.96	0.93	0.80	-14.79		
Black-and-white Warbler	Mniotilta varia	1.46	0.91	0.61	0.76	0.67	-14.58		
Swainson's Thrush	Catharus ustulatus	15.17	14.25	11.74	8.94	8.00	-14.51		
Ochre-bellied Flycatcher	Mionectes oleagineus	1.36	1.70	1.93	1.32	0.47	-14.51		
Magnolia Warbler	Dendroica magnolia	0.82	0.29	0.42	0.43	0.27	-13.94		

Species	Scientific Name	2003-04	2004-05	2005-06	2006-07	2007-08	Average % decline	Trend Coefficent (R^2)	P value
Indigo Bunting	Passerina cyanea	0.75	0.56	0.43	0.52	0.40	-12.63		
Ruddy Woodcreeper	Dendrocincla homochroa	1.26	1.31	1.09	0.86	0.80	-10.13		
Greenish Elaenia	Myiopagis viridicata	1.10	0.69	0.49	0.69	0.60	-9.50		
Ivory-billed Woodcreeper	Xiphorhynchus flavigaster	1.31	1.14	0.88	0.87	0.87	-9.33		
Long-tailed Manakin	Chiroxiphia linearis	8.74	7.74	6.30	5.98	6.33	-7.31		
Rufous-capped Warbler	Basileuterus rufifrons	3.77	2.72	3.06	3.05	2.73	-6.52		
Least Flycatcher	Empidonax minimus	0.68	0.41	0.52	0.63	0.47	-4.54		
Yellow-olive Flycatcher	Tolmomyias sulphurescens	1.37	1.22	1.16	1.18	1.20	-3.05		
Stub-tailed Spadebill	Platyrinchus cancrominus	0.14	0.28	0.28	0.14	0.07	-1.62		
Orange-billed Nightingale-Thrush	Catharus aurantiirostris	0.00	0.08	0.12	0.09	0.07	0.34		

Species	Scientific Name	2003-04	2004-05	2005-06	2006-07	2007-08	Average % decline	Trend Coefficent (R^2)	P value
Long-billed Gnatwren	Ramphocaenus melanurus	0.26	0.28	0.16	0.13	0.20	0.38		
Yellow-green Vireo	Vireo flavoviridis	3.39	3.01	2.48	2.08	3.07	0.59		
Berylline Hummingbird	Amazilia beryllina	1.24	1.16	0.77	1.13	1.27	4.56		
White-tipped Dove	Leptotila verreauxi	0.66	0.84	1.19	1.03	0.67	4.93		
Lesser Greenlet	Hylophilus decurtatus	0.68	0.60	0.29	0.43	0.60	6.38		
Rufous-and-white Wren	Thryothorus rufalbus	1.12	1.19	1.67	1.78	1.33	6.94		
Elegant Trogon	Trogon elegans	0.35	0.40	0.61	0.60	0.40	8.13		
Summer Tanager	Piranga rubra	0.07	0.09	0.09	0.04	0.07	8.16		
Clay-colored Robin	Turdus grayi	2.55	2.35	2.20	2.78	3.53	9.76		
Red-crowned Ant-Tanager	Habia rubica	0.23	0.18	0.25	0.40	0.27	10.83		
Blue-throated Goldentail	Hylocharis eliciae	0.14	0.12	0.28	0.29	0.07	11.31		

Species	Scientific Name	2003-04	2004-05	2005-06	2006-07	2007-08	Average % decline	Trend Coefficent (R^2)	P value
Blue-crowned Motmot	Momotus momota	0.90	1.30	1.64	1.58	1.33	12.68		
Dusky-capped Flycatcher	Myiarchus tuberculifer	0.14	0.08	0.18	0.23	0.13	15.97		
Blue-headed Vireo	Vireo solitarius	0.21	0.16	0.17	0.39	0.40	29.24		
Brown-crested Flycatcher	Myiarchus tyrannulus	0.14	0.08	0.04	0.13	0.13	31.47		
Yellow-throated Euphonia	Euphonia hirundinacea	0.21	0.24	0.19	0.35	0.60	36.22		
Spot-breasted Wren	Thryothorus maculipectus	0.10	0.23	0.35	0.35	0.27	40.23		
Western Tanager	Piranga ludoviciana	0.61	0.56	0.35	0.83	1.47	41.65		
Plain Wren	Thryothorus modestus	0.07	0.08	0.13	0.22	0.27	42.82		
Yellow Warbler	Dendroica petechia	0.07	0.04	0.04	0.13	0.13	43.48		
Rufous-browed Peppershrike	Cyclarhis gujanensis	0.07	0.20	0.40	0.29	0.07	43.60		
Turquoise-browed Motmot	Eumomota superciliosa	0.07	0.08	0.04	0.04	0.13	44.49		

Species	Scientific Name	2003-04	2004-05	2005-06	2006-07	2007-08	Average % decline	Trend Coefficent (R^2)	P value
Eye-ringed Flatbill	Rhynchocyclus brevirostris	0.18	0.04	0.21	0.17	0.00	45.55		
Ruddy Quail-Dove	Geotrygon montana	0.13	0.08	0.04	0.13	0.20	45.63		
Warbling Vireo	Vireo gilvus	0.36	0.33	0.25	0.74	1.27	59.07		
Wilson's Warbler	Wilsonia pusilla	0.18	0.00	0.04	0.17	0.20	79.74		
Blue Seedeater	Amaurospiza concolor	0.00	0.22	0.47	0.35	0.20			
Tody Motmot	Hylomanes momotula	0.00	0.00	0.00	0.13	0.27			
Canivet's Emerald	Chlorostilbon canivetii	0.19	0.11	0.00	0.00	0.07			
Red-legged Honeycreeper	Cyanerpes cyaneus	0.07	0.04	0.00	0.00	0.13			
Streak-headed Woodcreeper	Lepidocolaptes souleyetii	0.00	0.04	0.04	0.04	0.13			
Alder Flycatcher	Empidonax alnorum	0.00	0.11	0.11	0.00	0.00			
Ruby-throated Hummingbird	Archilochus colubris	0.07	0.09	0.04	0.00	0.00			
Streak-backed Oriole	Icterus pustulatus	0.00	0.00	0.00	0.00	0.13			

Species	Scientific Name	2003-04	2004-05	2005-06	2006-07	2007-08	Average % decline	Trend Coefficent (R^2)	P value
Cinnamon Hummingbird	Amazilia rutila	0.00	0.00	0.08	0.08	0.00			
Scrub Euphonia	Euphonia affinis	0.00	0.08	0.08	0.00	0.00			
Bar-winged Oriole	Icterus maculialatus	0.00	0.04	0.04	0.04	0.07			
Mourning Warbler	Oporornis philadelphia	0.00	0.04	0.04	0.00	0.07			
Hammond's Flycatcher	Empidonax hammondii	0.10	0.06	0.00	0.00	0.00			
White-eared Hummingbird	Hylocharis leucotis	0.00	0.04	0.04	0.00	0.00			
Sulphur-bellied Flycatcher	Myiodynastes luteiventris	0.07	0.04	0.00	0.00	0.00			
Mangrove Cuckoo	Coccyzus minor	0.00	0.00	0.00	0.04	0.07			
White-eared Ground-Sparrow	Melozone leucotis	0.00	0.04	0.04	0.00	0.00			
Golden-olive Woodpecker	Piculus rubiginosus	0.00	0.00	0.00	0.00	0.07			
Yellow-throated Vireo	Vireo flavifrons	0.00	0.00	0.00	0.04	0.07			

Species	Scientific Name	2003-04	2004-05	2005-06	2006-07	2007-08	Average % decline	Trend Coefficent (R^2)	P value
White-eyed Vireo	Vireo griseus	0.00	0.00	0.00	0.04	0.07			
Olivaceous Woodcreeper	Sittasomus griseicapillus	0.00	0.00	0.04	0.04	0.00			
Mottled Owl	Ciccaba virgata	0.00	0.00	0.04	0.04	0.00			
Yellow-breasted Chat	Icteria virens	0.00	0.00	0.04	0.04	0.00			
Lesser Ground-Cuckoo	Moroccoxyx erythropygus	0.00	0.04	0.04	0.00	0.00			
Collared Aracari	Pteroglossus torquatus	0.00	0.04	0.04	0.00	0.00			

Appendix C. Mean monthly detections (birds detected per 400 net hours) by year at Finca Nuevos Horizontes monitoring station. These measures were regressed against season in order to identify temporal trends (given only for species with 10 or more detections). Percent average decline over the 5 year study period also given (negative values indicating a decline and positive values indicating an increase).

Species	Scientific Name	Avg 03-04	Avg 04-05	Avg 05-06	Avg 06-07	Avg 07-08	Avg % Change	Trend Coefficent (R2)	P value
Spot-breasted Wren	*Thryothorus maculipectus*	1.85	1.20	0.68	0.54	0.33	-34.31	32.50	0.00
Rufous Sabrewing	*Campylopterus rufus*	1.48	1.24	0.59	0.25	0.11	-45.38	20.10	0.00
Wilson's Warbler	*Wilsonia pusilla*	4.53	2.01	2.33	2.50	1.56	-17.56	14.50	0.01
Plain Wren	*Thryothorus modestus*	1.00	0.64	0.82	0.70	0.39	-16.51	13.80	0.01
Rufous-capped Warbler	*Basileuterus rufifrons*	3.00	2.99	3.66	3.44	2.48	-2.96	11.90	0.01
Slate-throated Redstart	*Myioborus miniatus*	0.07	0.19	0.28	0.42	0.39	62.54	11.90	0.01 (positive)
House Wren	*Troglodytes aedon*	1.17	0.62	0.46	0.66	0.72	-5.02	11.60	0.02
Violet Sabrewing	*Campylopterus hemileucurus*	1.06	0.94	0.78	0.70	0.44	-18.70	11.10	0.02
Yellow-green Vireo	*Vireo flavoviridis*	0.98	0.90	0.45	0.17	0.11	-38.62	11.00	0.02

Species	Scientific Name	Avg 03-04	Avg 04-05	Avg 05-06	Avg 06-07	Avg 07-08	Avg % Change	Trend Coefficent (R2)	P value
Tennessee Warbler	*Vermivora peregrina*	14.95	9.18	3.47	3.11	1.50	-40.73	10.50	0.02
Willow Flycatcher	*Empidonax traillii*	3.07	2.09	0.55	0.29	0.11	-53.60	9.60	0.03
Ovenbird	*Seiurus aurocapilla*	2.27	1.99	1.24	0.80	0.61	-27.28	9.40	0.03
Golden-olive Woodpecker	*Piculus rubiginosus*	0.76	0.60	0.67	0.50	0.28	-19.77	8.70	0.04
Swainson's Thrush	*Catharus ustulatus*	4.05	3.68	5.78	4.10	2.06	-7.74	8.70	0.04
White-tipped Dove	*Leptotila verreauxi*	0.70	0.71	0.65	0.55	0.38	-13.20	7.70	0.05
Cinnamon Hummingbird	*Amazilia rutila*	0.56	0.44	0.42	0.39	0.22	-19.21		
Fan-tailed Warbler	*Euthlypis lachrymosa*	0.67	0.39	0.42	0.53	0.22	-16.12		
Painted Bunting	*Passerina ciris*	1.56	1.54	1.39	0.99	0.94	-11.12		
Least Flycatcher	*Empidonax minimus*	1.25	0.58	0.52	0.67	0.61	-10.89		
Rufous-browed Peppershrike	*Cyclarhis gujanensis*	0.32	0.42	0.36	0.20	0.17	-10.59		
Yellow-breasted Chat	*Icteria virens*	0.31	0.18	0.12	0.16	0.17	-9.46		
Magnolia Warbler	*Dendroica magnolia*	0.73	0.35	0.37	0.47	0.39	-9.11		
MacGillivray's Warbler	*Oporornis tolmiei*	1.11	0.77	0.35	0.46	0.56	-8.20		

Species	Scientific Name	Avg 03-04	Avg 04-05	Avg 05-06	Avg 06-07	Avg 07-08	Avg % Change	Trend Coefficent (R2)	P value
Streak-backed Oriole	*Icterus pustulatus*	0.94	1.01	0.81	0.75	0.72	-5.77		
Lesser Goldfinch	*Carduelis psaltria*	0.00	0.25	0.48	0.31	0.11	-2.83		
Golden-fronted Woodpecker	*Melanerpes aurifrons*	0.54	0.28	0.30	0.41	0.39	-2.52		
Yellow-bellied Flycatcher	*Empidonax flaviventris*	0.27	0.21	0.35	0.33	0.17	-2.15		
Berylline Hummingbird	*Amazilia beryllina*	0.75	0.56	0.42	0.75	0.62	2.83		
Prevost's Ground-Sparrow	*Melozone biarcuata*	0.35	0.31	0.44	0.51	0.34	2.91		
Blue-crowned Motmot	*Momotus momota*	1.10	0.89	0.86	1.12	1.23	4.39		
Black-and-white Warbler	*Mniotilta varia*	0.30	0.32	0.46	0.40	0.33	5.19		
Black-throated Green Warbler	*Dendroica virens*	0.99	0.22	0.48	0.43	0.39	5.39		
Ruby-throated Hummingbird	*Archilochus colubris*	0.45	0.46	0.63	0.80	0.56	8.80		
Turquoise-browed Motmot	*Eumomota superciliosa*	0.56	0.23	0.46	0.62	0.44	11.08		
Rufous-naped Wren	*Campylorhynchus rufinucha*	0.44	0.60	0.78	0.69	0.66	12.47		
Western Tanager	*Piranga ludoviciana*	0.38	0.30	0.57	0.55	0.50	13.79		

Species	Scientific Name	Avg 03-04	Avg 04-05	Avg 05-06	Avg 06-07	Avg 07-08	Avg % Change	Trend Coefficent (R2)	P value
Black-headed Saltator	*Saltator atriceps*	0.69	0.42	0.56	0.80	0.94	13.89		
Ferruginous Pygmy-Owl	*Glaucidium brasilianum*	0.15	0.22	0.18	0.25	0.28	21.51		
Clay-colored Robin	*Turdus grayi*	1.20	0.98	1.34	2.10	2.65	25.25		
Blue-headed Vireo	*Vireo solitarius*	0.17	0.09	0.25	0.25	0.17	25.81		
Warbling Vireo	*Vireo gilvus*	0.12	0.11	0.34	0.33	0.06	27.60		
Bar-winged Oriole	*Icterus maculialatus*	0.22	0.22	0.63	0.62	0.16	27.88		
White-throated Robin	*Turdus assimilis*	0.10	0.15	0.21	0.25	0.28	28.80		
Ivory-billed Woodcreeper	*Xiphorhynchus flavigaster*	0.14	0.08	0.20	0.32	0.33	42.25		
Indigo Bunting	*Passerina cyanea*	0.28	0.56	0.83	1.05	1.06	43.83		
Rose-throated Becard	*Pachyramphus aglaiae*	0.09	0.08	0.33	0.25	0.06	48.58		
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	0.10	0.21	0.59	0.69	0.44	66.08		
Bushy-crested Jay	*Cyanocorax melanocyaneus*	0.00	0.13	0.13	0.08	0.44	132.44		

Species	Scientific Name	Avg 03-04	Avg 04-05	Avg 05-06	Avg 06-07	Avg 07-08	Avg % Change	Trend Coefficent (R2)	P value
Canada Warbler	*Wilsonia canadensis*	0.24	2.47	2.80	0.89	0.56	211.30		

Appendix D. Mean monthly detections (birds detected per 400 net hours) by year at Los Volcanes (cloud forest) monitoring station. These measures were regressed against season in order to identify temporal trends (given only for species with 10 or more detections). Percent average decline over the 5 year study period also given (negative values indicating a decline and positive values indicating an increase).

Species	Scientific Name	Avg 03-04	Avg 04-05	Avg 05-06	Avg 06-07	Avg 07-08	Avg % Change	Trend Coefficent (R2)	P value
Green-throated Mountain-gem	*Lampornis viridipallens*	23.30	14.13	10.09	8.44	6.66	-26.34	29.8	0
Worm-eating Warbler	*Helmitheros vermivorum*	3.68	2.59	1.39	1.37	0.86	-28.70	14.8	0.01
Slate-throated Redstart	*Myioborus miniatus*	7.70	6.46	6.92	5.49	4.36	-12.56	14.3	0.011
Black-and-white Warbler	*Mniotilta varia*	1.06	0.49	0.31	0.38	0.31	-21.51	13	0.016
Ruddy-capped Nightingale-Thrush	*Catharus frantzii*	11.36	10.09	9.25	6.96	5.06	-17.91	12.1	0.021
White-throated Robin	*Turdus assimilis*	1.32	2.31	1.91	3.23	5.10	46.07	10.2	0.034 (Positive)
White-winged Tanager	*Piranga leucoptera*	0.32	0.23	0.00	0.00	0.00	-64.29		
Berylline Hummingbird	*Amazilia beryllina*	0.00	0.00	0.24	0.19	0.00	-61.36		
Amethyst-throated	*Lampornis*	0.00	0.00	0.18	0.14	0.00	-61.36		

Species	Scientific Name	Avg 03-04	Avg 04-05	Avg 05-06	Avg 06-07	Avg 07-08	Avg % Change	Trend Coefficent (R2)	P value
Hummingbird	*amethystinus*								
Bar-winged Oriole	*Icterus maculialatus*	0.00	0.00	0.12	0.09	0.00	-61.36		
White-naped Brush-Finch	*Atlapetes albinucha*	0.31	0.08	0.07	0.05	0.00	-54.00		
Townsend's Warbler	*Dendroica townsendi*	0.40	0.36	0.18	0.09	0.00	-52.00		
White-faced Quail-Dove	*Geotrygon albifacies*	0.19	0.00	0.49	0.47	0.24	-51.48		
Plain Wren	*Thryothorus modestus*	0.16	0.11	0.06	0.05	0.00	-49.70		
Blue-throated Goldentail	*Hylocharis eliciae*	0.15	0.18	0.06	0.00	0.00	-48.59		
Magnificent Hummingbird	*Eugenes fulgens*	5.57	3.35	3.97	2.85	0.54	-32.67		
Blackburnian Warbler	*Dendroica fusca*	0.00	0.07	0.12	0.05	0.00	-30.81		
Cinnamon-bellied Flowerpiercer	*Diglossa baritula*	1.35	0.57	1.01	0.61	0.13	-25.08		
Violet Sabrewing	*Campylopterus*	0.29	0.35	0.36	0.23	0.06	-21.82		

Species	Scientific Name	Avg 03-04	Avg 04-05	Avg 05-06	Avg 06-07	Avg 07-08	Avg % Change	Trend Coefficent (R2)	P value
	hemileucurus								
Barred Forest-Falcon	*Micrastur ruficollis*	0.00	0.00	0.12	0.14	0.07	-15.88		
Rose-breasted Grosbeak	*Pheucticus ludovicianus*	0.26	0.26	0.06	0.05	0.07	-15.58		
Ovenbird	*Seiurus aurocapilla*	2.17	1.16	1.31	1.44	0.96	-14.14		
Tennessee Warbler	*Vermivora peregrina*	1.60	0.69	1.33	0.98	0.36	-13.66		
Spot-crowned Woodcreeper	*Lepidocolaptes affinis*	0.61	0.79	0.90	0.65	0.36	-7.17		
Wilson's Warbler	*Wilsonia pusilla*	7.37	4.17	3.52	4.23	4.78	-6.47		
Crescent-chested Warbler	*Parula superciliosa*	3.13	3.24	2.67	2.32	2.39	-6.09		
Eye-ringed Flatbill	*Rhynchocyclus brevirostris*	1.64	2.09	1.55	1.27	1.20	-5.54		
Brown-backed Solitaire	*Myadestes occidentalis*	2.76	2.91	2.18	2.07	2.26	-3.95		
MacGillivray's Warbler	*Oporornis tolmiei*	0.29	0.14	0.24	0.18	0.18	-2.96		

Species	Scientific Name	Avg 03-04	Avg 04-05	Avg 05-06	Avg 06-07	Avg 07-08	Avg % Change	Trend Coefficent (R2)	P value
Yellowish Flycatcher	*Empidonax flavescens*	2.06	2.30	2.78	2.38	2.15	2.18		
Wood Thrush	*Hylocichla mustelina*	0.31	0.37	0.24	0.10	0.19	3.55		
Indigo Bunting	*Passerina cyanea*	0.11	0.08	0.00	0.05	0.12	10.08		
Blue-headed Vireo	*Vireo solitarius*	0.22	0.30	0.24	0.33	0.30	12.14		
Rufous Sabrewing	*Campylopterus rufus*	0.32	0.68	0.66	0.42	0.43	19.29		
Emerald-chinned Hummingbird	*Abeillia abeillei*	0.00	0.00	0.31	0.47	0.42	20.45		
Spot-breasted Wren	*Thryothorus maculipectus*	0.00	0.07	0.12	0.14	0.12	22.24		
Black Robin	*Turdus infuscatus*	0.79	1.22	1.62	1.95	1.68	23.62		
Flame-colored Tanager	*Piranga bidentata*	0.26	0.19	0.06	0.09	0.24	27.27		
Scaled Antpitta	*Grallaria guatimalensis*	0.31	0.22	0.53	0.73	0.42	27.64		
Dusky-capped Flycatcher	*Myiarchus tuberculifer*	0.00	0.07	0.18	0.18	0.12	38.27		

Species	Scientific Name	Avg 03-04	Avg 04-05	Avg 05-06	Avg 06-07	Avg 07-08	Avg % Change	Trend Coefficent (R2)	P value
Mountain Elaenia	*Elaenia frantzii*	2.07	4.89	4.41	3.60	6.06	43.96		
Canada Warbler	*Wilsonia canadensis*	0.00	0.08	0.25	0.24	0.12	48.81		
Swainson's Thrush	*Catharus ustulatus*	1.64	2.48	1.81	3.61	6.93	54.00		
Baltimore Oriole	*Icterus galbula*	0.11	0.08	0.61	0.47	0.00	132.87		
Emerald Toucanet	*Aulacorhynchus prasinus*	0.10	0.22	0.13	0.05	0.29	140.84		
House Wren	*Troglodytes aedon*	0.00	0.00	0.00	0.05	0.18	288.24		
Green Violet-ear	*Colibri thalassinus*	0.29	0.07	1.02	0.88	0.12	289.28		
Sharp-shinned Hawk	*Accipiter striatus*	0.00	0.07	0.06	0.05	0.06	*		
Painted Bunting	*Passerina ciris*	0.00	0.07	0.06	0.00	0.06	*		
Brown-capped Vireo	*Vireo leucophrys*	0.00	0.00	0.00	0.09	0.12	*		
White-tipped Dove	*Leptotila verreauxi*	0.00	0.00	0.06	0.04	0.06	*		
Black-throated Blue Warbler	*Dendroica caerulescens*	0.15	0.10	0.00	0.00	0.00	*		
Swainson's Warbler	*Limnothlypis swainsonii*	0.11	0.08	0.00	0.00	0.00	*		

Species	Scientific Name	Avg 03-04	Avg 04-05	Avg 05-06	Avg 06-07	Avg 07-08	Avg % Change	Trend Coefficent (R2)	P value
Singing Quail	*Dactylortyx thoracicus*	0.00	0.08	0.07	0.00	0.00	*		
Black-throated Green Warbler	*Dendroica virens*	0.00	0.00	0.06	0.05	0.00	*		
Hammond's Flycatcher	*Empidonax hammondii*	0.00	0.00	0.06	0.05	0.00	*		
Blue Bunting	*Cyanocompsa parellina*	0.00	0.07	0.06	0.00	0.00	*		
Wine-throated Hummingbird	*Atthis ellioti*	0.10	0.07	0.00	0.00	0.00	*		
Yellow-bellied Flycatcher	*Empidonax flaviventris*	0.00	0.00	0.00	0.05	0.06	*		
White-eared Ground-Sparrow	*Melozone leucotis*	0.00	0.00	0.06	0.05	0.00	*		
Yellow-faced Grassquit	*Tiaris olivacea*	0.00	0.00	0.00	0.00	0.06	*		
Blue-winged Warbler	*Vermivora pinus*	0.00	0.07	0.06	0.00	0.00	*		
Nashville Warbler	*Vermivora ruficapilla*	0.00	0.00	0.00	0.00	0.06	*		

Species	Scientific Name	Avg 03-04	Avg 04-05	Avg 05-06	Avg 06-07	Avg 07-08	Avg % Change	Trend Coefficent (R2)	P value
Fan-tailed Warbler	*Euthlypis lachrymosa*	0.00	0.00	0.06	0.05	0.00	*		

* capture rates were to small to calculate a percent decline