ASSESSMENT OF THE AVIFAUNA AND FLORA OF THE WHITE-SAND FORESTS IN UPPER PERUVIAN AMAZONIA

Peru – Future Conservationist Award 2006

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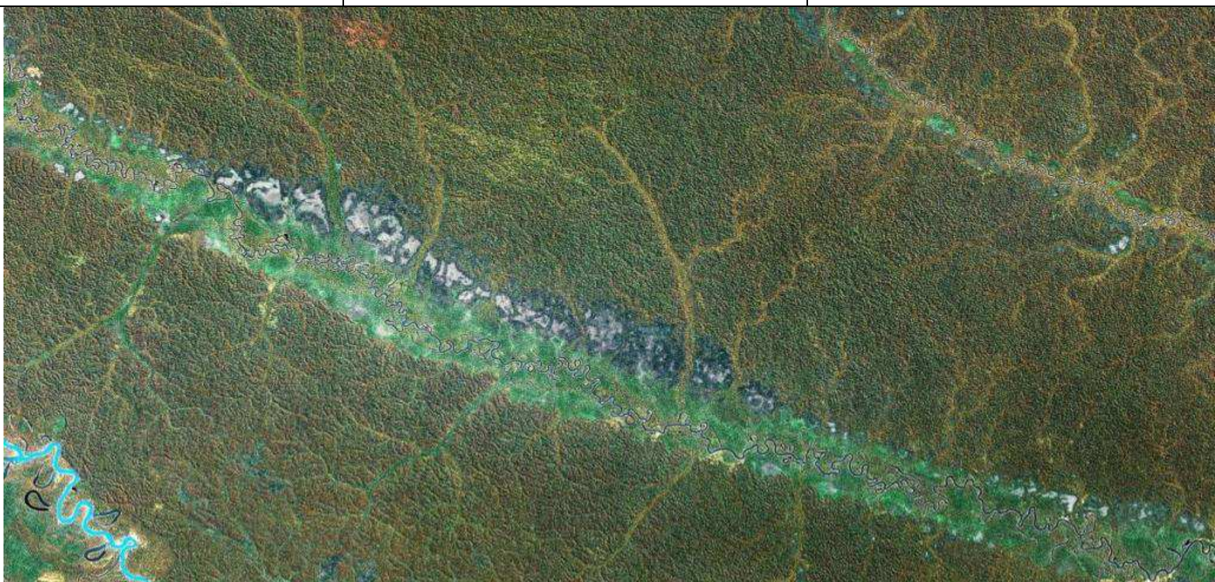

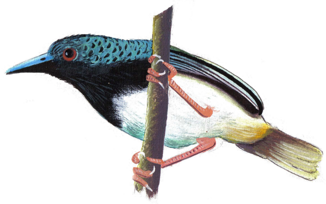

TEAM VARILLAL 2006

Aim: To assess the abundance and distribution of ten recently described bird and plant species restricted to Peruvian white-sand forests as well as to create local conservation awareness for these unique habitats.

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1. ACKNOWLEDGEMENTS

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2. SUMMARY

In the Peruvian Amazon an unusual habitat develops on poor-nutrient white sand soil of quartzitic origin called white-sand forests. Locally, it is known as 'varillales' and occurs scattered on the upland forest of the northern part of Amazonian Peru, Brazil, Colombia, Venezuela, Guiana, French Guiana, and Surinam. White-sand forests (WSF) are strikingly different in their flora, structure, and physiognomy to other *terra firme* forests in Amazonia. They have characteristically high stem density and poor diversity but with many endemics and habitat specialists. They are rare and are still chronically understudied but support a specialized edaphically-restricted flora and fauna. An important characteristic of white-sand forests, at least in western Amazonia, is their patchy distribution on the landscape, as islands of different sizes surrounded by tall rainforest. The area of distribution of the Peruvian white-sand forests is contained in the Upper Amazon-Napo Lowlands Endemic Bird Area (EBA) identified by Birdlife International (BI 2003). According to BI "within [this] EBA there are interesting distributional patterns" and "bird distributions in this part of the Amazon basin are very poorly known" (BI 2003). We identified 10 recently described species from the white sand forests of Amazonian Peru, five birds--*Herpsilochmus gentryi* (Gentry's Antbird), *Percnostola arenarum* (Allpahuayo Antbird), *Polioptila clementsi* (Iquitos Gnatcatcher), *Zimmerius villarejoi* (Mishana Tyrannulet), *Myrmeciza castanea* (Northern Chesnut-tailed Antbird)--and five plants--*Tovomita calophyllophylla* (Clusiaceae), *Potalia coronata* (Gentianaceae), *Lissocarpa kating* (Lissocarpaceae), *Metaxia lanosa* (Metaxiaceae), *and Pseudoxandra atrata* (Annonaceae--and proposed to investigate their relative abundance, and distribution in five unstudied patches of white-sand forests of this region in order to provide conservation recommendations. Since this habitat occurs in a matrix of Amazonian forest they are also threatened by selective and destructive logging activity prevalent in the area. Consequently another goal of this project was to create local awareness for the conservation of this important habitat. We studied five white-sand forests occurring in the Nanay and Tigre basins in northern Amazonian Peru. At each study site we set up a 0.1 ha floristic plots to study quantitatively their floristic composition. The avifauna was studied by a combination of visual, bird netting, and auditive records at 1-km transects traversing each white-sand forest. We paid special attention to record our target species and quantify or estimate their relative abundances as well as sampling the local variation in bird and plant community diversity on these forests. We found a total of 177 bird species belonging to 35 families out of total of 455 records in the whole expedition. A total of 172 plant species distributed in 101 genera and 58 families were found across all studies sites. Of the ten species of birds and plants focus of this project we found 8 of them. The two species we did not find (*P. clementsi*, and *P. atrata*) may occur at extremely low density or occupy only the lower parts of the Nanay basin from which they were originally described.73% of the white-sand forest avifauna community was found to be rare (20% of species were rare, and 52% of species were almost rare). Only 15% of bird species (27 out of 177 species) were found to be common compared to 27% that was fairly common across sites. All plant target species found occurred at low densities except for the fern *M. lanosa*, which was locally abundant at some understory white-sand patches. Last but not less we report for the first time a new genus in the Ochnaceae family for the Peruvian flora: *Blastemanthus*. This genus

has never been recorded for the Peruvian Amazon before, and its few species are reported to occur on white-sand forests of the Upper Rio Negro basin of Venezuela, and Brazil. Further taxonomic work may confirm this taxa a a new report for Peru or as a new species for science. Local communities were enthusiastic in supporting our project and we involved children and teachers at local schools in both basins in our conservation awareness activities. Our most important recommendation is that in order to guarantee the conservation of its specialized flora and fauna we have to focus the conservation on the forests patches itself (cluster of patches in different regions). This is more apparent when considering that new species, as the ones we studied, wait to be discovered from these unique forests in Amazonia.

Project members

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3. PROJECT AIMS AND OBJECTIVES

Aim: To assess the abundance and distribution of ten recently described bird and plant species restricted to Peruvian white-sand forests as well as to create local conservation awareness for these unique habitats.

Objectives:

a) To assess the avifauna of five unstudied white-sand forests and estimate the relative abundance of their specialized bird community with special emphasis in five recently described species: *Herpsilochmus gentryi* (Gentry's Antbird), *Percnostola arenarum* (Allpahuayo Antbird), *Polioptila clementsi* (Iquitos Gnatcatcher), *Zimmerius villarejoi* (Mishana Tyrannulet), *Myrmeciza castanea* (Northern Chesnut-tailed Antbird). (Figure 1)
b) To assess the flora in five unstudied white-sand forests with special reference to five newly described species: *Tovomita calophyllophylla* (Clusiaceae)*, Potalia coronata* (Gentianaceae)*, Lissocarpa kating* (Lissocarpaceae)*, Metaxia lanosa* (Metaxiaceae)*, and Pseudoxandra atrata* (Annonaceae) (Figure 2)
c) To create public awareness in the local communities living nearby white-sand forests in Amazonian Peru about the unique value of this habitats.

4. STUDY AREA

We studied white-sand forest in northern Peruvian Amazon, which lies in the political department of Loreto where the majority of white-sand habitats have been reported for this region. There, white-sand forests occur patchily distributed and embedded within the species-rich upland forests on clay. They are especially common in the Rio Nanay basin. Patches of white-sand forests also exist in the Rio Tigre basin that is located contiguous to the Nanay basin (Figure 3). The areas we selected in this region have not been studied by botanists or ornithologists in the past and we concentrated out fieldwork on these areas.

White-sand forests in both basins were studied for a total of five sites in the floristic study and four sites in the avifauna assessment (Table 1, Figure 1). We reached to our study sites from the city of Iquitos by means of river transportation (1-2 days) via the Nanay and Tigre Rivers. There are local communities living along the banks of both Amazonian rivers and we developed our prepared outreach activities in the communities closest to the white-sand patches, especially focusing our effort to include local schools.

Table 1. Study sites for the assessment of the white-sand forests birds and flora.

Sites	Latitude (S)	Longitude (W)	Elevation (m snm)
Catalán	03º 52' 32.1"	73º 51' 50"	80
Otorongo 1	03º 52' 34.8"	73º 50' 39.7"	106
Otorongo 2	03º 52' 33.3"	73º 50' 41.7"	108
Libertad	03º 44' 22.7"	74º 06' 16.5"	122
San Andrés	03° 42' 24.50"	74° 26' 31.26"	115

Figure 1. Illustrations of some target bird species along with other nutrient-poor restricted birds in the Peruvian Amazon. [1]Photo credit: Winder West.

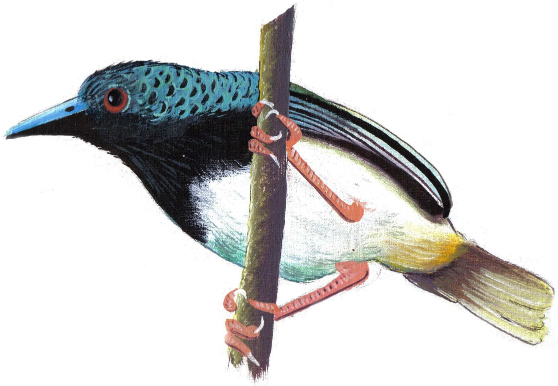
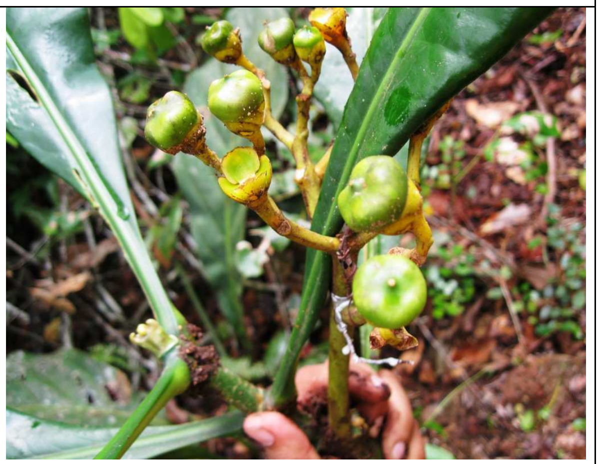
Polioptila clementsi[1]	*Herpsilochmus gentryi*
	
Percnostola arenarum	*Myrmeciza castanea*
	
Zimmerius villarejoi	
	

Figure 2. Target plant species restricted to nutrient-poor white-sand soil in the Peruvian Amazon. [1]Photo credit: MBG.

Metaxia lanosa (fern)	*Lissocarpa kating* (treelet)
	
Tovomita calophyllophylla (tree)	*Potalia coronata* (treelet)
	
Pseudoxandra atrata[1] (tree)	
	

4.1 Study sites

Following is a description of our study sites. We surveyed the flora and avifauna of all study sites at least otherwise specified.

4.1.1 Catalán

Our first study site was Catalán which is part of three patches that exist in this area (the other ones are called Otorongo, and San Juan) and is located on the right bank of the Upper Nanay River (03º 52' 32.1'' S, 73º 51' 50'' W). The Catalan WSF extended originally from the riverbank where the village of San Juan de Ungurahual is at present settled. We can still observe the white sand forest from the riverbank that extends into to the upland forest of the area. The studied WSF was relatively short in size, approximately 1 km in extension. The area was selectively logged in the past, specially the forest on clay soils, and we can still see the tractors track used for transporting the timber from inside the forest to the riverbank. The area selected for study is in good conditions and the locals mentioned that there have been no extracting forest products for about 6 years from this area. Another important extractive resource in the area is the leaves of the palm *Lepidocaryum tenue* used for roof thatching.

4.1.2 Otorongo 1

This study site share similar characteristic with Catalán, and it is located in the Upper Nanay River (03º 52' 34.8'' S, 73º 50' 39.7'' W) close to San Juan de Ungurahual village. According to a classification this white-sand forest is a wet and high 'varillal' (over 25 meters height) with a very bad drainage (García-Villacorta *et al*. 2003).

4.1.3 Otorongo 2

This study site share similar characteristic with Catalán, and it is located in the Upper Nanay River (03º 52' 33.3'' S, 73º 50' 41.7'' W) close to San Juan de Ungurahual village. According to a white-sand forest classification this forest corresponds to a wet and high varillal (over 25 meters height) with a very bad drainage (García-Villacorta *et al*. 2003). This site only covered plant survey and no bird sampling.

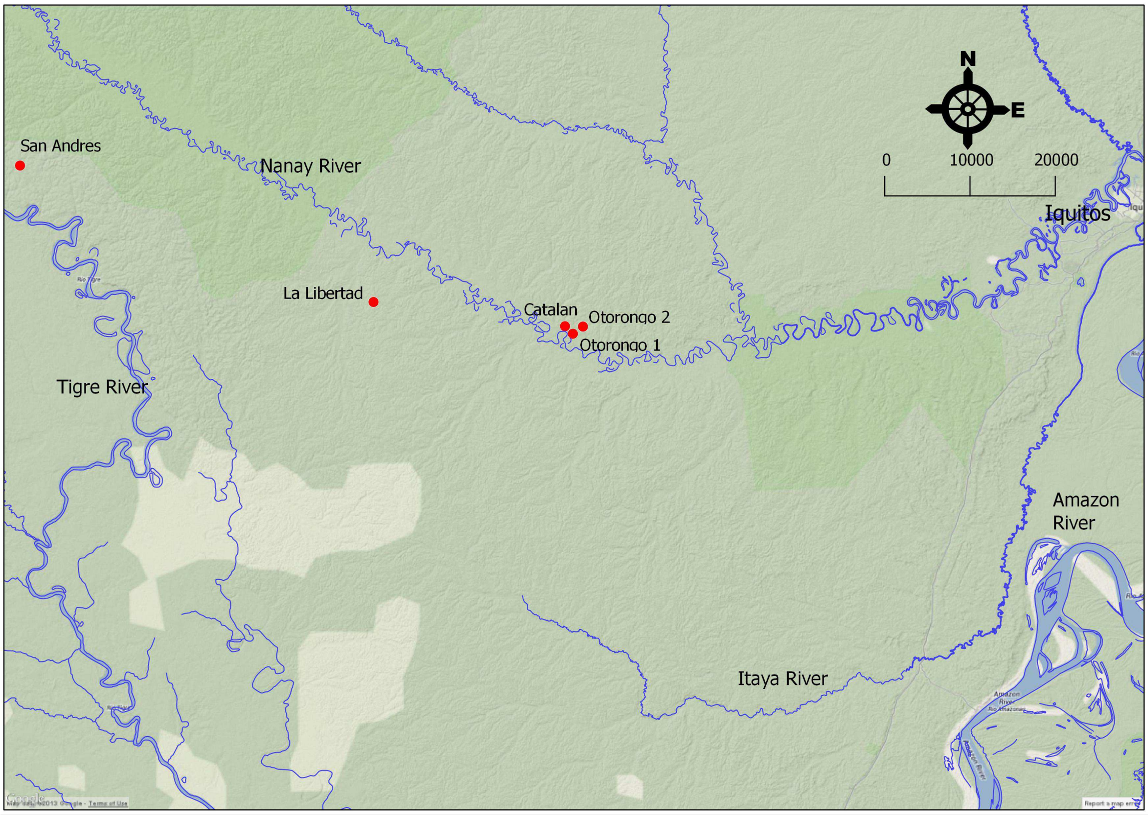
4.1.4 Libertad

The study site was located at the left side of the upper Nanay River, in the department of Loreto, Northern Amazonian of Peru (03º 44' 22.7'', 74º 06' 16.5''). This area sampled white-sand forest on the opposite side of the ones studied at Catalán, Otorongo 1, and Otorongo 2. The white-sand forest patch is located 45 minutes walk from the Nanay River bank. Before reaching this site we passed through other two forest types common in this site: flooded and riparian forests of the Libertad creek, followed by a forest swamp with *Mauritia flexuosa* palms. This white-sand patch was full of forest trails because people logged round wood to sell it to the Iquitos market.

4.1.5 San Andrés

This study site is located on the left margin of the Tigre River in the surroundings of the San Andrés village, district of Loreto, department of Loreto in northern Peruvian Amazonia (03° 42' 24.50'' S, 74° 26' 31.26'' W). This basin does not have a large extension of white-sand forest like in the Nanay River but small patches occur in some areas, and one would assume that connectivity via dispersal may occur between both areas.

Figure 3. Map of study sites in the Peruvian Amazon: Otorongo 1, Otorongo 2, Catalan, La Libertad, and San Andres.



5. BACKGROUND

In the Peruvian Amazon an unusual habitat develops on poor-nutrient white sand soil of quartzitic origin. Compared to the typical Amazonian rainforest these habitats are rare and occur scattered on the upland forest of the northern part of Peru (Figure 5). Several hypotheses exist about the origin of white-sand soils in the Amazon. In some parts of the Amazon, especially those located in the eastern Amazon close the Guiana region it is thought that have been formed by sand eroded from sandstone mountains in millions of years of deep weathering. These sediments may have later be reworked and transported to other parts of the Amazon basin by river erosion and deposition.

In the western Amazon, where the Peruvian white-sand forests occurs, such mountains do not exist and geologists have proposed that white-sand soils may have developed by prolonged weathering of sandy-clay soils (thousands to million of years), in a process known as podzolisation, where clay elements are destroyed leaving as a product sandy soils. Regardless the precise origin of these soils what is remarkable is that white-sand soils support a unique flora and fauna in the entire Amazon biome, witch many endemics and habitat specialists.

White sand forests (WSF) are strikingly different in their flora, structure, and physiognomy to other *terra firme* forests in Amazonia (Prance 1996). Compared to other forests types in Amazonia they have caractheristically high stem density (Figure 4) and poor diversity with many endemics and soil specialists. They are rare and are still chronically understudied but support a specialized edaphically-restricted flora and fauna (Kinzey & Gentry 1979; García-Villacorta et al. 2003).

An important characteristic of WSF is their patchy distribution on the landscape of Loreto in Amazonian Peru (Whitney & Álvarez-Alonso 1998), as islands of different sizes surrounded by the tall rainforest (Prance 1996). The area of distribution of the Peruvian WSF is contained in the Upper Amazon-Napo Lowlands Endemic Bird Area (EBA) identified by Birdlife International (BI). According to BI "within [this] EBA there are interesting distributional patterns" and "bird distributions in this part of the Amazon basin are very poorly known" (BI 2003).

Recent studies in the WSF avifauna (Whitney & Álvarez-Alonso 1998; Isler et al. 2001a; Isler et al. 2001b; Álvarez-Alonso & Whitney 2001, Whitney & Álvarez-Alonso 2005)–and flora (Smith et al. 2001; Maas & Westra 2003; García-Villacorta & Hammel 2004; Struwe & Albert 2004; Wallnöfer 2004) has shown that a large part of the endemism in this EBA—and its "interesting distributional patterns" (BI 2003)—is almost exclusively due to the endemic birds inhabiting white-sand forests and hence would represent world level conservation priority.

Indeed, recent trends in species description from the WSF raise the possibility that more new species wait to be discovered and described. The assessment of WSF patches in the lowlands of Loreto as proposed in this project is exciting for science and for conservation and will fill a knowledge gap in this important EBA.

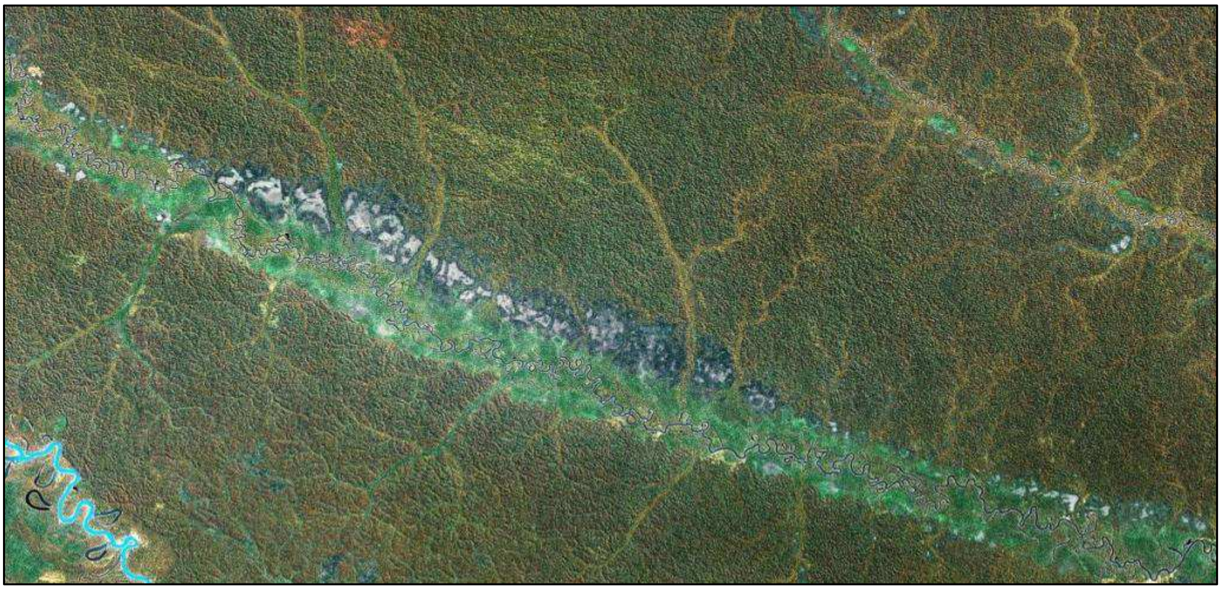
Figure 4. View of a packed-stem forest density typical of white-sand forests in Peru

This is more a necessity now than ever since the government of Peru has issue recently an indiscriminate concession for timber extraction in Loreto that may probably affect these forests. Given its geographical distribution as patches of different sizes the flora and fauna of these forests qualify as fragile ecosystems and we still require more information about their distribution and abundance before we can conclude safely about their real conservation status.

We identified 10 recently described species from the white sand forests of Amazonian Peru (five birds, and five plants) and proposed to investigate their relative abundance, and distribution in five unstudied patches of WSF of this region. Bird and floristic assessments on white-sand forests in Peru are scarce and none one have visited the selected study sites in the Upper Nanay and Tigre Rivers (Alvarez-Alonso 2002; García-Villacorta et al. 2003). Since this habitat occurs in a matrix of tropical Amazonian forest they are also threatened by selective and destructive logging activity prevalent in the area. Consequently another goal of this project was to created local awareness for the conservation of this important habitat.

In this report we present the results of our expeditions to the white-sand forests of the Upper Amazon in Peru which includes a detailed analysis of the data, along with comparison with other sites, relative abundances, and degrees of similarities among study sites. Both results of flora and avifauna are contrasted as well as a summary of our efforts to build conservation awareness for these forests in local Amazonian communities.

Figure 5. Landsat satellite image of the Upper Nanay River showing the distribution of white-sand habitats (whitish-gray color).



6. METHODOLOGY

6.1 Avifauna

To study the bird community at our study sites we used a 1-km transects crossing each white-sand forest supplemented with bird nets arranged systematically along transects. We recorded the presence or absence of birds along these transects and recorded bird relative abundance at each 25 m distance on the transect using the point-count method (Edwards et al. 1981).

Bird assessment included a recording of their song or call when possible for later identification. We also used six bird nets of 12 meters systematically distributed along the patch in order to capture and photograph bird species. Birds caught with nets were photographed and released briefly afterwards (Figure 6, Annex 4).

For bird observation and recording we used a 10x40 Zeiss® and Leica® binoculars and two song recorders: a Sony® TCM-200DV, and a Panasonic® 200DV along with a directional microphone. In order to gather abundance data we used four classes of relative abundance: C = common (observed each day, more than 8 individuals), F = slightly common (observed each day, less than 8 individuals), U = almost rare (observed more than twice but not each day), R = rare (observed only once). Bird assessment was conducted in a period of 4-6 day interval at all sites.

To gain insights into the bird community diversity and abundance we analyzed the data at the family and species levels. We paid special attention in the abundance level of our five target species as well as the diversity patterns among sites. To understand better the compositional data we performed a clustering analysis with Ward algorithm based on species presence/absence data. A similarity matrix using the Jaccard index was developed to compare the degree of similarity between sites. We used a Non-metric Multidimensional Scaling (NMDS) analysis to further explore compositional similarity among sites.

Figure 6. Bird nets were systematically arranged along the 1 km-transect at each site.

6.2 Flora

At each study site we set up a 0.1 ha floristic plot consisting of 10 50x2 m transects arranged perpendicular to a baseline of 180 meters. At each plot all the plants larger than 2.5 cm diameter were counted, and identified to species. Any plant that was not positively identified to species was collected for posterior work at the herbarium of the Universidad Nacional de la Amazonia Peruana. Collected plants were preserved in alcohol in the field following standard botanical protocols.

Because two of our target species were a small treelet (*Potalia coronata*) and a fern (*Metaxia lanosa*) that our quantitative sampling protocol would have miss, we walked outside the plots along the trails to search for the presence of these particular species. Study sites were chose to represent primary conditions of white-sand forests, avoiding as much as possible areas with clear human impacts.

Floristic lists of the total five plots were subjected to the following analysis: relative diversity, relative density, relative dominance, and relative frequency. This data were further used to calculate an Importance Value Index (Mori et al. 2003) for each species to gain insights in forest structure, ecological dominance and diversity patterns. Similarities among white-sand patches were determined by calculating a Bray-Curtis index for each pair of sites using abundance data (Magurran et al. 1988).

We also analized the relative abundance of species, genera, and families across the study sites. We complemented these analysis calculating an index of dominance (D), and Fisher's Alpha index of diversity which has been shown to be appropriate when number of stems varies between study sites.

The dominance index ranges from 0 to 1 (zero meaning all taxa are equally present, and 1 when one taxa dominates the community completely). Higher Fisher's Alpha index value means higher diversity.

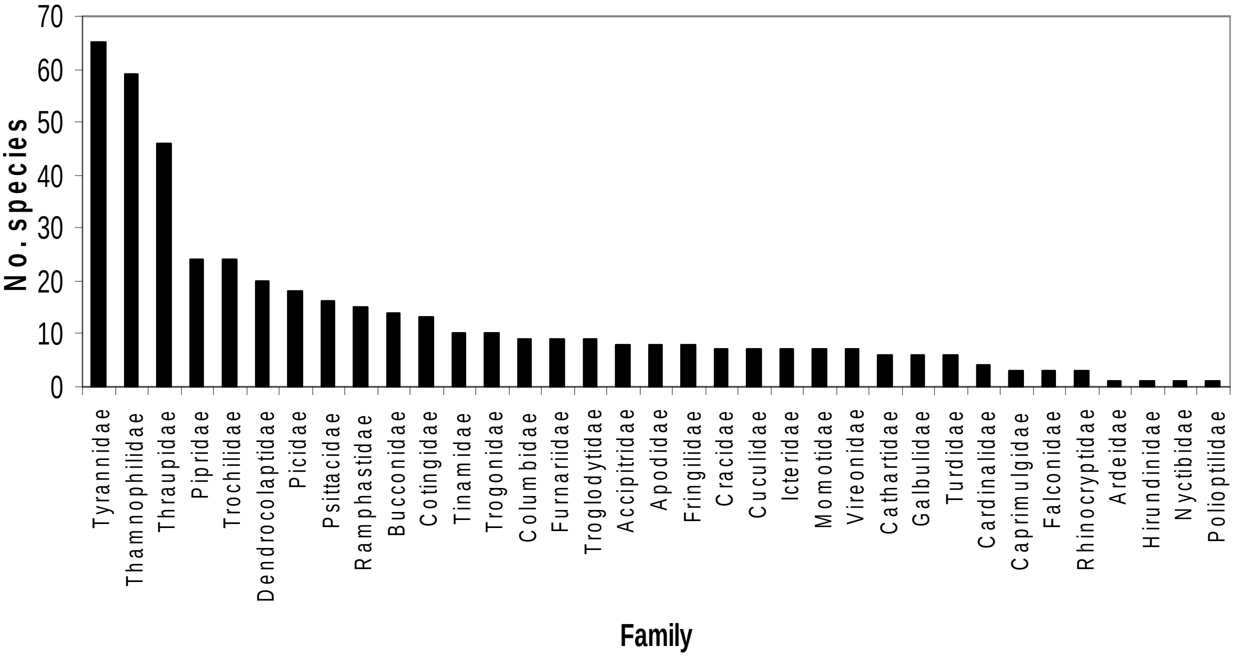
In addition to the previous analyses, we conducted multivariate analyses using clustering and ordination techniques. We used a hierarchical clustering method with Ward algorithm, which measures the variance in species composition between pair groups when making the groupings. For ordination analysis we used Non-metric Multidimensional Scaling (NMDS) that plots together similar study sites and further apart dissimilar sites.

7. OUTPUTS AND RESULTS

7.1 Avifauna

We found a total of 177 species belonging to 35 families out of total of 455 records in the whole expedition. The three most important families per number of species in the white-sand forests we visited were Tyrannidae, Thamnophilidae, and Thraupidae (Figure 7). The rarest families, represented by only one species, were: Ardeidae, Hirundinidae, Nyctibidae, and Polioptilidae.

Figure 7. Avifauna species richness of families found in all four white-sand forests sites.



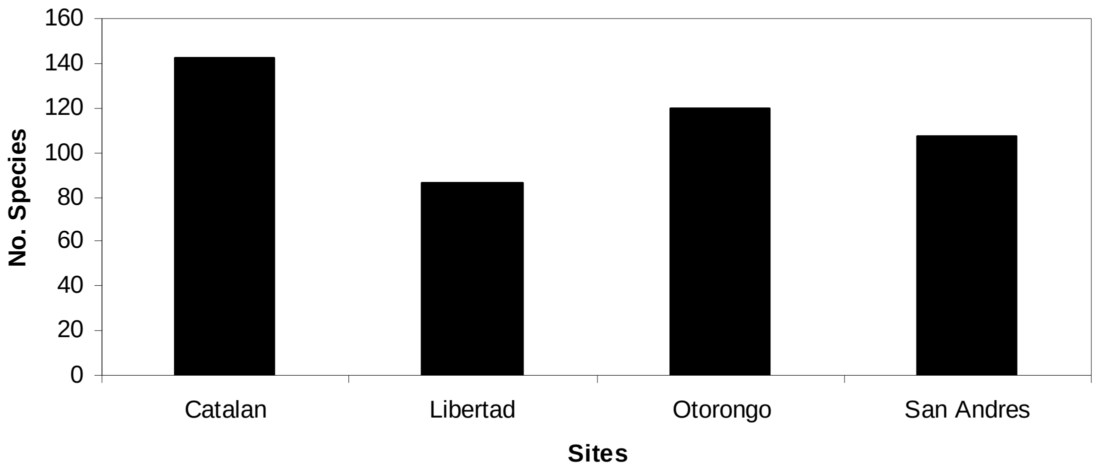
73% of the white-sand forest avifauna community showed some degree of rarity (20% of species were rare, and 52% of species were almost rare). Only 15% of species (27 out of 177 species) were found to be common (recorded at more than 8 individuals) compared to 27% that was fairly common across sites. Regarding our target species *Myrmeciza castanea* (Northern Chesnut-tailed Antbird) and *P. arenarum* were found to be common but at different abundance levels among sites (Table 2). *P. arenarum* was recorded at all four sites: common at Catalán and Otorongo, fairly common at Libertad (Nanay River), and rare at San Andrés (Tigre River). *M. castanea* was found common at Catalán and Otorongo but uncommon at Libertad and San Andrés.

H. gentryi occurred at all four sites but was uncommon in all of them. A weak song of *P. clementsi* was recorded at Catalán but we concluded that it is no possible to be certain about its presence based on this unique record and we left its presence as uncertain until more studies verify its presence on this area. If confirmed this would be a second record for *P. clementsi* which has only been recorded for white-sand forests located on the lower Nanay River area. *Z. villarejoi* was recorded as rare in both Catalán and Otorongo. Annex 1 present a full list of bird species found at each study tide along with abundance and habitat preferences information.

Table 2. Summary table of the relative abundance of the five white-sand bird specialists found in four study sites, Peruvian Amazon. Abundance: C = common (observed each day, more than 8 individuals), F = slightly common (observed each day, less than 8 individuals), U = almost rare (observed more than twice but not each day), R = rare (observed only once)

Species	Abundance	Catalan	Libertad	Otorongo	San Andres
Herpsilochmus gentryi	U	✓	✓	✓	✓
Percnostola arenarum	C	✓		✓	
	F		✓		
	R				✓
Polioptila clementsi		?			
Zimmerius villarejoi	R	✓		✓	
Myrmeciza castanea	C	✓		✓	
	U		✓		✓

Figure 8. Bird diversity among study sites: Catalán, Otorongo, and San Andrés. Catalán site was the most diverse overall with 142 species) and Libertad the less diverse site (86 species).



Bird compositional similarity measured by Jaccard's presence-absence distance and cluster analysis showed that San Andres and Otorongo sites were more similar compared to Catalán and Libertad sites (Table 3, Figures 9).

Figure 9. Cluster analysis of avifauna sites based on a presence-absence index of similarity computed with Jaccard's index and Ward's distance for making the groups.

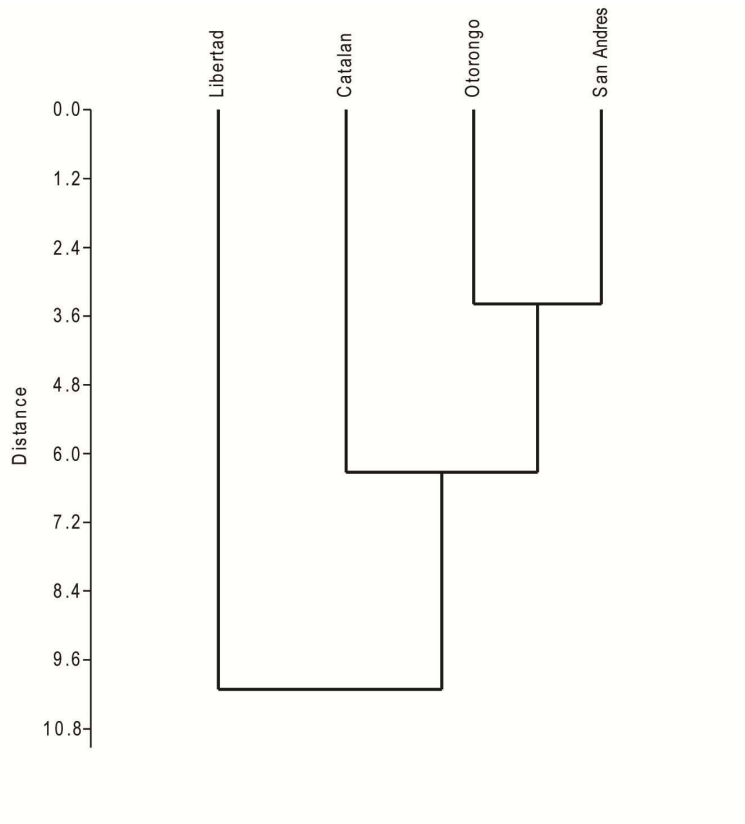


Table 3. Similarity (upper diagonal) matrix based on species composition between sites using the Jaccard index. Values range from 1 (completely similar) to 0 (completely different). Extreme values in bold.

	Catalan	**Libertad**	**Otorongo**	**San Andrés**
Catalan	1	**0.34118**	0.71242	0.64901
Libertad		1	0.37333	0.39855
Otorongo			1	**0.816**
San Andrés				1

Detailed results at each site

Catalán

We found 142 species of birds belonging to 34 families. The most important bird families in number of species were Tyrannidae, Thraupidae and Thamnophilidae. Among the WSF specialists we found *Herpsilochmus gentryi*, *Percnostola arenarum*, *Zimmerius villarejoi* and *Myrmeciza castanea*. We also found four recently reported species for Peru: *Notharchus ordii*, *Hemitriccus minimus*, *Neopelma chrysocephalum*, and *Xipholena punicea*. One species associated with poor soils was also found here: *Heterocercus aurantiivertex*. Among the white-sand forest specialists *Percnostola arenarum* and *Myrmeciza castanea* were the most common in this area, specially in the first 300 m of the transect which had a bad soil drainage (wet WSF). *Zimmerius villarejoi*, another rare species from white-sand forests was also found in this habitat, and less frequently *Herpsilochmus gentryi*. Two species were more frequent in this WSF patch: *Neopelma chrysocephalum* and *Heterocercus aurantiivertex*. Both species were common along the transect but the second was most commonly observed on the white-sand forest with good drainage (dry WSF) at the last part of the 1-km transect. Regarding the target species all white-sand specialists were found at this locality except for *Polioptila clementsi* that so far is only known from a small population in the Allpahuayo-Mishana National Reserve near the Iquitos. See Annex 1 for a detailed list of species and their relative abundance found in this area.

Otorongo

In the white-sand forest at Otorongo we recorded a total of 120 species, corresponding to 31 families. The families Tyrannidae and Thamnophilidae tanager recorded the highest number of species for this site. Of the 16 species of birds discussed by Alvarez and Whitney (2003) associated with poor soils we found four newly described species: *Herpsilochmus gentryi*, *Percnostola arenarum*, *Zimmerius villarejoi*, and *Myrmeciza castanea* (Álvarez and Whitney 2003; Alvarez and Whitney 2001; Isler et al, 2002; Isler et al, 2002; Whitney and Alvarez 1998, 2005) and four newly reported species for Peru *Notharchus ordii*, *Hemitriccus minimus*, *Neopelma chrysocephalum*, and *Xipholena punicea*. We also recorded an additional species associated with poor soils *Heterocercus aurantiivertex*. In the first 100 meters, which corresponded to a high-wet white-sand forest (García-Villacorta et al. 2003), *Percnostola arenarum*, and *Myrmeciza castanea* were common. *Zimmerius villarejoi* was recorded at about 500 meters of the trail, on a dry-tall white-sand forest, and it was one of the rarest species for this varillal. Another species found infrequently in this varillal was *Herpsilochmus gentryi*. Two species were found much more frequently, these were *Heterocercus aurantiivertex*, and *Neopelma chrysocephalum*; both were very abundant in this white-sand forest. The later was much more frequently found in the wet part of this white-sand forest, while the former, could be found in the wet and also in the dry white-sand forest. A tyrannido, *Neopipo cinnamomea*, which is rare to find and also has some degree of preference for the poor soils was captured in nets, along with the boreal migrant *Catharus ustulatus*, caught in nets and photographed (Annex 4). One of the records, so far uncertain, was of an individual of the rare and threatened

Libertad

In the white-sand forest at Libertad we recorded a total of 86 species occurring in 25 families. Thamnophilidae (18 species), and Tyrannidae (11 species) were the families with the greatest number of species on this site. Of all the bird species discussed by Alvarez and Whitney (2003) associated with poor soils we only found three of our target species: *Herpsilochmus gentryi*, *Percnostola arenarum*, and *Myrmeciza castanea* (Álvarez and Whitney 2003; Isler et al, 2002; Isler et al, 2002; Whitney and Alvarez 1998, 2005). There was also an additional species associated with poor soils *Heterocercus aurantiivertex*. Few other species associated with other habitat types different from white-sand were found in this white-sand forest patch. According to the classification of Garcia-Villacorta *et al*. (2003) the studied white-sand forest patch corresponds to a low and wet white-sand forest (less than 25 m tall) with very poor drainage.

San Andrés

In the white-sand forest of San Andres we recorded a total of 107 species, corresponding to 29 families. Tyrannidae (15 species), Thraupidae (13 species) and Thamnophilidae (11 species) recorded the highest number of species for this site. According to the classification of García-Villacorta *et al*. (2003) the white-sand forest studied corresponds to a low-wet-white-sand-forest (less than 25 m forest height) with very poor drainage.

Of all the bird species discussed by Alvarez and Whitney (2003) associated with poor soils found in the study site only six were found, these include three newly described species: *Herpsilochmus gentryi*, *Percnostola arenarum*, and *Myrmeciza castanea* (Álvarez and Whitney 2003; Isler et al, 2002; Isler et al, 2002; Whitney and Alvarez 1998, 2005) and three species newly reported for Peru: *Notharchus ordii*, *Neopelma chrysocephalum* and *Xipholena punicea*. There was also an additional species associated with poor soils, *Heterocercus aurantiivertex*. Few other species associated with other habitat types were also found on this white-sand forest patch.

7.2 Flora

A total of 172 plant species distributed in 101 genera and 58 families were found. In terms of species richness Libertad had the most number of species with 105 species whereas Otorongo2 had 38 species. Total number of individuals varied several order of magnitudes between sites, ranging from 190 (Otorongo2) to 882 individuals (Libertad). The site with the highest dominant score was Catalán (0.15) compared to Libertad (0.06). Species diversity measured by Fisher's Alpha showed that Libertad was the most diverse site (Fisher's Alpha = 31.06) followed distantly by San Andrés (20.19) and Otorongo1 (21.36). The least diverse site was Otorongo2 (14.28) (Table 4).

Table 4. Summary table of species richness, diversity, dominance, and abundance at each study site.

	Catalan	Libertad	Otorongo1	Otorongo2	San Andrés
No. Species	46	105	64	38	73
Individuals	456	882	406	190	730
Dominance	0.1521	0.05778	0.0612	0.09535	0.06485
Fisher's Alpha	12.77	31.06	21.36	14.28	20.19

Caraipa utilis, a canopy tree, was the most important species overall in terms of number of individuals and Importance Value Index (IVI), with 372 stems out of a total of 2664 stems and 114.20 IVI value respectively. However, its abundance differed among sites, being most abundant at Libertad (172 stems) and San Andrés (112 stems) compared to the other sites. *Pachira brevipes* was the second species with a large number of individuals in all the plots, totaling 256 individuals. The ten most important species are showed in Table 5.

Table 5. The ten most abundant species across study sites. Each site was 0.1 ha. Plant threshold sampling was 2.5 cm DBH (Diameter at Breast Height).

Species	Catalán	Libertad	Otorongo1	Otorongo2	San Andrés	Total
Caraipa utilis	20	172	42	32	112	378
Pachira brevipes	70	22	53	17	94	256
Blastemanthus sp. nov.	154	0	0	0	0	154
Ferdinandusa loretensis	12	53	0	0	52	117
Chrysophyllum sanguinolentum	2	26	32	6	24	90
Cupania diphylla	8	29	12		37	86
Dendropanax umbellatus	10		36	12	20	78
Dicymbe uaiparuensis	21	38	14	4	0	77
Sloanea parvifructa	10	14	17	0	34	75
Remijia macrocnemia	5	1	41	19	4	70

Dominance in structural patterns suffered some changes when we incorporated frequency, density, and species dominance (as represented by basal area) into the analysis measured by IVI (Importance Value Index). In this analysis the top most abundant species however keep their hold (*C. utilis*, and *P. brevipes*) and *C. sanguinolentum* moved ranks up. Interestingly, we found that five of the most abundant species were replaced by another set of five species. The most striking change in the rankings occurred to the treelet *R. macrocnemia which* went from number ten in the abundance table (Table 5) to number four in the IVI analysis (Table 6).

Table 6. The ten top species measured by their Importance Value Index (IVI = relative density (rde) + relative frequency (rf) + relative dominance (rdo)). Notice density and basal area are estimated in hectares.

Species	Density/Ha	Freq.	Dominance [Basal Area/Ha]	Rde	rf	rdo	IVI
Caraipa utilis	756	1	85.25	14.19	100	0.01	114.20
Pachira brevipes	512	1	4100.76	9.61	100	0.56	110.17
Chrysophyllum sanguinolentum	180	1	157.92	3.38	100	0.02	103.40
Remijia macrocnemia	140	1	1809.06	2.63	100	0.25	102.88

Ternstroemia klugiana	72	1	8211.96	1.35	100	1.13	102.48
Parkia igneiflora	94	1	140.34	1.76	100	0.02	101.78
Ilex cf. vismiifolia	38	1	3540.43	0.71	100	0.49	101.20
Buchenavia amazonia	22	1	567.24	0.41	100	0.08	100.49
Aspidosperma excelsum	34	0.8	48982.43	0.64	80	6.73	87.37
Sloanea parvifructa	150	0.8	7685.24	2.82	80	1.06	83.87

Among the tree species target of this project *Lissocarpa kating* (Lissocarpaceae) was found at three out of our five sites but in very low abundance (1-2 individuals). A similar low abundance value was found for the tree *Tovomita calophyllophylla* (Clusiaceae). The only target tree not found in any of our study plots was *Pseudoxandra atrata* (Annonaceae).

The other two species focus of this study was a treelet (*Potalia coronata*, Gentianaceae), and a fern (*Metaxia lanosa*). They did not fall into the quantitative sampling of the plots but both of them were present among the study sites: *P. coronata* had a low abundance, whereas *M. lanosa* was very abundant in the understory of some plots (Figure 1). Table 7 gives a summary of the abundance level of our target species.

Table 7. Abundance of the five target plant species found at five white-sand forests of the Peruvian Amazon. *P. coronata* (treelet), and *M. lanosa* (fern) abundance were measured qualitatively.

Species	**Catalan**	**Libertad**	**Otorongo1**	**Otorongo2**	**San Andrés**	**Total**
Lissocarpa kating	1	0	1	2	0	4
Tovomita calophyllophylla	0	2	1	0	1	4
Pseudoxandra atrata	0	0	0	0	0	0
Potalia coronata	rare	rare	rare	Rare	Rare	Rare
Metaxia lanosa	common	common	common	Common	Common	Common

The most diverse genus was *Macrolobium* (Fabaceae, 7 ssp.), followed by *Sloanea* (Elaeocarpaceae, 6 spp.), *Pouteria* (Sapotaceae, 5 ssp.), *Protium* (Burseraceae, 4 spp.), *Aspidosperma* (Apocynaceae, 4 spp.), *Swartzia* (Fabaceae, 4 spp.), *Tachigali* (Fabaceae, 4 spp.), and *Tovomita* (Clusiaceae, 4 ssp.). Annex 2 shows the full species found at all sites along with information of their relative abundance.

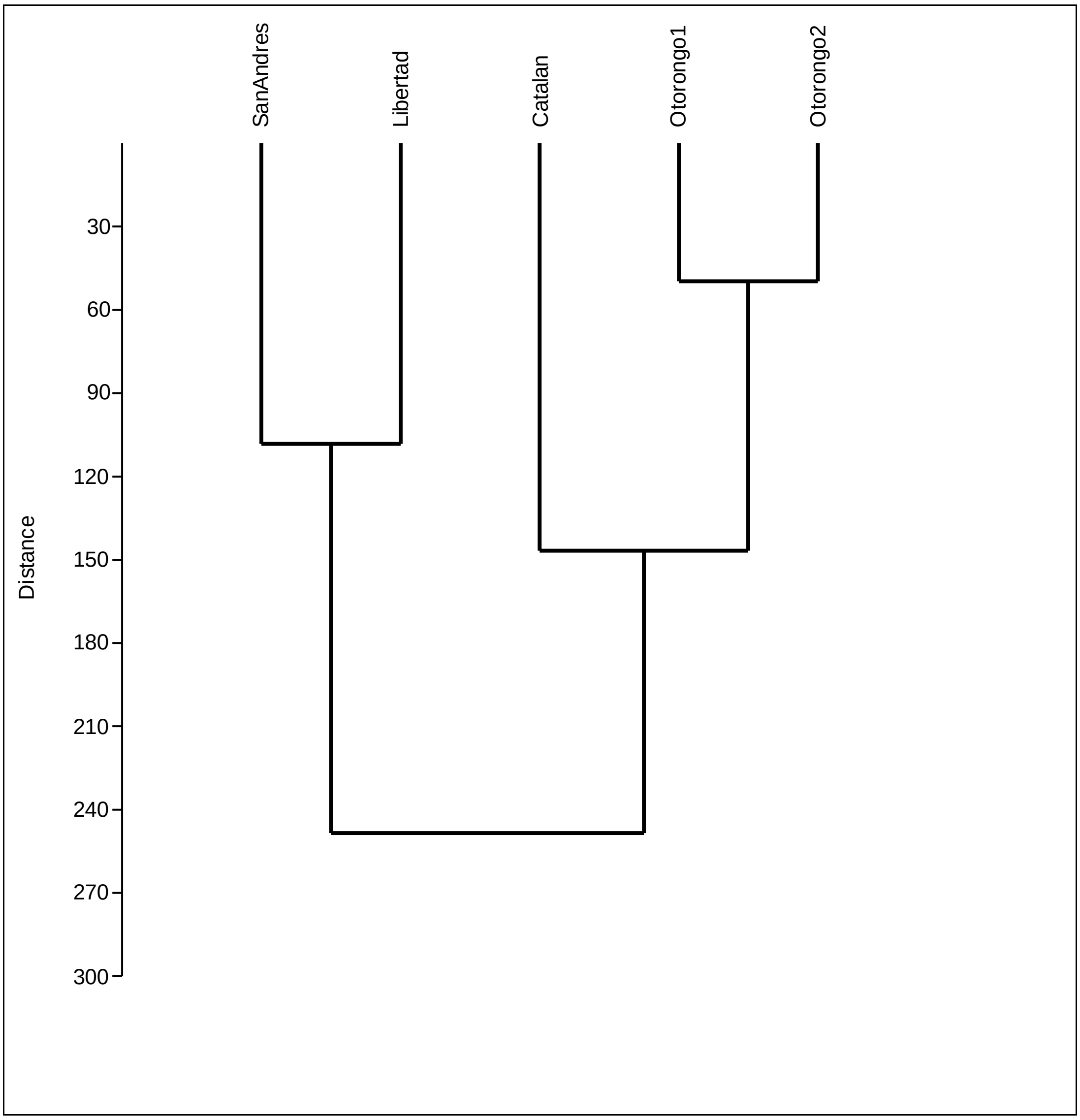
At the family level Calophyllaceae (398 stems), Fabaceae (335), Malvaceae (257), Rubiaceae (210), and Sapotaceae (179) concentrated 52% of all stems (2664) of the total 58 families. The sixth position was occupied by Ochnaceae with *Blastemanthus* sp. nov. which was absent at all other sites. Table 8 shows the 10 most important families in number of stems among study sites.

Table 8. Summary of abundance (number of stems) of the ten top plant families across study sites.

Family	Catalán	Libertad	Otorongo1	Otorongo2	San Andrés	Total
Calophyllaceae	20	192	42	32	112	398
Fabaceae	34	224	41	15	21	335
Malvaceae	70	23	53	17	94	257
Rubiaceae	18	58	41	20	73	210
Sapotaceae	41	39	56	17	26	179
Ochnaceae	154	0	0	0	0	154
Arecaceae	0	34	4	0	79	117
Sapindaceae	9	32	12	1	45	99
Elaeocarpaceae	10	15	24	0	44	93
Araliaceae	10	1	36	12	20	79

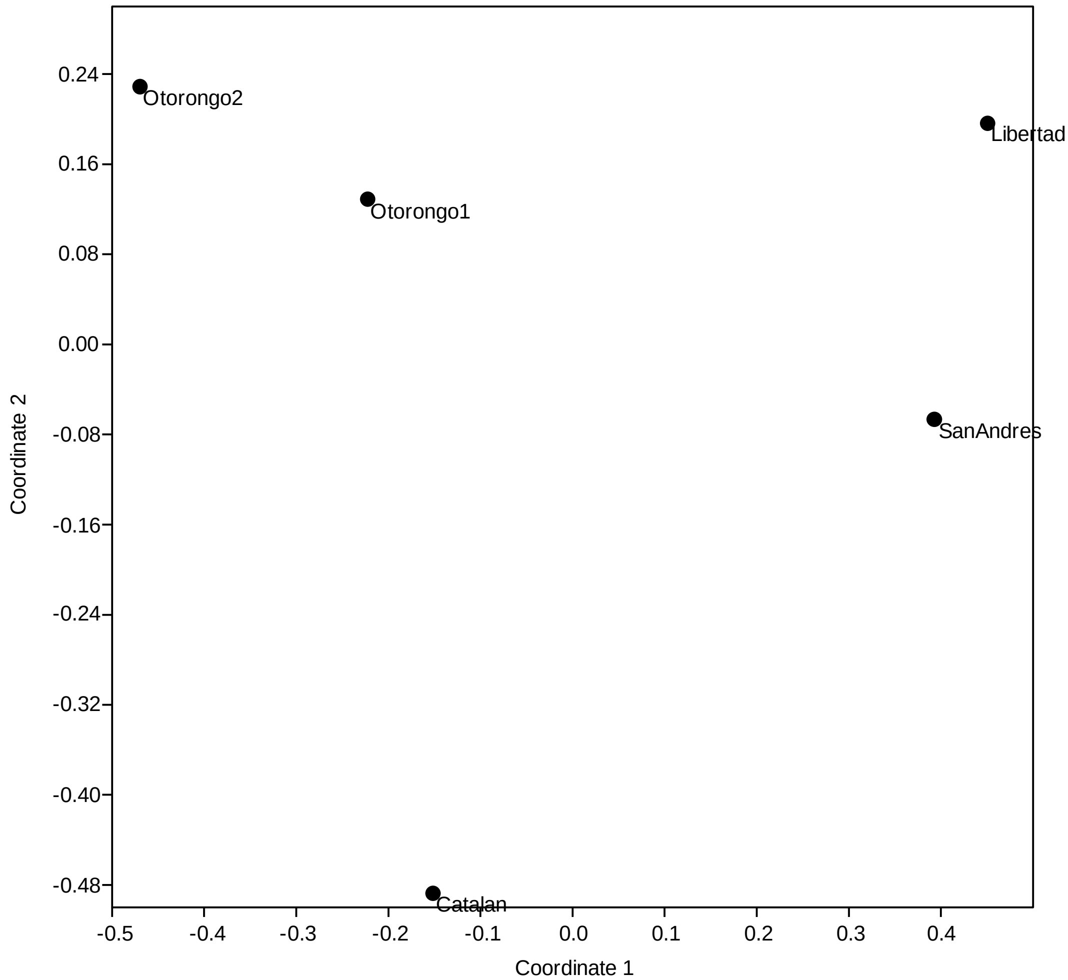
The cluster analysis revealed that San Andrés (Rio Tigre) and Libertad (Rio Nanay) were floristically more similar compared to the other three sites, which opposite to the pattern we found with birds. In this group Otorongo1 and Otorongo2 formed another group along with Catalán (Figure 10).

Figure 10. Cluster analysis of sites based on floristic composition and Ward's distance.



The ordination NMDS analysis supported the cluster analysis results but highlighted that Catalán was indeed different from the rest of sites in floristic terms as expressed by the separation of this site along the two ordination axes (Figure 11).

Figure 11. Non-metric Multidimensional Analysis (NMDS) of study sites based on the floristic composition of species using Bray-Curtis index.



Last but not lees, perhaps the most exciting plant finding of all sites was the discovery of a new genus for Peru and potentially a new species for science in the genus *Blastemanthus* (Ochnaceae). This *Blastemanthus* unnamed species only occurred in the Catalán white-sand forest, and dominated this plot in sheer number of individuals (154 stems) and this sole abundance positioned it as third in rank on the top of dominants across sites based on number of individuals alone.

8. DISCUSSION

8.1 Avifauna patterns

Our assessment of five previously unvisited white-sand forest patches in the Peruvian Amazon shows the presence of the majority of the plants and bird species described as new to science in the past 10 years with only two exceptions: *Polioptila clementsi* and *Pseudoxandra atrata* (Table 2, and Table 7). Most of the avifauna, including target species, occurs at low abundance levels with 73% being rare overall and 27% species common or fairly common (Annex 1). From our target species list *Percnostola arenarum*, and *Mirmeciza castanea* were the only two species found to be common or fairly common in at least one study site (Table 2). Alvarez-Alonso (2002) studied four white-sand forests in different sites to ours on the same region. He found that *P. arenarum* was significantly associated with low-humid-varillales where the palm *Euterpe catinga* was dominant. Interestingly *P. arenarum* was recorded as rare at San Andrés, the only site we recorded the palm *E. catinga*. It was however common at Catalán and Otorongo plots were this palm species was not found. Although the bird sampling at San Andrés was hindered by rainy days this does not explain the presence of this species in Catalán and Otorongo. This result may indicate that either we missed to sample *E. catinga* palm in other sectors of these varillales at Catalán and Otorongo or that this bird species uses wet varillales more broadly, without restricting itself to white-sands with this palm species. He also found that *P. arenarum* and *H. gentryi* were consistently more common, using both transect and point count sampling among his study sites, compared to our findings (Table 2). *P. arenarum* and *M. castanea* were found along with *H. gentryi* at all of our sites. However the two first species were observed at different degrees of abundance levels whereas *H. gentryi* individuals were consistently rare at all sites.

These later differences may be explained by their natural variation in abundance patterns (*H. gentryi* being rarest) as well as the broader niche breath of the other two species that allow them to exploit other poor-nutrient habitats but not necessarily on white-sands. In his analysis of species distribution patterns of the same three species as ours Álvarez-Alonso (2002) catalogued *H. gentryi* as "facultative white-sand specialist", whereas *P. arenarum* and *M. castanea* were classified as "near obligate white-sand specialist", meaning that they were found at white-sand forests in Peru but also at other habitat types in other regions of the Amazon. *Z. villarejoi*, another of our target species, was found to be rare in the only two sites we detected its presence: Catalán and Otorongo. This species has apparently preference for "low-dry white-sand forest" with the multi-stemmed legume *Dicymbe uaiparuensis* structurally dominant (Álvarez-Alonso 2002). *D. uaiparuensis* was the 13th species in importance in our sites and was absent only at San Andres, where *Z. villarejoi* was not found. This habitat type is not common at our study sites, except for some sectors at Catalán and Otorongo, and may imply that sampling of more white-sand forests of this type may yield a better abundance representation of this bird species. Either way, our findings seems to support the observation that *Z. villarejoi* is an "obligate white-sand species" that occur on white-sand forest with good drainage conditions where D. uaiparuensis happens to prefer (Álvarez-Alonso 2002). It is important to stress here that soil moisture gradients in white-sand forests varies continuously in the same forest patch and thus certain bird species may prefer certain sectors according to their ecological preferences. *Polioptila clementsi*, a white-sand specialist first described for the white-sand patches of Allpahuayo-Mishana Reserve, lower Nanay River, was not found with certainty at any site. We have a potential record at Catalán but it is not conclusive and it will be necessary to monitor this area for its presence in the future.

The avifauna assessment in the white-sand forests of San Andrés shows low presence of bird species target of this project. Of the new species described, both *Herpsilochmus gentryi* and *Myrmeciza castanea* were found infrequently along the transect in this forest. *Percnostola arenarum* was very rare in the study area, recorded just once during the whole study period (Table 2). Although the habitat was optimal for the presence of *P. arenarum*, its low abundance may be due to the continuous rains that occurred while we doing the field work at this site. It is important to mention that the northern Peruvian Amazon does not have a particular dry and wet season, and rain fall continuously along the year. The same level of frequency was found for *M. castanea* and *H. gentryi*. However we also suspect that the low record in abundance of the latter could be associated with the low canopy height of this white-sand forest patch. Two species were found much more frequently: *Heterocercus aurantiivertex*, and *Neopelma chrysocephalum*. Both species were very abundant in this varillal, the latter being most frequent. *Zimmerius villarejoi*, and *Polioptila clementsi* were absent in this white-sand forest patch probably because of the distance that separates this forest patch with other places where *P. clementsi* is more common (lower Nanay River) or the height of the forest. The explanation for the absence of *Z. villarejoi* from here however is more straightforward: this species prefer a better-drained white-sand forest, clearly absent from this white-sand forest at San Andrés. The migratory species *Catharus ustulatus* ("Swainson's Thrush") was captured in a mist net at this study site (Annex 4).

The results of our avifauna assessment in the white-sand forests of Libertad, showed that the newly described species of *H. gentryi* and *M. castanea* were found infrequently in this site along the 1-km baseline transect of mostly dry white-sand forest. *P. arenarum* was unusually prevalent in the study area and apparently this habitat was optimal for the presence of this rare ant bird. Unlike *M. castanea*, and *H. gentryi*, which were rare on this forest patch, *Heterocercus aurantiivertex* (an oligotrophic specialist) was very abundant in this white-sand forest; and this is probably due to the proximity of water bodies such as the Nanay River or swamps on its floodplain. *Zimmerius villarejoi* and *Polioptila clementsi* were absent in this varillal. It is interesting to point out that the two most diverse bird families (Tyrannidae, and Thamnophilidae) include one and three of our target white-sand bird specialists respectively. What ecological or historical factors make the members of both families more prone to have white-sand specialists? We do not have yet the answer, but we hope to tackle this question in the future.

The cluster analysis showed that Libertad (in the Nanay basin) hosted a different white-sand avifauna based on its species composition to the other sites. This result is striking considering that our Site at San Andres (Tigre basin) clustered with our other two sites in the Nanay area. Given its position in another basin we expected that this site will separate by itself from the other sites. This result can only be explained by the fact that the avifauna sampled at San Andrés inhabited a similar white-sand forest than our other two sites at Nanay: Otorongo and San

Andrés. According to our field data Libertad site was basically a dry-white-sand forest, which was almost absent in our other sites (except perhaps for some sectors at Otorongo and Catalán).

8.2 Floristic patterns

Our floristic data recovered a partial pattern with two groups, separating clearly Otorongo (1 and 2) and Catalán as a group. This same result was reflected in our plant ordination analysis, with Libertad and San Andrés more close together than the other sites. It is important to note however the NMDS ordination analysis also separated Catalán from the rest of sites (Figure 6). However it clustered floristically Libertad with San Andrés as a group. This partial grouping inconsistency between datasets may reflect the fact the both San Andrés and Libertad and geographically closer (albeit on different basins, Figure 1) compared to our other sites. It may also indicate that San Andrés flora may have a good number of species that thrive on both dry-and-wet white-sand forests. An examination of our species lists on these sites shows that the difference in ecological patterns between studied groups may be a consequence of similarity in forest structure that both San Andrés and Libertad may share, measured as stem-density (and hence micro-habitat types). Both sites had the highest number of stems of all sites (Libertad = 882 stems vs. San Andrés 730 stems) compared to less than 500 stems found at the other three sites (Table 4). This by itself is remarkable and may set them apart and help explain their similar avifauna composition as shown by the cluster analysis.

In addition to having similar stem density, a canopy tree representative of wet white-sand forests, *Caraipa utilis* (Calophyllaceae), makes most of the stems (172 vs. 112) at both sites compared to less than 50 individuals (range = 20-42) found at the other sites in our samples. The most notable difference in structure that may not have a noticeable influence on the avifauna composition and diversity at both sites is the average forest height (8 m vs. 16 m at San Andrés and Libertad respectively). Overall however, *C. utilis* was the most important species in terms of abundance, frequency and dominance across all sites, as expressed by its high IVI (Importance Value Index), followed closely by *Pachira brevipes*, a slender mid-canopy tree (Table 6). Both species characterize white-sand forests on bad drainage (wet white-sand forests) in Peruvian Amazonia (García-Villacorta 2003).

In terms of plant target species, we found all plant species in our study areas but one, the Annonaceae *Pseudoxandra atrata*. This tree has been reported from the Allpahuayo from the Allpahuayo Mishana Reserve, and the locality of Mishana in lower Rio Nanay. We expect that future botanical explorations in these areas will focus their efforts to document this rare plant species. Overall, all other species in our target list were found to be rare, or at least not common in the forest community except for the fern *Metaxia lanosa* (Table 7). This species (Figure 2) sometimes thrives on the forest understory of certain dry and wet white-sand forests and we believe has a healthy population in the forest patches we studied. It is important to emphasize at this point that the majority of species occurring at white-sand forests are rare, but some of them can achieve dominance due to stochastic and/or ecological adaptations.

8.3 A potentially a new species in the genus *Blastemanthus* (Ochnaceae)

Finally, we found a remarkable plant species in the genus *Blastemanthus* (Ochnaceae) that dominated in number of individuals the sampling plot at Catalán. In fact, this species was only found at this site and nowhere else. This genus has never been recorded for Peru before, and its few species are reported in the botanical literature to occur at white-sand forests of the Upper Rio Negro basin of Venezuela, and Brazil (Gentry 1993).

Figure 12. A potentially new species for science in the genus *Blastemanthus* (Ochnaceae) found at Catalán, Nanay River.

Its leaves have super-dense secondary veins, acuminate leaf tip, high-relief midrib on the upper leaf side, and a decurrent leaf base clustered at the end of short shoots along slender branches similar to Combretaceae. It does not reach a big size and occur mostly as a treelet (Figure 12, K. Meza. pers. obs.). As the site where we find it testifies it prefers white-sand forests with bad drainage (wet white-sand forests *sensu* García-Villacorta *et al*. (2003). Although it is possible that its presence at Catalán site represents a range extension from the Guianan ecoregion of a currently known species, a preliminary review of the scientific literature give us confidence that this collection may result in a new discovery for science. We found this species without fruits and flowers and we intend to monitor it in the future to get fertile collections that can allow its formal description.

9. CONCLUSIONS

1. We found a total of 177 bird species belonging to 35 families out of total of 455 records in the whole expedition. A total of 172 plant species distributed in 101 genera and 58 families were found across all studies sites.

2. Of the ten species of birds and plants we studied in the white-sand forests of upper Peruvian Amazonia we found 8 of them. The two species we did not find (*Polioptila clementsi*, and *Pseudoxandra atrata*) may occur at extremely low density or occupy the lower parts of the Nanay basin from which they were originally described.

3. We report for the first time a new plant genus in the Ochnaceae family for the Peruvian Amazon: *Blastemanthus*. This genus has never been recorded for the Peruvian Amazon before, and its few species are reported to occur in the botanical literature at the Upper Rio Negro basin of Venezuela, and Brazil. Fertile material is required for a formal description.

4. We estimated quantitatively and qualitatively plant and avifauna abundance patterns. We also analized the similarities and differences on their abundance, dominance and structural patterns in order to gain knowledge on their ecological preferences, natural history and rarity. Both groups of organisms expressed complementary results.

5. 73% of the white-sand forest avifauna community was found to be rare (20% of species were rare, and 52% of species were almost rare). Only 15% of species (27 out of 177 species) were found to be common compared to 27% that was fairly common across sites. We found all plant species in our study areas but one, the Annonaceae *Pseudoxandra atrata*. All plant target species found occurred at low densities except for the fern Metaxia lanosa, which was locally abundant at some understory white-sand patches.

6. Of the total number of birds restricted to white-sand forests all of them were present on at least one site except for *Polioptila clementsi*. This rare bird is apparently confined to small populations of the lower Nanay River, specifically at the white-sand forests of the Allpahuayo Mishana Reserve where its original description comes from.

7. The plant community did not show a similar pattern than the avifauna. Floristic similarity driven the dominance of one canopy species, *Caraipa utilis*, resulted in two sites located at different basins (Libertad in the Nanay basin, and San Martín in the Tigre basin) cluster together both in our analysis. *Caraipa utilis* was indeed the most important species across all sites in terms of abundance, frequency, and dominance by basal area.

8. Local communities were enthusiastic in their support of our project and we involved children and teachers in our conservation awareness activities that included talks, distribution of flyers, and conservation games.

10. ACHIEVEMENTS AND IMPACTS

Local communities realized the uniqueness of the white-sand forests. Although this project focused its effort on documenting the presence and abundance of ten newly described species of birds and plants from these forests, we believe that the conservation effort should be directed to conserve the habitat to maximize conservation gains. White-sand forests are patchy in their distribution, and population of many species may live depending of resources among patches, in a source-sink system.

At each studied locality we developed conservation activities that consisted in structured talks (Annex 3) about white-sand forest ecosystems along with contests and game activities. The talk consisted of general information of the habitat, their flora and avifauna, and the importance to conserve this habitat. We provided educational material in the form of flyers, and pictures of representative birds.

We printed t-shirts with the logo of our sponsors for this project as well our representative birds. The game we introduced was the "island habitat" with the hula-hula that perfectly related the kind of system we were studying. Patches of island represented each hula-hula that was disappearing over time because of perturbation and timber extraction with consequences for the flora and fauna.

At the end it was evident that local children and villagers increased their conservation awareness for this habitat and realized sometimes for the first time the importance of these unique forests they have in their surroundings. Our promotional t-shirts were handed to several kids and schools on the sites we visited. Annex 5 shows the range of activities we developed in the different local villages.

Based on the qualitative and quantitative analysis of this project we have recommend the protection of entire white-sand patches (cluster of patches in different regions) in order to guarantee the conservation of its specialized flora and fauna. This is more apparent when considering that new species can still wait discovery from these forests (e.g. *Blastemanthus* sp. nov.) and that composition and diversity patterns of plants and animals between white-sand patches differ in some respect as our data has shown.

Based in part on the results of this study we have extended the conservation awareness of white-sand forests patches towards the conservation of ecological services they provide to local villages. Furthermore, given the high concentration of endemics and rare species in these habitats, ecological and evolutionary processes were studied at the regional level. The local government has issued recently a local law to promote their conservation in regional reserves of Loreto: http://www.procrel.gob.pe/www/descargas/pdf/Estrategia%20Procesos%20Loreto.pdf

11. PROBLEMS ENCOUNTERED AND LESSONS LEARNT

Some areas that surround white-sand forests had a past of timber extraction that affected directly and indirectly to the white-sand forests via the creation of trails to extract the timber from the predominant forest on clayey soil in the surroundings. We found that some white-sand forests were not in a primary condition to properly study the populations of our target species. Because local villagers know about the land use better than anyone else, we relied on their knowledge to properly locate well conserved primary white-sand forests.

The plant sampling at each locality used a Gentry's 0.1 ha protocol that is flexible and rapid to set up in the field. We are glad to confirm that this sampling method work very effectively in white-sand forests and we recommend its use in future studies.

The avifauna sampling used a 1-km transect and in some circumstances it entered different vegetation types at its extremes. This problem was solved by first walking around the forest patch to make a qualitative evaluation of the white-sand forest and its extension, and thus avoiding as much as possible this problem.

One of our study sites (San Andrés) suffered a long week of rainy days that affected mainly the ornithology team. The region we studied does not have a clear rainy or dry season. It is therefore recommended that future studies plan for at least 10 days of field work at ach site to avoid the effect of whether in the observability of animals during the inventory.

Our conservation activities were successfully adopted by local teachers and were easy to understand in the context of island-habitats as white-sand forests are interpreted by biologists. One important aspect to gain the support of the local teachers is to work first with the communal leaders and explain how these activities will be benefitial for raising conservation awareness in students. It is important to contribute to local school with educational material that can be used later on the by the teachers. The use of games and t-shits with conservation messages were an important element in the interaction with students and recommend to be a top item in future conservation awareness initiatives.

12. IN THE FUTURE

Our most important recommendation is that in order to guarantee the conservation of its specialized flora and fauna we have to focus the conservation on the forests patches itself (cluster of patches in different regions). This is more important when we consider the fact that new species, as the ones we studied, wait to be discovered from these unique forests in Peru. In the future we would like to assess how much of theses habitats are already being conserved and how much it is not. Improving our knowledge of the natural history, abundance and distribution of the flora and fauna in these forests is therefore our first priority for the future. It is important to realize that these patchily-distributed sandy soils are extremely poor for agricultural activities and a blinded assignment of lands to productive activities will only waste time and money to the local governments, destroying these forests forever at the same time. Therefore another future goal is to properly locate and map white-sand forests in the whole Peruvian Amazon. This map can then be used by the local government for policy making and conservation decisions. Finally, the archipelago of Peruvian white-sand forests share many species with other poor-nutrients habitats of the rest of the Amazon and the Guiana Shield region. We do not know the origin and relationships of the flora and fauna among these regions and therefore studying the origin and biogeographic connections among Amazonian white-sand forests must be a priority.

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14. DISTRIBUTION LIST

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Annex 1. Checklist of the bird species found at all study sites using point counts and 1-km transects at each site. Visual, auditive, and capture data are lumped together. Habitat: A = Air, Vh = wet WSF, Vs = dry WSF, B2 = Secondary forest, Mr = riverbank, M= other habitats. Abundance code: C = common (observed each day, more than 8 individuals), F = slightly common (observed each day, less than 8 individuals), U = almost rare (observed more than twice but not each day), R = rare (observed only once)

Family	Site	Species	Habitats	Abundance
Accipitridae	Catalan	*Elanoides forficatus*	A	U
		Harpagus bidentatus	Vh	R
		Ictinia plumbea	M	U
	Libertad	*Buteo magnirostris*	Vs	F
		Harpagus bidentatus	Vs	R
		Spizaetus tyrannus	Vs	U
	Otorongo	*Harpagus bidentatus*	Vh	R
	San Andres	*Harpagus bidentatus*	Vh	R
Apodidae	Catalan	*Chaetura brachyura*	A	F
		Chaetura cinereiventris	A	U
		Tachornis squamata	A	C
	Otorongo	*Chaetura brachyura*	A	F
		Chaetura cinereiventris	A	U
		Tachornis squamata	A	C
	San Andres	*Chaetura brachyura*	A	F
		Tachornis squamata	A	C
Ardeidae	Catalan	*Ardea cocoi*	Mr	F
Bucconidae	Catalan	*Chelidoptera tenebrosa*	Vh,B2	C
		Monasa morphoeus	Vh	F
		Notharchus ordii	Vh	U
		Notharchus tectus	Vh	U
	Libertad	*Malacoptila fusca*	Vs	F
		Monasa morphoeus	Vs	U
		Monasa nigrifrons	Vs	U
	Otorongo	*Chelidoptera tenebrosa*	Vh	C
		Malacoptila fusca	Vh	U
		Notharchus ordii	Vh	U
		Notharchus tectus	Vh	U
	San Andres	*Chelidoptera tenebrosa*	Vh	C
		Notharchus ordii	Vh	U
		Notharchus tectus	Vh	U
Caprimulgidae	Catalan	*Caprimulgus nigrescens*	Vs	C
		Nyctidromus albicollis	Vs	F
	Otorongo	*Nyctidromus albicollis*	Vs	F
Cardinalidae	Catalan	*Cyanocompsa cyanoides*	Vh,B2	R
	Libertad	*Cyanocompsa cyanoides*	Vs	R
	Otorongo	*Cyanocompsa cyanoides*	Vh,Vs	R
	San Andres	*Cyanocompsa cyanoides*	Vh	R
Cathartidae	Catalan	*Cathartes melambrotus*	A	U
		Sarcoramphus papa	A	U
	Otorongo	*Cathartes melambrotus*	A	U
		Sarcoramphus papa	A	R

	San Andres	*Cathartes melambrotus*	A	U
		Sarcoramphus papa	A	R
Columbidae	Catalan	*Claravis pretiosa*	Vs,Vh	C
		Patagioenas plumbea	B2,Mr,Vh	F
		Patagioenas subvinacea	B2,Mr,Vh	U
	Libertad	*Patagioenas plumbea*	Vs	F
		Patagioenas subvinacea	Vs	U
	Otorongo	*Claravis pretiosa*	Vs,Vh	C
		Patagioenas plumbea	Vh	F
	San Andres	*Claravis pretiosa*	Vh	C
		Patagioenas plumbea	Vh	F
Cotingidae	Catalan	*Cotinga maynana*	Mr,Vh	R
		Iodopleura isabellae	Vh,Mr	C
		Lipaugus vociferans	M	F
		Xipholena punicea	Vh	U
	Libertad	*Querula purpurata*	Vs	R
	Otorongo	*Iodopleura isabellae*	Vh,Mr	C
		Lipaugus vociferans	Vh,Vs	F
		Phoenicircus nigricollis	Vh	F
		Xipholena punicea	Vh	U
	San Andres	*Iodopleura isabellae*	Vh	U
		Lipaugus vociferans	Vh	F
		Phoenicircus nigricollis	Vh	R
		Xipholena punicea	Vh	U
Cracidae	Catalan	*Ortalis guttata*	B2,Vs	R
		Penelope jacquacu	Vs	R
	Libertad	*Penelope jacquacu*	Vs	U
	Otorongo	*Ortalis guttata*	Vh	R
		Penelope jacquacu	Vh	R
	San Andres	*Ortalis guttata*	Vh	R
		Penelope jacquacu	Vh	R
Cuculidae	Catalan	*Crotophaga major*	B2	U
		Piaya cayana	M	U
		Piaya melanogaster	Vh,B2	F
	Libertad	*Piaya melanogaster*	Vs	R
	Otorongo	*Piaya melanogaster*	Vh	U
	San Andres	*Piaya cayana*	Vh	U
		Piaya melanogaster	Vh	U
Dendrocolaptidae	Catalan	*Dendrocolaptes certhia*	Vh,Vs	U
		Glyphorynchus spirurus	Vh,Vs,B2	C
		Lepidocolaptes albolineatus	Vh,Vs	U
		Nasica longirostris	Vs	R
		Xiphorhynchus guttatus	Vh,Vs,B2	F
		Xiphorhynchus ocellatus	Vh	F
	Libertad	*Dendrocincla fuliginosa*	Vs	U
		Dendrocolaptes certhia	Vs	U
		Glyphorynchus spirurus	Vs	C
		Xiphorhynchus guttatus	Vs	U
		Xiphorhynchus ocellatus	Vs	U
	Otorongo	*Dendrocolaptes certhia*	Vh,Vs	U
		Glyphorynchus spirurus	Vh,Vs	C

		Lepidocolaptes albolineatus	Vh,Vs	U
		Nasica longirostris	Vs	R
		Xiphorhynchus ocellatus	Vh	F
	San Andres	*Dendrocolaptes certhia*	Vh	U
		Glyphorynchus spirurus	Vh	C
		Lepidocolaptes albolineatus	Vh	R
		Xiphorhynchus ocellatus	Vh	F
Falconidae	Catalan	*Herpetotheres cachinnans*	(en blanco)	U
		Micrastur gilvicollis	Vh	R
	Otorongo	*Micrastur gilvicollis*	Vh	R
Fringilidae	Catalan	*Euphonia minuta*	Vh	R
		Euphonia rufiventris	Vh,Vs,B2	U
	Libertad	*Euphonia rufiventris*	Vs	U
		Euphonia xanthogaster	Vs	R
	Otorongo	*Euphonia rufiventris*	Vh,Vs	U
		Euphonia xanthogaster	Vh	R
	San Andres	*Euphonia rufiventris*	Vh	U
		Euphonia xanthogaster	Vh	R
Furnariidae	Catalan	*Automolus ochrolaemus*	Vh,Vs	F
		Synallaxis rutilans	Vh	U
		Xenops minutus	Vh	R
	Libertad	*Automolus ochrolaemus*	Vs	F
		Xenops minutus	Vs	R
	Otorongo	*Automolus ochrolaemus*	Vh,Vs	F
		Synallaxis rutilans	Vh	U
	San Andres	*Automolus ochrolaemus*	Vh	F
		Synallaxis rutilans	Vh	U
Galbulidae	Catalan	*Galbula dea*	Vh	U
		Jacamerops aureus	Vh	U
	Libertad	*Galbula dea*	Vs	U
		Jacamerops aureus	Vs	U
	Otorongo	*Galbula dea*	Vh	U
	San Andres	*Galbula dea*	Vh	U
Hirundinidae	Catalan	*Stelgidopteryx ruficollis*	B2,Mr	U
Icteridae	Catalan	*Cacicus cela*	M	U
		Psarocolius angustifrons	A,B2	U
	Otorongo	*Cacicus cela*	Vh,Vs	U
		Icterius chrysocephalus	Vh	U
		Psarocolius angustifrons	A	U
	San Andres	*Cacicus cela*	Vh	U
		Icterius chrysocephalus	Vh	U
Momotidae	Catalan	*Baryphthengus martii*	Vh	U
		Momotus momota	Vh,Vs,B2	C
	Libertad	*Momotus momota*	Vs	C
	Otorongo	*Baryphthengus martii*	Vh	U
		Momotus momota	Vh,Vs	C
	San Andres	*Baryphthengus martii*	Vh	U
		Momotus momota	Vh,Vs	C
Nyctibidae	Catalan	*Nyctibius griseus*	B2,Mr	U
Picidae	Catalan	*Campephilus rubricollis*	Vh	U

		Celeus grammicus	Vh,Vs	F
		Dryocopus lineatus	Vh	U
		Melanerpes cruentatus	Vh,Vs,B2	U
		Veniliornis affinis	Vh	U
	Libertad	*Campephilus rubricollis*	Vs	U
		Celeus elegans	Vs	R
	Otorongo	*Campephilus rubricollis*	Vh	U
		Celeus grammicus	Vh,Vs	F
		Dryocopus lineatus	Vh	U
		Melanerpes cruentatus	Vh,Vs	U
		Veniliornis affinis	Vh	U
	San Andres	*Campephilus rubricollis*	Vh	U
		Celeus elegans	Vh	U
		Celeus grammicus	Vh	F
		Dryocopus lineatus	Vh	U
		Melanerpes cruentatus	Vh	U
		Veniliornis affinis	Vh	U
Pipridae	Catalan	*Dixiphia pipra*	Vh	U
		Heterocercus aurantiivertex	Vh	C
		Neopelma chrysocephalum	Vh,Vs	C
		Pipra erythrocephala	Vh,B2	F
		Schiffornis turdinus	Vh,Vs	U
	Libertad	*Chiroxiphia pareola*	Vs	R
		Dixiphia pipra	Vs	U
		Heterocercus aurantiivertex	Vs	C
		Lepidothrix coronata	Vs	F
		Machaeropterus regulus	Vs	R
		Schiffornis turdinus	Vs	U
		Tyranneutes stolzmanni	Vs	R
	Otorongo	*Dixiphia coronata*	Vs	F
		Dixiphia pipra	Vh	U
		Heterocercus aurantiivertex	Vh,Vs	C
		Neopelma chrysocephalum	Vh,Vs	C
		Pipra erythrocephala	Vh	F
		Schiffornis turdinus	Vh,Vs	U
		Tyranneutes stolzmanni	Vh	U
	San Andres	*Dixiphia pipra*	Vh	F
		Heterocercus aurantiivertex	Vh	C
		Neopelma chrysocephalum	Vh	C
		Schiffornis turdinus	Vh	U
		Tyranneutes stolzmanni	Vh	U
Polioptilidae	Libertad	*Ramphocaenus melanurus*	Vs	U
Psittacidae	Catalan	*Amazona ochrocephala*	A	R
		Ara ararauna	A	R
		Brotogeris cyanoptera	A,Vh	C
		Orthopsittaca manilata	A	U
		Pionites melanocephalus	Vh,Vs	U
		Pionus menstruus	A	U
		Pyrrhura melanura	Vh,B2	F
	Libertad	*Amazona farinosa*	Vs	R
		Brotogeris cyanoptera	Vs	F
		Pionites melanocephalus	Vs	R
	Otorongo	*Brotogeris cyanoptera*	A,Vh	C

		Pionites melanocephalus	Vh,Vs	U
		Pionus menstruus	A	U
	San Andres	*Brotogeris cyanoptera*	A,Vh	C
		Pionopsita barrabandi	A	U
		Pionus menstruus	A	U
Ramphastidae	Catalan	*Capito auratus*	M	C
		Ramphastos tucanus	Vh	C
		Ramphastos vitellinus	Vh	C
		Selenidera reinwardtii	Vh,B2	U
	Libertad	*Ramphastos culminatus*	Vs	C
		Ramphastos tucanus	Vs	C
		Selenidera reinwardtii	Vs	R
	Otorongo	*Capito auratus*	Vh,Vs	C
		Ramphastos tucanus	Vh	C
		Ramphastos vitellinus	Vh	C
		Selenidera reinwardtii	Vh	U
	San Andres	*Capito auratus*	Vh	C
		Ramphastos tucanus	Vh	C
		Ramphastos vitellinus	Vh	C
		Selenidera reinwardtii	Vh	U
Rhinocryptidae	Catalan	*Liosceles thoracicus*	Vh	U
	Otorongo	*Liosceles thoracicus*	Vh	U
	San Andres	*Liosceles thoracicus*	Vh	U
Thamnophilidae	Catalan	*Cercomacra nigrescens*	Vs	F
		Gymnopithys leucaspis	Vh,B2	U
		Herpsilochmus gentryi	Vh	U
		Hylophylax poecilinotus	Vh	F
		Hypocnemis hypoxantha	Vh	F
		Myrmeciza castanea	Vh	C
		Myrmoborus myotherinus	Vh,B2	F
		Myrmotherula axillaris	Vh,Vs	C
		Myrmotherula ignota	Vh,B2	F
		Neoctantes niger	Vs	R
		Percnostola arenarum	Vh	C
		Percnostola leucostigma	Vh,B2	U
		Pithys albifrons	Vh,B2	U
		Thamnomanes caesius	Vh,B2	U
		Thamnophilus murinus	Vh,Vs	F
	Libertad	*Cercomacra serva*	Vs	F
		Cymbilaimus lineatus	Vs	U
		Gymnopithys leucaspis	Vs	U
		Herpsilochmus gentryi	Vs	U
		Hylophylax naevia	Vs	U
		Hylophylax poecilinotus	Vs	F
		Hypocnemis hypoxantha	Vs	F
		Myrmeciza castanea	Vs	U
		Myrmeciza melanoceps	Vs	F
		Myrmoborus myotherinus	Vs	F
		Myrmotherula axillaris	Vs	C
		Myrmotherula hauxwelli	Vs	F
		Myrmotherula ignota	Vs	F
		Percnostola arenarum	Vs	F
		Rhegmatorhina	Vs	U

		melanosticta		
		Schistocychla leucostigma	Vs	U
		Thamnomanes ardesiacus	Vs	U
		Thamnomanes caesius	Vs	U
		Thamnophilus murinus	Vs	F
	Otorongo	*Gymnopithys leucaspis*	Vh	U
		Herpsilochmus gentryi	Vh	U
		Hylophylax naevia	Vh	U
		Hylophylax poecilinotus	Vh	F
		Hypocnemis hypoxantha	Vh	F
		Myrmeciza castanea	Vh	C
		Myrmoborus myotherinus	Vh	F
		Myrmotherula axillaris	Vh,Vs	C
		Myrmotherula ignota	Vh	F
		Neoctantes niger	Vs	U
		Percnostola arenarum	Vh	C
		Thamnomanes caesius	Vh	U
		Thamnophilus murinus	Vh,Vs	F
	San Andres	*Gymnopithys leucaspis*	Vh	U
		Herpsilochmus gentryi	Vh	U
		Hylophylax naevia	Vh	U
		Hylophylax poecilinotus	Vh	F
		Hypocnemis hypoxantha	Vh	F
		Myrmeciza castanea	Vh	U
		Myrmoborus myotherinus	Vh	F
		Myrmotherula axillaris	Vh	C
		Myrmotherula ignota	Vh	F
		Percnostola arenarum	Vh	R
		Thamnomanes caesius	Vh	U
		Thamnophilus murinus	Vh	F
Thraupidae	Catalan	*Chlorophanes spiza*	Vh	U
		Cyanerpes caeruleus	Vh,Vs,Mr	F
		Cyanerpes cyaneus	Vh,Mr	F
		Cyanerpes nitidus	Vh,Vs	F
		Dacnis cayana	Vh,Mr	R
		Dacnis flaviventer	Vh,Mr	U
		Dacnis lineata	Vh,Mr	U
		Hemithraupis flavicollis	Vh	U
		Ramphocelus carbo	Vh,B2,Mr	C
		Ramphocelus nigrogularis	Vh,Mr	U
		Tachyphonus cristatus	Vh	U
		Tachyphonus surinamus	Vh,Vs	R
		Tangara chilensis	Vh,Vs,B2	F
		Tangara nigrocincta	Vh	R
		Tangara velia	Vh	R
		Thraupis palmarum	M	F
	Libertad	*Tangara chilensis*	Vs	C
	Otorongo	*Chlorophanes spiza*	Vh	U
		Cyanerpes caeruleus	Vh,Vs	F
		Cyanerpes cyaneus	Vh	F
		Cyanerpes nitidus	Vh,Vs	F
		Dacnis cayana	Vh	R
		Dacnis flaviventer	Vh	U
		Dacnis lineata	Vh	U

		Hemithraupis flavicollis	Vh	U
		Ramphocelus carbo	Vh,Vs	C
		Ramphocelus nigrogularis	Vh	U
		Tachyphonus cristatus	Vh	U
		Tachyphonus surinamus	Vh,Vs	R
		Tangara callophrys	Vh	U
		Tangara chilensis	Vh,Vs	F
		Tangara velia	Vh	R
		Thraupis palmarum	Vh	F
	San Andres	*Chlorophanes spiza*	Vh	U
		Cyanerpes caeruleus	Vh	F
		Cyanerpes cyaneus	Vh	F
		Cyanerpes nitidus	Vh	F
		Dacnis cayana	Vh	R
		Dacnis flaviventer	Vh	U
		Dacnis lineata	Vh	U
		Hemithraupis flavicollis	Vh	U
		Tachyphonus cristatus	Vh	U
		Tachyphonus surinamus	Vh	R
		Tangara chilensis	Vh	C
		Tangara velia	Vh	R
		Thraupis palmarum	Vh	F
Tinamidae	Catalan	*Crypturellus cinereus*	Vs, Bs	F
		Crypturellus soui	Vs,Vh	U
		Tinamus guttatus	Vs,Vh	U
	Libertad	*Crypturellus cinereus*	Vs	F
		Crypturellus soui	Vs	U
		Tinamus guttatus	Vs	U
	Otorongo	*Crypturellus cinereus*	Vh,Vs	F
		Tinamus guttatus	Vh	U
	San Andres	*Crypturellus cinereus*	Vh	F
		Tinamus guttatus	Vh	U
Trochilidae	Catalan	*Florisuga mellivora*	Vh,B2	C
		Glaucis hirsutus	Bs,Vs	U
		Helidioxa aurescens	Vs	R
		Heliothryx auritus	Vs	R
		Phaethornis bourcieri	Vh	U
		Phaethornis ruber	Vh,Vs	F
		Thalurania furcata	Vh,Vs	U
	Libertad	*Florisuga mellivora*	Vs	C
		Helidioxa aurescens	Vs	R
		Phaethornis bourcieri	Vs	U
		Phaethornis ruber	Vs	F
		Thalurania furcata	Vs	U
	Otorongo	*Florisuga mellivora*	Vh	C
		Glaucis hirsutus	Vs	U
		Helidioxa aurescens	Vs	R
		Phaethornis bourcieri	Vh	U
		Phaethornis ruber	Vh,Vs	F
		Thalurania furcata	Vh,Vs	U
	San Andres	*Florisuga mellivora*	Vh	C
		Helidioxa aurescens	Vh	R
		Heliothryx auritus	Vh	R

		Phaethornis bourcieri	Vh	U
		Phaethornis ruber	Vh	F
		Thalurania furcata	Vh	U
Troglodytidae	Catalan	*Campylorhynchus turdinus*	M	F
		Microcerculus marginatus	Vh	U
		Thryothorus coraya	B2	U
	Libertad	*Microcerculus marginatus*	Vs	U
		Thryothorus coraya	Vs	R
	Otorongo	*Microcerculus marginatus*	Vh	U
		Thryothorus coraya	Vh	U
	San Andres	*Microcerculus marginatus*	Vh	U
		Thryothorus coraya	Vh	U
Trogonidae	Catalan	*Trogon violaceus*	Vh	U
		Trogon viridis	Vs,Vh,B2	F
	Libertad	*Trogon collaris*	Vs	U
		Trogon rufus	Vs	U
		Trogon violaceus	Vs	U
		Trogon viridis	Vs	F
	Otorongo	*Trogon rufus*	Vh	U
		Trogon viridis	Vs,Vh	F
	San Andres	*Trogon violaceus*	Vh	U
		Trogon viridis	Vh	F
Turdidae	Catalan	*Turdus lawrencii*	Vh	U
	Libertad	*Turdus lawrencii*	Vs	U
	Otorongo	*Catharus minimus*	Vh	Um
		Turdus lawrencii	Vh	U
	San Andres	*Catharus minimus*	Vh	Um
		Turdus lawrencii	Vh	U
Tyrannidae	Catalan	*Attila citriniventris*	Vh	U
		Conopias parvus	Vh	U
		Hemitriccus minimus	Vh	C
		Lophotriccus vitiosus	Vh,Vs	U
		Mionectes oleagineus	Vh,B2	C
		Myiarchus ferox	B2,Mr	F
		Myiopagis caniceps	Vh,Vs	U
		Myiozetetes granadensis	B2,Mr	U
		Myiozetetes luteiventris	B2,Vh	U
		Pachyramphus marginatus	Vh	U
		Pitangus sulphuratus	M	F
		Ramphotrigon ruficauda	Vh,Vs	F
		Rhytipterna simplex	Vh	U
		Terenotriccus erythrurus	Vh,B2	U
		Tityra cayana	Vh,B2	U
		Todirostrum maculatum	Mr,B2	U
		Tolmomyias poliocephalus	Vh,Vs,B2	C
		Tyrannulus elatus	Vh,B2	C
		Tyrannus melancholicus	M	F
		Zimmerius gracilipes	Vh,B2,Mr	F
		Zimmerius villarejoi	Vs	R
	Libertad	*Attila citriniventris*	Vs	C
		Attila spadiceus	Vs	R
		Conopias parvus	Vs	U
		Mionectes oleagineus	Vs	C

		Myiodianstes maculatus	Vs	F
		Myiopagis caniceps	Vs	U
		Onichorinchus coronatus	Vs	R
		Ramphotrigon ruficauda	Vs	F
		Terenotriccus erythrurus	Vs	U
		Tolmomyias poliocephalus	Vs	C
		Tyrannulus elatus	Vs	C
	Otorongo	*Attila citriniventris*	Vh	U
		Conopias parvus	Vh	U
		Hemitriccus minimus	Vh	C
		Lophotriccus vitiosus	Vh,Vs	U
		Mionectes oleagineus	Vh	C
		Myiopagis caniceps	Vh,Vs	U
		Myiozetetes luteiventris	Vh,Vs	U
		Pachyramphus marginatus	Vh	U
		Pachyramphus polychopterus	Vh	C
		Pitangus sulphuratus	Vs,Vh	F
		Ramphotrigon ruficauda	Vh,Vs	F
		Rhytipterna simplex	Vh	U
		Terenotriccus erythrurus	Vh	U
		Tityra cayana	Vh	U
		Tolmomyias poliocephalus	Vh,Vs	C
		Tyrannulus elatus	Vh	C
		Zimmerius gracilipes	Vh	F
		Zimmerius villarejoi	Vs	R
	San Andres	*Attila citriniventris*	Vh	C
		Conopias parvus	Vh	U
		Hemitriccus minimus	Vh	U
		Lophotriccus vitiosus	Vh	U
		Mionectes oleagineus	Vh	F
		Myiopagis caniceps	Vh	U
		Myiozetetes luteiventris	Vh	U
		Pachyramphus marginatus	Vh	U
		Pachyramphus polychopterus	Vh	C
		Ramphotrigon ruficauda	Vh	F
		Rhytipterna simplex	Vh	U
		Terenotriccus erythrurus	Vh	U
		Tityra cayana	Vh	U
		Tolmomyias poliocephalus	Vh	C
		Tyrannulus elatus	Vh	C
Vireonidae	Catalan	*Hylophilus hypoxanthus*	Vh	C
		Hylophilus ochraceiceps	Vh	R
		Viero olivaceus	Vh,B2,Mr	F
	Otorongo	*Hylophilus hypoxanthus*	Vh,Vs	C
		Viero olivaceus	Vh,Vs	F
	San Andres	*Hylophilus hypoxanthus*	Vh	C
		Viero olivaceus	Vh	F

Annex 2. Checklist of plant species found at five white-sand forests in the Peruvian amazon ordered by family. Numbers are abundance data (number of stems >2.5 cm Diameter at Breast Height) of each species at each site. Cat = Catalán, Lib = Libertad, Oto1 = Otorongo1, Oto2 = Otorongo2, SA = San Andrés.

Family	Genus	Species	Cat	Lib	Oto1	Oto2	SA	Total
Anacardiaceae	Tapirira	*Tapirira guianensis*		8	1			9
Annonaceae	Annona	*Annona sp. 1*		1				1
	Diclinanona	*Diclinanona tessmannii*		7				7
	Guatteria	*Guatteria decurrens*		3			8	11
	Guatteriopsis	*Guatteria blepharophylla*			1		1	2
	Oxandra	*Oxandra leucodermis*		2				2
		Oxandra xylopioides					1	1
	Undet.	*Annonaceae sp. 1*		3	6			9
	Xylopia	*Xylopia benthamii*		2				2
		Xylopia parviflora					2	2
Apocynaceae	Aspidosperma	*Aspidosperma cf. pichonianum*		2		1		3
		Aspidosperma excelsum		8	7	1	1	17
		Aspidosperma schultesii		3	2			5
		Aspidosperma sp. 1		2				2
	Macoubea	*Macoubea guianensis*		17			19	36
	Parahancornia	*Parahancornia peruviana*	1					1
Aquifoliaceae	Ilex	*Ilex cf. vismiifolia*	7	2	2	1	7	19
Araliaceae	Dendropanax	*Dendropanax umbellatus*	10		36	12	20	78
	Schefflera	*Schefflera morototoni*		1				1
Arecaceae	Bactris	*Bactris sp. 1*					3	3
	Euterpe	*Euterpe catinga*					61	61
		Euterpe oleracea		1				1
	Mauritia	*Mauritia flexuosa*					5	5
	Mauritiella	*Mauritiella aculeata*		25	4		9	38
	Oenocarpus	*Oenocarpus bataua*		8			1	9
Bignoniaceae	Jacaranda	*Jacaranda macrocarpa*	1	3		1		5
	Tabebuia	*Tabebuia obscura*	1	1			12	14
Burseraceae	Protium	*Protium aracouchini*		1			1	2
		Protium crassipetalum		1				1
		Protium ferrugineum	2					2
		Protium subserratum		17	3			20
	Trattinnickia	*Trattinnickia rhoifolia*	2		1			3
Chrysobalanaceae	Couepia	*Couepia parillo*	2					2
		Couepia williamsii		4				4
	Licania	*Licania heteromorpha var. heteromorpha*		5				5
		Licania intrapetiolaris	2		5	2		9
Clusiaceae	Clusia	*Clusia amazonica*					1	1
	Garcinia	*Garcinia macrophylla*					1	1
	Tovomita	*Tovomita calophyllophylla*		2	1		1	4
		Tovomita sp. 1		2				2
		Tovomita sp. 2		3				3
		Tovomita umbellata	3		10	37	2	52
Combretaceae	Buchenavia	*Buchenavia amazonia*	2	4	1	2	2	11
Dichapetalaceae	Tapura	*Tapura amazonica*			1			1

Elaeocarpaceae	Sloanea	*Sloanea brachytepala*					1	1
		Sloanea cf. latifolia			2		2	4
		Sloanea floribunda		1	4		4	9
		Sloanea parvifructa	10	14	17		34	75
		Sloanea sp. 1			1		2	3
		Sloanea sp. 2					1	1
Euphorbiaceae	Aparisthmium	*Aparisthmium cordatum*				2		2
	Hevea	*Hevea brasiliensis*	2	33	1		21	57
	Micrandra	*Micrandra spruceana*		5				5
	Nealchornea	*Nealchornea yapurensis*					1	1
	Pera	*Pera bicolor*	3	2		1	1	7
	Undet.	*Euphorbiaceae sp. 1*		1				1
		Euphorbiaceae sp. 2	4					4
Fabaceae	Batesia	*Batesia floribunda*		1				1
	Dalbergia	*Dalbergia aff. inundata*	2					2
	Dicymbe	*Dicymbe uaiparuensis*	21	38	14	4		77
	Dimorphandra	*Dimorphandra macrostachya subsp. macrostachya*		32				32
	Hymenolobium	*Hymenolobium excelsum*	1	2				3
		Hymenolobium nitidum	1	3			1	5
		Hymenolobium pulcherrimum		1				1
	Inga	*Inga heterophylla*	1	13	3			17
		Inga sp. 1					1	1
	Macrolobium	*Macrolobium angustifolium*				1	4	5
		Macrolobium arenarium			1		1	2
		Macrolobium bifolium		9				9
		Macrolobium limbatum			2		3	5
		Macrolobium machaerioides					3	3
		Macrolobium microcalyx		42	5	2		49
		Macrolobium sp. 1		1			3	4
	Parkia	*Parkia igneiflora*	7	23	11	2	4	47
		Parkia panurensis		1				1
		Parkia velutina			1			1
	Pterocarpus	*Pterocarpus rohrii*		6				6
	Swartzia	*Swartzia benthamiana*		3	1			4
		Swartzia cardiosperma		3				3
		Swartzia klugii		6				6
		Swartzia pendula		2				2
	Tachigali	*Tachigali bracteosa*		10				10
		Tachigali paniculata		2	1	4		7
		Tachigali ptychophysca		7				7
		Tachigali sp. 1		12				12
	Taralea	*Taralea oppositifolia*	1	7	2	2		12
	Zygia	*Zygia cataractae*					1	1
Humiriaceae	Humiria	*Humiria balsamifera*	3	2	1			6
	Sacoglottis	*Sacoglottis guianensis*					6	6
Icacinaceae	Emmotum	*Emmotum floribundum*	10	7	2		3	22
Lauraceae	Aniba	*Aniba sp. 1*		1				1
	Licaria	*Licaria cannella subsp. cannella*		5	3		1	9
	Ocotea	*Ocotea aciphylla*	1	4				5
	Persea	*Persea peruviana*			1			1
		Persea sp. 2					10	10

	Undet.	*Lauraceae sp. 1*					4	4
		Lauraceae sp. 2					2	2
		Lauraceae sp. 3		1				1
		Lauraceae sp. 4			2			2
		Lauraceae sp. 5		1	2	7		10
Linaceae	Roucheria	*Roucheria columbiana*	3					3
		Roucheria schomburgkii		1	3	3	1	8
Melastomataceae	Graffenrieda	*Graffenrieda limbata*					8	8
	Mouriri	*Mouriri cauliflora*		3				3
		Mouriri sp. 1			1	1		2
Meliaceae	Trichilia	*Trichilia septentrionalis*			1			1
Moraceae	Brosimum	*Brosimum utile*					2	2
	Ficus	*Ficus americana*		1				1
	Pseudolmedia	*Pseudolmedia rigida*		2	1			3
Myristicaceae	Iryanthera	*Iryanthera ulei*			2	1	2	5
	Virola	*Virola minutiflora*					13	13
		Virola pavonis	1	3	1		2	7
Myrtaceae	Eugenia	*Eugenia sp. 1*					20	20
		Eugenia sp. 2		1				1
	Undet.	*Myrtaceae sp. 1*		1	1			2
		Myrtaceae sp. 2	1	12				13
		Myrtaceae sp. 3				2		2
		Myrtaceae sp. 4	2			1		3
		Myrtaceae sp. 5	2		1		1	4
		Myrtaceae sp. 6		5				5
		Myrtaceae sp. 7		3				3
Nyctaginaceae	Neea	*Neea divaricata*					26	26
		Neea sp. 1		2				2
Ochnaceae	Blastemanthus	*Blastemanthus sp. nov.*	154					154
Rosaceae	Prunus	*Prunus detrita*		2				2
Rubiaceae	Alibertia	*Kutchubaea oocarpa*				1		1
	Ferdinandusa	*Ferdinandusa chlorantha*		1				1
		Ferdinandusa loretensis	12	53			52	117
	Kotchubaea	*Kutchubaea insignis*					10	10
	Ladenbergia	*Ladenbergia sp. 1*					2	2
	Platycarpum	*Platycarpum orinocense*		1			1	2
	Psychotria	*Psychotria sp. 1*		2				2
		Ronabea latifolia	1					1
	Remijia	*Remijia macrocnemia*	5	1	41	19	4	70
		Remijia pacimonica					4	4
Rutaceae	Adiscanthus	*Adiscanthus fusciflorus*			2	1		3
Sabiaceae	Meliosma	*Meliosma sp. 1*		2	1	1		4
	Ophiocaryon	*Ophiocaryon manausense*			1	3		4
Sapindaceae	Cupania	*Cupania diphylla*	8	29	12		37	86
	Matayba	*Matayba inelegans*	1	3		1	7	12
	Talisia	*Talisia sp. 1*					1	1
Sapotaceae	Chrysophyllum	*Chrysophyllum manaosense*		1			1	2
		Chrysophyllum sanguinolentum	2	26	32	6	24	90
	Micropholis	*Micropholis egensis*				1		1
		Micropholis guyanensis subsp. duckeana		1				1
		Micropholis venulosa		1	8	7		16
	Pouteria	*Pouteria aubrevillei*			2			2
		Pouteria cuspidata	8	4	12	2		26

		Pouteria lucumifolia		5	1	1	1	8
		Pouteria sp. 1		1	1			2
		Pouteria sp. 2	31					31
Simaroubaceae	Simaba	*Simaba polyphylla*		1				1
Siparunaceae	Siparuna	*Siparuna guianensis*			8		4	12
Styracaceae	Styrax	*Styrax guyanensis*			1		1	2
Ulmaceae	Ampelocera	*Ampelocera edentula*		1				1
Undet.	Undet.	*Undet.*		2				2
Violaceae	Paypayrola	*Paypayrola grandiflora*		1				1
Vochysiaceae	Ruizterania	*Ruizterania trichanthera*		2				2
Phyllanthaceae	Amanoa	*Amanoa sp. 1*	11		9	4		24
Malpighiaceae	Byrsonima	*Byrsonima sp. 1*		1				1
		Byrsonima stipulina			2			2
Calophyllaceae	Caraipa	*Caraipa tereticaulis*		20				20
		Caraipa utilis	20	172	42	32	112	378
Primulaceae	Cybianthus	*Cybianthus peruvianus*		1				1
	Stylogyne	*Stylogyne longifolia*	6		5		6	17
Ebenaceae	Lissocarpa	*Lissocarpa kating*	1		1	2		4
		Lissocarpa stenocarpa		1				1
Malvaceae	Lueheopsis	*Lueheopsis althaeiflora*		1				1
	Pachira	*Pachira brevipes*	70	22	53	17	94	256
Urticaceae	Pourouma	*Pourouma bicolor*		35			6	41
		Pourouma cecropiifolia	1	3			14	18
Pentaphylacaceae	Ternstroemia	*Ternstroemia klugiana*	16	13	3	2	2	36
Total general			456	882	406	190	730	2664

Annex 3. Structured talks about the White-sand forests were presented at local schools on the villages nearby our study sites (In Spanish)

BPCP Conservation
Programmme Winner 2006

"Los varillales y sus habitats"

1. ¿Qué son los *varillales*?

Los *varillales* son bosques que crecen sobre suelos arenosos, también se les conoce como *bosques de arena blanca*. Son bosques de altura (no se inundan por los rios) muy especiales pues no se encuentran en otros lugares de la Amazonia Peruana. En nuestra región se les llama *varillales* por el gran número de tallos verticales semejantes a varillas

2. ¿Por qué se caracteriza un *varillal*?

Los varillales se caracterizan por crecer sobre suelos arenosos con pocos nutrientes y las plantas al crecer sobre suelos muy pobres se desarrollan en condiciones difíciles y por eso tienen características muy especiales como:

- Árboles no muy altos y algunas veces enanos.
- Elevado número de tallos delgados
- Capa gruesa de hojarasca en el suelo.
- Hojas muy gruesas
- Alta penetración de luz

3. ¿Dónde se encuentran los *varillales*?

Los bosques de arena blanca o *varillales* también se encuentran distribuidos en Venezuela, Colombia, Brazil y Perú. Los *varillales* son muy escasos en la amazonia peruana y están distribuidos como manchales de diferentes tamaños en algunas áreas al sureste de la Amazonia. La mayor concentración de *varillales* que se conocen se encuentra en el bajo y alto Nanay, cerca de la ciudad de Iquitos. También se conoce la existencia de *varillales más pequeños* en Jenaro Herrera (Río Ucayali), los alrededores de Yurimaguas, bajo Río Morona, las cercanías de Jeberos (bajo Río Huallaga) y Tamshiyacu.

4. ¿Por qué son importantes los *varillales*?

Los *varillales* son importantes por que son bosques donde viven una flora y fauna muy especial que solo son encontradas en este tipo de bosque y en esta zona del Perú,

Un ejemplo de esta fauna son las aves del *varillal*, ya que muchas de ellas sólo pueden ser encontradas en este tipo de bosque.

Los *varillales* también son importantes por que de ellos conseguimos materiales para nuestras casas y otros productos, es por eso que conservándolos aseguramos que en el futuro no se acaben y podamos seguir haciendo uso de ellos.

Con este propósito el estado ha creado la Reserva Nacional Allpahuayo - Mishana (RNAM) la cual alberga las áreas más extensas de *varillales* protegidas actualmente en el Perú.

5. ¿Cuáles son las plantas y aves de los varillales?

En los *varillales* se encuentran un gran número de especies de plantas muchas de ellas son muy conocidas por su uso en la construcción de casas. Entre ellas comunes tenemos:

- Aceite caspi blanco
- Aceite caspi negro
- Boa caspi
- Irapay

En cuanto a las aves tenemos a las siguientes:

- El tiranuelo de Mishana
- El Hormiguero de Allpahuayo.
- El Hormiguero de Cola Castaña.
- El Hormiguerito de Gentry.

6. ¿Qué aves son endémicas de los varillales?

Perlita de Iquitos

Tiranuelo de Mishana

RECUERDA: ESTAS PLANTAS Y AVES SOLO VIVEN EN LOS VARILLALES. Por esta razón **protegiendo y cuidando los *varillales* aseguramos que la flora y fauna (aves, monos, insectos, plantas) de estos bosques también sobrevivan!!!!!**

Annex 4. Some bird species caught with bird nets to complement transect and point count methods. Birds were released after photo sessions.

Percnostola arenarum

Glyphorynchus spirurus

Malacoptila fusca

Myrmeciza castanea (macho)

Percnostola arenarum

Percnostola arenarum

Percnostola arenarum

Heterocercus aurantiivertex

Myrmeciza castanea

Myrmeciza castanea

Myrmeciza castanea

Percnostola arenarum (hembra)

Catharus ustulatus

Catharus ustulatus

Terenotriccus erythrurus

Catharus ustulatus

Threnetes leucurus

Lepidothrix coronata (male)

Pithys albifrons

Myrmotherula axillaris (female)

Willisornis peocilinotus

Onychorhynchus coronatus

Neopelma chrysocephalum

Glyphorynchus spirurus

Neopelma chrysocephalum

Hypocnemis hypoxantha

Myrmotherula axillaris (male)

Rhegmatorhina melanosticta

Annex 5. Photographic record of conservation awareness activities develop during our project.

Photo 1. Local villages we visited in our project were settled on a bank of the Nanay and Tigre Rivers, Peruvian Amazon.

Photo 2. Part of our conservation awareness activities consisted in giving talks at local schools about birds and flora from white-sand forests

Photo 3. We distributed t-shirts at schools with messages to conserve white-sand forests

Photo 4. Students participating in conservation games

Photo 5. Hula-hula game in which one hula-hula represents a white-sand forest patch and kids are bird species trying to get into the disappearing patches.

Photo 6. Students participating in the conservation awareness games we developed

Photo 7. School teacher support were critical for getting access to the school and develop our outreach activities

Photo 8. Laminated photos of white-sand birds were handed out to students to learn and recognize bird species.

Photo 9. Previous to each game we rehearsed concepts and ideas about conservation of birds and related to game activities.

Photo 10. We coordinated and provided material to school teachers before each conservation awareness activity

ASSESSMENT OF THE AVIFAUNA AND FLORA OF THE WHITE-SAND FORESTS IN UPPER PERUVIAN AMAZONIA

Peru – Future Conservationist Award 2006

CLP ID: 00100

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