University of Glasgow Exploration Society

Ecuador 2012

Expedition Report

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Foreword

It is with great pleasure that we present this document, which details the scientific studies and methodology undertaken during the 11th University of Glasgow expedition to north-eastern Ecuador during the summer of 2012. This report also outlines the financial and logistical planning of the expedition.

We are extremely pleased with the outcome of this year's expedition and feel as though we have discovered yet more of the animal life of Ecuador's north-eastern province of Orellana.

The aims of this expedition were to continue to study the ornithological, herpetological, canopy and mammal biodiversity of the region, which has been ongoing since 2000. This involved compiling species lists and undertaking population counts.

The University of Glasgow's expeditions to Ecuador are part of the larger long-term Payamino Project. This project is in association with Aalborg Zoo in Denmark and aims to support the Payamino Community in their efforts to keep oil companies off their land (16 000+ hectares of primary Amazon rainforest) and allow the community to decide their own future.

Over the 11 years the expedition has been running, we are continuing to build and maintain strong relationships with the local indigenous community and with their help we look forward to continuing our studies on the biodiversity of this fascinating environment for many years to come.

Hannele Honkanen

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Acknowledgements

We would like to express our deepest gratitude to all who sponsored and supported our expedition. Without their financial and logistical support, our expedition would not have been possible. It is because of the generosity of such organisations that the University of Glasgow's Exploration Society is able to organise undergraduate expeditions and provide those students who have an interest in natural history with valuable and enjoyable experiences.

The expedition acknowledges the support of the University of Glasgow, the Carnegie Trust, the Glasgow Natural History Society, the Russel Trust, the James Watt Trust and Tunnocks Ltd.

A great proportion of funds were also raised by the team members themselves. This was achieved by organising various fundraising events such as band nights, ceilidh, bake sales, zumba, clothes swap and a sponsored climb of Ben Lomond.

We would like to express our thanks to all those who contributed to the success of these activities. In particular, the team would like to thank family members and friends who were extremely supportive through the fundraising process, as well as the staff in the Zoology museum who allowed us to hold so many bakesales. We would also like to thank members of staff at our favoured meeting haunt Dram.

The team would like to thank our referees and scientific advisors, namely Prof Roger Downie, Prof David Houston, Dr Isabel Coombs, Prof Graeme Ruxton, Dr Richard Preziosi.

Finally, a huge thank you to the members of the Payamino community, who made us feel extremely welcome. Their advice, knowledge and generosity were of invaluable help in allowing the expedition to achieve its aims. In particular, we would like to thank Mr Javier Patino for all of his help throughout the expedition, as well as our local guides and many other community members who worked extremely hard and showed great patience to ensure we did not get lost.

Introduction

The 2012 expedition to Ecuador, comprised of 11 undergraduate student members and one member of staff support. This was the 11th such research expedition to Ecuador organised by the University of Glasgow Exploration Society since the year 2000. The three research groups, ornithology, herpetology and canopy access/camera trapping, each had roughly four members. All students worked extremely hard throughout the expedition, adding valuable data to the ever expending records of biodiversity of this area of primary rainforest. The expedition made use of local guides and local provisions in an effort to ensure as much of our money as possible went back into the local community. This was important in achieving one of our aims: helping local communities develop their environment sustainably, whilst also making a fair living for themselves. This also helped us, as we found the local knowledge our guides had of the areas and native wildlife was a great help in our research. We feel both parties learned greatly from each other, and hopefully this will continue for many years, and even lead by example to other conservation projects.

Location and accommodation

The expedition spent three days in Quito organising necessities and acclimatising before flying to Coca where we gathered our supplies before the final leg of our journey. We then travelled to the field site in the Napo region of Ecuadorian Amazonia to our research site at San José de Payamino, where we began our research, staying on site for the full five weeks. The group then returned to Quito for another three days before travelling home.

Ecuador is unique in its biodiversity and scientific interest: lying on the equator in the north west of South America. Ecuador's location allows it to host a wide variety of habitats, including the high altitude Andes, Andean cloud forest, lowland Amazon rainforest and the Galapagos Islands. This range of habitats has made Ecuador one of the most biodiverse in the world.

Figure 1: Map of the research area in Orellana, showing the locations of our research station (Timburi Cocha) and the village of San Jose de Payamino.

The expedition conducted research at a site of primary and secondary lowland tropical rainforest in the Napo region of eastern Ecuador's province of Orellana; San Jose de Payamino (00*28′55″S, 77*17′06″W). See Figure 1 for a satellite image of the research station and the village of San Jose de Payamino.

Ornithology report

Introduction

The Amazon rainforest is not only the largest tropical rainforest on the planet but one of the most biodiverse, particularly for birds. Already being well studied in temperate regions of the Earth, the biodiversity and ecology of birds remains to be thoroughly studied in tropical regions. Due to the rapid deforestation of pristine primary rainforest occurring throughout Amazonia by oil and timber companies, conservation concerns are on the increase and so is the need for rapid assessment techniques to assess tropical diversity and its changes. Traditional survey methods used commonly in temperate forests are not practical in tropical forests due to the need for long term studies and the higher density of vegetation and the topography of the land. Rapid assessment methods were developed to overcome these problems and provide a quick, simple and flexible way to ascertain levels of diversity.

Ecuador is classed by the World Conservation Monitoring Centre as a 'megadiverse' country due to its large number of bird species, 1600. This is 15 percent of the world's known bird species. 38 of Ecuador's bird species are endemic in the Galapagos Islands. This illustrates the importance of the need for rapid assessment in this country, due to the importance of the area for bird species as well as many other animal groups. If more is known about the habitats and their wildlife, the more we could begin to understand their vulnerability and the threats they are facing. After such assessments, projects can be designed to monitor and attempt to mitigate any foreseeable threats before they become significant.

This study aims to determine the relative avian diversity and abundance of one primary evergreen forest site within the Payamino region of north eastern Amazonian Ecuador whilst adding to the total species count for the Sumaco region, building upon work carried out by the expedition since 2000.

Methods

The Sumaco reserve is relatively new reserve created in undisturbed lowland rainforest in the Napo lowlands region of Ecuador at approximately 77 10'W, 025'S. The sites sampled were predominantly terra firma interspersed with pockets of varzea. Rapid assessment 10-species MacKinnon Lists and ground level mist-netting were used to assess diversity. MacKinnon Lists are a widely used technique in the tropics (MacLeod et al, 2011): observational and call identification studies are carried out and the first ten bird species recorded. Each species only appears on each list once. To avoid bias, unidentified species were given a temporary name and a detailed description for later identification. The majority of observational studies were done in clearings, along main tracks and out over the rivers, however at some sites it was possible to observe within the vegetation.

Mist netting occurred throughout the jungle in cleared transects, however sampling effort was not constant for all sites. Mist netting would begin shortly before dawn, approximately 5.30am, using six 18m x 2.5m, 33mm mesh-size mist nets. The nets were checked hourly to remove captured birds, this time period being ample to allow efficient capture of birds without endangering their health or lives. Any captures were transported back to base to be identified, ringed, measured and released. Those captured in nets further away from the research base were returned to the area they were captured. All identifications were made using reference books on South American avifauna (Ridgely and Tuder, 1989, 1994; Ridgely and Greenfield, 2001 a, b). Mist netting continued until midday, after which the nets were taken down and moved to new sites, unless further sampling was required within the same site. In general, the nets were moved after each day in order to gain a larger sample size and to avoid the birds becoming habituated to the nets.

Results

During the study, a total of 339 birds of 64 species were captured. Mist nets tend to be biased towards smaller understory species and MacKinnon lists tend to be biased towards larger and more vocal species. Neither method alone succeeds in sampling the full complement of species; however the weaknesses of one method are compensated for by the strengths of the other. So to accurately determine tropical avian diversity it is suggested that a combination of methods should be used.

These birds comprised of 62 species, 10 of which were new species for the area for 2012 (Table 1). These add to the total species count for Payamino to give a count of 339 species. We are pleased to say that we have now recorded 32 of the 33 indicator species for the area (Stotz et al., 1996). This year there was some construction work at the research station and the noise it caused most likely affected the birds in the vicinity of the site.

Tachybaptus dominicus	Least Grebe
Accipiter superciliosus	Tiny Hawk
Herpetotheres cachinnans	Laughing Falcon
Micrastur semitorquatus	Collared Forest-falcon
Eurypyga helias	Sunbittern
Zimmerius chrysops	Golden-faced Tyrannulet
Pachyramphus polychopterus	White-winged Becard
Notiochelidon cyanoleuca	Blue-and-white Swallow
Clypicterus oseryi	Casqued Oropendola
Gymnomystax mexicanus	Oriole Blackbird

Table 1: List of the 10 new species for the area found in 2012.

The continued discovery of new species for the area emphasises the need for rapid assessments. If an area which contains one of these species were to be destroyed then certain species may be lost from the Sumaco region which would have a significant impact on the biodiversity. However, the sampling effort carried out in each area may not have produced an entirely accurate representation of the species within the area therefore it cannot be said with great certainty that if a species was found in one area only then that is the only area it inhabits. Bird species may not always be captured by mist netting therefore any study that looks to investigate the distribution of possible vulnerable species would have to use a combination of sampling methods and for a longer time period as to avoid any inaccurate findings.

Conclusion

The 2011 and 2012 expeditions stayed around one research station, but the expeditions prior to 2011 studied two or three different sites, so those results are not directly comparable with the most recent findings. The 2011 ornithology group caught 393 individuals of 73 species, while the 2012 group caught 339 individuals of 62 species. However this year was more successful in regards to new species for the area; 10 were found this year, while the 2011 total was 6. So while we had hoped to reach similar numbers to the 2011 results, we are very pleased with the 10 new species found. This clearly shows that even after 11 years of research there is still much to be discovered and further study is still very much needed to achieve a total species list for the area. Further studies should increase the sampling area and continue studying new locations and habitats. In addition to mist netting and visual surveys, the role of camera traps should not be ignored – for example, one of the new species for 2012, Chestnut-headed crake (*Anurolimnas castaneiceps*), was only captured on camera traps.

Herpetology Report

Introduction

The Payamino Reserve lies within the boundary of the Napo Biodiversity Hotspot – one of the 25 most biologically rich areas under the greatest threat of destruction, as defined by Conservation International. This was the seventh year the herpetological project was conducted at the Payamino reserve and up until this year's expedition a species list of 73 has been compiled since research started in 2004. While this is extremely encouraging, there are still many more species to find. Species discovery rates have actually increased since the project started, indicating that the potential for further research is huge. Now that we have a good knowledge of the more common species and the geography of the area we can start long-term studies into species composition and population numbers. Although many monitoring studies are underway, very few of them are long-term studies (Young et al. 2001). Our study has been running since 2004 and thus offers valuable information on the long term trends of species diversity in the Payamino area.

Amphibian populations are declining all over the world (Houlahan et al, 2001), and Ecuador is an important area for amphibian study since "The largest numbers of threatened species occur in Latin American countries such as Colombia, Mexico and Ecuador" (IUCN et al., 2006). Also, many species which are data deficient for endangered classification could potentially be threatened (Stuart et al., 2004). For these reasons it is important that more studies are carried out on amphibians in Ecuador, and around the world, in order to gain significant data to effectively evaluate the amphibian decline (Young et al. 2001; McCallum, 2007). Another point of importance for this study was as part of Project Payamino: a conservation iniative in the Payamino region in partnership with Zoos Go Wild and Aalborg Zoo in Denmark, which strives to protect the biodiversity and culture of the area.

The aims of this project were to continue creating an inventory of the amphibian species found and assess the species richness and abundance in comparison with previous years.

Methods

Transects were cut at each site in areas close to the base camp and accessible by local paths. Guides assisted in finding suitable areas for transects and, using machetes, cut five parallel 100 metre tracks separated by four 20 metre tracks to allow crossing between (see Figure 2). After cutting, transects were given a day to allow the habitat to settle before sampling began.

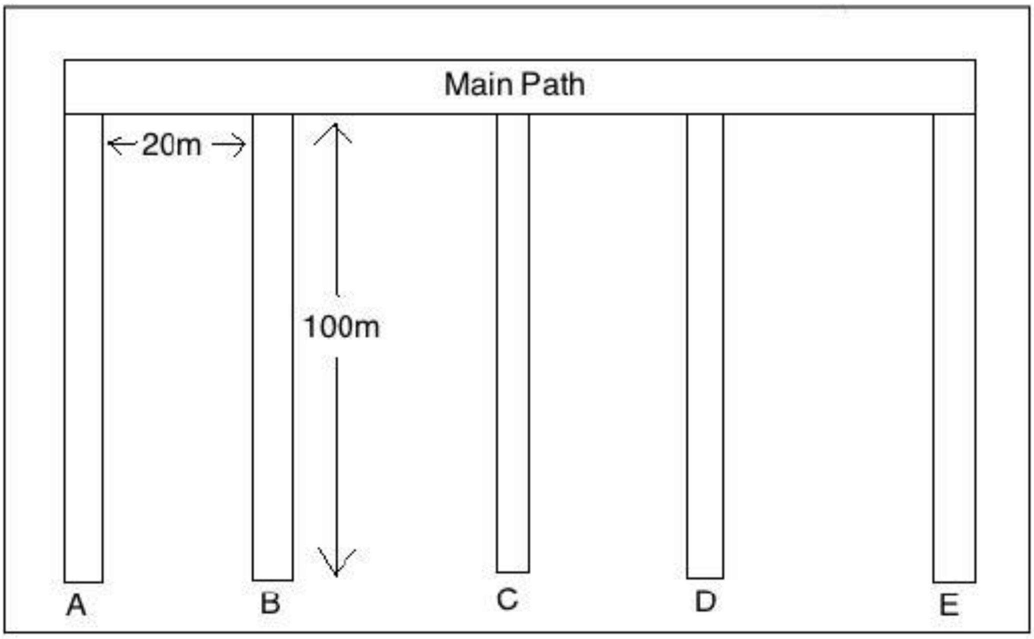

Figure 2: Diagram of layout of transects as seen from above.

Visual encounter surveys (VES):

Five transects were cut and used for visual encounter surveys. Transects one to three were in the secondary rainforest and transects four and five in the primary rainforest. At each of the transects one evening and one morning VES was carried out. Evening surveys were started between 7.30-8.00pm and morning surveys between 7.00-7.30am. During VES, one team member walked at the front attempting to catch specimens, two further members followed behind, focusing on either the left or right side, fourth looked higher on tree trunks, while the last member checked under logs and debris. Each VES included 1 metre either side of the transect and 2 metre up from the forest floor. The time spent sampling each transect was aimed to be kept constant.

When specimens were caught they were placed in a zip-lock bag with a leaf and a breath of air, then numbered in the order they were caught. It was also noted on which substrate (leaf litter, leaf, log, fern or branch) and at which height the specimen was found. The area they were found was also marked to allow return to the exact spot. Once all five sub-transects had been searched, bags were taken back to the lab and hung from a line until the morning when they were identified.

Amphibians were identified as far as possible using two books: Reptiles and Amphibians of the Amazon: An Ecotourist's Guide by Bartlett and Bartlett (2003) and Cusco Amazonico: The Lives of Amphibians and Reptiles in an Amazonian Rainforest by Duellman (2005). Each frog or toad was also photographed and photos of those not identified at site were referred to experts. In addition to identification, weight and length measurements were also taken for each individual.

Results

The data collected for this study was used for Bryony McCallum's Honours project and the following data analysis has been done by her. The species inventory shows a total of 129 individuals from 22 different species found at San José de Payamino were captured (Table 3). The most abundant species found in 2012 was *Rhinella margaritifer* with 34 captured individuals. No significant difference was found between the number of amphibians between the five transects (p=0.676). There also was not a significant difference between the number of amphibians found and the time of the day (morning or evening). A Shannon Wiener Index was used to measure which transect had the highest diversity (Table 2). It was found that transect B was the most diverse. Using another diversity index, Simpson's D Index, also showed that transect B had the highest diversity of species.

Transect	**H**
A	2.319
B	2.609
C	1.768
D	2.366
E	2.480
All sample index	2.683
Jackknife STD Error	0.03906

Table 2: The calculated Shannon Wiener Index values (H) for each transect.

This may not be a true representative sample of the amphibian fauna found in the area as our sampling methods were confined to sampling those within our reach. This year canopy access was not used for the herpetological study and so arboreal species were unable to be fully sampled. On previous years, most of the transects were nocturnal, but this year nocturnal and diurnal transects had equal sampling effort. For this reason, it can be said that the species inventories contain a fair representation of the nocturnal and diurnal terrestrial amphibians in the area, but no data was collected for the arboreal species.

Adenomera hylaedactyla	7
Ameerega bilinguis	1
Chiasmocleis bassleri	1
Chiasmocleis ventrimaculata	1
Dendropsophus sp	1
Hyalinobatrachium munozorum	1
Hypodactylus nigrovittatus	9
Leptodactylus wagneri	1
Lithodytes lineatus	5
Osteocephalus planiceps	2
Phyllomedusa vaillantii	2
Physalaemus petersi	3
Pristimantis altamazonicus	2
Pristimantis conspicillatus	1
Pristimantis croceoinguinis	3
Pristimantis kichwarum	22
Pristimantis lanthanites	3
Pristimantis martiae	6
Pristimantis quaquaversus	6
Pristimantis variabilis	7
Rhinella dapsilis	11
Rhinella margaritifer	34
22 species	129 Individuals

Table 3: List of the species and numbers of individuals found.

Conclusions

The 2011 expedition found 58 individuals from 20 different species, so this year the expedition, with the total of 129 individuals from 22 different species, was much more successful. In the light of the current global amphibian crisis, the high number of individuals found is very good news.

The herpetology group had wished to do more transects, but only 5 transects could be cut due to the limited number of local guides who were available to do the cutting. The group was also faced with delays in getting transects cut and some days with very heavy rainfall, which meant that each transect could only be sampled twice. In future years, to gain an even more accurate picture of the amphibian diversity, more transects and replicants should be done. It would also be beneficial to use sound recording for identifying species. This technique was not used during this expedition as the identification is the calls is quite time consuming and very challenging for an unexperienced person.

However, the herpetology team was very satisfied with the data collected and feels that the 2012 project was successful.

Camera trapping report

Introduction

Studying tropical rainforest mammals can be tricky. The elusive behaviour, especially of the carnivorous mammals, low densities and the dense coverage of their habitat can make visual methods of sampling difficult. For this reason scientists have adopted camera trapping as a sampling method to overcome these constraints.

A network of camera traps can be set up in various locations around the forest which aim to capture photographic images and provide scientific information about endangered and elusive species. Cameras detect movement when the targeted animals moves into range and takes digital photographs which can then be uploaded onto a database and studied in more detail.

Methods

The team first of all carried out several treks into the forest with local guides to assess the probable sites in which large mammals way be found. Sites were chosen based on tracks, scats, existing trails and access to a water source. 10 camera traps were placed in various locations around the study site for five weeks. Cameras were positioned in the morning or afternoon and left undisturbed for five to seven days before being brought back for analysis. Some traps were baited with tuna. This year we had two colour camera traps and video camera trapping was also used.

Results

Using the camera-trapping technique we were successful in capturing many images of rainforest animals, both mammals and birds, listed in Table 4. Some example photos are shown in Figures 3 and 4.

Photos:	**Video:**
Brazilian tapir *(Tapirus terrestris)*	Agouti (unknown sp.)
Agouti (unknown sp.)	Greater long-nosed armadillo *(Dasypus kappleri)*
Chestnut headed crake (*Anurolimnas castaneiceps*)	Opossum (unknown sp.)
White hawk *(Pseudastur albicollis)*	Racoon (unknown sp.)
Opossum (unknown sp.)	Piping guan (*Pipile* genus)
Small deer (unknown sp.)	
Small rodent (unknown sp.)	

Table 4: Table of seen and identified animals.

*Figure 3: Examples of colour camera traps photos. On left, agouti (unknown species) and on right, White Hawk (*Pseudastur albicollis*).*

*Figure 4: Examples of the black and white camera trap photos. On left, Brazilian tapir (*Tapirus terrestris*) and on right, unknown mammal.*

Conclusions

This was a successful study in that we were able to identify several species of mammal in the area. 2012 was only the second year that camera trapping had been properly used on the Ecuador expedition, so while the team used the information gained last year, they were still learning through trial and error. However, we had positive interactions finding several species.

In future, this project should be continued and further improved, in order to continue building a complete mammal species list for the area. Techniques such as baiting the traps with food were successful; however using a more familiar food source for the carnivorous species may be more beneficial. Use the local knowledge of areas where big mammals can be found should be increased. In order to evaluate whether the mammal species in the area are at a healthy density, a lot more research must be carried out, investing in colour camera traps and video camera trapping could aid in identification and using GPS to mark the locations of each camera trap station. The more information that we can collect, the easier it will be to diagnose the health of these mammal populations. Practicing the technique beforehand on Scottish wildlife may also be beneficial.

Canopy Access report

Introduction

It is thought that 70-90% of rainforest life is found in the canopy. After introducing the canopy access project in 2011, the Ecuador expedition had the opportunity to continue exploring this understudied area of the rainforest. The team focused on building a picture of the area and its suitable trees for canopy access and did a pilot study on butterfly diversity using traps. Like last year, the team was fully trained by Canopy Access Ltd.

Methods

The team consisted of three members; one member of the 2011 team who went through the training in 2011 and two newly trained and qualified people. In 2011 the team was under the supervision of experienced canopy access trainer Vicki Tough for the first two weeks. We were hoping to repeat this in 2012 but due to other work commitments, Vicki Tough was unfortunately unable to join us. The trained members were in charge of determining the safety of the study site and also keeping other members of the expedition safe while they are working in the canopy.

Individual trees were examined to determine their safety. Visual tree assessment included checking for any animal nests, strength of the branches, health of the tree and condition of roots. Trees that were safe to climb were rigged using a rope and pulley system. Round butterfly traps with some fruit as bait were hung from branches, on heights varying from 5 to 15 meters. Canopy nets, measuring six meters tall and two meters wide, were suspended at approximately 25 meters in the targeted tree. Canopy nets were suspended first thing in the morning as with the ground mist nets and were checked every hour for captured birds. Canopy nets were moved to a different location every week.

Results/Conclusion

The team faced several difficulties this year, which meant that targets were not achieved. Compared to last year, the weather in the research station was much hotter. There were several days when the high temperatures made working dangerous to team members' health and thus impossible. Assessing trees and rigging them requires adequate light, so working after sunset was not an option either.

The team also struggled to find suitable trees despite spending considerable time walking around the area in search for big, healthy and safe trees. Much of the rainforest around the research station is secondary forest and thus does not have many big emergents – and the majority of those that the team found had been damaged in storms or by animals which made them unsafe for climbing. It is suggested that in future years, the canopy access team should focus on the primary rainforest areas much further away from the research station. As the distance to the research station is long (over one hour walk) and the equipment is very heavy, we think the best solution would be to build a temporary shelter on site, allowing the canopy team to stay and work deeper in the primary forest, without having to move between the research station and the working site. For safety reasons, having a local guide accompanying the team would be recommended.

Butterfly project

Introduction

One team member, Bertie Allison, conducted his final year Honours project on the butterfly diversity in the area. All of the following results, data analysis and figures are Bertie's work. Data collection was done mainly by the canopy access/camera trapping group, with some help from members of other groups. No similar study has been done on Payamino area before, so the project was essentially also a pilot study.

Butterflies are one of the best known taxon in the world due to their attractiveness and relatively conspicuous nature. There are thought to be around 15-20,000 species of butterfly with the vast majority of them found in the tropics (Stork & Gaston, 1990). Due to their close relationship with plants throughout their life-cycle and their sensitivity to environmental change they are thought to be good indicators of disturbance. This study looks at butterfly diversity and abundance relative to habitat disturbance with reference to Connell's Intermediate disturbance hypothesis and the habitat Heterogeneity hypothesis. Butterfly activity at different times of the day and in different weather conditions was also compared.

Methods

The butterfly diversity was studied using walk-and-count transects and three different habitats (see Figure 5) with varying levels of disturbance were compared: primary rainforest, secondary rainforest and open clearings. In primary and secondary rainforest transects, already established paths were used for ease of movement and because butterflies use them as pathways and are thus likely to be found around them. Every time a butterfly was seen, it was counted and group members tried to catch it with a net. When caught, each individual was photographed for later identification. Each transect was 60 minutes long – whenever a butterfly was caught, the stopwatch was stopped while a photo was taken to make sure that the set transect time was always 60 minutes. Butterflies were counted if they were within a 3 metre radius from the path. Transects were done by two people who had butterfly nets, a tally counter, a stopwatch, camera and a notebook. Each habitat had four transects and each transect was sampled twice, during morning and afternoon. No transects were done during rainfall.

Figure 5: Satellite image of Payamino site. The black arrow indicates the location of the field station. The black oval on the left encircles Armadillo Hill, around which the transects for Primary Rainforest were conducted. The black shape closer to the river shows the area in which transects for Secondary Rainforest and Open Clearings were conducted. Examples of the various open clearings can be seen as the brown patches dotted amongst the Secondary Rainforest.

Results

One of the aims of this project was to see if there was a difference in abundance of butterflies in different habitats of San José de Payamino. During the 4 weeks of sampling using walk-and-count transects, a total of 1881 individuals were counted amongst the 3 separate habitats. The results show the most densely populated habitat was Open Clearing with 876 individuals tallied. This was followed by 667 tallied in Secondary Rainforest and 338 in Primary Rainforest, as shown in Figure 6. A Chi-squared test was conducted to see whether there was a significant difference found in the number of individuals tallied in the 3 habitats. The null hypothesis states there is no difference in butterfly abundance between the 3 habitats.

Another aim was to test whether the time of day affected butterfly activity. The number of butterflies tallied was used as a measure of butterfly activity, i.e. when comparing 2 conditions: if there were more butterflies tallied in one condition, then their activity was greater than in the other. In each habitat, there were more butterflies tallied in the afternoon transects. In fact, this is true for every single transect. It is also true for caught individuals in the majority of transects. In just a few cases were more individuals caught in the morning than the afternoon.

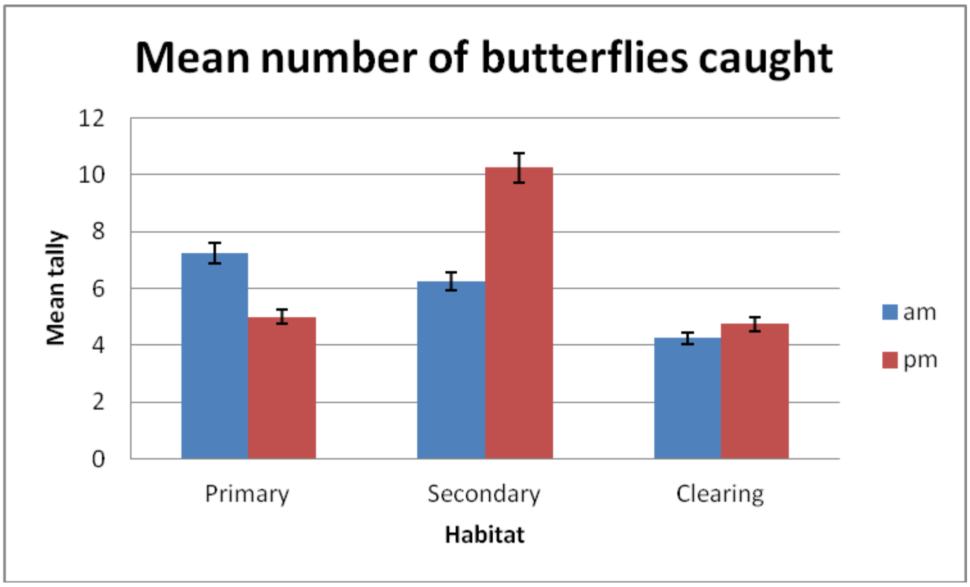

Figure 6: Mean number of butterflies caught on morning and afternoon transects in each habitat with 95% confidence intervals.

In order to compare butterfly diversity between the 3 habitats, the species richness (that is the number of species) and the species evenness (abundance of each species) must be taken into account. Two species diversity indices which take these into account were used to compare each habitat's diversity. The first of these is the Shannon Diversity Index (H). Having greater species evenness or having more unique species increases the index. The second index used was Margalef's Index (D). Table 5 gives the Shannon and Margalef indices for all 3 habitats.

	Shannon Index (H)	**Margalef Index (D)**
Primary Rainforest	3.147	7.195
Secondary Rainforest	3.423	9.513
Open Clearing	3.338	8.093

Table 5: Shannon and Margalef Indices of Species Diversity for all three habitats.

Table 5 shows that Secondary Rainforest has the highest diversity according to both indices with values of 3.423 for Shannon and 9.513 for Margalef. Primary Rainforest has the lowest species diversity when using both Shannon's and Margalef's Indices. A T-test showed there was no significant difference between the Shannon values of each habitat, whereas there is a significant difference between the Margalef values of Primary and Secondary Rainforest but not between Primary and Clearing nor Secondary and Clearing.

Rate of species accumulation can be used to estimate richness using species accumulation curves. Figure 7 below, shows the species accumulation curve of total butterfly species caught in all habitats.

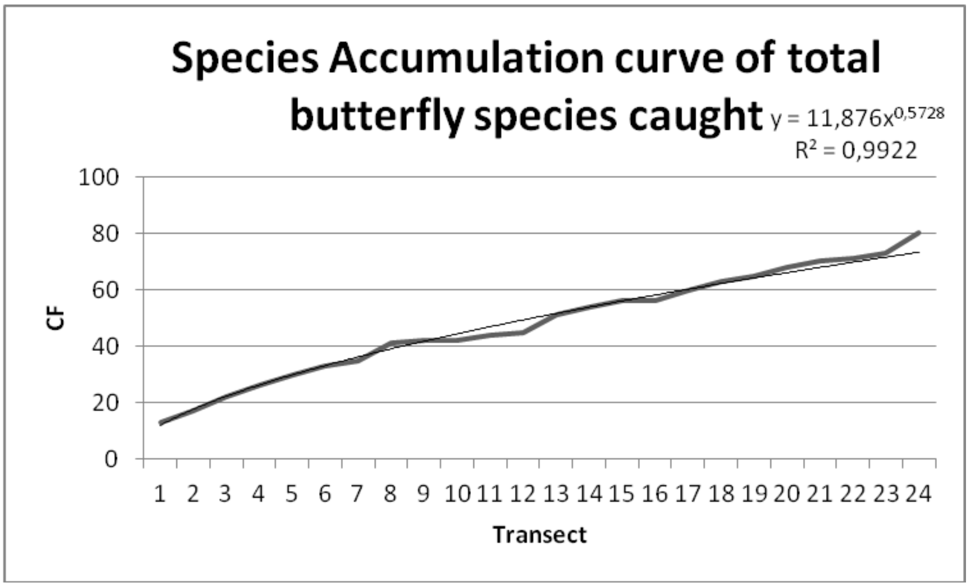

Figure 7: Species Accumulation curves of butterflies caught from all habitats, with line of best fit and equation, along with coefficient of determination (R^2).

As you can see in Figure 7, the line of best fit (describing the line to an R2 value of 0.99) is almost linear, indicating that there is not a large enough sample to estimate total species numbers. This means the total number of species in the area is much greater than the 80 species that were caught.

Species	Sub-Family	Primary	Secondary	Clearing
Aeria eurimedia pacifica	Ithomiidae	Y	N	N
Aeria eurimedia spp.	Ithomiidae	Y	N	N
Cithaerias aurorina	Satyridae	Y	Y	N
Cithaerias phantoma	Satyridae	Y	Y	N
Dismorphia pinthaeus	Pieridae	N	Y	Y
Dygoris dircenna	Ithomiidae	N	N	Y
Euptychia cephus	Satyridae	N	Y	N
Eurytides molops	Papilionidae	N	N	Y
Forbestra proceris	Ithomiidae	Y	N	N
Haetera piera	Satyridae	Y	N	N
Heliconius wallacei	Heliconiidae	N	N	Y
Hypoleria aureliana	Ithomiidae	Y	N	N
Hypoleria orolina orolina	Ithomiidae	N	Y	N
Hyposcada anchiala	Ithomiidae	Y	N	N
Hyposcada illinissa ida	Ithomiidae	Y	Y	N
Hyposcada illinissa idina	Ithomiidae	Y	N	N
Hyposcada illinissa #1	Ithomiidae	N	Y	N
Hyposcada illinissa #2	Ithomiidae	N	Y	N
Hyposcada kena	Ithomiidae	N	Y	N
Ithomia derasa	Ithomiidae	N	Y	Y
Mesosemia loruhama loruhama	Riodinidae	N	Y	N
Methona confusa	Ithomiidae	Y	Y	Y
Miraleria cymothoe	Ithomiidae	N	Y	Y
Morpho menelaus	Morphidae	Y	Y	Y
Oleria agarista agarista	Ithomiidae	N	Y	N
Oleria astrea	Ithomiidae	N	Y	N
Oleria assimilis	Ithomiidae	Y	Y	N
Oleria enania tacoaiensis	Ithomiidae	N	Y	N
Oleria gunilla lota	Ithomiidae	Y	N	N
Oleria ilerdina lerida	Ithomiidae	Y	N	N
Oleria onega spp.	Ithomiidae	N	Y	Y
Oleria onega janarilla	Ithomiidae	Y	Y	N
Oleria #1	Ithomiidae	N	Y	N
Oleria #2	Ithomiidae	N	Y	N
Perrhybris pyrrha	Pieridae	N	Y	Y
Pierella astyoche lucia	Satyridae	Y	N	N

Table 6: Species list and location(s) of capture.

Conclusion

This was the first study on butterfly diversity and their habitat preference conducted in the area, so we had no previous knowledge on what techniques should be used and most common species. Thus we had no numerical targets we wanted to achieve. We feel that the project was successful, and are very pleased with the 80 species discovered. This project was an excellent pilot study and we hope that future expeditions will continue this project.

Secondary Rainforest was shown to have the highest species diversity of the three habitats according to two indices. These conclusions correlate with the proposed hypotheses; that the habitat with moderate levels of disturbance and highest botanical complexity will host the highest diversity. Results from Open Clearing showed it had a very heterogeneous species composition with each family being represented and it had the greatest species evenness according to two indices. Primary Rainforest had the lowest species evenness and diversity.

The study showed Open Clearing had the greatest abundance of individual butterflies, although, ignoring possible anomalous results, Secondary Rainforest had the greatest abundance while Primary Rainforest had the lowest. Abundance tallies were also used to determine butterfly activity in the morning and the afternoon and in varying weather conditions. Butterflies were shown to be most active in the afternoon and when weather conditions were sunnier and perhaps warmer.

The Experimental design worked well in the most-part but aspects of the Open Clearing habitat provided anomalous results and could have been improved upon.

Finally, the status of butterflies and insect populations is hugely important due to their relationship with the environment and a combination of habitat-based conservation, indicator species and protection of a rich mosaic of habitats is the best way to conserve them.

Expedition personnel

Herpetology group:

Jessica Fordyce
Bryony McCallum
Ryan Carter
Jessica Clark

Ornithology group:

David Logan
Laura France
Erin Robertson
Agnieszka Dzegan
Dr Stewart White

Canopy access / camera trapping group:

Hannele Honkanen
Bertie Allison
Kelsie Braidwood

Financial report

Income	
Personal contribution (£1050 each)	£12600
Bake sales	£ 358
Band nights	£ 193
Bucketing	£ 749
Busking	£ 34
Ceilidh	£ 398
Pancakes	£ 54
Clothes swap	£ 45
Zumba	£ 70
Sponsored climb of Ben Lomond	£ 354
Sponsored leg wax	£ 85
Busking	£ 34
Coffee morning	£ 115
Collecting Tins	£ 128
Tiger Suit	£ 102
Carnegie Trust	£2000
James Watt Trust	£ 750
University of Glasgow	£1900
Gilchrist Trust	£1000
Glasgow Natural History Society – BLB	£ 600
The Cray Trust	£ 200
Tunnocks	£ 50
Sally Jane Bags	£ 50
Intelligent Finance	£ 50
Connell & Connell	£ 50
Deanway Development	£ 100
S White - donation	£1895
Total	**£23964**

Expenditure	
International flights	£10935
Internal flights	£ 680
Accommodation – Payamino	£7110
Acommodation – Quito	£ 624
Accommodation – Coca	£ 500
Food	£1250
Equipment/licences	£1000
Canopy Access Training	£1300
First aid course	£ 200
Reports	£ 300
Taxis	£ 65
Total	**£23964**

References

Bartlett, R.D. and Bartlett, P (2003) Reptiles and amphibians of the Amazon: an ecotourists guide. Gainesville, University Press of Florida.

Duellman, W.E. (2005) Cusco Amazónico: the lives of amphibians and reptiles in an Amazonian rainforest. Ithaca, Cornell University Press.

Houlahan, J.E., Findlay1,C.S., Schmidt, B.R., Meyer, A.H. and Kuzmin, S.L. (2000) Quantitative evidence for global amphibian population declines. Nature **404**, 752-755.

MacLeod, R., Herzog, S., Maccormick, A., Ewing, S., Bryce, R. and Evans, K. (2011) Rapid monitoring of species abundance for biodiversity conservation: Consistency and reliability of the MacKinnon lists technique. Biological Conservation, 144, 1374-1381.

McCallum, M.L. (2007) Amphibian decline or extinction? Current declines dwarf background extinction rate. Journal of Herpetology, **41(3),** 483-491.

Parris, K.M., Norton, T.W. and Cunningham, R.B. (1999) A comparison of techniques for sampling amphibians in the forests of south-east Queensland, Australia. Herpetologica, **55(2),** 271-283.

Pearman, P.B., Velasco, A.M. and Lopez, A (1995). Tropical amphibian monitoring - a comparison of methods for detecting inter-site variation in species composition. Herpetologica, **51(3),** 325-337.

Ridgely, R.S. and Greenfield, P.J. (2001a) The birds of Ecuador, Status, distribution & taxonomy, volume1. Ithaca, Cornell University Press.

Ridgely, R.S. and Greenfield, P.J. (2001b) The birds of Ecuador, a field guide, volume 2. Ithaca, Cornell University Press.

Ridgely, R.S. and Tudor, G. (1989) The birds of South America: The oscine passerines. Oxford, Oxford University Press.

Ridgely, R.S. and Tudor, G. (1994) The birds of South America: The suboscine passerines. Oxford, Oxford University Press.

Stork, N. E., Gaston, K. J., (1990) Counting species one by one. New Science, 1729: 43-47.

Stotz, D.F., Fitzpatrick, J.W., Parker, T.A. and Moskovits, D.K. (1996) Neotropical Birds: Ecology and Conservation. Chicago, University of Chicago Press.

Stuart, S.N., Chanson, J.S., Cox, N.A., Young, B.E., Rodrigues, A.S.L., Fischman, D.L. and Waller, R.W. (2004). Status and trends of amphibian declines and extinctions worldwide. Science, **306(5702),** 1783-1786.

Waddle, J. H., Rice, K. G., Mazzotti, F. J. and Percival, H. F. (2008). Modeling the effect of toe clipping on treefrog survival: beyond the return rate. Journal of Herpetology, **42(3),** 467-473.

Young, B.E., Lips, K.R., Reaser, J.K., Ibanez, R., Salas, A.W., Cedeno, J.R., Coloma, L.A., Ron, S., La Marca, E., Meyer, J.R., Munoz, A., Bolanos, F., Chaves, G. and Romo, D. (2001) Population declines and priorities for amphibian conservation in Latin America. Conservation Biology, **15(5),** 1213-1223.