Canopies, Climate, and Critters of the

Ecuadorian Rainforest

2012 FIELD REPORT

Background Information

Lead PI: Mika Peck

Report completed by: Mika Peck

Period Covered by this report: June - August 2012

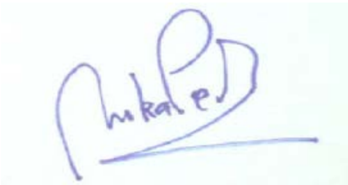
Dear Earthwatch Volunteers,

Thanks so much for your support during the 2012 Field Season. This was a challenging year with two of our research team (including myself) unable to join you in the the field teams due to injuries yet, in spite of this, you have managed to collect an incredible diversity of data and we have managed to put together a number of scientific papers published in international scientific journals.

There have been a number of successes for 2012; the establishment of the first hectare plot to investigate carbon dynamics in the Western Andes; collection of over 2600 bird sightings to continue monitoring environmental impacts to bird communities; and in particular the results of the camera trapping project this year that has provided us with a clear idea of the abundance and diversity of elusive small cats in the reserve. We are currently analysing this dataset and plan to publish a short article in the new year.

Thanks to all once again.

Best wishes



Dr Mika Peck

SECTION ONE: Scientific research achievements

Top highlight from the past season

For projects that aim to improve forest habitat there is the urgent need to develop simple indicators of forest improvement or degradation. The ability to detect environmental change is also important in the context of habitat degradation and climate change. We combined datasets for birds, reptiles, small mammals and bats from the Earthwatch project to investigate the cost-effectiveness of species groups in detecting habitat status. Birds provided a suite of cost-effective indicators of habitat in Andean montane forests for biodiversity monitoring and management. We suggest that scientifically robust, cost-effective bird monitoring programs have the potential to act as litmus tests for the impacts of environmental and climatic change, and furthermore have the potential to integrate conservation, ecological research, environmental education, capacity-building and income generation in Andean forest systems.

Reporting against research objectives

Objective 1: Rapid methods for determining the presence/absence and hence distribution of study species

Progress toward/against Objective 1 : Use of camera traps for mammal inventory. Continuing on from previous year's camera trapping studies the 2012 camera trap network was set up using 11 Reconyx RC 60 cameras. These cameras have very fast trigger times and an invisible infra-red flash. They have proved to be robust enough to withstand the cloud forest environment and they also assure photo capture of all passing wildlife.

This year's set up of the camera trap sites on the Reserve's pathway network was specifically targeting the small cats that have previously been observed. Cameras were set between 30-60cm from the ground and perpendicular to the path (Table 1.1). The goal was to gain a close up of passing cats so that identification of individuals was possible using their spot patterning. All photo captures of other forest mammals were recorded, in addition we recorded: human presence to gain a measure of disturbance at each camera trap site; habitat status using a habitat assessment at each camera trap site; signs of animal presence; proximity to water and vegetation density. Earthwatch volunteers assisted in the initial set up of the camera trap network, site set up, site maintenance, data collection, data entry and site habitat assessments.

Table 1.1 Camera Trap location details

Camera	Location	GPS location	Elevation (m)	Mammal Captures	Species Diversity
1	Autoguida Trail	17N0765233 UTM 0012458	1821	20	8
2	Lower Banana Trail	17N0765233 UTM 0012457	1567	13	8
3	Upper Banana Trail	17N0765433 UTM 0012864	1687	18	6
4	Lower Cascades Trail	17N0766313 UTM 0012309	1582	11	5
5	Upper Cascadas Trail	17N0766119 UTM 0012851	1758	12	7
6	Lek Trail	17N0768743 UTM 0012803	1748	0	0
7	Upper Principal Trail	17N0768658 UTM 0014987	2308	4	2
8	Lower Principal	17N0767736 UTM 0013838	1958	12	3
9	Rio, Bananas Trail	17N0767069 UTM 0012776	1341	11	6
10	Mid-Gomez Trail	17N0767110 UTM 0012500	1744	0	0
11	Lower Gomez Trail	17N0767279 UTM 0012112	1573	5	1

Results :14 species from five orders, 11 families and 13 genera (Table 1.2) were recorded in a total of 182 capture events at 11 camera trap sites over the period of 45 days, this amounted to over 11,800 camera trap hours with a per individual capture rate of 65 camera hours each.

Table 1.2. Order, family and number of species of mammals

Order	Family	Genus	Species
Certariodactyla	Cervidae	1	1
Carnivora	Felidae	2	3(4)
	Procyonidae	2	2
	Mustelidae	1	1
	Ursidae	1	1
Cingulata	Dasypodidae	1	1
Didelphimorphia	Didelphidae	1	1
Rodentia	Cuniculidae	1	1
	Dasyproctidae	1	1
	Sciuridae	1	1
Total 5	**11**	**12**	**13(14)**

Ground foraging birds accounted for almost 40% of images and unidentifiable pictures for 5% of this total. Discounting the birds and unidentifiable captures and just looking at the mammal count (106) showed that the most frequently observed animals were the small cats (17.75%) thought to be margays or oncillas. Due to the individual spot patterning of these cats we were also able to identify seven separate individuals. Next in frequency were opossums (16%) that were also observed at the greatest number of camera sites (8 of 11). Notable of mention was the photo capture of an Ocelot (Figure 1), never previously observed at the Santa Lucia Reserve site. Mammals recorded during this year's study represent over 10% of the total number of mammals present in the western subtropical region and over 3% of the total number of mammals registered in Ecuador to date (382 species according to Tirira, 2007).

Camera sites were set up specifically to target the small cats (Figure 2) and the results show that the methodology elicited success, the methodology could also be attributable to the increased frequency of bird captures during the study period due to cameras being lower to the ground than previous study years. Felidae was best represented within the reserve with 3 or possibly 4 species recorded; procyonidae was represented by 2 species. All other families were represented by a single species.

Figure 1: The first photo capture of an Ocelot at the Reserve. Its markings are distinctly different from those of the smaller cats and it's about three times their size.

Figure 2: One of the small cats at Santa Lucia Reserve suspected to be an Oncilla or Margay

From the total of 106 mammal photo captures obtained 43 were carnivores (40.5%), 5 were ungulates (4.7%), 5 were armadillos (4.7%), 17 were opossoms (16%) and 37 were rodents (34.9%).The diversity of species seen shows an abundant and diverse prey base (rat, squirrel, agouti, opossum, armadillo, deer, coati, mouse) for the observed carnivorous species (small cats, ocelot, puma, tayra) and the presence of the wide roaming bears is a testament to the protection afforded by the study site and neighbouring forest areas. Experiments with trap baiting using a catnip solution proved unsuccessful in terms of soliciting interest from the cat species but did provoke some interest from opossums and coatis. This year's study increased the observed species count since the beginning of this project to 21 species, additional to those is unidentified mouse and rat species that cannot be reliably identified without direct capture.

Bird survey: Species diversity The datasets from 2008 – 2011 were reviewed as part of an internship project by Jared Cole (Appendix 1). This provided good quality control on the dataset to 2012 and formed the base dataset for a publication submitted to Conservation Biology (See below under Objective 2) and a paper to be submitted to Biological Conservation in December 2012. In 2012 we added a further 2,660 observation to the dataset – now totalling 15,988 individual observations from the network of 126 point samples that span habitat and altitudinal gradients. Diversity data is summarised in the report by Jared Cole.

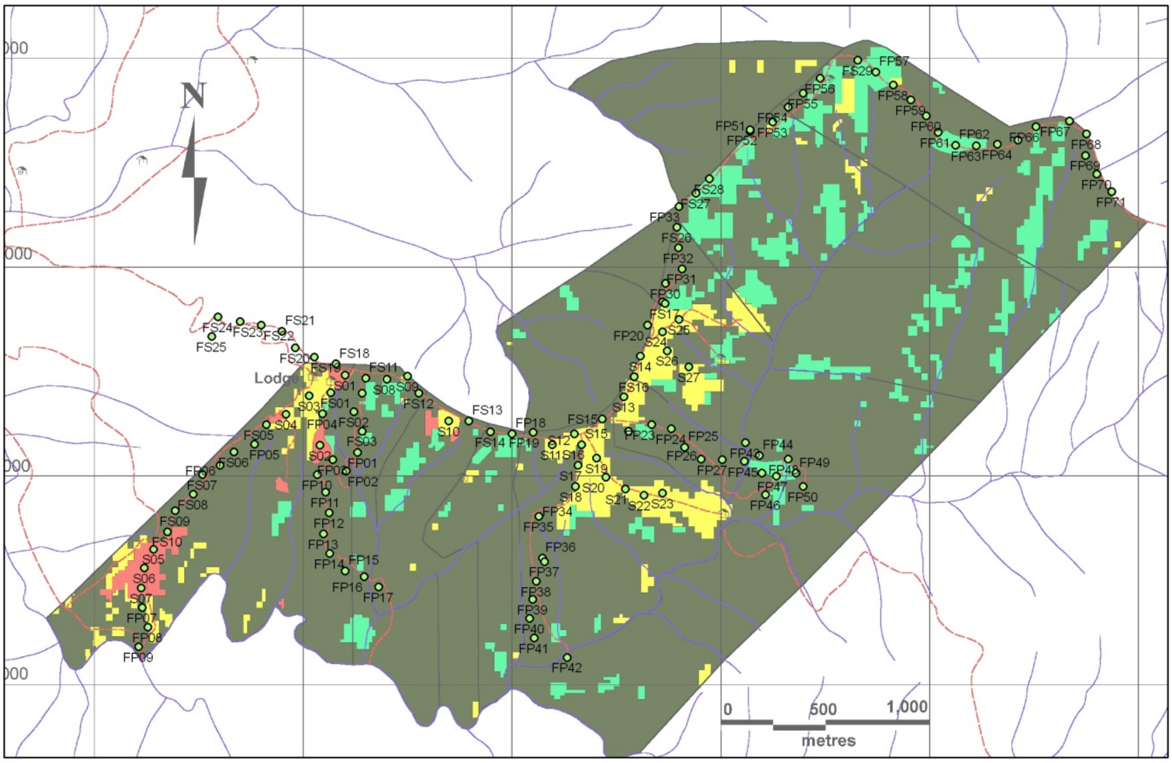


Figure 3: Bird Survey; species diversity:

Objective 2: Estimates of population density of study species allowing long-term monitoring of population trends.

Progress toward/against Objective 2: For projects that aim to improve forest habitat, i.e. as part of REDD+, there is the urgent need to develop simple indicators of forest improvement or degradation. The ability to detect environmental change is also important in the context of habitat degradation and climate change. We combined datasets for birds, reptiles, small mammals and bats from the Earthwatch project and further fieldwork in the Junin Reserve (a similar habitat located some 20km to the north of the Santa Lucia site) to investigate the cost-effectiveness of species groups in detecting habitat status. The paper has been submitted to Conservation Biology (October 2012). The title and abstract are pasted in below.

Title: Cost-effectiveness of using small vertebrates as indicators of habitat.

Authors: Mika Robert Peck, Simon T. Maddock, Jorge Noe Morales, Hugolino Oñate, Paola Mafla-Endara, Vanessa Aguirre Peñafiel, Wilmer E. Pozo-Rivera, Xavier A. Cueva-Arroyo & Bryony A. Tolhurst.

Abstract: Effective decision-making in the management and conservation of tropical habitats requires cost-effective tools to assess response of biodiversity to habitat degradation and restoration. To date no studies have investigated cost-effectiveness of small vertebrates as habitat indicators in tropical montane forests where assemblages can be structured by both habitat and altitude. We surveyed birds, leaf-litter lizards, bats, and small mammals using standard field survey techniques in primary, secondary and agroforestry systems in Andean montane forests of NW Ecuador. By fitting generalized linear models (GLM) and generalized linear mixed-effects models (GLMM) to abundances of individual species we modelled how survey effort and costs influence number of effective indicator species for each group. Total survey costs varied 4-fold between taxa and yielded differential success: no indicator species were detected for bats, two were found for both leaf-litter lizards and small mammals, and 20 identified for birds. At standardised costs lizards and bats failed to generate any indicator species, small mammals produced one and birds retained 17. Birds provided a suite of cost-effective indicators of habitat in Andean montane forests for biodiversity monitoring and management. The relative cost-effectiveness of birds as indicators relates to: 1) the ecological diversity and abundance of bird species in Andean montane forests; and 2) the effectiveness of the survey method. The importance of altitude in structuring bird assemblages implies a key role for avifauna as biomonitors of Andean climatic change. Scientifically robust, cost-effective bird monitoring programs have the potential to act as litmus tests for the impacts of environmental and climatic change, and furthermore have the potential to integrate conservation, ecological research, environmental education, capacity-building and income generation in Andean forest systems.

Objective 3: Information on the status of food webs and habitat of study species

Progress toward/against Objective 3: Water tank Bromeliads – diversity with altitude.
An undergraduate thesis was completed in 2012 by an Ecuadorian student (Earnesto Villacis, Universidade San Francisco de Quito). The dataset was collected during Earthwatch to investigate food webs in water tank bromeliads although the focus of the thesis was altitudinal diversity of macroinvertebrates. The abstract is shown below.

Abstract: Diversity patterns can be observed at different scales across the planet. The high concentration of species diversity and abundance in the tropics occurs and is maintained by

several factors, such as peaks of primary net productivity and access to energy. These effects can also be responsible for diversity variation due to altitude. Mountain ecosystems pose a geographical and physiological barrier to the dispersion of organisms, and colonization costs are higher when altitude increases due to the lack of available niches to colonize. Using microcosms such as phytotelmata bearing plants (i.e. bromeliads) presents an opportunity to analyze ecological processes such as dispersion and colonization. Their limits are more discrete than other ecosystems and they allow their faunal communities to be easily observed and collected. The main objective of this study is to analyze the variation in diversity and abundance of invertebrate species that inhabiting bromeliads with altitude. Ten bromeliads were collected from the Santa Lucia Cloud Forest reserve, in the Northwestern region of Pichincha, Ecuador. The samples covered the whole altitude range of the reserve (1400 m - 2600 m). Prior to collecting the bromeliads, a series of environmental variables were taken (i.e. canopy cover percentage, altitude above sea level, bromeliad height and diameter at the base). Their fauna was sorted, taxonomically identified and classified into morphospecies. 4063 individuals were found and classified into 197 morphospecies comprising 4 animal phyla. Species richness and abundance were quantified using alpha diversity indexes, and the similarity of the faunal communities at different altitudes was analyzed using beta diversity indexes. These results suggest that there is a positive correlation between altitude and community diversity. These assemblages of animals experience high rates of immigration; they respond to a logarithmic series abundance model, where morphospecies represented by a single individual are the most common. Rarefaction curves show an expected diversity peak at 2100 meters above sea level, which raises by 300 meters the previously reported diversity peaks of similar ecosystems in other regions. These diversity patterns can be explained by large-scale factors, such as primary net productivity, among others. In contrast, for this altitudinal range species diversity normally decreases with altitude in several animal groups, such as birds and insects.

Birds and habitat: Combining the bird survey, lizard, small mammal and bat datasets with micro-habitat data collected in 2010 we found that altitude has a greater influence than primary forest loss on small vertebrate diversity and community structure in the Tropical Andes. The implication is that climate change is likely to have strong impacts on vertebrate community composition. The draft abstract of the paper to be submitted to the journal Biological Conservation in December 2012 is included below:

Abstract: The tropical Andes contain threatened mega-diverse communities of high conservation priority. The cloud-forests of the Western slopes of the Ecuadorian Andes have, in particular, suffered high levels of habitat degradation, yet the response of most bioindicator species to altered habitats is unknown. We surveyed four small vertebrate taxa: birds, leaf-litter lizards, non-volant small mammals, and bats, in cloud-forest reserves of NW Ecuador. We compared species diversity and community composition across altitudinal and environmental gradients, in three differentially disturbed habitat types (primary and secondary forest, and a form of agro-forestry termed silvopasture). We recorded distinct bird assemblages in each habitat, and highest bird diversity in primary forest. Lizard relative abundance, species richness, and diversity were all greatest in primary forest. For both groups, the most disturbed habitat (silvopasture) supported intermediate levels of diversity, while secondary forest was generally depauperate. Contrasting effects were found for small mammals, with greater abundance and richness in secondary, although only weak effects were detected for bats. For all groups studied, altitude had the greatest impact, and there was evidence of a mid-domain effect (MDE). Bird assemblages in primary forest were additionally structured by forest sub-type (gap, closed canopy, regenerating) altitude, number of adult trees, number of aroids, percentage ground cover, and percentage total vegetation cover. Our results do not conform to the intermediate disturbance hypothesis (IDH), nor do they indicate that secondary forests act as biodiversity refugia. However, an additive effect of habitat loss on diversity may indirectly occur due to altitudinal shifts in distribution patterns under various climate change scenarios.

Objective 4: A novel remote sensing based methodology for habitat assessment metrics of canopy tree species in Andean mountain environments

Progress toward/against Objective 4: The potential for very high resolution imagery in identification of canopy species has been analysed and our results summarised in a paper published in 2012 in the Journal of Applied Vegetation Science. The title and abstract are summarised below.

Title: Identifying tropical Ecuadorian Andean trees from inter-crown pixel distributions in hyperspatial aerial imagery.

Authors: Mika Peck, Ana Mariscal, Martin Padbury, Tim Cane, Dominic Kniveton, Miguel Angel Chinchero. Applied Vegetation Science. Vol 15 (4): 548 -559.

Abstract: Question: Identification of tropical tree species from low-cost, very high-resolution (VHR) proximal canopy remote sensing imagery has great potential for improving our understanding of tropical forest ecology. We investigated whether inter-crown pixel information from VHR imagery could be used for taxonomic identification of trees and characterization of successional stages of tropical Andean mountain forest. Location: Santa Lucia cloud forest reserve, NW Ecuadorian Andes. Methods: We gathered digital camera imagery (0.05-m spatial resolution), using a remote-controlled helicopter platform, from primary and secondary forest and identified visible crowns to species before extracting digital crown samples (2-m radius). Using an object-based approach, histogram descriptors and diversity metrics of pixel intensity in red, green and blue (RGB) bands were calculated for crowns, and patterns in similarity explored using ordination. Predictive models were developed and validated using four decision tree models (CHIAD, Exhaustive CHIAD, CRT and QUEST). Results: Aerial imagery represented 54% of families, 53% of genera and 56% of species sampled from the ground. Ordination (redundancy analysis) confirmed that inherent continuities, based on crown metrics, correlated with traditional species, genus and family groupings ($P < 0.05$). Data were best described by histogram means in the green band. The best predictive model (CRT) generated a 47%probability of correct species identification for 41 species – with similar success at genus and family level. Predictive ability was highly species specific, ranging from zero for some taxa to 93%for Cecropia gabrielis Cuatrec. Conclusions: From the crown metrics tested, we found the mean pixel intensity in the green band was most effective in predicting species and species grouping of tropical mountain trees. This metric integrates species-specific differences in leaf density of crowns and reflectance in the green waveband. High predictive success for indicators of primary (Cornus peruviana J.F. Macbr.) and secondary forest (Cecropia gabrielis Cuatrec.) shows that VHR imagery can be used to identify species from pixel information to provide ecological information on successional status. Further research is needed to develop pattern and textural metrics specifically for hyperspatial digital imagery to identify tree species from crown imagery in diverse tropical forests.

Objective 5: Monitoring climate change – data loggers and bryophytes

Progress toward/against Objective 5: We now have a 4 year timeline of temperature throughout the altitudinal range of the reserve. The dataset requires analysis against the bryophyte dataset (see 2010 report) to determine the potential for monitoring climatic trends using moss and liverwort communities.

Objective 6: Integrate methods and results for biodiversity and carbon within a framework to estimate ecosystem services.

Progress toward/against Objective 6: New financing mechanisms for tropical forests are coming online and include finance from REDD+ (Reduced emissions from deforestation and degradation). Scientific information that underpins any REDD project includes standing stock of carbon for the various forest types.

In 2010 we undertook a field sampling programme to provide information on the above-ground carbon stocks of Santa Lucía Reserve.

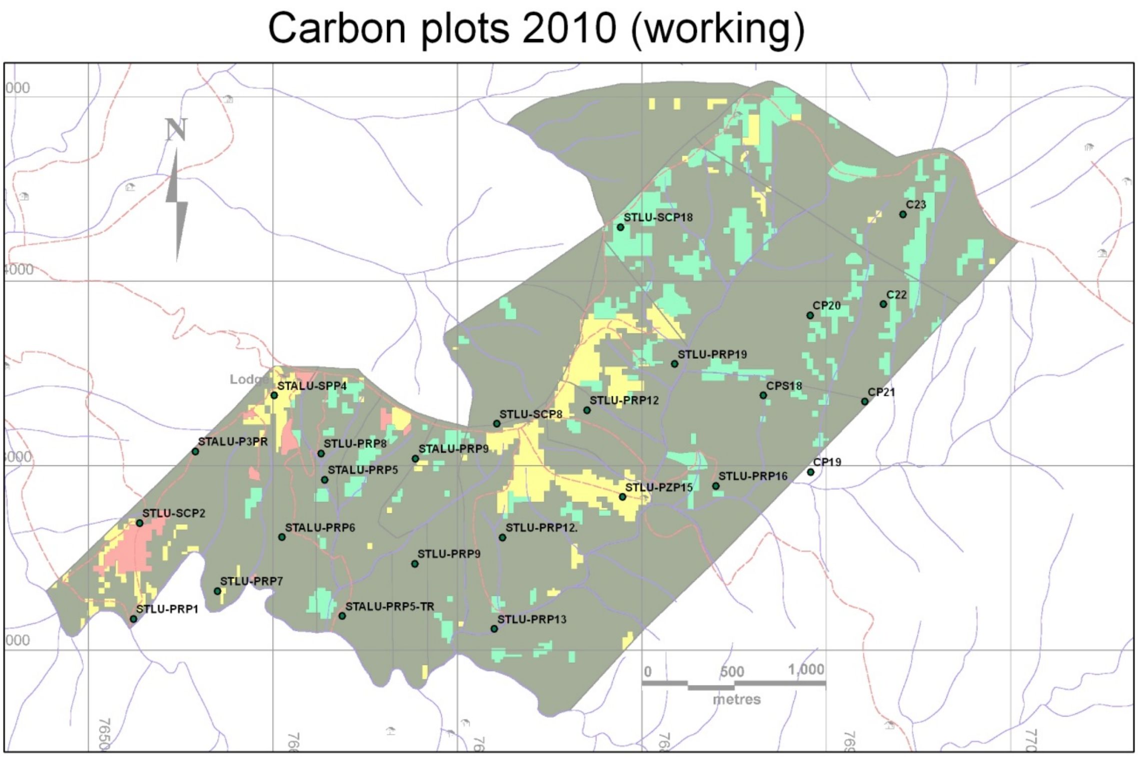


Fig 4: Carbon Plots 2010

This information, with further data on local rates of deforestation, forms the basis of financing mechanisms for REDD projects. For Santa Lucia we found that above ground carbon stock with 95% confidence intervals (Live + deadwood) were estimated at 143.63 (± 27.13) t C/ha and below ground carbon stock = 19.38 (±4.09) t C/ha. This estimation of carbon stock for the reserve is vital should Santa Lucía decide to explore REDD as a financing mechanism. For the Earthwatch project, it represents the start of a research programme that aims to provide greater scientific understanding of carbon in cloud forest systems. In 2012 we installed a permanent hectare plot to study the long-term dynamics of forest. The hectare plot was marked out in an area approximately 1km from the lodge at Santa Lucia. The 100m x 100m plot was marked out and further broken down into 25 (20m x 20m) composite squares. We registered 746 trees of 2.5cm or greater in the hectare plot in 2012 and recorded Diameter at Breast Height (DBH), height to the first branch, total height, canopy spread, distance to the western-most border (x axis), distance to the southern-most border (y axis) and epiphyte coverage. Trees were tagged with an individual identification number and their family, species and local name was noted. In 2013 dendrometer bands will be fitted to the trees to aid in long-term monitoring of growth rates. In addition to information on forest dynamics, the hectare plots provide the basis for estimating the rates of carbon sequestration associated with cloud-forest environments.

SECTION TWO: Impacts

Partnerships

Project success has been based on partnerships with:

1. A private donor Scott Rassmussen from the USA for help with purchasing Camera traps;
2. Holly Hill Trust for ongoing financial support of Ecuadorian researchers;
3.. The Universidad Andina Simon Bolivar – research partners;
4. The Cambugan Foundation who provided administrative and scientific support;
5. Pontificía Universidad Católica del Ecuador (PUCE) has provided help in identification of reptiles and amphibians;
6. Santa Lucia Cloudforest Reserve - through provision of excellent infrastructure and personnel.

Contributions to conventions, agendas, policies, management plans

- **International**

At the international scale the project contributes to the Ecuadorian government's obligations under the Convention on Biological Diversity, in particular to Article 7 (Identification and monitoring), Article 8 (In-situ conservation), and Article 12 (Research and Training).

- **National or regional**

Regionally the project contributes to the establishment of the Choco-Andean corridor. This network of protected areas connects forest in Ecuador through to Colombia. The Santa Lucia Reserve is a key linkage connecting forest starting at Mindo through to the Cotacachi-Cayapas Ecological Reserve. The Research laboratory space, finished for 2012, at Santa

Lucia now provides the facilities for Universities (local and national) to run field courses in the distinctive Andean forests. This year the centre hosted University students from the University of Sussex (UK) as part of the Tropical Forest Science Undergraduate module and in 2014 will also host a student group from Lincoln University (UK).

- **Local**

The project directly supports the existence of the Santa Lucia Cloudforest Reserve. As a financial input the annual contribution makes the community-based reserve financially sustainable resulting in the protection of 700 hectares of forest within a biodiversity hotspot

Developing Environmental Leaders

In 2012 we provided the opportunity for emerging young Ecuadorian scientists to lead teams as part of the 'Climate change, canopies and critters' project; Carlos Vargas (Cambugan Foundation) - led the botanical team establishing the hectare plot. Sara Andrea Vaca Sánchez (Ambato University) - supported camera trapping and bird survey teams.

Actions or activities that enhance natural and/or social capital

The project acts to conserve 700 hectares of Ecuadorian Andean Cloudforest by providing sustainable income through scientific ecotourism.

Conservation of Taxa

The project, by conserving at the habitat level, maintains an extremely diverse range of species. The species are listed in our 2010 report.

Conservation of Habitats

Conservation of prime forest habitat underpins the entire project philosophy. As such the Earthwatch project contributes to long-term conservation of 700 hectares of Andean mountain forest - classified as a global biodiversity hotspot (Myers et al 2000).

Ecosystem Services

The project supports the maintenance of the pristine Andean cloud forest and as such contributes to the following environmental services: carbon sequestration (thorough avoided deforestation and flux), watershed protection and provision of water supplies, biodiversity conservation (and all associated ecosystem services including pollination and seed dispersal) and erosion regulation.
From data generated by the 2010 Earthwatch field season we can conservatively estimate that the reserve provides carbon sequestration (through avoided deforestation alone) of approximately 1600 tons C per annum*. To provide some context, this represents approximately 800 transatlantic return flights (per person calculation).

* Calculation: Avoided deforestation per annum (tons C/year) = primary forest area in hectares x carbon per hectare x local deforestation rate (Cotacachi County rates from Peck 2010)

Conservation of Cultural Heritage

The project focuses on the maintenance of natural heritage but also keeps local skills alive including:
1. Sugar production (with a small sugar cane press at the reserve)
2. Local shade grown coffee (with Santa Lucía coffee grown within an agroforestry matrix)

Impacting Local Livelihoods

1) Direct financial support of staff and reserve infrastructure with approximately 80% of funds from Earthwatch going directly to the Santa Lucía Cooperative.
2) Local employment during the project period of guides and support staff
3) Guaranteed income allowing reserve to undertake infrastructure development

Local community activities

As the project sits within a participatory, community-run reserve there is a close relationship between the Earthwatch project and all local staff engaged in running the project. In addition the outreach programme that includes inviting youth members from the local community to join Earthwatch teams, at no cost to themselves, provides the mechanism through which conservation and training are disseminated directly at a community level.

Dissemination of research results

Scientific peer-reviewed publications

Peer reviewed publications 2011/2012 acknowledging Earthwatch:

Peck M.R., Maddock S.T., Morales J.N., Oñate H., Mafla-Endara P., Aguirre Peñafiel V., Pozo-Rivera W.E., Cueva-Arroyo X.A., Tolhurst B.A. (2013). Cost-effectiveness of using small vertebrates as indicators of habitat. *Conservation Biology* (Submitted October, 2012)

Peck M.R., Mariscal A., Cane T., Padbury M., Kniveton D. (2012). Identifying tropical Ecuadorian Andean trees from inter-crown pixel distributions in hyperspatial aerial imagery. *Applied Vegetation Science*. **15** (4): 548 -559.

Maddock, S.T., Tolhurst, B., Aguirre P., V., Mafla-Endara, P., Torres-Carvajal, O., Peck, M.R., Morales, J.N. (2012). The reptiles of the Santa Lucía Cloud Forest Reserve, Pichincha, Ecuador. *Herpetological Conservation and Biology*. (under review)

Maddock, S.T., Smith, E.F., Peck, M.R., Morales, J.N (2012). *Tantilla melanocephala* (Black-headed snake) diet. *Herpetological Review*. (in press)

Maddock, S.T., Tolhurst, B., Brown, M., Peck, M.R, Villacis Perez, E., Morales, J. (2011) Body bending behaviour – more widespread than previously thought? New reports from two snake species of Northwest Ecuador. *Herpetology Notes*, **4**: 079-081.

Maddock, S.T., Smith, E.F., Peck, M.R., Morales, J.N. (2011). *Riama oculata* (NCN) prehensile tail and new habitat type.Herpetological Review 42:277–278.

Maddock, S.T., Aguirre P., V., Torres-Carvajal, O., Morales, J.N., Peck, M.R. (2011) Riama unicolor (NCN). Feeding and new altitudinal range. Herpetological Review 42:278.

Grey literature and other dissemination

In 2012 the resident scientist (Matthew Brown) established a regular newsletter covering research and developments at the Santa Lucia Reserve and web presence on a blog, twitter and facebook. Available at: <http://www.facebook.com/santaluciaecuador> <http://santaluciascience.blogspot.co.uk/> <www.flickr.com/photos/santaluciaecuador>

SECTION THREE: Anything else

Is there anything else you would like to tell us?

In 2012 a previous Earthwatch volunteer published a book about his experiences volunteering around the world. One chapter is about his experience with Earthwatch on our research project in Ecuador. More information can be found at; http://www.thevoluntouristbook.com/about-the-book/

Acknowledgements

We would like to thank all volunteers, research staff, funders and especially the staff and community of Santa Lucia for their hospitality during all these years.