A comparative study of herpetofauna in natural primary forests and reforested areas at similar elevations, within and near the Jama-Coaque Ecological Reserve, in Coastal Ecuador.

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Abstract

It's important to protect the Earth's biodiversity. Deforestation is impacting a large portion of coastal Ecuador and is altering not only habitats but also microhabitats which area crucial for species which are sensitive to abiotic factors and seasonal changes. Reforestation efforts are increasing, but little is known about herpetofaunal reconstruction post-reforestation, beyond it being a slow process. It is likely that the species composition, abundance, diversity, and richness are lower in the reforested area and higher in the forested area as disturances are known to affect these species, and this study strives to address this question. Three transects were established in each of two plots (one reforested and one primary forest) in and near the Jama-Coaque Ecological Reserve at similar elevations. Visual Encounter Surveys (VES) were carried out for each of these transects. Species composition was determined, and abundance, richness, and diversity were calculated. Five species of reptiles were detected and 8 species of amphibians The transects within the reforested area yielded 6 species (27 individuals) and the transects within the forested area yielded 10 species (132 individuals). Species richness and abundance were higher in the forested area, the diversity was similar between both plots, and the species composition had overlap with some variation between species present. The results for species richness and abundance were expected, but low sample sizes made further analysis and conclusions difficult. These results can be used to extrapolate patterns to other reforested areas, contributing to the understanding and therefore better management of remaining tropical forests.

Introduction

Biodiversity is the foundation of life on Earth, and all species on earth have important roles in ecosystem processes, whether as part of the food web or otherwise. Reptiles and amphibians are among those species that are critical to life systems, and are one of the groups of species which are not only important to food webs, but also bring aquatic and terrestrial systems together (Urbina-Cardona 2008). Over half of these continental surface species which are so critical to life functions can be found within Tropical forests, which are contained within only 7% of the land mass on Earth (Urbina-Cardana 2008). Many of these species are in decline and at risk of extinction, with amphibians as one of the most at risk species due to their importance as key indicator species within our environment (McCallum 2007). Rates of extinctions are occuring exponentially and it has been estimated that current amphibian extinction rates are currently 211 times background rates (McCallum 2007), and it is crucial that we protect not only these amphibians, but all herpetofaunal species, reptiles included. Without amphibians and reptiles, human comfort and quality of life will be affected, as well as critical ecosystem functions (McCallum 2007). We must therefore ask ourselves how much more can be lost before this is evident that it is happening to us.

Many of the herpetofaunal extinctions that take place occur for a select few key reasons. These include land use changes which are linked to deforestation, fragmentation, and habitat degradation, habitat loss, diseases and pathogens, the release of toxins into the environment (and toxin accumulation within species and the environment), overexploitation including illegal trafficking and uncontrolled scientific collection, the introduction of invasive species, synergetic interactions with climate change (Urbina-Cardona 2008), pollution, contaminants, or a combination of factors (McCallum 2007). These factors have resulted in fluctuations in the timing and duration of breeding periods, the destruction and loss of breeding sites, a decrease in genetic diversity, an alteration in the home range of various species, isolation of populations, changes in the growth rates of individuals and their activity patterns, and changes in the use of microhabitats (Urbina-Cardona 2008).

One of the main forms of habitat alteration within Tropical Rainforests is deforestation. Deforestation is impacting a large portion of the tropical forests throughout Ecuador, South America, and the whole world, and it it is important to observe and understand the impact of this on the species that live within these regions that are being subjected to deforestation, so that they can be conserved and protected more effectively. Deforestation can have negative effects on the species richness of areas, the reproductive success of various amphibians species, and change the species composition and proportional biomass compared to the area pre-deforestation (Enge & Marion 1986). Available water for breeding and availability of food may also be altered, which may also negatively affect the herpetofauna within an area that has been deforested (Enge & Marion 1986). The edge-effects resulting from deforestation may also have negative impacts on the herpetofauna of the region and many reptiles and amphibians respond to altered microhabitats resulting from new edges, as the wind, moisture, temperature regimes, solar penetration, and changes in vapour pressure generally are distinctly different near edges (Lehtinen 2003). These responses may have strong seasonal variations (Heinen 1992) and have been linked to an increase in extinction vulnerability, as herpetofauna are sensitive to temperatures due to their ectothermic characteristic, and amphibians are sensitive to moisture due to skin respiration which makes them more vulnerable to desiccation, which is more likely at edges where it is typically drier (Lehtinen 2003).

These responses to deforestation are becoming more frequently studied, and reforestation efforts are beginning to increase globally. It is important to understand to understand how these reforestation efforts affect the herpetofauna as these planted forests mature, as this understanding is critical for decision making processes for future management of areas that are affected by deforestation and reforestation. Herpetofauna restoration has been shown to be a slow process, and the maintenance of primary forest is critical for the survival of some species (Heinen 1992). This study was conducted in order to understand the effects of these reforestation efforts by determining if there is a difference in species composition, abundance, diversity, and richness between a forested area (primary forest) and a reforested area (reforested one year prior to the commencement of the study) of similar elevations in and near the Jama-Coaque Ecological Reserve, near Camarones, in the Manabi province, in the Pacific coastal forests of Ecuador. This location is a good representation of the Pacific coastal forests of Ecuador as it is one of the largest remaining tracts of undisturbed primary forest within the Choco-Manabi corridor, while also containing areas which did not escape the deforestation that accompanied road development and the spread of agricultural lands between 1965 and 75. It is therefore able to provide good baseline data for the herpetofaunal responses of these reforestation efforts that are attemting to offset and reverse the negative effects caused by deforestation.

As moisture and elevation have been shown to influence density, diversity, and biomass of herpetofauna communities (Heinen 1992), both study areas selected were at similar elevations (252-435 meters above sea level), in close proximity to each other, at the same time of year (September 2013 in the dry season), and both plots had one transect running through a creek and two through the vegetated portion of the plots. Based on the pre-mentioned factors such as microhabitat alteration, effects of the area being recently deforested, increased solar penetration, decreased moisture presence, and increased human presence and activity, it is most likely that the species composition, abundance, diversity, and richness are lower in the reforested area, while remaining higher in the forested area. The null hypothesis is therefore as follows:

No: There is no difference between the species diversity, composition, abundance, and diversity of the forested area and the reforested area.

The results from this study in the Jama-Coaque Ecological Reserve can be used to extrapolate the effects of reforestation to larger scale reforestation efforts that are taking place throughout Ecuador, South America, the Tropics, and the world. As we learn more about the effects on reforestation on herpetofauna, we can better understand how our actions are influencing these species. Once this understanding has been established, the most effective ways to protect and conserve the remaining reptiles and amphibians in areas of high human pressure can be determined, thereby making better management decisions and protecting the biodiversity of the world.

Materials and Methods:

Materials: Materials include a camera (Canon Powershot Sx210 IS, another Canon, a Global Positioning System (GPS) device, a headlamp (Ptzel 40 lumens), a flashlight (90 lumens), a watch, a notebook (Rite in the Rain), a pencil, a machete, a measuring tape (30 meters), a rope (measured to 100 meters), a Sharpie marker, and orange flagging tape.

Methods:

Study Area: The research was carried out in and near the Jama-Coaque Ecological Reserve, Camarones, Manabi province, coastal Ecuador, which can be found within the Choco-Manabi corridor along the northern portion of the Pacific coast of South America. There are high levels of deforestation within this area, and the reserve can be found on one of the last remaining portions of coastal equatorial rainforest. The area in which this study was conducted contains both tropical wet forest and cloud forest. The reserve is composed of primary forest, and the areas selected ranged in elevation from 256 to283 meters above sea level in the reforested plot adjacent to the reserve, and 252 to 435 meters above sea level in the primary forest located on the reserve. The mean annual temperature of the area has an average of 21-28 degrees Celsius in the dry season, and 23-29 degrees Celsius in the wet season. The average rainfall per month in the wet season is 2-100 cm and less than 10 cm of rainfall per month in the dry season. The vegetation of the forested area is dominated by trees and small shrubs and herbs, and the vegetation of the reforested area is dominated by grass and tree samplings of various native species.

Site Selection: Three transects were selected in each of the two plot (Reforested area and Primary forest) based on locations of pre-existing trails in order to minimize the disturbance, although a machete was used in both plots for additional clearing where it was overgrown and passage was difficult. The sites included a forested area within the Jama-Coaque Ecological Reserve (Montanita trail) and a reforested area nearby that can be found at a similar elevation. The proximity of study sites and similarity in elevation allows for enough similarity between sites that the main factor controlling the herpetofauna is the effects of reforestation compared to an undisturbed site.

Establishment of transects:

Reforestation Plot: The transects in the reforested area (Plot A in the Finca de Mandera, managed by Third Millennium Alliance, through the Jama-Coaque Ecological Reserve) were established through the creek in the valley which goes through the middle of the plot, and mid-way up the hill on either side of the creek, following the clearings where the trees were planted one year ago as can be seen in Figure 1. All transects were established in parallel lines with the transects running in an East-West orientation (see Appendix 1 for more information) with a 50 meter buffer from the edge of the plot, and transects were 200 meters in length. A GPS device was used to mark the starting point (50 meters into the plot) with flagging tape, and the GPS coordinates and elevation were recorded (see Appendix 2 for more information). A rope measured to 100 meters was tied to a branch or clump of grass at the starting point and was used to measure the 200 meter transect (two times the length of the rope). Flagging tape was also labelled and placed at the end of the transect, and GPS coordinates and elevation were recorded.

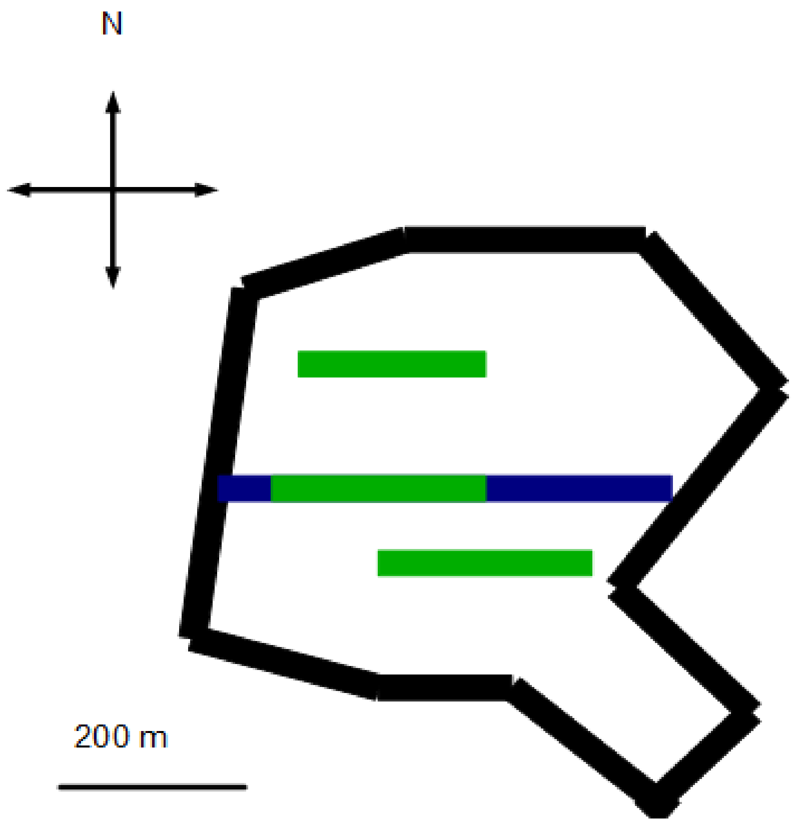

Figure 1. Three parallel 200 meter transects through the reforested area near to the Jama-Coaque Ecological Reserve; one through the creek (#2), one north of the creek (#3), and one south of the creek (#1). All transects are approximately equidistant from each other and are illustrated in green, while the river is illustrated in blue, and the plot border in black.

Forested Plot: The transects in the forested plot (Montanita trail in the Jama-Coaque Ecological Reserve) were placed along the creek (Rio Camarones) at the entrance to the trail, and the other two descended from each end of the ridge running along the top of the trail as can be seen in Figure 2. The creek transect was established with the use of two people and the measuring tape (30 meters) used to measure the rope used for the transects in the reforested plot. The measuring tape was used to establish the transects 100 meters in each direction from the trail entrance. Each end of the transect was labelled and flagged with flagging tape, and the GPS coordinates and elevation was recorded (see Appendix 2 for more information). The trail was followed to the top of the ridge and followed back 200 meters (again with the use of two people and the measuring tape), and both ends were labelled and flagged with GPS coordinates and elevation was recorded. The trail was followed to the other end of the ridge where the same procedure was carried out to establish the third transect in this plot.

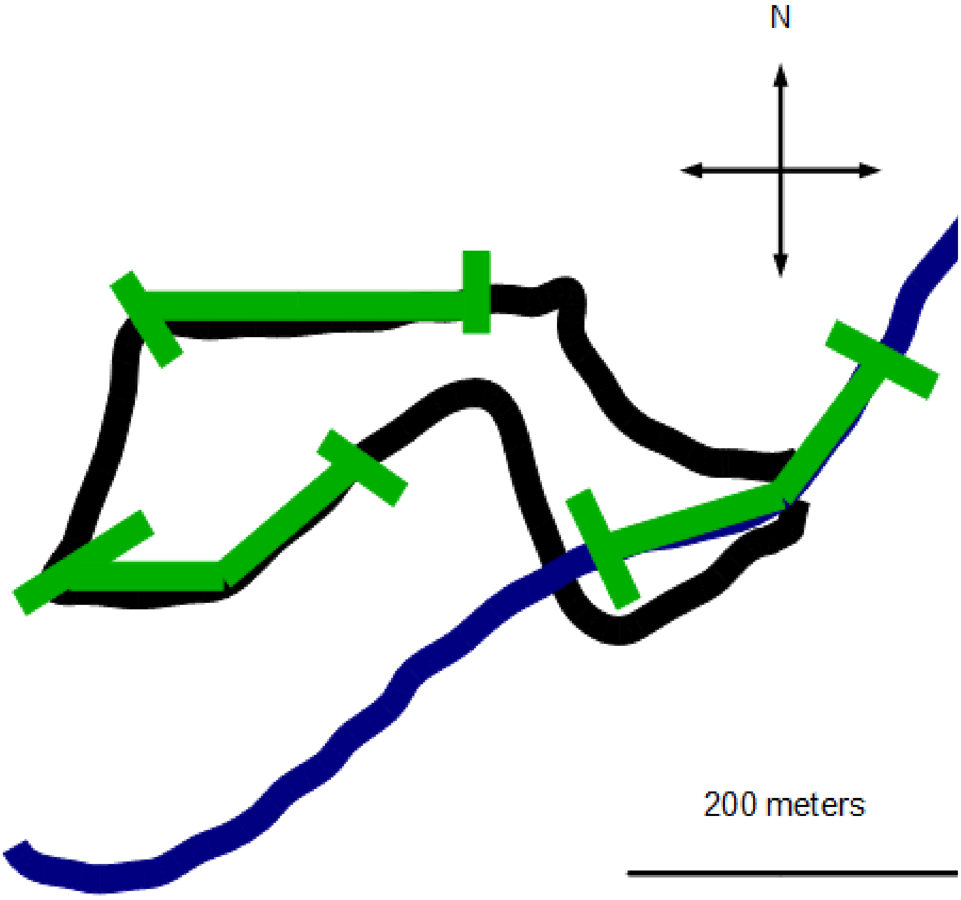

Figure 2. Three 200 meter transects through the Primary forest of Montanita trail near the Jama-Coaque Ecological Reserve; one through the river (#1), one on the northern portion of the river, (#3) and one on the southern portion of the trail (#2). All transects are illustrated in green, while the river is illustrated in blue, and the pre-existing Montanita trail in black..

Survey Methods: Visual encounter surveys (VES) were used for data collection over a 3 week span during early-mid September to late September 2013. I walked to the beginning of a transect in the evening, so that it could be started between 20:00 and 21:00. The route taken to get to the beginning was such that the transect itself was left undisturbed, and a wide berth was given to it while walking was done as quietly as possible. Upon arrival to the transect start point, the date, start time, transect name, and weather were recorded. I then walked along the transect, going as quietly as possible, while looking and listening for visual and auditory cues indicating the presence of herpetofaunal individuals within 2 meters on each side of the transect, or less if vegetation prohibited seeing further. The ground, grass, shrubs, trees, plants, and in crevices were all thoroughly observed with the use of a flashlight, as well as under natural cover objects such as under rocks, logs, and under leaf litter. All natural cover objects were returned as closely as possible to their original location afterwards to minimize bias for future surveys due to potential habitat alteration. When a herp was located, a photo was taken, the GPS coordinated were recorded when the equipment was available, and the photo number, dominating vegetation, microhabitat, height off the ground, species, estimated size, distance from water (for transects 2 and 7 which are through creeks), and any other additional notes were recorded. The snout-vent length was estimated for Anurans while total length was estimated for lizards and snakes. The transect was walked slowly (approximately 1-2 hours for the 200 meter transect), and upon arrival to the end point, the end time was recorded. This method was used for the diurnal transects as well, which I commenced between the hours of 14:00 and 15:00. This methodology was carried out two times during the day and once at night for each of the transects, for a total of 3 repetitions of each transect. At least 12 hours were waited before returning to a transect to begin the following survey and the transects were surveyed in the same order repeatedly, in the following order: 1, 2, 3, 7, 8, 9 (See Appendix 3 for transect details).

Identification Methods: When possible, species were identified in the field. When unable to identify individuals immediately, photos were used to identify individuals by being used in conjunction with reference materials including J. Savage's "Reptiles and Amphibians of Costa Rica", a field guide to the Reptiles of Ecuador, and information and photos uploaded on the website "ReptiliaWeb" and "AmphibiaWeb", which can be found at (http://zoologia.puce.edu.ec/vertebrados/Vertebrata.aspx). If these resources did not allow for complete identification of an individual, I communicated with Ryan Lynch, who helped in the identification of many species. The dominating vegetation and microhabitat were identified by selecting the most appropriate option(s) from the lists compiled of all possible options for these categories, which can be found in Appendix 4.

Analysis Methods: I calculated the total number of species per transect and per plot to determine the species richness of the study areas, divided into per transect so that microhabitat could be taken into consideration, and as a total to compare the two study areas overall. The species richness was calculated, as well as the abundance of species within the plots, based on the density that was found. This information was used so that I was able to determine the species composition. I also used the Shannon Diversity Index to calculate the diversity of both the reforested plot and the plot within the Primary forest.

$$H' = -\Sigma PiLNPi$$

Shannon Diversity Index:

For these analysis to be carried out, it was assumed that the data collected from the three transects per plot was representative of the entire plot, that all individuals had an equal chance of being observed, all abiotic factors were equal and did not affect the data collection, and observer bias was consistent throughout the entire survey on all transects.

Results:

During the 3 weeks of sampling from early to late September, 5 species of reptiles were detected (11 individuals) and 8 species of amphibian were detected (148 individuals). The forested area contained 7 of the amphibians species (127 individuals) and 3 of the reptile species (5 individuals), and a total of 1800 meters were surveyed over 1068 minutes. The reforested area contained 3 of the amphibian species (21 individuals) and 3 of the reptile species (6 individuals), and a total of 1800 meters was surveyed over 999 minutes. *Epipedobates machalilla* was the most common taxa observed in both plots and accounted for 70% of the total individuals observed in each plot as a proportion of the total number of individuals detected per plot.

The species composition for both plots can be seen in Table 1 below, and the compositon can be seen for the reforested area in Figure 3 below, with a large proportion of the species belonging to the species *E. Machalilla* (many detected individuals were transformlings) which was commonly observed near the creek. The species composition of the forested area can be seen in Figure 4 below, and a large proportion of the species in this plot also belongs to the species *E. Machalilla* which was commonly seen near the river, as well as *Pristimantis achatinus* which was commonly found in more forested areas, including along the river. There was some overlap in the species composition, and some species which were unique to each plot.

Table 1. The species composition of reptiles and amphibians detected during VES surveys for a reforested area and a portion of primary forest in and near the Jama-Coaque Ecological Reserve.

Species	Reforested Area	Forested Area
Anolis bitectus	0	1
Barycholos pulcher	0	4
Bothrops asper	0	1
Craugastor longirostris	0	1
Engystomops montubio	1	1
Epipedobates machalilla	19	93
Hyloxalus awa	0	4
Hyloxalus infraguttatus	0	1
Oxyrhopus petola	1	0
Pristimantis achatinus	0	23
Rhinobothryum bovalli	1	0
Smilisca phaeota	1	0
Stenocercus iridescens	4	3

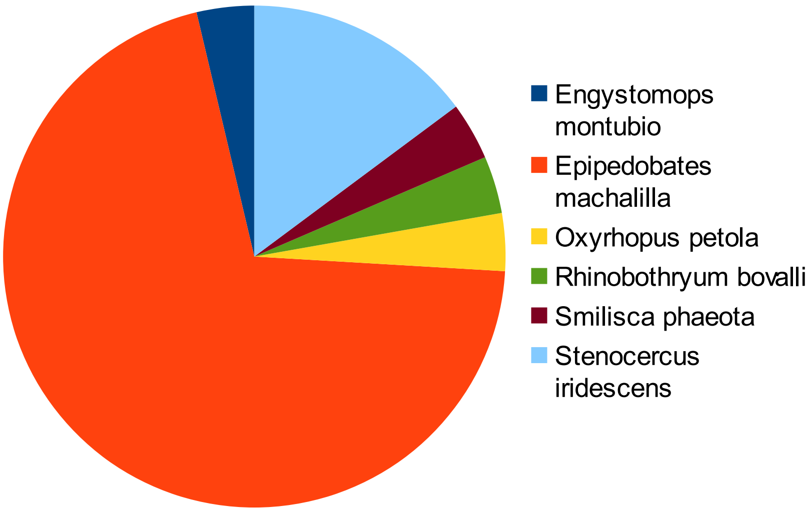

Figure 3. The species composition for the reptiles and amphibians detected in a reforested area near the Jama-Coaque Ecological Reserve in coastal Ecuador.

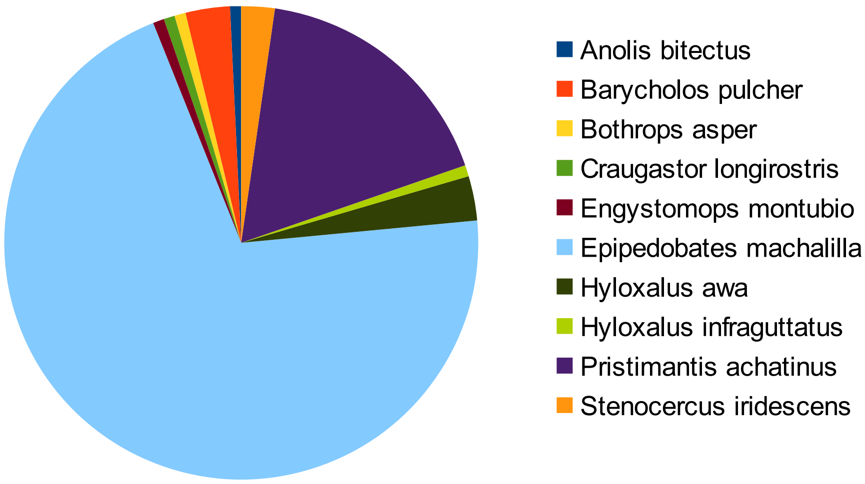

Figure 4. The species composition for the reptiles and amphibians detected in a section of primary forest in the Jama-Coaque Ecological Reserve in coastal Ecuador.

Abundance was measured by calculating the density within each of the two plots. The density was much higher in the forested plot, with a total of 0.08 individuals per meter. The abundance within the reforested plot had a total of 0.02 individuals per meter. The diversity on the other hand was very similar, with a diversity index for the reforested area of 1.2 and a diversity index for the forested area of 1.03.

Discussion & Conclusion:

The species richness varied much more considerably for the amphibians than for reptiles between the forested area and reforested area, with the same number of reptile species being detected, and more than double the number of amphibian species being detected in the forested area. The abundance was much different between the two plots, and the density found within the forested plot was approximately 4 times the density of the reforested plot. The low numbers in both species richness and density could be due to the sensitivy of amphibians to human activities such as the clear cutting that took place prior to the reforestation efforts. Amphibians in the area may still be in low numbers due to lingering impacts of habitat alteration, a change in food and habitat availability, a change in water quality for breeding resulting in a reduction in reproductive success, as well as due to potential mortalities occuring during both the deforestation and reforestation efforts, as was seen in Florida clearcutting operations (Enge & Marion 1986). The reduction in tree cover may also contribute to this trend in lower numbers of amphibian individuals and species as it increases climatic extremes and due to an increased susceptibility of amphibians to extremes of temperature and moisture (Heinen 1992). Lehtinen (2003) found that there was a strong seasonal response to edges in frogs in Madagascar, and linked this to a decrease in amphibians in these uncovered areas during the dry season. It is thought that this is due to the permeable nature of amphibian skin which needs cool moist conditions for respiration (Lehtinen 2003).

The diversity of the two plots were very similar and the abundance of all species was lower in the reforested plot, which does not agree with the findings of Heinen (1992) in a study carried out in Costa Rica. Those results indicated that abundance and biomass of herpetofauna increased in disturbed sites, and diversity was much higher in primary forests. There was a high number of sightings of herpetofaunal individuals on the very edges of the reforested area along the road ways, even if those individuals were not detected on the transects themselves. That could have been due to large quantities of tall grass both alive and shielding the view of much of the area adjacent to the transect and dead on the ground composing many layers of leaf litter, which hindered the collection of thorough and unbiased data due to poor visibility. The similar diversity levels could have been due to low numbers of species and individuals being collected for analysis. Larger sample numbers may have yielded different results. The survey was completed during the end of the dry season which most likely contributed to the low number of species and individuals being detected. Lower temperatures and less moisture both in the air and on the ground (respiration and microhabitats for breeding) typically results in lower activity levels of many amphibians, with approximately 4 amphibian species disappearing for each additional month of the dry season (Scott 1976).

The species composition of both plots had similar proportions of *E. Machalilla*, with 70% of the individuals being of this species. The reforested plot also had a few other herpetofaunal species present in small quantities, and a few *Stenocercus iridescens* individuals, which was the only reptile species found on both plots during this survey. The *E. Machalilla* individuals were found near the creek transect in this plot, and seemed to be seen only in close proximity to a body of running water. The forested plot had many *E. Machalilla* individuals present, and these were also found near the river transect in this plot. *P. achatinus* was found to be the second most common species during this survey, and this frog was found primarily in the forest and near the river in close proximity to the trees in the forested area only. The remainder of the species found in this plot were found in small quantities. The high number of individuals by the creek and river in each plot correlate with studies completed in Costa Rica (Scott 1976 & Heinen 1992) in which herpetofaunal densities were greater in wet areas compared to dry. The same study also found that flat terrains contained more individuals than slopes, and all transects except the ones through water were on slopes, and the highest concentration of herpetofauna in this study was in these flat wet transects. It is possible that the higher number of species found in the primary forest is linked to the proximity of this wet forest to the cloud forest as the perpetually moist conditions of cloud forests have been shown to result in lower seasonality of amphibian species (Scott 1976). The high proportions of *E. Machalilla* may be attributed to the high energy and moisture demands due to an active lifestyle, which appears to have prevented dormancy from developing during the dry season, as has been noted in some species within their family, Dendrobatidae (Scott 1976).

A general comparison of the two plots seems to show the forested plot to have higher species richness and higher abundance, while the diversity and species composition are fairly similar. This in part follows with the initial hypothesis that the species composition, diversity, species richness, and abundance would be higher in the forested area. It is possible that if the sample size of individuals detected were higher then more conclusive results could be drawn.

Higher sample numbers would most likely be achieved by sampling during the wet season or shortly after, and with the use of an experieced observer. It is also possible that due to the sites both being disturbed by heavily clearing shortly after the establishment of the transects and before sampling commenced, that this may have affected the results. The use of VES in conjunction with other methods such as pitfall traps and quadrat leaf litter searches may have also yielded more detections as pitfall traps typically find cryptic species more effectively, and a combination of methods increases effectiveness, improves sample representation, and therefore fewer surveys are needed which decreases human impacts during surveys (Ribeiro-Júnior et al. 2008). Pitfall traps also reduce observer bias increases the effectiveness of surveys (Enge & Marion 1986).

Limitations to this study include the time of year (dry season), observer experience, technological problems with the cameras used (the main camera being used broke part way through the survey), and possibly fatigue on some occaisions. Limitations also included knowledge and ability to identify some species that it was not possible to get pictures of, and small sample sizes which makes further analysis and speculation on the broader significance of this data difficult.

As initial data has been collected for the reforested plot which has been reforested recently (1 year ago), further studies to monitor yearly changes to the species richness, composition, diversity, and abundance would be very valuable. As suspected, the reforested area did show lower levels of abundance and species richness, which is most likely due to increased temperature and moisture extremes. This would indicate that just as Heinen found in Costa Rica (1992), restoration of herpetofauna takes time, and is not a rapid process. As areas continue to be reforested, maintenance of remaining primary forest is important until sufficient monitoring as been conducted to ensure that these forests will allow for similar species composition, abundance, richness, and diversity as prior to deforestation. This will allow for the survival of rare species, key indicator species that play important roles in ecosystem and life functions, and can lead to the protection of not only the biodiversity of the Jama-Coaque Ecological Reserve, but also all of South America, the tropics, and the entire world.

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Appendix 1. The orientation of the six transects established in a reforested area and a forested area in and near the Jama-Coaque Ecological Reserve, Manabi province, coastal Ecuador.

Plot	Transect	Orientation	Notes
Reforested Area	1	West- East	1-3 are parallel
Reforested Area	2	West- East	
Reforested Area	3	West- East	
Forested Area	7	North- South	
Forested Area	8	West- East	Perpendicular to ridge
Forested Area	9	West- East	Perpendicular to ridge

Appendix 2: Transect information including location, orientation, habitat type, length, GPS coordinates, and elevations for six transects in a reforested area and a primary forest plot in and near the Jama-Coaque Ecological Reserve, Camarones, Manabi, Ecuador.

Transect Name	Location	Orientation	Habitat Type	Length	Start Point GPS Coordinates	End Point GPS Coordinates	Starting Elevation	Ending Elevation
FDM_A_1	Reforested Area	South Slope	Grassy reforested area	200 meters	17 M 0596901 UTM 9987741	17 M 0596724 UTM 9987837	283 meters	276 meters
FDM_A_2	Reforested Area	Middle Creek	Creek	200 meters	17 M 0596889 UTM 9987847	17 M 0596710 UTM 9987885	257 meters	256 meters
FDM_A_3	Reforested Area	North Slope	Grassy reforested area	200 meters	17 M 0596701 UTM 9987919	17 M 0596879 UTM 9987925	266 meters	249 meters
Montanita_7	Forested Area	East Creek	Creek	200 meters	17 M 0597220 UTM 9987147	17 M 0597078 UTM 9987013	253 meters	252 meters
Montanita_8	Forested Area	South Slope	Forested with trees and shrubs	200 meters	17 M 0596908 UTM 9987141	17 M 0596740 UTM 9987098	341 meters	357 meters
Montanita_9	Forested Area	North Slope	Forested with trees and shrubs	200 meters	17 M 0596912 UTM 9987348	17 M 0596758 UTM 9987394	365 meters	435 meters

Appendix 3. The details for each Visual Encounter Survey carried out during September 2013 for reptiles and amphibians in and near the Jama-Coaque Ecological Reserve, Manabi province, coastal Ecuador.

Survey Number	Transect Number	Date	Start Time	End Time	Total Time (minutes)	Observers	Day/Night	Weather
1	FDM_A_1	8 September 2013	20:58:00	22:47:00	109	1	Night	Humid, warm, no rain
2	FDM_A_1	9 September 2013	14:52:00	16:40:00	108	1	Day	Humid-ish/muggy, warm, no rain, breezy, overcast
3	FDM_A_2	9 September 2013	20:26:00	22:56:00	150	1	Night	Humid, warm, no rain, no wind
4	FDM_A_2	10 September 2013	14:54:00	17:03:00	129	1	Day	Little humid, warm, breezy, no rain, overcast
5	FDM_A_3	10 September 2013	21:03:00	23:04:00	121	1	Night	Warm, humid, occasional breeze and mist
6	FDM_A_3	11 September 2013	14:36:00	16:09:00	93	1	Day	Warm, little humid, sunny earlier, no rain, breezy
7	Montanita_7	11 September 2013	21:23:00	23:52:00	149	1	Night	Warm, little humid, no rain, no breeze
8	Montanita_7	12 September 2013	14:44:00	17:02:00	138	2	Day	Warm, not very humid, no rain/breeze, overcast
9	Montanita_8	16 September 2013	15:43:00	17:23:00	100	1	Day	Warm (23 C), humid, no rain, breezy, sunny earlier, overcast
10	Montanita_9	17 September 2013	14:31:00	16:34:00	123	1	Day	Hot (24 C), little humid, no breeze/rain, sunny (not reaching forest floor), clouded over during transect
11	FDM_F_6	18 September 2013	14:56:00	16:43:00	107	1	Day	Hot, little humid, some sun, bit of a breeze, little rain last night
12	Montanita_8	18 September 2013	21:09:00	23:41:00	152	1	Night	Warm, humid, sunny day, no rain, no wind, clear sky with bright almost full moon
13	FDM_F_5	19 September 2013	15:05:00	17:05:00	120	1	Day	Warm-ish (cooler than usual-21 C), little humid, occasional mist, overcast, tiny bit of rain last night, slight breeze
14	FDM_F_4	20 September 2013	14:26:00	16:12:00	106	1	Day	Warm, little humid, overcast, no rain, slight breeze; got cooler and windier during survey
15	FDM_A_1	23 September 2013	15:04:00	16:26:00	82	1	Day	Cool, breezy, humid (less than usual), no rain, overcast, few tiny rain drops while walking
16	FDM_A_2	24 September 2013	14:32:00	16:22:00	110	1	Day	Warm, humid, overcast, breezy, no rain
17	FDM_A_3	25 September 2013	15:13:00	16:50:00	97	1	Day	Warm, humid, overcast (sunny earlier), rain last night, breezy
18	Montanita_9	25 September 2013	21:15:00	23:25:00	130	1	Night	Warm, humid, no wind, no rain, clear sky
19	Montainita_7	26 September 2013	14:26:00	16:28:00	122	1	Day	Warm, little humid, no rain, some sun, breeze
20	Montainita_8	27 September 2013	14:43:00	16:10:00	87	1	Day	Cool, little humid, overcast, rain last night, breezy
21	Montainita_9	28 September 2013	14:29:00	15:36:00	67	1	Day	Cool-ish, little humid, overcast, no rain, breezy

Appendix 4. The dominating vegetation and microhabitat options used for selection purposes for recording vegetation and microhabitat data for each reptile and amphibian detected in transects carried out in a reforested area and forested area in and near the Jama-Coaque Ecological Reserve, Manabi province, Ecuador.

Dominating Vegetation	**Microhabitat**
Grass	Leaf litter
Trees	Tree trunk
Shrubs	Leaf
Forbs	Fallen log
Leaf litter	Creek
	Ground
	Branch
	Dead branch
	Boulder/rocks
	Mud