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Monitoring Biodiversity and the Effects of Climate Change on the Peruvian Amazon Rainforest Report.

Objectives

This project aimed to quantitatively investigate population demographics of key indicator groups such as terrestrial mammals, caimans, macaws, and fish through extensive surveying within the Pacaya-Samiria Nature Reserve in Peru. This task was part of a larger objective to understand, predict and mitigate the impact of climate change on Amazonian fauna.

Survey Site

The site consisted of predominantly flooded rainforest adjacent to the Samiria river in the Pacaya Samiria National Reserve, Peru (Fig. 1). Water levels dropped by approximately 3m over the 6 week summer period. The area is inhabited only by small villages of Cocoma people who can exert significant amounts of hunting pressure in the area. The site had very limited management and did not suffer from deforestation.

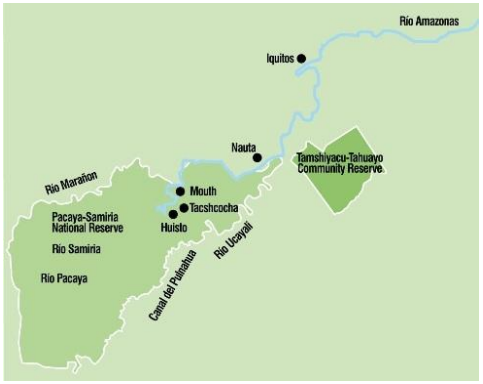

Figure 1: Map of Pacaya Samiria National Reserve. Surveys took place at the Operation Wallacea maintained Tacshcocha site. GPS: 18M 0571549 9461021

Methods

Caimans: Aquatic transects travelled by boat using a GPS to track distance and location. Caimans were identified by eye reflections and those <2m in length were safely captured to ascertain weight, sex and length. The number of individuals per km was then calculated and the average number of caiman per km per week compared.

Macaws: Point counts were performed twice a day with 15 minutes spent at each point, points were separated by 500m along a transect. All flying or perched individuals were counted. The number of individuals per point was then calculated.

Fish: Nets and rods were used to capture fish in the lake. Individuals were identified, weighed and measured and the catch per unit effort calculated by dividing the number of individuals by fishing effort. Unfortunately, uniformity of survey methodology was not maintained due to fluctuating usage of different baits, fishing spots and volunteer participation and effort.

Terrestrial mammals and game birds: Ten transect trails varying between 2-5km in length were created to collect census data. Observers walked as a silent group and recorded all sighted individuals along the transect. Number of individuals per km was then calculated.

This expedition focused on two key hypotheses: (H_1): the population abundances and diversity of caimans, macaws and fish are significantly greater than results from identical surveys in 2011-2013 (H_2): the population abundance of hunted animals such as deer, peccaries and game birds are significantly greater than in 2011-2013.

Results

Caimans

The Pacaya-Samiria Reserve is home to three species of caiman; the black caiman (*Melanosuchus niger*), the speckled caiman (*Caiman crocodilus*) and the smooth fronted caiman (*Paleosuchus trigonatus*). Between 2011-

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2014, *Paleosuchus* was the rarest sighted caiman, with *Caiman* and *Melanosuchus* similar in abundance and alternating dominance during the years of study (Fig. 2A). However overall abundances of all caiman species show indicate than in fact 2014 showed significantly less caiman sightings than previous years (Fig. 2B) Importantly, this data cannot indicate population size as the number of sightings and/or captures that were the same individual is unknown, which is a flaw in the survey methodology. A method for determining recapture rates is currently being developed though imaging of scale patterns which could potentially identify individuals.

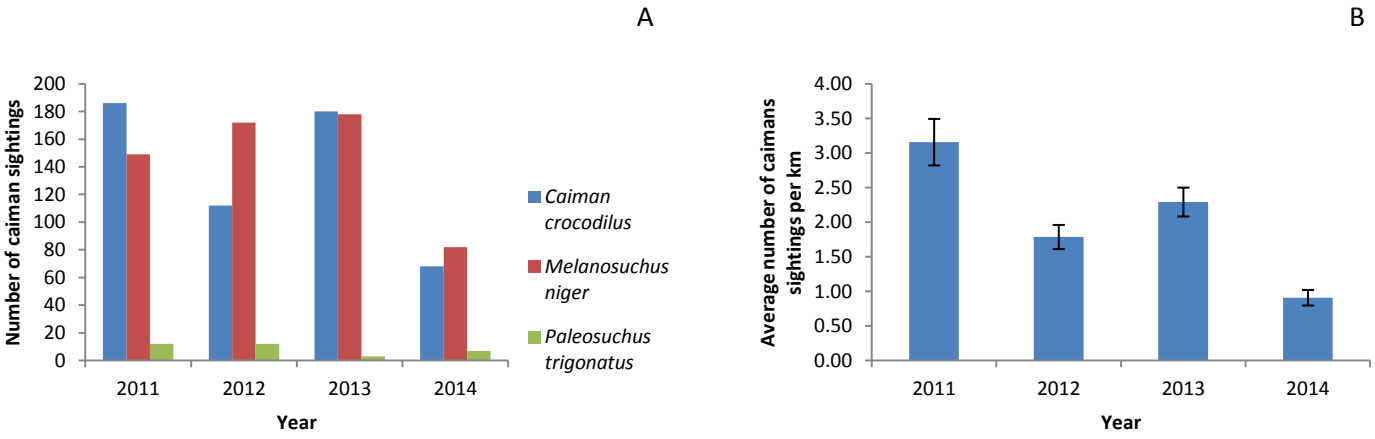

Figure 2: (A) Comparison of average number of caiman species sightings from 2011-2014. (B) Comparison of average number of caiman sightings per km per week (n= 8 weeks) between 2011-2014.

Macaws

The Pacaya-Samiria reserve is home to 5 species of macaws, however, it is primarily dominated by the red bellied macaw (*Orthopsittaca manilata*). Other less common species include the blue and yellow macaw (*Ara ararauna*) and the chestnut fronted macaw (*Ara severa*). Unfortunately, like the collection of caiman data, there was no method to try to establish the number of resightings. However, we can assume that the number of sightings will be proportional to population abundance and thus conclusions about population size can be suggested from sighting data. This year's total macaw sightings are potentially significantly lower than both 2012 and 2011, therefore, rejecting the hypothesis (H1). This could be related to the abundance of macaw food in the form of forest fruits which may have fluctuated due to climatic factors such as river water level year on year.

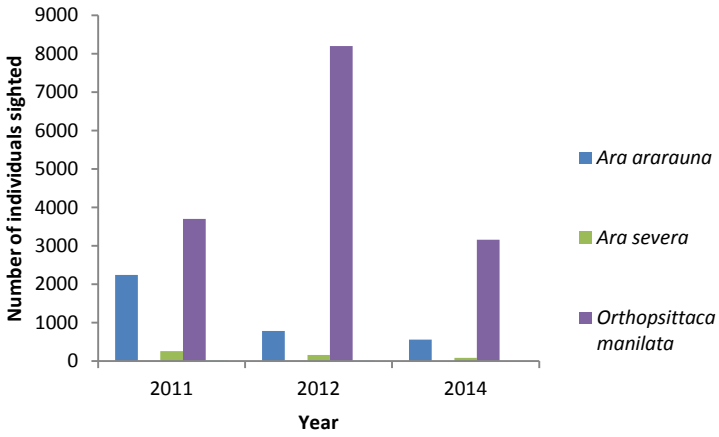

Figure 3: Comparison of the total number of macaw species sightings across three years over the same 6 week period.

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Fish

Fish species numbers have remained similar over the studied years alongside local biodiversity as characterised by Shannon's Index values which average at 9.1 (Tab. 1). However, the dominant species has changed from the armoured catfish (*Liposarcus pardalis*) in 2011 to the red bellied piranha (*Pygocentrus nattereri*) in 2012 and 2014. These species' relative dominance can be heavily influenced by water levels, with the red piranha characterised by high water and the armoured catfish by low water levels, which may explain their dominance of any given year. Fish surveys could have been improved by standardising the type of bait used for the rods and number of fishers.

	2011	2012	2014
Alpha diversity (Shannon's Index)	8.60	9.41	9.21
Number of species sighted	52	42	49
Dominant species	*Liposarcus pardalis*	*Pygocentrus nattereri*	*Pygocentro nattereri*

Table 1: Summary characteristics of the Samiria river fish population over time. Shannon's Index, H= $\sum_{i=1}^{r}$ pi ln p i

Terrestrial Mammals

Alpha diversity in 2014 was greater than 2011 and 2012, however the number of species sighted was down from the maximum observed of 29 in 2011 (Tab. 2). The most dominant species has consistently been the black capped squirrel monkey (*Saimiri boliviensis)*, other common species include the tuffed capuchin (*Cebus apella*) and the brown mantled tamarin (*Saguinus fuscicollis*). Therefore, the diversity has notably increased but the community assemblage has changed with fewer species now being sighted.

	2011	2012	2014
Alpha diversity (Shannon's Index)	6.24	5.13	7.05
Number of species sighted	29	17	20
Dominant species	*Saimiri boliviensis*	*Saimiri boliviensis*	*Saimiri boliviensis*

Table 2: Summary of characteristics of the Pacaya-Samaria terrestrial mammal sightings over time. Shannon's Index, H= $\sum_{i=1}^{r}$ pi ln p i

Conclusion

The results suggest that the number of sightings of both macaws and caimans are less than in previous survey years, which may be related to food supply and water levels respectively, contrary to H1. Fish diversity and species richness has remained relatively stable between 2011-2014. Terrestrial mammal diversity has increased in 2014, despite less species sighted overall, suggesting H2 should be accepted. Any potential causal relationship between these patterns and climate change factors such as flooding and drought can only be speculative at this point. Causal relationships may only be possible to ascertain over longer time periods, thus highlighting the importance of continued scientific effort dedicated to fauna monitoring programmes.

Personal Statement

This trip has been a very helpful source of transferable skills which will valuable for my aspiration to complete a PhD. By travelling abroad to a new country and continent I have gained considerable confidence in conversing in a new language, adapting to new cultures and learning to relate to remote isolated peoples. I have experienced firsthand the realities of tropical rainforest field work which has allowed me broaden my horizons of what research area I would most enjoy as a career.

I have improved upon my data collection, management and analysis skills, learning the importance of standardising data formats and teasing patterns from long term trends. I also have a renewed and larger appreciation for the practicalities of conservation, the need for local community involvement and the

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monitoring effort required to make sure conservation goals are met. Most of all, this expedition has given me a fuller appreciation for the global scale with which climate change needs to be addressed and how varied different countries are in the nature of their challenges.

Acknowledgements

I have been extremely fortunate in the amount of support I have been given towards this expedition. First and foremost I would like to thank both my personal tutor Dr Gail Jackson and Emeritus Professor John Grace for their guidance and support in the initial stages of this project. Huge thanks to the University of Edinburgh's Weir Fund, British Travel Fund and James Rennie Bequest for their extremely generous financial support. In addition, I would like to thank The Harvey Benham Trust in Essex and Ian Murray MP for their kind financial support for this project. Finally, a big thank you to Operation Wallacea and their amazing staff for their scientific knowledge, training and making this expedition so memorable.

Photos

Please see attached folder for a small selection of the project photos.