Anthropogenic activity and bioclimatic variables affecting the distribution of primates in the Atlantic forest of Brazil

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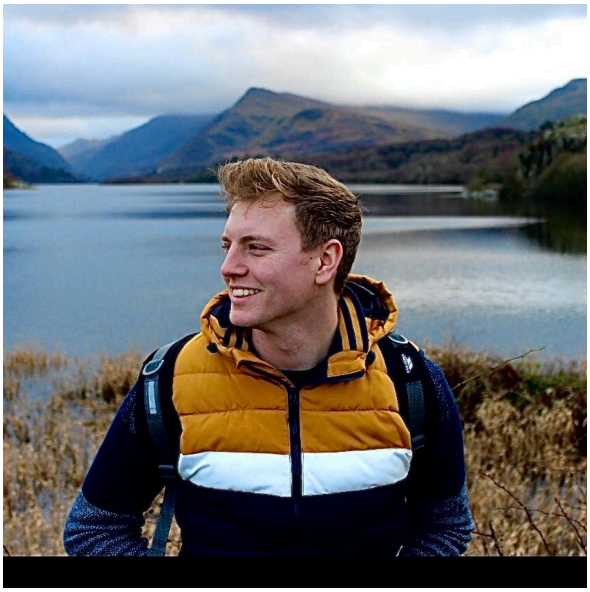
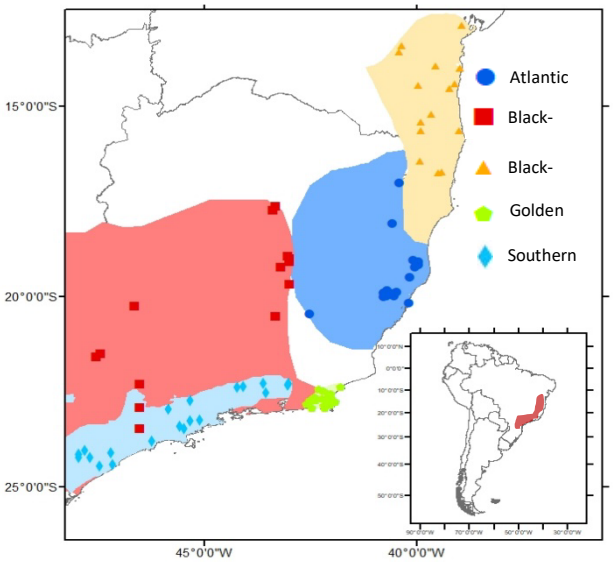


I am now at the end stages of my Master's year, finishing up my four years at Bangor University as a Zoology student. Throughout my time here, I did not pick a specific field of which to focus my studies per se; instead, I opted for modules including aspects from very different parts of zoology. In my second year, my modules included Integrated Zoology and Evolution and Genetics as well as a field course to South Africa. In my third year, alongside starting voluntary work at the Welsh Mountain Zoo so I could get some practical animal experience, I selected Animal Survival Strategies, Human Evolutionary Biology and Primatology for my main modules - this is where my interest in primates actually begun, late on into my university studies.

Fast-forward to now and I am completing my own research in the field of primates: when it came to thinking about what I could base my project on, I knew that I wanted to incorporate human activity into it. I have always had an interest in anthropogenic impacts to species and habitats and so I thought it would be appropriate to see how much research had already been done. It will come as no surprise that human activity is a busy topic among most environmental research papers.

My project is focused on assessing the anthropogenic activity, categorised into anthropogenic land covers (ALCs), currently impacting primates endemic to the Atlantic forest of eastern Brazil, and specifically those found close to Rio de Janeiro and Sao Paulo. My other main focus was on comparing the relative importance of including bioclimatic variables in studies regarding current distributions of species. The five species I selected to focus my research on were the Atlantic titi *(Callicebus personatus),* black-fronted titi *(Callicebus nigrifrons),* black-handed titi *(Callicebus melanochir)*, golden lion tamarin *(Leontopithecus rosalia)* and southern muriqui *(Brachyteles arachnoides)* – all of which are either Critically Endangered, Endangered or Vulnerable according the IUCN red list. Their estimated ranges are confined to the largely coastal regions of Brazil overlapping considerably with the two megacities.



Localities for each of the five study species, with their IUCN ranges overlaid. Relative location of the study area displayed in the secondary map.

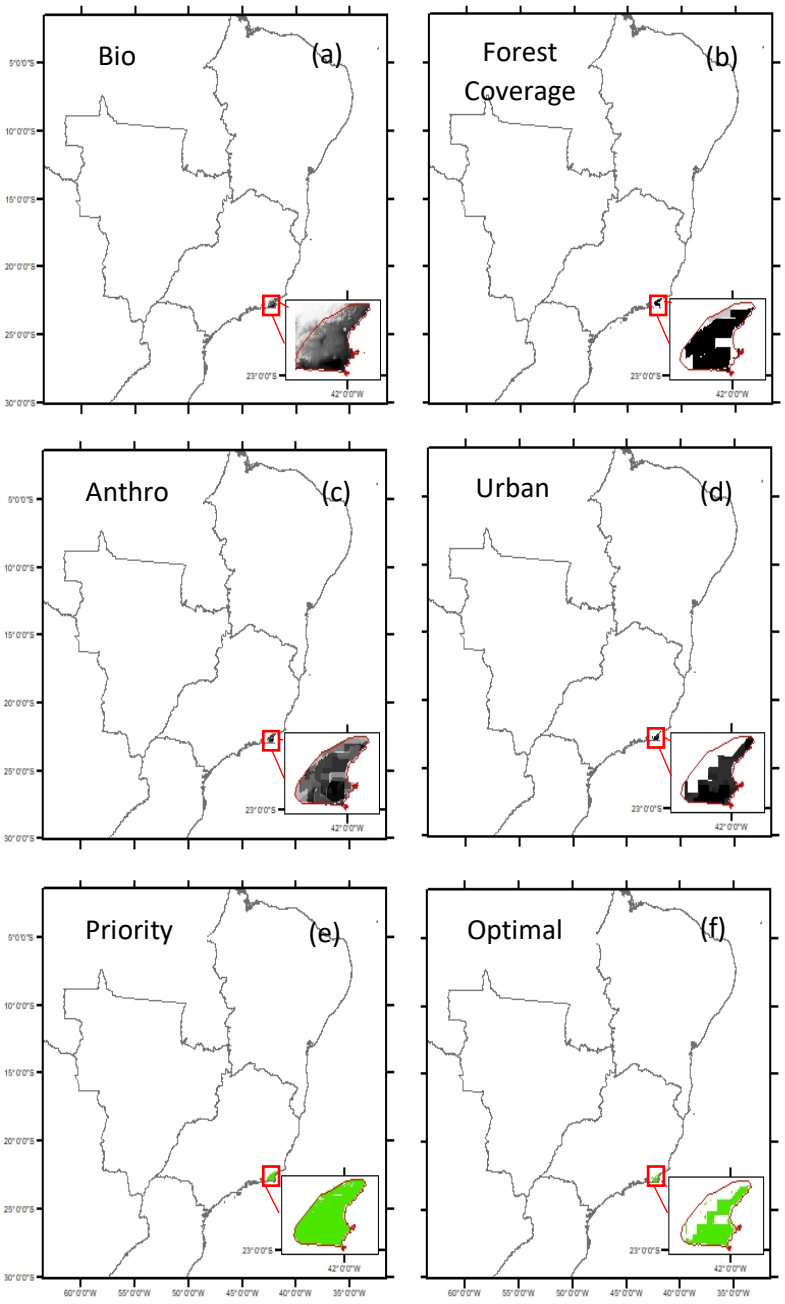
I used bioclimatic data from the WorldClim database to firstly create a bioclimatic model to run against locality data I had collated from the scientific literature and the Global Biodiversity Information Facility (GBIF) for each of my five study species (these are illustrated in the image).

I also created three models from my own research into anthropogenic activity whereby I used ArcGIS to create feature layers to run through Maxent – I ended up with 9 anthropogenic layers: Humanpop (high human population density), Highfoot (high level of human footprint), Modfoot (moderate level of human footprint), Urban (areas of urbanisation), Deforested (deforested forest), degraded (degraded forest), Fragmented (fragmented forest), ProtectedArea (protected habitat) and Agriculture (agricultural land), which were then made into three separate models in additions to the bioclimatic model. A summary of the four final models in my study is shown below:

Variables

Bioclimatic	Forest Coverage	Anthropogenic	Urbanisation
Annual Mean Temperature (BIO1)	Deforested	Deforested	High Human Footprint
Mean Diurnal Range (Bio2)	Degraded	Degraded	Moderate to High Population Density
Isothermality (Bio3)	Fragmented	Fragmented	Urban
Temperature Seasonality (Bio4)		Moderate Human Footprint	
Annual Precipitation (Bio12)		High Human Footprint	
Precipitation of Wettest Month (Bio13)		Moderate to High Population Density	
Precipitation of Driest Month (Bio14)		Protected Area	
Precipitation Seasonality (Bio15)		Agricultural	
Precipitation of Warmest Quarter		Urban	

GOLDEN LION TAMARIN



All finalised model outputs for golden lion tamarin. Maps a-d show the outputs of the four models and maps e and f show conservation priority and optimal habitat.

Main Findings

Most model iterations showed moderately good performances meaning I could be confident in the percent contributions for each variable for each model. Tree coverage variables, human footprint and agricultural layers contributed to the anthropogenic models the most whilst diurnal range, annual mean temperature and annual precipitation contributed significantly to the Bioclimatic model. Using ArcGIS, I completed some further analyses on the model outputs, finalising a map for each model as well as a conservation priority area and optimal habitat. An example of this can be seen in the golden lion tamarin model outputs (left).

My most significant finding was that when predicting primate distributions, at least for the five study species, anthropogenic activity and bioclimatic conditions impact habitat suitability almost equally, I therefore suggest that we should consider both of these factors when researching species distributions as a minimum. This was a really interesting result for my project, and it has allowed for further opportunity to challenge where conservation should realistically be focused. A secondary finding of my research concluded that not only could conservation focus be too climate or anthropogenic-heavy, but also when investigating anthropogenic activity exclusively, we should switch our direction from large-scale urbanisation to more moderate-scale human activity with smaller human footprints.