Progress Report I

June 2019-November 2019

1 – Summary of activities in the period.

ACTIVITY	LOCAL	PERIOD	CITY, STATE	COUNTRY
Update geographical occurrences dataset	**LABECA - INPA**	**17/06 – 19/07/2019**	**Manaus, AM**	**Brazil**
Ecological Niche Models construction	**LABECA - INPA**	**19/07/2019 – Now**	**Manaus, AM**	**Brazil**

2 – Description of activities.

Seeking a better understanding of the steps by the reviewers, this presentation will follow the subdivisions: (1) Update and reorganization of Datasets (2) Modeling routine.

(1) Each occurrence record obtained consist of a Latitude-Longitude pair denoting the location of a species. After the pre-programmed visits to eight herpetological collections and museums (main activity performed with the support of my first RUFFORD Small Grant #), as a way of complement the data an intensive search will be made in the scientific literature. This search for the compilations of data will be carried out through specific portals in internet such as: ISIWEB of Science, Jstor, Scielo, PubMed etc. When geographical coordinates were not available for the literature occurrence records, they were acquired manually from specific gazetteers following the information provided in site description. In addition, as an alternative source of data collection, domains that freely provide massive amounts of information on the world biota will be visited. These sites, such as Global Biodiversity Information Facility - GBIF, International Union for Conservation of Nature - IUCN, Sistema de Informação da Biodiversidade Brasileira – SIBBr and VertNet, gather information from a wide variety of sources and make them available on the internet.

In (2), A total of 1432 occurrence records were used for the construction of each Ecological Niche Models -ENM´S for the time period corresponding to the present. Specifically, after updating the dataset, we obtained 73 records for *P. ayeaye*, 388 for *P. azureus*, 10 for *P. centralis*, 273 for *P. hypochondrialis*, 65 for *P. megacephalus*, 345 for *P. nordestinus*, 45 for *P. oreades*, 72 for *P. palliatus* and, 161 for *P. rohdei,* with a satisfactory coverage of their known distributional ranges.

Ecological Niche Models – ENM´s were constructed using the maximum entropy algorithm MaxEnt using the newly released package in the Environment for Statistical Analyses R, KUENM. MaxEnt generates predictions from presence only data, based on the principle of maximum entropy, which assumes that the best approximation for an unknown distribution is one that satisfies any constraint to their distribution. This algorithm became the most adequate and widely used tool for modeling ecological niches and, among other advantages, is considered more successful than other methods for generating models from a reduced number of points of occurrence, as is the case for some species in this study.

The final models were generated using 10 independent replicates while 50% of the points (k) were used for testing using the Bootstrap method. Bootstrap is recommended for reduced numbers of occurrences because it randomly selects from the original dataset a number (k) of records for testing model.

This routine involves choosing and replacing each of the test points so the same occurrence record can be included in a model test more than once. We chose the logistic output for the presentation of ENM´s in geographic space (potential distributions), with each pixel (geographic cell) representing suitability from 0 (representing inadequate conditions) to 1 (maximum suitability). The performance of the candidate models was evaluated using three independent and complementary criteria employed automatically in the KUENM package: significance, predictive ability and complexity, following this order of priority. That is, models were initially filtered to detect those statistically significant; later the "low-omission criterion" (via Area Under Curve – AUC method) was applicated to further reduce the set of models and finally, among the significant models with the lowest omission rate, those with delta AICc values smaller than two are selected.

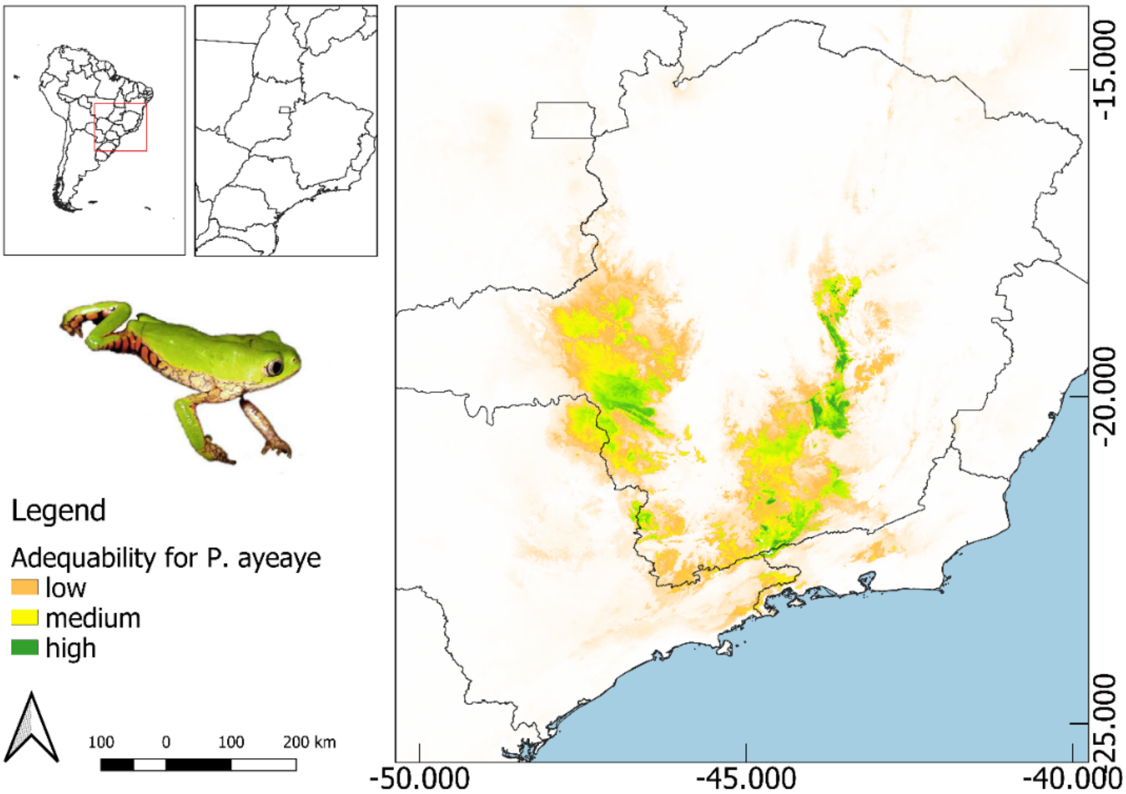
In order to obtain each of the models presented here (see section 3 – Preliminary Results) an average of 2,000 candidate models per species were built and concomitantly tested and selected according to the three criteria presented above. The construction of this universe of possible candidate models used specific combinations of environmental variables to create particular sets for each species. We assembled digital layers of environmental variables with continuous data for temperature and precipitation obtained from the "WorldClim Global Climate Data" (*http://worldclim.org/*). We also used two more predictors related to the availability of water in the environment. The first layer representing the process of evapotranspiration (*"Potential Evapo-Transpiration-PET"*) and the second, *"Aridity Index-AI",* that simulates the high temperature stress (*http://cgiar.community/*).

3 – Preliminary results.

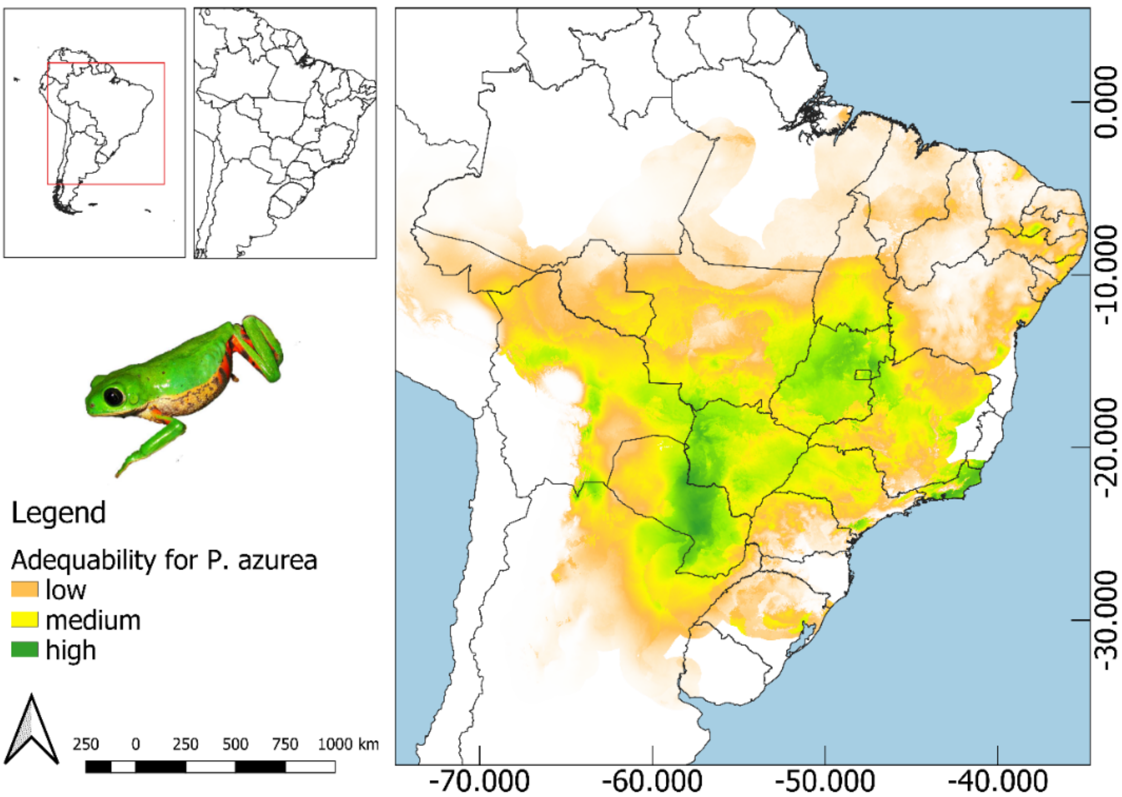
It is worth noting that given the relevance of the issues in which this technique is applied the need for increasingly robust models, which represent in a most reliable way the phenomena being modeled, has become (and still does) more and more required. Here, using the KUENM package and the newly automation of important modeling routine steps, we tested multiple parameterizations (different configurations of Maxent algorithm elements) which allowed us to present models with high robustness and refinement and the construction of inferences (e.g., about the potential impacts of climate change or the possible speciation mechanisms involved in genus diversification) with high credibility.

3.1 – Spatialization of treefrog species Ecological Niche Models – ENM´s

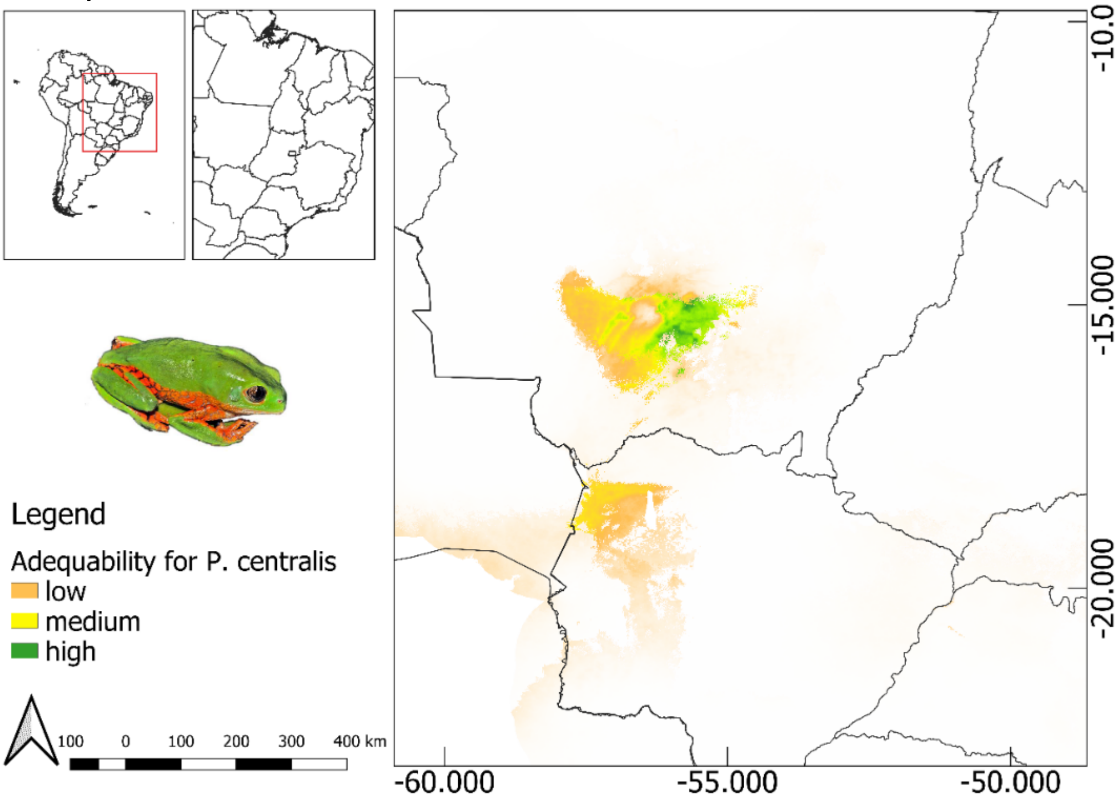
Pithecopus ayeaye



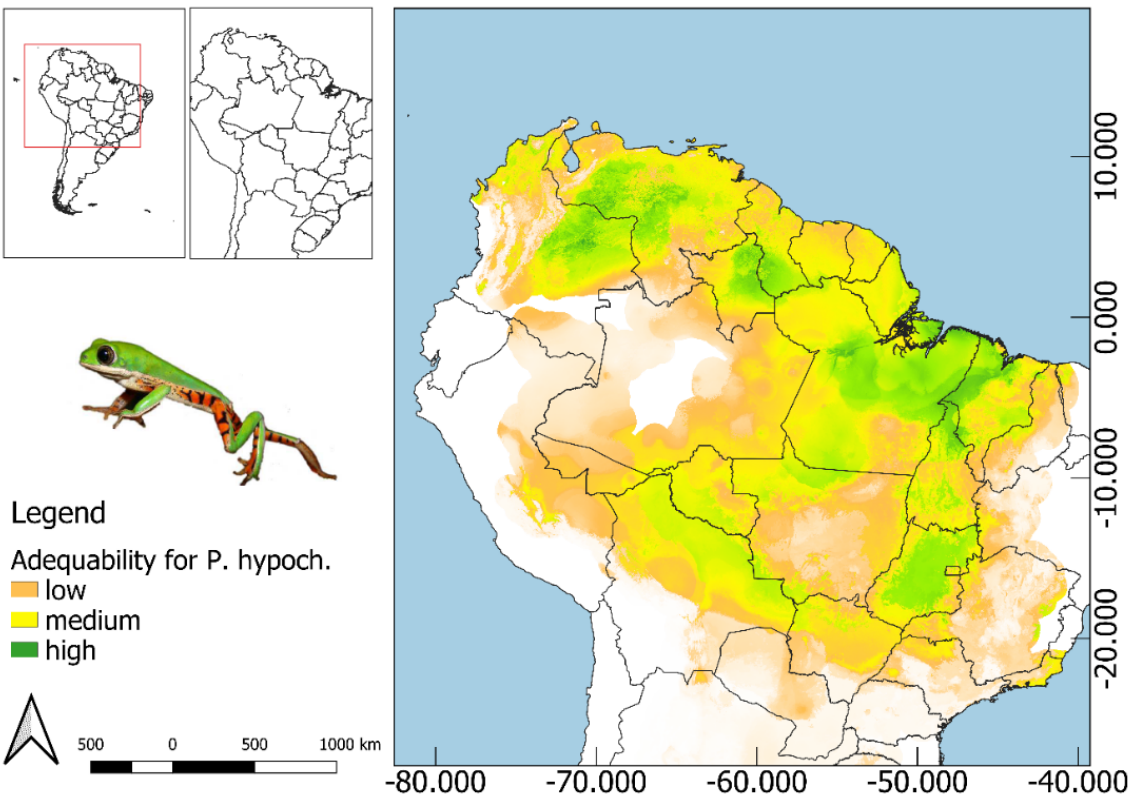
Pithecopus azureus



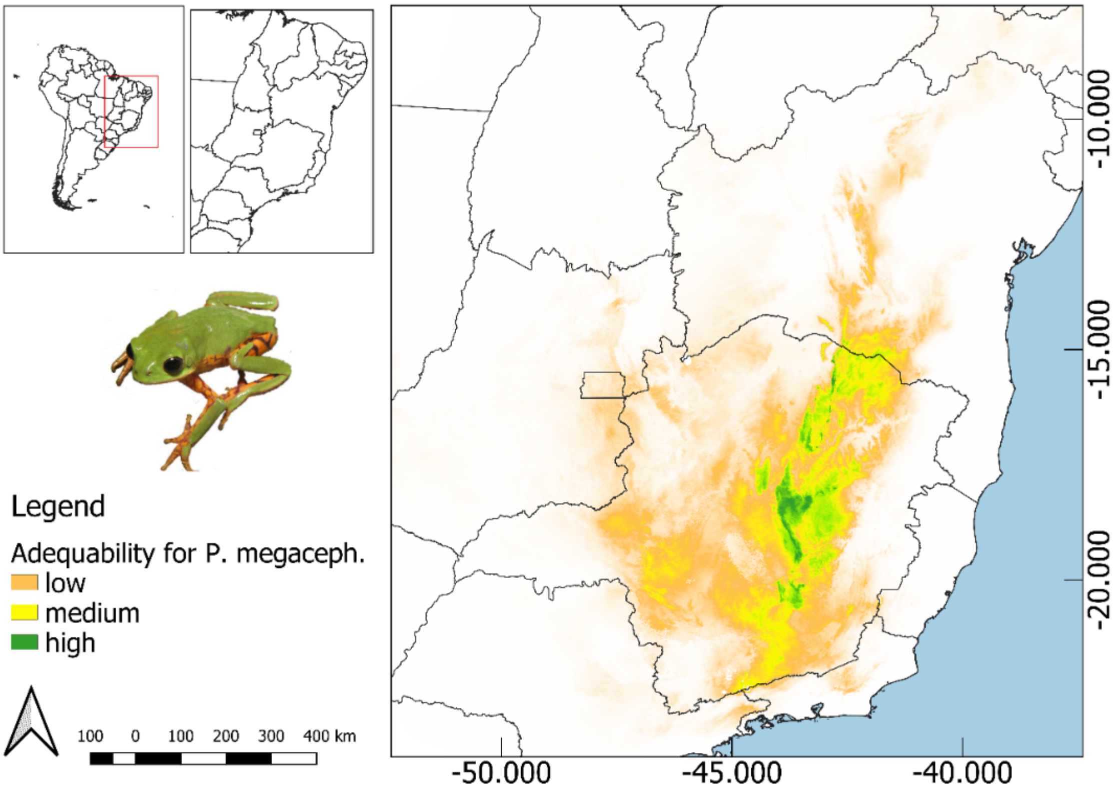
Pithecopus centralis



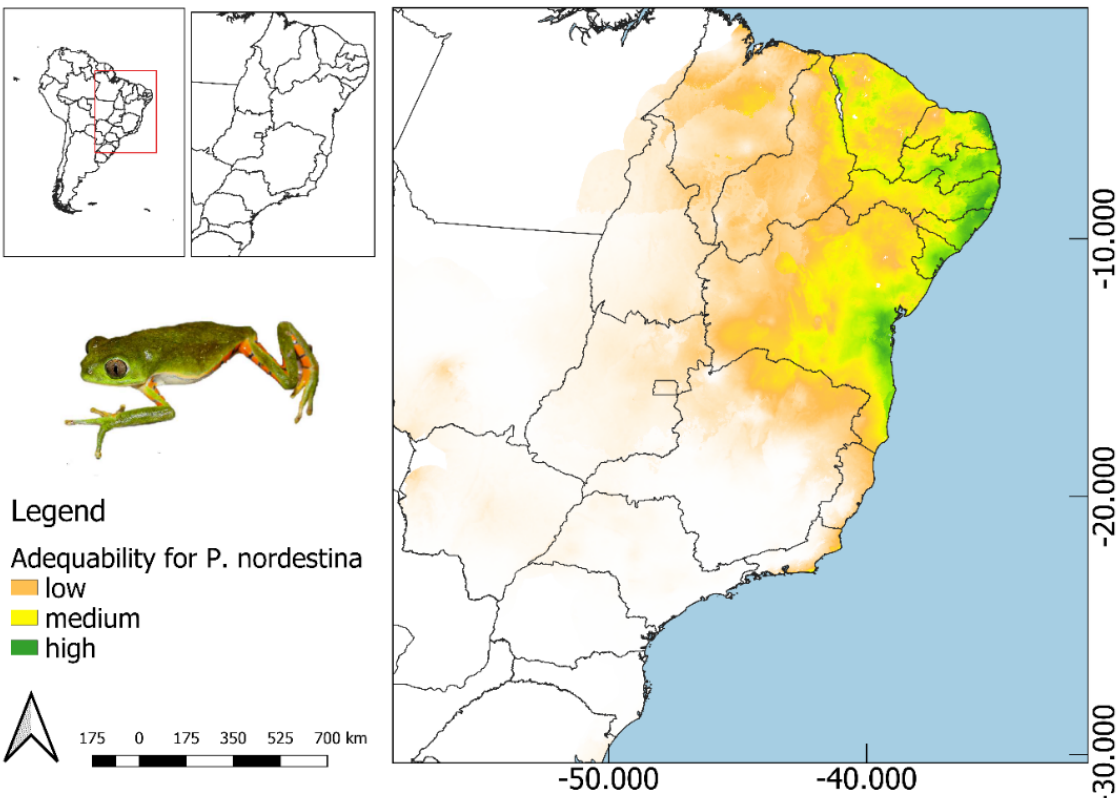
Pithecopus hypochondrialis



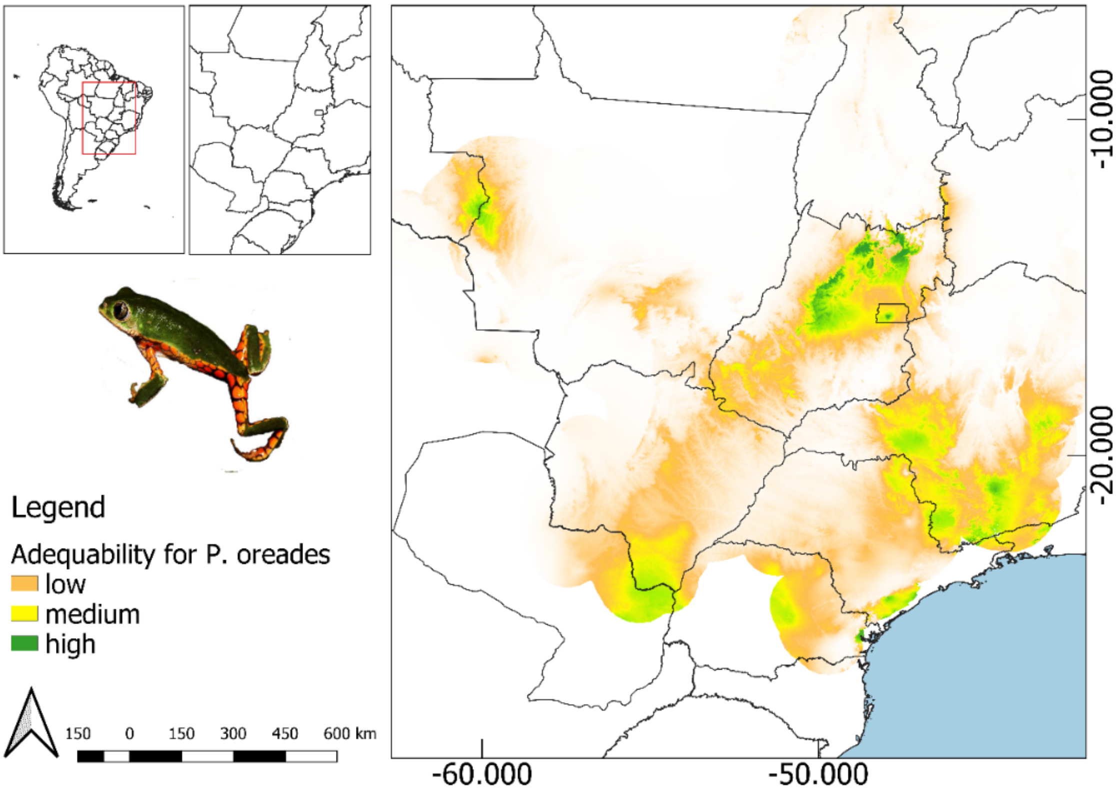
Pithecopus megacephalus



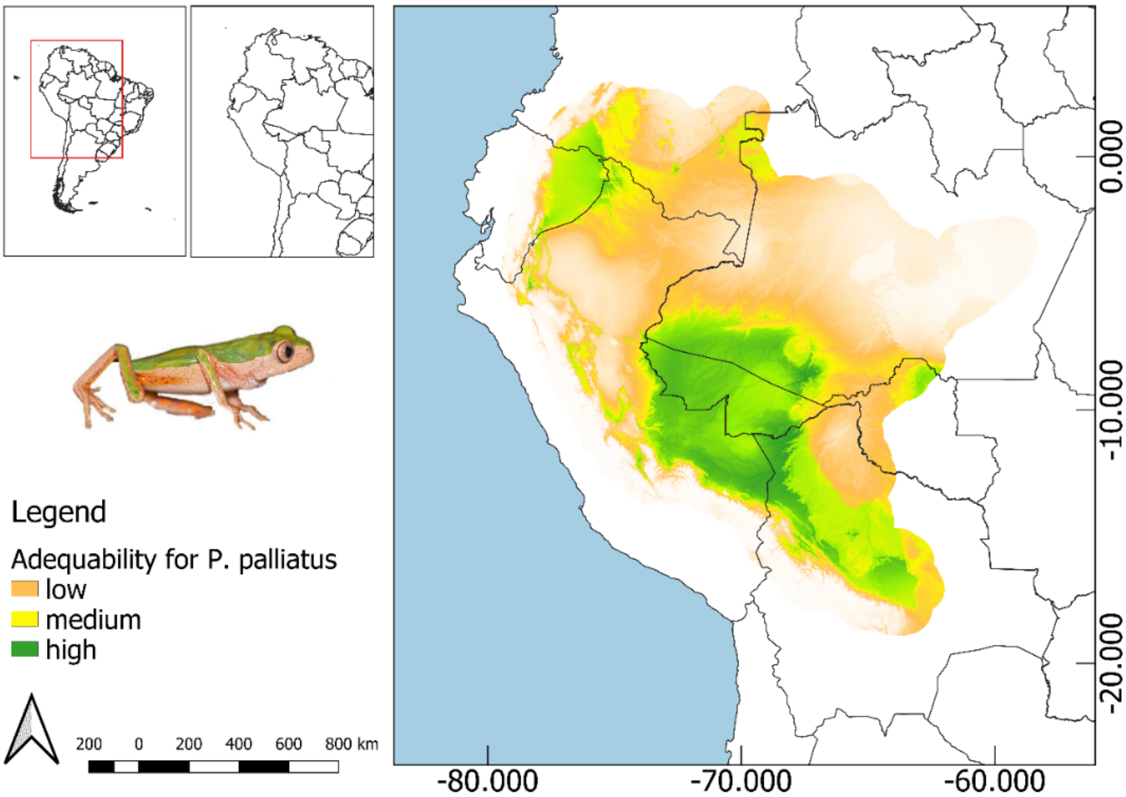
Pithecopus nordestinus



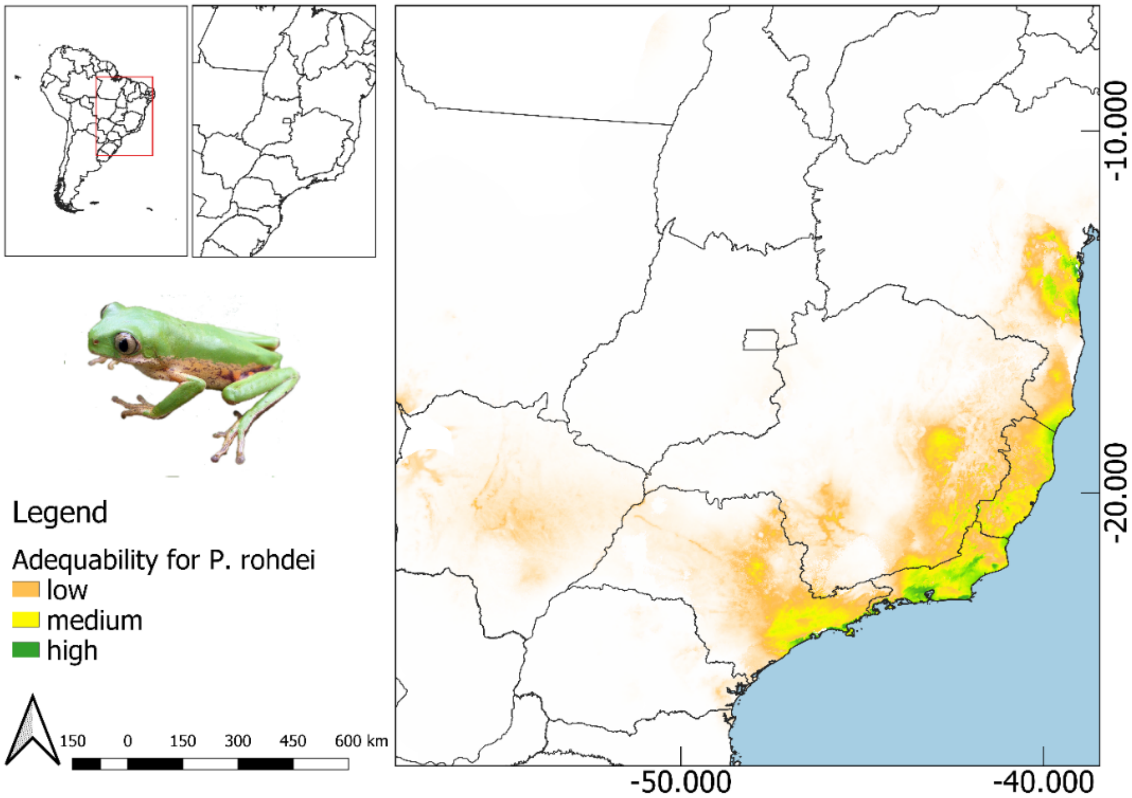
Pithecopus oreades



Pithecopus palliatus

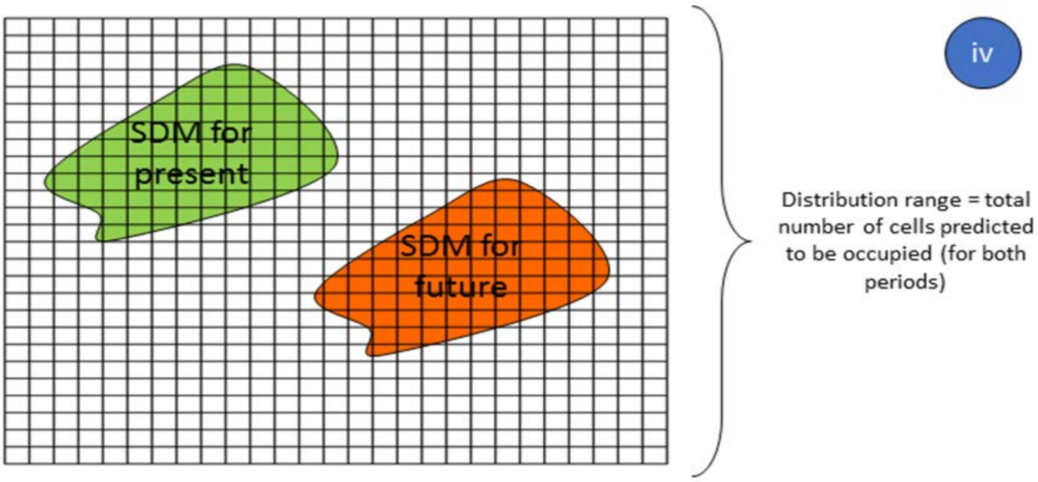


Pithecopus rohdei



4 – Next steps.

During the period between February 15 to May 15, 2020 I will be at the University of Kansas - KU, Lawrence, USA for the second time as a visiting researcher being mentored by Professor Andrew Townsend Peterson. Specifically, these are the key activities that will be developed by me at the Ecology and Evolution Laboratory at the Natural History Museum of the University of Kansas – KU (see figure below for summary):



$$E = \frac{UC's\ RANGE}{TOTAL\ DISTRIBUTIONA\ RANGE}$$

E = UC´s efficiency

UC´s Range = How much of the predicted area occurs within the area of conservation units

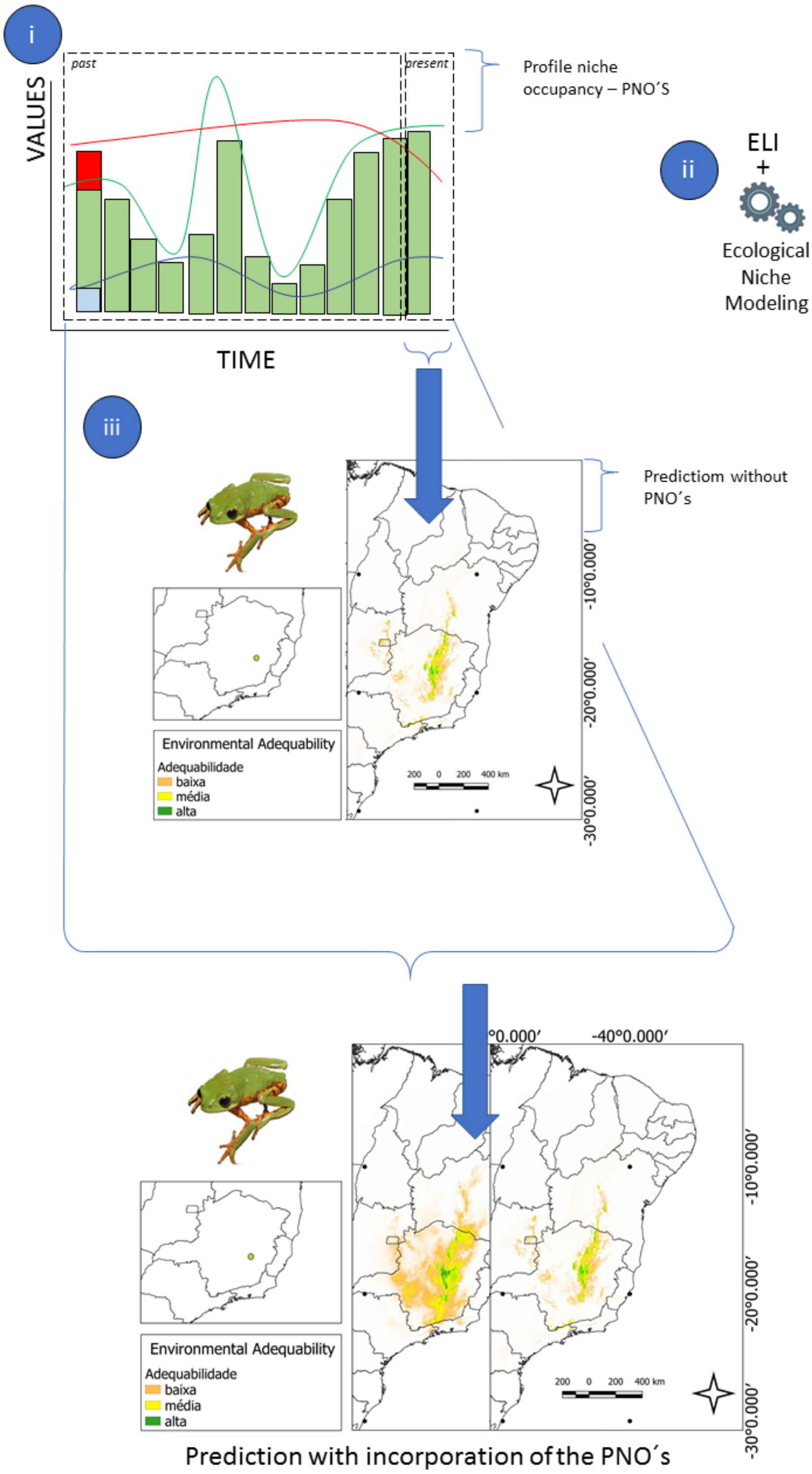
Total Distributional range = total area predicted to be occupied

i) idealization, conceptualization and development of the ecological lability index - ELI;

ii) Development of the methodology that incorporates the "ELI" in the predictions for future scenarios;

iii) Construction of potential distribution models for future scenarios considering the ecological lability of each species;

iv) Analysis of the efficiency of Conservation Units.



Briefly, this index will denote the potential ecological flexibility of species based on niche "behavior" throughout their evolutionary history. In other words, this index will represent the ecological resilience of each species and will feature the ability of each species to adapt to environmental changes. *Besides,* it is worth mentioning that this routine, is an attempt to construct a new methodology idealized by me and my supervisors and collaborators, if this is done, we believe that this methodology will allow for predictions and, consequently, more robust inferences.