Interactive Maps from:

Modelling 21st century refugia and impact of climate change on Amazonia's largest primates

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Abstract

Aim: Unsuitable edaphic and vegetation conditions can render climatically suitable sites inadequate for a species to persist, constraining both the amount of suitable habitat and the possibilities of tracking their preferred climatic niche under future climate change. We combined climatic and remotely sensed environmental data to estimate current and future distributions of nine extant lineages of ateline primates across the whole Amazon basin. We used these estimations to identify and quantify range changes and potential refugia at taxon and complex levels up until the mid-21st century (2041-2070) under two different climate change scenarios.

Location: Amazonia.

Taxon: Atelinae (Primates).

Methods: We used an ensemble forecasting approach for species distribution models combining occurrence data from online sources and scientific literature, bioclimatic layers from Climatologies at High Resolution for the Earth's Land Surface Areas (CHELSA), and reflectance data from a basin-wide Landsat TM/ETM+ image composite.

Results: We found that all taxa are likely to experience pronounced range losses irrespective of climate change scenarios. Modelled ateline richness exhibited a broadly similar spatial pattern under both climate change scenarios with a visual decrease in areas with higher predicted richness, and a possible redistribution/migration along the northernmost parts of western Amazonia. Refugia from 21st century climate change for the conservation of the whole complex were mostly concentrated in the western part of the Amazon basin, especially in the southern region.

Main conclusions: We were able to identify hotspots of vulnerability to climate change and 21st century refugia for all Amazonian atelines while accounting for habitat characteristics that must remain coupled with climatic conditions to guarantee the continued existence of colonizable habitats for these strictly arboreal forest-dwelling taxa. Increasing the understanding of reactions to climate change for this climate-sensitive group can help to spatially-inform conservation planning decisions and management to sustain forest-dwelling biodiversity over large areas such as Amazonia.

Range change analyses

To evaluate the proportional change in range size in the future compared to the present, we used the pixels for each taxon with predicted habitat suitability above and below the threshold where the sum of model sensitivity and specificity is maximized (max SSS: Liu, Berry, Dawson, & Pearson, 2005). Pixels predicted above and below the max SSS will hereafter be referred to as suitable and unsuitable habitat, respectively. Using this cut-off from the ensemble models (Thuiller, Guéguen, Renaud, Karger, & Zimmermann, 2019), we identified areas of range contractions (i.e. grid cells that were modelled as currently suitable but predicted to become unsuitable), range expansions (i.e. grid cells that are currently not suitable but were predicted to become so in the future), refugia (i.e. grid cells that were modelled as currently suitable and predicted to remain so in the future), and absence (i.e. grid cells unsuitable in both time periods). We considered range changes under two alternative dispersal scenarios: (i) assuming that a taxon would be able to completely disperse into any new suitable grid cells in the future (full dispersal), and (ii) assuming that a taxon would be unable to disperse from currently suitable grid cells (no dispersal). Although we recognize that dispersal constrains are more likely to play a role somewhere between these two extremes, such assumptions have been made in other recent studies on primates (Carvalho et al., 2021; Linero, Cuervo-Robayo, & Etter, 2020) with which we wish to draw comparisons. We quantified overall future projection outcomes by subtracting the proportional amount of range contractions from the proportional amount of range expansions.

Interactive maps

To access the output from the range change analyses, please download the repository Amazonian atelins as a zipped (compressed) file and open the *.html* files available in the Data folder (Figure 1). This will open a web map visualisation allowing assessment of different components (e.g., background (Esri.world imagery, OpenStreetMap, among others), and the target taxa [Figure 2]).

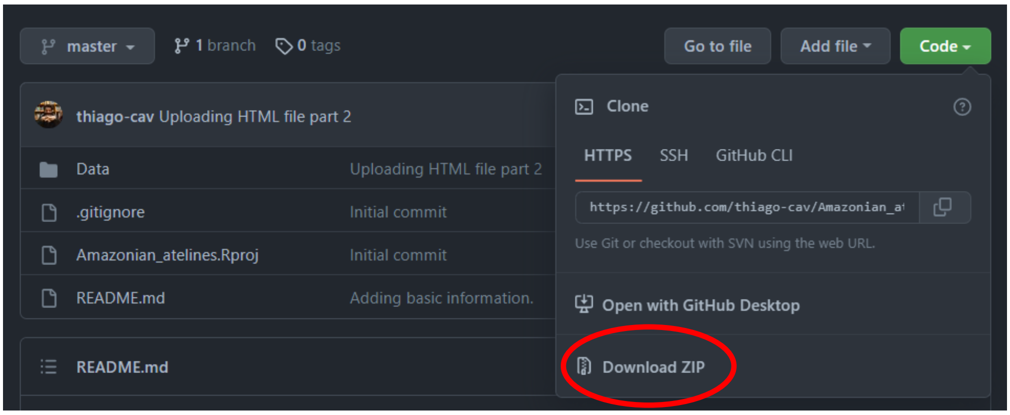

Figure 1. Downloading from GitHub.

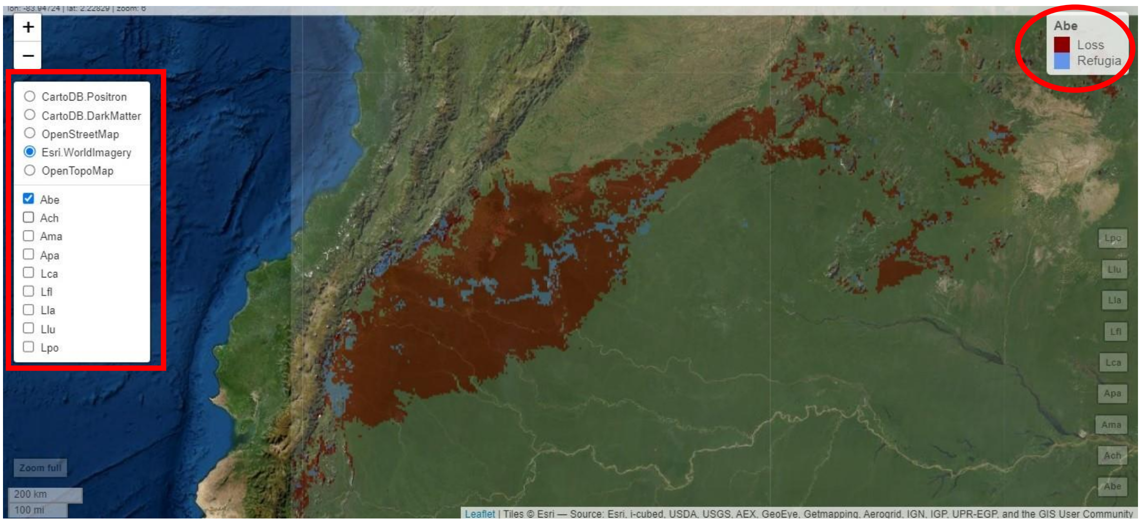

Figure 2. Interative maps. Taxon name abbreviations: Abe – *Ateles belzebuth*, Ach – *Ateles chamek*, Ama – *Ateles marginatus*, Apa – *Ateles paniscus*, Lca - *Lagothrix lagotricha cana*, Lfl - *Lagothrix flavicauda*, Lla - *Lagothrix lagotricha lagotricha*, Llu - *Lagothrix lagotricha lugens*, Llp - *L. lagotricha poeppigii*.