Endangered species and forest connectivity across Liberia and neighboring countries

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ABSTRACT

Liberia is unique among West African countries in that (1) it holds c. 42% of the remaining isolated region of humid Upper Guinea lowland rainforest, and (2) still holds rather extensive such forest in a good state of preservation.

Here we used ecological niche modeling approach to estimate the current and potential future distributions of African Forest Elephant, Western Chimpanzee, and Pygmy Hippopotamus in Liberia and neighboring countries, and we modeled habitat connectivity for two forest complexes.

We used six years occurrence data (2010-2016) for the three species from two well-sampled national parks in Liberia (Sapo National Park and Gola National Park), and five years remotely sensed MODIS enhanced vegetation index data (2010-2015). We used independent chimpanzee datasets from several research projects across the region to test the predictability of our models.

Our models performance well in predicting Western Chimpanzee distribution in Liberia and neighboring countries. Liberia had the largest portion of predicted suitable habitats for all three species. Predicted corridors for connectivity overlap for all species in the three forest complexes.

This study identifies priority areas for further research and provides useful tools to optimize the conservation of these species in the region.

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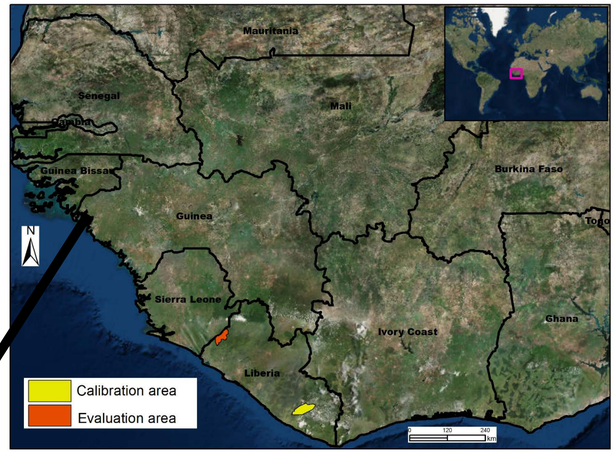
INTRODUCTION

The Upper Guinea forest of West Africa is one of the biodiversity hotspots in Africa (Myers et al., 2000), but equally under immense threat from agricultural expansion, logging, mining, and development. The region has had a long history of deforestation (Allport, 1991). Today, Liberia has the largest remaining portion (c. 42%) of the forest block in the region.

Initiatives to optimize the protection of the region's lush fauna and flora species however, have been hampered by lack of data on species distributions, ecology, and population density. For example, there are ongoing regional efforts to address increasing threats to biodiversity by establishing new protected areas and creating transboundary protected areas connectivity between countries for smooth dispersal of species across the region.

The aims of this study were to use two emerging approaches in conservation biology (ecological niche modeling and connectivity analysis using Circuitscape) (McRae et al., 2008; Peterson, 2011; Phillips et al., 2006) to estimate the current and potential future distributions of three large mammals of global conservation concern, Western Chimpanzee, African Forest Elephant, and Pygmy Hippopotamus in Liberia and neighboring countries, and to model protected areas connectivity for two forest complexes in the region (Tai-Sapo and Gola-Ziama).

STUDY AREA



METHODS AND MATERIALS

Input data
- We used 6 yrs. (2010-2016) occurrence data for the 3 species from 2 well-sampled national parks in Liberia.
- We used independent chimpanzee occurrence dataset from across the region to test the predictability of our models.
- We used 6 yrs. (2010-2015) remotely sensed MODIS enhanced vegetation index multispectral data to characterize species' environments.

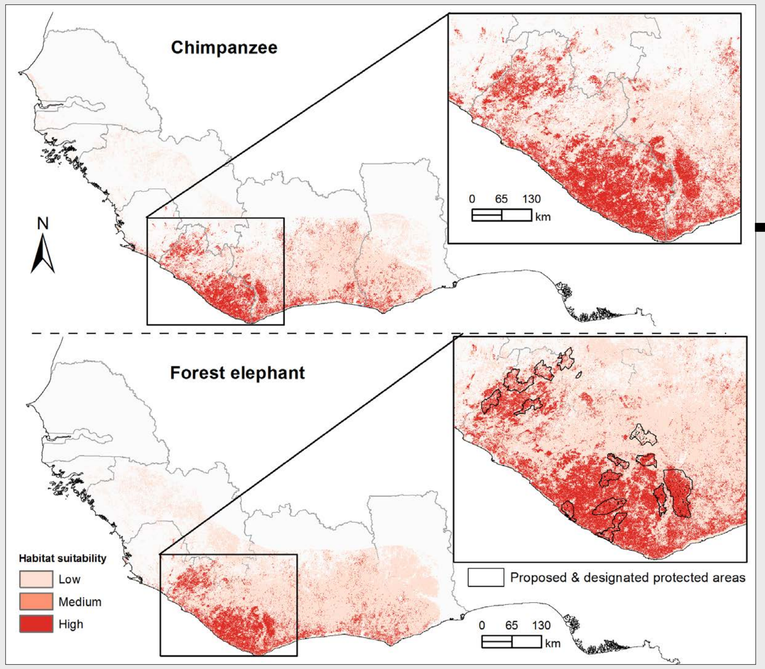
Data processing
- MODIS images were mosaicked and subjected to principal component analysis (PCA) to reduce dimensionality and compress the data. The first 46 PCs were selected for modeling.
- All data were processed and visualized in ArcGIS 10.4.1.

Ecological niche modeling
- 180 ecological niche models were built using Maxent version 3.3k (Phillips et al., 2006) using different combinations of feature classes and regularization multipliers.
- Models were calibrated in Sapo National Park and evaluated in Gola National Park in Liberia.
- Best models were selected based on low AICc and significant partial ROC scores.

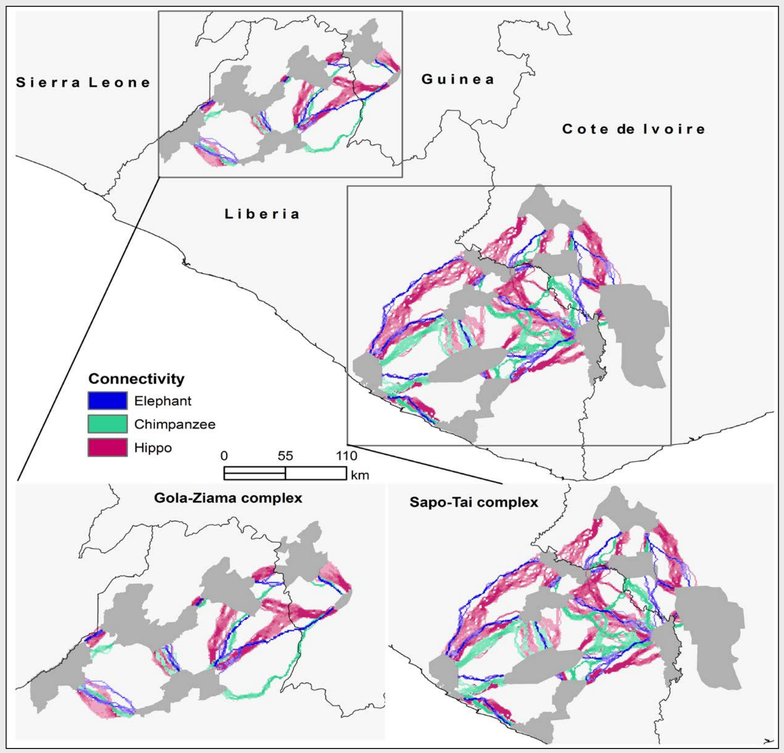
Connectivity analysis
- We summed the best models for each species and took the inverse of each to represent our resistance surfaces.
- We used the resistance layers together with shapefiles of selected proposed and designated protected areas in the region to build connectivity models using Circuitscape (McRae et al., 2008).

RESULTS

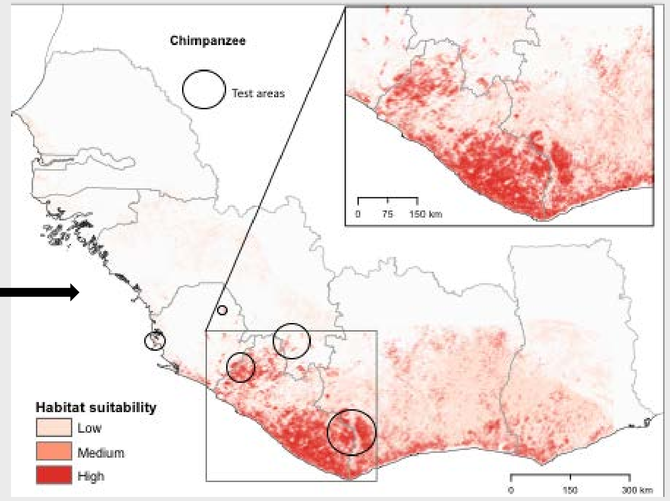
SPECIES DISTRIBUTION MODELS



HABITAT CONNECTIVITY



HIGH PERFORMANCE OF PREDICTABILITY OF CHIMP MODELS



DISCUSSION/CONCLUSIONS

This study identifies priority areas for further research and provides useful tools (distribution maps) to optimize the conservation of these species in Liberia and neighboring countries. For instance, predicted corridors for connectivity overlap for all species in the three forest complexes, emphasizing areas of overlap as priority sites.

Our results reemphasize the importance of Liberia in biodiversity conservation. Of all the countries, Liberia had the largest portion of predicted suitable habitats for all the three species, followed by Ivory Coast.

We also show that ecological niche modeling is a useful approach in predicting species distributions in the region. This was demonstrated in the performance of our chimpanzee models when tested with independent regional dataset, suggesting the need to adopt this approach for conservation planning and biodiversity research in West Africa.

FUTURE DIRECTION

The next steps for this research is to expand the species pool by including more species of global conservation concern (birds, plants, and mammals), assess their vulnerability to climate change, and model protected areas connectivity in response to climate change.

REFERENCES

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McRae, Brad H., Brett G. Dickson, Timothy H. Keitt, and Viral B. Shah. "Using Circuit Theory to Model Connectivity in Ecology, Evolution, and Conservation." *Ecology* 89, no. 10 (2008): 2712–2724.

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