Distribution and the potential habitat of the Vulnerable Himalayan wolf *Canis lupus chanco* in Bhutan

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SUPPLEMENTARY MATERIAL 1 Habitat suitability mapping of Himalayan Wolf *Canis lupus chanco* in Bhutan using *MaxEnt*

Occurrence point and predictor variables.
Wolf occurrence points were derived from three sources: the national snow leopard survey (2022-2023, *N=30*), the national tiger survey (2021-2022, *N=1*), and a Pallas's cat survey in Jigme Dorji National Park (2022, *N=1*). The national snow leopard survey covered potential snow leopard habitats in the country utilising a 2km x 2km grid employing two-camera stations (NCD, 2023). Similarly, the National Tiger survey focused on potential tiger habitats within a 5km x 5km grid (DoFPS, 2023). The Pallas's cat survey used a 2 km x 2km grid in the Soe region of Jigme Dorji National Park. A total of 32 georeferenced points were initially obtained, and to address spatial autocorrelation concerns, we applied the SDM toolbox in ArcGIS v10.8 to rarefy the occurrence points to a 1km x 1km resolution (Lham et al., 2021). The screening resulted in selecting 31 occurrence points for inclusion in this study.

We retrieved 19 Bioclimatic variables at a 30 arc-second spatial resolution from www.worldclim.org/bioclim. Elevation, slope, and aspect layers were extracted from the Bhutan Digital Elevation Model. Landcover data, comprising twelve landcover classes, was extracted from the Bhutan Land-Use Land-Cover Change 2016 dataset. Additionally, distances to the nearest road, river, and settlement were calculated using the Euclidean distance function within the Spatial Analyst tool in *ArcGIS v. 10.8* (ESRI, Redlands, USA). All the variables were prepared, including conforming cell size [30-arc second resolution], geographic extent, projection, and ASCII.

Selection of predictors and modeling process
A full model, including all variables and rarefied species occurrences, was executed in *MaxEnt 3.4.0* RGUI using default settings. Variables contributing less than 1% to the model building were excluded from subsequent analysis (Gong et al., 2023). We tested for multicollinearity among the remaining variables in R using the "*usdm*" package with a Pearson correlation coefficient value of 0.75. The ultimate set of environmental variables comprised BIO7, BIO10, BIO14, and Landcover. The final model was run with the following specifications: regularisation multiplier (fixed at 1); random seed, 15 replicates with cross-validation run type, 10,000 maximum number of background points, and logistics output format. We employed Jackknife sensitivity analysis to assess the specific contribution of each variable in determining the geographic distribution models.

Model performance was evaluated based on the area under the curve (AUC) of the receiver operating characteristic (ROC) plot, where an AUC threshold above 0.5 indicates a robust model (Philips et al., 2006). Habitat suitability was determined using the 10th percentile training presence logistic threshold. Final maps were generated using *ArcGIS v.10.8*.

Results

We obtained an AUC value of 0.970, indicating a high level of predictive performance. Four variables, namely, the mean temperature of the warmest quarter (BIO10), precipitation of the driest month (BIO14), the temperature annual range (BIO7), and land cover, contributed to model building.

References

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