SILVIS Lab

Spatial Analysis for Conservation and Sustainability

Predictive species distribution models from remotely sensed vs. traditional variables

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Introduction

- Halting biodiversity declines is a major conservation goal.
- This requires understanding environmental correlates of biodiversity patterns.
- Traditional measures, like land cover classes or climate, may fall short in characterizing factors that influence species distributions.
- Recently developed measures that characterize phenology and heterogeneity have potential to increase predictive power of models.

Goal

To compare the power of novel remotely-sensed measures with established traditionally used environmental variables to predict forest bird species distributions in Argentina.

Data and methods

Study site

Forested regions of Argentina.

Data

- eBird data for 25 forest affiliated bird species, 2008-2021
- Novel remotely-sensed environmental variables: *modeled forest structure, phenoclusters[1], spatio-temporal variability in greenness and land surface temperature (LST)[2]*
- 'Traditional' environmental variables: *elevation (srtm), precipitation (BIOClim), land cover, soil type, ecoregion*
- Resolution of all environmental variables was 1km.

Methods

- Modelled species distributions
  - 3 algorithms: GLM, Maxent, Random Forest
  - 3 models: remotely-sensed variables only, 'traditional' variables only; all variables
  - 4-fold cross validation – 70% training, 30% testing
  - ensemble models with AUC ≥0.8, TSS ≥0.5
- Compared ensemble models for each species with AUC & TSS
- Calculated variable importance and response curves for each species from the ensemble model with greatest AUC & TSS

[1]Silveira, E.M.O., et. al. 2022. Forest phenoclusters for Argentina based on vegetation phenology and climate. Ecological Applications (2022) e2526.
[2] Silveira, E.M.O., et. al. 2021. Spatio-temporal remotely sensed indices identify hotspots of biodiversity conservation concern. Remote Sens. Environ. 258, 112368.

Results: Model Comparison

Ensemble models of species distributions based on novel variables, 'traditional' variables, or all variables were compared based on AUC-ROC and TSS scores (**Fig. 1**). For some species, like *Saltator similis,* all variables sets resulted in models with similar predictive power.

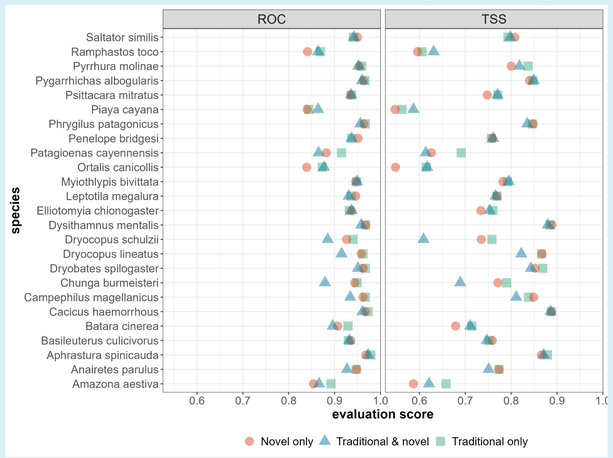

Fig.1 *Ensemble model evaluation scores for 1): using remotely-sensed variables only, 2): using 'traditional' environmental variables, and 3): using all environmental variables.*

Results: Important Environmental Variables

- Phenoclusters and spatial heterogeneity in winter land surface temperature were important for most species in models based on novel environmental variables only.
- Ecoregion, followed by precipitation seasonality and precipitation of the driest quarter were the three variables of greatest importance for most species in models based only on 'traditional' variables as well as models based on all variables

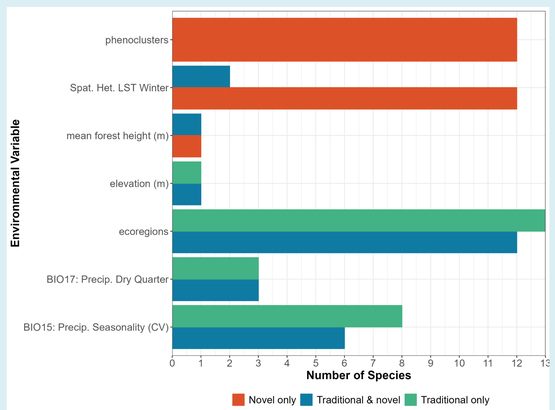

Fig. 2 *Environmental variables with the greatest variable importance value in in ensemble species distribution models 1): using novel remotely-sensed variables only, 2): using 'traditional' environmental variables, and 3): using all environmental variables.*

Results: Response Curves

For some variables, such as spatial heterogeneity in winter land surface temperature (LST) the predicted probability of species occurrence varied distinctly along the heterogeneity continuum (**Fig. 3**). But for other variables, such as spatial heterogeneity in annual LST, the nature of responses was similar among species, while the magnitude of the response varied.

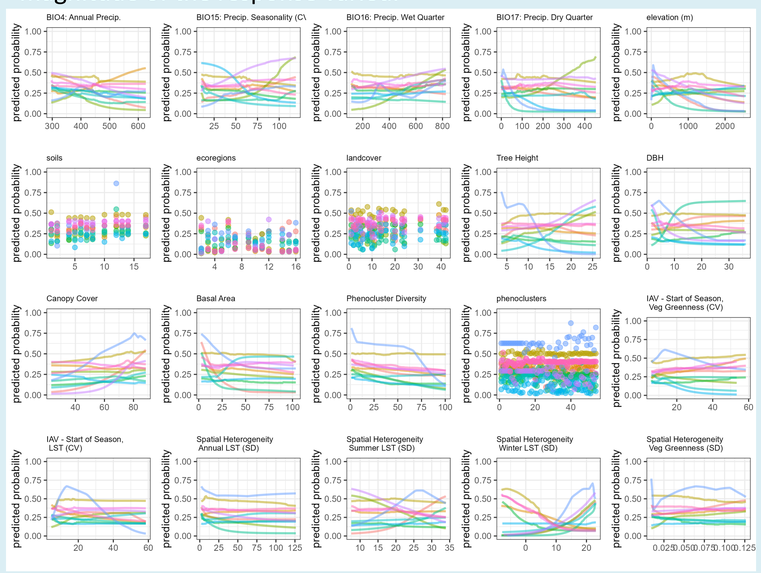

Fig. 3 *Individual species responses (predicted probability of occurrence, represented by a single line or individual points) related to environmental variables included in species distribution ensemble models.*

Discussion and conclusions

- For a subset of forest affiliated bird species in Argentina, ecoregion (15) and precipitation seasonality (8) were major predictors of their geographical distributions.
- In the 'traditional and novel' models, the novel remotely-sensed measures spatial heterogeneity of winter LST was important for 3 2 and mean forest height was important for 1 species.
- In the novel only model, phenoclusters and spatial heterogeneity of winter LST were the most important variables for 12 species each, however phenoclusters were not the most important when included in models with the 'traditional' variables.
- The relatively low proportion of species for which novel remotely-sensed measures were the most important in predicting distributions could be because the 1km resolution of the variables smoothed out important fine-scale heterogeneity.

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