HABITAT SUITABILITY MODEL OPTIMIZATION FOR STAND INITIATION IN BOTTOMLAND HARDWOOD FORESTS, LOWER MISSISSIPPI ALLUVIAL VALLEY

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PURPOSE AND SCOPE

The purpose of this study was to develop a habitat suitability model for eight selected oak species in the Lower Mississippi Alluvial Valley (LMAV). The habitat suitability model used localized soil conditions, hydrology, and climatic conditions to identify suitable habitats for oak regeneration in the LMAV. The model aimed to improve afforestation success and ecosystem services in this unique ecosystem by matching species requirements to microsite conditions in the LMAV ecoregions and incorporating projected climate changes. The geographic scope of the study was the LMAV, which spans about 26.7 million acres across seven States in the Southern United States.

METHODS AND APPROACH

This study developed habitat suitability models for eight oak species in the LMAV by using species occurrence data from the U.S. Department of Agriculture, Forest Service, Forest Inventory and Analysis program and environmental predictor variables. Tree-level coordinates were estimated from plot center coordinates using azimuth and distance. Predictor variables were selected based on factors contributing to regeneration challenges in the LMAV. An ensemble modeling approach combining machine learning and generalized linear models was used to predict suitable habitats using the 'sdm' package in R (Naimi and Araújo 2016). The models were evaluated using area under the ROC curve (AUC) and true skill statistics (TSS), from a 5-fold cross validation in 10 runs for each algorithm.

FINDINGS AND IMPLICATIONS

The niche distribution model, based on five indices, revealed that the niches of eight oak species highly overlap within the LMAV, confirming their generalist nature, as supported by Kirsch and Kaproth (2022). However, our study quantified the suitability of different ecoregions for these species, unveiling significant variability in each ecoregion's ability to support oak regeneration.

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For instance, the Northern Holocene Meander Belts ecoregion was found to be most suitable for willow oak (3.34 million acres), and the St. Francis Lowlands ecoregion was most suitable for swamp chestnut oak (*Quercus michauxii*) (0.99 million acres). Water oak (*Q. nigra*) was predicted to grow best in the Southern Holocene Meander Belts (1.16 million acres), southern backswamps (0.21 million acres), inland swamps (1.28 million acres), and deltaic coastal marshes and barrier islands (0.76 million acres) ecoregions. Cherrybark oak (*Q. pagoda*) showed the highest suitability in the Western Lowlands Pleistocene Valley Trains (2.86 million acres) (fig.1). Furthermore, the study identified the climatic variables responsible for the suitability of each oak species and their responses to climatic changes. As Self (2024) emphasizes, understanding hardwood ecology, including the five "S" factors (site, species, species-site relationships, succession, and stand development) and their interactions, is crucial for successful management and avoiding costly delays or failures in meeting specific objectives. Our study provides a baseline for the successful regeneration of oaks in the LMAV by quantifying and identifying suitable ecoregions, contributing to the understanding of hardwood ecology in this region.

LITERATURE CITED

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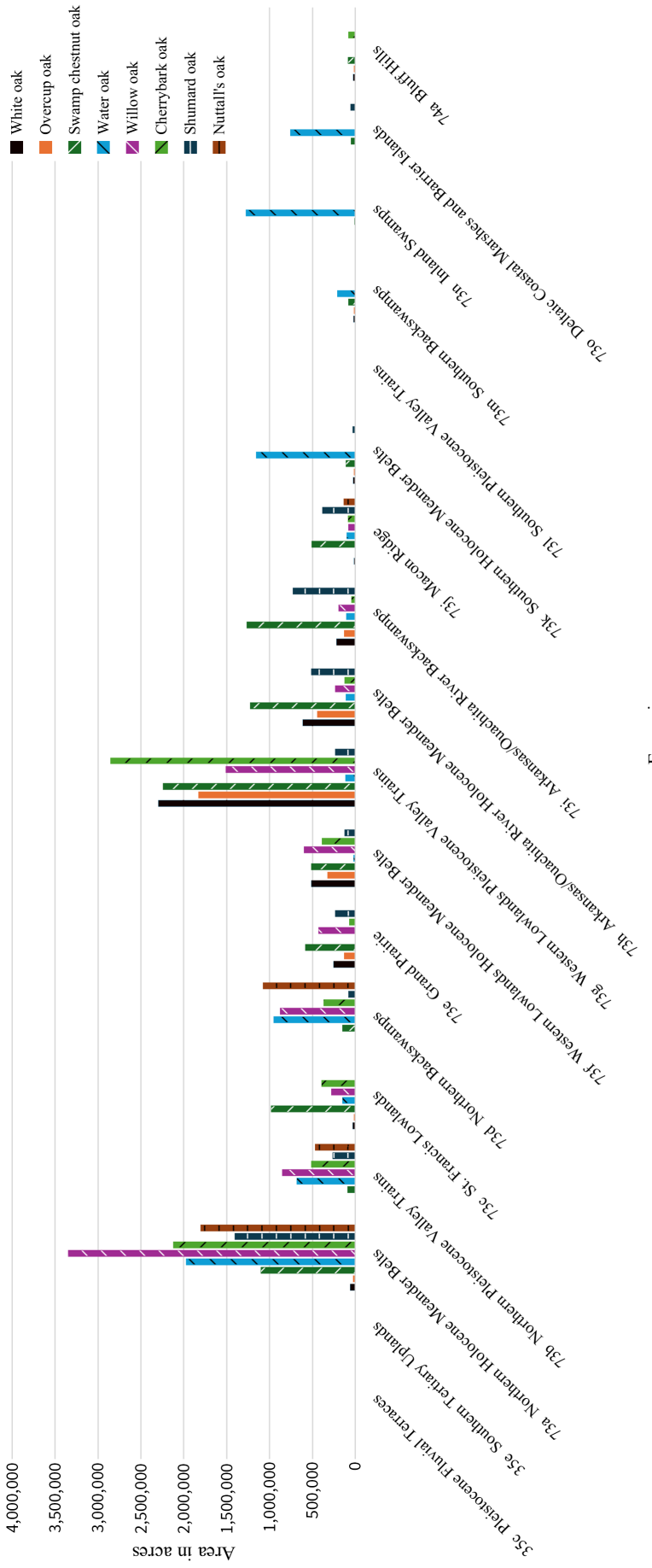

Figure 1—Oak species regeneration in each ecoregion of the Lower Mississippi Alluvial Valley as predicted by the niche distribution model.