

Unravelling the Impact of Climate Change on Honey Bees: An Ensemble Modelling Approach to Predict Shifts in Habitat Suitability in Queensland, Australia

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Abstract

Honey bees play a vital role in providing essential ecosystem services and contributing to global agriculture. However, the potential effect of climate change on honey bee distribution is still not well understood. This study aims to identify the most influential bioclimatic and environmental variables, assess their impact on honey bee distribution, and predict future distribution. An ensemble modelling approach using the BIOMOD2 package in R was employed to develop three models, i.e., a climate-only model, an environment-only model, and a combined climate and environment model. The climate-only model focused on the bioclimatic factors: radiation of the wettest and driest quarters, and temperature seasonality. By utilizing bioclimatic data from 1990 to 2009, combined with observed honey bee presence and pseudo absence data, this model predicted honey bee distribution for two future time spans: 2020-2039 and 2060-2079. The climate-only model exhibited a True Skill Statistic (TSS) value of 0.85, underscoring the pivotal role of radiation and temperature seasonality in shaping honey bee distribution. The environment-only model incorporated environmental variables: proximity to regional ecosystems (floral resources), foliage projective cover, and elevation. This model demonstrated strong predictive performance, with a TSS of 0.88, emphasizing the significance of environmental variables in determining habitat suitability for honey bees. Remarkably, the combined model had a higher TSS of 0.96, indicating that the combination of climate and environmental variables enhances the model's performance. Predictions for the 2060-2079 period revealed a concerning trend of 100% transition of highly suitable land into moderately (0.54%), marginally (17.56%) or not suitable areas (81.9%) for honey bees. These results emphasize the critical need for targeted conservation efforts and the implementation of policies aimed at safeguarding honey bees and the vital apiary industry.

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