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A multi-observation-platform habitat suitability model for vampire bat distribution in Peru

Bats are important reservoirs of emerging infectious diseases, but their nocturnal activity, capacity for flight, and reclusive nature frustrates understanding of their spatial distributions. In Latin America, common vampire bat (Desmodus rotundus) transmitted rabies virus represents a key example of how this uncertainty impedes successful management. Decades of efforts to reduce the burden of lethal rabies infections in livestock and humans by culling bats have had limited success. This is likely because the virus persists via spatial dissemination between colonies, but neither the number nor locations of colonies is known, precluding optimal allocation of culls or other interventions.

We will present a Bayesian joint point process model which integrates data on the locations and environmental characteristics of a limited number of vampire bat roosts (N=222) in southern Peru, along with data from 400 questionnaires describing the occurrence of bat bites in livestock, an indirect, but complementary measure of bat presence. The model identifies covariates of roost distribution including elevation and shows considerable reductions in roost detectability in regions that are less accessible. Importantly, the incorporation of bat bite data and landscape covariates enables imputation of the positions of unobserved roosts. Model predictions are validated using an independent dataset of bat roosts in other regions of Peru.

Our results identify areas in southern Peru which are predicted to have relatively high abundance of vampire bat colonies yet currently have only sparse occurrence records. Concerningly, some of these areas are geographically proximal to areas of active viral circulation, indicating a high risk of viral spread. The predicted distribution of roosts further provides valuable inputs for landscape models of rabies transmission and management. More broadly, our statistical framework is applicable for modelling the density of partially observed colonial species. Understanding the distribution of bats will become more important as climate change and urbanization increase contacts between bats, domestic animals and humans.