Predicting ecological interactions across space

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What we observe in nature is never the full picture.

When we study ecological communities, many species interactions go undetected. This makes it difficult to fully understand how ecosystems function.

Link prediction tools can help fill these gaps,
but they often depend on knowledge of species traits and ignore how interactions vary across space.

Goals

We set out to develop a method for predicting missing links in a target location using information from other locations, relying solely on network structure.

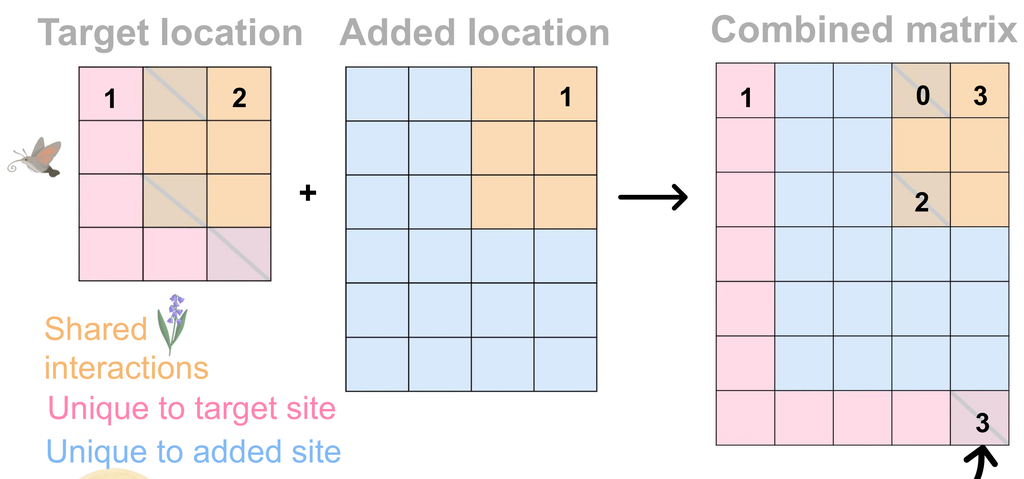
We then explored what factors influence how well we can predict these links across space.

Methods

Developed predictive pipeline

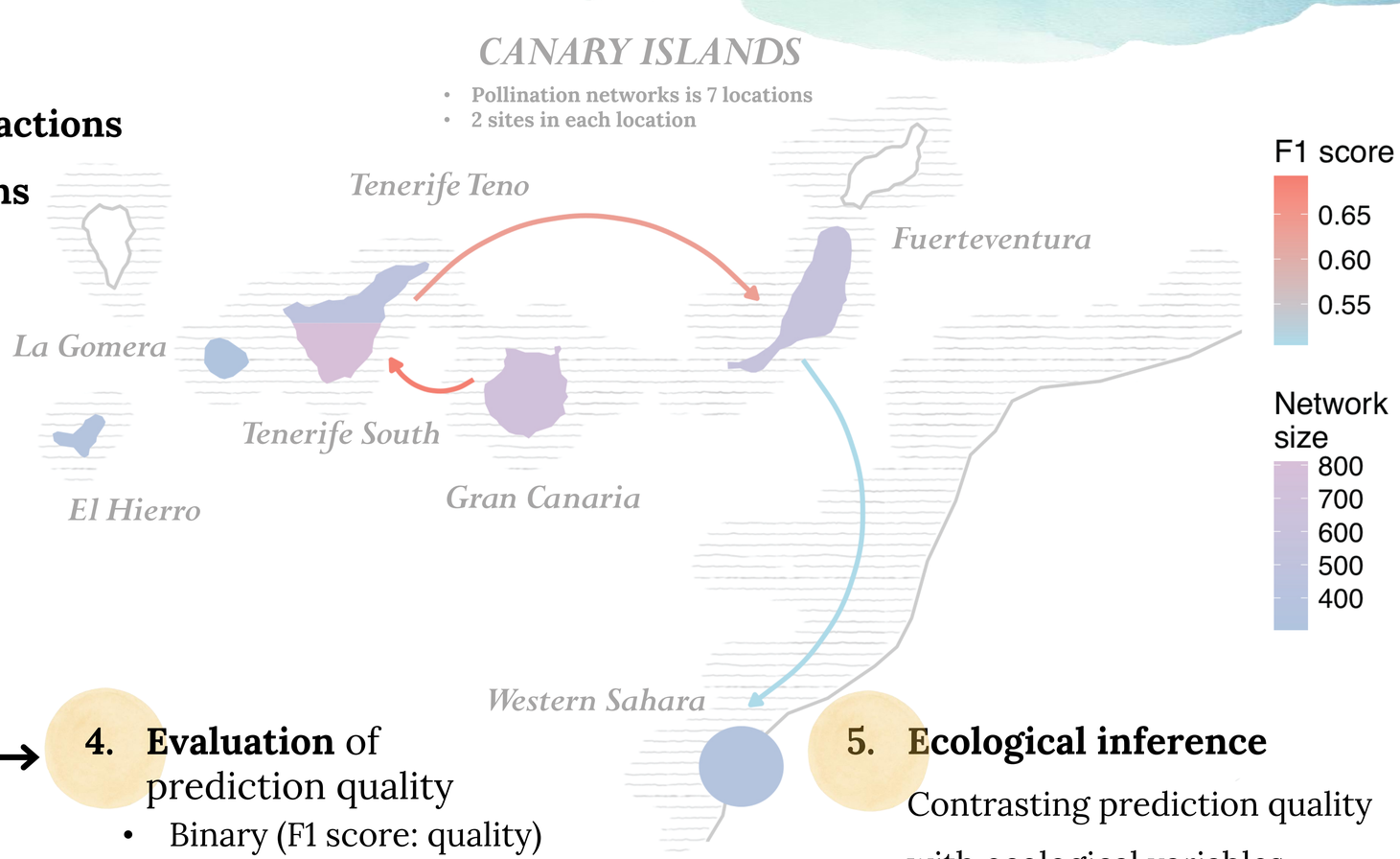
1. **Removing links randomly from a target location**

2. **Combining interactions from two locations**



3. **Predicting links** based on Singular Value Decomposition (**SVD**)

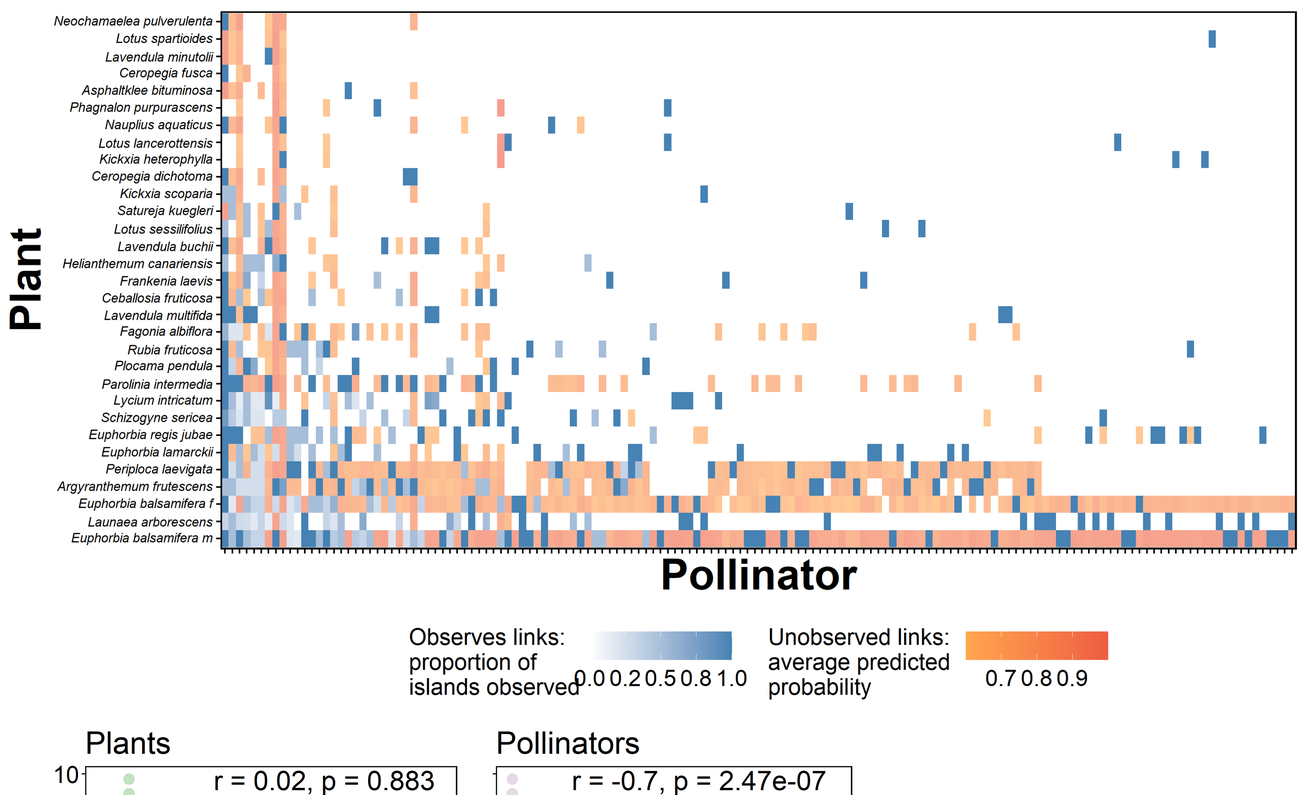
4. **Evaluation** of prediction quality
   - Binary (F1 score: quality)
   - Weighted (RMSE: error)



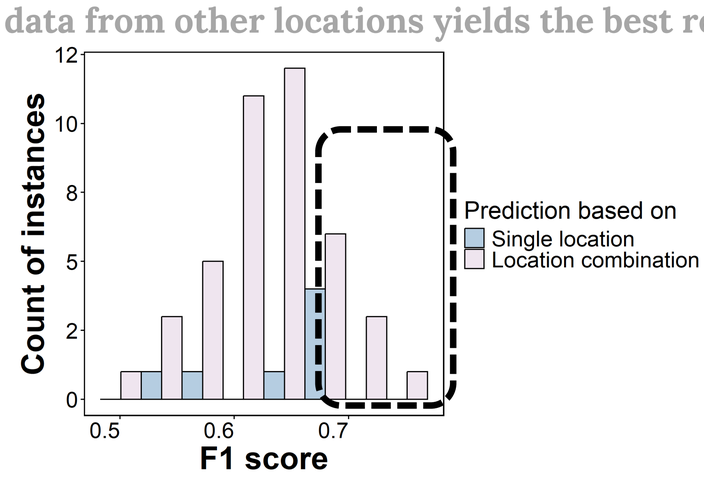
5. **Ecological inference**
   Contrasting prediction quality with ecological variables

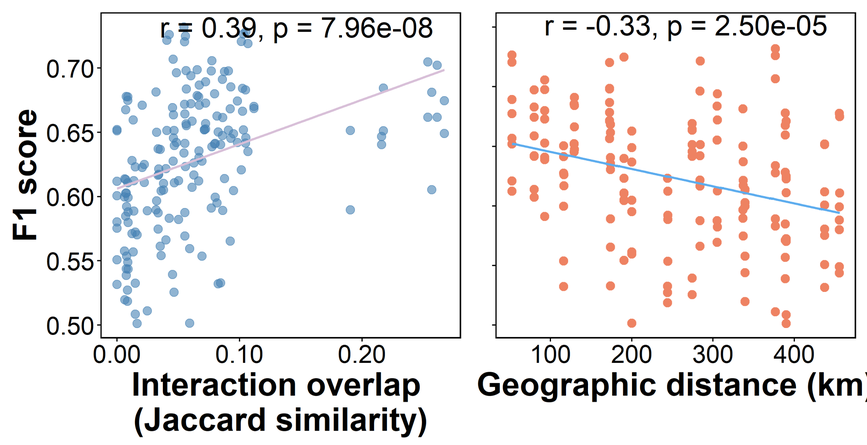
Results

Map of potential missing links in the Canary Islands pollination system

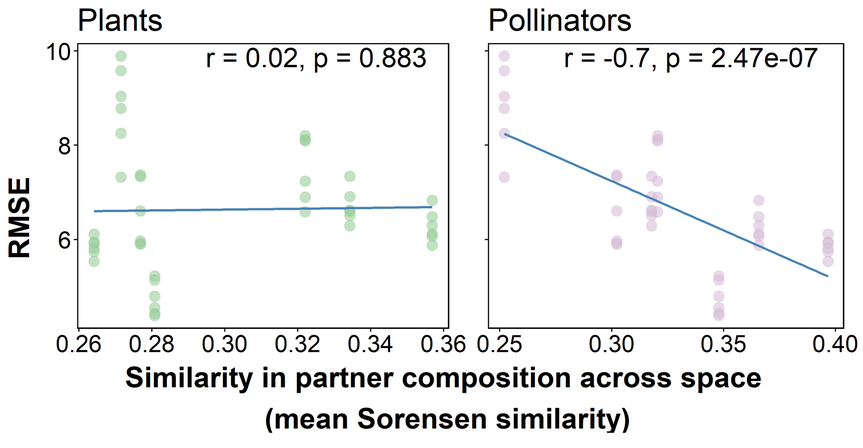


Adding data from other locations yields the best results

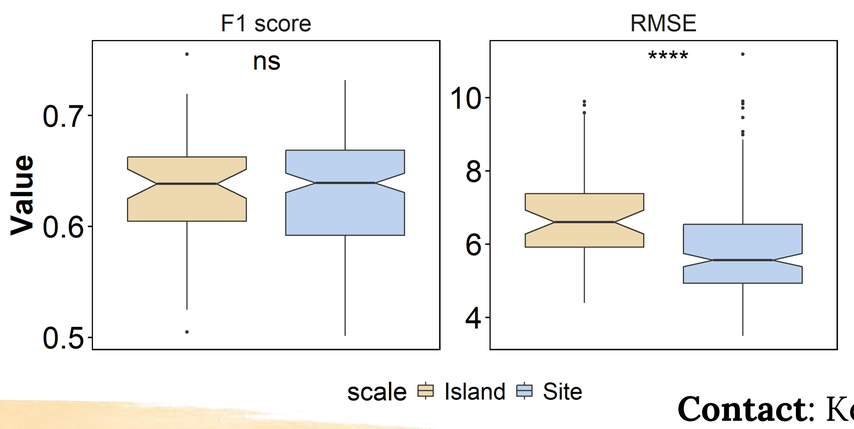




Similarity driven distance decay in predictive capacity



Predictive error drops for pollinators with consistent partner choices across space



For quantitative predictions, use smaller spatial scales

Conclusions

We can make ecologically relevant predictions based solely on network structure

We are more likely to predict correctly:

- By adding data from a similar, closer network
- Interactions that involve loyal partners

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