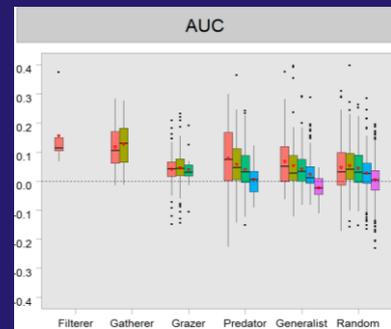


Alpha adjusted SDMs - Accounting for biotic interaction in species distribution models

DATA ANALYSIS



Yoni Gavish (gavishyoni@gmail.com)

Overview

Species distribution models (SDMs) predict the potential distribution of a species based on the characteristic fine-resolution environmental conditions in which the species was found. However, SDMs ignore the potential effects of biotic interaction on species distribution patterns. More specifically, an SDM's **Probability of Occurrence (PoO)** for a focal species is not affected by the number of species the site can support (alpha diversity) and by the suitability of the sites to the focal species, relative to its suitability to other species. To account for these biotic interactions, we developed the alpha-adjusted SDM, which adjusts the PoO of all species in all sites based on the predicted alpha diversity and the relative PoO of the different species. Thus, the alpha-adjusted PoO for a focal species will be higher than that of the original SDM where the site can support high alpha diversity and where a species' PoO is high relative to other species' PoOs. The alpha-adjusted SDMs account for both of these aspects simultaneously.

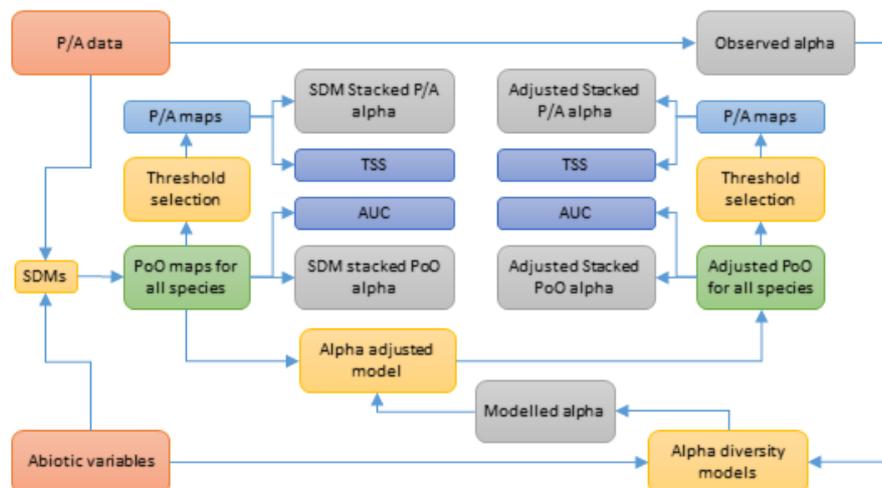


Figure 1. Main workflow for SDMs and alpha-adjusted SDMs. Presence/absence (P/A) data of species in multiple sites alongside abiotic variables are used to train an SDM and to produce probability of occurrence (PoO) maps. The P/A data are also used to estimate a site's alpha diversity, and to train an alpha diversity model. The SDM's PoO and the predicted alpha diversity values are then used in the alpha-adjusted model to produce the adjusted PoO of each species in each site. The SDM's PoO and the adjusted PoO can then be used to assess performance at the species level directly (e.g., AUC) or after applying a threshold to produce binary P/A maps (e.g., TSS). Similarly, summing the PoO or the P/A maps over all species in a given site predicts the site's alpha diversity.

Expected advantages

1. **Increased accuracy:** some species will not occur in suitable sites since they are outperformed by other species. On the other hand, some sites that seems unsuitable for a species are occupied since the species is more suited to the site's conditions than any other species. The alpha-adjusted model accounts for these issues.
2. **Predicted alpha diversity:** the model predicts the expected number of species at each site.

Applicability

The data required to fit the alpha-adjusted model include:

- Presence / absence data of multiple species at multiple sites (e.g., monitoring programs)
- Environmental and/or remotely sensed variables to fit the SDMs and alpha diversity model
- A minimal understanding of the species' biology to group them into suitable guilds

The R script that calculates the adjusted PoO per site is available upon request.

Potential users

Species distribution models are the main tool available today to predict species distribution pattern at fine resolution over wide extents. Similarly, alpha diversity models are used increasingly to produce alpha diversity maps. The end-users of the tool are those that utilize SDMs for reporting and management. The main users are those that are familiar with other SDM methodologies. The tool is extremely useful for reporting and management at the community or ecosystem levels of organization.

Case study

We have applied the models to 87 freshwater invertebrate species in one of EUBON's focal observatory sites, the Rhine-Main Observatory. We divided the species into 5 guilds and, within each, we explored the effect of the error associated with modelling alpha diversity, the intensity of biotic interaction, and the effect of the size of the species pool. In general (Figure 2), we found that the alpha-adjusted model returned more accurate maps for species when:

- a. alpha diversity can be modelled with sufficient accuracy
- b. the community is relatively small (around 10 species) and contains a set of species that strongly interact with one another (e.g., same feeding guild)

A publication summarizing the results of this analysis is currently being prepared.

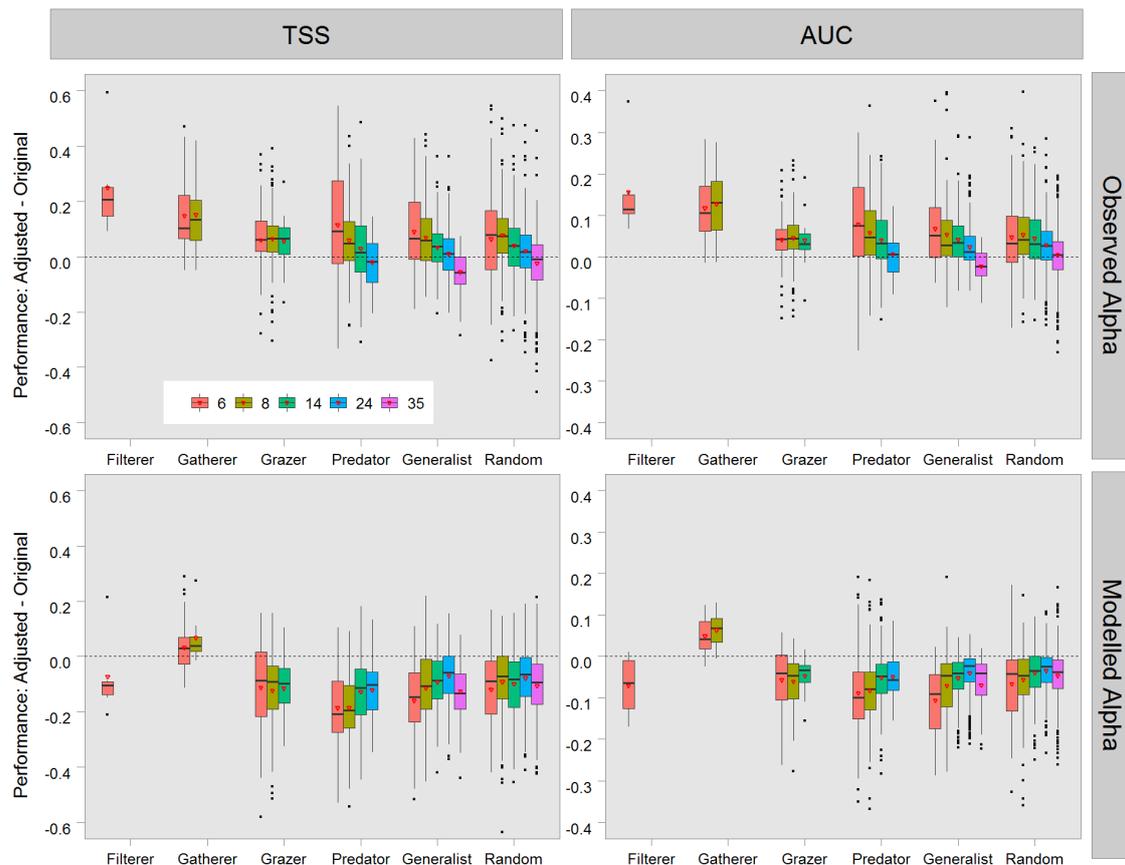


Figure 2. The difference between the adjusted and the original True Skills Statistics (TSS) and Area Under the ROC Curve (AUC) for different guilds and sizes of species pool (6, 8, 14, 24 and 35), based on the observed and modelled alpha diversity. Values larger than 0 (above the horizontal line) are cases in which the alpha adjusted model performed better than the original SDM. The means are given as red triangles, while the box represent the 25, 50 and 75 quartiles and the whiskers the 5-95% range. Outliers are given as black points.