

Community Occupancy Model

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1 Species Richness and Joint Modeling while Accounting for Detection Probability

The core idea of a community occupancy model is to jointly model detection data (Y) for species s (total n species observed) at site i with replicate surveys J to estimate the total species richness and share information across species in terms of effects on occurrence of each species as,

$$\begin{aligned} Y_{s,i} &\sim \text{Bern}(p_{\mu_{s,i}}, J) \\ p_{\mu_{s,i}} &= p_i \times Z_{s,i} \\ Z_{s,i} &\sim \text{Bern}(\psi_{\mu_i}) \\ \psi_{\mu_i} &= \psi_i \times w_i \\ w_i &\sim \text{Bern}(\omega). \end{aligned}$$

The parameter ω is an inclusion probability of species that have not been detected. This parameter governs the latent parameter w_i to decide on whether a species should be included as part of the community or not. Species that are detected are included and species that have not been detected across any sites are included with probability ω . For this to work, the detection data Y needs to include the sampled detection data of observed species along with all zero detections for n_0 number of species that have not been detected but could have been part of the community.

The occupancy and detection parameters for each species (ψ_s , p_s , respectively) can still be modeled with a logit-linear model, as is done with single species occupancy models.

The total species unobserved is summarized as,

$$\sum w_{n_0:(n+n_0)}.$$