

Warbler conservation model

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1 Model

Subscripts are i for site and t for time. Superscripts are B for blue wing, G for golden wing, $G|B$ for golden wing given presence blue wing, and $G|\tilde{B}$ golden wing given absence of blue wing. We use A to represent B , $G|B$, or $G|\tilde{B}$.

For variables we have, y for observed detections, z for latent occupancy, p for detection probabilities, ψ for occupancy probabilities, and x for covariates

1.1 Detection model, \mathbf{p} , \mathbf{z} to \mathbf{y}

$$y_{i,t}^B | p_{i,t}^B, z_{i,t}^B \sim \text{Bern}(p_{i,t}^B z_{i,t}^B) \quad (1)$$

$$y_{i,t}^G | p_{i,t}^{G|B}, p_{i,t}^{G|\tilde{B}}, z_{i,t}^B, z_{i,t}^G \sim \text{Bern}(z_{i,t}^G [z_{i,t}^B p_{i,t}^{G|B} + (1 - z_{i,t}^B) p_{i,t}^{G|\tilde{B}}]) \quad (2)$$

1.2 Occurrence model, ψ to \mathbf{z}

For all years other than the first year (i.e. $t > 1$), we have the following expression for the probability of occurrence of the blue wing,

$$\psi_{i,t}^B = z_{i,t-1}^B [1 - \epsilon_{t-1}^B] + [1 - z_{i,t-1}^B] \gamma_{t-1}^B, \quad (3)$$

and the probability for the golden wing as,

$$\begin{aligned} \psi_{i,t}^G = & \underbrace{z_{i,t-1}^B z_{i,t-1}^G}_{\text{(both present)}} \underbrace{(1 - \epsilon_{i,t-1}^{G|B})}_{\text{(G does not go extinct)}} + \\ & \underbrace{z_{i,t-1}^B (1 - z_{i,t-1}^G)}_{\text{(B present but not G)}} \underbrace{(\gamma_{i,t-1}^{G|B})}_{\text{(G colonizes)}} + \\ & \underbrace{(1 - z_{i,t-1}^B) z_{i,t-1}^G}_{\text{(G present but not B)}} \underbrace{(1 - \epsilon_{i,t-1}^{G|\tilde{B}})}_{\text{(G does not go extinct)}} + \\ & \underbrace{(1 - z_{i,t-1}^B) (1 - z_{i,t-1}^G)}_{\text{(both absent)}} \underbrace{(\gamma_{i,t-1}^{G|\tilde{B}})}_{\text{(G colonizes)}} \end{aligned} \quad (4)$$

Note that ϵ 's and γ 's mean extinction and colonization probabilities.

These occurrence probabilities can be used to specify a Bernoulli distribution for the occurrences,

$$z_{i,t}^B | \psi_{i,t-1}^B \sim \text{Bern}(\psi_{i,t-1}^B) \quad (5)$$

$$z_{i,t}^G | \psi_{i,t-1}^G \sim \text{Bern}(\psi_{i,t-1}^G) \quad (6)$$

1.3 GLMs

The extinction and colonization parameters linearly depend on environmental and spatial variables on the the logit scale,

$$\text{logit}(\epsilon_{i,t}^A) = \sum_{j=1} \beta_j^A x_{i,t,j}^A \quad (7)$$

$$\text{logit}(\gamma_{i,t}^A) = \sum_{j=1} \beta_j^A x_{i,t,j}^A \quad (8)$$

where the superscripts A refer to either B , $G|B$, or $G|\tilde{B}$.

We also need to model the effects of covariates on the detection probabilities,

$$\text{logit}(p_{i,t}^A) = \sum_{j=1} \alpha_j^A x_{i,t,j}^A \quad (9)$$

Note that j subscripts represent different covariates. Also note that we could have different covariates for each of the logit-scale equations. Finally, note that there are three equations for each logit-scale equation (i.e. for $A = B, G|B, G|\tilde{B}$).

1.4 Priors

Diffuse normals on β 's and α 's.