A framework for estimating human-wildlife conflict probabilities conditional on species occupancy

Appendix A

Model

$$
\begin{aligned}
y_i &\sim \begin{cases} 0, & z_i = 0 \\ \text{Binom}(K_i, r), & z_i = 1 \end{cases} \\
w_{i,t} &\sim \begin{cases} \text{Binom}(J_i, p_{10}), & z_i = 0 \\ \text{Binom}(J_i, p_{11}), & z_i = 1 \end{cases} \\
z_i &\sim \text{Bern}(\psi_i) \\
\psi_i &= \mathbf{X}'\boldsymbol{\beta}
\end{aligned} \tag{1}
$$

PRIORS

$$
\begin{aligned}
\boldsymbol{\beta} &\sim \text{Normal}(\boldsymbol{\mu}_\beta, \boldsymbol{\Sigma}_\beta) \\
r &\sim \text{Beta}(\alpha_r, \beta_r) \\
p_{10} &\sim \text{Beta}(\alpha_{p_{10}}, \beta_{p_{10}}) \\
p_{11} &\sim \text{Beta}(\alpha_{p_{11}}, \beta_{p_{11}})
\end{aligned}
$$

Posterior Distribution

$$[Z, \beta, r, p_{11}, p_{10}|\mathrm{Y}, \mathrm{W}] \propto \prod_{i=1}^{S}[y_i|r]^{z_i} \cdot 1_{y_i=0}^{1-z_i} \cdot [w_i|p_{10}]^{1-z_i} \cdot [w_i|p_{11}]^{z_i} \cdot [z_i|\psi_i] \cdot [\boldsymbol{\beta}][r][p_{11}][p_{10}]$$

Full Conditional Distributions

$[z_i|\cdot]$

$z_i = 1$ for sites with both sources of data and $y_i > 0$. For all other sites

$$\begin{aligned} z_i &\sim \mathrm{Bern}(\tilde{\psi}_i) \\ \tilde{\psi}_i &= \frac{\mathrm{A}}{\mathrm{A}+\mathrm{B}} \\ \mathrm{A} &= \binom{J_i}{w_i} p_{11}^{w_i}(1-p_{11})^{J_i-w_i}\binom{K_i}{y_i} r^{y_i}(1-r)^{K_i-y_i} \\ \mathrm{B} &= \binom{J_i}{w_i} p_{10}^{w_i}(1-p_{10})^{J_i-w_i} \end{aligned}$$

$[\boldsymbol{\beta}|\cdot]$

$$[\boldsymbol{\beta}|\cdot] \propto \prod_{t=1}\prod_{i=1}^{S}[z_i|\psi_i][\boldsymbol{\beta}]$$

Estimated using the Metropolis Hastings MCMC algorithm .

$[p_{11}|\cdot]$

$$p_{11} \sim \mathrm{Beta}(\Sigma_{z_i=1}(w_i) + \alpha_{p_{11}}, \Sigma_{z_i=1}(J_i - w_i) + \beta_{p_{11}})$$

$[p_{10}|\cdot]$

$$p_{10} \sim \mathrm{Beta}(\Sigma_{z_i=0}(w_i) + \alpha_{p_{10}}, \Sigma_{z_i=0}(J_i - w_i) + \beta_{p_{10}})$$

$[r\cdot]$

$$r \sim \text{Beta}(\Sigma_{z_i=1}(y_i) + \alpha_r, \Sigma_{z_i=1}(K_i - y_i) + \beta_r)$$