Occupancy estimation of jaguar *Panthera onca* to assess the value of east-central Mexico as a jaguar corridor

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SUPPLEMENTARY MATERIAL 1 Site occupancy modelling

The following is very similar to that reported in Zeller et al. (2011) and describes our modelling method.

We modelled probability of habitat use and probability of detection for single-state and multi-state models as a function of covariates, using logit and multinomial-logit (*m*logit) link functions, respectively (MacKenzie et al., 2006, 2009). The *m*logit model can be considered an extension of the logit model, for which each state is modelled separately with its own set of covariates. If data for a species are recorded in m states, the logit of the probability of habitat use in site *j* in state *m* is expressed as:

$$Z_{mj} = logit(\Psi_{mj}) = \alpha_{mj} + \sum_{i=1}^{n} \beta_{mji} X_{mji}$$

This is a linear function of *n* covariates ($X_1 \ldots X_n$) for site *j*, with intercept α and *n* β coefficients to be estimated.

The reference state is usually the lowest state, which in this case is state 0 (non-detection). The probability of membership in the other states is compared to the probability of membership in this reference state. For example, the probability of habitat use in site *j* in state *p* (m = 2… M) is:

$$\Psi_j(m = p) = \frac{\exp(Z_{pj})}{1 + \sum_{m=2}^{M} \exp(Z_{mj})}$$

Logit or *m*logit-based model-estimated C is unconditional, meaning it is modelled based on site covariates and is derived independently of detection probability. However, conditional probability (C-cond) is calculated using the detection history at the site. For single-state models, C-cond = 1 for sampling units with at least one detection, as species presence has been established unambiguously. For sites with no detection, conditional probability is calculated by factoring in the likelihood of not detecting the species (1 – *p*):

$$\Psi\text{-}cond = \frac{\Psi * Q}{((1 - \Psi) + (\Psi * Q))}$$

where $Q = (1 - p)^k$, for which k = number of surveys.

In the multi-state model, C-cond can be calculated using an expression similar to that above in which (1) the denominator includes all possible iterations of the site's detection history and (2) the numerator calculates the probability of the species being present in a given state. As an example, let $p_{o,r}$ represent the probability of detection when the observed state is o and the true state is r. For a detection history of 201011,

$$\Psi\text{-}cond_{state3} = \frac{\Psi_{state3}(1 - p_{1,3} - p_{2,3} - p_{3,3})^2 (p_{1,3})^3 (p_{2,3})^1}{\Psi_{state3}(1 - p_{1,3} - p_{2,3} - p_{3,3})^2 (p_{1,3})^3 (p_{2,3})^1 + \Psi_{state2}(1 - p_{1,2} - p_{2,2})^2 (p_{1,2})^3 (p_{2,2})^1}$$

The denominator of the expression provides all possibilities of the detection history. Perhaps the species was in state 3 but was undetected in the second and fourth surveys and observed in a lower frequency state in all other surveys; or perhaps it was in state 2, with only the first survey providing the 'correct' frequency state and all other surveys reporting a lower state.

For a detection history of 000000,

$$\Psi\text{-}cond_{state3} = \frac{\Psi_{state3}(1-p_{1,3} - p_{2,3} - p_{3,3})^6}{\Psi_{state3}(1-p_{1,3} - p_{2,3} - p_{3,3})^6 + \Psi_{state2}(1-p_{1,2} - p_{2,2})^6 + \Psi_{state1}(1-p_{1,1})^6 + (1 - \Psi_{state3} - \Psi_{state2} - \Psi_{state1})}$$

The final term in the denominator above represents a scenario in which the species is indeed absent in the unit.

Missing observations are omitted in the calculations.

Supplementary Material 2 Prey species equations

$$\Psi\text{-}cond_{GI} = (\Psi\text{-cond}_{state3_{paca}}) * (\Psi\text{-}3\text{-}cond_{armadillo}) \tag{1}$$

$$\begin{aligned} \Psi\text{-}cond_{GII} &= 1 - (P_{no\_species}) - (P_{only\_one\_species}) \\ &= 1 - ((1 - \Psi\text{-}cond_{CP}) * (1 - \Psi\text{-}cond_{RBD}) * (1 - \Psi\text{-}cond_{WTD})) \\ &\quad - (((\Psi\text{-}cond_{CP}) * (1 - \Psi\text{-}cond_{RBD}) * (1 - \Psi\text{-}cond_{WTD})) \\ &\quad + ((\Psi\text{-}cond_{RBD}) * (1 - \Psi\text{-}cond_{CP}) * (1 - \Psi\text{-}cond_{WTD})) \\ &\quad + ((\Psi\text{-}cond_{WTD}) * (1 - \Psi\text{-}cond_{CP}) * (1 - \Psi\text{-}cond_{RBD}))) \end{aligned} \tag{2}$$