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Wildlife Research

Supplementary Material

Bringing back the endangered bridled nail-tailed wallaby at Taunton National Park (Scientific) through effective predator control

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Appendix S1. Survival analysis details

The model used followed a robust design, with survival between trapping sessions being considered stochastic, but with no mortality possible within each trapping session. There were four trapping events (nights) within each trapping session. Thus, the number of times out of four trapping events that an individual was trapped, given that it was alive during the trapping session, was assumed to be drawn from a binomial distribution with event probability p_{it}, which is the probability of trapping individual i on one night of trapping during session t given that the individual was alive.

Nightly trapping probability was modelled as:

$$\text{logit}(p_{it}) = \text{logit}(d_{a[i,t],g[i]}) + \varepsilon_t,$$

where $a[i,t]$ is the size of individual i during the trapping session t, $g[i]$ is the sex of individual i, $d_{a,g}$ is the median trapping probability of individuals of age a and sex g, and ε_t is random effect term that varies between sessions to allow for temporal variation in trapping probabilities. The different values for ε_t were assumed to be drawn from a normal distribution with a mean of zero and a standard deviation (σ_d) that was estimated. Because there was not compelling evidence that trapping probabilities varied with size and sex of BNTWs, the final model assumed a single value of $d_{a,g}$ that was the same for all individuals, with only temporal variation in trapping probabilities. Survival from one trapping session to another was modelled by calculating the survival probability from one session to the next. To account for differences in the length of time between trapping sessions, the effective annual survival probability for each time period ($\pi_{a[i,t],g[i],t}$) was converted to a periodic survival probability

$$s_{a[i,t],g[i],t} = (\pi_{a[i,t],g[i],t})^T$$

where T is the length of time between trapping sessions expressed as a proportion of a year, and $s_{a[i,t],g[i],t}$ is the probability of survival from trapping session $t-1$ to trapping session t.

The effective annual survival probability was modelled as

$$\text{logit}(\pi_{a[i,t],g[i],t}) = \text{logit}(r_{a[i,t],g[i]}) + b_{C,a[i,t]}C_t + b_{D,a[i,t]}D_t + b_\text{R}R_t + \xi_t,$$

where C_t is the cat index for period t, D_t is the dog index for period t, R_t is the rainfall variable for period t, $b_{C,a[i,t]}$, $b_{D,a[i,t]}$ and b_R are the respective regression coefficients, and ξ_t is a random effect to allow for extra variation in survival among time periods. Note that the effects of cats and dogs varied with size of the wallabies. So too was the base survival probability $r_{a[i,t],g[i]}$, which also varied with sex. The different values for ξ_t was assumed to be drawn from a normal distribution with a mean of zero and a standard deviation (σ_s) that was estimated.

The statistical analysis of the mark-recapture model was conducted in OpenBUGS in a Bayesian framework using Markov chain Monte Carlo (MCMC) methods. This approach was chosen to allow flexibility in how the model was constructed. Flat prior distributions for the various parameters were chosen to ensure that the results were driven by the data rather than the priors. In particular, priors for regression coefficients were normal distributions with mean of zero and standard deviation of 1000, priors for probabilities (e.g., $d_{a,g}$) were uniform between zero and one, and priors for standard deviations were uniform between zero and 100. Samples from the posterior distributions were obtained by sampling from three different Markov chains after discarding the first 5000 MCMC samples of each as a burn-in and retaining the subsequent 20,000 samples of each. This burn-in and sampling were sufficient for the chains to converge and achieve good mixing of the samples. The indices of cat and dog activity were not available for the final BNTW trapping period, so this missing data point was included in the mark-recapture model by drawing the values from lognormal distributions, the means and standard deviations of which were estimated from the previous periods.