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Corresponding R scripts and data can be found at https://github.com/erwhite1/BodiePikaMetapop

Appendix S2 Estimation of weaning mortality and disperser mortality probabilities

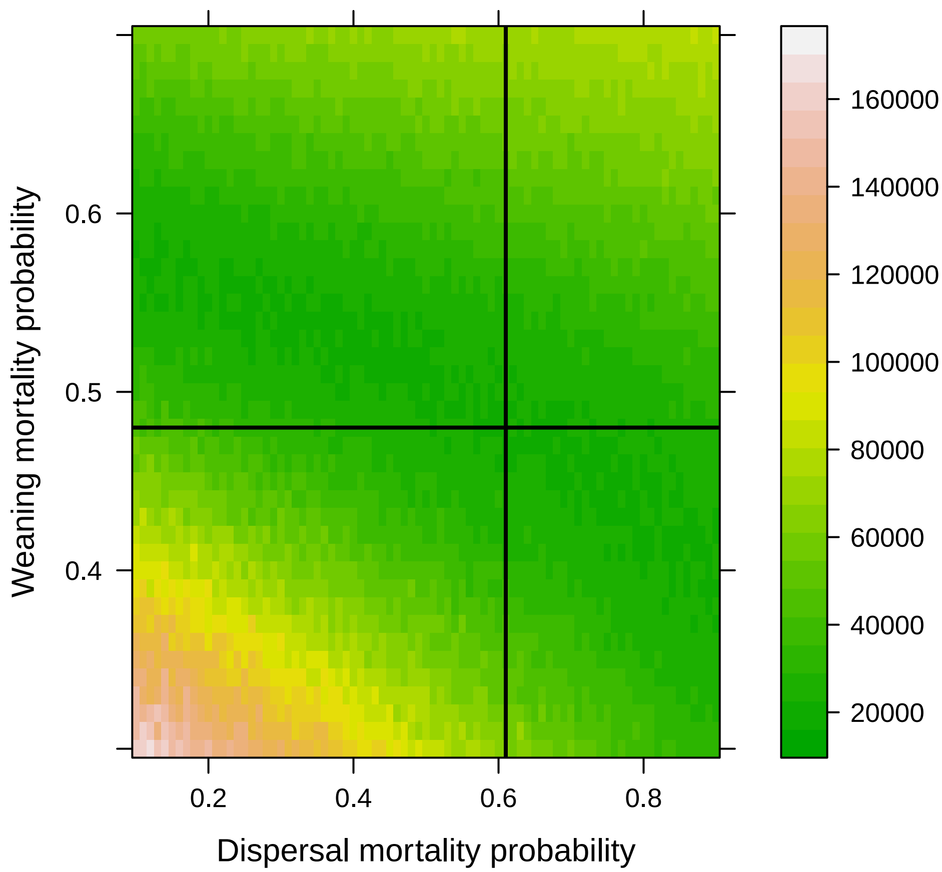

Figure S1: Mean squared error versus dispersal mortality probability and weaning mortality probability for default parameter values (see main text). The color indicates the mean squared error of simulated abundances compared to the field census. The intersection of the vertical and horizontal lines indicate the combination of weaning and dispersal mortality probabilities with the lowest mean squared error.

Although the importance of the cost of dispersal in driving dynamics at Bodie has been noted by several authors (Smith 1974, Peacock and Smith 1997, Smith and Nagy 2015), we still do not have a good field estimate of the parameter. During dispersal, juvenile pikas are often chased off patches by established adults, killed by predators, and have to endure high summer temperatures (Smith 1974, Peacock and Smith 1997, Smith and Nagy 2015).

We used our simulation model and an inverse pattern-orientated approach to estimate disperser mortality probability and the probability of mortality during weaning (Hartig et al. 2011, White et al. 2014). Essentially, we ran our simulation model with different combinations of dispersal mortality probabilities and weaning mortality probabilities. We then compared model outputs to census data. Here is a more detailed explanation of our approach:

1. We initialized our model with census data from the year 1991 and the other parameter values we have estimated in the field. We initialized the model with 1991 census data because the period between 1991 and 2010 is the most continuous set of census data we have for Bodie.
2. We then ran the model 50 times for each different values of disperser mortality probability and weaning mortality probability.
3. For each parameter combination, we calculated the mean squared difference between the total census size and the total census size predicted by our model for the subset of census years from 1991 to 2010.
4. Our estimated disperser mortality probability and weaning mortality probability are the values that minimized this mean squared difference (see Fig. S1).
5. We then used these probability estimates in the model with initial conditions from the year 1972 throughout our paper.

We found that a disperser mortality probability of 0.61 and a weaning mortality probability of 0.48 minimized the mean squared error between our predicted total population size and the census data. The high weaning mortality probability falls in line with past work (Smith 1974). He determined a first-year mortality rate (which combines weaning mortality and over-winter mortality) of 0.889 (Smith 1974).

Our approach assumes that these mortality probabilities are constant through time and space. It is possible that dispersal mortality rate has increased or fluctuated over time. While individual patch extirpations in the south did not appear related to increasing temperatures, the inability of pikas to disperse from the populated northern constellation of ore dumps to the south in recent years may have been due to documented global warming at Bodie (Smith and Nagy 2015).

References

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