Ecography

ECOG-01364
Walter, J. A., Johnson, D. M., Tobin, P. C. and Haynes, K. J. 2015. Topographic microclimates drive microhabitat associations at the range margin of a butterfly. – Ecography doi: 10.1111/ecog.01364

Supplementary material

Appendix 1: Sensitivity to dispersal parameters

We performed additional simulations to investigate how varying short and long-distance dispersal parameters affects invasion pulses. *Sr* and *Lr* correspond to the probability of short and long distance dispersal occurring. The proportion of the population dispersing to a different location is controlled by p_{sr} and p_{lr} for short and long-distance dispersal, respectively, and *Ld* affects the distance of long-distance dispersal. The parameter values presented in the manuscript were: $Sr = 0.1$, $p_{sr} = 0.01$, $Lr = 0.01$, $p_{lr} = 0.1$, and $Ld = 15$. Here we present two cases, a 6-year ($P = 0.16$) and a 10-year ($P = 0.85$) population cycle, both with normal cycle strength ($\lambda = 76.4$). As in the manuscript, simulations were run for 250 years with 150 years of run-up time and all figures represent the average (with 95% confidence intervals) global wavelet spectra from 100 model iterations.

In general, varying dispersal parameters did not affect the period lengths at which invasion pulses occurred (Figures A1, A2). Thus, these properties appear to be a consequence of population fluctuations alone. However, the magnitude of peaks in wavelet power indicating pulsed invasion behavior were sensitive to the probability of long-distance dispersal (*Lr*), and somewhat less so to the proportion of the source population dispersing (p_{lr}) with wavelet power of invasion pulses at the full population cycle length declining as *Lr* and p_{lr} increased. At the same time, the magnitude of a peak at ≈2 years increased, possibly reflecting the increased influence of stochasticity when long-distance dispersal occurred more commonly. This was particularly apparent for the 6-year population cycle length (Figure A1). Varying short-distance dispersal parameters had no significant impact on model results.

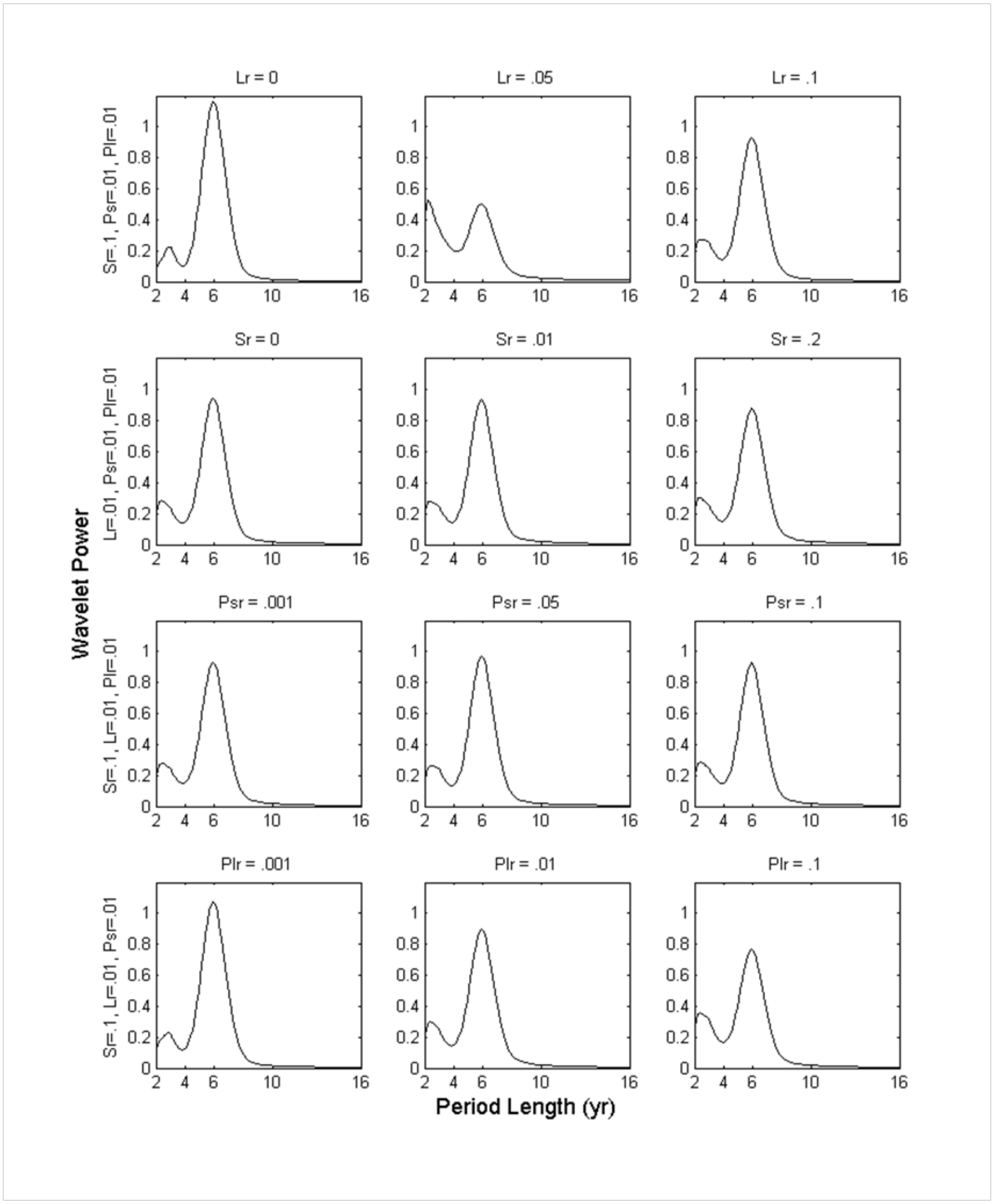

Figure A1: Averaged global wavelet spectra of invasion rate where $\lambda = 74.6$ and $P = 0.16$ (6-year period, normal cycle strength), showing effects of variation in *Lr*, *Sr*, p_{sr}, and p_{lr}. All rows have 3 parameters held constant, which are indicated by the *y*-axis labels, and the plot title indicates the varied parameter. The *y*-axes scale is wavelet power. For reference, parameter values in the center plot in the bottom row are those presented in the main manuscript.

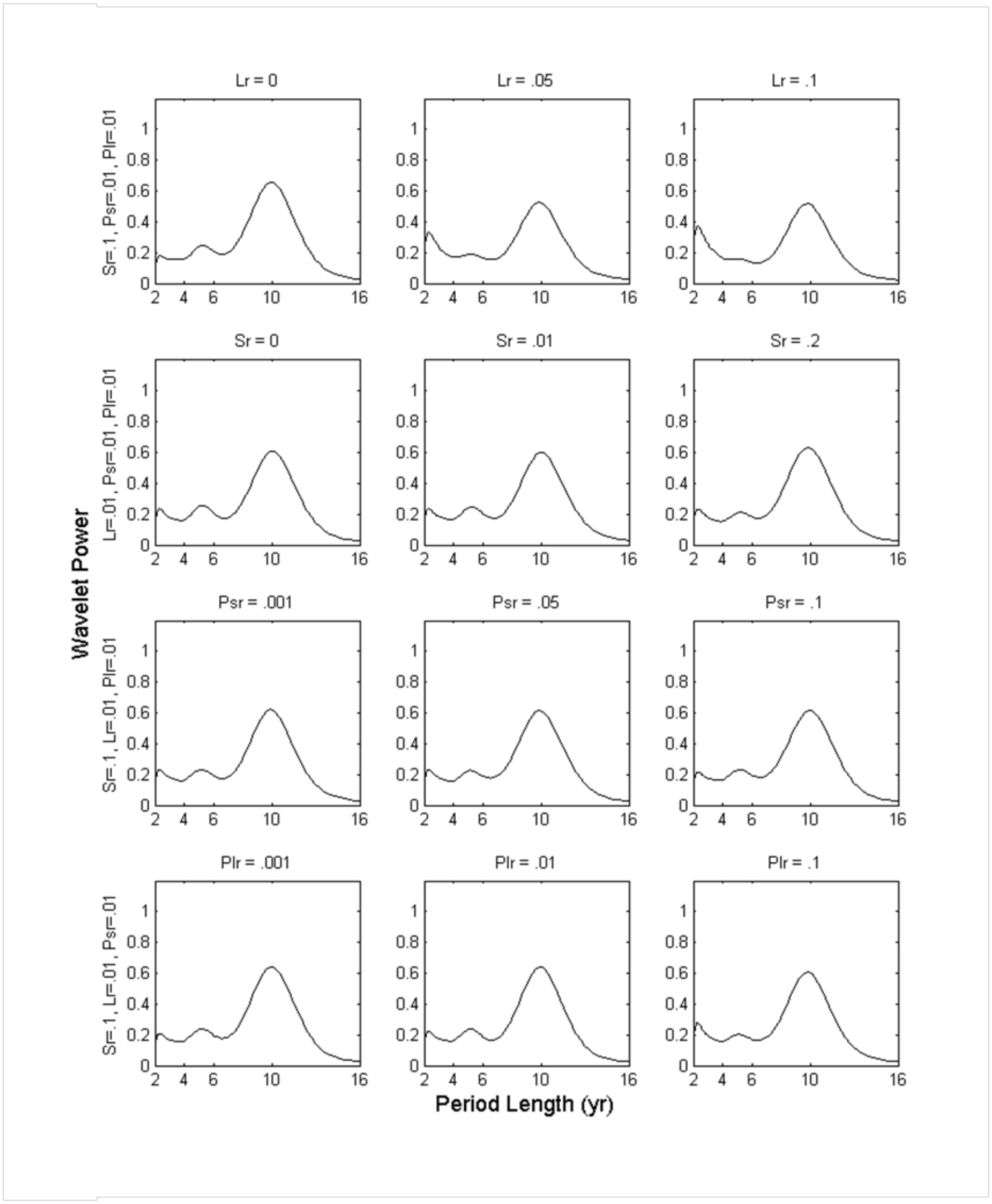

Figure A2: Averaged global wavelet spectra of invasion rate for a population with $\lambda = 74.6$ and $P = .85$ (10-year period, normal cycle strength) showing effects of variation in *Lr*, *Sr*, p_{sr}, and p_{lr}. All rows have 3 parameters held constant, which are indicated by the *y*-axis labels, and the plot title indicates the varied parameter. The *y*-axes scale is wavelet power. For reference, parameter values in the center plot in the 3rd row from the top are those presented in the main manuscript.

Appendix 2: Sensitivity to range boundary threshold density

We assessed the sensitivity of our results to variability in the population density threshold defining the range boundary. In the model, gypsy moth population densities fluctuated over 4 orders of magnitude, with the order of magnitude of population density at the nadir of population cycles declining from 10^{-5} to 10^{-7} as predator density, P, increased. We examined periodic fluctuations in the location of the range boundary when the range boundary was set at 10^{-5}, 10^{-6}, 10^{-7}, 10^{-8}, and 10^{-9} (Figure A1). The intrinsic rate of increase, λ, was set to 74.6 and we varied P to cause the population to cycle with 6, 8, 10, and 12 year periods. The population density defining the range boundary affected the detected periodicity in invasion pulses when it exceeded the density at the nadir of population cycles. In these cases, the period length at which wavelet power peaked tended to be shifted toward shorter period lengths (Figure A3).

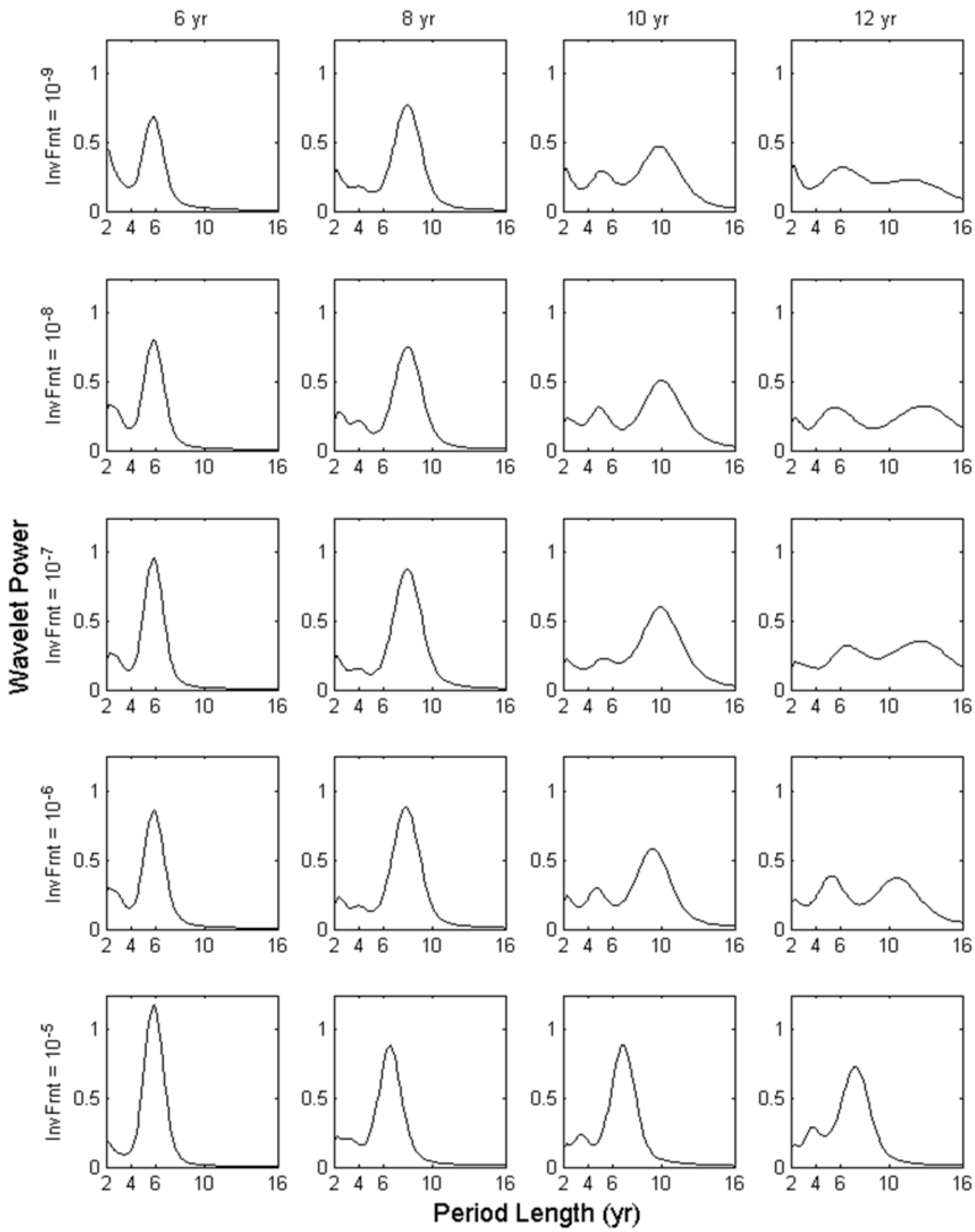

Figure A3: Sensitivity of model results to the choice of population density threshold defining the range boundary. Columns have common period length; rows have common range boundary threshold.