Predicting how climate change will affect how and where terrestrial mammals will move in British Columbia, Canada

Appendix

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1 Directed Acyclical Graphs

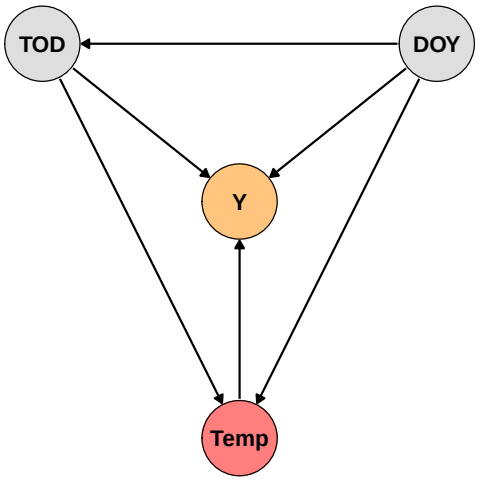

Figure S1: Directed Acyclical Graph assumed for inferring the causal effects of temperature (Temp) on probability of moving, speed when moving, or distance traveled (Y) while accounting for the effects of time of day (TOD), day of year (DOY), and their interaction effects. Temperature directly affects Y, but the effects of temperature depend on the time of day and season. Time of day and day of year also affect Y directly, but the effect of time of day changes throughout the year due to changes in day length and seasonality.

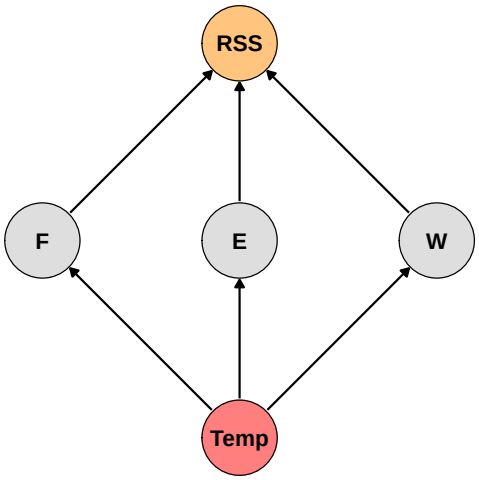

Figure S2: Directed Acyclical Graph assumed for inferring the causal effects of temperature (Temp) on Relative Selection Strength (RSS) for percent forest cover (F), elevation (E), and distance from water (W). The RSS for of a given habitat depends on all three resources, and the selection for each resource is independent of the other two resources and dependent on temperature.

2 Effects of temperature on movement rates

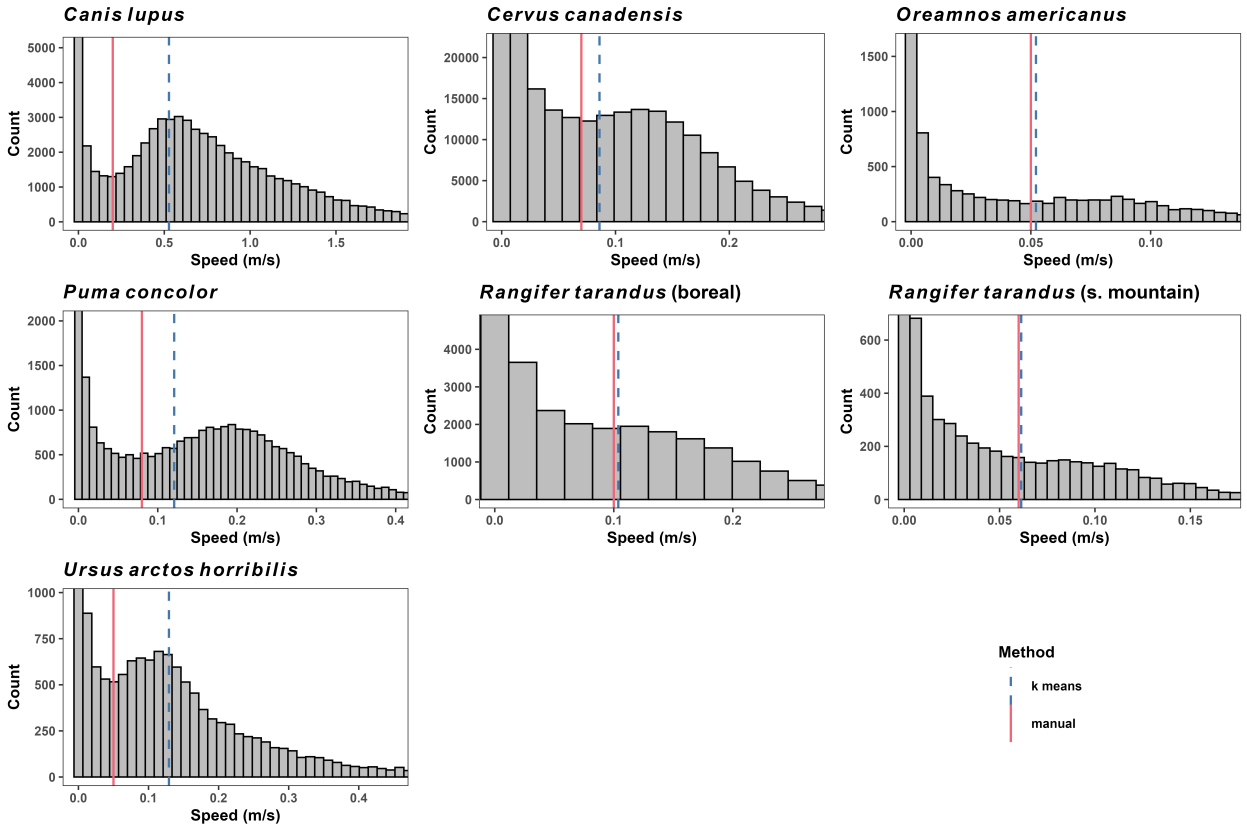

Figure S3: Histograms of each species' estimated speed. Continuous red lines indicate the values used to determine whether an animal was moving or not, which were determined visually using the inflection points of the histograms. Dashed blue lines indicate the minimum speed corresponding to a moving animal as determined by k-means algorithms with 2 clusters. For ease of readability, the x axes range from 0 the 0.99 quantile, while the y axes range from 0 to one fortieth of the total number of estimates.

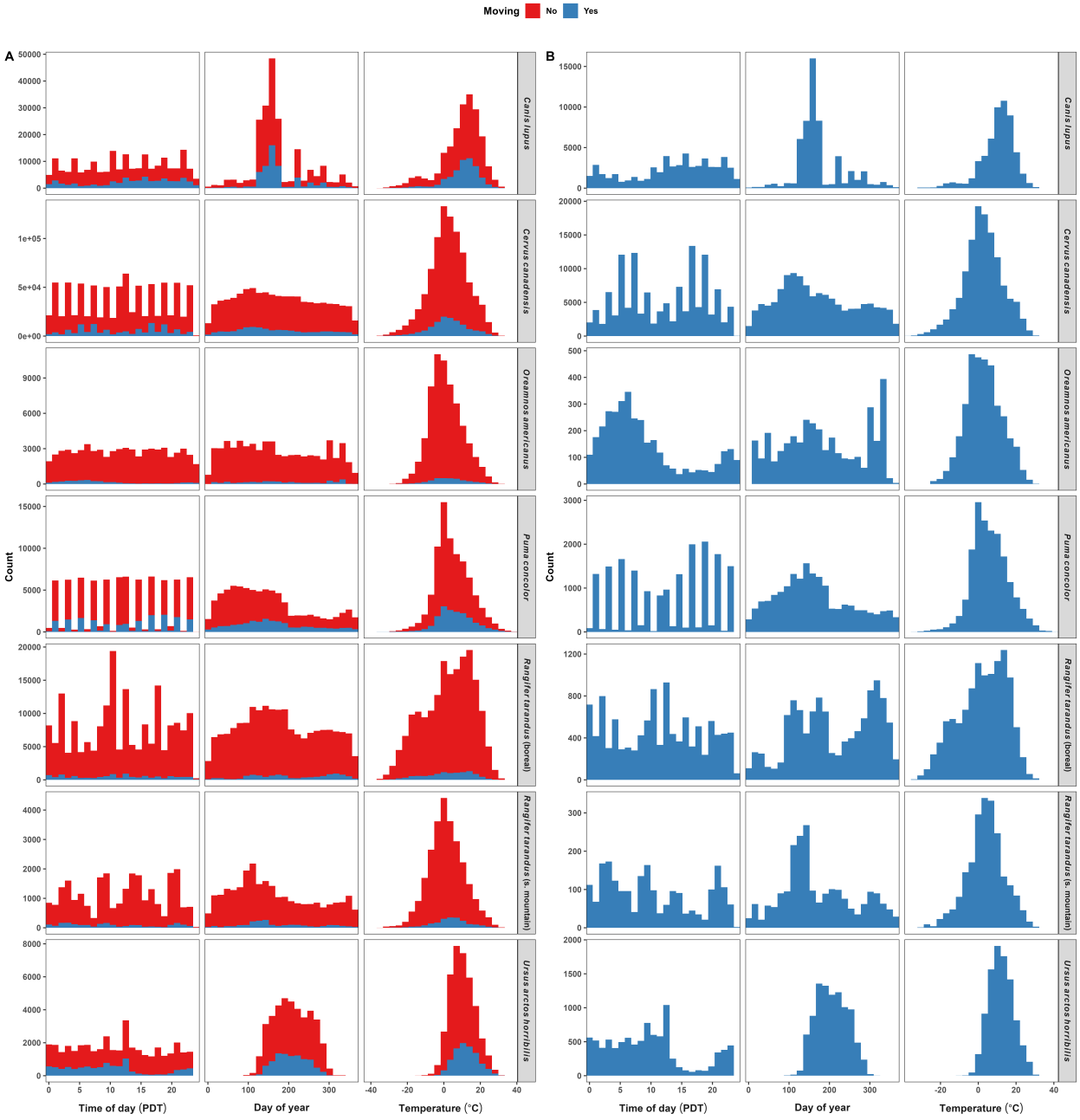

Figure S4: Histograms of the number of states (**A**) and speed estimates (**B**) over time of day (Pacific Daylight Time, PDT), day of year (Julian date), and air temperature.

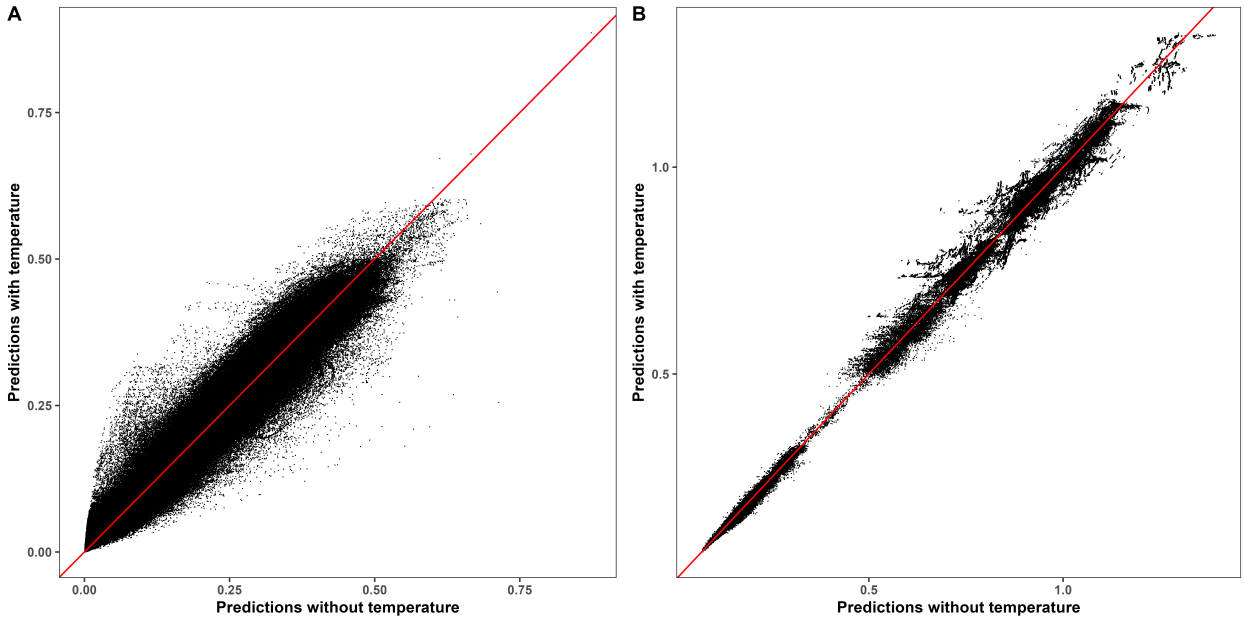

Figure S5: Scatterplot of the fitted values from the HGAMs with and without including temperature for the probability of movement (**A**) and speed when moving (**B**).

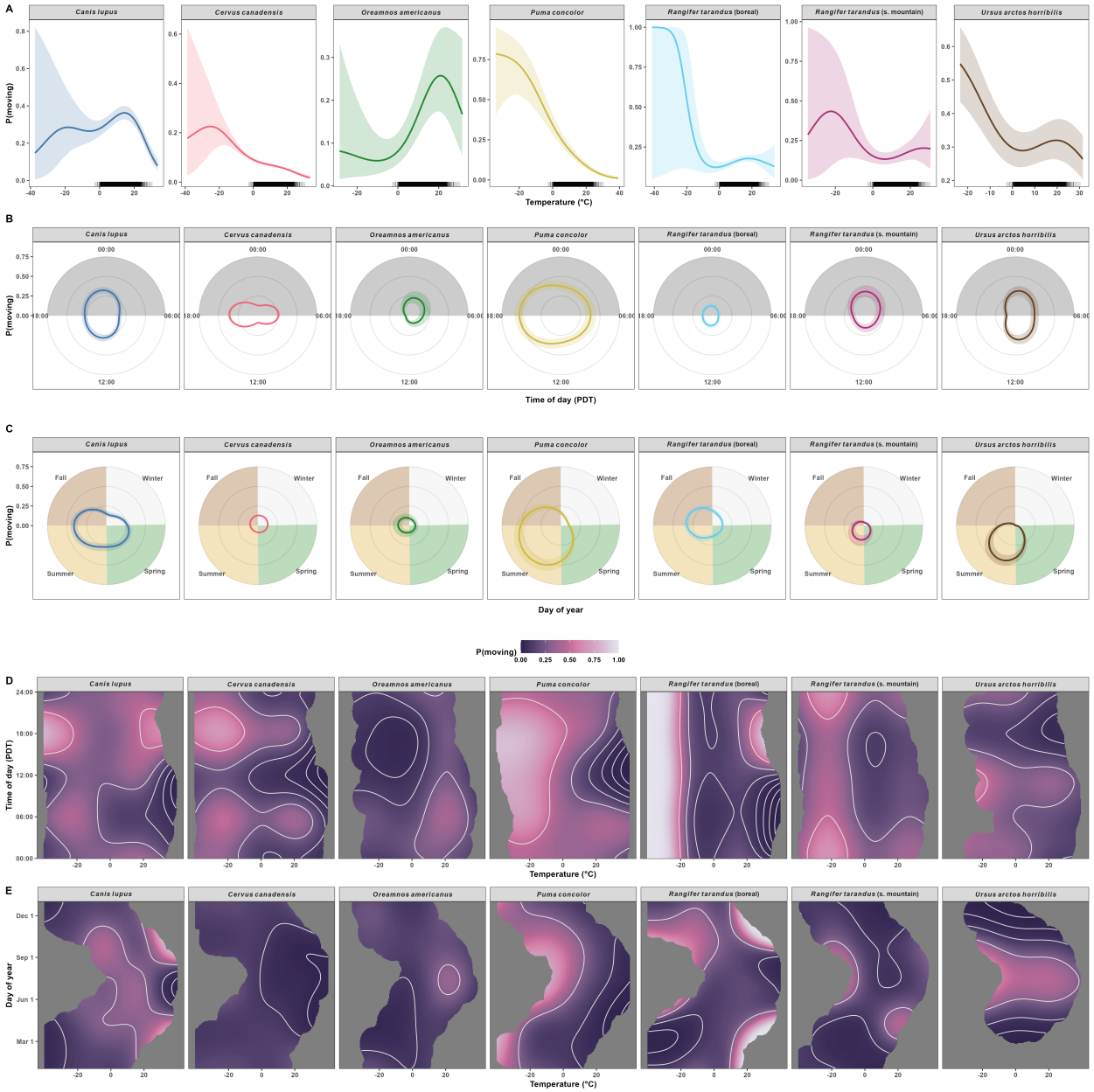

Figure S6: **A.** Estimated effects of temperature on each species' probability of moving on June 1st at 12:00, Pacific Daylight Time (PDT). The rug plot indicates each species' data on June 1st. **B.** Estimated effects of time of day on each species' probability of moving on June 1st at 0°C. The grey area indicates evening and night (hours between 18:00 and 6:00). **C.** Estimated effects of day of year on each species' probability of moving at 12:00 with a temperature of 0°C. The year is divided into the four seasons: winter (white), spring (green), summer (gold), and fall (brown). In panels A-C, ribbons indicate 95% Bayesian Credible Intervals, and the sampling rate was post-stratified to $\Delta t = 1$ hour for all species. **D.** Effects of time of day and temperature on species' probability of moving on June 1st at 12:00 PDT. **E.** Effects of day of year and temperature on species' probability of moving at 12:00 PDT. Surfaces in panels D and E extend to 10% of the range away from each datum.

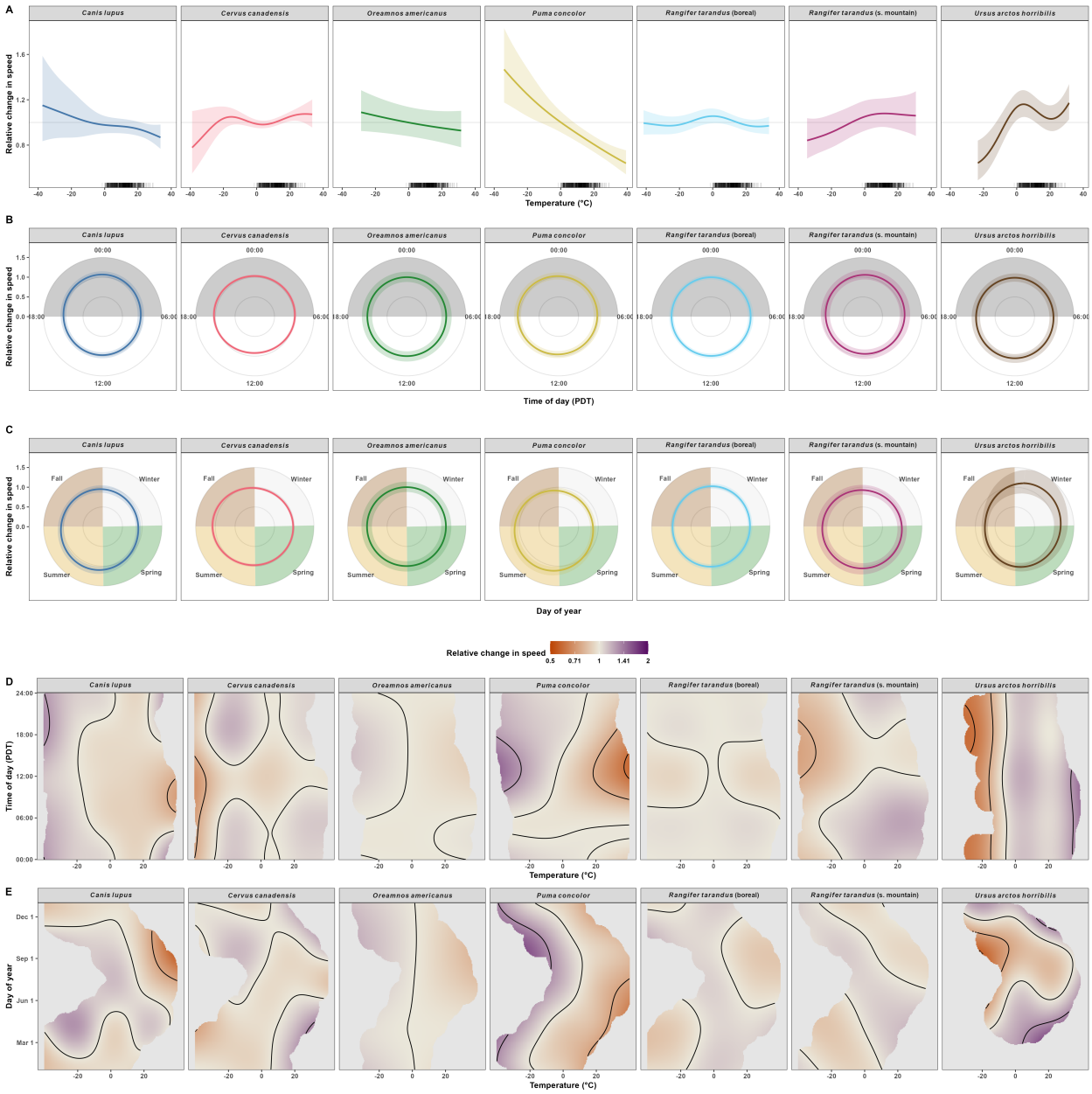

Figure S7: **A.** Estimated effects of temperature on each species' speed when moving on June 1st at 12:00, Pacific Daylight Time (PDT). The rug plot indicates each species' data points where an animal was moving on June 1st. **B.** Estimated effects of time of day on each species' speed when moving on June 1st at 0°C. The grey area indicates evening and night (hours between 18:00 and 6:00). **C.** Estimated effects of day of year on each species' speed when moving at 12:00 with a temperature of 0°C. The year is divided into the four seasons: winter (white), spring (green), summer (gold), and fall (brown). In panels A-C, ribbons indicate 95% Bayesian Credible Intervals, and the sampling rate was post-stratified to $\Delta t = 1$ hour for all species. **D.** Effects of time of day and temperature on species' speed when moving on June 1st. **E.** Effects of day of year and temperature on species' speed when moving, if the animal was moving at 12:00 PM PDT. Surfaces extend to 10% of the range away from each datum. The color bar is on the $\log_2$ scale to help visualize patterns in doubling.

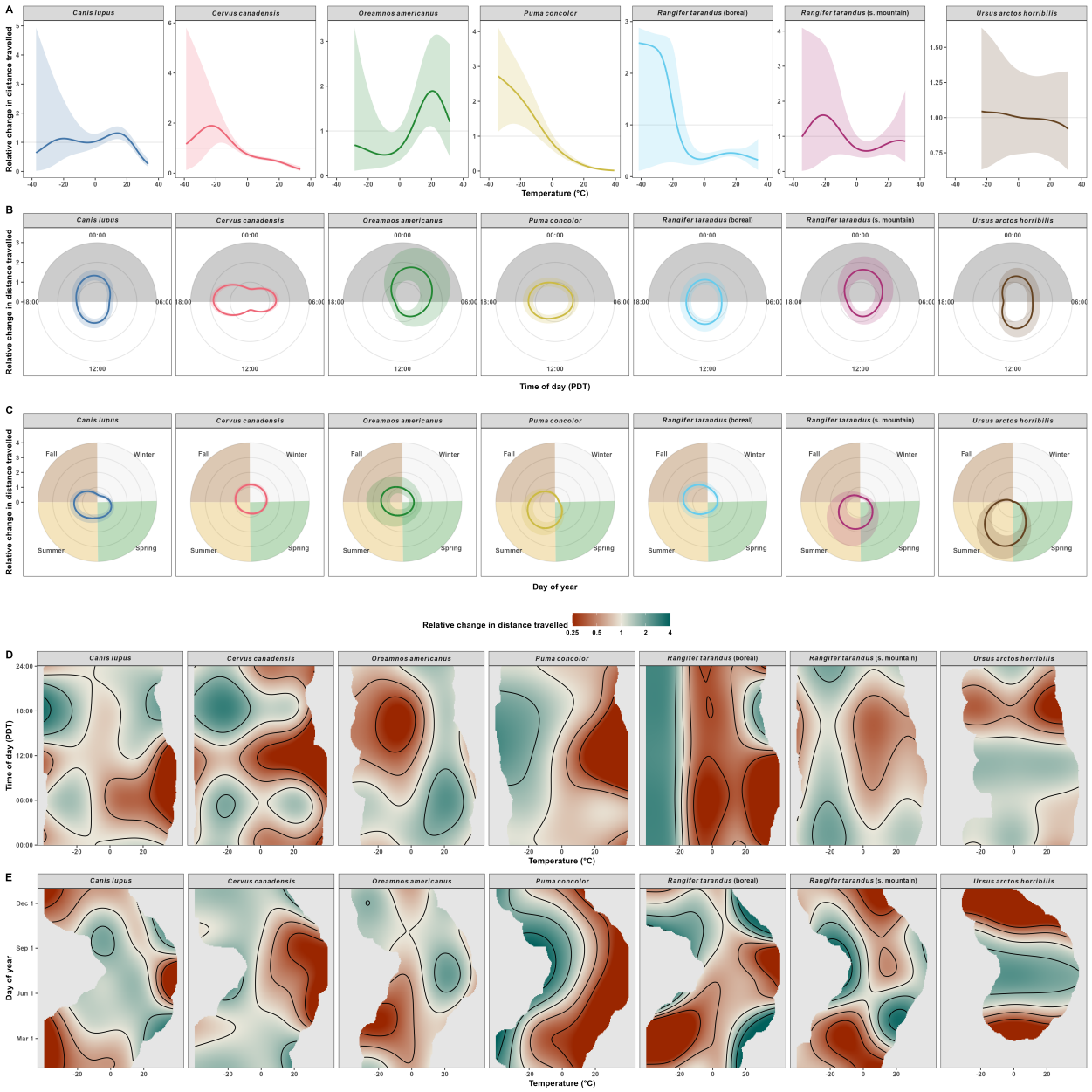

Figure S8: **A.** Estimated effects of temperature on each species' distance traveled on June 1st at 12:00, Pacific Daylight Time (PDT). The rug plot indicates each species' data points where an animal was moving on June 1st. **B.** Estimated effects of time of day on each species' distance traveled on June 1st at 0°C. The grey area indicates evening and night (hours between 18:00 and 6:00). **C.** Estimated effects of day of year on each species' distance traveled at 12:00 with a temperature of 0°C. The year is divided into the four seasons: winter (white), spring (green), summer (gold), and fall (brown). In panels A-C, ribbons indicate 95% Bayesian Credible Intervals, and the sampling rate was post-stratified to $\Delta t = 1$ hour for all species. **D.** Effects of time of day and temperature on species' distance traveled on June 1st at 12:00 PDT. **E.** Effects of day of year and temperature on species' distance traveled at 12:00 PDT. Surfaces extend to 10% of the range away from each datum. The color bar is on the $\log_2$ scale to help visualize patterns in doubling.

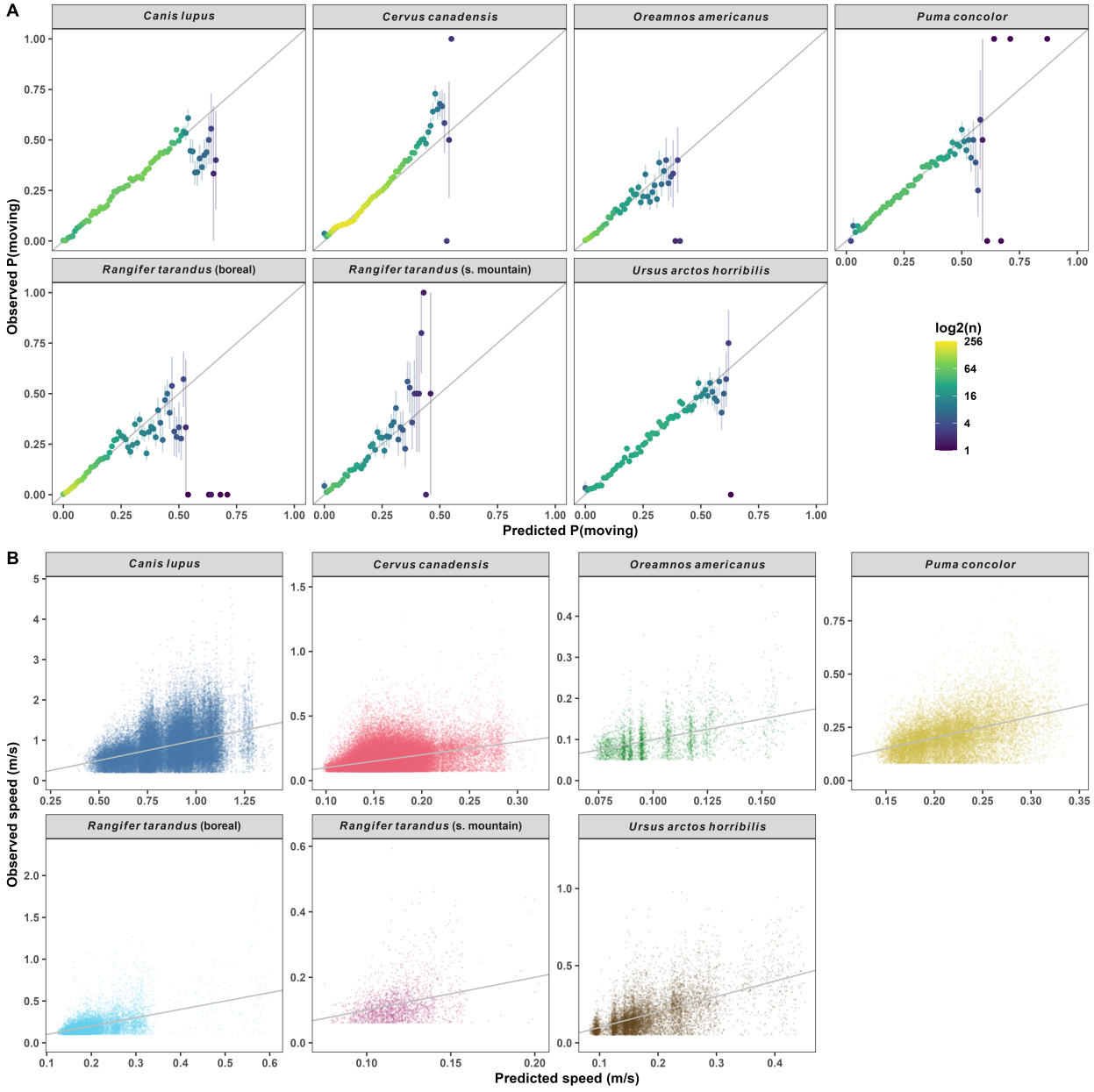

Figure S9: Relationsips between the observed and predicted values for probability of movement (**A**) and speed given that an animal was moving (**B**). The color in panel **A** indicates the number of points used to calculate the estimate (on the $\log -2$ scale), while the grey lines in both panels indicate perfect prediction (i.e., the 1:1 line).

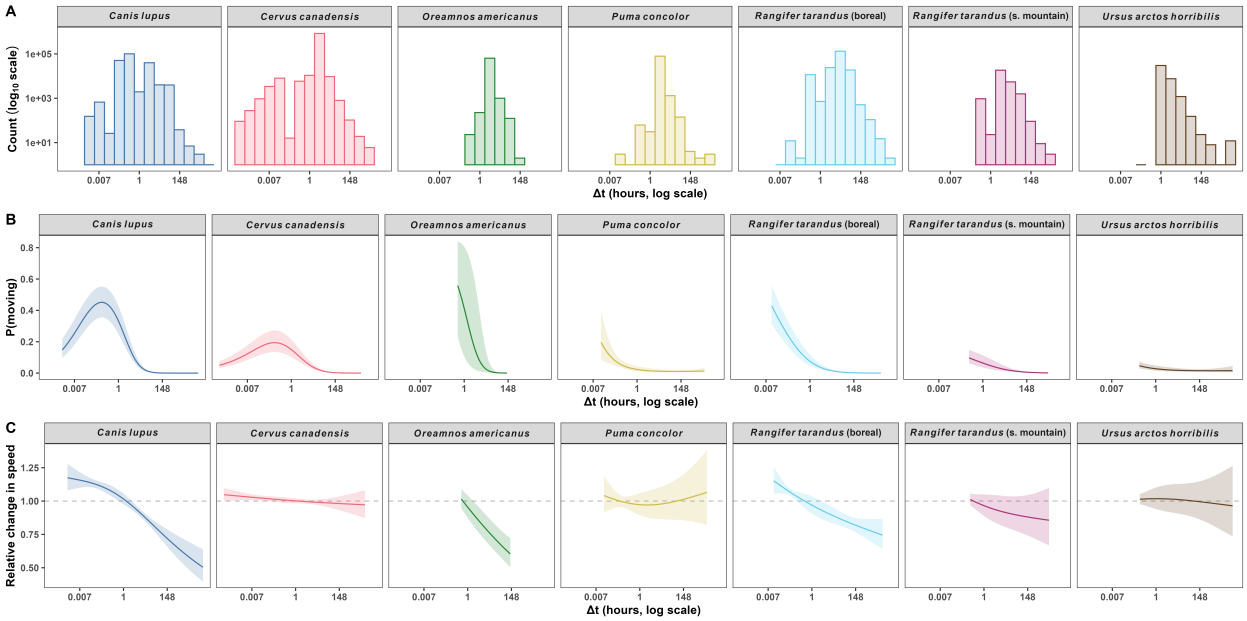

Figure S10: **A.** Histograms of sampling intervals between GPS locations, with counts on a $\log_{10}$ axis for ease of readability. **B.** Species-level smooth effects of sampling interval on the estimated probability of the animal moving. **C.** Species-level estimated smooth effects of sampling interval on an animal's speed when moving. All x axes are on the natural logarithm scale.

3 Effects of temperature on habitat selection

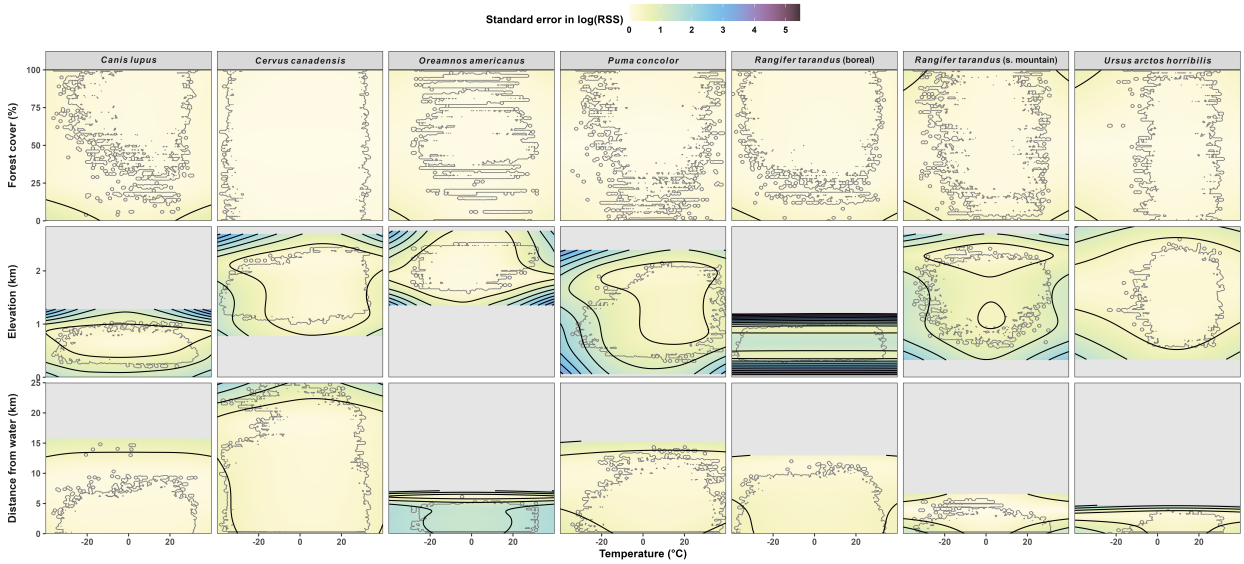

Figure S11: Estimated standard error in the relative selection strength (RSS) for forest cover (%), elevation (km), and distance from water (km) as a function of temperature (see Fig. 3 in the main text). The grey contours indicate the extent of each speices' observed locations.