*Data Analysis*

Activity since sunrise Response Models

I analyzed the relationship between time since sunrise, temperature, relative humidity and beep counts using generalized additive mixed models (GAMMs). In this method, both time since sunrise and each individual are treated as independent variables. The general formula was as follows:

where is beep count and is the intercept. I also used a penalized thin plate regression spline that estimated using the function

Where is the function the model tries to fit, is the best estimate of , is the control parameter for the amount of variation in the regression line, and is the constraint constant (Woods, 2003). The latter two represent the penalty term (Woods, 2003, 2006 in-depth explanations and derivations). I also built separate GAMMs for each individual to look more closely at between-individual variation.

Individual GAMMs included one smoothing term using a penalized thin plate regression spline (slightly more linear compared to bs=”cs” [cubic regression]), where is individual activity:

Chart

Description automatically generated

Figure : Beep counts of all individual vs time since sunrise from January 22-March 28, 2021 in Oklahoma. Generalized additive mixed models using an identity-link function and thin plate regression splines were fit for each individual bird to understand the extent of individual variation within the population

Chart, histogram

Description automatically generated

Figure : Beep counts of all individual vs air temperature from January 22-March 28, 2021 in Oklahoma. Generalized additive mixed models using an identity-link function and thin plate regression splines were fit for each individual bird to understand the extent of individual variation within the population

Chart, line chart

Description automatically generated

Figure : Beep counts of all individual vs relative humidity from January 22-March 28, 2021 in Oklahoma. Generalized additive mixed models using an identity-link function and thin plate regression splines were fit for each individual bird to understand the extent of individual variation within the population

GAMM showed a statistically significant positive relationship between beep count (activity) and time since sunrise, temperature, relative humidity and TagId (p <2.22e-16, standard error = 9.72, t value = 11.647)

I analyzed the relationship between mean overnight temperature, mean overnight relative humidity and beep counts using generalized additive mixed models (GAMMs).

Chart, line chart

Description automatically generated

Figure : Beep counts of all individual vs mean overnight temperature from January 22-March 28, 2021 in Oklahoma. Generalized additive mixed models using an identity-link function and thin plate regression splines were fit for each individual bird to understand the extent of individual variation within the population

Chart, line chart

Description automatically generated

Figure : Beep counts of all individual vs mean overnight relative humidity from January 22-March 28, 2021 in Oklahoma. Generalized additive mixed models using an identity-link function and thin plate regression splines were fit for each individual bird to understand the extent of individual variation within the population

GAMM showed a statistically significant positive relationship between beep count (activity) and mean overnight temperature (p = 0.015, adjusted R-sq = 0.29) and positive significant relationship between beep count and mean overnight relative humidity (p= 0.01, adjusted R-sq = 0.29).