"How does tree girth and time period influence budburst in Quercus Robur, accounting for variability across differing sampling locations?"

Hypothesis(es):

In *Quercus Robur:*

- Change in tree girth will affect the advent of budburst timing in the year

- There is a difference in budburst timing between tree measurement periods (2007-2015 and 2016-2018)

Data Wrangling in R (version 4.3.3, 2024-02-29)

The phenology and trees CSV files were merged by TreeIDs of *Quercus robur*, excluding rows with NAs. Dates were converted to Julian days, and budburst scores were defined as < 2 or 2 (none recorded in 2019). The `girth.csv` file was then merged, duplicating rows as necessary based on matching TreeIDs and years. Stratified sampling selected one TreeID per period, reflecting the `girth.csv` sampling method, with a random seed set for reproducibility (`set.seed(123456)`).

Statistical Analyses

data from 2405 observations of budburst events in *Quercus robur* were analysed using a linear mixed effects model to observe the effects of tree girth (CM) and measurement period on the timing of budburst (in Julian days). In the model, tree girth was measured as a continuous fixed effect and period as a categorical fixed effect. Accounting for potential variation across different sampling locations, measurement location was also included as a random effect. TreeID was initially also considered as a random effect however was removed from the final model due to lack of variability in the samples and multicollinearity.

Results

Descriptive Statistics

In a dataset of 2405 observations of budburst recordings containing 2146 individual treeIDs which were sampled within 33 unique locations. 2092 observations were recorded in period 1 (2007-2015) and 313 in period 2 (2016 - 2018). The model revealed a significant negative effect of tree girth on Julian day. It also showed a significant difference in budburst timing between periods 1 and 2 aswell as location having an effect on variation in days until budburst.

Main Result(s)

- For every for every centimeter of growth in girth per tree, budburst occured 0.0223 days sooner in the year ($\beta = -0.02284$, $SE = 0.002684$, $t = -8.509$, $p < 0.001$).

- Budburst occured in trees recorded between 2007-2015 on average 1.44 days later than trees recorded during 2016-2019 ($\beta = 1.441$, $SE = 0.5984$, $t = 2.407$, $p = 0.0161$).

- The random effect of location accounted for approximately 2.91% of the total variation in days until budburst.

The results confirm our hypotheses that both tree girth and measurement period have an effect on time at which budburst occurs in the year.

Table and Figure

Fixed Effects		
Coefficient	**Estimate $\pm$ SE**	**t-value**
Intercept	109.80 $\pm$ 0.53	205.56
Girth (cm)	-0.02284 $\pm$ 0.00268	-8.509
2016-2018 compared to 2007-2015	1.44 $\pm$ 0.59	2.365
Random Effects		
Location	2.701	
Residual	90.12	

Table 1: Coefficients from the linear mixed model examining the relationship between Julian days until budburst with tree girth and measurement period. Coefficients are presented alongside their standard errors. The random intercept for Location accounted for variability attributed to the Location of TreeID. Significance was assumed when $t < -1.96$ or $t > 1.96$.
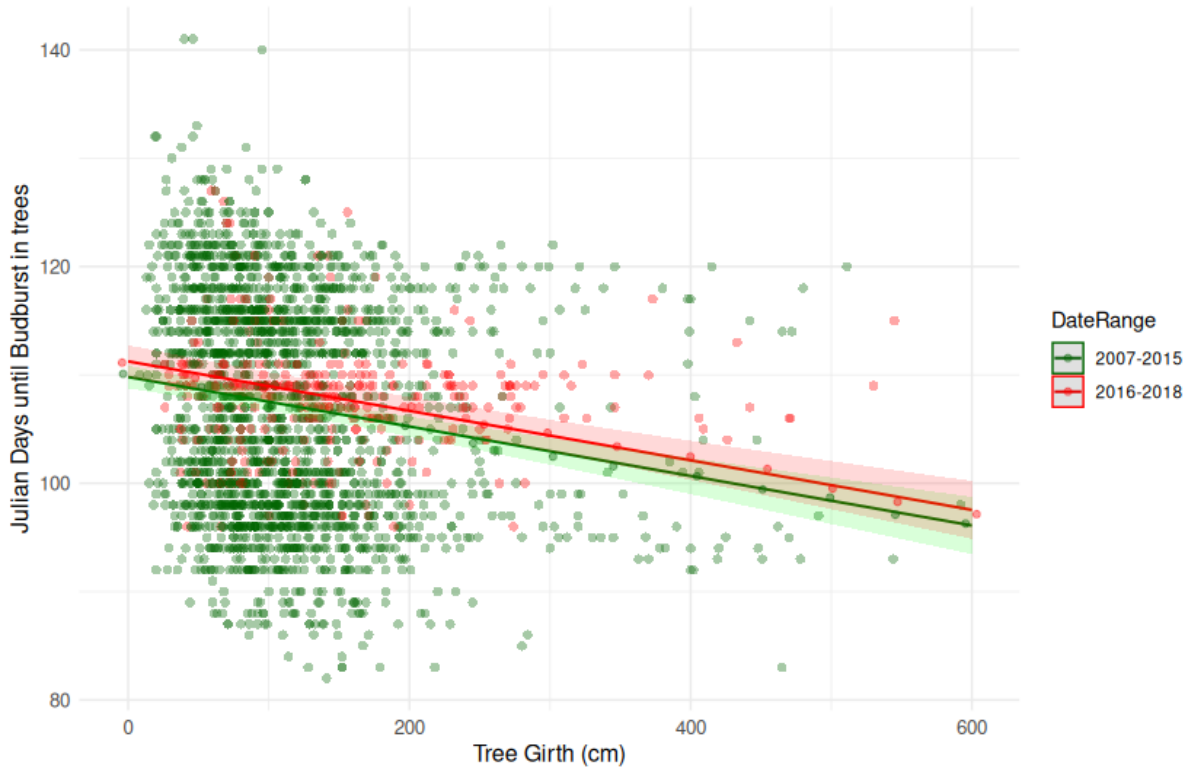

Figure 1: The relationship between time until budburst from the beginning of the year (measured in Julian days) and tree girth of *Quercus robur*. Measurements are categorised by time period within which it took place (green: 2007-2015, red: 2016-2018). Regression lines with 95% confidence intervals are plotted according to the linear mixed model coefficients from Table 1.