**Group K Final Report**

**Abstract**

Territory acquisition is critical for juvenile North American red squirrels (*Tamiasciurus hudsonicus*), providing resources essential for survival and fitness. This study investigates the effects of sex and ecological factors, such as predator abundance, birth timing, and food availability, on territory acquisition. Logistic regression and Lasso regression were used to evaluate predictors and their relative importance. We found that females were significantly more likely to acquire territories than males, although standardized birth date (Std.BD) emerged as the strongest predictor. Late-born juveniles had a reduced likelihood of acquiring territories, showing the competitive advantage of early birth. Predator-prey dynamics and food abundance also influenced acquisition, with hare abundance positively affecting acquisition, while cone abundance had a modest negative effect. These findings reveal the interplay between individual traits and ecological factors in shaping population fitness, with implications for understanding territorial behaviors in changing environments.

**Introduction**

Territory acquisition is a critical life-history event for many territorial species, including juvenile red squirrels, as it enhances survival by mitigating predator and climate effects (Hendrix et al., 2020). This study analyzes a 27-year (1989-2015) dataset from Yukon, Canada, to examine factors influencing juvenile territory acquisition in May (spring) and August (autumn). Red squirrels cache white spruce (*Picea glauca*) cones to survive winter (Larsen & Boutin, 1994), and face predators like *Lynx canadensis* (Stuart-Smith & Boutin, 1995) and mustelids (Kerr & Descamps, 2011). Acquired territories provide essential resources like food, shelter, and predator protection, thereby enhancing survival and fitness.

We aim to identify factors affecting juvenile red squirrel territory acquisition and its impact on population dynamics. Haines et al. (2022) observed that females allocate most energy during lactation, while males invest in winter and early spring mating seasons. This resource caching influences reproductive timing and reflects sexual selection on behaviors preceding breeding. Based on this, we hypothesize that juvenile males and females differ in their likelihood of acquiring territory, with sex being a key determinant.

Our first prediction is that females are more likely to acquire territory in autumn, aligning with their resource acquisition behaviors for breeding. We also predict that sex has a stronger influence on territory acquisition than other factors, such as growth rate, birth timing, food availability, predator abundance, and temperature. We standardized continuous variables and excluded incomplete data, encoding territory acquisition as a binary outcome. Logistic regression assessed the direct effects of sex, while Lasso regression identified the most influential predictors from the dataset.

By identifying the primary drivers of territory acquisition, this study clarifies the role of sex and ecological factors in shaping survival and fitness, contributing to our understanding of population dynamics in territorial species, with broader implications for managing territorial species in changing environments.

**Methods**
*Data Description*

We analyzed a 27-year dataset of juvenile red squirrels in Yukon, Canada. Variables included sex, birth timing (Std.BD), growth rate (Std.growth), predator indices (Std.lynx, Std.mustelid), prey abundance (Std.hare.fall), food availability (z.cones), and territory acquisition status.

### Data Analysis

Continuous variables were standardized, and missing data were removed to ensure reliability. The `sex` variable, originally recorded as 'M' (male) and 'F' (female), and the `owner`, initially recorded as 'acquired territory' and 'not yet acquired' were converted into binary variables `sex01` (0 = female, 1 = male) and `acquired_terr` (1 = acquired, 0 = not yet acquired) to facilitate analysis in the regression models. Temperature (z.temp) was excluded from the final analysis as it showed minimal effect on territory acquisition in preliminary models.

Logistic regression tested the first prediction, focusing on sex as a predictor. Lasso regression identified the relative importance of all predictors by shrinking less relevant coefficients to zero. To better predict the result of territory acquisition, a logistic model named "model_full_com" was built, which considered the individual effect of sex, Std.BD, Std.growth, and z.cones as well as the combined effect of Std.mustelid, Std.lynx, Std.hare.fall, Std.Cleth, and z.density. The combined effect reveals the interaction among predators and preys, including predation and competition. The Akaike information criterion (AIC) was calculated to evaluate this model.

## Results

Logistic regression revealed that males were significantly less likely to acquire territories than females (coefficient = -0.466, $p < 0.001$). Lasso regression identified standardized birth date (Std.BD) as the strongest predictor (coefficient = -0.756), with late-born juveniles less likely to acquire territories. Sex remained significant (coefficient = -0.509), while hare abundance positively influenced acquisition (coefficient = 0.486), likely due to reduced predation pressure. Cone abundance had a modest negative effect (coefficient = -0.307), suggesting less urgency for territories when resources are plentiful. Predators like mustelids and red-backed voles showed negligible direct effects. The final logistic model achieved the lowest AIC (1462.63), highlighting the importance of combined interactions between prey and predators.

## Discussion

This study underscores the critical role of birth timing and ecological factors in shaping territory acquisition among juvenile red squirrels. Contrary to our prediction, sex was not the most influential factor, with standardized birth date (Std.BD) having the strongest effect. Early-born juveniles had higher acquisition success, reflecting the competitive advantage of earlier access to resources. Females were more likely to acquire territories than males during spring and autumn, likely due to reproductive reliance on cached resources.

Hare abundance positively influenced acquisition, likely by distracting predators, while cone abundance reduced acquisition urgency when food was plentiful. These findings reveal the interplay between individual traits and ecological dynamics in determining population fitness. However, limitations include reliance on data from a single population, which may limit generalizability. Future research should explore broader contexts and experimentally manipulate key variables to clarify causal relationships. Overall, this study highlights the complex interactions shaping territorial behaviors and informs management strategies for territorial species in changing environments.

# References

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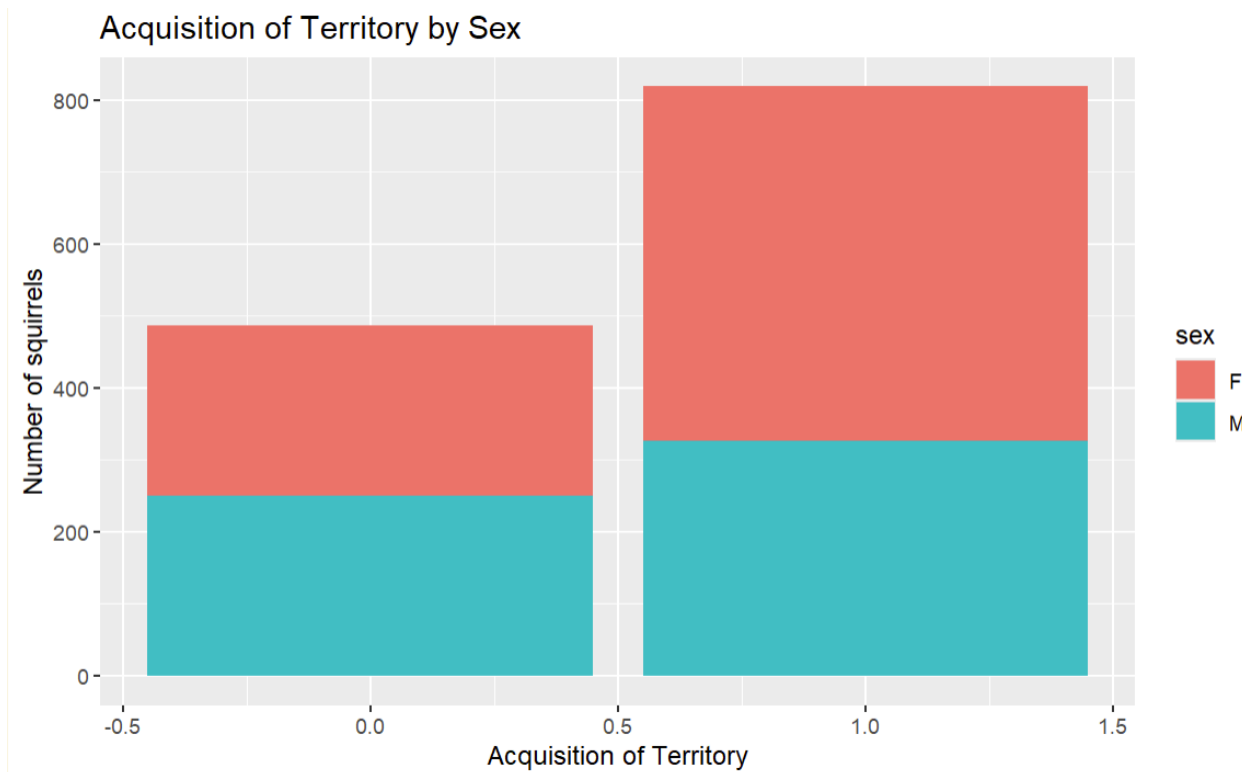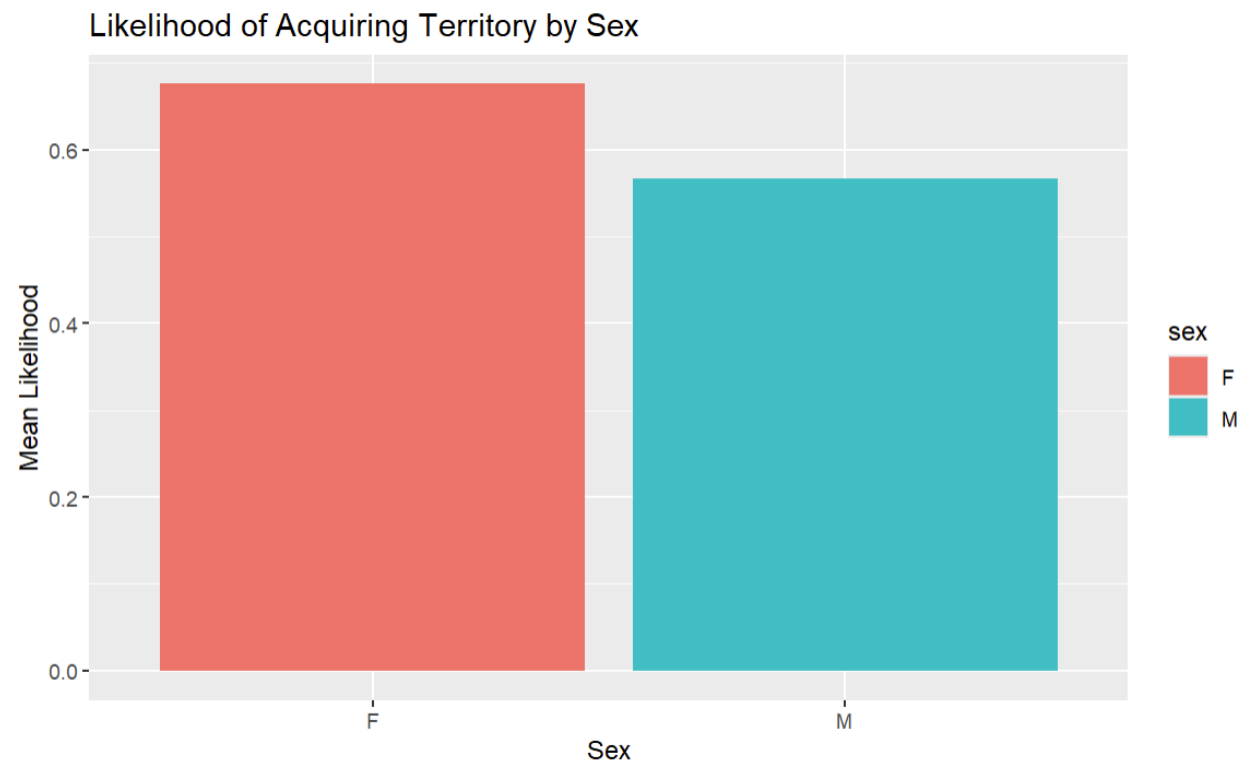
**Appendix**



Figure 1.1: Acquisition of Territory by Sex



Figure 1.2: Likelihood of Acquiring Territory by Sex
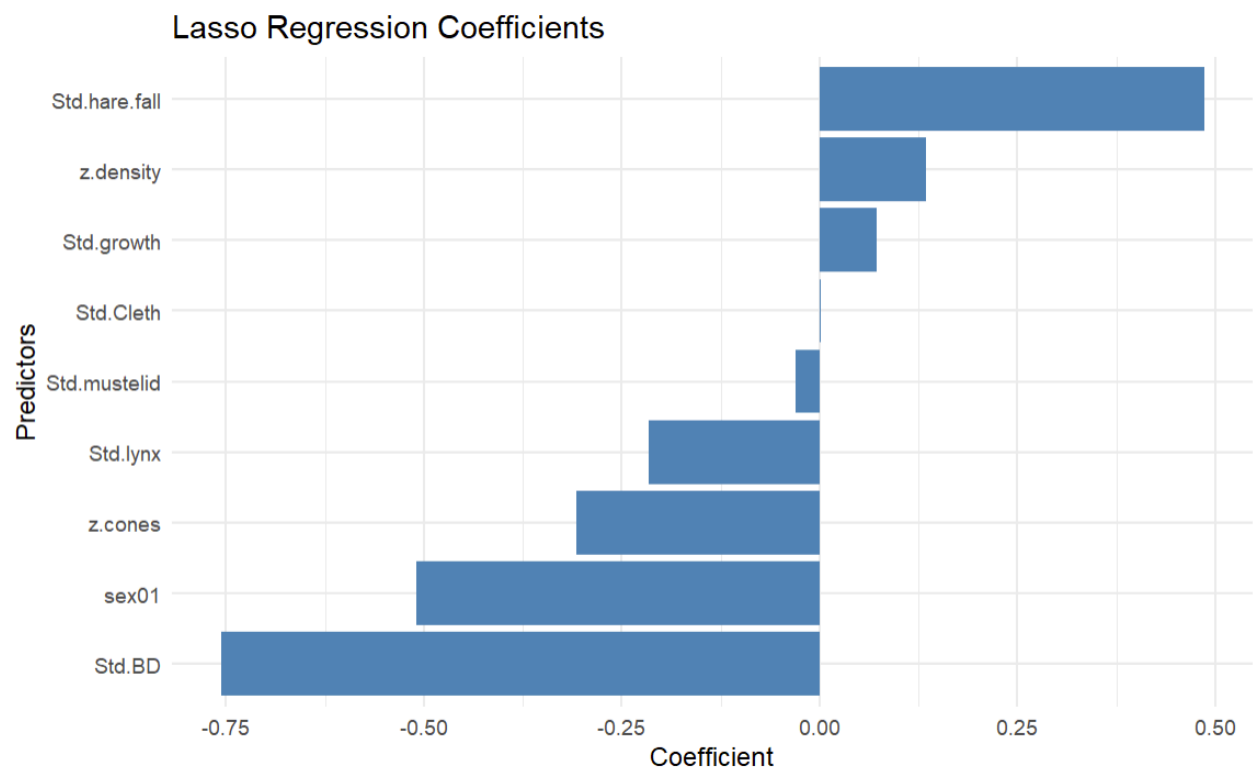
Figure 2.1: Lasso Regression Coefficients of Each Predictor

| | Model <chr> | AIC <dbl> |
|---|---|---|
| 1 | Full Combined model | 1462.633 |
| 2 | Full model | 1512.747 |
| 3 | Combined_effect_model | 1617.405 |

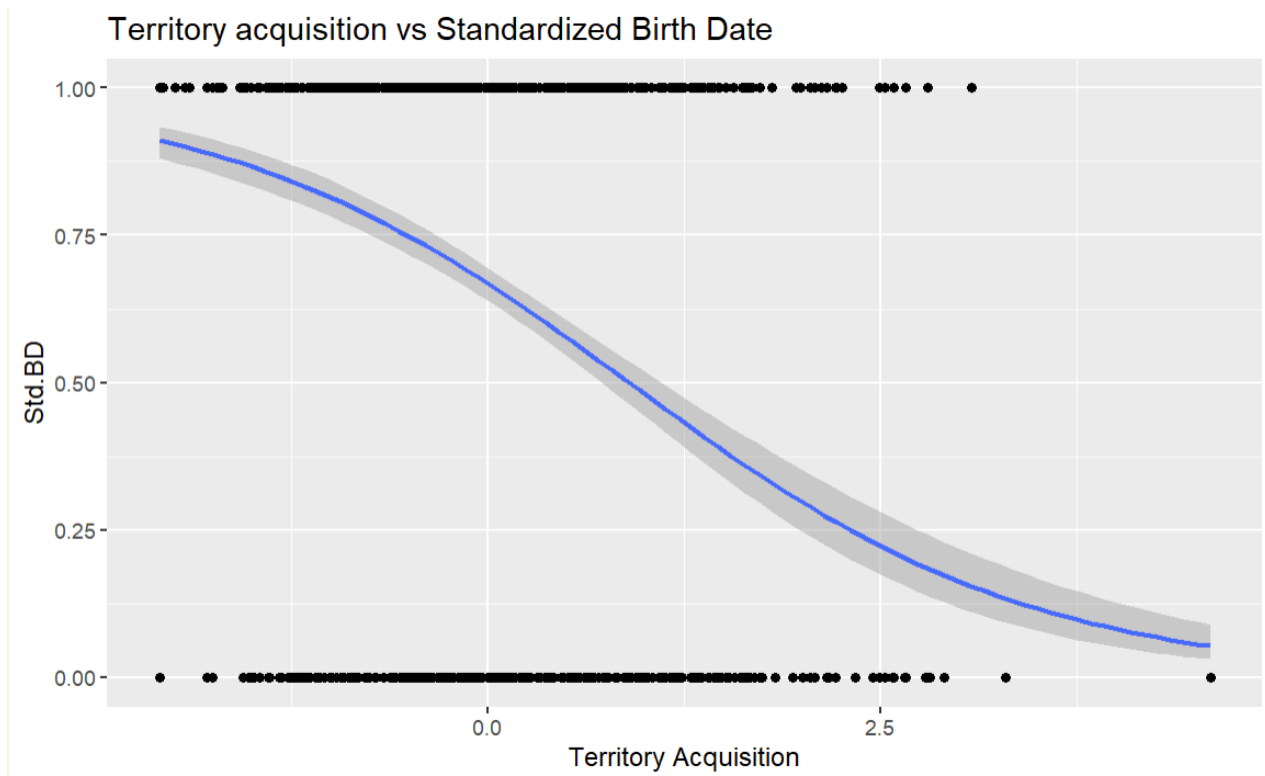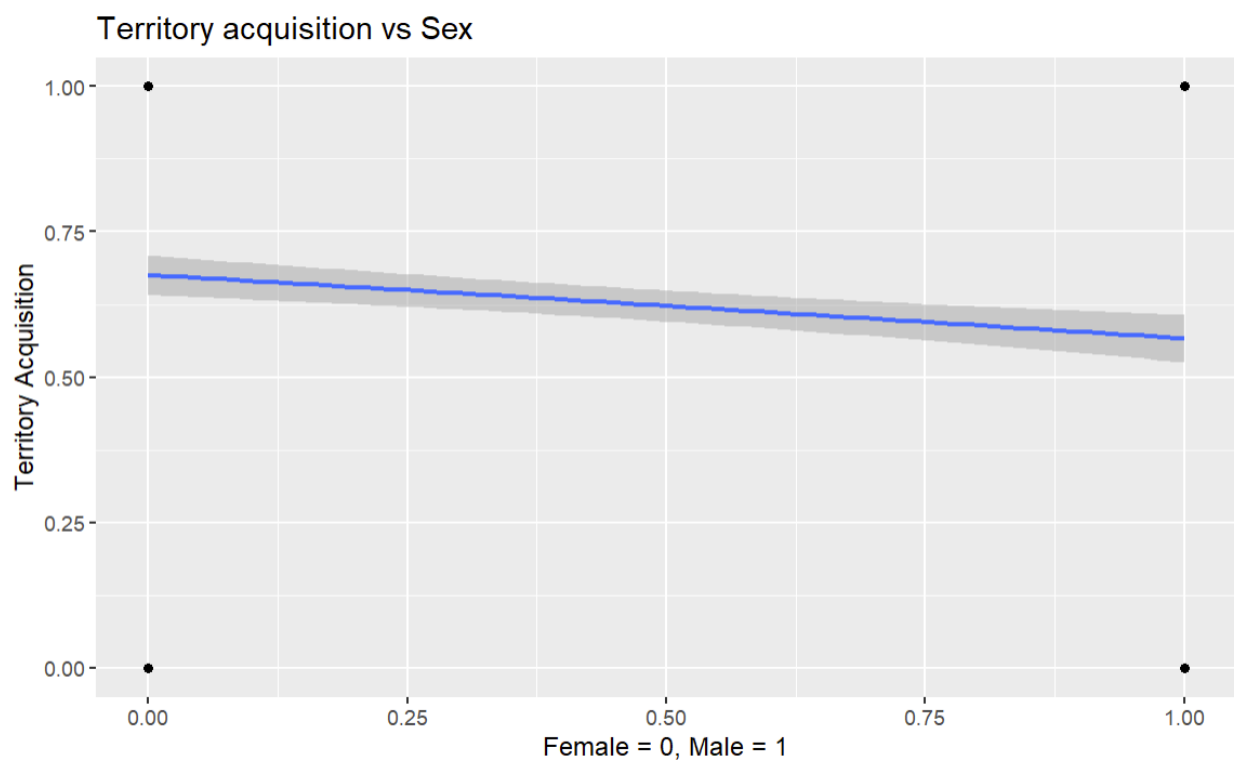Table 2.1: AIC Values of Each Predicted Model

Figure 2.2 Territory Acquisition vs Standardized Birth Date



Figure 2.3 Territory Acquisition vs Sex