Do Bobolinks (*Dolychonyx oryzivorus)* and Savannah Sparrows (*Passerculus sandwichensis)* adjust nest initiation in response to a changing climate?

Maeve McGowan[1*], Noah Perlut[1] and Allan Strong[2]

[1]Department of Environmental Studies, University of New England, *mmcgowan@une.edu

[2]Rubenstein School for Environment and Natural Resources

UNE UNIVERSITY OF NEW ENGLAND

Introduction

Migratory birds determine the timing of their migration based on various ecological cues, including but not limited to the blooming and fruiting of plants, and the ending of insect diapause. As greenhouse gases continue to be introduced to the atmosphere, the timing of seasonal events is shifting so that they may no longer serve as accurate cues to be followed by migratory birds. Short distance migratory bird species may be capable of altering their migratory behavior based on the ecological conditions they observe. Contrastingly, long distance migrants base the timing of their migration on endogenous circannual rhythms (Marra et al. 2005); therefore, climate change may misalign their arrival on their summer breeding grounds and the availability of resources they rely on.

Bobolinks (*Dolichonyx oryzivorus)* winter in central and southern South America and summer in northern North America. Savannah Sparrows (*Passerculus sandwichensis)* winter in southern and summer in northern North America. Both species are obligate grassland songbirds who nest on the ground and commonly share habitats, particularly in New England. To determine if there is a differential response by Bobolinks and Savannah sparrows to changes in climactic conditions, we explored the relationship between nest initiation date (e.g. the onset of breeding) and weather at wintering, migratory, and breeding sites.

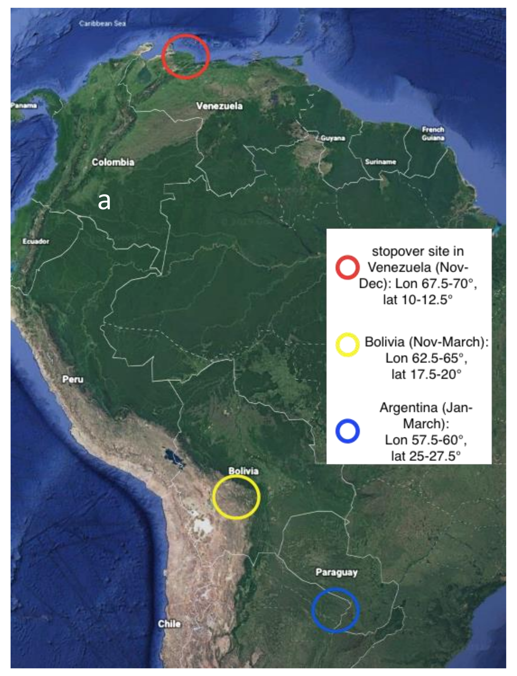
Because our study population nests in agricultural fields, their reproductive success is contingent on the timing and frequency of haying. Therefore, we simultaneously explored how farmers are adjusting the timing of their mowing in response to climate change.

Hypotheses (H) and Predictions (P)

H1: Due to the substantial distance between the summer breeding site and the wintering and stopover sites (Fig. 1), Bobolinks will not adjust nest initiation dates in response to phenological shifts resulting from climate change.
P1: Variation in Bobolink nest initiation dates will not be associated with changes in climate trends.
H2: Due to the relative proximity between the summer breeding site and the wintering sites, Savannah Sparrows will adjust nest initiation dates in response to phenological shifts resulting from climate change.
P2: Variation in Savannah sparrow nest initiation dates will be positively associated with changes in climate trends.

Methods

We monitored Bobolinks and Savannah Sparrows reproduction in Shelburne, VT, in 2002-18. After identifying wintering sites for each species following Renfrew et al. (2013) and Woodworth et al. (2016; Fig. 1), we collected temperature and precipitation data from weather stations located in the respective areas for 2001-2100 using the KNMI Climate Explorer tool. We also collected North Atlantic Oscillation (NAO) and El Niño Southern Oscillation (ENSO) values which depict different regional and global trends in precipitation and temperature, as well as winds and currents. Due to extreme uncertainty surrounding the future of ENSO and NAO, climate projections were considered assuming ENSO and NAO conditions consistent with those historically observed over the course of this project. We recorded average first mowing dates of the breeding site fields from 2002-18.



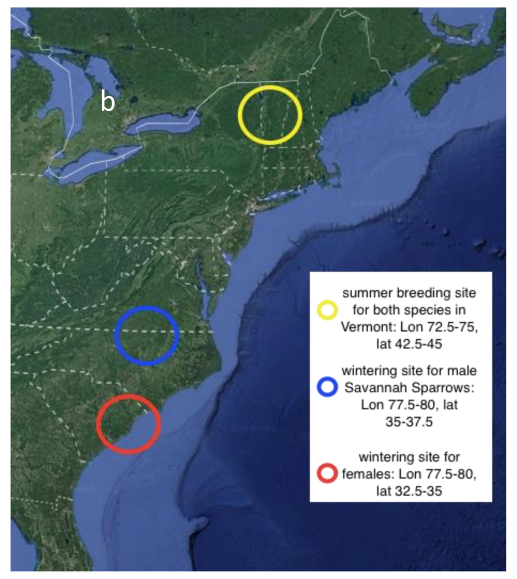


Fig. 1a-b: We collected weather data from stations at each of the respective locations above, representing the wintering or migration stopover locations for Bobolinks (top, a) and Savannah Sparrows (bottom, b).

Model	ΔAICc	AICc weights (xi)
Bobolinks		
Venezuela avg temp * NAO Nov-Mar	0.00	0.40
Venezuela avg temp * NAO Apr	1.20	0.22
Venezuela avg temp * ENSO Feb-Apr	1.30	0.21
Savannah Sparrows		
Female Winter precipitation * ENSO Feb-Apr	0.00	0.43
Female Winter precipitation * ENSO Dec-Feb	0.5	0.33

Table 1: The top candidate models with a ΔAICc < 2, which explain the variation in nest initiation date. The AICc weight (xi)) is the percentage of variation in the dataset explained by that model.

Data Analysis

Using a Information-Theoretic Approach (ITA), we used the climate measures to build single factor, additive and two-way interactive mixed models, aiming to explain variation in nest initiation dates. We ran 158 and 120 models run for Savannah Sparrows and Bobolinks, respectively. Here, a model with a ΔAICc < 2 is considered biologically relevant and the AICc weight describes how much variation in the data set is explained by that particular model (table 1).

Results

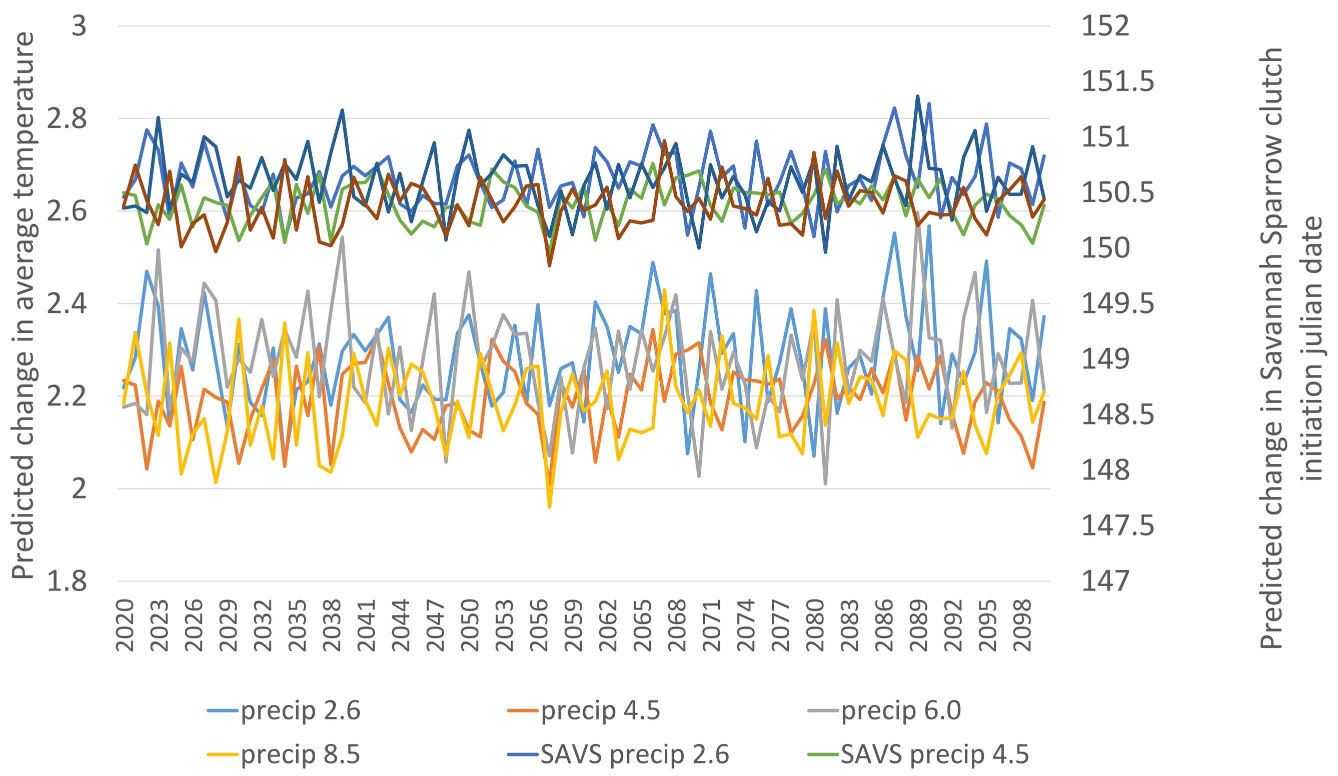


Figure 3: Projected change in Savannah Sparrow clutch initiation julian date based on ENSO conditions and projected precipitation in the mean female wintering region, Georgetown, SC.

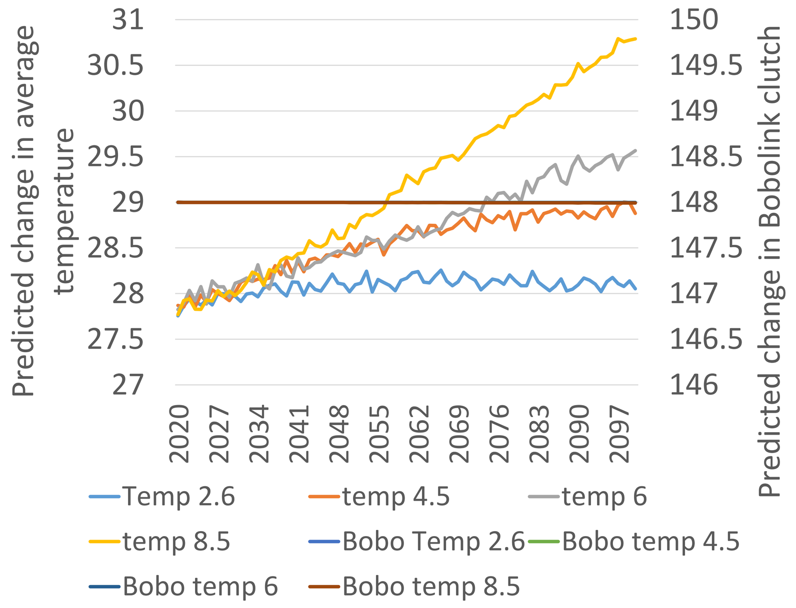


Figure 4: Predicted changes in Bobolink clutch initiation julian date based on ENSO conditions and projected temperature in the stopover site of Venezuela

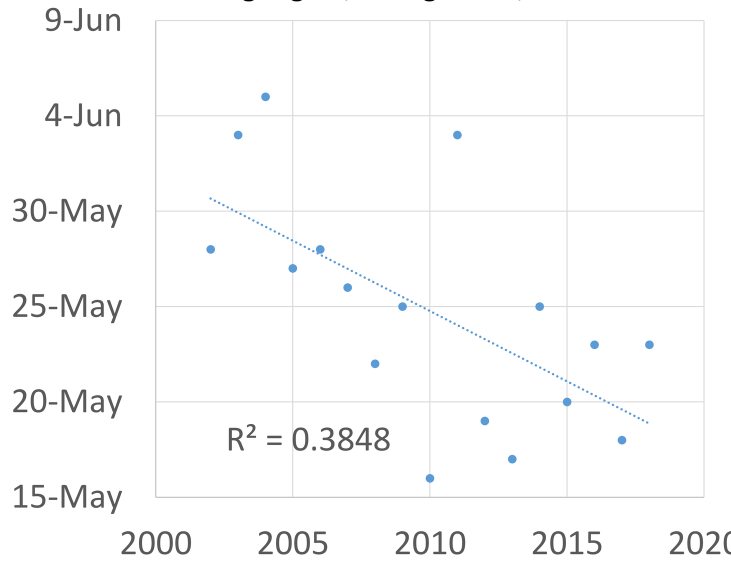


Figure 5: Observed mowing dates on in Shelburne, VT from 2000-2018

For Bobolinks, the interaction between the temperature at their Venezuela stopover site in Oct and Nov, as well as the atmospheric conditions (NAO) during winter explain variation in their nest initiation dates (Table 1). For Savannah Sparrows, the interaction between winter precipitation and the strength of El Niño (ENSO) explained variation in nest initiation dates (Table 1). Projecting from the slope of these results, clutch initiation date for Savannah Sparrows (Fig 3) and Bobolinks (Fig 4) are unlikely to change. Mowing dates advanced by ~10 days over the course of this study. If this shift continues and Bobolinks and Savannah Sparrows do not alter their nest initiation dates, on early-hayed fields, the impact of first haying may decrease. Conservation efforts may need to refocus on the timing of the second harvest, where a delayed second harvest may increase reproductive success and survivorship.

Acknowledgements

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