Mitigating the effects of high temperatures on mating behavior via morphological features in a subtropical passerine (*Peucaea aestivalis*)

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BACKGROUND

- Climate change is increasing average temperatures and the intensity, duration and frequency of heatwaves.
- These factors pose an escalating thermoregulatory challenge that can impact fitness on the individual, population, and species levels.
- Heat poses both lethal and sublethal threats to organisms.
- Sublethal effects can impact time, energy, and effort budgets, which in turn effect fitness.
- Climate change research has been focused on ectothermic organisms in hot-arid regions or polar zones.
- How is climate change affecting endothermic species, behavior, how organisms are coping in different climactic regions, or the role other climatic factors, like humidity?
- **My research will address this knowledge gap by assaying aggressiveness and measuring physical traits in male Bachman's sparrows at the hottest points in the breeding season.**

Study system: Bachman's sparrow (*Peucaeea aestivalis*) (Fig. 1)

- As temperatures increase many organisms are expected to experience loss and/or shifting of their ranges.
- This is especially concerning for vulnerable, range restricted, habitat specialists like the Bachman's sparrow.
- Bachman's sparrows inhabit long leaf pine forests (Fig. 2) and are highly fire dependent.
- Species has experienced an 82.5% decline since 1970, due mostly to habitat loss.
- Numbers are stable is southern Florida, where climate change impacts are expected (Fig. 3 (a) & (b)).

Figure 2: Slash pine forest in Jonathan Dickinson State Park, Hobe Sound, FL

METHODS

- Capture, color-band for identification, and take morphological measurements (i.e., bill length/width/depth, tarsus length, mass, body condition).
- Bill and legs are uninsulated, vascular appendages that have been shown to play a large role in heat dissipation.
- During the hottest portion of the breeding season (June/July) conduct simulated territorial intrusions (STIs) to quantify territorial defense effort.
- STIs = a model of a Bachman's sparrow and an audio speaker in a bird's territory to simulate a conspecific intrusion. Quantify aggressiveness.
- Analyze morphological features known to play a thermoregulatory role (e.g., bill size, tarsus length), aggression, and weather parameters (i.e., temperature, humidity).

Figure 1: Bachman's sparrow (*Peucaea aestivalis*)

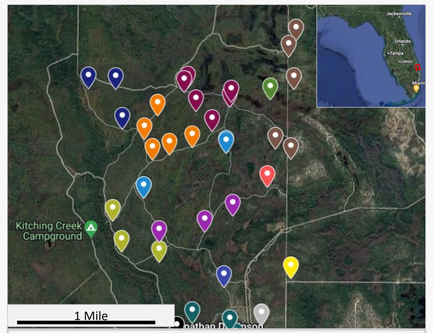

Figure 4: Locations of the 40 Bachman's sparrow to this point during the 2022 field season. Each colored marker represents one individual.

QUESTIONS

- Are variations in morphological features known to play a role in thermoregulation (i.e., bill size, leg length) correlated with variations in aggressive behaviors during periods of elevated temperature?
- Do variations in the same morphological features covary with features of song (i.e., song rate, frequency, duration) during periods of elevated temperature?

HYPOTHESIS

- Differences in morphological features known to be important to thermoregulation will correlate with differences in aggression and song features.

PREDICTION

- Birds with larger bills and longer legs will be able to more efficiently dissipate heat, will spend less time engaging in thermoregulatory behavior, be more aggressive, and sing more songs for longer than individuals with smaller bills and shorter legs.

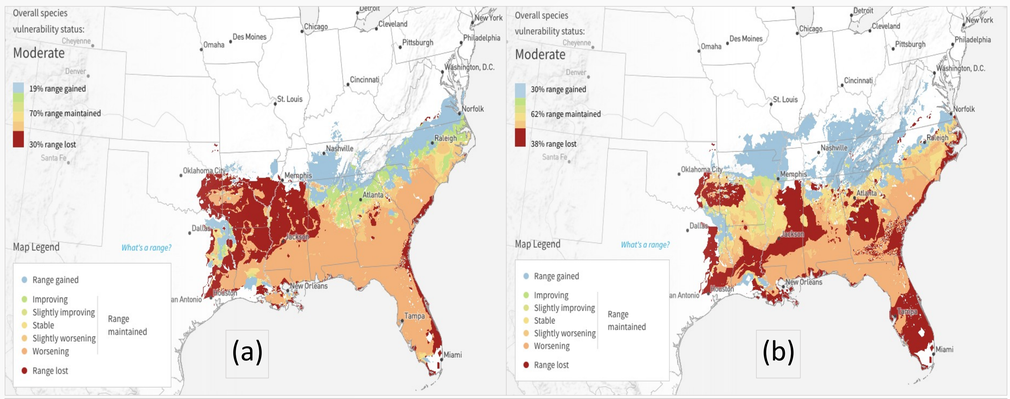

Figure 3(a): Expected Bachman's sparrow range shift if climatic temperatures increase 1.5 °C
Figure 3(b): Expected Bachman's sparrow range shift if climatic temperatures increase 3.0 °C
(*Data and map credit: Audubon – Guide to North American Birds*)

IMPORTANCE & IMPLICATIONS

- Must broaden understanding of the impacts of climate change on a wide range of organisms and across climatic regions. How do variations in morphological features buffer these effects?
- Understanding links among behavior, morphology and climate is key to anticipate how organisms will respond as temperatures continue to increase.
- This knowledge can be used to help guide conservation decisions such as where to restore or preserve habitat, and what species should take conservation priority.

2022 FIELD WORK & DATA COLLECTION

- Field work for the 2022 season began on 7 March.
- To date 40 sparrows have been captured and banded in Jonathan Dickinson State Park (Fig. 4).
- Morphological measurements: sex, body condition, bill, tarsus and wing size, mass, epaulette coloration, taken for each individual (Fig. 5).
- Territories are mapped and preferred singing perches are identified and marked using GPS.
- Song repertoires are recorded for each bird.
- Late June STIs will begin to measure aggression levels of males defending territories.

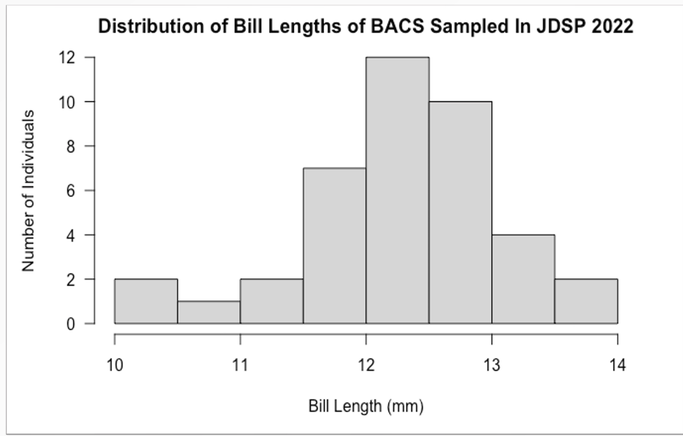

Figure 5: Histogram depicting the distributions of bill length of each Bachman's sparrow captured and measured to this point during the 2022 field season (March – Present).

REFERENCES & AKNOWLEDGEMENTS

- Ali, S., & Anderson, R. (2018) *Song and aggressive signaling in Bachmans's sparrow*. The Auk. 135: 521-533. DOI: 10.1642/AUK-17-216.1.
- Coomes, C.M., & Derryberry, E.P. (2021). *High temperatures reduce song production and alter signal salience in songbirds*. Animal Behaviour. 180: 12-22. https://doi.org/10.1016/j.anbehav.2021.07.020.
- Cunningham, S. J., Gardner, J. L., & Martin, R. O. (2021). *Opportunity costs and the response of birds and mammals to climate warming*. Frontiers in Ecology and the Environment. 19(5): 300-307. https://doi.org/10.1002/fee.2324.
- Kaufman, K. (2001). Audbon: Guide to North American Birds. https://www.audubon.org/field-guide/bird/bachmans-sparrow#:~:text=Plain%20in%20appearance%20but%20with,pine%20branches%20only%20to%20sing.
- Luther, D., & Danner, M. D. (2016). *Males with larger bills sing at higher rates in a hot and dry environment*. The Auk. 133-4: 770-778. DOI: 10.1642/AUK-16-6.1.
- Pattison, N.B., Thompson, M.L., Griego, M., Russell, G., Mitchell, N.J., Martin, R.O., Wolf, B.O., Smit, B., Cunningham, S.J., McKechine, & A.E., Hockey, P.A.R. (2020). *Heat dissipation behavior of birds in seasonally hot, arid-zones: are there global patterns?* Journal of Avian Biology. 51. https://doi.org/10.1111/jav.02350
- Ryding, S., Klaassen, M., Tattersall, G. J., Gardner, J. L., & Symonds, M. R. E. (2021). *Shape-shifting: changing animal morphologies as a response to climatic warming*. Trends in Ecology & Evolution. https://doi.org/10.1016/j.tree.2021.07.006.

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Figure 4: Bachman's sparrow mode to be used during STIs