Why do the effects of temperature on nestling growth and survival vary across land uses?

The interactive effects of climate change and habitat conversion to agriculture constitute the primary threat to terrestrial wildlife.[1] As climate change progresses, human-dominated landscapes may expose birds to new temperature extremes because converting forested land to agriculture removes trees that insulate the understory from ambient temperature.[2,3] In hot ecosystems, climate change-driven temperature spikes often induce nest failure and drive population collapse.[5] For example, my preliminary results from an analysis of Cornell University's NestWatch database show that, across North America, temperature spikes lower nesting success in agriculture and urban environments.

For this project, I will investigate the two main mechanisms that could underlie the consequences of temperature spikes: direct thermoregulation challenge for nestlings and food availability. Nestlings can survive heat waves by using more energy to thermoregulate, but this may decrease growth and lead to lower survival.[6] Furthermore, heat waves may reduce food provisioning to nestlings, either by forcing adults to spend more energy thermoregulating or by reducing prey availability.[7] Here, I propose to investigate the relative contributions of thermoregulation challenge and food provisioning to reduced nestling growth under temperature spikes across four land uses: natural open canopy (grassland), natural closed canopy (riparian forest), agricultural open canopy (row crop), and agricultural closed canopy (orchard).

To do so, I will monitor Tree Swallow and Western Bluebird nest boxes in these land uses at 12 sites (N= 3 sites/land use * 4 land uses). This season we expect to monitor 72 nests. At each nest box, after the start of incubation, I will place one HOBO temperature logger outside and one inside to measure nest temperature. To quantify nestling growth, I will measure mass and morphometrics of each nestling three times during the nestling period and paint the toenails of the chicks to track individuals until banding. To quantify parental food provisioning rates, I will use motion-activated cameras (Phillips et al. in review) that save footage 30 seconds before and after motion activation and place a camera on two boxes per site for a total of 24. I will use image recognition software to determine which videos contain footage of birds and calculate the hourly feeding rate. To measure thermoregulation challenge, I will use ELISA assays to measure blood cortisol concentrations of nestlings. I will use GLMMs to compare effects of provisioning rate and nestling cortisol concentration on nestling growth and survival rates among land uses.

The results of this project will provide crucial insight into the mechanisms by which climate change may affect the ability of birds to survive in human-dominated habitats. They will also provide concrete avenues through which working landscapes could be modified to better accommodate cavity-nesting birds. If the direct effects of heat are more important than food-mediated effects, nest boxes could be modified to reduce their internal temperature. If food-mediated effects predominate, then maintaining patches of non-crop habitats in working landscapes to support food resources may be more effective.

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