Effects of local population density on reproductive success and feeding behavior of the Savannah Sparrow

David Anderson, 2019

To properly conserve and understand migratory bird species it is important to understand the effects of population density on breeding populations. While the general concept of density-dependent population regulation is foundational in ecology[1], little has been done to determine what scale and manner density-dependence operates in (Hixon et al. 2002). A twenty-seven year study of the Savannah Sparrow (*P. sandwichensis*) on Kent Island, New Brunswick, found that while density of the entire study site was negatively correlated with reproductive success via double brooding and depredation, local density had almost double the effect (Woodworth et al. 2017). In more straightforward terms: the number of sparrows within a $50m^2$ plot has a greater effect on whether or not those sparrows' young will be depredated and whether or not the parents will choose to raise a second brood of young during the summer.

While this phenomenon is clearly seen in the data, understanding why it occurs is more difficult. We came up with two hypotheses. The first is straightforward: perhaps higher sparrow densities resulted in more competition for food resources and consequently lower reproductive success. To test this, we compared average feeding rates at different nests in the ten days immediately after young were fledged. If there were less resources available in high density areas we would expect feeding rates to be significantly lower in high density areas.

The second hypothesis is slightly more nuanced. It rests on the facts that a) Savannah Sparrows are highly territorial and b) that post-fledge, young sparrows wander off from the nest despite still needing to be fed by their. Presumably in high-density areas young would be more likely to wander into neighboring territories, which in turn would cause the parents to be harassed while feeding. This increase in energy expenditure could lead to a lower likelihood of double brooding and consequently reduced reproductive success. To test this the number of territorial interactions that feeding parents were engaged in were recorded for five half-hour periods spread across ten days immediately post-fledge. If density-dependent interactions were the cause of the decline in high-density success we would expect to see a) positive correlation between density and number of interactions and b) fewer interactions at nests which raised a second brood.

Analysis of the data collected revealed a positive linear correlation between density and the number of interactions between birds as expected (R^2=0.452, N=21, ANOVA test of predictors p=0.002). However, there was no significant difference in interactions between birds that double brooded and birds that did not (unpaired t-test p=0.956), suggesting that the increased number of interactions does not explain decreased reproductive success in high-density areas. No significant difference was detected in feeding rates between high and low-density areas either, suggesting that resource scarcity is not driving lower reproductive success in high density areas either. To further test the scarcity hypothesis it might be valuable to study *what* food the parents are bringing back; for example, it may be of poorer quality in high density areas.

Overall this study raises more questions than it answers. Resource scarcity and social interactions, the two obvious explanations for how density negatively affects reproductive success, don't seem to be backed up by observational data, so it stands to reason that some other regulatory force is at work. Discovering what this force is may be an interesting subject for future research.

Faculty Mentor: Ryan Norris[2], Ed Minot[3]

Funded by the Kent Island Summer Fellowship 2017

References (if applicable)

Hixon MA, Pacala SW, Sandin SA. 2002. Population Regulation: Historical Context and Contemporary Challenges of Open Vs. Closed Systems. Ecology 83:1490–1508. doi:10.1890/0012-9658(2002)083[1490:PRHCAC]2.0.CO;2.

Woodworth BK, Wheelwright NT, Newman AEM, Norris R. 2017. Local Density Regulates Migratory Songbird Reproductive Success Through Effects on Double-Brooding and Nest Predation. Ecology 98. [accessed 2017 Aug 29]. https://ncbi.nlm.nih.gov/labs/articles/28555872/.

[1] In a nutshell: natural populations grow at different rates depending on how tightly clustered the population is.

[2] Department of Integrative Biology, University of Guelph

[3] Bowdoin College