Prairie Babies: Sparrows, Cowbirds, and Experimental Design

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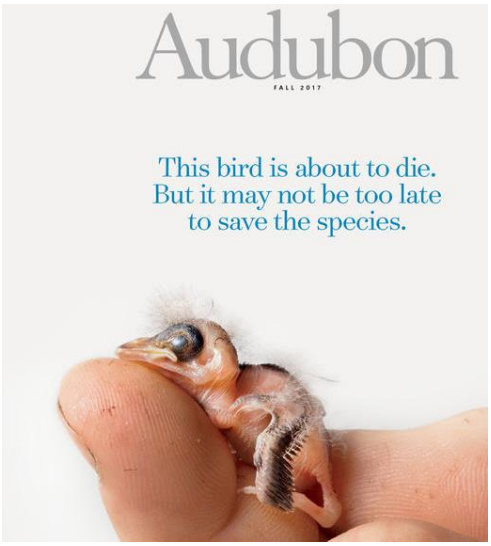
I have worked at the Konza Prairie Biological Station for five years, studying the lives of Grasshopper Sparrows. These tiny brown songbirds are important members of prairie communities—they eat tons of grasshoppers that could overwhelm the prairie plants. In Kansas, these birds are quite common, but in some places in the United States they are in trouble—the Florida Grasshopper Sparrow is the most endangered bird in North America, with as few as 30 pairs left. We want to learn how healthy sparrow populations survive, so we can advise the scientists trying to save the Florida sparrows.



On the right, the fall 2017 Audubon magazine featured the plight of the endangered Florida Grasshopper Sparrow

Sparrow observation blind

In the first two summers of studying these sparrows, I spent a lot of time hiding in a hunting blind (pictured on the left), watching the sparrows take care of their babies. Over those summers, I started to realize that not all baby sparrows grow up in the same way. Some grow very quickly and leave the nest when they are only a week old. Some grow much slower, leaving the nest at ten days old. **These observations led me to my current research question: why do baby birds grow and develop in different ways?**

One of the wonderful things about working in a community of scientists is that we share our research with other scientists all around the globe. I knew that I probably was not the first scientist who asked this question, so I started searching for others who had already studied bird growth and development. If someone else had already asked this question and found a satisfying answer, there would be no need for me to spend my time and research money re-learning the same information. Other scientists have looked into this question, and their results were a little complicated. Some have showed that the amount of food the babies get determines how quickly they grow. Others have shown equally strong evidence that the risk of predators affects growth. By researching past studies, I had identified two hypotheses: (1) that food

young Grasshopper Sparrow

affects growth and development, and (2) that predation affects growth and development. I also learned, though, that there was a hole in our understanding: none of the previous researchers had thought to study whether the presence of parasitic Brown-headed Cowbirds affected growth and development. Because these birds are present in Kansas and lay their eggs in sparrow nests, it is reasonable to also hypothesize that (3) parasitism affects growth and development. **Our simple question had led to three different hypotheses!**

adult sparrow with food

We developed a series of predictions based on our hypotheses. For example, for our first hypothesis about food, we predicted that baby birds that received more food would grow faster than birds with less food, that more food would allow baby birds to gain fat more easily, and that sparrows in habitats with more food available would grow more quickly. Each of these predictions is related to our food hypothesis, and each can be answered by a simple yes or no. All of the predictions could be right, or maybe only a couple of them are (or even none of them!). **When all of our predictions were created for each hypothesis, we needed to design a series of experiments to test them all.**

How do you measure the amount of food a baby bird is receiving without spending too much time at the nest and bothering the birds? How do you determine whether or not a nest is more likely to be found by predators? How do we know if cowbirds are changing normal growth and development? Perhaps most simply, how do we even measure growth and development? We spent almost a full year just figuring out how we could measure the right things to collect data that would accurately assess our predictions and help us answer our big question.

Our amazing 2017 data-collection crew

The most important part of our experiment is finding bird nests. Until we find the nests, we cannot measure nestling growth or any of the factors we hypothesized are affecting growth. Every year I hire a team of college students that help me find nests—we work from 5 AM to 3 PM six days a week, finding nests and collecting data! The birds we study hide their nests in the prairie, so in order to find the nests we have to get creative. We walk around the prairie and watch for birds flying off the ground—often these birds are females who were sitting on their eggs, so we can look for a nest from the place she left. The prairie is gigantic, so each of us walking is unlikely to find all the nests, so we came up with a system called rope-dragging. We drag a giant rope across the prairie, allowing us to cover half the length of a football field at a time!

Once we find the nests, we take some simple data. How many eggs are in the nest? Are they sparrow eggs or cowbird eggs? We go back to the nest every other day so that we know when the eggs hatch. Once they have hatched, we measure many different aspects of growth and development. We measure the length of the babies' legs, the length of their wings, the length of their feathers, the size of their beak, and how much they weigh. Because we come back every other day, we can then calculate how fast their legs, wings, feathers, and beaks are growing, and how much weight they are putting on.

On the right, we measure a nestling wing

For some of the nests we also used a fancy machine called a Quantitative Magnetic Resonance (or QMR) machine. This piece of equipment is basically a special type of MRI machine, which a doctor would use to scan the inside of a human body and look for hurt muscles or hard-to-see damage to bones. We use our QMR to "look inside" the birds and measure how much fat and muscle they have, so we can calculate how quickly their muscles are developing and how quickly they are putting on fat. Unfortunately the QMR machine is giant and hard to move around (we have to keep it in a camping trailer) so we cannot bring it to every nest.

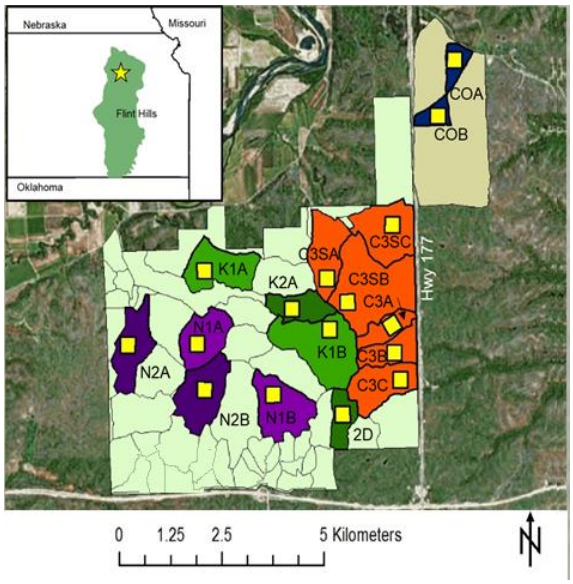
The trailer with our QMR scanning machine

So, once we have the data to look at growth and development, how do we collect the data about the factors we hypothesize are affecting the growth and development? We cannot sit at each nest all day to see how much food the babies are getting (because that would make the parents mad), so we turned to technology. We created cameras that record 24 hours a day by piecing together parts of security cameras, tv DVRs, and motorcycle batteries. The cameras themselves are really small, so we can camouflage them and hide them right next to the nest, so they record the parents coming back with food. We run a long cord underground from the camera to a box that contains the batteries and DVR. The hardest part about setting all of this up is that we need to make sure the cows and the bison in our pastures don't find the cameras and destroy them! By the end of this summer, we had recorded 2,600 hours of footage (that is 111 days!) that we

A still image from a nest video showing an adult feeding babies

are now watching in the lab to determine how often the parents bring to food to each nest. For each nest, we will be able to determine how much food the babies are getting, and since we already know how fast they are growing, we will be able to see if birds that receive more food are growing faster than birds receiving less food, addressing the predictions for the first hypothesis.

What about predators? We predict that birds in areas with lots of nest predators will develop faster so they can leave the nest more quickly, but how do we know which areas have more predators? For this part of our experiment we turn to the Konza Prairie site itself. Konza is a National Science Foundation research site—over 200 researchers are working at Konza this year to gather data about everything from water quality to nutrient cycling to cattle grazing. In order to facilitate all of this research, Konza has a unique experimental design—the prairie is split up into "watersheds," and each watershed has by a particular grazer (bison, cows, or deer) and burned at different intervals (every year, 2 years, 3 years, 4 years, or 20 years). Grazing and fire are both important factors that affect the types of plants that grow and the amount of nutrients available to those plants—so every watershed has different plants, and has been that way for over 30 years. Researchers studying snakes and other predators have shown that there are more predators in some watersheds than others, so we can look at the growth and development of birds in high-predator watersheds and compare them to birds in low-predator watersheds. Of course, predators can move, so perhaps the differences in watersheds do not really matter—because this is a possibility, we have decided to collaborate with other scientists studying sparrows in different parts of the United States. We know that the predators are different between Kansas, Maryland, Florida, and Arizona, so the researchers working in those other states are recording the growth and development of their sparrow babies and sharing the data with us. We will be able to compare the growth and development of nestlings at high-risk and low-risk nests at Konza and across the country!



The Konza Prairie experimental design map. We work on all of the colored units. Purple are grazed by bison, green by deer, and orange/blue by cattle.

Grazing and intentional fires create watersheds of different plants that house different nest predators

Finally, cowbirds! How do we study the effect of cowbirds on growth and development? We can compare the growth and development of baby sparrows in nests with cowbirds and in nests without cowbirds, but we can also take it a few steps further. Using the cameras we can see if the cowbirds are keeping the baby sparrows from getting enough food, and we can look at growth and development in those nests. We can see if the effects on growth and development are different in nests with different numbers of cowbirds, since we see nests with up to six cowbirds! We can compare the growth and development in the different populations that other researchers are studying—in Arizona there are fewer cowbirds, and in Maryland and Florida there are no cowbirds at all. We plan to explore all of these options to better understand the effect of cowbirds on growth and development.

A hungry young cowbird

Finally, we want to learn a little bit about nestling survival. We think that the differences in growth and development may make some nestlings more likely to survive than others, which could mean that natural selection will ultimately favor one growth and develop strategy over another. In order to determine the survival of nestlings from different nests we will put radio trackers on some of the babies. These trackers are basically small backpacks that we put on the birds. After the bird is released, we can find them again by using an antennae and tracking the signal that the little backpack makes. We will be able to relocate the birds for a month or so after they leave the nest, so we will be able to see if birds with different growth strategies survive longer than others.

A young bird with a transmitter "backpack" that will help us learn about survival

By the end of the two summers of data collection we will have a treasure trove of data that we can analyze to address our hypotheses and, ultimately, find a solution to our larger question about why bird development strategies differ. When I finish the analyses I will present the results to other scientists by writing papers to share and by going to meetings around the world. Our data will hopefully allow us to make recommendations to non-scientists, like ranchers managing their prairies and others who may be interested in our results. Ultimately, my data and this project will be useful for others who are interested in testing their own hypotheses about their own study system for years to come.

Project Prairie Babies: Experimental Design Cheat-Sheet

Observation: Baby Grasshopper Sparrows at the Konza Prairie in Northeast Kansas grow at different rates and leave the nest at different times.

Question: Why do baby birds grow and develop differently?

Hypothesis 1: The amount of food baby birds receive affects the way they grow and develop.	**Hypothesis 2:** The risk of predation at the nest affects birds' growth and development.	**Hypothesis 3:** The presence of Brown-headed Cowbird parasites affects birds' growth and development.
Sample prediction: Baby birds that receive more food will grow faster.	**Sample predictions:** Baby birds in high-risk areas will grow faster to leave the nest earlier, or will prioritize the development of wings so they can escape predators better.	**Sample predictions:** Baby birds in nests with cowbirds will develop more slowly, or birds in nests with parasites will prioritize the growth of their beak to compete with cowbirds for food.
Data: use cameras to see how much food baby birds are eating	**Data:** compare growth rates at areas with low and high predator risk	**Data:** compare growth rates in nests with and without cowbirds

Bonus: Use transmitters to see if the different growth and development strategies influence nestling survival

Conclusions: Determine the effect(s) of food, predation, and cowbirds on growth and development strategies. Determine whether or not certain strategies affect nestling survival. Connect this research project to our understanding of the evolution of bird development.

Next steps: Prepare these results for publication in scientific journals, presentations at scientific meetings, recommendations for land owners and managers, and presentations to interested non-scientists. Future scientists can then use this data to inform their experiments!

A couple of final thoughts:

This research is only made possible thanks to the support of many invested students and collaborators, and thanks to funding from the National Science Foundation, Konza Prairie, Kansas State University, and the Southwest Association of Naturalists. Continued support for science requires the interest and excitement of all citizens, including you!

If you are interested in this project and want to know more or stay up-to-date as we make conclusions, please check out www.sarahwinnicki.com or follow #prairiebabies on my Twitter feed (@skwinnicki).