From an early point in my career, I have been driven by a fundamental curiosity: why do different species, and even individuals within a species, exhibit unique behaviors? This question has been a central theme of my research career, in which I've sought to understand the molecular and ecological mechanisms underlying behavioral diversity in wild bird populations. My research integrates cutting-edge technologies like high-throughput sequencing and automated radio telemetry with detailed behavioral observations to explore how behavior evolves at multiple levels of biological organization. By bridging scales from molecules to landscapes, my aim is to not only unravel the biological drivers of behavioral variation but also translate these insights into effective conservation strategies. In an era of rapid environmental change, understanding the complex interplay between genetics, behavior, and ecology is critical for predicting species resilience and guiding wildlife management.

I made the decision early on to focus on basic research, rather than applied or policy driven research, for the simple reason that I wanted to be guided by curiosity. One of my most formative classroom experiences was in an endocrinology course with a professor who would become my honors thesis advisor. It was in that class that I really began to consider how behavior was driven by biological mechanisms in the brain and body, which fascinated me and set me on a path to explore behavior from within individual organisms. My undergraduate research focused on the relationship between stress and parental behavior in birds. Parenting is stressful on its own, but if circumstances take a turn for the worse there comes a point at which survival may supersede investment in offspring. To better understand that tipping point, my research involved using enzyme-linked immunosorbent assays to measure glucocorticoids (the stress hormone in birds) from blood samples collected from tree swallows. This project was a perfect combination of field work and lab work, granting me time to observe the behaviors of wild animals and apply techniques that really dig into the mechanisms underlying those behaviors. I won an award for best oral presentation at the undergraduate level from my university for this work and soon began to consider graduate school.

My next spark of curiosity came during a meeting with my undergraduate research advisor who told me about a former lab mate of hers who studied white-throated sparrows, or the species with four sexes. In this species there are two morphs, the white-striped morph which is aggressive and brightly colored, and the tan-striped morph which is parental and has muted plumage. White-striped and tan-striped birds are equally represented in both sexes, and they almost always pair with the opposite morph; so, a white-striped male almost always breeds with a tan-striped female, and a tan-striped male almost always breeds with a white-striped female. The behavioral polymorphism, that is how white-striped birds are more aggressive and less parental than tan-striped birds, persists within both sexes, and is determined by a large chromosomal rearrangement which is present in all the white-striped birds and none of the tan-striped birds. The fact that behavior could be so neatly and clearly tied to genetic variation captivated my attention, and this species became my model organism for graduate school.

Both my master's thesis and doctoral dissertation were centered around the gene for vasoactive intestinal peptide (*VIP*), which was named for its role in blood flow to the gut, but plays a key role in both aggression and parental behavior in birds. *VIP* is also captured by the chromosomal inversion that determines the two morphs in white-throated sparrows, which makes it an appealing candidate for understanding how genetic variation influences behavior. For my master's research, I used high-throughput sequencing to measure an epigenetic marker called methylation in part of the gene for *VIP* that controls how and where the gene is expressed in the brain. This enabled me to begin to explain one way that *VIP* may differ between the inverted chromosome and the non-inverted chromosome and cause downstream effects on behavior. My doctoral research took this a step further by connecting both aggression and parental behavior with *VIP* expression in the brain. Like with my undergraduate research, I coupled behavioral observation in the field with lab techniques for both projects.

At this point in my career, I had zoomed into some of the smallest units of biological organization such as brain regions, hormones, and genes, with the goal of understanding behavior at a nearly molecular level. Along with the field and laboratory skills, I also gained experience learning how to analyze large, abstract data sets, like sequencing data, that represent small elements within large complex systems that zoom all the way out to social interactions between birds. I also had gained an appreciation for the unique challenges that researchers face when working with wild animals and applying cutting-edge techniques to new species. When it came time for me to find a new research project for my post-doc, I was interested in opportunities in which I would be able to continue to grapple with large, complex data and leverage new technologies in wild birds to understand their behavior. I found both of these things in my current position, in which I've begun to explore behavior at a broader level of biological organization, zooming out from the individual organism rather than zooming in.

In Grand Forks, ND there is an unassuming international airport that boasts one of the highest levels of air traffic in the nation due to the aviation school in town. On average, there are upwards of 200,000 takeoffs and landings that occur at this airport each year. Neighboring this airfield, however, is a wastewater treatment facility that holds more than 1,000 acres of shallow, nutrient rich water that is irresistible to a host of avian life in the area. Thousands of waterfowl, waterbirds, and shorebirds use the wastewater treatment facility each day, especially during the spring and fall when transient populations visit during migration. The proximity of the wastewater treatment facility to the airport has created a situation for human-wildlife conflict to occur due to the risk for collisions between aircraft and birds, or “bird strikes.” Employees of the city have several strategies at their disposal to deter birds from using the ponds at the wastewater treatment facility, including non-lethal hazing strategies like air cannons and flare guns as well as lethal removal in some cases. However, managers are always looking for new strategies to help with mitigating this human-wildlife conflict. One tool that holds promise for this is harassment with uncrewed aircraft systems (UAS), or drones, which is where I come in.

My post-doctoral research has focused on understanding how birds respond to hazing with UAS. I have been particularly interested in species-specific behaviors and how species respond differently to UAS approach. In this context, understanding species differences in response to UAS approach is extremely important because the stakes are so high. For example, if flying a drone at one species causes them to flee and fly away, then we can then trust that UAS hazing would work as a deterrent. However, if a different species is attracted to the drone, then UAS hazing could worsen the problem and increase the risk of bird strikes. The methodological approach for this research leverages both behavioral observations and automated radiotelemetry using the Motus network to better understand how birds respond to UAS approach. For this project, my scope has zoomed out to a broader level of biological organization which has also broadened my skillset into new species and field techniques, and I have exchanged the wet lab for more analytical heavy lifting.

Across all of my research experiences, I have found myself frequently having to adapt not only to the challenges of field work, but also to apply new techniques in the process of collecting and analyzing data. I’ve frequently picked up small side projects, some of which never came to fruition like the luciferase assay I began to design in my first year of my Ph.D., and some have been part of much larger efforts, like the citizen science project called the Wolverine Watch that I helped with in college. The result is a diverse and perhaps eclectic skillset, however one of the most valuable of those skills is the flexibility to think about research from an interdisciplinary perspective and to communicate about my research with a wide variety of people. While my doctoral research led me to have discussions with geneticists, neuroscientists, and psychologists, my postdoctoral research has me engaging with ecologists, wildlife managers, and even airport operation professionals.

My decision to go down a path that focused more on basic than applied research is one that I stand by, however the management implications of my current research have reminded me that I also have a passion for conservation. Going forward, I aim to be more intentional about blending these elements in my research, like I have often blended field and lab work. I would like to continue to investigate how molecular and behavioral mechanisms interact with environmental and spatial factors to shape adaptive phenotypes and how these insights can inform conservation efforts. I also want to continue to explore ways to apply new technologies to wild bird populations, focusing on species of interest in environment local to my lab. In the prairie pothole region of North Dakota, the “duck factory of America,” these animals are largely waterfowl and waterbirds, and much of my previous work has focused on songbirds which are abundant everywhere.

In California, there are some interesting conservation issues related to habitat disturbance that would fit well with my skillset. For example, my experience with spatial movement data and genetics fit well with a project aimed at understanding how fragmentation is affecting the mating systems and reproductive success of at-risk populations of sage grouse. Alternatively, the implementation of fuel-reduction projects that attempt to reduce the risk of dangerous wildfires may have uncertain effects on the reproduction of species that may depend on those resources for things like nest building or foraging. For instance, the removal of snags may reduce the availability of nest cavities that are utilized by species like chickadees and owls. Although I am interested in working with charismatic species like sage grouse, I expect that I will also work with songbirds because they are relatively accessible for smaller student-led research projects and are better suited for certain molecular techniques.

When I think ahead to my future research program, I envision an integrative space that reflects the interdisciplinary and broad scope of my previous research experience. My career so far demonstrates that one of my greatest strengths is being able to flexibly adapt to the specific needs of a given research question, learning or applying new skills and technologies along the way. My core motivation is to understand why animals behave the way they do, and from there the specific questions may come from a spark of curiosity, like how the white-throated sparrow captured my attention, or they may be driven by a need for change, like with mitigating bird strikes. This openness and breadth provide the space necessary for curiosity to flourish, which I hope, in turn, will foster the enthusiasm and passion that I have for biology in my future trainees. Further, I aim to foster a culture of accessibility and collaboration both within my lab and with others. Ultimately, I hope to establish a research program that is locally grounded and that generates valuable science about avian behavior.