I have barked at toads to collect their sperm and dissected the ovaries of dogs and mice to manipulate their oocytes. My interest in reproductive biology was ignited by reading Darwin's *The Descent of Man & Selection in Relation to Sex*. I was fascinated by his description of sexual selection and the powerful influence reproduction can exert on the evolution of traits and behaviors. Darwin's journey of discovery inspired me to explore reproductive diversity around the world, from developing conservation methods for amphibians and mammals to studying fertilization in order to improve human health. My graduate research on sexual selection and reproduction in *Drosophila* seeks to build on my experiences in applied reproductive biology and study the evolutionary mechanisms that underlie reproductive diversity in animals.

I attended a small liberal arts school, Beloit College, for my undergraduate education. Although Beloit did not provide many research opportunities, the environment encouraged me to develop my own interests and actively seek out external research experiences. By majoring in biology and minoring in chemistry and anthropology, I developed a broad perspective on science from atoms to human culture. This interdisciplinary background instilled an appreciation for integrative solutions to biological problems, as well as a desire to engage diverse communities in discussions of my research in reproduction and related topics of gender, sex, and sexuality.

Intellectual merits: My first experience with reproductive research was during a semester abroad at the University of Tasmania, Australia. I deliberately chose Tasmania because it was a stop on Darwin's voyage and it supports an extraordinary diversity of reproductive systems. In addition to my coursework, I volunteered as a field assistant with graduate students at the University. I was immersed in field research on the basic biology of endangered Australian species, which motivated my subsequent pursuit of reproductive biology research in a conservation context.

On my return to the USA, I interned at the Memphis Zoo to study amphibian assisted reproductive technologies. Amphibians are experiencing a global extinction crisis and developing captive breeding techniques is a vital component of preventing species loss. I was part of a project developed by Dr. Andrew Kouba to improve gamete collection protocols in Fowler's toads, as a model species for endangered amphibians. I conducted experiments to determine the frequency that hormone-induced sperm collection could be administered without decreasing the quantity or quality of sperm. I collected and evaluated sperm as well as designed a study to test the stress of the collection method on sperm characteristics. We found a significant decrease in sperm concentration and movement attributable to the frequency of hormone-induced sperm collection. I analyzed the data, incorporated the results into my honors thesis and, subsequently, a manuscript that was recently accepted for publication[1].

Following graduation, I sought out opportunities to delve further into conservation reproductive biology, learn new techniques, and study the female reproductive system. I received a summer fellowship to conduct research at the San Diego Zoo Institute for Conservation Research on rhinoceros reproduction in captivity. Previous studies of rhinoceros estrogen receptors transfected into human embryonic kidney cells suggested that estrogen receptors of species with reproductive difficulties are more sensitive to dietary phytoestrogens. However, results from this artificial experimental system may not reflect the actual physiological response of rhinoceroses. With my mentor, Dr. Christopher Tubbs, I developed a novel method for evaluating the role of estrogen receptor sensitivity in captive infertility using rhinoceros fibroblast cells. These cells are a more appropriate proxy for *in vivo* rhinoceros response because they endogenously express rhinoceros hormone receptors and associated genes. My results with this new method revealed sensitivities to phytoestrogens that were previously undetected. These

findings were recently published in a review that proposed new, more sophisticated molecular techniques that can be utilized by zoos[2].

At the end of my fellowship, I crossed the country to study canine conservation at the Smithsonian Conservation Biology Institute with Dr. Nucharin Songsasen. As laboratory-technician intern I was part of a team studying canine reproductive behavior and physiology in captivity, as well as methods of improving *in vitro* fertilization techniques. I conducted enzyme-immuno assays of maned wolf (a threatened species from Brazil) fecal hormones to study how to refine management conditions for natural breeding and induce ovulation. Using the hormone profiles, we evaluated ovarian activity and determined that wolves either had to be housed with a mate or receive multiple hormone-injections to ovulate[3]. Additionally, I conducted an independent project optimizing *in vitro* follicle maturation techniques to collect and mature oocytes of genetically important individuals for *in vitro* fertilization. I compared the efficacy of follicle culture methods on oocyte growth and survival in canine species and found that 3D methods of follicle encapsulation were superior to other techniques. Through my zoo-based research positions I was able to contribute to the conservation of a variety of species via assisted reproductive technologies. Although I enjoyed these experiences, I felt constrained by limited availability of study animals and the lack of genetic tools needed to address broader research questions. I decided to explore reproductive biology research in contexts beyond conservation.

I sought out opportunities where I could research the interaction of female and male gametes in a human health context. As a post-baccalaureate fellow at the National Institutes of Environmental Health Sciences my research with Dr. Carmen Williams explored mechanisms of fertilization to understand human infertility and improve *in vitro* fertilization methods. I presented these results at the *NIH Post Baccalaureate Poster Day* and my research was selected as an "Outstanding Poster"[4]. I am currently involved in preparing a publication on this research.

My experiences in applied reproduction strengthened my interest in sexual selection theory and my passion to investigate the evolutionary processes that have given rise to the incredible diversity of reproductive systems. To this end, I have joined a highly collaborative and integrative group of researchers at Syracuse University, headed by Profs. Scott Pitnick, Steve Dorus, and John Belote, who are leaders in the field of sexual selection and post-copulatory interactions between the sexes. As a member of this group, I intend to utilize their expertise in an array of approaches from behavioral to molecular biology to examine previously unexplored aspects of female-mediated processes and contributions to reproduction.

Broader Impacts: My graduate research on the evolution of female-mediated reproductive mechanisms and ejaculate-female interactions in the *Drosophila* model system will impact our understanding of speciation mechanisms and the origins of biodiversity. Moreover, a greater knowledge of the female environment during reproduction can influence a range of fields, including conservation and human health. The study of post-copulatory interactions during fertilization has increasing relevance to understanding infertility and improving *in vitro* fertilization methods.

Outreach is an integral part of my approach to science, although it can be challenging to communicate my interest in reproductive biology to adolescents and community members. As an undergraduate I was involved in the Beloit College Girls and Women Conference. The conference brought 6th grade girls from the surrounding community to the college for a weekend to interact with college students and participate in scientific activities. I started as a volunteer leading a biology lab for the girls, the experience was incredibly rewarding, and in my senior year I took on the role of Administrative Coordinator. In this position I invigorated our outreach

to schools in the community and found new sources of support from local businesses. I also added new activities in departments with the greatest female underrepresentation (computer science and physics). This opportunity enhanced my organizational and communication abilities, and I intend to apply these skills to design and implement outreach programs at Syracuse University. In addition to one-on-one mentoring, I will also try to organize educational outreach into Syracuse high school classrooms. With the support from established outreach programs and inexpensive, open source computers from the biology department, I will develop a bioinformatics lesson to provide local students with a hands-on experience in molecular evolutionary biology.

In a related endeavor, I am committed to making the academic environment more accepting and tolerant. At Syracuse, I am involved in the graduate LGBT organization to support sexuality and gender diversity. I am also interested in feminism and gender equality and I recently spoke on a panel at the Wisconsin Symposium on Feminist Biology[5]. This symposium brought together scientists who endeavor to enhance minority representation in the sciences and incorporate feminist perspectives into the ethos of science. The goal of this effort is to recognize our own biases so we can combat the potential for methods of knowledge production to feed into institutionalized sexism and racism. Reproductive biology, in particular, is susceptible to the influence of cultural assumptions about sex and gender. I endeavor to hold my colleagues and myself accountable for representations of gender and sexuality in science.

The study of reproduction in an evolutionary context is powerful. It can help us understand biodiversity and speciation as well as how to manipulate reproduction for human and ecosystem benefits. The inspiring research community at Syracuse University, in conjunction with my previous applied experiences, is the ideal environment to tackle novel reproductive questions. The NSF GRFP will help me to pursue my ambition of a career in academia. I aspire to use my research to advance our understanding of reproductive variation by studying the underlying evolutionary mechanisms and their fitness consequences. I will also develop my teaching abilities by participating in Syracuse University's Future Professoriate Program. In addition, I am motivated to improve science outreach, increase interdisciplinary collaboration and enhance diversity in the scientific community. I present my research at every opportunity and am actively involved with programs to make science accessible for everyone, efforts I will continue throughout my career.

1) **McDonough CE** *et al.* 2014**.** Frequency of exogenous hormone therapy impacts spermiation in male Fowler's toads (*Bufo fowleri*). *Under Revision, RF&D* 2) Tubbs C, **McDonough CE**, Felton R, Milnes MR 2014. Advances in conservation endocrinology: the application of molecular approaches to the conservation of endangered species. *Gen. and Comp. Endo.* 203, 29-34 3) Johnson AE, Freeman EW, Colgin M, **McDonough C**, Songsasen, N 2014. Induction of ovarian activity and ovulation in an induced ovulator, the maned wolf (*Chrysocyon brachyurus*), using GnRH agonist and recombinant LH. *Theriogenology*, 82, 71-79 5) **McDonough CE** 2014**.** Presentation: Focus on female factors involved in fertilization. *WI Symp. on Fem. Bio.*, Madison, WI.