Alexis Marie Mychajliw
Paul D. Schreiber High School / Cornell University

"I am Alice in Wonderland. It's an inane statement, but it's true. I've cracked the shell of reality, landing somewhere foreign and unknown. I've always attempted to chase small animals and to get lost in the simple web of suburban sidewalk. I'm infectiously curious; I'm constantly determined to explore.

I can remember quite clearly the first time I broke the surface. I was in the mountains of upstate New York and still retained the neutral eyes of a child. One morning I took my basket to pick blackberries along the edges of a nearby forest, and I saw a buck standing beneath an apple tree. The breath left my lungs and in an instant I was after him, my basket thrown haphazardly onto the soil. He was a flurry of tawny whiteness, a larger-than-life sprite I was destined to catch. He wound through the foliage, bounding like the shadow of a falling leaf. I was nearly at my threshold, panting, fingers yearning to reach when...

The forest's borders ended, and I was left spinning into a sea of dazzling blossoms and gargantuan weeds. My head was heavy, my eyes were scanning, but I could not for the life of me find my target. It was as if we both evaporated, and I had no idea when I would be real again. It was liberating in a sense, to be unaware of anything and for everything to be unknown. I was not afraid; I was intoxicated. I spent the entire day not in a panic wondering where I was, but instead, fantasizing who I could be or what creatures I might encounter. There was no premise of science from which to evaluate that world— it was natural awe, left unfiltered by the perspective of child's eyes.

It took about two hours for my dog to find me. I had scoured the area, chasing after my version of the elusive white rabbit that for all purposes may not have even existed. I could have been chasing sunlight. There was no proof. I realized then the sweeping power of curiosity, and it lingers still. My life is a balance of questions and answers, mysteries and logic. I have always been awed by the smallest spot of life, and now, as a scientist, I can appreciate the complexity that lies within each speck. Everything to me is a microcosm, a labyrinth.

I believe that to find something you must be lost in the first place. You must work yourself so deeply into the maze that there is no option but to find the solution. You must deduce, even in the absence of logic. I am not afraid of losing something if only to attempt to find it again. I am who I am because I so desperately hope to internalize the world around me. I need to dig my fingers in, write long lists of adjectives until I finally get down to the core. I meticulously uncoil the world to find myself because aren't we all somehow a part of everything? Our cosmic dust, our crystalline, glass-edged, over simplified world is made of billions of pieces and individual universes, and I want to draw each one to the pure, unadulterated crux that is life.

I will always be chasing something I cannot quantify, and I do not care if I ever catch it. I will continue to follow not because of what immortal secret lies within the rabbit I chase, but because of what fanciful worlds the chase takes me through."

I wrote that passage a year ago, while trying to decide exactly what I wanted to do with the rest of my life. Yes, it was for college, a bit too literary and on the surface not quite personal enough, but with deeper consideration, it became obvious that I am a scientist in every way possible.

This short essay was written on my ancient computer at my cottage in the Catskill Mountains, upstate New York, after a full day of working in the field. I was trying to describe the feeling of walking into a forest and being able to recognize all its inner workings as if you, too, were but a mechanism as well. This is the ecologist's view— the challenge of studying something objectively that you are so subjectively entwined with. To me, entering any natural habitat, without the whisperings of humanity, is as if you are standing in a parallel world, a separate wave function of quantum mechanics and reality itself.

I have been fortunate enough to have spent all of my summers in the Catskill Mountains. My father and aunt encouraged my adventures into the forests, and would even aid me in my early specimen collection (frogs, newts, bugs and the like). I never called these outings a "science", but after taking several high school science classes and realizing that a laboratory course of study did not pique my interest, I went back to doing what I know.

In the summer of my sophomore year of high school I contacted a newly opened Cornell Cooperative Extension that was working with the Agroforestry Resource Center of Greene County, a small environmental center that encompassed an expansive model tree farm but lacked data on the land they owned. The original concept was to simply collect data about the streams that bisected the farm, such as the levels of organic pollutants and the benthic macroinvertebrates (little stream bugs) that inhabited the waters. However, after my first day of field work (which to me felt like nothing but a childhood excursion), I realized that the stream itself is nothing more than an extension of the forest surrounding it. There is no boundary between one habitat and another— they are both ecosystems, feeding into each other symbiotically. I expanded my research to include the flora and fauna of the forest as well, showing that there is an intimate relationship between aquatic and terrestrial ecosystems. However, the meat of my data focused on determining the health of the streams, and was designed as a baseline study for Cornell University to use in the future. I myself was not satisfied with merely *knowing* there was an entanglement; I wanted to understand how the ecosystems, those separated by miles even, could be so necessarily adapted to each other through the organisms within them.

The next year, the summer dedicated to my Intel project, I decided to return to this question that I've been observing for the past seventeen years of my life but never answered: how does the behavior of all the organisms I've observed influence each other, and how adaptive are they to the environment? At what point does an organism redefine its niche based upon changes in their surroundings? How can these changes be used for the restoration of multiple ecosystems?

While I was upstate, I was alerted to a new statewide program called the New York State Natural Heritage Program that was performing a census of Odonate populations – dragonflies and damselflies. These organisms are incredible indicators of environmental health because they straddle two ecosystems: in their larval stage they live underwater and contribute to fish and amphibian food chains, and as they mature and form their functional wings they can move about into terrestrial ecosystems as well. I sorted through scientific literature to learn more about Odonates and how they function in nature, and came across something interesting known as a "biased sex ratio". This means that, for whatever unknown reason, females and males within an Odonate population do not inhabit the same habitat equally.

Just as I was performing this background research, I was exploring possible work sites in the area near by house and near the tree farm where I had worked the past year. I noticed that one area which I had explored since childhood in search of baby turtles and wild mushrooms had suddenly been demolished for housing developments. What was weird, however, was not so much the housing development (which has now accelerated into all the remaining natural areas in New York, sadly), but instead that the meadow itself was destroyed, yet there was a thin fluorescent yellow line near the wetland that read “Department of Environmental Protection”. If, as I knew, both ecosystems were somehow connected, how was it possible that the removal of the adjacent meadow would not disrupt the protected wetland?

For my Intel project, I integrated all of these concepts into an experimental hypothesis: if the meadow were to be removed from the symbiotic system of terrestrial and aquatic ecosystems, then the wetland itself would falter regardless of its designated protection. I wanted to use the special feature of Odonates as “keystone species” (organisms that are the centerpieces of ecosystems) to study how their movements and responses to the environment would be visible in both meadow and wetland systems.

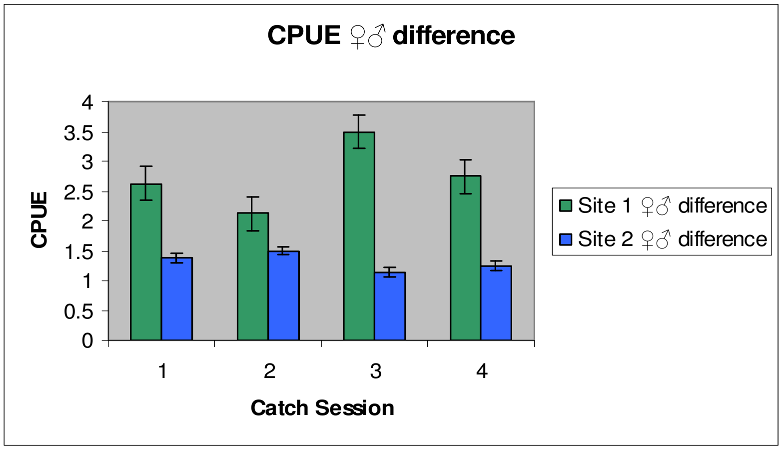
I returned to the concept of a “biased sex ratio” – why was it that females and males performed optimally in different habitats, different sub sects of the overall ecosystem. I researched the behaviors of Odonates and their physical characteristics in hopes of discovering subtle yet vital disparities between genders. I believed that there existed a behavioral “push” for females to inhabit a meadow caused by the aggressive behaviors of males in the wetland. Females require a much higher energy intake because they must travel between habitats to reproduce and lay eggs. In the process of traveling, they are exposed to many more predators in both air and water. Therefore, a female must depend on resources of the environment to make a decision: do I have enough energy to reproduce, or should I remain in the meadow to avoid predatory animals?

Because males remain only in the wetland, I realized that the movements of female Odonates between these meta-ecosystems of meadow and wetland could be used to understand how an environment influences the behaviors of key organisms, which could lead to changes in their niche and a restructuring of the entire system. This means that in that housing development I noted earlier, Odonate females that once inhabited the meadow environment would suddenly left with only the wetland, forcing them into a habitat in which there was no available niche. To me, this meant that current conservation policy is ineffective because it only preserves half of a larger ecosystem, disrupting the food web and ultimately destroying the wetland that was supposedly protected.

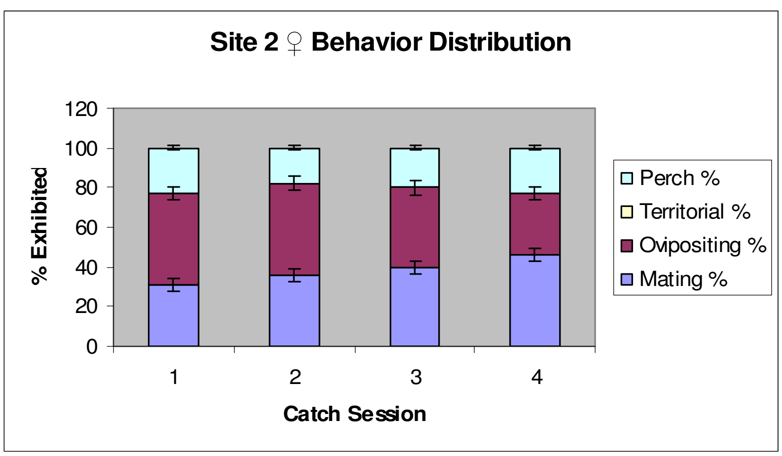
The title of my Intel project was "The Impact of Vegetative Coverage on Sex Ratios, Prey Availability and Predation Risk in Wetland Odonate Populations". Because vegetation is often associated with high biodiversity of insects and a higher coverage from predators, the stereotypical meadow, I decided to use levels of vegetation as my environmental factor that would produce visible results in female movements. I chose two areas of study, a wetland/meadow ecosystem with 75-100% of vegetative coverage and one with only 0-25%. Both areas had a 94% vegetation species overlap, so I could therefore assume that changes in prey availability and predation risk were due to volume of vegetation, not ecological differences.

For my study, I did not need any advanced mathematical formulas or crazy statistics. In ecological studies, there exists a measure known as a Catch Per Unit Effort, or CPUE. The CPUE formula is as follows: (# of specimens caught) / (# of netting hours x # number of netters within the habitat). This simple calculation in effect standardizes the number of specimens caught per session because it discounts any catching equalities caused by different numbers of participants and/or work hours. In my research I also relied heavily on tallying specimens. It was necessary for me to log the gender, behavior, and environment of each Odonate species to later be used in creating bar graphs divided between genders and then further correlated to different behaviors. According to my hypotheses, females should be more likely to perform reproductive related behaviors in a wetland environment, whereas males should be acting in an aggressive fashion.

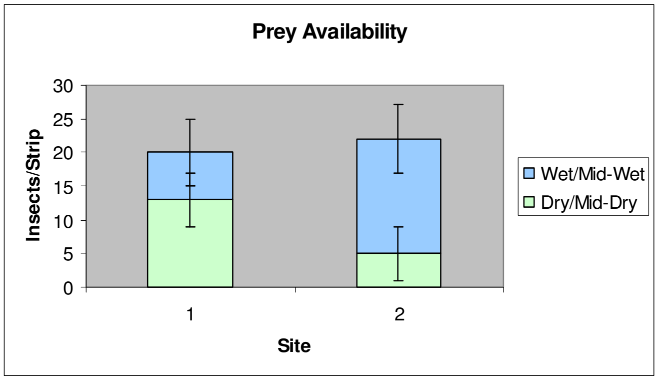
To assess prey availability, I measured the entire environment and cut it into four equal portions, placing a fly tape in each area that showed the gradient from pure wetland to pure meadow. I needed to calculate the prey density in each area and once again determine if there was a relationship between high prey levels in a meadow and many female specimens. I also determined predation risk in a similar fashion by scoring certain predatory populations on a rank system from "absent" to "abundant", each category given a numerical gradation that could be graphically represented. I had a tremendous amount of raw data from observations and collections, and it was crucial to demonstrate my argument through graphical means.



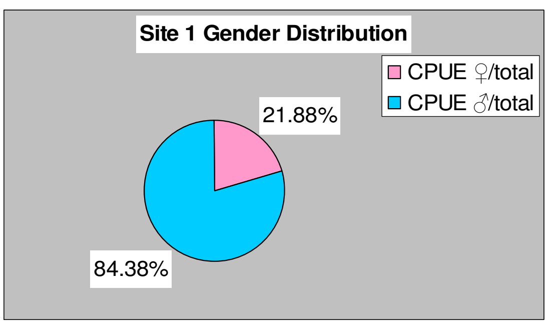
The graph above is an example of the CPUE values I used to standardize my data. This graph shows the difference in CPUE that results from subtracting the female CPUE from the male CPUE at both sites. All specimens were captured only in the wetland. Site 1 is the area with high vegetation; Site 2 is with low. This graph beautifully illustrates that there is a smaller biased gender ratio in areas with little to no meadow land because females are pushed into the wetland habitat to search for energy sources, supporting my thesis.

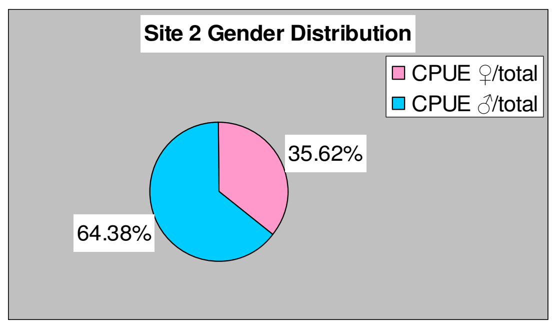


This graph is an example of how I organized my behavioral data. I divided all subpopulations based upon their behaviors.



This graph demonstrates the average prey availability per site. Here I've already made the calculations for insect per strip, taking into account the size and biomass of each insect, and now further broke apart the data to show the percent of the total prey availability distributed from meadow to wetland.





Although simple, these pie charts show my data in a way that is straightforward but effective. Clearly, there exists a stronger bias between genders in a natural area with its meadow and high vegetation, Site 1, as hypothesized based on my integrated theory of behavior.

While performing this experiment, every calculation and observation seemed to me to be a logical, natural progression of research. There were no odd formulas or rigid protocol; it was about the most logical way to catalogue an ecosystem and create a quantitative bridge showing the relationship between a variable in the environment and its subsequent ripple through the systems around it. The math I performed was tangled into the science itself.

In terms of direct application, my research shows that current conservation policy needs to evaluate an organism's role in an entire ecosystem, not just a single piece of it. It is more important to preserve a microcosm of both meadow and wetland than to have an isolated wetland without its necessary partner. On a more theoretical level, however, I personally enjoyed the ability to virtually dissect an ecosystem and derive from within it certain layers: the layer in which the abiotic factors interact, overlaid by organisms of various trophic levels, and followed at last by the overall picture of society and nature intermeshed. I was able to actually manipulate how organisms would behave in a natural setting!

I believe that to save something, one must understand it as if it were oneself. Too few studies are being performed on the world so intimately connected to us, and are instead isolated in stainless-steel laboratories with little glass beakers. An experiment executed in the field can be just as eloquent and scientific as those in vacuum-sealed containers— they just happen to be, in my opinion, more fun.

The best part about research is finding your own relationship with science and mathematics, whatever field you may choose. It might be something you've grown up with that has been right outside your backyard, a microscopic nanotube you've never ever dreamed of before, a cure for AIDS based on the folding of certain proteins, a new quantum theory of gravity… or even picking up a bug.