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NOTES FROM THE FIELD

The Biannual Newsletter of the Intercollege Graduate Degree Program in Ecology

The Pennsylvania State University

Ecology students clearing out parts of Millbrook Marsh on our Service Day

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ECOLOGY: PAVING THE WAY TO INTERCOLLEGE GRADUATE DEGREE PROGRAM

By: Elyse McMahon

The Ecology program was the first of its kind in 1972. I had the opportunity to interview Dr. Andy Stephenson to discuss his knowledge of the program. “Originally, the University was more of silo than it is now. Departments had their own grad program, their own requirements, etc. And you could only have one member from outside the department be on faculty,” said Dr. Stephenson. However, through the hard work of 12-15 faculty members across departments including Ecosystem Science and Management, Engineering, Biology, Agricultural Sciences, Forestry, Entomology, and others, the Ecology program was created and became a model for all other degree programs. The department graduated several masters students through 1973 and their first Ph.D. student, Shirley Mahaley in 1974. Dr. Mahaley went on to become name a distinguished Penn State alumnus for her national leadership in promoting diversity and inclusion in STEM.

Dr. Stephenson started his position here in August of 1978. “Penn State interviewed me in first two weeks of May [of 1978], and I decided if they offered, I was going to take that one. I heard about the Ecology program when I was here. I met Dr. Ed Bellis, the chair of the program, and he told me all about it and it sounded great. So, when I came, one of the first things I did was start the application process to become a member and to get on the graduate faculty in Ecology. There really wasn’t a time when I wasn’t in the Ecology program.” Over the years, Dr. Stephenson experienced many aspects of the program and watched it grow. Originally, both faculty and graduate students faced challenges of being understood by other departments at the University. “Faculty who taught core ecology courses didn’t always get the credit and many of the courses took several years to get cross-listed,” said Dr. Stephenson. However, over time and as the program gained recognition, many departments became familiar with Ecology and the program became even more interdisciplinary. One significant change Dr. Stephenson has seen is that now, all intercollegiate graduate degree programs are welcomed as “dual citizens” in all departments that have faculty involved in them.

Other events within the program have changed over time. One of the many events that I found interesting was the brown bag lunch series. Dr. Stephenson ran this lunch series where faculty and students would present progress reports, ideas for research, or new methods or equipment that they were using. “It was more of a workshop. When the program was really clicking, it brought in students who weren’t just in the Ecology program, but other graduate students interested in Ecology,” Stephenson said. There would be 40-50 people who normally attended. “It wasn’t a place to present final talks. It was a place to present your half-baked ideas,” Stephenson continued. I think it would be a great exercise and important for other students to hear what type of research others are doing along with creating more collaborative efforts within the program.

This interview with Dr. Stephenson was enlightening. I learned a great deal about how the program started, how it’s changed, but also, aspects that stayed the same. “The important things that haven’t changed are the fact that there has always been a core group of faculty in the program that want to see it succeed and graduate students are enthusiastic about the program,” Stephenson said.

MAKING AN IMPACT AT MILLBROOK MARSH

By: Madalyn Meyers and Suzanne Fleishman

On September 20, 2019, the Ecology Graduate Student Organization (EGSO) performed a service day at the Millbrook Marsh Nature Center by removing invasive plant species. The Millbrook Marsh Nature Center (MMNC) is home to a diverse wetland ecosystem of plants and animals. The MMNC is a popular location for members of the State College community to fish, bird watch, and have outdoor events. As a nonprofit organization, their mission is to educate and inspire people about the natural world, and to instill a passion for the environment through science, history, culture and art. Unfortunately, invasive plant species displace native plants at the site, threatening important habitats for the wildlife that the public enjoys. Throughout the marsh, four main invasive plant species dominate the landscape. Watercress (*Nasturtium officinale*) is an invasive aquatic species originating from Europe. It spreads along the water's surface and its seeds are distributed by the water's current, making it extremely important to tackle the invasion at the head of the stream first. This species is particularly harmful to stream dwelling organisms, because its overwhelming presence absorbs high levels of oxygen while effectively slowing down stream flow, creating hypoxic environments. Narrowleaf Cattails (*Typha angustifolia*) grow throughout the marsh, also thought to originate from Europe, and outcompete the native Broadleaf Cattails (*Typha latifolia*). Similarly, the invasive Bull Thistle (*Cirsium vulgare*) easily pushes out several native thistles species by showing resistance to the predation of thistle head weevils while native species do not. Lastly, while Black Walnut (*Juglans nigra*) is native to the area, their phytotoxin ability makes it difficult to promote biodiversity in the area if they become too prominent. Removing these trees before they dominate the area is necessary to maintain a healthy and diverse ecosystem.

Prior to the start of the annual fall picnic, the EGSO gathered at the marsh with the goal of releasing the pressure that these invasive species have put on the landscape. Overall, the group was able to remove enough Watercress to overflow three compost bins. The piles of invasive Cattail, Thistle, and Walnut saplings was so big, that we could barely see the service gate behind it. Water from the stream ran free and fast, which was a refreshing change of pace compared to the floor of dominating Watercress that greeted us as we arrived. The EGSO would humbly like to thank everyone who volunteered to help with this worthwhile effort. A special thank you goes out to **Kamrai Thai and Sushi House**, located at 901 Pike Street, Lemont, for sponsoring this event and allowing our organization to thrive and continue similar service days in the future. We hope that this experience of invasive plant removal effort ends up being the first of many for our group.

PENNSYLVANIA FISH & BOAT COMMISSION UNASSESSED WATERS INITIATIVE

By: Richard A. Novak

Across Pennsylvania there are thousands of miles of streams that provide us with bountiful recreational opportunities and ecological services. While many of the larger rivers have been well studied and classified, thousands of smaller and often unnamed streams remain unsampled. Therefore, it is unknown exactly what resources these streams produce, and what condition they are in. The Pennsylvania Fish & Boat Commission's (PFBC) Unassessed Waters Initiative has been working to make progress towards classifying all moving waters throughout the state.

Started in 2009, the goal of this program is to document the presence of wild trout in unassessed streams. Once a stream is identified as supporting wild trout, it can then be further classified into different biomass classes that have been developed by PFBC. Both wild trout status and high-quality trout biomass inform increased environmental protection for those streams by Pennsylvania Department of Environmental Protection.

This summer, I worked as a Fisheries Biologist Aide with the Coldwater Unit of PFBC. Based out of the Centre Region Office, our work was mainly focused in the Northcentral region of the state. GIS tools have been developed to identify unassessed streams that are most likely to hold wild trout, focusing effort and resources. Generally, we would target these priority streams to get them listed and classified as soon as possible. Backpack electrofishing was the main gear used to sample streams over standardized lengths depending on sampling purpose. Occasionally, we would use towboat electrofishing on larger streams, but these surveys were for re-inventorying areas that had already been classified. Some basic water data were collected at each site, including pH, conductivity, alkalinity, and temperature.

Brook trout and brown trout are the primary wild Salmonids found in Pennsylvania, with some scattered populations of reproducing rainbow trout scattered throughout the state. We would usually encounter only brook trout in smaller, colder streams, while in the larger and warmer streams we would either find a mix of brook and brown trout or a stream almost completely dominated by browns. In an unnamed tributary to Penns Creek, we found two young tiger trout, a hybrid of brook and brown trout.

I was surprised to learn how productive a small stream can be and the size of fish they can support. In many of the sites, we would find at least one exceptionally large trout, our reactions to which were often quite memorable. We'd really never know what could be lurking in a pool or hiding in an undercut bank until we sampled it. Thus, the fun and excitement that comes with electrofishing; it never got old for me to sample a stream and not knowing what we may find. We found brook trout in the 10-12-inch range somewhat often in the more productive mountain streams, lengths that are very respectable for this species. I remember numerous brown trout over 15 inches, with a handful at or above 20 inches, and again these were often found in small streams that one may not expect to support such large fish. Plus, all of the fish were beautifully colored and unique.

One additional measure we took was to inspect trout for gill lice. Gill lice are parasites that likely originated in a hatchery setting and have now spread into our streams. The females are visible to the naked eye and resemble a grain of rice that is affixed the gill tissue, operculum (gill covering), and possibly the pectoral or other fins. There are two species of gill lice and their respective hosts are the brook trout and the rainbow trout; it does not appear that brown trout are susceptible to this parasite. To inspect the fish, we would simply flip them over and gently check the gills and operculum for lice as well as the fins. In most cases where we encountered gill lice, specimens were collected off of the infected trout for later identification and testing. While the exact impacts of gill lice on trout remain unknown, it is important to keep track of their distribution and make efforts to prevent their spread.

While we were focused on collecting trout data, we found many other fish species as well. Species of dace, suckers, sculpins, and various minnow and sunfish species were all common finds across the state. I was able to observe some species for the first time, including American eel in Penns Creek and the four-spine stickleback in Big Spring Creek. Several rattlesnakes were spotted, as well as the occasional bald eagle or bear. It was a treat to be surrounded by Pennsylvania's wildlife and fauna on a daily basis.

My experience with PFBC was very engaging and positive. I greatly enjoyed working with the Coldwater Unit and am proud to have been a contributor to their meaningful efforts. The exploratory nature of the work always made things interesting and offered lots of learning opportunities for me. The Unassessed Waters Initiative will continue its great work into the future, classifying and informing protection of our vast wild trout and water resources across The Commonwealth.

DEER BROWSING IS NOT STOPPING THE DENSIFICATION OF FORESTS IN THE EASTERN US

By: Dr. Marc Abrams

White-tailed deer (Odocoileus virginianus) have increased during the past century in the United States. Greater deer densities may reduce tree regeneration, leading to forests that are understocked, where growing space is not filled completely by trees. Despite deer pressure, a major transition in eastern forests has resulted in increased tree densities. To reconcile this paradox, Dr. Marc Abrams along with his co-author Brice Hanberry, a research scientist with the U.S. Forest Service, applied generalized linear mixed models to compare deer densities during 1982 and then 1996 to tree stocking after about 30 years and 15 years of potential reductions of small trees by deer, for the entire eastern US and 11 ecological provinces. We also compiled deer browse preferences and compared preferred browse with trends in tree species composition from historical (1620 to 1900) and current tree surveys. The results of this study were recently published in the journal Ecological Processes.

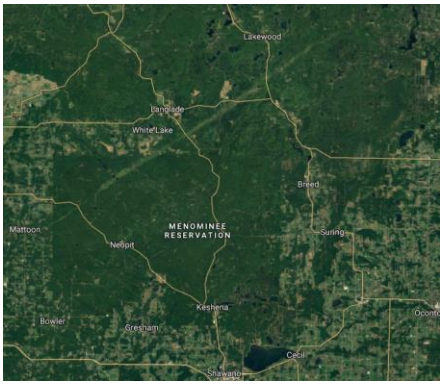
We found that the forested area of the eastern US, including a prairie ecological province, was equally well-stocked (52%) and understocked (48%) during 2011 to 2017 tree surveys. For 1982 deer densities, 38% of area had deer densities >5.8 deer/km2 (>15 deer per mile2) and for 1996, 66% of area had deer densities >5.8 deer/km2. Deer densities and tree stocking were not related significantly for the entire eastern U.S. Deer may reduce tree stocking in the Laurentian Mixed Forest; however, this province had both lower deer densities and greater tree stocking than other provinces. Furthermore, major tree species trends did not match tree browse preferences. We concluded that rather than too few trees as a result of deer browsing, there exist too many trees in most forest regions. This is a major ecological problem where historical open oak and pine forests had herbaceous understories, and currently, trees have captured growing space. We attribute other drivers, mostly the suppression of fire after the 1930s, rather than deer to explain this transition.

VISUALIZING FOREST FUTURES (VIFF) PROJECT AT PENN STATE

By: Amy Wrobleski

A feather waited for me on the hood of my car. Long, slender, and black; it likely belonged to one of the Bald Eagles that were nested in the Menominee forest that surrounded the small cabin I was staying in for the summer. My heart swelled in a combination of excitement and confusion. I was thankful for not only what I taught my students that summer, but what they taught me. Before the summer began, I could have used books to identify the feather, I could have talked about how the feather was shaped to keep the bird airborne, or how the colorful pigments are a result of generations of selection. What I learned that summer is that for Menominees, a Native American group with Wisconsin who I worked with in the summer of 2019, a feather is one of the most meaningful gifts that could be given. And the knowledge and perspective that I gained this summer was probably one of the most meaningful gifts that I could receive.

In the summer of 2019, after the first year of my Ph.D. program, I worked with the Visualizing Forest Futures (VIFF) project at Penn State under Dr. Erica Smithwick and the Sustainable Development Institute with the College of the Menominee Nation. While VIFF's primary goals were to look at the impacts of climate change and use virtual reality to measure the values of different communities, my goal was the mentor four Menominee students: Evelynn Grigon, Nicholas Schwitzer, Jacob Schwitzer, and Matthew Schwitzer. I encouraged them to develop their own projects, with a focus on community, storytelling, and ecology.



The tornado scar, stretching from the bottom left to the upper right corner of the landscape

The students worked together to create a virtual reality experience telling the story of a tornado that ripped through the northern corner of the reservation a decade ago. They wanted to compare areas that hadn't been disturbed by the tornado to areas that had, visually showing how the forest changes. I provided the students with resources on the importance of wind disturbance to midwestern ecosystems and lead discussions on the topic. They reached out to Menominee community members who managed the forest in the decade after the tornado event, as well as meeting with foresters from the Chequamegon-Nicolet National Forest to the north of the

reservation, which was also impacted by the tornado. I taught the students how to structure a narrative interview, as well as went over the ethics of interviewing.

We spent time out in the field, learning about the native plants on the tornado scar both on and off the reservation. The students learned how to capture and record audio, the whole group ducking behind trees and bushes so that they could get the "perfect" shot. We all spent hours in the computer lab, pulling the project together. But, like all experiences in the field, it wasn't all work. I learned about the wonders of Kwik Trip, the regional "good" gas station for Wisconsin, home of Glazers (terrifyingly sweet donuts that somehow are glazed on all sides). And more recently, Glazer flavored potato chips. After a *very* scientific taste test, we all decided that they tasted terrible and yet none of us could completely stop eating them. Wisconsin: home of amazing field work, outreach, and strangely flavored potato chips.

FINDING THE NUTRITIONAL "SWEET SPOT" FOR HONEY BEES

By: Makaylee Crone

Though there are countless studies detailing the effects of pesticides on bees, from memory loss to paralysis, there are few that propose solutions aside from ceasing the use of problematic pesticides. This summer, we set out to see if we can reduce the effects of pesticides on honey bees (*Apis mellifera*) by adjusting their diets.

Pollen is the main source of proteins and lipids in a honey bee diet. There is growing evidence that the impact of stressors, including pesticides, parasites, and pathogens, can be mitigated by high-quality nutrition. Recent research has also found that when pollen is chemically split into two macronutrient components, the proteins and lipids, bees fed lipid-rich pollen during parasitization by a common honey bee pest had a higher level of survival than those fed protein-rich pollen, indicating that lipids may be more important for stress tolerance. This led us to hypothesize that bees fed lipid-rich pollen would have a higher rate of survival than bees fed protein-rich pollen when exposed to the organophosphate pesticide chlorpyrifos.

To test this hypothesis, we conducted trials on >3000 bees in two different experimental systems. One day-old honey bees were collected and sorted into cup cages. In each cage, bees were fed a sucrose solution and a pollen diet (more details below). On day five, all groups except the control began receiving 5.8 ppm chlorpyrifos sucrose solution to induce pesticide stress, which they continued to feed on for the remainder of the 12 day mortality monitoring period. Mortality was recorded daily and analyzed using Kaplan-Meier survival curves. Bees were collected from six different honey bee colonies, so we could take into account any genotypic effects.

We tested the effects of pollen diets altered by either extracting or adding proteins and lipids, using protocols from previous studies. With these manipulations, we were able to create diets that had protein:lipid ratios of 1.6:1, 2:1, 4.5:1, 5:1, and 10:1. We also included a pollen diet that was unaltered and remained at 3.6:1, a sucrose only diet, and a control group fed the same P:L ratio that was not exposed to pesticides.

In the extracted diet trials, bees fed unaltered (3.6:1) pollen had near equal mortality to those fed protein-rich (4.5:1), and both had significantly higher survival than those fed lipid-rich pollen (2:1).

In trials where proteins or lipids were added to pollen, bees fed unaltered (3.6:1) pollen had significantly higher survival than bees fed lipid-rich (1.6:1) or protein-rich (5:1) pollen. Mortality continued to significantly increase as bees were fed more protein in the 10:1 treatment. Our hypothesis was not supported by our results, and it appears as though any pollen that is too protein or lipid-rich is harmful for honey bees in this context. Our results indicate that there may be a "Goldilocks sweet spot" for honey bee nutrition between ~3.6:1 and 4.5:1. This "sweet spot" theory is supported by the work of another student in the Grozinger lab, Tyler Jones, who found that a P:L ratios averaging 4.3:1 was collected by honey bees from 15 different apiaries across Pennsylvania in August of 2017.

As we learn more about honey bee pollen preferences, this leads to interesting land management implications. Though we had the goal of altering pollen to decrease stress, it seems as though we cannot simply feed honey bee colonies that will be exposed to pesticides additional macronutrients by adding canola oil (lipids) or bovine casein (protein). If honey bee P:L preferences truly are narrow, we will need to provide nutritional supplementation by planting flowers at the edge of agricultural sites, a strategy that is already in use by some land managers to increase pollinator forage and habitat. A wide variety of flowers with different P:L ratios would allow bees to balance their macronutrients on their own to fit their nutritional needs. These resources could also be used by wild bees, which may have different dietary P:L preferences than honey bees. For example, bumble bees have been found to favor pollen around 5:1 under normal conditions.

Though these results are exciting, more work will need to be completed to determine if we have found the ideal nutritional range or not. It could be possible that honey bees are less tolerant of added canola oil and bovine casein than the bumble bees in a previously mentioned study. It could also be possible that this range only suits honey bees experiencing stress from organophosphate pesticides, and the ideal P:L ratio may change based on the pesticide class used, or another type of stress altogether, such as pathogens or parasites.

Next field season I plan to test the tolerance of honey bees to pollen diets that are naturally different rather than by artificially altering P:L ratios. We are also currently examining expression of genes involved in different metabolic and detoxification pathways in honey bees, to better understand the mechanisms underlying the differences in survival that we observed. This project has taught me that it isn't the end of the world if your hypothesis isn't supported by your data. At the end of this field season we were left with more questions than answers, but that makes continuing our work all the more interesting!

ANDERSEN AWARD REFLECTION

By: Melanie Kammerer

Melanie presenting her talk on how landscape and climate affect wild bees

This fall, I travelled to St. Louis to participate in the 2019 Entomological Society of America annual meeting. It was an exciting conference full of entomophiles, including a record setting 1,150 students! I had an amazing opportunity at this meeting to co-organize and moderate a symposium entitled 'How to Speak for the Pollinators: Using Big Data to Manage and Conserve Pollinator Communities.' We had a wonderful line-up of speakers using 'big data' for insect conservation, including fascinating presentations on identifying bees from wing photographs with machine learning models and monitoring bumblebees visiting flowers by recording their buzzing. I was also excited to hear from our international speakers working on butterfly conservation in nature reserves in Germany and honey bee landscape ecology in Kenya.

During the symposium, I presented one of my dissertation projects using a large monitoring dataset to understand the effect of land use and climate on wild bee communities. After my presentation and throughout the week, I was able to talk with several other pollination ecologists and gather some crucial feedback on my work, including an encouraging report of anecdotal evidence that matched my results!

Reflecting on my experience, I would highly encourage other students and early career scientists to consider organizing a symposium at an upcoming scientific meeting. Once we chose a theme, I was pleasantly surprised by how many of the speakers we invited agreed to participate. Sometimes networking at a large conference is difficult (we all know we *should* network more…), but organizing a symposium was the perfect chance to interact with scientists you've always wanted to meet or get to know better. It was one of the best networking opportunities I've had in graduate school, and I'm grateful to my adviser and co-organizer, Christina Grozinger, for the initial suggestion and guiding me through the planning process. I would also like to thank the Ecology Program, the award selection committee, and Dr. Frank A. Andersen for the opportunity.

Publications

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Davis, C. L., **Miller, D. A.**, Grant, E. H. C., Halstead, B. J., Kleeman, P. M., Walls, S. C., & Barichivich, W. J. (2019). Linking variability in climate to wetland habitat suitability: is it possible to forecast regional responses from simple climate measures?. *Wetlands Ecology and Management*, *27*(1), 39-53.

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Nihranz, C.T., Kolstrom, R.L., Mescher, M.C., De Moraes, C.M., & **Stephenson, A.G**. (2019) Herbivory and inbreeding affect growth, reproduction and resistance in rhizomatous offshoots of *Solanum carolinense* (Solanaceae). *Evolutionary Ecology* 33(4): 499-520

Rich, L.N., **Miller, D.A.**, **Muñoz, D.J**., Robinson, H.S., McNutt, J.W. and Kelly, M.J., 2019. Sampling design and analytical advances allow for simultaneous density estimation of seven sympatric carnivore species from camera trap data. *Biological Conservation*, *233*, pp.12-20.

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White, S., Faulk, E., Tzilkowski, C., Weber, A. S., **Marshall, M.**, & **Wagner, T.** (2019). Predicting fish species richness and habitat relationships using Bayesian hierarchical multispecies occupancy models. *Canadian Journal of Fisheries and Aquatic Sciences*

Williams, D. P., **Brittingham, M. C**., & **Avery, J. D.** (2019). Eastern Bluebird (Sialia sialis) feeds Tree Swallow (Tachycineta bicolor) nestlings: Support for location-based decision rule. *The Wilson Journal of Ornithology*, *131*(3), 633-637.

Grants, Awards and Achievements

Onofrio, Lauren and **L. Leites**. Don't move me too far, I'll be homesick: learning about adaptation to climate in forest trees and its consequences under a changing climate. Competitive Outreach Award from The Arboretum at Penn State.

Sarah Isbell: USDA- National Institute of Food and Agriculture (NIFA) Predoctoral Fellowship (2019-2021, $120,000), "Using cover crop mixtures to shape the soil microbiome for targeted nitrogen cycling services"

Dr. Marc Abrams: Lifetime Achievement Award at the 6th Fire in Eastern Oak Forests Conference.

Noah Winters: USDA NIFA Predoctoral Fellowship. (August 2019-August 2021, $120,000). Uncovering the Genetic Basis of Non-Host Resistance in Wild Relatives of a Perennial Tree Crop.

Shannon White (advisor: Tyler Wagner) received the Alumni Associated Distinguished Dissertation Award and was named a Distinguished Doctoral Scholar. This award, which is considered to be among the most prestigious awards given to graduate students across the university, recognizes the accomplishments of her dissertation research on the conservation significance of genotypic and phenotypic variation in populations of cold water fish influenced by climate change. As part of the award, she received $5000 and the Distinguished Doctoral Scholar medal.

Asia Murphy-Received the Intercollege Graduate Student Outreach Achievement Award. This award recognizes outstanding research achievements of graduate students that bring their research to the community.

Laura Jones, Miranda DePriest, and Caylon Yates: Received the Alfred P. Sloan Foundation's Minority Ph.D. (MPHD) Scholarship.

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