



Madeleine McGrath's High School Junior Project: A Professional Research Experience with NMSP

By Lisa Fields

At Germantown Friends School in Philadelphia, PA, high school juniors spend the month of January in a Junior Project as volunteer interns. The internships are selected to engage students in a professional, academic or humanitarian interest to gain experience outside the classroom.

Student Madeleine McGrath sought a Junior Project experience that would place her in a laboratory setting. She explained, "I always enjoyed science and math, and I'm taking Biology and Advanced Chemistry this year. I wanted to learn what it was like to do laboratory research. I'm from suburban Germantown in Philadelphia and haven't been exposed to agriculture. I looked on-line at the work done by the Nutrient Management Spear Program (NMSP) in the Animal Science Department at Cornell University, applying agricultural research to extension outreach. I thought it would be an exciting opportunity to do laboratory research work and also gain some knowledge about agriculture."

McGrath arrived at NMSP on January 2, 2019. Professor Quirine Ketterings, leader of the NMSP, designed a project for Madeleine that included laboratory work relevant to the program's focus on evaluating active carbon in soils. Active carbon is measured using a permanganate extractable carbon method. As it is considered to be sensitive to agricultural management practices, measuring active carbon is a useful tool for farmers and researchers to evaluate soil health and productivity.

"My project was '*Comparison of Two Methods to Determine Soil Active Carbon*,'" McGrath noted. "My first assignment when I arrived at the NMSP was to read materials that would give me an understanding of what active carbon is and how the permanganate method determines this in soils. Next, with guidance from Quirine, I prepared my research proposal that described the objectives and significance, methodology, and research process for my project."

The purpose of McGrath's project was to assess the accuracy and precision of an alternative active carbon extraction and determination method. The alternative method described by the team as the 'Vanek method' uses an inexpensive Hanna Phosphate meter (a colorimeter). The original method for permanganate extractable carbon is referred to as the 'Weil method' and requires a spectrophotometer. The Vanek method's equipment is considerably cheaper than the Weil method's, but the Vanek method is only useful as a replacement if the results are repeatable and consistent.



Madeleine McGrath weighs soil samples for active carbon analyses in the NMSP laboratory at Cornell University.

Greg Godwin, NMSP Research Support Specialist, supervised McGrath in the laboratory and taught her the methods she needed to learn. "I got to use equipment that was new to me, such as the spectrophotometer. I always had support from Greg, so it never felt overwhelming," McGrath said. "In the timespan of my Junior Project of just over three weeks, I was able to take a research project from the point of learning how to write the proposal through the execution phase and compilation of the results."

Godwin enjoyed working with McGrath. "I was consistently impressed with Madeleine's enthusiasm and independence. She was running samples on her own within days."

McGrath described the laboratory work she performed. "I needed to run the same five soil samples ten times for each method. I prepared all the samples, which involved accurate measurements and a lot of precise and highly organized notes. In order to compare the outcomes of the Weil and Vanek methods I also needed to evaluate the means, standard deviations and ranges of the results. An additional piece was to run both methods on a series of soil samples with varying crop and nutrient input histories and see how well the results lined up across those samples."

Presenting her proposal and her project's final results to the NMSP team was a significant part of McGrath's research project. Ketterings explained, "I asked Madeleine to present to the team when she had her proposal ready and had gained some experience in the laboratory, and again at the end of her internship. It is important for students to be able to convey what they are working on and why, in addition to talking about methodologies. Madeleine did a phenomenal job with both her presentations."

"I was nervous when I presented my proposal," McGrath said. "Everyone in the room was a knowledgeable professional, and I wanted to be very well organized and use the correct terminology. I got very encouraging and useful feedback, so my final presentation

of the project results was a lot less stressful."

She added, "I embarked on this experience prepared to work and learn, but I never expected the process to be so collaborative. Walking into a new experience as I did could have been intimidating, but I quickly grew comfortable. The environment at NMSP is really positive, and everyone's attitude here reflects that."

The results of McGrath's project indicated that the Weil and Vanek methods generated comparable but not identical measures of soil active carbon. Further improvements of the Vanek method should be considered to increase repeatability and to better evaluate consistency among both methods for a given set of soils.

McGrath summarized her internship with the NMSP. "A highly important aspect of having the Junior Project is experiencing first-hand the difference between a high school class where you learn skills and the professional setting where the integrity of the process really matters. During my NMSP internship, when any part of the process didn't go quite right, I learned the steps to take to troubleshoot and correct it. Getting the chance to be immersed in that environment outside of school was a tremendous learning experience that was very satisfying."

McGrath added, "The importance of agriculture drew my interest in the NMSP's research, and my experience really expanded my understanding of some of the management decisions that farmers face. The month I spent in the laboratory doing research was a life changing experience for me, and it has helped me to decide that I want to pursue a career in science. I am truly grateful that I had this incredible opportunity."

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The **Nutrient Management Spear Program** (NMSP) is an applied research, teaching and extension program for field crop fertilizer and manure management on dairy and livestock farms. It is a collaboration among faculty, staff and students in the Department of Animal Science, Cornell Cooperative Extension, and PRO-DAIRY. Our vision is to assess current knowledge, identify research and educational needs, facilitate new research, technology and knowledge transfer, and aid in the on-farm implementation of strategies for field crop nutrient management including timely application of organic and inorganic nutrient sources to improve farm profitability while protecting the environment. An integrated network approach is used to address research, extension and teaching priorities in nutrient management in New York State. For more information on NMSP projects and extension/teaching activities, visit the program website (<http://nmsp.cals.cornell.edu>) or contact Quirine Ketterings at qmk2@cornell.edu or (607) 255-3061.