LESSONS LEARNED FROM A CAREER IN FORESTRY SCIENCE

Ruth Yanai: Don't Be Afraid to Ask Questions

Editor's note: This month we feature Ruth Yanai, a professor at the State University of New York (SUNY) College of Environmental Science and Forestry (ESF) in Syracuse. Yanai received the 2020 Barrington Moore Award in recognition for her research in forested ecosystems. Among her accomplishments are advancing uncertainty analysis in ecosystem studies via the QUEST (Quantifying Uncertainty in Ecosystem Studies) research network, leading the Multiple Element Limitation in Northern Hardwood Ecosystems (MELNHE) study, and publishing more than 100 journal articles on topics ranging from root lifespan to country-level forest carbon accounting. In this essay, Yanai shares the importance of questioning assumptions and adapting to a virtual environment.

By Ruth Yanai, responding to an interview by Andrea Watts

My interest in forest research dates to 1979, when, as an undergraduate, I was inspired by a course I took at the Yale Forestry School taught by Herbert Bormann and Tom Siccama. Herb Bormann had originated the approach to monitoring ecosystem input- output budgets in small headwater catchments at the Hubbard Brook Experimental Forest, beginning in the 1960s. Tom Siccama encouraged me, and in 1983 I went back to Yale as a PhD student to conduct nutrient cycling research at Hubbard Brook under the direction of Bormann.

My assignment was to characterize the effects of clearcutting on phosphorus cycling in a whole-watershed experiment. I became known as a phosphorus (P) expert in a field where more researchers are interested in nitrogen (N). Now, decades later, with Tim Fahey (Cornell University) and Melany Fisk (Miami University), I lead a project involving sites at Hubbard Brook as well as other forests in the White Mountains of New Hampshire, in which we have been applying N, P, or neither, or both, in large plots in 13 forested stands. Most forest fertilization experiments add N, and maybe N plus P, or maybe lime, but ours is the first long-term experiment in a temperate forest to have all the combinations of N and P addition (a "full factorial" design). Nobody had tested the effect of P addition alone because they all assumed that N was more important.

But guess which nutrient has made the trees grow more—P! We thought that only tropical forests or highly weathered soils were limited by P. How could our system be P limited? It was glaciated only 10,000 years ago—we should have plenty of P, and N should be the element in short supply. Keep in mind, however, that human activities have vastly increased the amount of N available to ecosystems, including that deposited in acid rain. Unfortunately, we can't go back in time to see whether our northern forests were always P limited or whether this is a consequence of air pollution since industrialization.

How forestry research has changed

This is one way that forestry research has changed. In the early years at Hubbard Brook, and this was true of my dissertation, we thought we were studying "undisturbed" ecosystems, and comparing them to those we were managing. Now, it's abundantly clear that no forest in the world is in a "natural" state. The concentration of carbon dioxide in the atmosphere has changed, which is critically important to photosynthesis. The climate has changed, which affects all organisms. Pollutants affect forests, as in the case of N deposition serving as a fertilizer. Even the players have changed, with exotic plants, animals, and insects moving around the planet. We can't pretend that we are studying forests in a natural state. Maybe we don't need to.

On being unafraid to ask questions even in the face of authority

When I was a student, I was not afraid to raise my hand and say, 'I don't understand this,' because I knew that if I didn't get it, someone else didn't get it. As an instructor, if I'm teaching a concept and the students don't understand it and they're afraid to say so, then I'm not being effective in teaching that concept. I tell students to ask the person next to them, and if that person doesn't know the answer either, then they need to tell me. I'll stop what I'm doing and address it, rather than lose the opportunity to bring them along.

There is a lesson here for parents as well as for teachers. We shouldn't punish children for making honest mistakes—and we need to encourage honesty when it comes to admitting

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ignorance. I feel now that my courage to ask questions, and maybe even my comfort with uncertainty analysis, is partly a gift from my parents, because I was allowed to make mistakes.

A corollary of this gift of being allowed to admit to not understanding something is to be able to recognize untruths--not to believe in the Emperor's new clothes, if you can't see them. I came of age, politically, in the 1970s, organizing non-violent direct action and civil disobedience. For example, on the way home from my first field trip to Hubbard Brook, as part of that class I took in 1979, I joined an illegal occupation of the Seabrook Nuclear Power Station by the Clamshell Alliance. At that time, I used to wear a button that proclaimed "Question Authority." I stopped wearing the button when I realized that it wasn't saying anything people didn't already know about me.

Advice to our youth? Just because someone tells you that something is true doesn't mean that you should believe it. You should think about it and see if it makes sense, and test if it you have any doubts. If I ask a student, "Why are you doing that?" and they say, "Because you told me to," I say, "That's a terrible reason. You shouldn't do it unless you think it's right." So, you guessed it: my parents never said, "Because I told you so." Admitting ignorance (or disbelief) may be a privilege of being female, in our society. Men are not supposed to ask for directions, but women can. Men are not supposed to ask for help, but women can. I am grateful for any privileges of birth or upbringing that allow me to ask questions. They helped to make me a scientist—and they allow me to be comfortable with quantifying uncertainty.

Identifying and quantifying uncertainty

When I was first studying forest nutrient cycling, for my dissertation on the pools and fluxes of P at Hubbard Brook, I was troubled by the lack of confidence intervals in ecosystem budgets. I was particularly irked by the reported budget gap for N: there was more N in forest growth, according to the best calculations than could be explained by the measured inputs (like precipitation) minus outputs (like stream export) and the difference, 14.2 kg/ha/yr, was attributed to N fixation, although nobody could measure this. 14.2, as if they were confident of that third digit, plus or minus what?

But it's not easy to establish confidence in ecosystem budgets—replication isn't an option, for a whole-watershed clearcutting experiment. I fretted about this problem for 25 years, until in 2008 Chuck Rhoades and Jennifer Knoepp were planning a symposium on forest nutrient budgets for the annual meeting of the Soil Science Society of America. (Rhoades is a research biogeochemist with the USFS Rocky Mountain Research Station, and Knoepp is an emeritus research soil scientist with the Southern Research Station.) I suggested that someone should address uncertainty, and they signed me up to give a talk! Fortunately, I was just starting a sabbatical with Ed Rastetter, a senior scientist at Woods Hole (to model N and P co-limitation, which helped the MELNHE project get funded) and he told me I could do Monte Carlo in Excel (not recommended if you want to do 10,000 iterations, but feasible for 100). I propagated uncertainty in the allometric models used to calculate forest biomass from tree inventory and had my first answers in time to present at the symposium. The uncertainty in N in forest biomass at Hubbard Brook was about 8% of the total.

A year or two later, when I organized a session on uncertainty analysis for the Hubbard Brook scientists, I was joined by Mark Green and John Campbell, and ultimately many others, to form a Research Coordination Network to promote and improve uncertainty analysis (QUEST; Quantifying Uncertainty in Ecosystem Studies). We organize workshops, publish papers, and maintain a website with tutorials, bibliographies, and sample code (visit us at www.quantifyinguncertainty.org). Our latest project, QUERCA (Quantifying Uncertainty Estimates and Risk for Carbon Accounting), will help to improve the uncertainties reported by countries claiming reductions in carbon emissions from tropical deforestation. I feel really good about contributing to the effectiveness of international carbon finance for climate mitigation. Just this week we got our first contract with the World Bank, which administers REDD+ (Reducing Emissions from Deforestation and forest Degradation, conservation, sustainable management of forests, and enhancement of forest carbon stocks).

By the way, the answer to the confidence on that 14.2 kg/ha/yr of missing N? It's plus or minus 57kg/ha/yr, because it's so hard to measure changes in N in the soil. So, although we can be very confident that the vegetation was getting N from somewhere, we can't say, based on the budget, whether it was coming from the atmosphere (via N fixation) or the soil (via N mineralization). Understanding exactly what we do and don't know is very helpful to figuring out how to get better information.

Play to your strengths

Young people should be trying to fill gaps in their knowledge and in their skill sets. But after a while, you come to a point when it's smarter to admit what you're not good at. Then you look for people who complement your strengths, to collaborate with. It feels so much better to be providing what you know you do well and what brings you joy, than to be struggling to keep up on something you're not good at. And you can appreciate and reward

the contributions from your collaborators.

Improving collaboration in virtual settings

This pandemic has been a global experiment in lots of ways. For one thing, it has showed us the value of meeting in person. My most cited first-authored paper, "Soil carbon dynamics after forest harvest: an ecosystem paradigm reconsidered" was the product of a hallway conversation at a professional meeting. Bill Currie, Christy Goodale and I were criticizing Wally Covington's claims about how forest floor organic matter decomposes, but we each had different problems with it. (Currie is a professor with the University of Michigan School of Environment and Sustainability, and Goodale is an associate professor at Cornell University in the Department of Ecology & Evolutionary Biology.) We decided to write a paper together. I don't know if that would have happened in a Zoom chat box. Professional meetings bring together people with different approaches to similar research problems, and we aren't doing that now.

But there are also benefits to meeting virtually. Last month, I facilitated a meeting of the Committee of Scientists from the Hubbard Brook Ecosystem Study. The goal, inspired by our surprising results about P limitation, was to develop ideas for research on P to be included in our next proposal to the National Science Foundation, which supports Long-Term Ecological Research. I created a Google document to allow participants to share their comments during the Zoom presentations on different topics related to P. It was exciting to see everyone working in the document simultaneously, typing ideas and pasting in graphics and hyperlinks--I couldn't possibly follow it all! It was a strange experience because I felt responsible for facilitating, but having outsourced the product, I wasn't really needed.

One of the scientists told me afterwards that this was the best online meeting ever. He had expected to organize field equipment while listening in (I confess I prep dinner while attending remote faculty meetings), but instead he was totally engaged in the side conversations and brainstorms and taking notes in the google doc. He said it was better than in-person discussions getting cut off to rush to the next topic. Similarly, last spring, when we moved to remote instruction, I was pleased to find that some students who didn't speak out in class were more comfortable typing. And I've had collaborators in other countries come to visit my Zoom classes, at no added expense and with no jet fuel burned. We are finding new ways to improve communication and collaboration and equalize participation, and we will continue to benefit from these developments long after the pandemic is over.

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Do you have lessons learned that you would like to share with fellow SAF members in a future issue? Please e-mail Andrea Watts, wattsa@safnet.org.

This article has been updated to reflect edits that should have been included in the hardcopy edition of The Forestry Source.