



By Sam Matey

Scientist Spotlight #1: An Exclusive Interview with Dr. Elena Bennett

Dr. Elena Bennett (pictured) is an ecosystem ecologist working at the McGill School of Environment of McGill University in Montreal. She is the leader of the Bennett Lab at McGill, a fellow of the Royal Society of Canada, and the cofounder of the Seeds of Good Anthropocenes project. Her research currently focuses on ecosystem services, the Good Anthropocenes project, and human impacts on planet-scale nutrient cycling.



A lightly edited transcript of this exclusive interview follows. This writer's questions and remarks are in **bold**, Dr. Bennett's responses are in regular type. **Bold italics** are clarifications and extra information added after the interview. Dr. Bennett's lab website is available at

<http://bennettlab.weebly.com/>. We encourage you to check it out!

Hi Dr. Bennett! There are so many things I want to talk to you about! Let's start chronologically, if you will-why did you become a scientist? And more specifically, why did you become an ecosystem ecologist, interested in how humanity is transforming our world's natural cycles and interactions?

In a sense, I became an ecosystem ecologist by accident. I went to undergraduate thinking that I would study ecology, and when I was there the ecologists in the biology department were mostly on sabbatical. So I ended up switching over to environmental studies, and that put me on a path where I thought I was going for environmental history. Then, I happened to take a class with a person who ended up being my Ph.D. supervisor. It was a class on Lakes and Society, and it was just so good, even from the first lecture. I was like "That is what I need to do and this is the person I need to work with."

That is awesome! So, one of your major research topics is quantifying planetary boundaries, the points at which human-caused changes could destabilize processes across the Earth system, correct? You've written several papers on



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phosphorus cycling in particular, and you've written about how humanity's impact on the phosphorus cycle has already exceeded the planetary boundary, thanks to our use of fertilizer. Could you tell us, the readers of this interview, more about how this planetary scale nutrient cycling works, how you measure it, how humans are involved, and why it's important?

Wow, that's a big question. I'll talk specifically about phosphorus, although there is planetary-scale cycling of other nutrients. You hear about carbon a lot because of climate change, and many other biogeochemists study nitrogen. Phosphorus is interesting because it's a major component of fertilizer. Phosphorus has a natural cycle, that would have it being eroded from rock, and then it becomes part of the soil, and then it's taken up by plants, and then it might be eaten by animals, and then the animal might die, and it goes back into the soil. Eventually, it would make its way from a rock into the ocean over many thousands of years. Now we dig it out of the rock ourselves, put it in bags of fertilizer, and ship it around the world. Then it's taken up by plants, and we cut down the plants and ship the plants around the world. We've really radically changed how much is coming out of the rock to start with and where it is around the planet. That creates a number of problems for us, which is why we have a planetary boundary for phosphorus.

So, how do you define the planetary boundary? They're like quantitative lines in the sand after which we'd expect major transformation of the earth system. For phosphorus, we find those boundaries based on the point at which we'd expect significant eutrophication—you know, over-fertilization, or pollution-of freshwater systems. **(For more on eutrophication, check out goo.gl/5Twhth).**

There are similar ones for climate change, biodiversity loss, et cetera. The way to think about it is as that transformation point at which things become radically different from what we know.

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That is awesome! Well, obviously it's not awesome that we're breaking planetary boundaries, but it's awesome that you're working at this level, that humanity is trying to find out how far we've gone. To expand on the phosphorus cycle, could you give me an example the impact of phosphorus on water quality?

The way that this works is that we add phosphorus to agricultural areas because it's a great fertilizer, but it's a great fertilizer for all kinds of systems, including aquatic systems. So, when it gets into our lakes, it causes a lot of algal growth. We put it on our agricultural fields, but it doesn't stay in one place, it moves. It rains and the soil moves, and the soil has little phosphorus particles stuck on it. Or maybe it moves dissolved in water, and that gets into the waterway and we get this excessive algal growth. And that causes a number of other problems. For one thing, when the algae die and decompose, it smells really bad for one thing, but it also takes oxygen out of the water, which leads to fish death. The algae themselves can also release toxins that mean we can't use the water. **Like the red tide in Florida that was in the news recently, or the lakes that have become so eutrophic that nothing can get oxygen from the water.** Yeah, that's right. And there's pretty good evidence that that's spreading. It's happening more and more in lakes near agricultural systems all around the world, and we're having dead zones in coastal areas. They're caused by a combination of nitrogen and phosphorus, to be fair, so there's more than one nutrient at play in those systems.

Fascinating. So to pivot from phosphorus, another one of your research topics is ecosystem services, the benefits that ecosystems provide human society. And, correct me if I'm wrong, you are also the co-chair of ecoSERVICES (, a worldwide research project on how ecosystem services are produced and governed. Could you tell our readers more about ecosystem services and your research on this topic?

"Ecosystem services" is the shorthand for basically all the benefits that people get from nature. It's stuff people think about all the time, like food or fresh water. It's the things we enjoy a lot, like recreation, hunting, and aesthetic value. And it's also things we don't think about at all, like nutrient cycling. That rarely comes up. We're not like "Wow, what a

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services has mostly been about trying to understand how we can better manage landscapes for multiple services. So, trying to make sure that we don't end up with landscapes where we're really just producing food to the detriment of every other service that we care about. Instead, we can manage for landscapes where we can have recreation, alongside production, and alongside good nutrient cycling.

Awesome! So, building on that, you've also led a project known as the Monterege Connection, in which you do exactly what we were just talking about, in which you model the land use, ecosystem connectivity, ecosystem services, and biodiversity of a specific region in Quebec. Could you tell me more about that project's goals and share some of your experiences working in Monterege? What are some of the new connections you found?

One of my favorite things about that project was that it was designed with scientists and decisionmakers working together, so we spent a long time trying to figure out what questions were scientifically interesting but were also useful to the landowners. That was really fun, because even though I might try to be practical in my research, I'm not always practical, because my head is full of stuff that's interesting to other scientists. The decisionmakers had practical questions that weren't always scientifically interesting, so we had to find a middle ground. Once we figured that out, we found that we had some common ground around this idea of multifunctional systems that would provide multiple services. The communities had some grant money they could use to restore forests, but they didn't know which forests. We could figure out with our measurement and models which forests were more likely to end up delivering a better package

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of ecosystem services to the landscape based on what kind of forest they are and where they are in the landscape. It was really fun, it was a huge project involving lots of people and lots of different ecosystem services. We looked at agricultural production since it's a big agricultural area, recreation, pollination, nutrient cycling, maple syrup production, carbon storage...lots and lots of different things. **That's awesome! I saw a video about that project, actually-didn't you find that if you kept some forest fragments you helped with pollination, since bumblebees needed some forest habitat?** Yeah, what we found with the bees was how the diversity of land uses was affecting the pollinator diversity and pollinator visitation rates for apples. Apples are a pretty important product in this part of the world, and so that was



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important. It was neat to think about how having a mix of suburban land uses around these apple agricultural areas was important.

Another of your projects that really interests me, in fact interests me the most, is the Seeds of a Good Anthropocene initiative. Here, you collect stories of social and ecological initiatives that are helping to create a good Anthropocene, or as you describe it a “just, prosperous, and ecologically diverse world.” I think that’s really inspiring, by the way. These are some truly amazing things that you’re describing, from a project planting oyster beds to protect the Alabama coastline from sea level rise to a group offering Bornean villages healthcare in return for commitments to reduce deforestation. Could you tell me about some of your favorite seeds, and about the project as a whole?

I really like that Bornean healthcare one, because it started in a place that I find essential. It starts with listening. It started with someone going in and saying “You tell me what’s important.” That really affected my experience in the Monteregie, where I needed to not just come in as a scientist and say “Listen, people, I have answers for you,” but say “What are your questions? How can I help?” So that one really resonates with me for that reason. Plus, I just think it’s neat to find a connection between deforestation and healthcare. I just love them all, they’re just so interesting to me.

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There are a few in Montreal that have to do with food systems. There’s one called Santropol Roulant, and what I like about that is that it started as essentially a Meals on Wheels program for seniors, then they decided they would start doing deliveries on bikes because it was greener. Then it developed into all of these other things. They have a restaurant that’s a social gathering place, and they have this multigenerational connection between people. They went from being this small thing about delivering food to the elderly, and then they expanded into all kind of food things with gardens, and now it’s about urban gardening and greening urban areas and connecting peoples. They have grown in terms what they’re interested in, and I just find that so fascinating.

That’s fascinating. Another thing that you point out, and I’ve noticed it too, is that conversation about the future is often dominated by dystopian narratives. Do you share these stories because it shows people a way they can be, to show hope, not just fear?



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Yeah, that's right. The way I have started describing this is that you steer at what you're looking at, so if we're talking about dystopias all the time, even if you have no intention of aiming for that, you kind of do because it's in your mind. I keep saying that I do think it's important to be aware of the problems. To bring planetary boundaries

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back in, that's a really important piece of research because it makes us aware of these very real problems. It's still really important that we have something hopeful that we can look at, and think about, and aim for.

Speaking of this, one common thread I've noticed is that several of your projects revolve around food, and agricultural landscapes. From the impacts of fertilizer to the impact of landscape fragmentation on ecosystem services to novel forms of agriculture, such as vertical farms and permaculture, there are so many issues impacting food and agricultural production. What do you think the future of food is, or should be, in the Anthropocene.

That's a really good question. It's clearly really important-to me, food is so central, partially because you need it to live, and partially because it's so central to our communities. Food also sits at the center of so many environmental problems-we're moving phosphorus around for food, we're polluting water for food. I'm not sure I have a great answer to the question of what the future should be, so maybe I'll make another question out of it. One of the things that is so complicated is that some people's vision of a good food future is directly in conflict with other people's vision of a good food future. If I pick a really simple example, there some people who saying that we need to have a lot more vegetarians, and maybe even vegans, because that's better for the environment. And as a broad statement that's probably true, for a variety of reasons. But that's really bad for anyone who's, say, a poor shepherd who makes their living raising animals. And it's probably not good if we want to have more circular agriculture, where we're growing animals and they produce manure, and we put the manure back on the land. So those ideas of circular agriculture and vegetarian planning are directly in conflict. It seems to me that how and where we build a patchwork of these good things is very important work, and really interesting work, and really hard work. **That's an important thing you're talking about here. In any big question, there's a lot of stakeholders with different ideas on what should be done.**

So you also lead the Bennett Lab at McGill, right, with a lot of research projects under that umbrella. Could you tell me more about that experience, and what your graduate students are working on?



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Yeah, that's my lab, and I have a lot of graduate students working under me. They are doing all kinds of different things. We link around ecosystem services as a central focus, but beyond that, I have people working on the role of protected areas in ecosystem services. I have people working on how climate change is going to affect sea ice in the polar parts of Canada and how that is going to affect ecosystem services. I have people working just generally on how to model ecosystem services and improve our models.

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I have people working on food systems. It's pretty varied, possibly too varied for me to keep a good handle on it at the moment, but, you know, that's a lot of fun. Working with students is the best part of this job.

That's awesome! It's fascinating work that you all are doing. I saw that one other amazing project that your lab is working on is participatory scenario planning with indigenous peoples in the Kitikmeot Region of Nunavut, in the Canadian Arctic. Could you tell me more about that project?

That's really being run by Marianne Pardot. She is a marine biologist by training and wanted to expand into some of the more social science and management aspect. She is doing a combination of different natural science and social science projects to understand how-we know we're losing sea ice in this region, and she's looking at how that's affecting the food web. Who's eating who? She uses isotope techniques and lab techniques to map out changes in the food web. From there, she is looking at how that is changing the fatty acids and mercury content of the fish, and how that affects the health of the people who are eating that fish, which is mostly indigenous people in that region. **Sounds like an awesome project.** Yeah, it's really fun.

So, what else would you like to share? I've asked questions based on what I've read about your research, but I might have missed something. What do you feel that citizens should know about ecosystem ecology and the issues you're working with?

That's another good question. The message that I would send to people, which is maybe a little bit less about ecology and more about people, is that people are having a lot of angst right now about what they should be doing if they care



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about the environment. Should they be recycling? Is that enough? Do they need to be badgering their government for more changes? I think the message that I would want to share for people is that the science says that all of that has worked. If what you can do right now is manage to get your recycling into the recycling bin, and that's what you can do- awesome, keep doing it. If what you can manage to do is that and working to change governance in your area, to help more people recycle or help people drive less or improve transportation systems, awesome-we definitely need that. We need all of that. The key is while you're doing all of that, to communicate, to ensure that your vision of where you're going isn't conflicting with somebody else's vision, and to sort out how to do that.

All right! That leads me to another thing. I know you live and work in Canada, but as you know, in America right now, the governing party routinely attacks scientists, the validity of scientific findings, and the very concept that we should be listening to scientists. How do you see the role of scientists in determining public policy under circumstances like these? What would your advice be to American scientists, and scientists around the world, on how we should communicate and defend our work in the era of "fake news"?

I would tell American scientists to hang in there. Canadian scientists used to be in a very similar situation (***under Prime Minister Stephen Harper, of the Conservative Party***) where we were being suppressed by the government.

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Canadian scientists actually had something they called the March for the Death of Evidence, which I thought was just a fabulous name. It wasn't just a march in support of science, it was saying "you guys are making evidence-free decisions" and I thought that had a good ring to it. So, you know, hang it there, it can turn around. The other part of the message is that when you hear people saying things that have no basis in science, to gently and with respect and with good listening practices help them to understand where the science really is at. That takes a careful ear, you have to come into it listening to what people are telling you, and help them to understand what's truthful and what's not truthful. When you're reading something online, how to tell whether that's a pack of lies or not. That's something we can really do as scientists. **Yeah, we can help show people the data! Because a lot of claims right now are being made based on emotion or faction loyalty or something. What I feel is really admirable about your work, and environmental science in general, is that it's a barometer of the world we live in.** Yeah, exactly.

Well, Dr. Bennett, thank you so much for sharing your wisdom. Thank you so much for joining this interview. It's been a pleasure talking with you.