Freshwater Ecosystems on Campus and Beyond, with Dr. Amber Rock

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Dr. Gay

Welcome to *30 Brave Minutes*, a podcast of the College of Arts and Sciences at the University of North Carolina at Pembroke. In *30 Brave Minutes*, we'll give you something interesting to think about. I'm Richard Gay, Dean of the College of Arts and Sciences and with me are Associate Deans, Ashley Allen and Joanna Hersey. Joining us is Dr. Amber Rock from the Department of Biology here at UNCP, now get ready for 30 Brave Minutes.

Dr. Allen

Welcome Amber. It's wonderful to have you with us this morning. I was hoping that you could talk to us a little bit about your research, but also just introduce yourself to our listeners.

Dr. Rock

Yeah, absolutely and thank you so much for having me. I really, it's great to be here. I am Dr Amber Rock, this is my 4th year at…no, 5th year, at USC Pembroke, I believe. Time is flying, I am a fresh water ecologist by training. I got started in that in undergrad actually, I worked for a professor in Pennsylvania, where we looked at water quality in some headwater mountain streams, and that's when I fell in love with learning about those freshwater ecosystems and all the really fascinating critters that live in them. So then I went on to grad school at Miami University in Ohio, and there my PhD work focused on experimental work, tracking energy movement through aquatic food webs, and trying to figure out which environmental conditions lead to an increased transfer of energy through those food webs, and that's important because you get more energy to the top of the food chain. You get bigger fish and more fish and lots of other things related to how healthy the ecosystem is.

So then after my PhD, I came here to UNC Pembroke, and I kind of went back to my roots a little bit, focusing more again on water quality, specifically in the Lumber River, I've been working with students since my first year, we go out and we sample the river, all sorts of different parameters, from temperature and dissolved oxygen to water chemistry, to looking at the little invertebrates that live in the river, just to kind of see what's going on. The research that we're going to focus on today, kind of took us a different direction, and I started a brand new project for my lab looking at ecosystem metabolism in some of the campus ponds.

Dr. Allen

Okay, so this research that you're working on now, with the campus ponds, has been going on for how long now?

Dr. Rock

A little over a year now.

Dr. Allen.

A little over a year. So do you have any findings that you can share with us? I'm curious. I've been wanting to follow up for a while.

Dr. Rock

So I think my main finding as is true with a lot of research in general, but especially ecological research is, it's complicated. So what we're doing, just as a little bit of background, we're using temperature and dissolved oxygen logger sensors. So, what they do is you drop them in the pond and they record temperature and dissolved oxygen at whatever interval you want, we're doing every 15 minutes, and then you can take that data and feed it through a really fancy model in the R program and it will tell you, basically, how much carbon dioxide the ecosystem is taking in from the atmosphere. So that process is photosynthesis, when the algae and other plant life are taking in carbon dioxide. And then it will tell you how much carbon dioxide is being released. So, when we, you know, our cells do their thing, metabolism, right? The process of metabolism is cells using energy doing stuff and then we release carbon dioxide when we breathe out. And so pretty much all organisms do that, that process of releasing carbon dioxide, and so we can figure out how much of that is going on also. The fancy science term for that is cellular respiration. And the balance of the two, so you've got photosynthesis, taking carbon dioxide in, cellular respiration, releasing carbon dioxide. The balance of the two is ecosystem metabolism.

You can figure out whether your pond as a whole is removing more carbon dioxide from the atmosphere than it's releasing, or if it's releasing more to the atmosphere than it's removing. And so this has implications for climate change and things like that. If it's releasing more carbon dioxide, that means it's adding to the total amount of carbon dioxide in the atmosphere, which is not maybe what we want to see, but that is a normal natural process. So so I say all of that to say that the data that we've collected so far, has shown some of the patterns that we expect to see in terms of temperature and dissolved oxygen, which I had some students present on that. We haven't unfortunately gotten to the point of running the model yet, because we also need to collect, or we need to get weather data from a local weather station, and that's been put on hold a little bit. I was working with another faculty member to try to use the weather station at the campus garden, but we had some issues with data collection there, so I'm gonna need to switch to using a different weather station, but once we get all of that data together, I have an awesome collaborator out in Washington state, who's going to help me figure out the model and do all of that.

Dr. Gay

So at this point, are you able to determine how healthy the ecosystem is on campus or do you still need more data before you can make a determination?

Dr. Rock

Yeah, that's a great question and it's one that I get asked a lot. How healthy is this river? How healthy is the system, and healthy is kind of a difficult term when we're talking about aquatic ecosystems, because there's so many different parts to it, right? So, are we talking about healthy in terms of fish population? Are we talking about healthy in terms of the amount of algae you know, all of that. What I can tell you is that the campus ponds have relatively low nutrient levels, which is common in this area. But we do have a lot of algal blooms still you can see it when you drive by, right? So, the one pond looks more green. We use the one down by the facilities building. That's one of them. That one tends to look more green, and actually, if you catch it, and this is a little bit of an aside, but if you catch it at the right time of day it looks almost red, and that's because of the specific organisms that have bloomed there. I'm pretty sure they're Euglena, is the genus name and so, sometimes, they look green when they're doing photosynthesis but they're also capable of ingesting other cells to get energy and when they're doing that, they look more red. So there's that pond and then the other one that we're using is the one by the Village Apartments, and that one looks more kind of yellowey brown.

So it's just different species of algae that are blooming and kind of taking over in those ponds, and again, that's kind of normal for this area. It's a retention pond that's really warm, and so we would expect the algae to boom. However, I do know that one, at least one summer, we did have some fish die in the pond by the Village Apartments, which indicates a little too much algae. And then, when that algae dies and decomposes, it uses up all the oxygen in the water, and that can lead to what we call a fish kill. And so that does happen every so often, and again, it's just because the ponds are standing water, they're retention ponds, right? They're meant to catch stuff and keep campus from flooding as much as possible, but they do support fish populations, which suggests that, you know, on some level they're doing okay. And it's just a question of if there's interest in managing them for things like algal growth and stuff like that because if they're performing their primary function of catching water from on campus, then maybe that's all that we need on campus, but if there is interest in trying to decrease algae growth and things like that, we'd have to do more studies and figure out the best way to do that. That was a very long answer to your question.

Dr. Gay

I think it's fascinating though. And I was curious about how much carbon dioxide we were putting into the atmosphere, and I think that's part of, you know, the later part of your study is as well. I'm interested in gardens and gardening, and one of the things I've heard is that for, like, a healthy fish pond in your backyard, you need one third of the pond should be covered in green growth plants of some type. Is there a similar formula for natural ponds like we have, or artificial ponds like we have on campus, to help maintain a good equilibrium?

Dr. Rock

I'm not sure of any sort of common formula or anything like that, because each pond and each ecosystem is is different, right? Things like the depth of the water can inhibit growth, like, if you

wanted actual submerged plants. If the water's too deep, they're not going to get any light and so that won't work. Or if there's a lot of algae, they can shade out those plants, things like that. If the bottom, the material on the bottom, if it's a lot of mud and decomposing organic material, which is what we have in the two ponds we're using, that introduces a lot of nutrients and other things into the water that can fuel algae growth. And so, yeah, so I'm not sure of any specific formula, but generally, speaking, if you wanted to sort of make the water more clear, then you have to kind of figure out a way to deal with that excessive algae growth. And that is, that would be very challenging, in more northern climates, you kind of get more of a yearly cycle, because all the algae dies off in the winter when it's really cold, and we do see some of that here, but it doesn't get as cold. And so we have a lot of it just kind of surviving from year to year.

Dr. Gay

I've always heard that fountains and backyard ponds are a lot of work and I can see why after your description there.

Dr. Rock

Yeah, now fountains could have the benefit of keeping oxygen levels increased. So, then you might not run into that problem of the fish kills if you would have something like a fountain in those ponds.

Dr. Allen

So, how does doing the research in the campus ponds compare to being out at the Lumber River? I mean, obviously they're different research questions that you're addressing in each place, I'm assuming because looking at the metabolism component in the Lumber River is going to be more challenging than it would be in standing water with a campus pond, is that true?

Dr. Rock

So actually, the researchers who kind of started doing the ecosystem metabolism stuff, it actually got started in streams and in running water systems, and we started doing this in lakes and ponds a little bit later. But, if I'm going to be completely honest, one of the big sort of driving forces behind this research for me, was number one, wanting to use these sensors, because this is kind of the way that ecological research is going, and so getting students exposed to this kind of, we call it high frequency data collection, is really important. So they can kind of get a feel for it. But also, this was in the middle of Covid, and so finding a project that we could do without having to pile everybody into a van and drive somewhere, you know, things like that. What do they say, necessity's the mother of invention? You don't want to say that Covid was a good situation, but it gave me the combination of sort of, like I said, driving forces that I needed to get this project going, something we could do on campus but then using these high frequency sensors and everything. So, yeah, not having to go somewhere was really important.

And I think the students do enjoy seeing that you can still do science on a college campus, right, even in a little retention pond. There's always good questions you can ask, there's always something you can learn in your own backyard, and so I do think that a good outcome of this, is that students are able to see that you can do science wherever, and you can still learn things and ask interesting questions, even in a little retention pond, but, you know, in contrast, there is something really exciting about getting in a van and getting off campus, right? The Lumber River research students also really enjoy, and again, a lot of our students are local, and so to them, the river is their backyard, and learning more about that ecosystem, they really enjoy as well. I do that with both my classes and with my research students, and I'm getting them out onto the river to collect some data.

Dr. Gay

Could you tell us a little bit more about that?

Dr. Rock

Oh, yeah, for sure, so like I said before we're collecting data on everything we can, basically, so that includes physical data such as temperature, dissolved oxygen pH, all of those things. And then what we call chemical data. So, looking at the amount of nitrogen and phosphorus in the river, because all the agriculture in the area can be a major source of pollution, of those nutrients that can fuel algae blooms and things like that. And then we sample the little bugs that live in the bottom, the mud in the bottom of the river. What we've found so far suggests that, ecologically speaking, anyway, the river seems to be relatively healthy, there's that word healthy, right? Based on at least the data that we're able to collect, right? I can't possibly test for every single contaminant out there. But, you know, dissolved oxygen levels tend to be pretty good.

The species of those bugs that we're finding tend to indicate fairly good water quality, at least for the Blackwater river, you would expect to see different organisms in a blackwater river than you would in, like a really clear mountain stream, and we actually see really low levels of nitrogen and phosphorus which again is fairly common for a blackwater river, because all of those surrounding wetlands are really good sponges for a lot of contaminants, and especially things like nitrogen and phosphorous coming off of the farm fields, so they just kind of suck up all of that, and that's what they're supposed to do. So yeah, we've seen a lot of really good, you know, if you want to call it good data, but we've seen a lot of indications that the river's doing okay, at least in terms of what we can measure.

Chancellor Cummings

This is Chancellor Robin Cummings and I want to thank you for listening to 30 Brave Minutes. Our faculty and students provide expertise, energy and passion, driving our region forward. Our commitment to Southeastern North Carolina has never been stronger through our teaching, our research and our community outreach. I want to encourage you to consider making a tax-deductible contribution to the College of Arts and Sciences at the University of North Carolina at Pembroke, with your help, we will continue our impact for generations to come. You can

donate online at uncp.edu/give. Thanks again for listening, now back to more 30 Brave Minutes.

Dr. Allen

I would love to hear more about your students who are involved in these research projects with you. I know you spoke about your own undergraduate research experience and how impactful that was for you and even how the research you're doing now is sort of connected to what you even did as an undergraduate student, and I think that getting that research experience is so important for our students as well. So, tell me, like, from a student perspective, what do they get to do on these different research projects and what parts are they involved in?

Dr. Rock

So I've got students that kind of do all sorts of different things, so I mostly get research students either through our BIO 4990 class, which is our research class, or through the RISE program, either the full year RISE scholars, or the summer RISE fellowship, which has been wonderful having, you know, students either earn credit, or get paid to do this work is really great, then it feels kind of like, you know, an internship, like it's a job. Yeah, so for the Lumber River project, I've got, you know, this kind of long term stuff going on that students can kind of jump on board with and help me collect the next round of samples. Some of my goals for them are, number one to become acquainted with aquatic sampling techniques, learn using different types of sensors and other equipment, because we're using the exact same stuff that industry uses. But then also, one thing that I think is really important is getting students to actually work with the data they collect, and learn how to analyze it, interpret it, and make graphs, those types of skills are also in really high demand for environmental scientists and biologists and things like that.

So, my goal is always to have my students present something, usually at a poster session on campus, or something like that. So, they get that kind of whole process of telling the world about the data that they've collected. I've also had students who have come and had ideas for different projects that they want to do, and so those really motivated students design their own project, figure out together the best way to collect the data and everything. I had a student last year named Carly who was awesome and she really, I actually had her for two years. She wanted to sample for micro-plastics, another pollutant that's in the news a lot these days, and so we talked to a post doc here who had done some micro-plastics work and she, I mean, she really took the reins and figured out the best way to collect the samples. And it's not something I had done before, and I think that's really fun, figuring out something for the first time with a student, and they really feel that strong ownership of the project and so she collected samples from both the water and the sediment for micro-plastics. Didn't find a ton so that's a good thing.

And then sort of the next step, I guess, in some of this work is my freshwater ecosystems class this semester, they are doing a service-learning project involving a new collaboration that I've set up with a local interest group, the Winyah Rivers Alliance. So they are interested in the

health basically of all of the rivers that drain into the Winyah Bay, and so they got a grant to establish a volunteer water quality monitoring group, but they've had major delays in getting their equipment delivered, like 18 to 20-25 weeks, waiting on sensors and things like that. But we have a lot of that equipment here, and so my students are going to be going out and collecting data and try to get some of that started, and then my hope is that this becomes a long term service-learning collaboration where students can work with the other community volunteers and things like that.

And so I'm really excited about this new piece where students are still collecting data, they're still getting out on the river, but I'm hoping that they can see a little more about how scientists and science can work within the community. And things like that, so that's, uh, that's next goal and even with this ecosystem metabolism project, you know, these sensors aren't that expensive in the grand scheme of things, so if there's a group out there who's interested in this kind of data, you know, we can develop more collaborations and they can understand more about how their lake or pond or river is functioning. I would love to be able to to do this on the Lumber River once we figure out some of those hiccups with weather data and things like that, it would be great to expand what we're doing with that too.

Dr. Gay

I was thinking that it's so important for the students to see you solving these problems, right? I think sometimes our students look to faculty as if we have all the answers, and the relationship you're describing shows that the students are learning that just like them, you have to problem-solve and work out a solution for these, and that's an invaluable lesson to learn there. It's also wonderful what you're doing and contributing to the community as well with this project, right? So, I'm very excited about the service-learning options as well. You mentioned briefly there were the sensors that you use are similar to ones that are used elsewhere in industry, and stuff, and that led me to the question about if there are any type of industrial applications for the ecological work that you're doing locally.

Dr. Rock

Yeah, well, so I don't know if this is necessarily what you consider industry, but a lot of the techniques that we use, and a lot of the things that we sample for are really important in wastewater treatment, you know, you've got the wastewater coming in and it has to go through the treatment process and you have to do a whole bunch of testing on your, what they call the effluent, the outflow, that goes back out into the river, and they're testing for pH and oxygen and nutrients, sometimes, and things like that. People don't necessarily think of working at a sewage treatment plant as an ideal job, but they're good jobs right? And we need people who can do that and we need people who can innovate within that sector because, you know, they are potentially big sources of pollution and things like that. Any sort of industry that uses cooling ponds or retention ponds, they could potentially be interested in something like this to make sure that the water that they're eventually discharging back out into the ecosystem is meeting the standards that they need to meet, they have people doing that kind of testing as well.

Dr. Hersey

Amber, how did it come to pass that you chose this for your life's work?

Dr. Rock

When I started college, I came in having taken one of those career interest surveys in high school. I don't know if they still do those, but I remember that my top three potential jobs were butcher, garbage collector, and wildlife biologist, and of those, I latched onto the wildlife biologist part. I think it's because I said I like being outside.

Dr. Hersey

When you said on that survey that you wanted to be outside, what kinds of things were you envisioning? What did you think of when wildlife biology came up?

Dr. Rock

So I didn't really know what a wildlife biologist was, I'm the first ecologist in my family and the first to go to grad school, you know, things like that. So I just enjoy being out in the creeks and splashing around and going out for hikes. So, it was when I got to college, and I said, 'I think I might be interested in wildlife biology' to my advisor. He said, 'well, we don't really have anyone here that does that,' I went to a very small school, but he said, 'but we have this freshwater ecologist, and that's kind of the closest thing, so why don't you see if you like what he's doing?' I ended up really liking what I was doing there, and again that particular professor, he worked with a lot of community groups, he established an institute to work specifically with community groups to help them collect data, and petition to get federal protections for different streams, and so I think I saw from the beginning how important it is for us as scientists to get out in the community and connect with people and help collect data and things that help not only to protect streams, but just help to inform people about what's going on in their area. And so I think that was part of the reason why I was so excited to get back into the service-learning stuff and to develop these collaborations here.

Dr. Allen

And we're super excited about that collaboration as well. I was gonna ask, if you could pick one moment, or story, from your work at UNCP with your research, or with the students which has been the most impactful for you.

Dr. Rock

Going back to the idea of learning along with your students and showing your students that you are, you don't have all the answers right, and you're still learning, even as a faculty member I think that's really important. And I also think it's important to show that you're human to your students too, right? We have, when I take students out with my freshwater ecosystem class, we have this trailer with six boats stacked on it, and they're tied down with these giant ratchet straps. And ratchet straps, I will, I'll say it, they're the bane of my existence. As someone who routinely uses trailers, I should be better at them, but I'm not, and so I had a

student out with me who grew up on farm, you know, all this kind of stuff and we had to put on new ratchet straps and I said, ‘look, can you show me how these work? Like, this is so silly, but I cannot figure these out,’ and he looks at me and he goes, ‘I never ever thought I would be able to teach a professor something.’ You know that idea that everybody has unique knowledge and life circumstances that can have an important role in your class or in your research, it's so important for students to recognize that just because they grew up on the farm doesn't mean they don't know anything.

Dr. Allen

Has it has it helped? Do you now know how to put on ratchet straps?

Dr. Rock

I'm better at it.

Dr. Allen

Okay.

Dr. Rock

They require a large amount of upper body strength and especially once they're on there for a couple of years and get a little cruddy, then they're really hard to open and, we make it work though. One of my favorite experiences has been getting students outside, getting them a little bit out of their comfort zone. I've had several students both in class, and for research, who have never been in a boat, and they're scared about being out on a boat and things like that. But just, I had one student in particular, she was so scared to get out on a boat, but then, you know she did it, she collected the data, and she became just this absolute force in the lab, learned everything, paid a lot of attention to detail to the point where we had a question about one of our sensors, and I said, ‘okay, well, I'll call the company and ask,’ and the next day she came in and she said, ‘I called them and I asked this question.’ I’ve never had a student call a manufacturer before, when students feel that much ownership over a project that they're like, I want to find the answer to this. It sounds silly, but I think that was one of my proudest moments, maybe, was having a student who felt so comfortable and so, in charge of this project, that she felt she could get the answers to these questions.

Dr. Allen

So, what's next for you Amber, where’s your research taking you after this?

Dr. Rock

Right now I'm focusing a lot on this new collaboration with the Winyah Rivers Alliance, and the Lumber River water quality stuff. And I'm hoping that that will, well I’m not hoping, I’m sure that it will, lead to a lot of potential new avenues for research, because this is going to open up the ability to collect samples over a larger area, because we can get their, potentially their people or their volunteers to help us collect. I see this as an opportunity to take what I've been doing and expand it, using this group of volunteers and the data that they've collected. So, I think

that'll be really cool for that project. For the metabolism project, one thing I did not consider when we started this project was that the pond near the facilities building on campus, they drain before every major storm event, so that it can hold more water. Didn't think about that. But that has the potential to ask another really interesting set of questions related to ecosystem metabolism, because we've essentially got one pond and it never gets drained, and one pond that gets drained fairly regularly, and they're not that far apart from each other, and so it could be interesting to see how much of an affect that drainage and refilling and drainage and refilling has on how carbon moves, carbon dioxide and carbon, moves through that ecosystem.

Because it could be that when that pond is drained, you know, it's releasing a whole lot of carbon dioxide, because there's more of the bottom material is exposed to air, and all that kind of stuff. So it could be that it goes back and forth, between releasing more carbon dioxide or, absorbing more carbon dioxide, so that's a potential future area, to keep the sensors in the campus ponds for a couple of years, just to see changes, if we can see changes year to year, but then potentially getting a few more sensors and seeing if we can do the Lumber River or work with another group to try to do these similar calculations in other places.

Dr. Allen

Do hurricanes impact your research heavily? So I was just thinking about it in terms of the projects that we've been discussing and how, you know, our last really big hurricane was 2018 and crossing our fingers we actually won't have another one like that for a long, long time, but I'm curious as to what kind of impact that does have on the metabolism that you're talking about, the ecosystems in general, what do you see when you factor those types of natural disasters in?

Dr. Rock

Any sort of really large storm that floods the area makes data collection really hard, because everything's flooded. You can't get to the actual river, to collect any data and it's not really safe when the water's running that fast to take a boat out or anything like that because all we have is row boats. So, there was a period of time, must have been spring of 2019? I had just started with a student and we got some major storms and the watershed, the area around the river, stayed flooded for, like, six weeks, and we couldn't get in there to collect data. And so that's not something I was used to, being in Pennsylvania and Ohio, everything drains really quickly, because there's an elevation gradient, or more of an elevation gradient than there is here, so that just essentially stopped the data collection. Material and things in general are going to move through the system a lot faster, because you've got all that water, just pushing things through. And so there would definitely be some kind of change or some kind of disturbance, and then how long it takes to kind of get back to where it was before, could be an interesting question. That's something, that's a whole other field of ecology is studying resilience in the faces of big environmental change. Also, one thing that is always a concern when you put sensors out in the world is, if you would get a big enough flood, they can go away. Because we weigh them down, but not a lot because they're just in this little pond, so if we would happen to get enough water, it could send them down the river.

Dr. Gay

I was curious if algae grows more at really warm temperatures, or if there's a point at which, when it gets so hot, like in August and stuff if the algae stops growing?

Dr. Rock

Remember that water heats up much more slowly than the surrounding air, okay, and so even if it's 100 degrees outside, so really, a really, really warm temperature for a pond is like, 40 degrees Celsius, that's like, crazy hot for a pond, okay, and I'm gonna have to figure out what that is in Fahrenheit because I only think about water temperatures in Celsius. So that's like, 100-104, but you almost never see water that gets that hot, even in a pond. Most people say, like, 30 Celsius is warm for a pond, as you get into bigger and bigger lakes then of course, they're not going to heat up as much either, the algae that tend to cause these big blooms, are usually adapted to those warmer temperatures, and they do really well in those warmer temperatures.

But now, if you were in a small campus pond, and it did get up to, 35-40 Celsius, you would need weeks and weeks of 100 degree temperatures for that to happen. But then, yeah, potentially, they wouldn't do so hot. But that's not something that happens super often, because even just cooling down at night, you know, it helps to prevent the overall temperature from getting too hot. So, yes theoretically, it could get too hot for them, but most of those algae are are pretty well adapted to warm temperatures. That's why you tend to see the blooms in the summer, and not in the winter.

Dr. Gay

Amber, thank you so much for joining us today. We've learned so much about the great work you're doing with the students and with the community and I can't wait to learn more about what you're doing with these projects. I think the ecology of the area we live in is something we're all invested in so I think the work you're doing is very important, so thank you so much for sharing it with us today.

Dr. Rock

Yeah, well I appreciate the opportunity to come and nerd out about science for a little bit, thank you so much.

Credits

This podcast was edited and transcribed by Joanna Hersey, and our theme music was composed by Reilly Morton.

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