

Erin Larson:

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Erin Larson:

Hello, I'm your podcast host, Erin Larson with The Society for Freshwater Science and my guest today is Amanda Subalusky, a postdoc with the Cary Institute for Ecosystem Studies. Welcome to the podcast Amanda, thanks for joining us.

Amanda Subalusky:

Thanks so much for having me.

Erin Larson:

So to start with, I was wondering if you could tell us briefly about your research and what makes you so excited about it.

Amanda Subalusky:

Yeah. I'm broadly interested in the way the animal movement and behavior can influence whole ecosystem function. And I study this in a river in East Africa, the Mara River, and I'm interested in the role of large wildlife in transporting carbon and nutrients from the terrestrial landscape into the aquatic system and what that does to the river ecosystem.

Erin Larson:

Awesome. What got you started working in the Mara?

Amanda Subalusky:

I had a background as a wildlife ecologist and I was getting more interested in understanding what wildlife behaviors do to the ecosystems that they live in. And after I finished my Masters research, I sought out an opportunity to work more in river ecosystem function. And I worked for a project with Florida International University, studying environmental flows in the Mara River.

Amanda Subalusky:

And one of the key things that I found when I was working there was that the large wildlife had a really important influence on the river ecosystem. And we would actually see remarkable declines in water quality as the river entered the region where the wildlife were. Which was opposite of what we expected.

Amanda Subalusky:

We expected to see the river kind of maybe impacted by human presence, but then recover once it entered the protected areas. And what we saw instead was what we think of as traditional indicators of water quality declined when the river entered the protected areas. And this seemed pretty clearly linked to the influence of large wildlife. And so I decided that I wanted to study that in more detail.

Erin Larson:

Awesome. And so what were some of those indicators of water quality that you saw declining when you entered the reserve?

Amanda Subalusky:

Turbidity goes up, so the amount of dirt in the river, suspended solids. Conductivity goes up, which is often considered an indication of pollutant load or contaminant load in the water and dissolved oxygen goes down pretty remarkably, particularly when the flow levels decline, which we've now linked to the settling and decomposition of hippo faeces on the bottom of the river.

Erin Larson:

Oh, cool. Interesting. So you had a recent study out in addition to your studies on hippos, looking at wildebeest drownings and how influence the river ecosystem function in the Mara. I was wondering if you could tell us a little bit about that study and how that came about.

Amanda Subalusky:

Yeah. There has been, of course, the Pacific Salmon workers. Famous work studying the influence of animal carcasses in river ecosystems, but there aren't a lot of natural river ecosystems anymore where this happens, where you see the large abundance of animal carcasses in the river.

Amanda Subalusky:

And early on when I started working in the Mara, we would see occasionally rafts of wildebeest carcasses piled on the banks of the river. And it struck me as really unique and a really exciting opportunity to investigate what the influence of large ungulate carcasses could be in a river system. And the Mara is particularly unique because we have these two different forms of animals moving resource subsidies into the river system.

Amanda Subalusky:

You have hippos which are doing this daily feeding migration and feeding in the grasslands, and then defecating and urinating in the river every day. And that's one kind of input and probably has certain kinds of ecosystem effects.

Amanda Subalusky:

But then you have this occasional periodic pulse of wildebeest carcasses going into the river during these mass drowning events. And it seemed like a really unique opportunity to study these two different forms of input and what they do to the system.

Erin Larson:

What was the most surprising thing you think you found during your wildebeest to be study? Was there something that, did you expect to find a certain impact that they had on the river and then saw a different impact, or what? Yeah. What was the most surprising result you think you found?

Amanda Subalusky:

Yeah. Well, two things I would say. First, I approached it seeing the wildebeest inputs as this kind of, as I said, a pulse input and time that was there. And after a few weeks, you don't see the carcasses anymore. They appear to be gone.

Erin Larson:

Mm-hmm (affirmative).

Amanda Subalusky:

But what we found through doing decomposition studies was that actually half of the weight, the dry mass of a Wildebeest carcass is bone. And that's where 95% of the phosphorus in the carcass is. And those bones decompose over years.

Erin Larson:

Wow.

Amanda Subalusky:

So even though the carcass to our visible eye at the surface of the water is gone after a few weeks or maybe months, the bone stay in the system for years. And because these mass drownings happen almost every year by the thousands, there's an incredible bed of bones at the bottom of the river, presumably slowly leeching out Phosphorus into this system and Calcium over time.

Amanda Subalusky:

So actually these periodic carcass inputs I think are much longer in their temporal influence on the river ecosystem.

Erin Larson:

That's super interesting. I was really interested to read when I read that paper too that you actually see biofilms growing on the bones and then that's something that then fish are eating as well.

Amanda Subalusky:

Yeah.

Erin Larson:

I'd never really thought about bones as being substrate for biofilms. As a stream ecologist just I'm like, "Oh yeah, rocks as substrate would all sorts of other types of detritus potentially can be substrates for biofilm." So it was really interesting to see the bones can actually play that role as well.

Amanda Subalusky:

Yeah. But I will say the second thing that I've found some very surprising and we're still trying to tussle with actually a bit is, so far with our measurements of biofilm growth and respiration on tiles and at the whole river level, we haven't really picked up an effect of wildebeest drownings and carcass inputs on what we think of as whole ecosystem function.

Erin Larson:

Mm-hmm (affirmative).

Amanda Subalusky:

So we don't actually see an increase in production or respiration at the river ecosystem level. Even when there are thousands of carcasses in the river. And this is really surprising and is a bit of a mystery for us and kind of setting the stage for, I think, our next stage of research in the system to understand that.

Erin Larson:

Yeah, I'm surprised by that. I would think that it's just a metabolism would really change as a result of those inputs.

Amanda Subalusky:

And I think part of why it doesn't is because it's a river that already has 4,000 hippos defecating in every day. And so it's about the context in which these carcass inputs are entering the river system.

Erin Larson:

Right. And so do you think in some ways potentially those hippo inputs might be, I was curious to see, and I think it's really interesting to think about this idea of there's these daily migrations and then you have these, maybe not so much pulse now that you're thinking about these bones decomposing for long periods of time, but do you think that one type of input might be more important for ecosystem function than another?

Erin Larson:

Or how do you think about the balance, I guess that's the future direction is thinking about the balance of those two types.

Amanda Subalusky:

And one thing I will say is, I say that when we see a bunch of carcasses into the river, we don't see a response in ecosystem metabolism, but, and sort of my first interpretation of that was, Oh wow, maybe carcasses don't matter when you have so much hippo loading because it's such a massive scale of loading.

Amanda Subalusky:

But another interpretation of that is that the wildebeest carcasses always matter and because their bones are always there and maybe the bones play a significantly large role that whether the actual fresh carcasses is there or not doesn't matter because the bones are kind of always playing this role in fertilizing the system.

Erin Larson:

Right. Yeah. That's super interesting. Super cool. What was some of the most challenging parts of that study? It seems like in general working in such an interesting area with large animals, I'm sure there's plenty of challenges. What was the hardest part in doing the wildebeest study?

Amanda Subalusky:

The hardest part is that they're fairly stochastic events. They're difficult to predict when they're going to happen. You need a crossing happening at certain crossing point when the river is a certain level. And so you can't really plan your research around when a drowning is going to happen. You have to be a little bit opportunistic and to take advantage of it.

Amanda Subalusky:

And on the other hand, one might not happen for months, so you kind of have to have other research going on that you're willing then to drop at a moment's notice when the drowning happens. And that was difficult. And then on a more practical side, litter bags turned out to be pretty difficult to do because we put out carcass litter bags.

Erin Larson:

Right. Yeah.

Amanda Subalusky:

Spent days preparing them so carefully and weighing every little piece and then put them out to come back the next day and find that crocodiles and Nile monitors had like plucked about half of our carcass litter bags overnight. And then they just thought it was, we'd put out the little goodie bags for them.

Amanda Subalusky:

So we had to then go get a big metal cage welded in town and redeploy litter bags inside of a cage.

Erin Larson:

Wow. How big were, so I'm sure most of our listeners are familiar with litter bags. These things that you put often leaves to decompose in streams and then measure decomposition rates. But it's funny in my mind to think about a litter bag full of [inaudible 00:09:38] piece.

Erin Larson:

So did you take just different parts of the wildebeest and put them in small bags?

Amanda Subalusky:

Yeah.

Erin Larson:

How big were these-

Amanda Subalusky:

They were small. We used small bags. They were maybe 10 by 10 centimeters. And used different parts of the carcass. Although my advisor has consistently pushed me to do a whole carcass litter bag. We haven't worked out the logistics of how we will pull it out of the river to reweigh it on a regular basis.

Erin Larson:

Yeah, that seems like it would be-

Amanda Subalusky:

It's a matter of discussion.

Erin Larson:

... A very difficult thing to do. So obviously research has its challenges, but also it can be super enjoyable. So what do you feel was the most fun part of the wildebeest drowning study? I'm sure there are many highlights. Hopefully. But what really did you feel like was the most, the fun part of doing that study?

Amanda Subalusky:

I love field work and the field work of it. To count the, although I was at the drownings are these tragic events that happen. And that's something that especially once we first witnessed our first drowning actually happening, that's kind of not lost on you, that is this really tragic on an individual scale loss of life.

Amanda Subalusky:

But the ecological response to it is really beautiful and it's this exciting response of life to this input of resources from death. And surveying that was really cool. So we would hire armed rangers to walk the riverbanks because riverbanks are actually kind of a dangerous place to be in the Sub-Saharan Africa.

Amanda Subalusky:

And we didn't have a lot of other opportunities to do those kinds of walks. And so we would walk these five kilometer stretches, surveying carcasses and counting crocodiles and counting vultures and that was just really exciting to be able to engage with the river in that way.

Erin Larson:

Yeah, that's awesome.

Amanda Subalusky:

Something we take for granted in North America where you can easily walk riverbanks, but they're harder to do in Kenya.

Erin Larson:

Yeah, I know. I'm sure I hadn't really thought about that. The Riverside is being a really dangerous place to be working.

Amanda Subalusky:

Yeah.

Erin Larson:

Yeah. That's really interesting. I want to talk a little bit about some of your hippo work as well. I really found your study interesting where you went and looked at hippo egestion and excretion in a zoo setting where it's easier to measure things like that. And then also translated that into thinking about hippo affects on the Mara.

Erin Larson:

So what was it like to actually work with captive hippos after you've seen them in their natural habitat. Was it, I'm just curious like what that felt like, what that was like.

Amanda Subalusky:

Yeah, it was really fun because hippos in their natural setting are really dangerous and intimidating animals. Although I love them and find them charming. They're always kind of watching them with one very cautious eye. And of course you never want to be close to them.

Amanda Subalusky:

And in the zoo, each of them had names and we got to feed them apples, through the cage obviously. But it was really fun to kind of get to engage with hippos in a different way, in and a more friendly way.

Erin Larson:

Yeah. No, that makes sense. And it's interesting to think about, it was interesting to read that paper and realize yeah, there it would be really hard to measure hippo excretion and egestion in the wild. And I work on insects and fish and smaller things where you can do that and it's easy to take them out of the stream and put them in a bucket or bag or whatever and do those types of measurements.

Erin Larson:

And it's interesting to think about zoos as a place where you can do the that type of research, especially with large animals where you really couldn't do that in the wild.

Amanda Subalusky:

Yeah. And I owe that inspiration to J.J Weiss who is a lab member of mine at the time and people in my lab have measured nutrient excretion from fish by putting them in a kind of a container and measuring the water before and after.

Amanda Subalusky:

And I was bemoaning that this would be difficult to find a container big enough for a hippo and J.J said, "The Milwaukee County Zoo, hippo exhibit would be perfect for this actually. And the folks at the zoo were really keen to be engaged. They thought it was interesting and they were happy to have people help shovel out the hippo."

Erin Larson:

I loved the description in your methods of wheelbarrows just full of, oh my God sorry, of hippo pop.

Amanda Subalusky:

Yeah.

Erin Larson:

It's just such a different scale to work and think about rivers on compared to, I think, those of us who work in either North America or South America or a lot of other rivers where you just don't have these large animals that play a huge role and ecosystem function.

Amanda Subalusky:

I would say where we don't have them anymore.

Erin Larson:

Yeah, that's true. I wanted to talk to you a little bit about that. I found it really interesting in your wildebeest study when you talked about this idea that bison probably historically played a really big role in the North American landscape and rivers and I was, yeah, I was curious to hear your take on that and how you think that re frames what you think about rivers and other places that historically had these large migrations.

Amanda Subalusky:

Yeah. It's something I'm still learning a lot about and I learned a lot about working on the wildebeest paper. I found records talking about huge drownings of thousands of carcasses recorded by early explorers suggesting that this happened on, maybe even close to annual basis, fairly regular observations of this happening.

Amanda Subalusky:

And it's incredible to me to think that we had maybe near 30 million bison in the Western United States 250 years ago. I mean, that's not long. I'm also thinking about Pleistocene megafauna extinctions. And that was 10,000 years ago, which in evolutionary timescales and in ecological timescales even it's not that long ago.

Erin Larson:

Right.

Amanda Subalusky:

But it's still a long.

Erin Larson:

Yeah.

Amanda Subalusky:

But the idea that yeah, 250 years ago only we might've had regular inputs of large drownings in our rivers is really interesting to me and it suggests that the rivers that we see now and what we think of as referenced streams and reference conditions for rivers maybe is a shifted baseline from what it was not that long ago.

Erin Larson:

Yeah, that's really interesting to think about. I just finished reading *Undaunted Courage* actually about the Lewis and Clark expedition and it was interesting to read some of their and hear more about the things that they observed when they were the white men seeing the Western U.S. for the first time.

Erin Larson:

And just to think about how different those systems look now in such a short timescale. It's definitely something important to keep in mind as ecologist when we think about, what is sort of normal or baseline for a certain system to really think that things have undergone big changes in not a very long amount of time.

Amanda Subalusky:



Mm-hmm (affirmative).

Erin Larson:

So what research are you really excited to do next in the Mara or elsewhere potentially? What are sort of the next steps that you'd really like to take in your research?

Amanda Subalusky:

Well, we have a fair amount of data showing that these wildlife inputs have a really important effect on the river food web, but we're still trying to understand the pathways through which those enter the food web. And I think that there's probably multiple pathways and that probably varies seasonally and I think there's some exciting work to be done there.

Amanda Subalusky:

Understanding the influence of subsidy form and magnitude on secondary production. I also think that there's really interesting biogeochemical cycling happening within these hotspots of wildlife loading because animals tend to aggregate in time and space. And we see that with the hippo inputs in these hippo pools.

Amanda Subalusky:

And with the carcass inputs because carcasses they happen at crossings and then the carcasses aggregate at rocks in river banks. You get these aggregations of different sizes and we see that the size of the input, the concentration of the input influences kind of the fate of the nutrients in the system.

Amanda Subalusky:

But we have a lot of work to do I think to understand how that influences the actual biogeochemical cycling of those inputs. And I think that's really exciting. And then I think that we've done a lot of work to understand the arrows going from the grassland into the river and it would be cool to do some more work. Understanding the arrows going back out to the grasslands.

Amanda Subalusky:

And we've started to do that a bit with avian scavengers and found that, that's a really substantial transport back to the grasslands. But I also imagine through aquatic insect emergence and probably some other interesting terrestrial animal vectors like hyenas and mongoose, that there's some other really interesting pathways to study.

Erin Larson:

Yeah, it's interesting to think about the whole food web effect of these carcasses. Do you see peaks in insect emergence or do you see fish aggregations around those big carcass buildups at all?

Amanda Subalusky:

Yeah. Anecdotally, yes. Although we haven't measured it. But you'll see fish feeding, you can see the activity under the water. Fish, crocodiles, Nile monitors coming in and really focusing on those aggregations. And one of the interesting phenomena we have observed is that about two weeksish after the drowning has occurred, you'll see big blooms of maggots in the river.

Amanda Subalusky:

And you actually you can put a net in the water and scoop out maggots because so many are floating downstream. Everyone's favorite type of field work. Because the carcasses have just been colonized by so many insects.

Erin Larson:

Yeah.

Amanda Subalusky:

And we have some work that we're working on publishing right now looking at scavenger succession on the carcasses, which is mostly terrestrial scavengers because that's what it's been easier to see. We use game cameras to observe that.

Amanda Subalusky:

And we see these really interesting succession patterns where first you get smaller vultures coming in marabou storks then you start to get near the latter parts sacred ibis and mongoose which are feeding on the insects that have colonized the carcasses. And so I think there's just some really interesting stories to be told there.

Erin Larson:

Yeah, that's awesome. We'll be looking forward to hearing what comes next for sure. So one of the things that we're starting to do a little bit more on the Making Waves podcast is to also talk about the scientists behind the science a little bit.

Erin Larson:

And so I was curious to ask you some questions about you as a scientist. So did you always know you wanted to be a scientist or what was your path towards becoming an ecologist?

Amanda Subalusky:

I call it the scenic route. No. I didn't always know that. I knew that I loved being outside and I still love being outside. That's kind of what I like to do. And I think it just took me a while to really realize that that could be my career, could be being outside and learning about the natural world.

Amanda Subalusky:

So I started thinking maybe I wanted to go into medical school and be a doctor. And so I was a biology major and that first gave me some experience doing field research and ... But it took me a while doing field research and doing my masters to kind of find what I felt was my place in the field.

Erin Larson:

I'm glad you made it here. You're definitely an inspiration to many of us. And what do you like to do when you're not doing science? What do you do in your free time?

Amanda Subalusky:

Well, like I said, I like to be outside so I'm going hiking or fishing or being on the water. I also have a daughter, a two and a half year old daughter.

Erin Larson:

Oh, awesome.

Amanda Subalusky:

So doing things with her and kind of introducing her to the outdoors, she loves to be outside too. This is actually her second field season in the Mara.

Erin Larson:

Oh, awesome.

Amanda Subalusky:

She really loves to be outside. So that's been fun. It's a whole new opportunity to learn about and experience the natural world through her eyes.

Erin Larson:

That's great. Thank you so much for joining us today Amanda. It's been great to hear more about your research and we're looking forward to hearing about what comes next.

Amanda Subalusky:

Thanks so much for having me.

Erin Larson:

Of course. And again, this has been your podcast host, Erin Larson with the Making Waves podcast joined by Amanda Subalusky.

Erin Larson:

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