ERDC EL
Moderator: Courtney Chambers
May 30, 2017
1:00 pm CT

Courtney Chambers: At this time I'll introduce today's speakers.

Dr. Kyle McKay is a research civil engineer with the US Army Engineer Research and Development Center's Environmental Laboratory. His research focuses broadly on examining ecological effects of water resources infrastructure with applications related to stream and watershed restoration, fish passage improvement, environmental flow management and sustainability policy.

Our second speaker is Ms. Caitlin Conn. She's an ecology PhD student at the Odum School of Ecology at the University of Georgia. Caitlin's research is broadly focused on how human activities, especially management practices, impact freshwater ecosystems, and how scientific research can be used to better inform these management practices. Her current research aims to quantify the effects of different flow conditions, and thus different management strategies on the key ecological functions of stream metabolism and nutrient retention.

And our third advertised speaker, Dr. Seth Wenger is unable to join us today he had to attend to another commitment, but Kyle will recognize him as part of this work as well. More information about these speakers and Dr. Seth Wenger can be found in their bios posted on the Environment Gateway along with today's presentation and recorded meeting.

We're pleased to have you two sharing with us today. Kyle, at this time I'll give you the presenter rights and we'll enter listen only mode.

Dr. Kyle McKay: Good afternoon everyone. As Courtney said, I'm Kyle McKay, and I work for the Environmental Lab. And I work for EL but I sit in the New York District to collaborate with the New York District and provide a conduit between the District and the Lab.

I want to start today by thanking Courtney and (Julie Marcy) for organizing the webinar series. Today we're excited to tell you about some ongoing research we've been doing, looking at how ecosystem functions could fit into the broader context of water management, and in particular ecosystem restoration.

As a general structure for our presentation today, we're sort of looking at three key questions. First we're going to tackle what are ecosystem functions. How are they different from structure and services? Second, why are biological functions crucial for us to be considering them in the restoration programs? And third, what would this look like in a real river – a messy case study on the ground? And that's where Caitlin's going to take over and tell us about some work she's been doing in the Middle Oconee River outside of Athens, Georgia.

As Courtney mentioned, Dr. Seth Wenger has been involved in this project all along. He is the Science Director at the University of Georgia River Basin Center. And he was slated to join us today but another obligation pulled him away. But I do want to acknowledge him because his input was crucial to pulling together many of these ideas.

So like many of our restoration webinars, I'm going to start with our policy statements for the Corps. And we have this overarching, driving purpose in our restoration programs of restoring significant structure, function and dynamic processes that have been degraded. And then policy goes on to clarify that with some additional intent and scopes it down to these nationally and regionally significant aquatic ecosystems.

So this comes in a lot of different flavors, but some of them are very large systems like the Gulf Coast or the upper Mississippi River or the Missouri River, Columbia River, all the way down to smaller scale efforts at perhaps a reach or the scale of a particular dune. And what one of the issues we're going to tackle today is clarifying that purpose statement about structure, function and dynamic process. Not from a policy standpoint, but from a technical standpoint of what does it mean to assess ecosystem structure and function, and how are they synonymous or different from ecosystem services?

So let's start with the first part of that question. Here I've pulled a couple of definitions from the National Academies who describe ecosystem structure as referring to the composition of the ecosystem, its parts, and then go on to describe function as being a process that takes place in an ecosystem as a result of the interactions of those parts.

So as a sort of crude analog, we can think of ecosystem structure as being like a list of parts of your car, you know, whatever they are – one door panel, one air bag, one steering wheel. But then the function provided by that list of parts is driving or braking or listening to the radio. So we're thinking differently about what's there and what the parts are versus what those parts do.

On the right we've pulled together some somewhat hyperbolic comparisons to clarify these concepts. There is of course a lot of grey space between these. But usually when we talk about structure, we're talking about what an ecosystem looks like, and we're thinking about it as a snapshot in time.

Whereas when we're thinking about function, we're thinking about what that ecosystem does, or a rate occurring in that system.

And accordingly, structure tends to emphasize the static condition of what's out there, whereas function focuses on dynamism and how things are changing through time. When we think about using structure in the context of restoration, structure is an incredible tool for indicating that something is wrong, but it doesn't necessarily tell us why it's wrong. And that's where we can start augmenting our knowledge of an ecosystem with this functional view of restoration.

Now a lot of times the words ecosystem services tend to come up with respect to structure and function, and so it's just a brief aside as to the difference in those three concepts. So ecosystem services are the benefits people obtain from ecosystems. That's what the Millennium Ecosystem Assessment suggested they were.

So this is a fundamentally socio-centric definition of ecological functions. They're thinking about not just how the system is functioning, but what we as users of the system are receiving as a result of that. And the ecosystem assessment goes on to suggest that there are different categories of services.

So here I've shown four categories with some subcategories under them, so thinking about things like provisioning services or those where we are directly receiving the good. And those are sort of in contrast to things like maybe these regulating services where we're thinking about for instance the water treatment benefits of natural systems.

I want to point out that (Elizabeth Murray) and a whole host of other folks have been really leading the charge on this for the agency. And I would encourage you to check out some of the reports they've put together on ecosystem goods and services and how they relate to the Corps mission.

But for now I mostly just bring this up because I want to point out that ecosystem structure and function are absolutely influencing what services are provided by a system, but they are not in and of themselves a service. So what do I mean by that? Here's a number of examples, and I'll only walk through a couple of these.

But on the far left we have a structural measure and on the far right a service oriented measure. In each row we have sort of a similar line of thinking. So let's tackle that first one. Maybe we're thinking about something related to fish. And for a structural measure of fish maybe we're going out there and measuring something about the physical structure of their habitat. So maybe it's the distribution of velocity or depth or dissolved oxygen in the system.

A fish could live there, but how quickly they are reproducing or how many of them are surviving through time? And then contrast that with an ecosystem service oriented view where we're thinking through, well maybe we're interested in the commercial fishing yield associated with that river, not just the survival rate or the reproduction rate. So again, just trying to draw some general lines between these ideas.

So let's take the third example there, and let's zoom in on nitrogen, and in this case nitrates. So for a structural view maybe we go out, scoop up a jug full of water, and we can measure the nitrate concentration in that jug. And that gives us a lot of information about that snapshot of where the ecosystem is today, and that embeds a lot of information. But maybe what we're interested in is how the system is either retaining or transforming that nitrate. So for instance is the system denitrifying and producing N2 gas? And if so, at what rate is that occurring?

And then third, that service oriented view would say, "Well, are communities downstream reducing their water treatment cost as a result of the level in uptake of nitrogen or denitrifying?" So again, just thinking about these as separate ideas, but there's clearly some overlap in the thinking.

So let's return to that policy statement. So our programs in the Corps often suggest that it is an aquatic ecosystem restoration program. So let's think about that word ecosystem for a minute. So we're defining and clarifying. What are we restoring? Are we restoring a particular species? A population? A habitat? Are we restoring soil quality?

It says right from the top that we're restoring ecosystems. So we're thinking explicitly about an ecosystem where we have a biotic community, and it's abiotic in its environment interacting together. So inherently we're implying that the biotic and abiotic worlds are both parts of the Corps restoration program.

So if we say that it's ecosystem restoration, it implies that there are biotic and physical components and the purpose of that restoration is to restore structure and function then it implies that we're thinking about all four of those parts.

So on the top row we have the abiotic view. The physical structure and function. And on the bottom row we have that biotic view of the biotic structure function.

So historically in the restoration world -- inside and outside of the Corps -- there's been a focus on the physical structure associated with the system.

Maybe it's the channel shape. So thinking about what a river looks like in terms of how wide or deep it is. Or maybe it's part of the flow regime in terms of how high a particular flood is. What the magnitude or duration of a particular flow is.

There's a growing emphasis on the physical function associated with restoration. And this is being used more and more commonly to think about things like well what trajectory is the channel changing towards or what trajectory is it on. So is there ongoing geomorphic change.

And here you're starting to see more discussion around issues such as sediment transport and wood recruitment and transport rates.

Moving to the lower left if we start thinking about the biotic structure associated with an ecosystem, I would suggest this is entirely in line with this growing interest in the conservation and restoration world of restoring for instance bio diversity for a system. There you're talking about something like the species richness or who is present. What parts of the biological community are present?

But there's this fourth quadrant of biotic function. And I would suggest that to date there's been less emphasis on this segment. And this is really what's motivating this broader project. And what our primary focus is on biotic functions.

So thinking not just in terms of who is there, but what are they doing. So what species are there. And what is their rate of change of birth or death rates. Or not only what nitrogen concentration is there, but what are the underlying processes of uptake or transformation associated with it.

So as I said this project this R&D focuses on emphasizing the biotic functions associated with ecosystem and emphasizing how we can measure those and begin to use them in the restoration world.

So transitioning into that discussion biotic function represents the activity of the life in the river. So for example one function we can measure is primary production or the amount of photosynthesis occurring

And primary production from algae in plants is one of two main energy sources in a river. The other source would be energy coming in from outside. Like leaves and other materials from terrestrial plants.

So without these other energy sources we wouldn't have the fish or bugs or other elements of biotic structure.

And as one example of an overarching ecosystem process we sometimes talk about the metabolism of an ecosystem or the metabolism of a river. And this is analogous to the metabolism of a person or any other organism. But scaled up to cover all of the organisms within a community.

And as we're thinking through ecosystem metabolism there are two main parts to this equation. First is the energy captured during primary production, which fuels the ecosystem.

And then second the energy consumed by all of the plants and animals in that system. And we called that consumption of energy restoration because it's essentially the process of converting oxygen to carbon dioxide.

We can also talk about metabolism as a carbon balance. So plants and algae and other primary producers turn carbon dioxide into plant material, which is grazed by bugs and fish. So that's the carbon coming into the system.

At the same time those same plants and animals and bugs and fish are burning energy, which respires that carbon dioxide. So that's a more carbon balanced view of metabolism.

Another way we can measure it is to measure the oxygen balance in the system. So primary producers are releasing oxygen when they're photosynthesizing. And at the same time they're consuming some of that oxygen as restoration.

Conversely animals of course only are consuming the oxygen. They're never producing it. So together this means that rivers tend to generate oxygen during the day and when – that is when they're getting sunlight and then consume it again at night.

Okay, but how much primary production is the right amount. I mean this is a fair question. Some primary production is a good thing, but some of the most dramatic failures in river and lake management often relate to harmful antibacterial algal blooms, which is when too much primary production by the wrong kind of producers is - leads to these larger blooms. And often this is driven by excess nutrients as part of that discussion as well.

So the complicated component of this is the rivers naturally have varying levels of primary production over the course of the year. And that's usually in response to different river flow levels.

So in the winter in cool parts of the country production is usually very low in the river. And it may ramp up in the spring as things warm up. But then come summer there is again a decline if the river is small and gets shaded in by trees.

The dominant type of primary producer can also change as the season is changing. So certain times of the year there may be big blooms of algae such as this filament of screen algae that (Caitlin) is holding. And that can be a natural part of these annual cycles.

And periodic high flows can scour these away and wash them down the stream before levels get too high.

So we need to learn about these natural cycles and relationships if we want to manage for ecosystem functions. And that's really our underlying motivation for this project. Is that if we really understand these processes, we can adjust our management activities. And when appropriate and where possible start to include biotic functions in our restoration actions.

So if we're going to study biotic function, we have to be able to measure it. For primary production the easiest thing – and I should note that it isn't that easy – is to go out and measure the amount of plants and algae of different types that are present.

But that's biotic structure, and it's not always a great solution because of critters like this little guy here. So this is a stone roller. A fish that grazes on algae. And if you have a lot of algal grazers present, they can be mowing down the algae as fast as it's growing.

And that's usually a good thing because it means that algae is fueling the rest of the aquatic community. If on the other hand you found a ton of algae present, that could mean that there's nothing out there eating it. And so either way it's hard to know how much actual production you've got in the system based solely on what you're observing in terms of biomass.

So just as another example this is a Heptagenia Mayfly who scrapes algae off rocks. And you'll note the strands of algae next to him that look like little hairs. And for scale this little guy's probably about half an inch long. So he is able to consume and make a relatively large impact on this algal community relative to these very small strands.

One way that we can get at the overall production is to measure the change in oxygen during the day and night. And as I noted earlier the amount of oxygen increases during the day in proportion to how much production is going on. And then at night it decreases in proportion to how many organisms and what biomass is out there respiring.

So just by putting an oxygen probe in the water we can get an estimate of that broader notion of ecosystem metabolism. But that doesn't always tell us who is doing the producing.

And to get at that we need a way of measuring the production of a representative sample of each kind of organism.

So this is where we're going to transition to how to do that. And (Caitlin) is going to show you how she's doing both of these – how she's tackling both of these processes of measuring biotic structure and biotic function in the Middle Oconee County River.

So with that I will pass the presenter rights to (Caitlin).

(Caitlin): All right. So I'm very excited to talk with everyone about what I'm doing Middle Oconee River in Georgia.

And just before I get started I want to mention that prior to coming to the University of Georgia the majority of the work that I did was actually main structural restoration. And so I did a lot of management in monitoring the systems and predominantly focused on the structures.

So it's been very eye opening for me and interesting to get into this very different complimentary and additional area (unintelligible).

Courtney Chambers: (Caitlin) I'm sorry, can I interrupt just a minute. If you wouldn't mind getting a little closer to your speaker or using the handset. You're a little distant.

(Caitlin): Absolutely. So I want to give you a little bit of a background of where the Middle Oconee River is. A little bit of information also about what we've been studying – and when I say we I mean the collaboration of many researchers in this area – since the 1960's.

And then also where we've gone with this project specifically. How it fits into a greater scheme of knowledge and adds to that. But then also how we hope to be able to pull information out for water management peoples. And also for information for ecological restoration.

So the Middle Oconee is located in the Piedmont region of Georgia. It's between the Blue Ridge Mountains and the upper coastal plain. And there's a lot of geological differences between these areas.

And one of the big things that happened in this area of much of the Southeast is historic farming that really removed a lot of that topsoil and created the sediment laden waters that we still see today.

And the Middle Oconee River is in this little red box. There's a small star where Athens is. And zoomed in here you can actually see the Middle Oconee River on the left. And the North Oconee River where it joins.

And it will eventually meet up together and then it will go down to the Ocmulgee, the Altamaha and eventually into the Atlantic.

But along the way there are numerous dams, water withdrawal intakes and reservoirs that impact the flow of the system. And many of those that have been there for a long time.

And our research takes place in a section that's specifically located at a public access point. It's in Ben Burton Park. It provides a really common context of – or context of common management issues. We have pumped off stream storage, we have small scale hydropower, a private facility.

And then we've also been having recurring droughts. We most notably had a very extreme one in 2007, 2008. But then again had continued droughts just as recent as last year.

And if you look at this map of the Athens area. So if you remember that red star, if you just place it right in the middle of that orange circle that you see that highway system. That's Athens right there.

And the North Oconee River is that number one intake over on the right. And so this blue line is the North Oconee. And point two is on the Middle Oconee which joins with the North Oconee down here. And the three is a third water withdrawal point for the Middle Oconee.

So in 2002 they constructed Bear Creek reservoir that's number three. And so water doesn't just go directly out of the Middle Oconee for drinking water directly. It also goes in say winter months to fill this reservoir as a backup.

And then that small hydropower facility that I mentioned is up at number four. And so this is as you can see that's above our site. So that intake for the reservoir over here number three is actually in the middle of our site. And then the hydropower facility is above our site.

And as I just briefly mentioned there's been a really rich history of research that's occurred not just from the University of Georgia, but of course the Corps of Engineers. And also scientists from USGS.

There's been studies that date as far back as the 1960's. Everything from studies on macroinvertebrate communities to fish populations. And really comparing the producer communities that existed in the 1960's to the 1990's. Looking at those structural components, but then also looking at some ecosystem functions.

And because this knowledge has already accumulated about the system structure and the hydrologic patterns this site is really ideal for studying the impact of flow on ecosystem function.

So we not only have this common set of management issues, but we also have some information about those management issues from studies that (Kyle) himself has done both as part of his dissertation, but then also his work with the core. And then as I mentioned these studies going as far back as the 1960's.

And then the last thing that's very interesting about our site is the stream order that it is. So the Middle Oconee River is actually a sixth order stream. So if you look over at the right here, I've just given you a small example of stream order increases. So as you go from the head waters down to larger systems and those streams join, you increase your stream order.

And as a sixth order stream the Middle Oconee has some predictable patterns. From the river continuum concept we know that structure changes predictably as you flow from those head waters down to estuaries or reservoirs. These changes occur as terrestrial carbon inputs go from big leaves to small broken down particles. Canopy goes from very closed and dark to open and channel whips and water ducks increase.

In the head waters, which I have up here. This is a conceptual diagram of how these changes occur that was published in the 1980s. And it's an often cited diagram if people haven't seen it before. It's simplistic, but again does change predictably as you go downstream from headwaters to bigger streams.

So in those head waters you get those darker areas, closed canopies and highly carbon inputs. And so you get a lot of those pathways that (Kyle) was referring the terrestrial inputs. Also brown pathways. So there's a lot of breakdown of leaf litter. That's really important. And they fuel a very different type of food web.

There's minimal primary production for the green pathways. But if there is, it's usually in the form of algae mixed in with other organisms that breakdown the leaf litter. And this type of grouping is called biofilm or periphyton. And it's something that you'll see commonly in those head water streams, but you can also see it in lower streams.

And these changes in basal resources impact the organisms all the way up. So the invertebrates that are going to be produced in this area are not going to be the type that are collecting things from the water column, they're going to be the type that are breaking down those leaves.

And as we move down to the bigger systems you have a much more open canopy. You have all of those leaf litter inputs from all up stream have been broken down. So the water column has much more fine particulate matter in it. And it's also very deep. So there's a lot less light penetration to the benthos or to that bottom – river bottom.

And those particles support planktonic algae that's floating around in the water column. And this changes all of those organisms that are higher up in the food web. So the invertebrates are going to be those that collect particles from the water column directly. And not so much those that are shredding things as you would find in those head water streams.

And then our stream of course as I mentioned is one of those intermediate streams. So we're still in an area that has water ducks that are not too much to decease light penetration. So we'll still get light penetration all the way down as long as the water's not too turbid.

But we have – and we have that open canopy to support a lot more growth. But we're also going to have a mix of fine particulate matter from things that were broken up stream that are coming in from tributaries.

And so we get a mix of these different types of producers that we see. Everything from the biofilm to aquatic plants. And you'll hear me mention the specific aquatic plant Podostemum again. We'll also get algal blooms that (Kyle) was referring to. We'll get a combination of all of these things.

And in these systems as I've shown primary production becomes a lot more important than it is in some of those higher head water streams. But those head water streams are where a lot of the research has been done on these ecosystem functions.

And one of the reasons for that is because quite frankly they're wadeable and that makes a big difference.

And so when people go into look at the different components the different producers or the brown pathways they can go in and they can collect a rock and put it in a chamber and figure out how much oxygen it's producing or how much respiration is occurring and oxygen's being consumed.

When you get to those larger systems people tend to use the metabolism approach that (Kyle) was referring to. And so you'll have studies where they put in those probes and they get an entire stream measurement of oxygen balance within the system.

And combination of those two things are really what is powerful because you can understand what's happening on the whole level, but understand the mechanisms and how it's occurring by looking at the different components.

In intermediate streams really allow that process to be flushed out where we can get at those mechanisms that allow us to understand what's happening in the whole stream picture.

So our specific research aims to quantify how changes in flow affects the very important process of primary productivity. And we've chosen to examine primary productivity because of everything that (Kyle) mentioned about it being a basal resource and feeding everything further up the food chain.

But also because it's a control and is related to a number of other really important ecosystem functions. Like the invertebrate secondary production, but also things like nutrient uptake.

And as a reminder here when I'm referring to secondary production I'm referring to those consumer organisms and primary production of course all the different photosynthesizers and plants and algae.

And when I'm referring to productivity I just want to remind everyone that I'm specifically referring to oxygen production. And so this is a rate. I'm not referring to a difference in biomass between time. Sometimes it's used that way, but we're specifically getting at how much activity is that plant having. So is it producing a lot of oxygen, is it producing a little bit of oxygen.

And our ultimate goal with this research – our long range goal is to be able to translate this information on how flow impacts primary productivities into predictions of how this system might change under different water management scenarios.

This type of information is the very type of information that managers and policy makers need to understand the effects of different water management strategies, on water supply and how it might affect things down streams and reservoirs. All of the things that we rely upon. All those services that we rely upon. We need to know how flow impacts the regulation of those services through these functions.

So this is a conceptual diagram of how our system works. And I'll step through it. So up at the top you'll see the main driver of everything. And this is the natural flow regime. So these are the prior flow conditions that impact other abiotic characteristics. So those three that are collected in that circle on the left here.

And then we've got chemical light sediment flux. And then these four combined really create the different biotic communities or the structure that you're going to see of your primary producers.

So the amounts of primary producers, the types of primary producers that you get. And then these biotic components then determine your function. Your nutrient uptake, your productivity, secondary production.

And everything that's occurring here is happening at the reach scale within this dotted box that you'll see. But then it's also impacting everything down stream. So depending upon what occurred with that reach you get different carbon and nutrient fluxes downstream to a reservoir or an estuary or even just different downstream segments.

So our prediction for the system are that the identity of biomass of the producer or other components matters. We think that some producers may be very active while others less so. So some might have a really great amount of oxygen production while others have less oxygen production.

We also think that some producers might collect more organic matter that's respiring and kind of balancing out that oxygen production.

And our key step here is that flow is going to impact both of these aspects. It's going to impact the primary producers that are there, but then also the rate of what they're doing. And so by changing the identity and the biomass of the producer you'll then determine different types of rates. So you might have a really high oxygen production rate or a really low oxygen production rate.

We also think that when we relate our prior flows to productivity we're going to find that more streams will likely lead to less biomass and less productivity.

But that intermediate area when we're getting different types of variability of flows we think that that's going to be a bit more complicated. And that it's probably going to be a balance of each of those different types of producers or those biotic components.

And so if we're not just talking about big scouring floods and we're not just talking about a drought we think that that middle ground of some flow – steady flow that's there, but maybe a couple of higher flow then. That's going to be a lot more complicated and we're going to have to understand those components and the mechanisms for each of those components to understand that full whole stream picture.

And so as I've mentioned we think that as maybe more extreme events occur as you see with that flow increase that it's going to decrease the primary producers and then also likely decease the rates that we'll see oxygen production.

And lastly we think that we're going to capture information about these different components, but it's really going to help us understand that whole stream picture. Things that scientists have been trying to look at for a very long time and see a lot of variability that they haven't been able to explain because they can't get in there and look at the mechanisms in such large systems.

So in our system – at the Middle Oconee – we have a number of different components for this project. We have five major parts. The Army core hydrology model. We have monthly biomass sampling. We have chamber studies, whole stream metabolism to get that whole stream picture and then eventually modeling this ecosystem function.

So the US Army Corps scientists with the help of a number of different students developed a 2-D hydrologic model that we're using to get ascendant flow conditions like water ducks, velocity and discharge for a given area within the stream.

This portion is already done and it gives us that flow information for what a specific area might have experienced in the past. So whether or not there were a number of high flow events or whether or not there were flows that were under 7Q10 for a long period of time.

We have monthly biomass sampling along established transects within the stream. This portion of the research captures that structure. So this is the snapshot idea. We're getting an understanding of what producers are there and in what biomass amounts.

We're also getting associated information so we have some organic matter some of that respiration that's also going to occur from that.

And we're capturing not just the benthos (the stream bottom), but we're also capturing everything in the water column when we go out to do this monthly biomass sampling.

We get everything from – as you can see over here I've got a lot of algae pictures used before. So this is what we captured last June. But then these transects when we go out will pick up from a certain spot. We have five spots on each transect. Destructive sampling. So we're taking everything with us. And whatever we do we reach down and we pick up a sample. So if we pick up a large rock, we get all of the aquatic macroinvertberates that might be on it, all of the filamentous algae that might be on it and we come back and get standardized mass for that. So we're getting ash free dry mass of every sample so we can compare the different types of producers.

And then we also have chamber studies. And the chamber studies are how we're actually getting at those rates that I keep on referring to. So we put a rock inside a chamber. And these are the chambers here. And for scale these are about two and a half feet long. Possibly actually three feet long if you include some of the piping that you see in the back. So they're quite large.

We put the rocks inside the chambers and it's a recirculating chamber. So this is going to go in the stream. And we have two different types of runs. We have a dark run where we are capturing respiration occurring. And then we have a light run where we're capturing productivity and respiration. And this allows us to see that balance and get both the information of what oxygen is being consumed, but then also the oxygen production.

And we can put different things in these chambers. And we are putting different things in these chambers. So we're not just putting aquatic macroinvertebrates, we're also putting biofilms and just water column into these chambers.

And then lastly we have the whole stream data that we're collecting. And these are loggers that we're putting out to collect everything from dissolved oxygen and also conductivity, but then we're also getting light at each sample.

And from all of these things combined we're hoping to model ecosystem functions. We're hoping to model this from those biotic components, but then we're also hoping to compare that to the existing information we've collected at the whole stream level.

So to understand how those components are creating that change at the whole stream level. And also possibly what some of the missing pieces are.

So this past season we were able to collect information on what is out there.

We have a lot of different types of algae. Filament is green if you will remember that picture of me holding it. That big chunk of filament is algae. We have filamentous algae that I've got down here, which is often a brown looking type of growth that you'll see and then biofilm what I've got over here this green stuff that's going on the rocks. And of course the water column producers.

So we captured predictable groups, but what wasn't necessarily predictable is what we saw when we actually compared this to the hydrograph and we went out and saw the different biomass amounts that were out there.

So this is this past season. And you'll notice two main events that I'll refer back to when I'm looking at biomass information. This one event doesn't actually look very big, but it was actually enough of a scouring flow. And then the second event that I'll refer to was a considerably larger event than this first one.

And so when we looked at these out in the stream. This is from those events. Before the flow we actually had a filament algae bloom. And again this is structural that we're looking at right now.

We had a filament algae bloom and then after the same high flow taken from a similar perspective, but not quite the same. The waters were quite low. You don't have the same filament as algae it's gone. And where you do have bedrock, it's very exposed. And open to dessication from the sun or exposed or debris from geese and turtles and all sorts of other organisms.

And when we look at the biomass we see some interesting trends. So this is the different types of algae the larger algae.

And so before this smaller event even we had quite a lot of variability in our filamentous algae. We had just some smaller amounts, but then we had quite a bit more of that. So the big strands that you also see that were attached to rocks.

But after that event those big strands seem to have gotten fluffed off and moved down the stream. And it never really recovered. And then when we got this other event it didn't come back. And when we actually looked at what was out there we saw that this was the filamented screen and then we saw a switch to a different type of organism and we had Podostemum that were existing on the rocks after that big scouring event. These are a lot smaller, they're not as susceptible to those high flows.

And then when we look at the Podostemum that was out there we saw stability – more stability in the amount if you look at the means. But what really decreased were these maximums. Before that big flow event we got some really large amounts of Podostemum. This is like an order of magnitude larger than what we saw with the filamentous algae.

So we saw some really large amounts of filamentous algae and those never came back after those high flow events. And one of the reasons we hypothesized that that occurred was because it was exposed. And we believe that the grazers or the sunlight through defecation could have been eliminating those larger maximums that could have existed.

In this season we've gone out and we have captured information that's quite different. It's not – it has not been as nearly as dry and we actually really got a large event this past April. So I'm very excited to see the information on biomass in this year.

And we started our metabolism study. So we started those chambers – then I'm just going to visit this very briefly so we can move onto a bit of questions.

But we – what I'm showing here is dissolved oxygen. This is temperature down at the bottom in the green. Dissolved oxygen is at the top. And this is time on the bottom.

So where the temperature is really low that's my dark run. So when it's covered – those chambers are covered with a black tarp. And then the light run when the tarp is removed you can see the higher temperatures.

And so this bottom left is chamber data. You don't have much respiration, but you do have a lot of productivity. That oxygen production.

Compare this to the biofilm, which has a lot of respiration and not as much productivity when you take that tarp off and the sunlight is there.

And then at top we have what would be producedin the water column. And this scale is pretty different from the two at the bottom, which is why these jumps appear.

And so this is actually pretty even between its jumping around a little bit, but if I were to put it on the same scale, it would look a lot different.

And so this really didn't show a lot of activity for respiration or productivity, but it's very interesting to see that yes these different primary producers are having different impacts, different rates.

And so what I want to move to next is really how we want to use this information and questions about where we stand, what we're getting to with this project, where we hope to get to and what that actually looks like for managers.

So as you can probably tell from this project it is a lot. There's a lot of different things that we still have to figure out. We have to collect a lot of baseline information of what the stream looks like. That doesn't necessarily mean that a manger using a function has to collect all of that. There's the potential to may be use something like a whole stream measurement that's very simple and you only put one probe in.

But in order for us to understand those mechanisms as a scientist I have to go in and evaluate those. And that is taking a lot of work and takes those different five components that we've mentioned.

And so with that I think I'll open it up to questions.

Courtney Chambers: Very good. Thank you (Caitlin).

Operator: All participants are now in interactive talk mode.

Courtney Chambers: Okay at this time please feel free to take your phones off of mute and you can ask questions that way or use your chat feature and type those in. And send that question to everyone if you use the chat box. Thanks.

Any thoughts for (Caitlin) or (Kyle)? Don't want to cut you short on time to think or process, but please don't be shy.

(Kyle): This is (Kyle). I'll just echo (Caitlin) a little bit there at the end. So that yes we're still learning a lot about ecosystem functions and how to use them in the context of management.

There's a lot of details to keep check of here. And we're not – I haven't seen that many examples of folks using these types of methods in the Corps. And so I would be very interested if folks on the call argue these in their own projects.

So I – if you have in addition to questions, if you have comments or input along those lines, I'd be interested to hear your thoughts.

(Chuck Theiling): Hi (Kyle) this is (Chuck Theiling) up on the Mississippi River. You know we've got partners in Academia that do some of this stuff. And more and more in our restoration projects we're putting out continuous monitors. We don't necessarily know how to use the data.

And I'd ask that if you guys – I'm sure you're willing to share – how you work up these metabolism data and can you point us to analytic routines our packages, which I know you know about that can help us process that continuous logger data because I think continuous loggers are something that are pretty common in our water quality monitoring branches.

(Kyle): Thanks (Chuck) that's a really excellent point. That a lot of times yes either at core projects and partnership with others or at local USGS gauges a lot of these data do exist.

And (Caitlin)'s been working with some other partners for instance (Bob Hall) at University of Wyoming who are developing algorithms for processing this giant pile of data that comes off of an O2 sensor. And how do you sort through and turn it into knowledge and useful information about what that emergent property of the ecosystem is.

But absolutely we're happy to share those lessons learned in that code as we move along. (Caitlin).

(Caitlin): Yes sorry to jump in there. This is one of my favorite parts of this project actually because one of the things I think people did very early was recognize the youth of a lot of those loggers. And so people started to use them. And it's actually been a bit of a catch up game to try and figure out well what's the power of that data. And what is it telling us for every single system because it's not the same based on the type of metabolism, the type of stream that you have. Similar to people it can change. There might be a metabolic regime specific to a type of stream in order of the stream regions for a particular stream.

And so the reason that it's one of the favorite parts of this project for me is because I feel like that's a lot of the power of what we're currently looking at. We're really trying to get what is informing that larger picture so that when you have these different fluxes that you can see at that whole stream level you'll understand some of the pieces that might lead to that.

But as (Kyle) mentioned researchers are just now getting those packages together that can analyze those tools that you can use to convert that information into really digestible chunks and graphs and figures that can mean something for you.

And so (Bob Hall) who was mentioning is the person who I'm using the R code for. And I believe it's freeware and again like you said I'd be more than happy to pass that along.

Courtney Chambers: (Kyle) and (Caitlin) if they're interested in that kind of information, would it be best for them to follow up with you individually by e-mail?

(Caitlin): Yes.

(Kyle): Right now that's probably the best way to get a hold of things. So yes please do follow up by e-mail.

Courtney Chambers: That might be more informative than anything we could post or just make available by a link right now I would imagine. Have a conversation. Okay any other questions or comments for (Kyle) and (Caitlin) before we wrap up today? All right. Well any final comments you guys before we finish?

(Kyle): I just want to thank everyone for their time. And I'm excited to see this project come together and see how this team is really tackling the use of ecosystem functions. And trying to move the needle from it being a discussion primarily in the academic world of how cool functions are to something that maybe we can use in the decision oriented context.

So I really appreciate you all's time and the UGA's team's efforts on this.

Courtney Chambers: Very good. Thank you guys very much. I do want to make all of you aware of our next scheduled ecosystem restoration webinar meeting. We have one scheduled for the 25th of July again at 1:00 central time. And that one's going to be about ecological model development and smart planning. A case study from Proctor Creek, Georgia, which will also be shared by (Kyle McKay) and a colleague (Todd Swannack) from here at the Environmental Laboratory as well. So we hope you can join us again for that. Thanks for taking your time out of your day to tune in. And we look forward to learning with you again soon.

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