5/31/2024 - 6/1/2024 - BD058

**BD058**: I saw that you talked to Susan Jackson…

**Interviewer**: Yes.

**BD058**: Did you have like an hour long chat with her as well? A lot of…all things BCG?

**Interviewer**: Yes, she was so informative and actually really like all of EPA…I keep joking with Sarah like you all are so friendly and like have offered so much time. So this is my first time working in the Chesapeake, I’ve been a postdoc at SERC with Emmett Duffy for about a year now, but we’re taking a case study approach to this project so our first case study was in the Gulf of Mexico in Mobile, Alabama down where Sarah and Steven are and we did that case study last fall. So this is my first, the past few months, is, really the past like two months, is my first time working in the Chesapeake and so I don't know anyone in the Chesapeake in terms of like finding participants for our study, folks to come to our workshop, and I… early on, a professor at VIMS that Emmett knows connected me with Galen Koffman who you might—I don't know if you know. Is he at the same office as you? Cause are you in D.C. or are you…?

**BD058**: I am. I’m in the D.C. office, I’m remote but yeah I’m in D.C.

**Interviewer**: Got it, okay. Yeah, so I met with him and then he connected me to Susan Jackson and Susan Jackson has connected me with like five other folks at the EPA and then they just connected me with someone at EPA Chesapeake Bay Program and so now I have like two or three people from EPA Chesapeake Bay Program and it’s like all of you EPA have like really helped me out. I appreciate it.

**BD058**: No problem. That’s what we like to hear. Don't talk to..never mind I’m gonna be quiet. Some of the other agencies are a little more difficult, tight-lipped slash…particularly some of the military related ones…I’m not sure if you've talked to anybody from the Coast Guard, something like that, or Navy. They can be a little tougher.

**Interviewer**: Yeah, we do have a collaborator at the Naval Academy who is helping which is great, and then I’m talking to someone in the Department of Defense on Friday so we’ll see how that goes. The other one…we don't need Coast Guard but the Army Corps has been really hard to get in touch with. We couldn't get anyone in Alabama, and I’ve emailed a few folks here, and I can’t get in touch with anyone here either.

**BD058**: That sounds about right. I don’t work very closely with them but I have colleagues on the Coral Reef Task Force that work with the Army Corps and our regional offices work very closely with them as well.

**Interviewer**: Yup, I mean I get it. Everyone’s so busy, so I understand.

**BD058**: Oh, I know, I know. Yeah, everybody is but…everybody has an hour or two though, so whatever. My personal opinion.

**Interviewer**: Do you–last thing on that–do you know Giancarlo…I’m gonna say his last name wrong… Ciccetti maybe? I think he’s… he’s at EPA. He’s someone else that Susan connected me with. He does like bioassessments and biocriteria up in the Northeast.

**BD058**: No. It’s not ringing a bell. And I’m not…that’s not surprising. I don't work terribly closely with Susan. I used to a little more, a few years back. I mean we connect, we share things with each other and what’s going on, particularly with the biological condition gradient that’s related to corals but I don't talk with her on a regular basis and she doesn't regularly attend our coral team meetings unless she’s working on a specific project. So I don’t–that name does not ring a bell actually.

**Interviewer**: Gotcha. Well, also I met him, I chatted with him yesterday and he was…we chatted for a while and he was like, “Yeah like the EPA, the government’s great, you have much better quality of life than being a ten-year tract professor.” And he was like, “I can just sign off early if I want and work some hours otherwise. I can do what I want. I have quality of life.” And I was like, “Great! Sounds good to me.”

**BD058**: Yeah, it is good. I agree. It’s pretty nice. Like I said, I’m remote work now which I probably leverage a little bit of–I mean COVID sort of changed the whole world, right, and so when that came around I was like, “Screw this, I’m not gonna go in” and my wife and I moved out to Manasses, if you're familiar with it in Virginia, but it’s about an hour west of D.C. and I was like, “welp, I’m not driving in everyday so let’s just see if I can get this pushed through.” And so they were a little…it was easier to get applications for remote work four years ago as you can imagine, so once you get it, it’s hard for them to take it back. Get it in writing and leave me alone. I’m not coming into the office. I don't need to come into the office, and so–I mean nobody does anymore just because honestly as a society. Our managers come in once or twice a week, staff sometimes. There’s just no point anymore these days, so, anyway.

**Interviewer**: Well, anyways but to jump into our interview questions, just to get started, you’ve already started talking about it a little bit, but we would love to just hear a little bit more about your area of expertise and your research at the EPA.

**BD058**: Sure. So I guess that I do peer research, but I’ll give you a background. I used to…I miss it. My background is actually geology. I have a PhD in geology and that was, god, ten or eleven years ago now, but I was very interested in ancient climates and I did a lot of geochemistry looking at ancient soils and ancient corals. So I worked with lots of rocks and dead corals. So that’s a long way of saying–so I did that and then I moved here back in 2016 with my wife, so I’ve been here for almost eight years now, which is hard to believe. And then I got to APPA through a AAAS fellowship. I was here for two years, in the same branch in EPA, so I’ve been in the same place now for four or five years, and I came in working on our corals program, which I’ll talk more about in a second, and then also within our branch we also have a ocean and coastal acidification program–I’m quoting programs, it’s like one person, which you’ll learn more about in a second. And then I also do some regulatory work, so I work with our vessels team on developing regulations. So, right now my time is split. I used to be basically 100% corals. I used to work on corals 100% of the time. Now, it’s about 50% corals and 50% regulatory work for vessel discharges, which is tricky and it comes with its own challenges. But, so at EPA, you don't really care about the vessels, but the corals program, the way that works, we call ourselves the corals program. There’s about…oh I would say ten of us across all of EPA, so EPA headquarters, all of our different regions that do something related to corals, very broadly. Nobody at EPA except for maybe a couple of researchers and our office of research and development are purely corals experts and/or work 100% on corals. Like I said, 50% of my time is on corals…in the regions, it’s probably even less for some of those folks, so. Like for example, we have a guy in Hawaii, his name’s Hudson Slay. He is the corals guy in Hawaii and it’s probably 25% of his portfolio, so EPA is not traditionally the corals group, that’s NOAA just to be honest with you. NOAA gets all the funding. EPA sort of has to kinda scratch and come at it from the angle of water quality and so everything that we do we filter through that and show how water quality and corals are related. So I don't do pure research. My main…I would say my main day-to-day activities are more coordinating among the regions, and I attend a lot of interagency meetings, primarily through the U.S. Coral Reef Task Force, if you’re familiar with that. Are you familiar with that?

**Interviewer**: I don't think so.

**BD058**: Okay. Just real quickly, so that’s…the U.S. Coral Reef Task Force, I think it started back in 1998 via an executive order and basically the goal is for different federal agencies to come together and leverage their resources to protect corals, make them resilient to climate change, so forth, and so it doesn't require us to give money or funds or require us to donate people time to the effort but we’ve done that over the years and EPA is a member of the U.S. Coral Reef Task Force, NOAA and the Department of the Interior Co-chair is, and so a lot of our work that we do at EPA feeds the task force if you will or supports the task force efforts, so we have our own mandates and directives at EPA but we try to align them with what’s going on in the Coral Reef Task Force because they do a lot of support for the islands and the territories. Let’s see…so yeah, most of my day-to-day right now is coordinating efforts among the regions and then working with different agencies on the Coral Reef Task Force. We have a monthly national coral reef team call which is just EPA folks which is again about eight to ten people, one to two people from each of our regions that covers the Pacific and Caribbean territories, so Virgin Islands, Puerto Rico, Hawaii, \_\_?\_\_ Guam, American Samoa, and we kinda catch up, we try to align our priorities, we try to find ways to leverage resources here at headquarters cause we have the money and time apparently, which we don't, but we always are trying to find ways to get corals included into whatever we can at EPA. So that’s…I’ll be quiet for a second, see if that answers your question and then you can follow up if not.

**Interviewer**: No, that was super helpful. Quick question, so when you talk about the ‘regions’, so do you do any work specifically in the Chesapeake or like how does that look across the different regions in the EPA?  
  
**BD058**: So I don't specifically do any work in the Chesapeake, so hopefully this is still helpful to you…

**Interviewer**: No, yeah it still is. I was just curious but it still is, yeah.

**BD058**: Yeah, so I don't work with anybody in particular that works in the Chesapeake. When I say ‘regions’, I’m referring to EPA regions. Sorry if I use terminology that’s odd here. So region 2 is our office based out of New York and that includes parts of the Caribbean, so the Virgin Islands and Puerto Rico where of course there are corals. Region 4 includes Florida which, of course, there are corals that have sadly been decimated, but they have a large coral reef tract. And then region 9 is out in the Pacific, so obviously the coral reefs in those jurisdictions out there. So when I say regions, I’m referring to those specific regions and mainly either the coastal people there in the regions that we work on, coastal issues, not freshwater but mainly coastal issues or different permitting and things relating to runoff, dredging, that sort of thing.

**Interviewer**: Okay, cool. Okay, great. Well that was super helpful. So, if this sounds good to you, we have some questions related to biodiversity, so I’ll give a little project background and then we can jump right into those. So, like, I think Susan sent some information and I did as well over email, but the really high level goal of the project is to understand the role of biodiversity in marine resource management, and so really what we want to understand is how do folks think about biodiversity and define it, cause we learned very early on that everyone thinks about it in different ways, there’s not a lot of consistency around how people are defining and quantifying biodiversity. And then we went to understand if and how we are currently managing for biodiversity either directly or indirectly in the U.S. and so to dive into some of our specific questions around that, we are using a tool called Mental Modeler. Are you familiar with that? Have you heard of that at all? Okay. So I’m gonna share my screen if I can, although Sarah I realized…I don’t know… I changed my settings on Zoom, let’s see if I changed it on this. I sure didn't. I got a new work computer a few days ago and all my settings are now messed up.

**BD058**: Yeah take your time. EPA rolls out updates all the time, like in the middle of the work day it’ll be like, “Your computers gonna restart in five minutes.”

**Interviewer**: We did an interview just last week where that happened. But it was someone NFWF, yeah they just like disappeared and they were like, “Yep my computer decided it needs to do this now.”

**BD058**: The government needed to do something really quick, so.

**Interviewer**: Oh, wait, I think I fixed it. Did I fix it?

**BD058**: Yeah.

**Interviewer**: Nice, love it. Okay, so can you see that screen well?

**BD058**: Yup.

**Interviewer**: Okay, perfect. So Mental Modelers is a tool that we use in environmental social sciences basically as a way to visualize and conceptualize how an individual sees the system that they live in or that they work in based on their knowledge and area of expertise. So what I’m gonna do is go through a series of questions related to biodiversity and management and as you’re talking, we’ll build a concept list for our system components, and then what we do with this tool is we can assess how those components are related to one another either positively or negatively. So if one component was to hypothetically increase what would be the relative impact on the other system component that we’ve drawn out.

**BD058**: Got it.

**Interviewer**: Okay so just to start really broadly, like I mentioned, based on our goals, we’re wondering when you think about biodiversity, what do you think about, what do you see as the key aspects of biodiversity?

**BD058**: Oh boy, big question.

**Interviewer**: That’s the answer we always get.

**BD058**: Do people tell you that? Well, I’m gonna give you…well, I work on corals, so I’ll give you the corals angle answer cause that’s where I see biodiversity. I’ll start with the coral reef ecosystems. So we…our aim is to protect corals we say, but really we’re working to protect ecosystems because the corals harbor or create their own ecosystem, right, and so they breed this biodiversity. If the corals go away, the whole system crashes, and so I think of it as all being related but I do have sort of a concept in my head of when I say coral reefs or corals, I think of it as the corals sort of at the top as a system, and the corals are the home, the food, the shelter for all these different plants and animals at that scale, and of course they have their benefits for society as well. There’s a ton of food, nutrition, all sorts of things, lots of ecosystem services, so. So I think about it sort of as that way coming from the top is corals and then the different services that they can provide as sort of the top of the–not food chain–but the top of sort of this hierarchy if you will. That’s the quick answer, how I view it and then the biodiversity that it breeds.

**Interviewer**: Okay, so I have, from all that, so I’ll add in coral reefs. Is there…like when you’re talking about the benefits that coral reefs provide, you listed off a few really quickly of like habitats and supporting biodiversity and other food web dynamics, so maybe I’ll add…I’m trying to think of like how to phrase those… So it's basically like biodiversity in coral reef ecosystems basically?

**BD058**: Yeah, yeah I mean yeah broadly and if the question is… is the question like how would I define it?

**Interviewer**: Yeah, exactly. And how you think about it.

**BD058**: Yeah, so that’s how I think about it. I’m not sure if that came across very well, but I think about it as, yeah, as the corals being sort of the major component of the system that lends itself to increased biodiversity. So without them, biodiversity crashes, which it does and I was listing the other things, the other sort of services they provide like for us as humans, so I was listing nutrition, I was listing they have lots of cultural significance, they protect the coast lines from flooding, from storms, so they have a lot of various components but without the corals themselves, the other parts of the ecosystem leave if the corals aren't there and so that’s how I kind of think about them from my biased coral protection perspective.

**Interviewer**: No, that makes perfect sense. Okay, so I was gonna add in a few other concepts related to habitat in the food web dynamics that you mentioned but my next question actually goes into that so I’ll kinda jump ahead and then we can go back and forth and make sure we’ve captured everything that you just said. So one of the things that our team has done to try to help conceptualize and define biodiversity is come up with a framework of four different groups of species to represent species diversity specifically, and so I’ll add those into the map and I’m wondering if you agree with those, you’ve already mentioned a few of them, and if they’re things that you think about in your line of work. So, one of them is habitat forming species, which, of course, you mentioned coral is a type of so that might be redundant, we could take that out or like reframe corals as a habitat forming species maybe based on what you said?

**BD058**: Yeah.

**Interviewer**: Okay, I’ll do that.

**BD058**: Yes, that’s how I would classify it.

**Interviewer**: Yup, okay perfect.

**BD058**: Not necessarily species but.

**Interviewer**: Yeah, okay, yeah. And then key food web supporting species was another one which you mentioned. And then the other two are species of conservation concern and harmful organisms. And so I know you were already saying coral reefs are important for key food web supporting species and for biodiversity, as like an example of how we’ll start to draw out these relationships essentially. So…and you were also mentioned the importance for like the services, so I can start drawing in some of these relationships as you’re talking too. And I’ll do this, okay. Okay so, do you have any other thoughts on those other components that I added in? Do those resonate with you based on your line of work?

**BD058**: Yeah, well when you say harmful organisms what I think of is… well, what comes to mind, again based on my work, is stony coral tissue loss disease, I’m not sure if you’re familiar with that, but it’s been this devastating disease that basically ravaged Florida corals and all throughout the Caribbean that started back in 2014, so it is a harmful pathogen that has caused a lot of issues and killed lots of different reef building corals in these systems, particularly in the Caribbean, and I still work on that a little bit and that’s some of the work I did with Sarah. There was concerns about how it’s hurting around it and so forth so I think in terms of harmful organisms, from a corals perspective it’s more about keeping those harmful organisms or managing those invasive species or aquatic nuisance species from either getting into these systems and affecting the corals or once they’re there, like for stony coral tissue loss disease, managing that outbreak or trying to ensure that…well not ensure that it doesn't spread cause it’s gonna spread, but managing as best we can the impact that those harmful organisms are having on these important reef building systems. So that’s how I think I guess about harmful organisms that maybe is a whole different way than what you're asking, but that’s kind of my perspective on that and how it impacts biodiversity in these systems.

**Interviewer**: Yep, no that’s great. So I added in stony coral tissue disease. Should–you mentioned invasive species briefly–should I add in…is that important as well in this system or is it more so focused on the pathogens?

**BD058**: we’ve tried to–that’s like a terminology thing–we’ve tried to almost…there have been efforts to classify whatever this unknown pathogen is as an aquatic invasive species almost or aquatic nuisance species, yeah so we’ve done a lot of work with the aquatic nuisance species task force. I’m not sure if you’re familiar with them but they don't typically–well I shouldn't say they don't typically, but we present this idea, we have this thing, we don't know what it is, we’ve spent years trying to figure it out that is killing these corals. It completely…it destroys them. \_\_?\_\_ come back it actually ends up killing the soft tissue of the coral and it is a pathogen so it’s definitely a nuisance and it’s aquatic, and so that has been our way of trying to work with other groups by defining this or viewing this as an aquatic invasive or nuisance species, so it’s not like it’s necessarily a zebra mussel or something that you can point to and say there it is or a lionfish or you know, whatever. It’s more of a nebulous pathogen that’s probably some sort of bacteria and/or viral thing that is killing either the corals or the associated zooxanthellae, you know, the algae that lives in there. So yeah, I’ll stop there. That’s kind of the way I think of that

**Interviewer**: Okay, cool. That’s good to know. We haven't…people have oftentimes kind of binned harmful organisms as like two separate invasive species and disease and pathogens so that’s why my brain went there but that’s a really helpful perspective to hear.

**BD058**: Yeah, that’s how I bin it at least. Could be wrong.

**Interviewer**: Okay, cool. And then what about species of conservation concern?

**BD058**: Yeah, I’m probably not the best person to talk on that and that’s probably more of NOAA’s realm just cause I don't deal much with that but of course there are endangered coral species but that…I don't, I can’t provide much more context on that. I would point you more to coral biologists which is not my background necessarily. I’m not a coral biologist, so I don't work to many things at that kind of level. But of course there are species of either endangered or on the endangered list of corals that we pay a little bit more attention to, but in my line of work, I focus more on the ecosystem as a whole, if that makes sense.

**Interviewer**: Yup, that makes a lot of sense, okay. So we’ll just take that out. Okay great, so then some of the other questions that we were gonna go through you’ve already addressed so I want to ask…so one of the questions we’ve been asking is are there any important stressors in the system so it sounds like the stony coral tissue disease is a stressor itself. Are there other stressors that are impacting these system dynamics that are important for your work?

**BD058**: Yeah, I would say so the disease of coral is almost a special case, it’s not…but I mean there are–so I bin them into global stressors and more localized stressors because–and I’ll define those for you–but because the way that we could actually address them. So global stressors would be the temperatures rising around the global, global temperature rise, global sea level rise, global increases in atmospheric CO2 and obviously dissolved CO2 in the oceans. Can myself and us in the regions and the 50 or 100 of us that work on corals address that? Not realistically. I mean, we can try, right, but on the timescales we’re talking about…So there’s global stressors that we acknowledge are there and then we say okay well what’s going on at the local level that’s impacting the corals because there are these local stressors that are much more easy to manage and we know what they are and we can see them actively. So the big ones that we deal with locally are polluted runoff, so you know, if it’s wastewater coming in that’s muddying up the water, that’s delivering high loads of nutrients into these ecosystems, the corals are very sensitive to those, they’re sensitive to nutrients, they’re very sensitive to temperature changes, they’re very sensitive animals, they’re very sensitive to changes in pH or dissolved CO2 and so all of those things we try to do our best to manage. One of the main ones is runoff and agricultural runoff and nutrient loads entering to the waters, and so we do a lot of our work to try to find ways to manage that more than anything. It’s not as easy to manage temperature. It’s not as easy to manage pH. It’s a little easier to manage pH in some of these systems, but the big one I would say is runoff, land based sources of pollution that we’re trying to manage whether that be through regulations or just best management practices for people living near these ecosystems.

**Interviewer**: Yeah, okay cool. So I added in kind of global stressors as like a big bin and then I put local stressors. I separated out the runoff and nutrients based on what you just said. Should we add in some other individual concepts of those local stressors that you started to mention like the pH and the local warming waters or do you think we should just focus on like kind of the runoff issue based on, you know, that being one of your focus areas?

**BD058**: Yeah I would add in those as local stressors. I mean they all, they overlap, right, they’re global and local in nature but we sort of break them apart just so we can almost manage them, so. Again I would say if you want to add some more tags there, the global stressors as I see them are, you know, global changes or increases in atmospheric CO2, okay, so that’s me as a global stressor, global average temperature increases around the globe, and globally increasing acidification of the oceans. Now, and when you deep dive into that, the more localized stressors to me are things like land based–I would call it land based sources of pollution. That’s sort of the big thing. And then you can dig down that and be like well what is that gonna do to the water, you know, it makes it more turbid, it’s delivering nutrients, so this pollution coming off is delivering nutrients, it’s delivering sediment which is blocking light, it’s changing the chemistry of the water. So I didn't even talk really necessarily about other water quality parameters that we’re also interested in but primarily its nutrients, changes in pH, and temperature as much as we can kind of monitor it, less manage it but monitor it, and then, yeah, water clarity is important as well. So those are some of the big ones that I would bin more into localized stressors.

**Interviewer**: Okay, so should we make a separate local OApH and a separate local water temperature bin or just kinda have that…

**BD058**: You know, I’ve never really thought about this, I mean I have thought about it this way but I’ve never put it on a map so this is actually kind of cool. So yes, I would have I think you could put it in both, right, you could have global forcings, global stressors, whatever you want to call them, and then some of them are gonna be the same, like you just said, so locally I would put temperature changes, changes in the chemistry or acidity of the water under the local bin as well, and just call it more localized or nearshore changes because those are much more fluid, they happen more quickly as you can imagine, right, we’re not talking about the big scale things and again those are more things that we can manage, so I would kind of have them in both and just put a word in front that says like local, nearshore, something like that and also have some of the same words in the more global, if you will, bin.

**Interviewer**: Okay, okay, okay, okay, so maybe, yeah that makes a lot of sense, so maybe for simplicity sake, cause as you can imagine, these things get really complex really quickly. So maybe I’ll have one bin that’s global stressors and I have in parentheses sea level rise, temperature, CO2, and I’ll get rid of these guys and then we’ll separate out the local ones since that’s maybe more important when we’re thinking about these local system dynamics that we’re drawing out.

**BD058**: Yep, I would do it like that. I would have a global stressors and local stressors and sort of bin out the local ones. At least the way I think about it because those are the ones that I focus more on in terms of addressing, and those are the ones that have more of the immediate impact that you can see, and the ones that we can actually address a little bit more, effectively.

**Interviewer**: Right, okay perfect. So you started to mention best management practices when thinking about how to handle these stressors so what are the current management approaches in this system and specifically, what are approaches that are considering directly or indirectly biodiversity in this system?

**BD058**: Yeah, so I would say that most of our best management practices revolve around education of the local community on how their work or their day-to-day activities can impact these coral reef ecosystems that they heavily rely on, that are integral parts of their lives, so most of them are related around sustainable farming practices, as well as about waste management. A lot, especially in the islands and the territories in the Pacific and the Caribbean, the infrastructure is just not as built up as it is on the mainland here, and so a lot of them still have cesspools, a lot of them have drainage of waste and stuff like that straight into the water, so cleaning those up, working with the local government to look for funds or resources to assist with that are some of the things that we always are kinda pushing for. I would say that’s some of the big ones that we try to do on the local bubble in terms of best management practices, so educating and providing or sharing resources to help them as best they can build infrastructure even if it’s at a small scale maybe for their own house only or their own family to try to prevent some of this runoff coming into the ecosystems and that’s probably one of the biggest ones honestly. When you get higher at the higher level and start working with state and then federal governments, we have different sort of, you know, different sort of plans of attack but the ones that work the quickest and seem to have the greatest impact are the ones where you’re actually working on the ground with these local communities to stop some of that acute sort of everyday impact or pollution that entering the waters.

**Interviewer**: Yeah, okay awesome, great. Okay so the last two things that I was gonna ask…one of them was what are the core ecosystem services which you already addressed and then who are the core stakeholders in this system or that are affected by this system?

**BD058**: So back to the ecosystem services, yeah I mentioned, so these corals provide nutrition, they provide a habitat for plants and animals, they provide lots of job security in a lot of these places, so it’s very important for these local communities that are relying heavily on if they’re fishing communities or if they’re harvesting other plants and animals from these nearshore systems so those are some of the ecosystem services that come to mind when I think about corals particularly. What was the second part of your question?

**Interviewer**: who are the core stakeholders involved in the system?

**BD058**: Oh yeah and then the core stakeholders are, I mean, I guess are these local communities. Again, I think about…when I see a picture in my mind, I visited some of these communities myself, I mean these are very rural, very small groups that rely heavily on the corals being healthy and the other parts of that system being healthy in association with the corals, and so I see the key stakeholders as being the community themselves and sort of educating them to protect that system itself. Obviously, the local and state or territorial governments have a part as well, a huge part, in terms of providing the resources and they have a stake in this but to me the take home as a stakeholder is, you know, the people living there and helping them to preserve these ecosystems for the future and also using them in a responsible way and so it kind of all comes together. It’s not, I wouldn't say I think about it as completely just we want the corals because we want humans to thrive, that’s not what I’m saying, we want them to meld and to protect these ecosystems, but with the understanding that they rely on them heavily and they need to use them responsibly if they want them to continue to flourish and so that kind of all ties back into the best management practices and things they can do to protect and help these ecosystems thrive.

**Interviewer**: Right, okay great. Okay awesome, so that was my set of questions for building out the concepts, so just with our last remaining minutes, as much as we can, it would be great to start to build out some more of these relationships between these system components. Of course this model is already pretty complex with all of these concepts so I don't expect us to talk about every potential relationship in the last 15, 20 minutes, so really just focusing on the core relationships that you see in this system, so we can…how we’re gonna phrase it is if one component was to increase, would that have a relative positive or negative impact on the other component, and then we can also, if you can and if it’s possible, we can add in a weight to the relationship and so we can add in a low, medium, or high score for each relationship and those are just relative to one another so it’s helping us assess which relationships are really driving the system dynamics, but I would say that that’s like second tier so what I tend to do is just add in each of the relationships as high as standard and then as we go, if there’s specific relationships that you say well that’s less so than the others, then we can make it a low or medium, essentially, for times sake. So maybe let's start with the coral reefs, so I already added those as being positive for the services and the stakeholders and the biodiversity, if coral reefs were, you know, as a healthy system, were to increase, what else would that impact in this system?

**BD058**: Oh boy. I mean, I’m looking at everything you have here. So basically you’re asking how it would positively or negatively impact these other components that the arrows are pointing to, right?

**Interviewer**: Exactly, yep.

**BD058**: Okay, well, if coral reefs themselves were to stay the way they are magically–not magically, that’s not the right word–but increase in terms of their spatial distribution and their size and their biodiversity, I mean it would increase the positive impacts of well, all the positive impacts would increase, right, so but I think if you’re asking for a–oh jeez, hold on, my monitor just went out on me.

**Interviewer**: Take your time.

**BD058**: I gotta fix this issue. It’s always something wrong.

**Interviewer**: Always something with technology.

**BD058**: I know. The screen I was looking at this on is–here we go. Okay. So the positive is gonna be more positive but I think maybe I can get more to your question of weight then, you know, that’s probably easier for me to say well if we had a more robust coral reef ecosystem or if it was more diverse, how would that actually impact some of these the most. So I think just looking here, the big one to me that jumps out that we've been working a lot lately is the coastal flood protection one. That has…there’s a lot of groups, agencies that are very interested in this, including the DoD actually and so it’s a really important one, right, because storms are getting more frequent, they’re getting more powerful, and so being able to protect these coasts from flooding in these major storm events is becoming more and more critical so keeping these coral reefs, the hard substrate that they form there and growing them would be wonderful. Now there’s not too many that I’m aware of that are actively increasing in size. It’s been more of a battle with trying to keep them where they are. It’s been a tough battle just to kind of clue you in if you’re not familiar with it (?). So if we were somehow able to do that either artificially which is some of the stuff the DoD is doing which is really cool, like building artificial reefs and trying to put the components out there to attract other animals to come and other animals to attract corals to live there. I would say one of the big ones though is the coastal protection piece and would weigh that…you said high, medium, low sort of thing?

**Interviewer**: Yep, yep, yep.

**BD058**: I mean I would put that one as a high, important piece. The other one obviously increasing these…I’m not sure if that one would give you the most… you know, I mean the biodiversity of ecosystems I think would increase obviously with an increase in the amount or again sort of spatial coverage of these coral reefs. That’s the other one that to me would sort of rise up there to a high or medium. The other ones are a little tough for me. I mean in terms of cultural services I don't think that would change too much, that’s more of almost a sociological, historical thing. But, and then the other one would be maybe like job security, things like that, I mean more corals, more biodiversity, more fish, more opportunities for local communities to get involved and to have jobs or provide income for themselves and their family.

**Interviewer**: So job security would also be high is what you’re saying?

**BD058**: I think so, yeah, yeah, and that’s tied closely–well it’s not tied closely to…I mean it is but the nutrition as well. I would say nutrition is probably high as well. I know I’m making them all high.

**Interviewer**: No, no, no that’s okay, that’s okay.

**BD058**: The cultural services, it’s not that it’s not important, I just don’t think you know if you’re increasing the robustness of these systems, it’s not gonna really impact the importance of them necessarily to these local communities. So high medium for the rest of them maybe that’s the only one that’s kind of on the lower end if you will.

**Interviewer**: Okay, okay cool.

**BD058**: It’s all important systemically.

**Interviewer**: No, no, that’s exactly what we’re looking for. That was perfect, that was great. Okay so you started to mention a little bit about the biodiversity specifically in coral reef ecosystems so I added…I drew that, that’s impacting job security like you mentioned. What else would an increase in that biodiversity impact in this system?

**BD058**: What else would an increase in the biodiversity, yeah that’s the one when I said that I was thinking about it. I was like well I’m not necessarily sure that’s something that would increase substantially with…I mean it would but…that’s a tough one. That’s why I’m not sure if that’s a low or a medium. I mean, I feel like you would increase the biodiversity of these ecosystems with more, if you will, coral but you actually might just bring in greater numbers of the types of plants and animals that already live there so instead of increasing the biodiversity you’re just sort of increasing numbers, and that one I would put a flag on because that’s a little bit…I think it’s a little bit out of my comfort zone of how that would interact and work. I think about more of the ones on the right side there that you have. So yeah, that one take with a grain of salt from my limited understanding of how that would really impact biodiversity but believing that it probably would have a huge impact, if you will, if we’re just increasing the robustness or the quality and the size of these coral reefs.

**Interviewer**: Okay, so maybe I’ll make like the link to biodiversity and key food web supporting species lower.

**BD058**: I would. I’m not 100% comfortable with that but that’s ignorance talking instead of understanding dynamics (?).

**Interviewer**: we call this fuzzy cognitive mapping because it’s fuzzy. It’s fuzzy logic. Although we don't want the weights to represent uncertainty, I will say that, but it sounds like you’re talking about like the services are more like relatively in this system dynamics are more higher weighted from the coral reefs.

**BD058**: Yeah that’s a fair assessment I think. And that’s the way I see it and view it. That is a fair way to put it at a very high level.

**Interviewer**: Cool. Okay awesome. Let’s see what else.

**BD058**: A coral biologist would tell you something else, so. They’d be like all this is not important.

**Interviewer**: I’m sure. That’s why we have a diverse sample. Okay so then what about–since we only have a little bit less than ten minutes left–I want to ask about these stressors. What do those impact in this system?

**BD058**: Right. Can you rephrase your question again? I’m gonna write it down.

**Interviewer**: Yeah. So if any of these stressors were to increase, what would that impact in this system?

**BD058**: Right. So, definitely temperature change obviously jumps out to me because we know that temperature changes can stress the corals and make them more vulnerable to disease, make them more vulnerable to bleaching which is bad of course. Those are the two big things that come to mind so there’s definitely a relationship between temperature and the stress on the animal itself. Let’s see. Turbidity is the one I’ll go to next because we know that these corals need clear waters to thrive and to grow so changes in turbidity of the water, yeah, just basically can severely impact their growth rates and their health, but more than anything…yeah I would say health generally so increases in turbidity have a great impact on how well and healthy those corals are gonna be doing. Let’s see, other stressors that are on here. Can you point me to one?

**Interviewer**: Yup, yup, the pH changes.

**BD058**: Yeah, so those are I would say–I’m thinking now in terms of timescales–so those are important but they’re a little slower in terms of their impacts, right, so yes you can have very significant changes on the short time scale of pH but that’s relatively rare unless we have just like a large amount of acidic water, if you will, entering a system but that’s generally…the ocean’s pretty good at buffering that unless you’re in some of these inclosed bays which where you do have some corals but that one to me is more something that can be managed on a longer timescale, so obviously I mean decreasing the pH is bad, that’s sort of the take home, right, so lowering the acidity of the water, the corals are having a hard time pulling out and creating calcium carbonate skeletons so it definitely…a lowering in pH is a very bad thing for the corals building their structures themselves but I feel like it’s a little bit more manageable on the timescales that we’re dealing with. So like some of the things they do in some of these bays maybe you’re familiar–I think they do it in the Chesapeake, or at least they do it…I think the Chesapeake–they have these oyster shells, I’m not sure if you’re familiar with, they’ll just put out these oyster shells in a lot of these systems to try to bring the pH back up so you know there’s things like that that are a little bit…they’re not immediate but they put them out there in the hopes that the system will re-equilibrate with the addition of these calcium carbonate shells, so that’s how I think about pH. Point me to another one.

**Interviewer**: Yeah, I think our last one is the global stressors.

**BD058**: Yeah, oy, global stressors are tough, I mean, so in a perfect world, sea level rise wouldn't be a huge deal for coral because they could keep up with it, right, if there was nothing else going on and it was slow, the corals would just keep building to the surface, but of course that’s not the way this works so when you have sea level rise, there’s more CO2 in the atmosphere, there’s more CO2 in the water which means they have a harder time building their shells and there’s a lot of negative feedback loops that come into play really quick. Of those, to try to pick which one is the biggest or the worst is tough. I guess I would…I guess the warming waters which is a consequence of CO2 would kind of jump out as being one of the big ones that is very difficult obviously to manage on a global scale, you and I, I mean it requires big efforts and it’s very politicized and it’s just a big mess and that’s a lot of times why we focus on these local stressors because we can actually do something but I would say that that is the one that would probably have, in my mind at least, some of the greatest impacts are these increasing sea surface temperatures because they get to a point, the corals just are done with it, they bleach…and then we have more bleaching events all the time for example and so out in the Pacific we have these very hot events where the water is getting–I think in Florida, oh my god what was it, it was like enormous, it was like 98 degrees or something ridiculous like in the water and so that’s local waters but, you know, that increase in temperature, the corals just can’t tolerate it, they expel their zooxanthellae and they basically bleach and die, so the tempratue to me is probably one of the most drastic ones there.

**Interviewer**: Okay and so it sounds like the global stressors also is what is increasing local temperature in particular, like that’s an important connection to draw there.

**BD058**: Yes, yeah that’s a good connection, I definitely agree. The other one…they’re all interrelated obviously but the global temperature and local temperature are definitely related very closely so, and I would even–if you push me–I would even say the CO2 and the local pH is somewhat of a good relationship. The sea level rise associated with…or the global sea level rise is a little bit more tenuous, you could probably stretch it to make some of those connections but I don't think it’s as clear at least in my mind as the other two.

**Interviewer**: Okay, I’ll put that lower. Okay great. Okay, I know I only have like three minutes left so I just want to ask before we hop off, is there any really important relationships from these management bins that we haven't drawn out yet that we should connect?

BD058: And so those were kind of BMPs right? That’s kind of how I was binning the waste management, sustainable farming practices…

**Interviewer**: Yeah, yeah.

**BD058**: So, you’re looking for potential connections in terms of increase/decrease kinda thing between those and some of the other things? That’s kinda what you’re asking?  
  
**Interviewer**: Yeah, exactly.

**BD058**: Okay yeah so well for sure implementing better waste management practices would improve things like turbidity. I don't know if you have nutrients on here, I’m not sure if you captured that when I mentioned that. That is a big one that’s sort of–oh it’s right there. So I would tie those two together, so management practices definitely tied to land based sources of pollution and turbidity, you could probably have somebody push you to tell you that they’re tied to all of these to some extent but that’s definitely the two big ones. Less so pH, temperature, that sort of thing. And then the same with the farming practices. I would tie those to the land based sources of pollution and turbidity. I mean you could probably…just leave it. I was gonna say…now I’m gonna start like dicing and \_\_?\_\_ and I’m not gonna do that to you.

**Interviewer**: That happens a lot, yeah.

**BD058**: I know. Yeah, now that I’m looking at it. Local funds and…okay that was also BMP. Local funds and resources I know that’s a very big bin but that, you know, they’ve used that in the past to really have some impacts on the pH, local changes in pH, so I think there’s some connections to there as well. And I’ll leave it at that not to drive you crazy cause those are the clear ones that jump out to me though.

**Interviewer**: Okay, cool, great. Well, I will save that and I will stop there cause I know we’re at 11 but thank you so much for your time today. We really appreciate it. This was super informative and a really, really cool model so we appreciate it.

**BD058**: Awesome. I hope it was helpful and it was great chatting with you. If you have any follow up questions or clarifying questions just let me know, okay?

**Interviewer**: Okay, thank you so much.

**BD058**: Okay, have a good day, both of you.

**Interviewer**: You too, bye.

**BD058**: Thanks, bye.