Interviewer: Okay, great. I'm recording. Okay, so I already know, obviously I saw your seminar at SERC and we've talked a bit, but it's been a while and Sarah hasn't met you before and I think it would be helpful for an interview to get us oriented if just to start you could tell us a bit more about your area of expertise and your current research.

BD023: Yeah, so I have a background in agricultural engineering and fisheries management. I did my PhD in marine quantitative ecology in Denmark, and then I moved to the US for postdoc positions, where I did one first position on biodiversity synthesis of marine crabs, and I was working with a lot of terrestrial ecologists, actually. And so we had projects in the lab from taxonomy up to conservation prioritization plans. And so I kind of contributed to the different components of names of species and just bringing all the taxa together and how to integrate biodiversity knowledge of global synthesis of entire groups. I worked on crabs. I used spatial biodiversity data and environmental data and traits and range information from experts as much as I could find online. And then I worked on benthic provinces and conservation indicators of representativeness in MPAs. And now at Rutgers University I'm funded by the Department of Defense on a project about resource shifts and climate change and impacts on international relations. So I work with policy people, policy scientists and economists, not just on marine work, but focusing on the different parts of biodiversity, I guess the resource part, the ecosystem part, not the species. And I work on fish biomass basically and agriculture and water so like taking ecology in a different context and climate change time series. And I'm focusing both on case studies and on the synthesis of known climate change projections that I'm not doing myself because I'm not a modeler. I don't want to do that actually. And the other component in my research is about international collaborations and consortium building around the use and the integration of scientific bottom-trawl surveys. So I know a lot since my PhD about the immersive communities on the continental shelves and slopes - that's the data that I worked with the most. So it's like spatial temporal scientific monitoring of these communities, mostly fish, since the 80s or so up to now in many different countries. And I developed my own consortium working with people from many different continents. As much as we can with them, we have money basically. But yeah, focusing on community change under climate change or fishing and comparing different regions of the world and how they react to different drivers basically.

Interviewer: That was great. Thank you, thank you so much. So, I'm gonna dive into some of those topics that you just went through. And I think for most of the interview, it'll be helpful to pick one specific area of expertise since you have such a wide range of expertise and things that you work on. But before we do that to start - so I think as I probably said in the email and since you and I have talked as well about this project a bit beforehand - the overarching really broad goal of the project is to understand the role of biodiversity in marine resource management. And so to start, one thing that we're hearing a lot or one thing that we're learning is that biodiversity means different things to different people, and of course can be measured in multiple different ways. And so to start, we're wondering what you think about when you think about biodiversity, and what you see as the key aspects of biodiversity.

BD023: Yeah, I think - I don't work on all the components. Obviously within my own expertise I've worked a lot in the, well, I don't work on genetics for instance, I don't work on phylogenetics, so like all of that part I know about but I don't focus on it. For me when I think of biodiversity it's a very multifaceted concept and I guess as a scientist I try to tackle those different aspects in different projects. I can never say I always have studied the breadth of biodiversity in one project because it just comes up in many different ways. I think for me what matters a lot is to define what you consider as biodiversity for a specific purpose which is what's sometimes missing when you read papers or when they see how biodiversity is taken for certain usage or conclusions that are made for more than just scientific articles. But yeah, I think for me, like in my head, it's very much from species, from individual, you know, variation in, yeah, spatial, spatial habitats up to ecosystem functioning. I think all of that kind of encapsulates the height, the big breadth of what biodiversity would be about. And so it's, you know, within species up to cross-species - up to how you interact with the larger environment. So that's what makes it so hard, I guess.

Interviewer: Yeah, okay. So, okay, so that being said then, maybe we could take a step back and focus the rest of our conversation on one specific project that you've worked on. 'Cause it sounds like if I'm understanding correctly, you're saying like, how we define biodiversity is going to be context-dependent based on the system or the research question that you're asking?

BD023: Yeah.

Interviewer: Okay. So do you think it would make sense to focus on - given the overarching theme of understanding biodiversity and marine resource management - to focus on your current work at Rutgers or some of your previous work that you were telling us about looking at the different biodiversity indicators spatially, correct? Over different like provinces and habitat types, if I'm remembering correctly?

BD023: Maybe that one. That one. Like species versus provinces and yeah, spatial information about taxonomy would be something I have a bit more of experience because it's not ongoing, I guess.

Interviewer: That was my thought process as well.

BD023: Like what I'm doing for this project right now, I'm almost - I'm like, ah, I'm still figuring it out. Don't know. So that makes sense.

Interviewer: Okay, so can we circle back then to that question of like for that, for this project, in that context, what do you think about when you think about biodiversity in that line of work?

BD023: Yeah, I think in that specific context it was very much about defining areas of the world that are distinctive enough from each other based on biodiversity knowledge of where the range, the spatial range of species is characterized by specific boundaries. So that usually is determined with impacts of the environment and other processes. But the data that I worked with was expert driven and I didn't create it myself, I just worked with it. And so I think sometimes it was a bit fuzzy because you don't know exactly how people make decisions about where the boundaries are supposed to be and when they're considered species composition to be shifting and being dramatically different from one place to another. But it's interesting because it's one of the methods that are the most used for policy making. So it's like in some ways it lacks a bit of transparency, but it's also very useful for management because it's very easy to have one map with like, you know, 50 regions and just considering them very different as different units of what they're supposed to represent in terms of biodiversity.

Interviewer: Gotcha. Sorry, can we, since we're gonna focus on this project, do you mind just like for my own brain, like walking through what the core research questions were for this project and then kind of what the key findings were since, or I'm sure you're still working on it, but like, since it's progressed through time a little bit more.

BD023: So there's two parts in this project. The first one was, well, it came from a struggle I had when I was working in my previous postdoc that I was trying to associate species occurrence points with a larger region because we wanted to model their distribution, but we wanted to constrain how much it would model, and because you don't want to model the entire ocean, it's computationally extensive, and intensive, sorry, and it's also not really representative. You wouldn't expect one species to be able to occur everywhere. And so that's where it came from. The fact that I was working on a group that did not have species specific maps that we could infer potential presence-absence web. So I worked on combining existing bi-geographic designations together in one shapefile. So in the process of revising it for publication as a data paper. And it has 100 benthic provinces that are distributed from the coast up to the deep sea. They have very different sizes. There's more coastal ones than deep sea ones. And they're supposed to, in theory, represent different regions of the world that are different from each other. And I think there's just like a lot of work in terms of like validating and refining. And if you were to like, you know, check how valid they are on one group, maybe they're going to work, maybe they're not going to work, but it's still not going to be very representative of how validated they are. But even if you took all the data in the world, you would still not know because you never have enough data of everywhere and of all species. So it's just a very, you know, just have to kind of trust the... just one type of knowledge brought into a map basically. So we use that map to look at representation of these provinces in the current network of MPAs because it's been very useful - it's kind of like the marine ecoregions of the world - it's been done I don't know how many times in papers but this is the first time we're doing from the coast to the deep sea because the the deep sea is extremely underrepresented in these kind of exercises and we developed simple indicators to just say where provinces are you know well covered or not. We're not talking about protection but just coverage which to me is very important. And we're also bringing it at the national level or the high seas level and trying to see where gaps basically are. If you were to like you know cover imported biodiversity areas by MPAs up to the international targets set by the international biodiversity agreements. Not saying they are great, but at least that's what people want to use and so just trying to use the broader context to look at what we have right now. So benthic, I'll just add that benthic areas are extremely diverse and they host many invertebrates, more than fish actually and so they are also hard to work with because we are still I think lacking a lot of information. Especially deeper in the oceans where we have you know, lots of worms, lots of I don't know many many different groups. And so it's also the opportunity to work on underrepresented areas and taxa.

Interviewer: So where you were saying you were synthesizing expert data - what data were you gathering to do that - to build the shape files?

BD023: I used the marine designations of the world for coastal areas and I used the - what they called like the - what was it - goods designations - it's like - level ocean and deep sea something - that were all in part recommended and requested by the UN or UNESCO or you know larger intergovernmental bodies because they needed this knowledge. And so they were not developed together and I see - so they are there - they were not complementary which was the struggle and so you have many different - so you have you know that geographic boundaries within you know the deep sea for instance. But you also have bathymetric driven boundaries of like the coast versus you know the lower deep sea versus the very deep sea versus tidal areas and there's two transition areas that I think are not well characterized at the moment, which we just don't have anything. So it's the region between 200 and 800 meters deep. We don't have any global accepted designation and beyond 6,000 meters deep is also not great.

Interviewer: So, okay. Okay. And so then what were the key findings in terms of representations of these different benthic provinces in MPAs?

BD023: So the deep sea is very not well represented as you would expect because most of it occurs in the high seas. There are very few high seas MPA and also like, you know, even if you have an MPA in the high seas, you have no idea whether it protects the actual seawater or not. And yeah, we found, you know, the usual differences between rich and developing countries where there is more coverage in developed countries, but that doesn't mean, well, that's just like a clear lack of capacity, but it doesn't mean impacts are distributed evenly either. And I think one important finding, linking it with geopolitics and maritime zones is that countries that have several marine territories such as the US or France or Australia, you know, they have many different EEZ, they are sovereign of and they have a tendency in putting MPAs in distant areas where people don't live and in not - so for instance the US really likes to put MPAs not in the main US and more outside - and so it's very easy to see that when you're looking at representation compared to just looking at the percentage of coverage, which to me shows it's very important to take into account representation, especially for countries that have the money to, you know, to place MPAs in like equal spaces, basically, especially in areas where there are conflicts and I think that's the main takeaway is that it's easier to place in places where there's no conflict for space. That's probably not new but it's true. Larger, especially for benthic areas that are affected by climate change but also trawling, fishing, and many other threats.

Interviewer: Yeah and so you said if I'm, I might be misremembering, but so is your work now at Rutgers kind of like building off that latter part and working more on the International relations policy side of things. Okay, that's really cool.

BD023: Yeah, but all the resources where there is a very direct economic interest for biodiversity. It's a little bit different, right? Yeah resources, you know like especially agriculture, water and fisheries are very linked to food security and I don't know, income economics, you have like a direct price associated with resources. So what is like relatively direct. And so it's a very different context because there is very strong political interest in trade and, you know, making sure you have the right amount of resources within your country versus how much you need. So it's a very different perspective. The benthic work is very much international cooperation for conservation and so advocating for conservation I think is a very different context in terms of where it would act in the government prior to using it and offices and people who would take that into consideration.

Interviewer: Right, interesting. Okay, cool. Okay, so to go back to our question about what you think about when you think about biodiversity. In terms of the marine resource management context, some previous work has put forth four bins, and I can't remember if we talked about this when you and I talked last time, but four components of marine biodiversity to generalize or compartmentalize marine biodiversity essentially. And so I'm wondering if you agree that these are the key components of marine biodiversity, And we can put them in the chat if you want, 'cause I'm personally a visual person, but the bins are habitat-forming species, species of conservation concern, harmful organisms, and key food web-supporting species.

BD023: So it's all species driven? Very species driven.

Interviewer: Yeah, yeah.

BD023: Do you want me to say what I think about that?

Interviewer: Yeah, please.

BD023: I mean, I think it's very linked to, to me, all of those are very linked to the relationship we may have with them more than the actual biodiversity itself, because it means that you can miss a lot of important species or just species that exist that do not fit into these categories. At least that's how I would see it. So you can have many non-habitat-forming species that are not necessarily of conservation concern. They are not harmful. And key food web supporting species that's always hard how you define it, I guess. That depends.

Interviewer: Yeah. Okay.

BD023: Yeah I guess that's very linked to the way we see how you useful or how endangered they are, more than - yeah, I guess it's for me like it incorporates two things, it incorporates biodiversity plus something else, right? In some kind of context in which they are - which humans think about them? Is that what you're getting at? Okay.

Interviewer: Yeah.

BD023: Okay. Okay, that makes sense.

Interviewer: So I think I want to jump, so you were talking a little bit - I know we had said we were going to focus on your benthic province work, but then the last, your most recent projects are also intriguing me in terms of the conflicts and how we manage for biodiversity and for what. And so I'm wondering if we could talk a little bit more about that because we're wondering when we think about biodiversity and how we manage it, like what ecosystem services is biodiversity providing for, essentially, in your research. So like what specific ecosystem…

BD023: Sorry, it might be me. Here, let me. Sorry, can you hear me now? Is that better?

Interviewer: What I was saying is, so I wanted to talk a little bit more if it's okay about your current project when you were talking about what we're managing for. So like how we define biodiversity. Is it managing for conservation? Like in some of your previous work? Or is it managing for ecosystem services, it sounds, in more of your current work of like how, what, yeah, what are we managing for? And like, how does it benefit humans? Is that how we think about biodiversity? And so I'm wondering like in your current work, if you could talk a little bit about what specific ecosystem services you're talking about and how those relate to biodiversity.

BD023: Yeah, so right now, is that okay if it's not just marine? Or it can just focus on the marine part.

Interviewer: This project is marine focused. I mean, yeah, so marine is like more beneficial for us. Yeah, if that's okay.

BD023: Right now I work with simulations of ecosystem functions basically in the future. So it's very different from what I've been used to. I'm very used to observational data. This is not what it is. And it's like outcomes from how we think an ecosystem works in the simplest way and just try to represent as much as possible past dynamics to then predict the future. So the ecosystem service for me is just very clear. It's the fisheries. I don't think they cover anything else and that maybe aquaculture in the future, they will cover, but I don't think that's the case right now. And so it's very focused on fish biomass. And so I think it incorporates indirectly food web dynamics. I don't necessarily work with that component exactly. I work with the outcome. So like fish biomass can increase and decrease, but you can have many different dynamics in the food web that can happen - we’re not at a stage where we can explain them super well. Some of the models I work with have both pelagic versus demersal components, so you're able to see the contributions of those different compartments in the ocean that function very differently and that provide very different types of resources. So I think one of the interests in trying to divide these components is to say fisheries and fish food will be more driven by that kind of species in these different areas and so therefore that can impact humans. And the way I work on it specifically is to try to understand increases and decreases at the country level in the future. So I have the data I work with - it’s part of a modeling project on climate change that informs the IPCC and other projects and they have replications, they use the same model, the same climate models, and then they use, I don't know, eight or nine or ten different ecosystem models. They run them separately, but they are comparable. And so you're able to say at this country level, the probability that the resource is going to increase and decrease is going to be something. So you try to combine how we think, how we think that every city drives ecosystem functioning in different ways and then see whether that gives, you know, similar outcomes in terms of future trends in fish biomass, I think is the way it is. And so the way it'll be incorporated is to try, and that's my understanding, and it's still under refinement, and it's very hard actually to define this project. The economists on our project wants to take those trends and those knowledge of between now and the end of the century or the mid-century. This is how we expect the future biometrics is going to change. And then you take that into an economics model, and then in the end you say this is how GDP is going to change. And it's like taking into account trade and other things that I don't know well. And so if you know how much your national GDP is gonna change based on the resource, you're able to think about how much that will drive a country's vision on interacting with neighbors, depending on how - yeah, so that's a bit of the approach. So for instance, we've worked on one case study about Atlantic Mackerel in the Atlantic. So I don't know if you know a bit about mackerel. The species shifted towards Icelandic waters in the early 2000s to pretty high levels. Iceland was not a country fishing Icelandic mackerel in the past, but because it became more and more abundant, they took the opportunity to exploit the resource. And so it led to mackerel wars because the EU and the Faroe Islands and Norway were like usual fishers and so they have this idea that there are some sobering utility over the resource even if it's shifting under climate change and so these countries are negotiating with like a management body that's related to the RFMO - so it's like the you know the regional fisheries management organization that's like linked with non-national waters because the majority occurs in like non-national waters as well. And the scientific advice is clear. It's, you know, everybody agrees. All different parties have scientists coming to work in groups in Europe and say we agree that this is the normal amount of fish that we should be able to catch. But the negotiations about who is supposed to be able to catch how much out of that total does not work and has been failing for more than 10 years because countries do not agree on the allocation. And so our two hypotheses of why that breaks down, which is important for the framing of the project, is that there's probably uncertainty associated with the resource. So how long the spatial distribution will remain in Iceland is one of the big ones. It's like we don't know how long it's going to stay like this. So we just want to take advantage of the resource right now and just don't think too much in the future, which then tends to fail in negotiations. And the other one is that there are many other factors besides the ecology and the climate itself related to politics and to how people see the importance of the resource in society that lead to countries and politicians coming into the room and saying, this is what we want to do. The fact that the UK left the EU - and then politically it's been a mess. The fact that there's been an interesting geopolitical context and then even if they are all democracies that get along with each other, the dynamics of biodiversity and climate change puts at risk our institutions and the way we manage because we're not prepared for the flexibility that's required over new shifting. Because you lose a lot of money. It's also related to culture, I mean, there's just like many components that enter.

Interviewer: Yeah, okay. So I know you work internationally. This project is US focused, but if you can't answer for US specific, that's fine as well, just to get your broad perspective. So you started to answer the question just now. We're wondering if biodiversity in your system, if it's explicitly considered in management, and if so, how? With what approaches or policies are you seeing biodiversity explicitly being managed for?

BD023: That's a hard question. Yeah. So this is where my expertise falls short.

Interviewer: No, no, I think even indirectly. We've already heard you talk a lot about this in some of your other answers.

BD023: Yeah, I think, I mean, for the resource to start, it's very easy. I think the US has a very effective management strategy for exploiting commercially important species with, you know, fish stocks, assessment, regulations and laws in the US. And, you know, obviously like resources put - that NOAA is investing in stock assessment to be able to assess sustainability of fishing and resources. So to me, that's like a very direct. And that also takes into account, you know, bycatch species or whatever over impact that fishing may have on the ecosystem. I think it's getting more and more integrated in management nowadays. For species that are not commercially interesting or that are of concern, I think there is also some clear laws in the US that you know under which you can place some species and they're concerned legally and then once that's done then you can have like recovery plans that are supposed to help that species to recover. I know it's very hard to get a species to be accepted as of concern which I think to me is a problem because it just can take so much time and sometimes it's rejected while scientific evidence shows that yes, it should probably be accepted as such because then there is all of this process. What I think is important and something that I worked a lot on also is that species most of the time are not restricted to the US in terms of their populations or their range. And I think this is where this is like the next frontier in terms of management and conservation is to be able to have greater cooperation both on the science and the management level. And I think it's going to be so much harder for the institutions to work together because they operate on very different mechanisms. So, I don't know. I want to be optimistic, but sometimes I'm just like, well, the legal framework is incredibly complicated. And there are species such as Atlantic halibut that are associated with concern on the US side, but sustainable on the Canada side while it's the same population. And so it's just kind of nuts to be able to reconcile all of these different things together.

Interviewer: Right, yeah, absolutely. For your previous work with the benthic provinces, are you seeing biodiversity as a direct consideration in some of your MPA work specifically when thinking about some of the policy reviews that you've done for that project?

BD023: I think for that project - it's very, I think the two, at least legal frameworks that apply are the 2030 CBD framework and the Biodiversity Beyond National Jurisdiction Agreement that was just signed. I think both of them are with the same objective of developing more MPAs. And it's a beautiful target. But in practice, you know, there's just like so much, and I'm still learning about this to be honest, because it's not something that I was trained specifically in, but I can give my ecological point of view of like how much more MPAs we would need for this specific topic. And I think when you're trying to consider the broad scope of everything that needs protection or some management level, it's becoming incredibly complicated because of so many layers. And I think the realism of like how much capacity there is for MPAs and how well they can be designed is that there's a lot of different philosophies at play. And I don't agree with all of them. So, I don't know.

Interviewer: Yeah. That makes sense. Are there other, like, aside from MPAs, are there other management approaches that you've seen been done, or you think should be done in the future to better manage for biodiversity? 'Cause I think MPAs is like one thing that people think of a lot, and you've done a lot of work in that space, but then like, it's really interesting hearing you talk about your more current work, thinking about like managing biodiversity from more of an ecosystem service perspective. So yeah, are there other approaches that you think could be or have been utilized?

BD023: I think fisheries management is in some ways technically a conservation measure. It's just never seen that way, unfortunately. I think there's so many different ways that, and because I think fishing is such a direct threat. It's just like physically a threat. You just remove biodiversity and resources from the ocean or you damage directly. So there's just like many ways you can improve gear selectivity, match sizes, areas where you go. I have a colleague who's working on bycatch of birds and just trying to understand why bycatch is the most important to avoid the areas. So I feel like the temporality in space of like where you would conduct an activity depending on where, you know, species you don't want to target are not there is very important. I know there's like dynamic marine protected areas on the west coast of the US that are starting to appear but I think it's not just MPAs, it's just like being more dynamic in terms of being able to understand when it's okay, relatively okay to like conduct an activity at sea. For climate change probably the best conservation measure we could have is to reduce gas emissions. That would be the most effective, for sure. I think also there's just like a lot of opportunities in reconciling the way we interact with the marine environment that does not necessarily require MPAs. It can be integrated in it, but I feel like there's such a variation of what an MPA is. And so, yeah, I think just trying to conduct activities that do not threaten the environment - it's just a learning process for everyone.

Interviewer: Right. For some of your work, looking at decision making and looking at conflict like you were talking about, in your experience, when thinking about conflict and allocations for this decision making, when making these decisions, who is in the room? Or like, I don't know if you can -

BD023: I can’t hear you again.

Interviewer: Oh, you can't hear me again? Ah, shoot. Let me see. What about now? Can you hear me now?

BD023: Yeah, it's good.

Interviewer: Okay. Sorry, what I was saying is, so for, I don't know if you can answer this based on the work that you've been doing, especially 'cause it's ongoing, but for some of your work that you've done in terms of decision-making and thinking about conflict when making decisions, from what you've seen or in your experience, who is a part of that decision making process and who are the people that are affected?

BD023: Yeah, the problem, well, the people who are part of the decision, I think, depends from one country to another for - I mean, if it's about conflict - I would say it's probably one of the highest levels in government. So, um, for, for one single resource or one single aspect in the case of mackerel, it was people who are in the, what do you say when you are a party of like a management decision committee. So you are part of the government. Sometimes you are part of the fisheries department. I think that depends a bit on what the management body is. But you are a politician, most of the time not a scientist, not an advisor. You're pretty higher up, I would say, especially when it's about conflict or a resource that has economic interest. The people who are the most affected by these decisions are, I would say fishermen, in the case of fisheries, fishing communities, fishing industry, anyone who benefits from the resource, even if it's just for food or cultural aspects. So like very wide societal impacts.

Interviewer: Yeah. Okay. Okay. Um, okay, great. So I know we've been on the phone for 45 minutes. I think I made this calendar invite for an hour and a half. I don't want to take up a ton of your time because I'm sure everyone's really busy. Sarah, is there anything that you could share at this point? It's okay if not, but yeah. Um, so I think I probably mentioned this to you when we spoke with Emmett, but we're using this tool in this project called mental modeling. Have you heard of this? Did we talk about this? Okay.

BD023: I don't remember.

Interviewer: Okay. Yeah. It feels like it was forever ago. Um, so it's a conceptual mapping tool, essentially, and so it's a way to model someone's knowledge system. And so what you can do is you can build a series of concepts based on your research question or based on how the individual sees their system. And then you can assess how those concepts are linked to one another. And so as we've been talking, Sarah has been building some concepts in the background in this software called mental modeler, which is used to visualize it.

BD023: That's cool.

Interviewer: And so if you want to share that, Sarah, and then we can just talk through it and talk about some potential relationships. Ok, there we go. So do you want to talk through the concept list, Sarah?

Interviewer 2: Yeah. So we'll start in the middle with the gray. These are the initial concepts that we came up with that people are thinking about biodiversity and then I added commercially important species that you mentioned. The orange is what you personally think of when you think of biodiversity. When you were talking about the differences between different habitats, I understand that as gamma diversity, but that may not be correct, so I can get rid of that phrase.

BD023: Yeah, I would say it's both gamma and beta components. At least I think about both in my work, so.

Interviewer 2: I'll add that too. Cool. The blue is management actions that are either already being incorporated or could be incorporated to manage for biodiversity. The yellow at the bottom is ecosystem services. The green are stakeholders or interested user groups. And then the pinkish purple at the top are different stressors or threats to biodiversity.

Interviewer: So what we can do with this tool, and we won't, it'll take a long time to like try to connect all of these components.

BD023: I think it's just like again, we can't hear very well.

Interviewer: I always have issues with teams. Can you hear me now?

BD023: Yes.

Interviewer: Okay. Maybe, Sarah, do you mind just like leading, filling in some relationships since my audio isn't working? 'Cause you know how to do this so well as well.

Interviewer 2: Yeah. Okay. So some of the arrows I've already filled in and the blue arrow means that like, for example, legal designations for conservation would increase species of conservation concern. And then the orange arrows would be negative. So reduction of greenhouse gases would theoretically reduce climate change. So I've added a few already, but I think we should start with the time we have with the concepts in the middle. So let's say, key food web supporting species, we'll start with that. Are there any concepts here that affect key food web supporting species or that key food web supporting species would affect? If we have to add something too, we can do that.

BD023: I'd say like fishing, fishing and climate change might negatively affect those. It's negatively, right? Not increase, decrease, I don't remember.

Interviewer 2: It can be increase, decrease or positive, negative. However you think of it.

BD023: Okay. Species, I would say like commercially important species are affected by climate change, which then drives conflict. Area-based management can improve any of the biodiversity components really, in theory. And I think targets about biodiversity is very linked to what we think of area-based management, maybe we can have a causal relationship from both. Improving fishing methods improves commercially important species directly and maybe indirectly or worse, I don't know, depending. What is legal designations for conservation? What was it that you were thinking about?

Interviewer 2: Just getting the status as endangered, I guess you mentioned.

BD023: Oh yeah, yeah.

Interviewer 2: Like I was thinking ESA, but you didn't specifically say that.

BD023: Yeah, yeah, yes, yes. I didn't say that, that's true. That's exactly what I had in mind though. Yeah, we have both improved fishing methods and fisheries management and I feel like they're maybe a bit redundant, so I'm wondering if we can just merge them. I'd say like commercially important species directly affects GDP and fishing. Obviously. I think like any of the gray components affect culture.

Interviewer 2: Would they all be positive?

BD023: I would say harmful organisms - no. Any of the others, well species of conservation concern, I guess it's negative too. That's the few - others can be positive. Okay, so now I have to think about the green ones. Seafood consumers, commercially important species, so from species to consumers, I guess. Can we also link the yellow and the green together?

Interviewer 2: Yeah. Okay, well, you can link anything to anything.

BD023: From fishing to seafood consumers. And from culture to seafood consumers. Fishing to fishing communities. I mean, politicians are very driven by GDP and economics. I would say politicians impact geopolitical conflict as well, as well as national governments.

Interviewer 2: In a positive way or a negative way?

BD023: No idea which one to put here. That is confusing. Well, I mean that depends, right? Because you could also decide to cooperate. So if we had cooperation somewhere, it's a positive relationship. So since we put conflict at the same negative, because conflict is not good. In my opinion. Yeah, I know some people think about it in a very different way. I think politicians can positively influence the production of gas emissions. I think national governments and intergovernmental bodies would affect targets of biodiversity. No, positive one. That's a neutral one, I don't know. Do you have neutral?

Interviewer 2: Yeah.

BD023: Ah, okay. Legal designations for conservation - I don't know how to link that. Yeah, I don't think it's interesting because in my head the orange boxes are not easily relatable to the grey boxes. Because counting species does not tell you whether they are of concern, or harmful, or commercially important, or habitat forming. I feel like it's including other types of knowledge to be able to make that link. So, um... I feel like there's something that... Oh, yeah. You know what? These are like very community ecology metrics, right? They're not species-focused, so... you know what kind of intermediary we could add to connect them? It's okay if not. Well I think we should have a species orange box, maybe. If that works.

Interviewer 2: I have species diversity.

BD023: Yeah, we have species diversity, maybe that's enough. I feel like the conservation concern... and I don't know if it's like, it's just so complicated because you have impacts that then you can assess via components of biodiversity such as traits, for instance survival and then you look at trends and then you say oh it should, it's probably a species of concern so it's a combination of human impacts and so maybe fishing negatively impacts species of conservation concern. But species diversity - it's natural relationship to species of conservation concept - and now I have to say, I don't know what to tell you anymore because it's very, this is like stuff everywhere. I think there's politicians that affect national governments in a natural way because they can be both good and bad and national governments that act at the international bodies level as well. It can be both ways. Both ways. Can we have like a double arrow? I think that industry and fishing communities are also driven by GDP. Yeah. I don't know, I can't think anymore, I'm sorry.

Interviewer 2: That's okay. Not everything has to connect to everything.

BD023: Yeah. I don't know.

Interviewer: Can you guys hear me? Is my audio working at all? Okay.

Interviewer 2: It's a little quiet.

Interviewer: That's so weird. Um, okay. Yeah. That's - we get this feedback a lot. Like an hour is kind of like, even when people physically have more than an hour, it's like your brain kind of shuts off after an hour in my experience doing these interviews. Um, I just want to ask before we go, just looking at this, are there-- when you think about biodiversity and marine resource management, are there key things that we're missing in this system diagram? Does this capture what you think about when you think about that, or are there big things we're missing?

BD023: I think maybe-- I did my PhD. Maybe I should say that. I did my PhD on the relationship between biodiversity and ecosystem functioning. And so I was working on different components of biodiversity and abundance distribution and how that links to productivity or biomass. And I feel like the internal ecosystem dynamics, it's just like, would affect all of the orange and gray boxes. And so they are in some ways all related to each other. And I feel like, considering like, putting the orange boxes in the middle and then saying they are driving species of conservation concern or harmful, of like whatever of a component for me is more straightforward than the way it is now. Maybe that's because of my ecological background and…

Interviewer: No, that makes sense. No, that makes sense.

BD023: Yeah, I think the other thing that I reflect on now is the effect of scale. So I think that the green boxes are the ones that have most of the scale in it, because it's from people, politicians, to larger organizations, you know, in terms of geographic or number of persons that are involved in them. I think that on the other components it's a little harder to organize, because some components are local, some are regional, some are global, and I think trying to organize this in some way in the diagram would be easier to read maybe, because not everything interacts with each other, it's just that sometimes it interacts on some scale but then not on another. So sorry. I'm not sure - I could reflect for the rest of the day and find things.

Interviewer: No, no, that's okay. We hear that all the time, but that is really helpful and makes a lot of sense. Well, we won't take up any more of your time, but thank you so much. We really appreciate it.

BD023: Sounds great. Well thank you so much for interviewing me.

Interviewer: Thank you so much for agreeing to participate. We really appreciate it.

BD023: Yeah it's very interesting to think about it in a different way I think.

Interviewer: Yeah definitely. We hear that a lot as well.

BD023: It's especially like once you see the visualization of it, it's a different way of thinking about things and organizing things. I'm sure you see a lot of different perspectives.

Interviewer: Yeah, we do. We do. And exactly what you said at the end about like, local and spatial dynamics being such an important component to this.

BD023: I can’t hear you.

Interviewer: Oh, all right. Well, on that note - we’ll end there.

BD023: All right. Okay. Have a good rest of your day and have a good weekend. And thank you.

Interviewer: Thank you too. Bye.