Interviewer: Okay, great. So yeah, so before I kind of dive into some of our specific interview questions, I was wondering if you would mind just telling me a little bit more about your area of expertise and your work. I know you're the Mariculture Lead at NOAA AFSC, but I was also looking at some of your previous work, I believe at your postdoc, at Simon Frasier, in the Salish Sea. So the Salish Sea is one of our case studies for this project, so it would be great to to hear about some of your work there as well, if you don't mind.

BD017: Yeah, definitely. So yeah, for the postdoc work, my work was mainly focused on looking at how management approaches account for the cumulative effects of multiple stressors. And so one aspect of that work was just comparing governments at different levels, like federal governments down to tribal or community, and how they approach at these different spatial scales governing for multiple stressors. And then we did a sort of case study in the Salish Sea looking at whether a combination of just an expert focus group could capture, just with their knowledge, a lot of the effects of these multiple stressors, even when there isn't the research in that area. So kind of comparing what does the literature say, or bringing together first a focus group to create a map of the multiple stressors impacting an ecosystem, in this case it was kelp, and then comparing, using that structure to then do a, guide a literature review that would look at what's the knowledge in this system, where the experts were versus what's the knowledge globally in comparable systems. And I mean, we found that like, obviously the experts know their stuff and it seemed like a really effective way to rapidly and given a great dearth of local data, capture some of the multiple stressors and cumulative effects on a system.

Interviewer: Cool, yeah, this project, as you can imagine from this interview, is doing a very similar thing, doing expert interviews and then eventually focus groups. So when I was reading your paper, I was like, this is a great sign that maybe this approach will work for our project.

BD017: Cool. Yeah. No, that paper, it was, yeah, it was way more work than any of us expected it to be, partly because just the literature review was so expansive. But it was really cool to see it come together and then see it, you know, part of it is to be able to guide management of either likely impacts to a system. But then part of it is to really highlight to students and researchers where some of the critical gaps are to be able to fill that in. And then a master's student, Stacy McMahon, I can't remember how she pronounces her last name, but she, for her master's work at UW, took that framework and the literature review and used it to inform a quantitative network model so that you could actually perturb it and say, "Okay, well if temperature increases given all these linkages and relationships, how will that affect your health?" What if temperature increases and shore hardening increases? Now how does that change things? So that was a really cool outcome to actually create almost like an interactive model from it.

Interviewer: Do you know or do you remember what kind of modeling tools you used for that project?

BD017: It was just a package in R that allows you to form a quantitative network model. So it's basically a matrix of positive and negative increases given the different directions of the connections that you make. But I can send you her thesis. I hope she publishes it someday, but you know, now she's not doing it.

Interviewer: Great. And then would you mind telling me a little bit more about your work at NOAA in terms of mariculture?

BD017: Yeah, so now I work with shellfish and macroalgae for the aquaculture industry here, but then also just general health macroalgae ecology. And so that has involved, you know, all sorts of projects, but working with industry regulators, tribes, communities, whoever it may be that is interacting with the mariculture or kelp space and working with them to address data gaps to build new efforts. Like right now we're building a research oyster hatchery that will be able to really move the industry forward for selective breeding and for just adapting technology for the conditions here. We've also just finished up a big kelp mapping project comparing century-old surveys to modern surveys to understand change at really big time scales, looking at habitat effects of the of farms, yeah, working on abalone, husbandry up here to see the abalone, could be a mariculture species, all sorts of different stuff. It's been a fun position.

Interviewer: Cool, great. Well I think I'm going to learn a lot from you today so I'm really excited. So I think like I probably said in the email, the very broad overarching goal of this project is to understand the role of biodiversity in marine resource management. And so to start, what we've been hearing a lot is that the term biodiversity means different things to different people and it can be measured in multiple different ways as you know. And so as a starting point, I'm hoping to understand what you think of when you think of biodiversity - what you see as the key aspects of biodiversity.

BD017: That is not a small question.

Interviewer: It is not, yeah. Sorry, starting out big.

BD017: The same definition changes depending on the context, right? Because we do work on phytoplankton communities and how phytoplankton communities influence oyster health and toxicity metrics. So in that context, biodiversity, we're just considering phytoplankton, which is - there's so many species - the biodiversity at that scale is massive but then when we're usually talking about the impacts of farms usually people are thinking about more macro biodiversity so the fish - the benthic organisms - um all the things multicellular that you can see with the naked eye. So yeah, I mean, I think changes by context, changes by question.

Interviewer: Okay, perfect. So for the rest of the interview, I think sometimes these conceptual models that we build can get really overly complex when we try to talk about everything within an individual's area of expertise, because like you said, you work across so many different species and components of research. So I think if it's okay with you, it would be most interesting to get your perspective on mariculture. I don't know if that would be like oyster or kelp based on your current area of focus, but picking one species within the mariculture realm to focus on might be helpful to help us narrow in, if that's okay. If there's something that…

BD017: I think from a biodiversity standpoint, folks are thinking more about kelp right now.

Interviewer: Great. So, okay. So thinking about kelp then, what aspects of biodiversity, and I think you answered this a little bit before, but what aspects of biodiversity are important for that species of focus for kelp?

BD017: Yeah, I think it would be three main things, like thinking about biodiversity is just general, biological communities. So what is the composition of those communities around kelp farms? The spatial aspect, how far away from the farm does that habitat affect last? And then the temporal aspect, when a farm goes in, does it take a certain level of kelp growth before you see a biodiversity change? Is it just the fact that there's gear in the water? It's like a fish aggregating device kind of thing. And then what happens when the kelp is harvested and when it goes from being this lush, mid-water kelp forest, a very unusual ecosystem to nothing and everything that's taken out. So what's then the effect on that biodiversity?

Interviewer: Okay, great. So when talking about the composition of the communities around the kelp farms, I guess thinking spatially about your work in Alaska, are there specific species or habitats that you think of that are important when thinking about biodiversity within a kelp habitat?

BD017: Yeah, so I mean, depends who you ask. The big concern is marine mammal entanglement. So if you think about kelp farms as a fish aggregating device, well, if forage fish and stuff are attracted to the structure of kelp farms, then marine mammals might be attracted to the presence of forage fish. And so now you get kelp farms as both contributing to or changing the biodiversity of a place, but it may be positive ways for the fish, but potentially negative ways for the marine mammals. There have not been instances of entanglement anywhere when it comes to kelp farms, but the risk remains and regulators are really concerned about it. And the industry is too, you know, they don't want to tangle the whales. One part - I think, I think fish, fish come and go. So I'm less worried about fish. Especially if the habitat gets removed, the fish can just slip and find somewhere else. Um, so I think biodiversity impacts benthic invertebrate species and species that don't move as fast. Um, I think that's a more interesting question like what happens when this habitat appears and disappears over the course of a year in a way that's mismatched with how wild kelp beds, how they grow and how they grow. So for like fouling communities that are literally on the gear - they would just get removed. Are they removed before they reproduce or after they reproduce? So is it a source? Is it a sink? What's that look like?

Interviewer: Okay, great. So I think that you just answered this question, but I'll ask it anyway. There's some parts of it I think you haven't answered. So part of our previous research has broken biodiversity down into four aspects that are important to consider. And those are habitat-forming species, species of conservation concern, key food web supporting species, and harmful organisms. And so to start, I'm wondering if you agree that those are the key components of marine biodiversity that we need to think about, if not what you would remove or what would be missing, and if those are key aspects within the kelp mariculture as we're talking about it. And I can put those in the chat.

BD017: Yeah, I say put them in the chat. That'd be helpful. I did catch harmful species, what do you count as a harmful species?

Interviewer: Yeah, so I mean really whatever you think of but we've been mostly defining it as either invasive species or disease as kind of the two main sub bins.

BD017: Um, habitat forming species, species of conservation concern. Seems like a good list. Okay. Um, I, well, so one other question that I've been thinking about, in terms of habitat, and it kind of fits in with the temporal aspect, are different life stages. So different life stages of a given organism might interact very differently and change whether this form of habitat is a source or a sink. The timing of the kelp growth can change which life stage it's interacting with. So I think that's more of an overarching thing like within habitat-forming species, which life stages are interacting the most with species on conservation concern, and that kind of thing.

Interviewer: Okay, great. Are there, so I think that when we were talking before, you obviously - kelp itself is a habitat-forming species, and you were talking about species of conservation concerned with marine mammals, and then with key food webs supporting species with some of the forage fish, benthic inverts, et cetera. Are there harmful organisms that play a role when thinking about biodiversity with kelp mariculture in the system in Alaska or Southeast Alaska?

BD017: How can - I can think of, I mean, the invasive species risk is generally more associated with oysters 'cause you're importing more things. And the only instance of an invasive, I think it was a sponge or tunicate was around oyster aquaculture gear in Sitka. They got on that pretty quick and it hasn't spread. But for kelp, there's some question about disease or like ciliates, which I guess would be considered kind of a pest organism - harmful to the quality of the crop. Like present in the marine environment. So I don't know if potentially farms could serve as, you know, dense aggregation, kind of a spillover effect of these pest species, but I haven't heard anyone talk about that in a concerned way, just 'cause the scales don't match up. Like the scale of the wild population is still way, way, way, way, way bigger than the scale of any optimal operations.

Interviewer: Okay, good to know, great. I'm wondering if you could describe a little bit about management processes around kelp mariculture to start.

BD017: Yeah, so the kelp farms, I mean, You need to get permits from Army Corps for putting structure in the water, from ADF&G - the Alaska Department of Fish and Game for growing things. They have to consult with NOAA about marine mammal and essential fish habitat interactions. There might be a few others. There's a really cool, if you want to get a lot of info, I know this is more just info you're getting from the interview, but there's a whole permitting portal that outlines it all. So I can just drop that real quick in the chat. And my colleague Alicia led this project. So it's very impressive. And so they have to do all that for kelp farms to get them in the water. And then when it comes to what kelp you're gonna grow, there's the 50 kilometer rule. So you have to collect seed from wild kelp from 50 different individuals within 50 kilometers of your farm. And this is just kind of a following of precautionary principle to reduce genetic contamination, basically genetic escapement from a population that's not found in that area. So we don't have, we don't know the population genetic structure of the species that are grown here. So this is just kind of the agency's best guess.

Interviewer: Gotcha. Okay. Is genetic diversity like elsewhere - is that an important consideration with kelp mariculture?

BD017: I don't think that, well, so other states are way smaller. And so I don't know what the rules are like on the East Coast about moving kelp between state lines but if you're staying within state lines you're basically following the 50 kilometer rule anyway. Just because the states are so much smaller. And California's kelp aquaculture is still pretty small and very vertically integrated so they're inadvertently following the 50 kilometer rule as well. But I know like Puget Sound or Washington is still kind of figuring out how they want to approach it and they have a little bit better population maps for some species. So yeah it's a big question.

Interviewer: Yeah. Okay. And then you mentioned briefly just now about consultations for NOAA, EFH and marine mammal consultation. So that kind of brings me to my next question when talking about the other components of biodiversity around kelp farming with marine mammals and other species of conservation concern with fish habitat, benthic inverts, are those components of biodiversity currently being managed and if so how in terms of like what policies and regulations?

BD017: So it all pretty much falls under the Marine Mammal Protection Act and the Magnuson Stevens Act because that's what the central fish habitat is under. And my colleague who did this permitting portal, Alicia Bishop, she'd be able, she's with the regional office and so she's on the permitting regulatory side of things. So she'd be great to talk to me about all of that, everything I know is from her. That's her email. So those concerns, I mean, it's using consultations based on best available knowledge. And in Alaska, there's a lot of data gaps. It's just so big. And so using best available science, NOAA informs the permitting agencies about concerns they might have if it's close to known seal haul out areas or close to known feeding grounds or marine mammal migration corridors. They consult on whether the proposed gear may pose increased or decreased risk of entanglement. And then for essential fish habitat, it's like, is this, you know, the state too considers, is this a known herring spawning location? So don't want to go there because it’s protected for some other reason - important salmon run in a block or something like that. NOAA is not a permitting agency in this context. So these are all consultations. Consultations. Then ADF&G and Army Corps, I think, as far as I know, they can take it or leave it.

Interviewer: And so then ADF&G and Army Corps then make the decision of whether or not to issue a permit based on the information provided by NOAA, essentially, regarding these other species that we're discussing?

BD017: Based on a lot of things including…

Interviewer: Okay. Yeah. Are there management actions that you think are needed to better consider these components of biodiversity regarding mariculture?

BD017: I think it's less management actions right now and more basic science. Because it could just be with the timing of it, like in Alaska, kelp is a winter/spring crop. And so generally, they harvest, the goal is generally to harvest right before the ocean really wakes up. Because as soon as there's that spring bloom, you just see a precipitous drop in surface nutrients, you see a lot of settlements, that's when everyone is spawning. So basically your kelp can go from beautiful to scummy and dead really fast once that spring bloom hits. So given that timing, like it could be that kelp actually doesn't have that much of an impact because it's when everything's a little bit hunkered down for winter. There's also, it also could be that, you know, species that react really strongly to the presence of kelp habitat. If you see, you have like kelp farms, they're growing in winter. Now they're really growing fast in spring and wild kelp beds are starting to grow in spring and really growing in summer. So it could almost just extend their time in that habitat or with that food source. So thinking about it that way, then it could have an effect of giving them, yeah, more time with their preferred associated organism.

Interviewer: Okay. What I was gonna ask is, is that timing component? Is that similar, do you know, in other areas where mariculture is happening? Or is that specific to Alaska given like the longer, colder winters and differences in seasonality?

BD017: California is different because California, they want to really target the upwelling season. And so that mainly happens in spring and summer. And then the East coast, I'm pretty sure the East Coast is different too, because they get a little bit more like nearshore icing over. And there's less kind of semi-protected areas. You get hit by winter storms and nor'easters and stuff. So I think they might be summer as well. But I'm not sure.

Interviewer: OK, good to know. I meant to ask this before. Is kelp mariculture occurring in the Salish Sea or Puget sound as well?

BD017: There's a tiny bit. So Puget Sound Restoration Fund folks there would probably be really good to talk to. They, I think, they've got, they're trying to grow bull kelp for restoration purposes. And then I think some of the oyster farms have been growing kelp at pretty small scales. So yeah, there's a little bit of kelp mariculture. And I would think that Salish Sea would have similar seasonality as Alaska because they have the same issues of nutrient, rapid nutrient depletion in spring and summer with the spring blooms.

Interviewer: Okay, yeah, that's what made me think of it. Okay, that's good to know. Okay, great. And then what stakeholders rely on biodiversity in the system around kelp mariculture and who's affected by management regarding kelp mariculture?

BD017: Again, right now, like the scale of kelp mariculture, I think my gut feeling is that it has highly localized biodiversity impacts, but if we're thinking at scale, those impacts are net for how productive Alaska is for how vast the coastline is. So thinking about like commercial fisheries where they are going far and wide, I don't think kelp mariculture have any effect. Maybe some subsistence or recreational or sport fisheries that are super local. Like maybe again, I just, I doubt because the main effect, the main ways that people are using or interacting with marine environment are fish and bivalves. Fish, like I said, move around. So I don't think mariculture…maybe they'll move to the kelp farm and it's harder to fish on the kelp farm, but then they'll move out. And bivalves, the place where people collect bivalves are in intertidal zones and the kelp is all subtidal. So I just, I don't think at this point there's that much interaction. Maybe some kelp detritus could fall out onto intertidal areas where there are bivalves and some of them could eat that kelp detritus. But again with how much natural kelp is in the system and how things are kind of more hibernating in the winter. I just, I don't know. I don't think it would have that much of an effect.

Interviewer: Okay, okay. That makes sense. Okay, great. So for the second half of the interview, I'm gonna attempt to build a conceptual model with you like I was describing based on your answers to those questions. So first I'm going to attempt to make a concept list for the model based on your answers. So bear with me for a second while I try to do that. So I'm going to put kelp mariculture at the center of the model. And then when we were talking about biodiversity, the core three things that you mentioned were biological community composition, I believe you said, composition. And then it was spatial and temporal, right?

BD017: Spatial and temporal components. Spatial. I'll say dynamics, spatial dynamics, temporal dynamics.

Interviewer: Okay. And then we talked about marine mammals maybe coming in. And then you just said like fish right like it wasn't specific to functional group or type of fish.

BD017: I mean fish that are attracted to structures so yeah that'd be like some species of rockfish, forage fish, maybe salmon.

Interviewer: Okay and then benthic inverts and then fouling communities, you said yes, right?

BD017: Uh-huh.

Interviewer: Okay. And then, I'm not gonna put any of the harmful organisms in 'cause it sounds like that was not really a concern right now. Okay, great. And then for management, we were talking about farm permitting. And maybe I'll put in MMPA, Marine Mammal Protection Act and MSA regarding EFH.

BD017: As far as I know, again, Alicia would speak more to that.

Interviewer: Gotcha. Okay. I think oh and then like it was - we were talking about data gaps for like need for science like better science right? Like okay um I think that was what we talked about. Did I forget anything?

BD017: Well ESA would be another one.

Interviewer: ESA. Okay. Great. Let me just get this organized and then I'll show my screen. Okay, so I'm going to share my screen so you can see this while we go. Okay, can you see my screen now? Can you see the model?

BD017: Yes

Interviewer: Okay, great. Okay, so it sounds like maybe because you've done some QNM stuff this will be familiar to you but the plan is I'll go through each concept and I'll ask you if one concept - so kelp mariculture is a good one to start with - if kelp mariculture was to increase would that have an impact on any of these other system components? If there is an impact on another component I'll ask you if it's a positive or negative impact and then if we can, and it's not big if we can't, but the difference between fuzzy cognitive mapping and qualitative network modeling is that with FCM we can add a quantitative weight so I'll ask you if the relationship has a low, medium or high impact on the system and those weights are just relative to one another in terms of the other weights in the system so we can go to the weights a little bit more once we get going, but the main thing with the weights is that it's not a measure of uncertainty in the relationship. It's the relative impact in relation to the other interactions in the system, if that makes sense. Okay, great. So, yeah, I'll start with kelp mariculture. So, and I'll say these three components of biodiversity on the left here, we might have to change those or think about how to restructure them. 'Cause I'm not envisioning how those would hypothetically increase or decrease, but we can get there as we go. It's usually important to have a component that could change, if that makes sense. So with kelp mariculture, I think that's an easy one to start with. So if that was to increase, would it impact any of these other system components?

BD017: Yeah, it would probably impact. So, well, okay. I guess, I don't know, all these things always, so you're like, well, let's just make it more complicated. So I think an increase, if we're talking about more farms or we're talking about size of farms, like that impact might be different and both of those are an increase. But I think in general, if it increased, it's going to have more, it will impact biological community composition because regardless of if the farm grows or the number of farms grow, and it will impact the spatial dynamics of that community composition, probably increase, well, unless the seasonality changed, I don't think it would impact the temporal dynamics. But with looking at different species, seasonality could change, I don't know. Likely will impact marine mammals more or more of a chance of interaction there. And forage fish, yep. Benthic inverts, yep. So that kind of all falls within the community composition too. Right, yeah. So fouling communities, yep. And then the rest are like management stuff so that's kind of different huh.

Interviewer: Okay perfect. So if mariculture, so I think maybe it might be worthwhile to separate mariculture out as you were saying of like the number of farms and then what the other thing you said was um

BD017: Size of farms.

Interviewer: Okay. So maybe let's start with, I should have put it the other way, but would those have the same or would those have relationships with each of the same components as we just drew or would those be different?

BD017: I think they would have, they would react really to all of them.

Interviewer: Okay, so to start with the number of farms then. So would increasing the number of farms have a positive or negative impact on the community composition?

BD017: I think probably positive.

Interviewer: Okay and if you can do you think that would be a low, medium or high impact? Relative to the other things in the model.

BD017: I feel like I should have drank more coffee before this. I'm so sorry. My brain's like, "Gah, gah."

Interviewer: I get that response a lot. People are like, "This is not a relaxing interview."

BD017: No.

Interviewer: Sorry.

BD017: My focus groups were at least lots of people in the room, so everyone could ponder together about my articles. Well, because biological community composition subsumes marine mammals, forage, fish, benthic inverts, and fouling communities.

Interviewer: So we can take that out if it's redundant.

BD017: I think it's redundant.

Interviewer: Yeah. Okay. Simplifying. It's always the goal.

BD017: So can we maybe... I think it might be helpful to break down the spatial dynamics and the temporal dynamics into something more specific. If we can, that could be easier... We could assess the relationships in an easier way. Is there a way to change those that I'm misinterpreting? Maybe a halo effect? Halo effect... for spatial. Because like I'm thinking bigger, you know, if we think about a farm similar to an MPA, like the same kind of line of thinking, not saying they're the same at all, but you know, the spillover effect of the farm. And then also the, so bigger farms might have more of a spillover effect. More biological activity could be going on within that larger habitat. A greater number of farms might have the kind of connectivity idea of MPAs, where now you've got novel habitat and there's more of it. So those are kind of different too. Well, but it's both this kind of halo effect.

Interviewer: But I mean, not to make it more complicated, but we could separate that out into connectivity. And I forget the first thing that you said that would be a concept. Spillover effect. Or we could leave it as one, if you think it would be the same. I mean, usually the benefit of separating out a concept is if, um, or you would need to separate out the concept into more specific concepts. If a relationship would be either or based on the differences between spillover effects and connectivity, for example.

BD017: Right. I don't know. I feel like maybe let's, well, let's leave it for now. And then if there becomes a situation where it's neither or we can separate it out if we have to. Because the other thing that feels tricky is that like marine mammals, fish, benthic inverts, fouling communities, those are like types of biodiversity and I imagine that the halo effect or the spillover or connectivity effect will differ for those. So like if we're talking about forage fish and marine mammals. If you get aggregations of forage fish, now if there's many different farms, marine mammals might be able to just like forage through one, now forage through the other, so you get that connectivity effect. Whereas benthic invertebrates, they're not necessarily moving between farms, but if there's more of them than as broadcast spawners, maybe that could influence their reproductive success if you get more connectivity between farms. So I don't know how to represent those subtleties or if you need to.

Interviewer: So that makes me think that we should separate out between spillover and connectivity based on how you just described that. Okay. Spillover effects.

BD017: I do, I agree with you. I like to take out concepts, not add them, but okay.

Interviewer: Okay. Okay, so let me see if I remember what you just said. So spillover effects would impact marine mammals and fish. Right, and then connectivity would impact benthic invertebrates. I think that's what - not to say that they don't impact the others, but I think that was what you just described, correct?

BD017: Yeah, we're thinking about reproduction. And I think connectivity would also impact marine mammals because then they could more easily feed between farms, but I don't think connectivity is necessarily gonna increase the forage fish.

Interviewer: Gotcha. Okay. Did we have that connected? Okay. No. Okay. Perfect. Um, okay. So maybe let's go back to number of farms really quick. Um, so if we increase number of farms, would that increase spillover effects? Or decrease or would that have an impact? I'm sorry. Is - how we should say on spillover effects?

BD017: Well I don't think each individual farm would change like the spillover effect per farm. I don't think it would change but the cumulative spillover effect might be because there's more farms so depending on how you structure this - is this everything in like impacts on a per farm basis or impacts on a whole ecosystem basis?

Interviewer: I would say the latter.

BD017: Okay, so if there's more farms in a given ecosystem - you would have greater spillover effects, but not a change per farm.

Interviewer: Okay, so okay, that, yep. So then would that be a low, medium or high impact relatively speaking? If possible.

BD017: Can we come back to that?

Interviewer: Yeah absolutely. So I'll make it positive. Sometimes it's easier to do the weights at the end because it's easier, like once you have the other relationships to see what relatively would be driving the system. Okay then what about size of farms that - would that still impact spillover effects since we changed the name of that concept.

BD017: Yes I think the spillover effect on a per farm basis would increase if you had bigger farms.

Interviewer: Gotcha. Okay. And then number of farms, would that, so we had that impacting, so would that impact connectivity I guess is what I need to ask?

BD017: Yes. Okay.

Interviewer: And would that increase or decrease connectivity?

BD017: Increase, if you had more farms.

Interviewer: And what about - What about for size of farms?

BD017: I guess, so I'm thinking about it as like, if in a given area, you have five acres that could be farmed - if that is five farms versus one five acre farm, is like the way I'm separating it in my mind. So no. If you just had one big farm taking up all that space, it wouldn't change connectivity. That would make sense, okay.

Interviewer: Okay, number of farms. Okay, so I feel like we've solved the issue of spatial dynamics, then temporal dynamics. Is there some way that we could or should change that concept to be more specific?

BD017: Yeah, so I guess what I was getting at - temporal dynamics is - the impacts of kelp farms on an ecosystem depends on when the farms are put in versus harvested but if we're just talking Alaska then that temporal dynamic isn't changing so we're just holding that steady but the impact of the - so then thinking about like what's the cumulative impact of the farms on these marine mammal, fish, benthic inverts, not thinking like what's the impact before harvest versus after harvest, which like we're also considering that level of detail in structure and you know, experiments and stuff.

Interviewer: Right. Right. Okay.

BD017: That level of detail in order to inform the question of what's the biodiversity impact of farms.

Interviewer: Right, okay, that makes sense. And that's, yeah, it's challenging for me to think about how to represent, I think that sounds really, really important. It's challenging for me to think about how to represent that in this model, because it is static, essentially. But I think that that - but so maybe it doesn't have to be in there, but like the idea is that any impacts are considered - on as a whole impact.

BD017: Right, right. That's when the farm's in the water versus when the farm's not in the water.

Interviewer: Okay, okay, okay. Yeah, so maybe we'll take that out for now, but that's good to know especially if it sounds like for the Salish Sea case study, um I mean I guess you said that there's less so kelp mariculture there but that's I think it's important for me to remember for other case studies it sounds like when thinking about these issues. Okay um okay so what about number of farms impacts on marine mammals?

BD017: Uh more farms will probably have more yeah more like interactions or impacts on marine mammals but the farms are gone before most of like the humpback activity is in the water right I'm just talking out loud.

Interviewer: Yeah no no it's no it's helpful.

BD017: But like seals and stuff are around all the time, right, okay and especially in winter it's like maybe harder for them to find food so the farms could if there's more fish around the farms that might be a nice food source in a time where it's harder.

Interviewer: Right, okay. And so, and so this is hard because I know you were also talking about potential entanglements with gear with marine mammals, but that hasn't been documented, right, at all. Like we haven't actually seen that. It's just a concern to keep an eye on for the future, essentially.

BD017: Yeah, because I mean, like, entanglement with fishing gear is a huge issue, but fishing gear is also not taut in the water and has literally captive fish on it. Whereas aquaculture gear might attract fish, but also the lines are really taut in the water, so that reduces entanglement risk. So I think entanglement risk is a present concern but not a likely occurrence.

Interviewer: I got you. Okay, because I'm just trying to think. So it sounds, because I just want to make sure that if I make this a positive, it sounds like how you're describing it in terms of ecology, that it could have a positive effect on marine mammals in terms of foraging grounds, right?

BD017: Yes, I think it would increase their foraging success.

Interviewer: Okay, but I want to, so I just wanted to put in for myself that that's marine mammal population because even though I don't know that it would be worth or necessary for us to add marine mammal entanglement into the model given what you've been saying, but given that there could be that risk, I don't want that to like be confused in the model. Unless you think, I mean we can put it in?

BD017: And I think it would, with more farms, you get more entanglement risk, but I think it is low - weighted low relative to some of the other stuff. I think if you didn't include it, then some people would be like, "You're biased in favor of mariculture." Which is what we have encountered. So gotta mention it. It's a real risk.

Interviewer: Okay. Yeah. I mean, thinking back of the Northeast, like the right whale drama. This is constant.

BD017: A lot of drama.

Interviewer: Drama, yeah. Okay, so it would be positive on the mammal population, but then it sounds like you could have a low negative on the entanglement.

BD017: Well, positive, 'cause it's more farms, more risk. But not a lot more risk.

Interviewer: Gotcha, okay, perfect. Okay, and then number of farms you said would be positive for fish?

BD017: I think so, yeah.

Interviewer: Yep, and then on benthic inverts as well, if I'm remembering correctly.

BD017: So that one I think is gonna be really site dependent, 'cause the benthic inverts, they're responding, they would be responding to kelp falling off of the farm, and then that's just more like organic matter on the bottom. But if your farm is in a pretty high current area, then whatever's falling off the farm is landing somewhere else and like diluting into the ecosystem. So I don't know how to improve, like it depends. I mean, for all this stuff, obviously it depends. That's like ecology's favorite phrase, right?

Interviewer: Right, right, it depends. Yeah, I know. And that's why building these kinds of models, especially when they're more ecologically focused in terms of food web dynamics - is so challenging for that exact reason. And that's why I always have to specify that like it's not, the relationships are not for uncertainty, which is challenging.

BD017: So maybe low impact of rethinking holistically for the system, 'cause some farms, they will fall in a concentrated way. Other farms, they will fall in a dilute way. So some total low impact.

Interviewer: Gotcha, perfect. Okay. Um, and then what about fouling communities?

BD017: So fouling communities, again, just reminding myself that we're thinking holistically. Yeah. I think kelp farms will be a sink for fouling communities because they will recruit to the infrastructure and then the infrastructure gets removed. So that they also get removed likely before they have a chance to complete their life cycle and reproduce.

Interviewer: Okay, so would that be a negative then?

BD017: I think so because it's not helping the overall biodiversity of fouling communities. Is that the right way to think about this?

Interviewer: Yes, but it sounds like that's a good example of where it wouldn't be high. It might be like a low - medium effect.

BD017: Yeah, so the way I'm thinking about it is it gives them more substrate to recruit on so you're like good. But that substrate gets removed before they then reproduce so bad. So that would be like a sink population if you're thinking about ecology.

Interviewer: Right. Okay. Yeah, I think, I mean, obviously we’re just about out of time. If we had more time I think that would be maybe something where we would need to like divide out into those two different instances to better populate but to better map it but it sounds like if it's like if it's a net negative like that's a good example of making it like a low negative if it's a sink.

BD017: Okay. Because they have plenty of other space to recruit on to like right - presence of the kelp isn't helping them but on a large scale I don't think it's necessarily hurting them either.

Interviewer: Okay okay um okay yes and we're just about out of time but I guess the last thing would be just if I could get the relationships for the size of farms and the number of farms just to like look at the impacts that the farms are having. So I think the last few would be for the size of farms if - what impact the size of farms would have on the biological organisms?

BD017: Yeah, I think size of farm would - for fouling communities, the same. Probably still a sink. For benthic invertebrates, maybe just more likely to be positive. So sum total - more positive or weighted more. Not like not thinking about certainty or whatever, but right.

Interviewer: That's yeah, that's a good example.

BD017: It's falling to the ground or there's and there's more of it falling so that it could be more concentrated.

Interviewer: So right. Yeah, because if it's not uncertainty, but it's like net impact, then like if there is some negative and some positive, but it's more positive than like, we'll give it a low positive, like you're describing. Yeah.

BD017: Okay, so that was like low quantities, but more than the number of farms. But more than the number of farms.

Interviewer: And I don't even think we weighted that. So I think we said, oh, we did say, we did say low. So we could say medium if that sounds accurate? Okay, yeah. Perfect. Okay. And then what about for on fish?

BD017: Uh, I think it'd be the same as number of farms. Same as number farms, but I think was - we just gave it a high positive. Uh-huh.

Interviewer: Okay. Um, and then on marine mammal populations.

BD017: I think it'd be the same. Well maybe positive, but not as strong as an effect as more as number of farms. So it's not. Now they're like foraging in one area, but it doesn't like increase the number of areas that they can be foraging.

Interviewer: Okay. So like medium then?

BD017: Sure. Okay. Um, I think that that was in general, like that one would be low and the other one would be medium because I don't think these farms are like having that much of an effect on marine mammals.

Interviewer: Okay. So this one would be low and this one would be medium. That's what you're saying? Okay, great. I know we're two minutes over. I don't want to take up any more of your time. But I really appreciate it. Just even starting the model and having this discussion is really helpful for me and for our team. So I really appreciate your time. And I know you're really busy, and I'm sorry it got rescheduled so many times. So thank you. I really appreciate it.

BD017: Yeah, I'm excited to see what comes in this project.

Interviewer: Yeah, I'll keep you posted.

BD017: Cool, thanks, Kelsi.

Interviewer: Have a good one, bye.