**PART 1:**

\*Only transcribed interviewers' responses due to a quick turnaround for the second interview to finish the model (Part 2 - full transcription below).

\*Red highlighted areas in Part 1 were used to build a concept list for the FCM built during Part 2

\*Yellow highlighted areas are species mentioned

Biodiversity - that’s a pretty broad catchall, so I’ll answer broadly. We often in dealing with these species are noting that - they’re ESA listed for a reason. They’re rare. But that doesn’t necessarily mean that they’re important to the ecosystem and that the ecosystem would be altered substantially through their absence or reduced abundance so that would be the first aspect of biodiversity, which is, it’s not just presence/absence, it’s numbers and ability to actually influence ecosystem with those numbers. That’s probably the primary biodiversity portion of the ESA for these species.

On top of that, food base is many times the reason why we’re seeing reduced recovery of or increased threats. And I imagine you’ll talk to somebody working with whales at some point. The classic case example for our region is north atlantic right whales, where climate change now is influencing biodiversity in more of a spatial way. I wouldn’t say that we’re losing species but we’re seeing shifts in regional community composition such that the preferred prey items for these animals are now located in areas that they haven’t been historically. So you’re seeing the whales moving further north then they have previously so they’re up in Canada when previously they were capped out? (1:50) in US gulf of maine for example. We had a problem with that a few years ago where the whales were up in Canada in an unexpected way and and unexpected time and we’ve spent a long time in the US creating laws to reduce ship speed in areas where the whales are commonly found or in certain times of year. We’ve spent a lot of time trying to reduce fishing pressure and entanglement risk in certain areas that the whales use. And these whales ended up in Canada in an area that didn’t have similar ship speed rules and recently had just gotten an extension on crab pot fishery season, and so we had a confluence of whales, vessels, and increased lines in the water, and it was resulted in a lot of mortalities for a species that is on the brink of extinction, so a bad circumstance for sure, driven primarily by i think the shifts in prey distribution i suspect that north atlantic right whales like many of our species are actually probably fairly robust to temperature in general. They live in a broader range of temperatures so when you see them moving in response to changes in climates and sea surface temperatures, I’m thinking that’s probably driven either by where their prey are located or by their knowledge of where they prey are likely to be. So there’s a lot of stuff going on that way.

We’re seeing - I published in Nature Scientific Reports - on manta distributions and one of the things we noted in that paper was a general northern shift to the distribution through time even over a fairly short, 20 or so year time window.

So we’re seeing that - that requires dynamic management, requires different regions to communicate and work with each other. It’s one of those things where what works now may not work in the future because of these shifts. So that’s another big aspect of biodiversity. The councils of the Caribbean and gulf fishery management councils have ecosystem technical committees that are developing fishery ecosystem plans. And those plans are working to address some aspects of biodiversity as well. Changes in the ecosystem can be disruptive. You can get different inflection points and create wholesale alterations.

We hear in the GOM a lot about red snapper replacing other species. We hear about red grouper replacing other species. Those regime shifts may take place. I would say that the harrows of regime shifts for protected species are amplified just because they don’t have the resilience from a demographic standpoint to withstand them.

And a lot of these species have something in particular - we’ve got a proposal for queen conch out - public comment period has closed - we’re working on addressing that as well - things that were identified in that rule included reduced abundance, densities below the threshold at many locations where reduction is likely to happen for the individuals are going to have problems with mate finding and then there's also - published a paper recently - looking at - there's likely additional requirements for reproduction for that species where presumably there might be some need for repeated exposure to other individuals to kick them into the reproductive cycle by triggering the hormonal cycle that need to happens to get them reproductively active and for some reason they seem to require a certain threshold of adults to get there. We’ve seen in the florida keys which have been enclosed for queen conch for a long time that in nearshore environments even in aggregation numbers they don’t seem to be reproducing at all. I think it’s still unclear what it is that’s driving that. So there may be other things as well with regards to pollution in the water causing problems with reproduction or maybe it’s water temp. Hard to say. So there’s a lot going on.

You also have, for these protected species, disruptions in connectivity. For example, the removal of individuals from certain areas might interrupt gene flow which then makes the entire population or species less resilient to changes that might happen.

And then most protected pieces just have a poor ability to rapidly adjust to a changing climate because they tend to be long lived with very low reproductive output. Very k selected.

I think of a giant manta ray - we’re looking at minimum to probably more like 4-8 years in between births. One individual born at 6 ft wide almost when it’s born. So really heavily invested in the survival of one offspring.

You think of the northern atlantic right whale and the huge depression in calving rates. One of our colleagues - Josh Stewart - just published a paper fairly recently indicating that entanglement - historical entanglement - was a predictor for reduced birth rates which totally makes sense.

I’ve got a paper out on Gulf of Mexico's sperm whales where we looked at bioenergetics of that species and as you reduce [the kind of] overall reproductive fitness you’re going to see potentially decreased birth rates which then reduces your ability to recover. Then these stresses keep piling up.

I’ll mention some other unusual activities within my group. I’m very active - involved in - a funded project on the DWH spill on pcons - population consequences of multi stresses - model for gulf of mexico sperm whales. So we’re looking at building bioenergetics and then a variety of stresses on top of a population model and projecting forward to determine the most efficient routes to recovering from the harm of DWH oil spill either by working to minimize vessel strikes or reduce noise associated with seismic airguns or reduce the risk of oil spills. All of those things take a pretty significant toll on that population.

4 CATEGORIES OF BIODIVERSITY:

I mean it seems reasonable. It encompasses some stuff and you cluster things - I’m sure there’s quite a bit of overlap in those things.

We tend not to have as big of a problem with the latter two that you mentioned there. We don’t have as big of an issue with invasive species. Obviously the lionfish invasions in the gulf of mexico got a lot of attention.

We recently delisted Johnson’s seagrass as an endangered species. And that was because we didn’t feel it was an invasive species but we did have genetic information from improvements in genetic techniques that indicated the entirety of that listed entity was really a single female clone of a halophila ovalis genotype which presumably was brought over on a ships bilge probably many many decades ago. And sort of took root in florida but it is a habitat forming - actually kind of primary succession seagrass species that then creates environments that are more favorable for more competitive not native seagrasses to inhabit and it gets outcompeted by the natives when that happens so re-categorize it more as an introduced than invasive species and still consider it to be EFH under the EFH rule. So our habitat conservation people still deal with it in a positive light. Provides valuable services to the ecosystem. So it is interesting - sometimes introduced species aren’t harmful and can actually be helpful but the invasive stuff certainly gets a lot of attention.

But the primary threats for the species I deal with are almost always historical overutilization - you think about the sturgeon - they were overharvested in most of the rivers and then you think about habitat destruction associated with human activities, especially for the sturgeon, that's a big problem. Altering the river ecosystems - dams being put in place that block their access to historically spawning habitats and then the toll that that takes on their ability to recover because the offspring are less successful in terms of survival.

Nassau grouper, queen conch - overutilization - obviously that’s a big problem - decimation of spawning aggregations.

MANAGEMENT:

Statoratory authority of the ESA and MMPA are fairly effective at, at least, stopping the hemorrhaging. Recovery is harder. So for example, I mentioned Section 7 earlier. It’s jeopardy if it’s likely to jeopardize the continued existence or recovery of the species. So if you think of a species where maybe the population trajectory is positive and then the human activity gets it to flat - that would not be jeopardy under a section 7 consultation. Even though it reduces the trajectory. Only if it went negative would it be jeopardy. And very clearly if it went negative to extinction would it be jeopardy in say a population viability analysis which is a tool we try to use often but typically have limited data to feed into that such that you evaluate scenarios and then a few say things are a fine and a few say things are bad and then what do you do. The knowledge gaps are a real problem.

I think that relative to other statutes the ESA and MMPA are fairly robust. And the MSA that puts emphasis on reducing bycatch is also helpful at times. Typically our fisheries are major impact factors of our species from the bycatch standpoint. Bycatch is often the biggest current threat to our species. Smalltooth sawfish for example. Giant manta ray. Those are the biggest issues for them in domestic waters. It’s often hard to quantify how much bycatch is happening and is the fishery to change practices because you have very limited observer coverage so you have limited documentation of interactions. And then when you spool those up in statistical models you get enormously wide confidence intervals that make it very hard to be copeling when you’re saying there’s a problem. Whereas some other regions have 100% observer coverage on some of their fleets and I would imagine they have a much easier time making a case. We’ve got - for our shrimp fishery which is like our number one bycatch fishery - we have less than 1% observer coverage. Doesn’t make for great statistics.

**PART 2:**

Interviewer: So after we chatted last time, Sarah and I built a conceptual model from our conversation and so our hope today is to show it to you, get your feedback, and then add some missing linkages. So have you ever used the tool Mental Modeler or built Mental Models before? Are you familiar with that?

BD020: Maybe as part of a meeting long ago.

Interviewer: Yeah, so basically it's just a tool that we use to make conceptual maps of how an individual sees a system. So we built a concept list from the answers that you gave us to the questions on Wednesday, Tuesday, whenever we talked. And then we assessed from some of your responses as well relationships between those concepts. And so what we can do is we can say if component A was to increase, would that impact other system components? If it would, would it be a positive or negative impact? And then if we can, we can assign relative weights to understand which relationships are driving the system. So if that sounds good to you, I'll share my screen if I can, if we don't have any more technical issues. Okay, okay great. So what I have here is this list of concepts from your answers. And so I think I'm actually gonna start in the upper right hand corner over here. And so these are some of the responses that you gave us about what you think about when you think about biodiversity. And so we have species presence and species abundance, species resilience and ecosystem function. So that came from some of your answers about, you know, a lot of times with ESA listed species, we think about presence absence, but sometimes it's abundance that also is important when thinking about their role in ecosystem function. And then we talked a bit about reproductive fitness, gene flow, disruptions in connectivity, also being important to affect species resilience. And then down here, we have some of the stressors that you talked about that are important for ESA-listed species. So you were talking about gear entanglements, ship strikes, bycatch, historical over-utilization, population consequences of multiple stressors and climate change, and then how climate change results in shifts in regional community composition. And then over here to the left, we have some of the management actions that you talked about. So you talked about MMPA and ESA, of course, a little bit about MSA as well and how that ties to observer coverage, which then can impact the gear entanglements and ship strikes to the ESA listed species. You talked a little bit about the importance of regional collaboration and dynamic and adaptive management moving forward. And then, of course, you talked about ESA species recovery plans and ESA species, ESA regulations and those ESA listed species themselves. So that's kind of a whirlwind summary of our 30 minute conversation that we had a few days ago. In the center here, we have those four components of biodiversity, if you remember, that we mentioned. So we called them species of conservation concern in our previous research. I think that's probably one and the same with ESA listed species, but I want to talk to you about that today and I left them separate for now. And then we had the habitat forming species, the key food web supporting species, and the harmful organisms. So that was a lot, I apologize. I can start by going back in the right-hand corner and go through each thing individually, or if you have overarching thoughts to start, we can start making adjustments.

BD020: Yeah, I mean, I guess first thought would be just species of conservation concern, that could be both MSA and MMPA listed species. And there's quite a few magnificent listed species that we love in that category too, when you look holistically within the ecosystem, the removal of large predators is generally a concern. The removal of parrot fish in the Caribbean has been a concern from ecosystem maintenance and coral settlement perspective.

Interviewer: Yep, okay. So is it okay with you? Is it accurate to put them all in one bin like I have right now?

BD020: Yeah, I mean, I would say I wouldn't consider all of the MSA listed species to be of conservation concern. I consider all of the ESA and MMPA species. So maybe some MSA listed, yeah. So yeah, I mean, that mostly makes sense.

Interviewer: I'm trying to figure out where to begin. So I feel like maybe if we want to start with-- what if we could start with this bin of species of conservation concern and kind of work our way around? And so usually how I navigate this process is I'll say, if species of concern were to increase, would that impact anything in the system? It might be easier with this research question to think of it in the opposite way. So do any of these other components in the system impact species of conservation concern? So if you were to increase local prey abundance, 'cause that's right next to it, would that impact species of conservation concern?

BD020: That would probably be a positive impact for a species of conservation for most situations. Harmful organisms could probably be a minus, although I wouldn't rank it in terms of order of magnitude as if you were doing thickness. Do the lines indicate weighting?

Interviewer: Mm-hmm, exactly.

BD020: I would rank that to the extent of like your entanglements or ship strikes or whatever, you know.

Interviewer: You would, sorry, would you really repeat that? You would rank it not as high as gear entanglements and ship strikes?

BD020: Correct, yeah, correct. And it depends on the species, but for the most part, harmful organisms in general haven't risen to that level for our species of conservation concern. Almost always it's historical over-utilization and then now currently either bycatch, ship strike or gear entanglement.

Interviewer: Okay, so this and historical utilization, ship strikes, gear entanglement and bycatch. Okay, we have all of those. And those are the high ones you said, those four. Okay, great.

BD020: Yeah. Whereas like the observer coverage that really is just a nuance of like, without it, we have a hard time controlling bycatch. It's hard for us to understand how much bycatch is happening and hard for us to develop regulations that are affected in control.

Interviewer: Okay, perfect. Okay, and I think we have that captured indirectly because we have observer coverage decreases bycatch, which then impacts species of conservation concern.

BD020: Right.

Interviewer: Okay, perfect.

BD020: Yeah, I'm not sure what to do with knowledge gaps that's floating out there. Knowledge gaps is clearly a negative in most instances. If you don't know it, you can't do anything about it. That probably could connect to every box on here other than the management ones. Even the management ones, we have the knowledge gaps of how effective our management measures are because we don't have adequate enforcement or observer coverage to figure that out.

Interviewer: Right. Yeah, if something's too broad, we can take it out or we can alter it as well. I think I put that in there because you were talking about maybe it was like fishery ecosystem plans or there's something management wise that you were talking about saying that it's hard to forecast into the future and to therefore manage for because of the significant knowledge gaps.

BD020: Yeah, I mean that certainly seems accurate. Another thing would be the population consequences of multiple stressors. So all those things that are negative, going in there could be flowing into that box and in there. They all could be going directly to the negative, but that that box is an assimilator of all of those other stressors. So like, right, becomes is not like a stressor. It's just a tool for evaluating the cumulative effects of many stressors.

Interviewer: Okay, gotcha. Okay, so should I rephrase this as more of a tool than the actual stressor? Maybe?

BD020: Correct. It's a way that you could take all those negative lines and route them directly into the species of conservation concern and understand the dynamics and interplay. The idea being, you know, for example, let's say you're a whale and you're entangled, right? Well, because you're entangled, you're having a harder time swimming, you're going to spend more time near the surface and you might have more vulnerability to your shift strike. Or historical entanglement caused you to lose some of your blubber mass and therefore you're having a harder time staying warm. You're burning more calories to maintain the body temperature which puts you in a negative spiral from a bioenergetics perspective. You end up, you know, having to spend more time feeding because you're making up for that issue and then you're not gaining enough weight to reproduce. So there's, it's a tool for getting all of that into a common framework.

Interviewer: Okay. Okay. So I'm trying to think about how to model that accurately. 'Cause if we're thinking of it as a framework, then would it tie more directly into the management nodes? Or if we're thinking of it as like the actual multiple consequences, the actual consequences of multiple stressors collectively, then that would be like a highly strong negative on the species of conservation concern, right? I'm trying to think about how-

BD020: Yeah, I mean, within your current model structure, I think what I would do is I would have the negative lines going directly into species of conservation concern, but then I would also have a second set feeding into that, which would then feed into a big strong line to make the point that like each one of these things by itself is bad. But when you view them holistically, their impact is greater than the sum of their individual parts. So anything about, you know, I'll give an example of my sister. If my sister doesn't get enough sleep, she almost always gets sick. That's a consequence of multiple stressors where like one thing leads to another bad thing.

Interviewer: So right now, I think maybe based on what you're saying in terms of weights, like I need to have the consequences of multiple stressors as the strongest weight to species of conservation concern. And the other one's still strong, but maybe a little less so to the species of conservation concern. Okay, perfect. Okay, I'm gonna go through and adjust the model after we have the phone to save time and complexity in the model, just so you know as well if I'm not making changes right now.

BD020: So theoretically, let's say you had four stressors. and each one of them had a weight of one, the sum of those stressors would be four, but when you view them holistically, the sum might actually be greater than four. So if each of your lines had a weight of one, then the P coms line would actually have a weight of like four and a half, five, ten.

Interviewer: Yeah, and it's hard because in this, so because this is more of a, we call it semi-quantitative, but it's like more of a qualitative conceptual tool. The weights aren’t additive in that way. So they're more meant to be relative to one another. And oftentimes we think of them as just categorical weights of like low, medium or high impact. So we couldn't represent the p cons through this tool the way that you're describing it, which is a challenge, which is the limitation, unfortunately.

BD020: I have it in my head. My wife and I published a paper last year, maybe the year before, where I did the weights of the lines based on the odds ratios. And one of the things have like odds ratio of like 16 fold increase probability. So it was very clear, like it made a great visual. If this happens, this is still going to happen, this is the driver of the entire process. So anyway, it was interesting. But, in terms of other stuff, habitat forming species would probably be a positive, linking in the species of conservation concern and probably also linking positively to key food webs supporting species. Spawning aggregations would link positively to species abundance.

Interviewer: Is there anything else that we missed that impacts species of conservation concern? I know we've added a lot.

BD020: Well, under the, excuse me, under the ESA we think of four demographic criteria. So we think of kind of abundance, connectivity, diversity, and productivity. Anything that impacts any of those four things negatively from the demographics standpoint of the species. So those wouldn't be stressors. Would be just like the inherent nature of the animal. But then you think about the - so we have five listing factors that we evaluate and those are all like the threats that we evaluate in considering whether a species should be listed and then also when you're developing a recovery plan, how would you do that? So you've got kind of like the historical over utilization category, you've got the inadequacy of management measures, that's pretty common one to couple with over utilization. So basically you get in a situation where probably it was a free for all and then we started to put in management but it's not effective, there's a lot of poaching, illegal fishing, poor compliance. So, you know, I don't know, inadequacy of management measures could be something that we could include in here. Predation is another thing that we consider, disease is something we consider, you know, for marine mammals especially, but probably also giant manta ray and some of our other, you know, filter feeding species. I'm pretty concerned that marine debris is a pretty huge threat. So we've got that.

Interviewer: And then, so I'm wondering, I mean, I know last time we had a whole conversation about like invasive versus introduced species and if they provide a positive or negative to the system. And so I had that in my head under the umbrella of harmful organisms, but you just mentioned disease as well. So I'm wondering if we should have that as a separate component in the model.

BD020: I think that would be a separate one. You know, again, cetaceans are better studied than anything else, and it helps that they're cute and they come to the surface to breathe, right? I mean, that drives a lot of it, and they have their own act protecting them and kind of getting paid funding lines. So we know a lot more about it. And we have unusual mortality events for cetaceans that happen constantly. There's a cetacean morbillivirus, which can be pretty devastating to local populations, that sort of thing. So I think disease is a pretty important stressor for marine mammals. And it's just not a well understood stressor for the other stuff. Clearly for coral, stony coral tissue loss disease is like decimated pretty much the entire Caribbean. So that is a pretty massive negative depending on what species you're talking about.

Interviewer: Okay. And we had marine debris and then inadequacy of management pressures. Was there a fifth one other than these four right here that you mentioned? I thought you said there was five.

BD020: Yeah, let me see. Yeah, habitat destruction. Habitat destruction, which I think I had that I had that at one point but maybe I took it out.

Interviewer: And then what I wanted to go back really quick - what you said before were four previous categories prior to the stressors that you were talking about - what the requirements to determine if it's an ESA listed species - is that correct - it's demographic factors so you consider demographics and then threats?

BD020: So basically like how's the species doing like right now? And then how threats impacted that and how capable is it of responding effectively to those threats? Which is what most of the species that are listed under the ESA are - large, long-lived, low reproductive species - just because they're less resilient to direct impacts. Like they're great competitors in the environment but when you remove them actively they have a long timeline to replace themselves. The list of exceptions, I mean you know, corals replace themselves fairly quickly but they grow very very slow. Nassau grouper are prolific reproducers but when you take too many of them their spawning aggregations break down and they stop reproducing. So there's nuances.

Interviewer: Right. Okay. Um, what the four were, I remember it was abundance connectivity. Was diversity one?

BD020: Yeah. So you're looking at genetic diversity basically. Gene flow.

Interviewer: And what, what was the fourth one? I thought there was four.

BD020: Yeah. So you've got productivity, diversity, abundance and then uh - now I'm forgetting. It's like, it's like a fun test. Friday afternoon.

Interviewer: Um, well, I think that we're already out of time. I don't want to keep you into the next meeting. But are there any like last things that you think are really important that we know? When we're thinking about this model. I know it's a lot.

BD020: Yeah, I mean, you know, conceptually it seems about right. There's obviously nuances and devils in the detail on the weighting adjustments and stuff are gonna depend, you know, there's probably general truths to like how you would adjust the weighting, but then there's obviously like case specific.

Interviewer: Right, absolutely. Yeah, that's a common challenge that we have, these models, especially right now, 'cause our research question is really broad. It's a lot easier when you have like a specific, spatial system or species that you're looking at when you're building these models, but anyways, okay. Well, sorry to, thank you so much for your time. We really appreciate it. And thanks for jumping on a second time as well.

BD020: Yeah, I hope it was helpful. Sorry about the tech issues and, you know, if you got any other follow up questions, just let me know.

Interviewer: Great, yeah, thank you, I appreciate it. We appreciate it. Bye.

BD020: Take care, guys. Have a good afternoon.

Interviewer: You too, bye