SOUTH ATLANTIC FISHERY MANAGEMENT COUNCIL

HABITAT PROTECTION AND ECOSYSTEM-BASED MANAGEMENT COMMITTEE

Hilton Cocoa Beach Oceanfront
Cocoa Beach, FL

June 13, 2016

SUMMARY MINUTES

Habitat Protection and Ecosystem-Based Management Committee

Doug Haymans, Chair
Wilson Laney, Vice Chair
Robert Boyles
Chester Brewer
Jack Cox
Jessica McCawley
Charlie Phillips
Lt. Tara Pray

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Anna Beckwith
Zack Bowen
Mark Brown
Chris Conklin (via webinar)
Dr. Roy Crabtree
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Roger Pugliese
Mike Collins
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Julie O'Dell
Chip Collier
Dr. Brian Cheuvront

Observers/Participants:

Dr. Bonnie Ponwith
Dr. Jack McGovern
Jocelyn D'Ambrosio
Erika Burgess
John Sanchez
Iris Lowery
Brett Boston
Tina Udouj
Dr. Marcel Reichert
Rick DeVictor
Nik Mehta
Brett Fitzgerald
Dr. Patrick Halpin
Dr. Laurent Cherubin
Jon Robertson
Justin Friesner
Jim Morley
Ken Childress

Additional Attendees Attached

The Habitat Protection and Ecosystem-Based Management Committee of the South Atlantic Fishery Management Council convened at the Hilton Cocoa Beach Oceanfront, Cocoa Beach, Florida, Monday afternoon, June 13, 2016, and was called to order by Chairman Doug Haymans.

MR. HAYMANS: Good afternoon, everyone. I will take a line from Jessica and say welcome to Florida, the fishing capital of the world, or so they think. Before we call the Habitat Protection and Ecosystem-Based Management Committee to order, we would like to welcome John Sanchez from the Gulf Council. He will be here for the week with us. I would like to welcome Robert Boyles, former council member and sitting in for Mel Bell.

MR. BOYLES: Thank you, Doug, and I wanted to say that Mel is a happy grandfather again, and so we're thrilled for that, and Mel wanted to be with his daughter, and I wanted to support Mel, and so thank you all for having me back.

MR. HAYMANS: We're glad to have you. We would like to institute a Boyle's Law through the week, if we have to. Where is the bowtie? Friday? Okay. Thank you. We all know the wonderful job that Monica does. She does such a great job that it takes two to fill in her place when she's not here, and so we would like to welcome Iris Lowery, and sitting back behind, at the table, is Jocelyn D'Ambrosio, and they're going to be representing NOAA GC this week.

DR. MCGOVERN: I would also like to recognize our new South Atlantic Branch Chief, Rick DeVictor, who is sitting behind me, and also with us today is Nikhil Mehta from our Regional Office.

MR. HAYMANS: Thank you very much. Congratulations, Rick. I will call to order the Habitat Protection and Ecosystem-Based Management Committee. Wilson and I co-chair this committee. We have a very full agenda. I would ask for approval of the agenda. Are there any additions or changes? Seeing none, we will accept the agenda as presented.

Hopefully you've had a chance to run through some of the minutes, and are there any additions or changes to those minutes? Seeing none, we will accept the minutes as they've been presented to us, and I'm sure we will sign them at some point later on.

Okay. We have a very full agenda. There is a lot of informative presentations that I'm looking forward to, but we need to be finished by 5:30 so that we can move into our industry-sponsored reception at 6:00 in Room 755. That's basically all of my opening comments. I am going to turn it over to Roger and Brett Boston for an FEP II status report.

MR. PUGLIESE: Okay. I'm going to be probably the briefest you've heard me at any of the council meetings this time, which is good. Today, what I want to do is I will hand it over to Brett to give a very concise review of where we are going with the FEP and partnerships and advancements. I did want to just kind of open up with today is hopefully going to be an opportunity to really look at a way forward in technology, support from broader scopes of participants in the region, to applications of those technologies and a way to address a lot of the other council directives into the future, and so hold on. I think it's going to be an interesting and informative and hopefully inspirational day.

I would like to introduce Brett Boston. Brett is with Group Solutions, and he has been coordinating with us for a number of years on different aspects, and specifically facilitating the advancement and collaboration on the development of the Fishery Ecosystem Plan.

MR. BOSTON: Thanks. I will be wearing multiple hats today to cover my bald head. One is to talk a little bit -- I've been working with all of the agencies of all the South Atlantic and the organizations and just donated some project team time to making the project come together. I'm also wearing a hat, a little bit later on, with the Fish and Wildlife Foundation of Florida and talking about citizen science, and so you'll see me up here. Sorry to be confusing about who I am.

This has been a fabulous project. I'm going to talk a little bit about where we are in the ecosystem plan update. This is really about building, as it says there, a more concise operational document with links to expanding the tools and capabilities available to all scientists, and certainly to you guys, but certainly all scientists that want to work in the region, and so I'm going to walk through a quick presentation, and I will take questions along the way. I will go fast, but if you've got any questions, just stop me. I will keep looking around to see if you need them, and we'll take them at the end as well.

Updating the Fishery Ecosystem Plan, really, when we talked I guess back in September, way back when, we said it was to be more concise, more operationally-focused, and more linked to online tools and models, and so that's been pretty much a guiding stretch through there, is to keep that linked, and so we're there, I think with what I see at least.

Also, in terms of updating the plan, we want to make sure we've got climate change, sea level rise, the food webs, of which that is the food web model. It's really small and you can't read it, but it's coming together from the Food Webs Team. Then there are links to other models and the online tools, which we'll talk about as we go through, and there are lots of them, either developed or under development right now.

The real new approach was to look and do a lot of virtual multiple writing teams of experts. We used a lot of face-to-face meeting time where we could, but, mainly, it was online and in virtual, WebEx and other meetings, but real broad engagement of experts and organizations throughout the Southeast and around the country, really. We did a lot of online tools, as I said, for drafting, editing, and sharing materials, and I think we're right now exploring what the integrated and linked digital document might look like. How do we present this so it's usable and it's not a static PDF, if you will? How do we link this stuff and make it very useable? That's what we're going to talk a little bit about.

Right now, last council, approximately, I know we have twenty teams working on this and various aspects of it. Those are the teams right there that I've got up. It's well over 150 participants, and we're about fifty-five organizations, and so you've got a very broad-based set of input going on in this rewrite.

We're talking about updating our content and design in new ways, focused on updating the habitat and species and the fisheries information within the plan, again using both online, mainly online, tools. It provides some ecosystem perspective, I think, from our region, and it's very focused on the Keys to the Virginia border, and so we're very focused on that piece. It addresses, I think, a lot of the directives you guys are currently wrestling with, whether it's the blueprint for snapper

grouper, the citizen science approaches, ecosystems approaches. Those things are all kind of in there as kind of the sidebars of how we're developing the product. We have Marcel and Luiz Barbieri very heavily involved in the product and making sure that it's going to be something that's useful for them.

We also have a real guiding principle at the end of the day that we want a product is a living document and it's not static. The contents, we're really spending a lot of time, particularly on the online tools, figuring out how do we easily update this so that it doesn't just die the first time we say, okay, here it is and we wait five years for an update. It needs to be something that's regularly and easily updated, and that's built into a lot of the thinking.

I think it's going to set a baseline for the South Atlantic. It provides the connectivity around spatial and habitat and your EIS work and permitting information, linking all of those things together. There are a lot of components in the plan, but I think long-term research and monitoring is thought through in this, the SEAMAP plan for the work that we need to do there. It's got a South Atlantic mapping strategy, and those things will be available online for anyone working in the region, and so this is a big, evolving piece of stuff, and it's a lot of things getting linked together, but it is happening.

It's also linking to the partnership data, such as the South Atlantic LCC, which funded the Ecopath/Ecosim modeling that's going on right now, and that gives you supports for habitat and species and linkages to SEDAR and other things that the SSC is going to need for their work, and so that's all happening.

I think it expands the conversation directive for essential fish habitat to a broader perspective. The links that we have to the South Atlantic LCC really move us upriver, and so you start to talk about watersheds and the estuarine areas and uplands information. The meeting last week with the South Atlantic LCC was in St. Augustine, and it was actually Peninsular Florida and the South Atlantic LCC, which would cover our entire region plus the Gulf. There was a lot of presentation on linkages and riverine systems all the way out into the Atlantic, and there is going to be some focus happening with the LCCs make that happen for us, and so I think there's a lot of really cool stuff, which would give us that north/south and east/west connectivity that's really important.

We also have, I think, support for mapping enhancements, for like the managed areas that you guys have got, whether it's the coral HAPCs or deepwater protected areas or whatever, spawning special management zones. Those things, I think, will be slowly being linked into the plan over time.

Essentially, again, we want to create the best possible information for our managers and decision makers, and one of the things we talked with you guys about in September was that we were going to talk to each and every one of you about what tools would be valuable for you as decision makers, and so I would like to set up, between now and that September meeting, an opportunity to really talk to each and every one of you about what kind of decision support tools will be of any value whatsoever in what you would like to see, and so that will be -- There is a follow-up on that. I think we're just now at a place where we've got products and things that you can actually see, touch, and work with and go, yes, that makes sense or that doesn't make sense, and so we'll be working on that with you guys. I will have Roger do the follow-up on that, Mr. Chairman, if that's okay, just to kind of follow up on how to do that.

We are working with the Chairs, as I said, Luiz and Marcel. We also have this Ecospecies Online System for managed species, and this has got really detailed habitat and fisheries information. FWRI is housing those. We just had a meeting two weeks ago with Marcel and the team to come together and really look at this product, and I think it's a fabulous product. It's got everything we need online. It's got all the research on any given species is out there, and these will be the kinds of things that will be linked in there, into what we're doing, and so that tool is coming together.

Again, we want a concise, policy-oriented document that's got links to all of our partner information and databases and the tools that are there, and that's really the task that we're moving forward with. What does that concise, policy-oriented document look like? How do we build the digital links and information that makes it easy, and I think we're well on the way. We've had a lot of those discussions, and so the goal is to link all of that stuff together and provide the spatial information on species, provide environmental information for stock assessments, give you the habitat characteristics, talk about connectivity from spawning to food webs to marine protected areas and all of those things and build the spatial world that we need to actually make the kind of decisions that we're making.

It will give you, I hope, when it's done, some more validation for some of the work that the SSC is doing, from your just basic population dynamics models to some other validation that might prove useful for decision makers. It will also help, I think, guide where researchers of the future can really target their efforts and priority areas that we need.

Then Roger has got kind of a timeline in his mind about where we go from here, but one of the things that I wanted to put in was between now and September, at least, a placeholder for getting together with council members and committee members, to make sure that we have a time to talk about what would an effective looking set of tools look like for you, in terms of decision support, and what would be easy to use, and so do you want to do the timeline?

MR. PUGLIESE: This is advancing from this point on into the future. It's the further development and refinement of the Fishery Ecosystem Plan and all the different aspects of it. Of course, this has been identified as also being the update for our essential fish habitat as well as providing the input on the five-year review and addressing some of the requirements and needs that we have been collaborating with the Habitat Conservation Division to accomplish or to set in motion, to make sure they are accomplished within this process.

What we do highlight is, stepping from this meeting, at least a status report of where we're moving and all these different aspects of the FEP in process, and then the opportunity to look at, into the future, technologies and advancements, our whole session today on different aspects of how a lot of those may be supported with the evolving capabilities in our region, because we're going to actively try to make some direct connections to those as we move forward.

September, we have the opportunity to look at the FEP and some specific components, look at two of the most significant parts of the developing document. We've had excellent teams building the food web and connectivity and climate variability in fisheries sections, which really advance some of the thinking into the future.

The opportunity to look at where those are and begin to look at some of the policy discussions that are coming out of that, to feed directly into two of the new policy statements that are going to be

developed through our Habitat and Ecosystem Advisory Panel, which leads to the November meeting. A lot is going to be accomplished at that meeting, with the idea to look at the Artificial Reef Draft Policy and the food web and connectivity and take some of these discussions about policy recommendations and craft those into more of a structured policy document as well as the fisheries and climate variability.

One of the other aspects not highlighted here, and it's touched on, and you probably just saw it in the list, is that one of the other excellent collaborations is the opportunity, as part of the long-term climate activities, the National Marine Fisheries Service was directed to build, in response to the National Climate Science Strategy, regional action plans, and what we've done is integrated it into our FEP discussion process and created a regional action plan group that is working directly with National Marine Fisheries Service, who have crafted a strawman.

We're pulling in our climate technical group that's building there, and we're going to advance that, and that can be part of the Fishery Ecosystem Plan information and serve the needs to address that mandate that's going down the road, and I think Bonnie may highlight more detail a little bit about some of that collaboration, but this is, again, one of these real reaching out and trying to work and make it even more than what I think anybody envisioned, and so that is going to be also happening and be supported and ultimately be integrated into the ecosystem plan.

As Brett had indicated, the Ecospecies System that is developing and has been in process for a while, we had that meeting with our core managed species, which primarily had a lot of the most significant snapper grouper experts in our region involved, as a stepping-off point, but restructured this so that, essentially, that system is going to provide the detailed species information, the detailed fisheries information, and so the FEP document itself will have -- Everybody is looking at crafting snapshots of the individual species and the individual components, with linkages back to this more detailed living online system that can get to and access either status of the species, detailed to the life stage, essential fish habitat information, fisheries operation, and really the bounds may even integrate things such as vulnerability, and so we had Grant Gilmore involved, and we may be build an entire sound vulnerability section of this. It has the opportunity -- It continues to evolve as we move forward, and so Ecospecies System is going to provide a lot of the more detailed and living access information.

That is going to continue to develop. That's probably going to be something we have to populate a lot of the species. Our core species have information, but a lot of those still we're going to be identifying the partners to get the rest of the information and expand that as far as we can, and there is the possibility to, again, collaborate with some of our partners to get even river information up into the estuaries and beyond, and that may be coming with some partners with the Southeast Resource Partnership, as well as the Landscape Conservation Cooperative, a lot of people working in the same way, again building those connectivity opportunities we have there.

That brings us to to the December council meeting, where the hope is to have drafts of those policies that are going to be integrated into the FEP available for deliberation, as well as really look at how some of that online functionality is going to work with say Ecospecies, as well as a status on the ecosystem modeling.

We are moving forward and advancing and hopefully, by that point at least, some of the ducks will be in a row on how far we're going to be able to go with the first generation of Ecopath, Ecosim,

and Ecospace, because we're really getting to the cutting edge of where that's going. We have reached out to the designers to get the most recent information and capabilities and are going to try to make the spatial side of that as functional as possible.

Again, this also is part of the FEP, the idea that collaboration with the LCCs and the conservation blueprint, that we've had input and have been evolving. The next generation, as it evolves, is going to refine the marine component, and so some of that information, as we're building that, feeds what we're working on in species distribution and habitat distribution and model inputs and outputs on that. That all connects directly into our collaboration with the Landscape Conservation Cooperative and the blueprint and the funding of those efforts.

In addition, as I mentioned before, we had the first stepping-stone of developing a mapping strategy for the South Atlantic region, as part of the last ecospecies discussion, and looking at how we frame the different avenues, and so we're going to advance that with our partnership with the SEAMAP Habitat and Species Characterization Workgroup, which still has to be integrated, and it may be in conjunction with the November meeting or sometime separately, but the idea is to really put some meat on the bones on operational capabilities in the South Atlantic region, processing capabilities in the South Atlantic, some of the technological advances we're going to see today on how you could apply that, so you know what some of the operation either costs or capabilities really can be and who can be involved.

That will be designed. What that ends up doing is it provides the foundations for a lot of these efforts advancing, which really, in order to get a lot of the different ones that I've identified, it's probably going to push this into a March or June completion of it. A lot of the core materials are going to be completed, but especially when we start talking about really getting an integrated, online interactive type of capability.

I think that's something that we're going to make happen, plus we want to make sure that some of the aspects really document how some of this can be used and advance us on use in stock assessment and tools the council needs, and that's why we want to have deliberations with members as this continues to proceed, and so some of it is definitely advancing, but there is a lot of the partnerships that we're relying on a lot of people that are stretched out in a lot of different directions too, but some real top-end minds are coming together to make this as useful for the council as it possibly can and for other partners in our region. Any questions?

MR. HAYMANS: So an extremely ambitious project that I think we've seen has grown since the beginning, and I think the reason why it's going to be a living document is there is never really an endpoint to this, and so hopefully early next year we will sort of at least put a stamp on where we are to that date, but it's going to continue to grow, which is a good thing. I think it's more information. Any questions?

DR. DUVAL: Roger, I think wasn't the initial -- The initial timeline for approval of the FEP was December, and so is there any reason why -- It seems like the delay to March is really coming from the additional work for all of these tools that you're developing that would push it into March that would come online, and so is there a reason why we couldn't put that stamp of approval on this concise operational document in December, but continue to move forward with those technological tools that are going to be so important to us actually operationalizing EBFM in the South Atlantic?

MR. BOSTON: Some of the writing teams are getting started later than anticipated, and so the online tools are not delaying us. It would be the integration of that, but it's the reviews and the edits and some of that stuff, and we did lose some key section chairs along the way, and so I think there's a few of the writing teams that are just now really, really starting to ramp up. Can they get done or not? I don't know, but I would say that, from my perspective at least, I don't think it's the online tools that are delaying us.

DR. DUVAL: This is sort of a flippant follow-up, but they can write less, perhaps.

MR. BOSTON: That's the challenge, for them to write less, but it's to make those links to where the information is in the document itself, and so I would say every single team -- Marcel has got figures like for each of the managed species, and we want to try to fit three of them on one page, but sometimes writing less takes longer, and so I would just say I don't think the tools are really delaying the project, in my opinion.

MR. PUGLIESE: Let me quick jump. I think that's one of the balances we're trying to do, is because I didn't realize how much we were going to try to move a lot of the detail, which actually is ultimately going to be more useful, into say the online, and so it addresses exactly, and really be concise on species presentation and fisheries presentations and come up with something that -- The key there was that it become something that doesn't necessarily have to be updated.

Everything else can feed in, and so that fine line of doing that and making sure that everybody is engaged, because, once we really started looking at the entire breadth of all the different species, going beyond where we need to, it's just a balance of making sure we get enough done and it's concise and it's valuable. I think to force it to get done before maybe we have at least even both of those kind of being addressed, because the rest can be finalized as we go into the future, of course, but I think we want to make sure that the document, both the concise document and the interactive capabilities of it, are operational.

MR. COX: I always enjoy the ecosystem talking points. I've been following it for a while. I'm on the board of Seafood Harvesters, and I know other councils are working on this kind of stuff as well. Since I first came on the council, I think it's pretty much when we started talking about ecosystem-based management, but, anyway, I have a motion that I would like to present before we get too far along. I don't know if this is the time to do it.

MR. HAYMANS: Let me hear what Wilson had first.

DR. LANEY: Thank you, Mr. Chairman. I had a comment and I had one question. The comment is one of the tardy participants in the writing team is -- We've said it before, but I will say it again, but a lot of our folks are volunteers. We are very, very fortunate now to have some really highly experienced, retired individuals like Jud Kenworthy, who has agreed to work on the SAV section of the document, and one of the issues we face is that there's been a tremendous amount of new work on a lot of these species and habitat types, and so it's always a challenge to try and decide how much of that you want to incorporate into the document.

The approach that we took -- When I say we, I'm talking about National Marine Fisheries Service Headquarters, the approach we took with the new striped bass report to Congress was to really, really cut it down a lot this year. In the past, it's been about a thirty-five-page document, and I

think now it's like an eight-page document, and one of the things we did was, for all the new information on striped bass, we just included the peer-reviewed literature references, period. We didn't attempt to summarize those in the document, and, for somebody like me, who wants to provide every single detail to Congress and their staffs, it's tough to just put the citation there and provide the link to them and assume they're going to go take a look at it.

That is one approach that we could take, I think, Michelle, if you wanted us to try and do that, is to, instead of trying to put like a full abstract in there from some of these peer-reviewed papers, we could just put the link in there to the paper. That would be one way to cut it down.

The question I had was, because Roger and I had a little bit of discussion about this at lunch, but production. One of the things we've talked about in the past, relative to where we want to get to with regard to ecosystem-based management, is to be able to, once we have an idea of what the amount of habitat is in the South Atlantic Council jurisdiction and how the species relate to those habitats, whether or not we would be able to say something about what sort of production levels we could expect, based on population densities and fishing management measures that we put into place and the amount of habitat available, and I don't know whether you want to comment on that or not, Roger.

We had a little bit of discussion at lunch about the fact that the tilefish may be good candidates for that sort of an approach, because their habitat requirements are pretty specific and they have sort of a sedentary, almost, lifestyle, since they occupy burrows, but it still may be challenge. We may not be ready to move too far in that direction, because we know so little about the life history of a lot of the other species, and, again, red snapper comes to mind as one of those that we really don't know a lot about the recruitment end of things, and so we may not be -- Even as much additional information as we have now, we may not get to the point where we can really start talking about production for a lot of the species just yet.

MR. PUGLIESE: I think, in response to that, I mean, best case scenario, if we had the ecosystem models completed at this point in time, we could probably be advancing that, at least in concept. However, I think this is the opportunity to have those kind of thought processes in developing those tools and capabilities, that those things are the types of things that we can begin to investigate as we build the next generation of Ecopath, Ecosim, Ecospace, and future models, and so I think we can begin to at least align those, because the intent there is to go beyond what's been done in the past to integrate environmental inputs, models, and a lot of other types of capabilities.

As you said, from a standpoint of production, that probably is one of the species that, with such a tight life history, might have the opportunity, but we need to take some of the steps forward on compiling all that type of information, and the ecosystem modeling effort that is underway right now I think will help advance some of those kind of across-the-board looking at habitat-related species and those and begin investigating that capability for our region. I think that's -- What I'm hoping is that some of that can inform us as we move forward in the process on the FEP, but I think we can only get so much out of that while we're trying to complete it.

The further down the road a little bit, we may get informed more, in terms of getting that into 2017, because we may have the beginnings of a generation to begin to start looking, and so that's another consideration, in terms of other capabilities that are trying to be connected with this effort.

MR. HAYMANS: Thank you, Roger. Jack, I'm a little concerned that we're thirty-three minutes in and you've got a motion. What's your motion?

MR. COX: Well, I don't want to get too far along with this. I've been listening to this for a while, since I've been on the council. Roger takes the lead on this. He's done an excellent job of it, and technical staff has worked on it as well. I had prepared a motion just so we could have a look at this before the September meeting, to have the council -- Pretty much what I want to do is the council take ownership and to kind of roll their sleeves up and kind of move this thing along a little bit, and so I have prepared a motion in such a way.

MR. HAYMANS: I mean we've been addressing it the last several meetings, and we've got what we hope is a definitive end date, March or June being a definitive end date, and so a year. You want to push faster than that? Is that what I'm --

MR. COX: No, what I am trying to do is get -- The council has an opportunity to look at the document before September. That's what I'm asking.

MR. HAYMANS: Okay. Do we need a motion for that or direction to staff to try to present something to us?

MR. COX: I think a motion just puts it out there, so that we have something in writing, something that we can follow.

MR. HAYMANS: Go ahead.

MR. COX: Okay. **The motion would read: To direct staff to provide executive summaries of the new climate variability and food webs and connectivity chapters and draft policy statements in advance of the September council meeting for discussion at that meeting.**

MR. HAYMANS: I will say this, while they're typing the motion up on the board. We have nine speakers, nine presentations, and we have three-hours-and-twenty-five minutes, and we want to put a break in there, and so I am going to try to keep us at thirty minutes, if we can, per presentation with questions. Just be conscious of that as we move through the afternoon.

MR. PUGLIESE: One thing I would note, Jack, is that the policies, as I indicated, there may be draft recommendations coming out of those sections, and so I mean it's semantics, maybe. We already have it as you said, and, truthfully, that was already in the schedule, because that was what I had projected on us, following the lead to advance that, and so I think this is actually in the schedule already, now that I'm reading exactly what you have. I mean that's your prerogative.

MR. HAYMANS: Jack, will you reread your motion, please?

MR. COX: My motion, again, reads: Direct staff to provide executive summaries of the new climate variability and food webs and connectivity chapters and draft policy statements in advance of the September council meeting for discussion at that meeting.

MR. HAYMANS: Thank you, Jack. Is there a second? I will first remind you of the committee, and the committee is Mel, Chester, Jack, Jessica, Charlie, Lieutenant Prey, and Bob Beal. Charlie seconds. Any additional discussion?

MS. MCCAWLEY: Why is the artificial reef one not on that list?

MR. COX: I certainly think you can add it on there. I would.

MR. PUGLIESE: Part of the issue with some of this is getting ahead of the game, because the policy statements were to be developed by the Habitat Advisory Panel with input from these different groups, and that's why we had somewhat of a timeline. There were policy recommendations coming out from the individual sections, which was going to be advanced to the Habitat Advisory Panel to provide a draft for council consideration, a full draft for council consideration, in December. That's why -- There is no structure in the existing. We've got the team moving forward, but nothing that would be advanced at that stage, and, plus, it would not have gone to the AP at all for any input.

I mean that's why some of that crafting of timelines and different things were laid out. I think the issue of discussing -- Maybe if you pull policy out of here and just identify the policy recommendations or whatever associated -- There won't be policy statements. Those will be policy recommendations coming out of those groups right now, but, getting back to Jessica's comment, that's why. That's the only reason, was we wanted to get that advanced, so that it can be finalized and then formally brought to the council.

MR. HAYMANS: Thank you, Roger. Any additional discussion about the motion? **Is there any objection? Seeing none, that motion is carried.** Roger, do you feel like we're pretty complete here?

MR. PUGLIESE: Yes, I think that's fine. I think it tracks exactly what we were planning and advancing, just the caveats on semantics, in terms of how we advance the process. It's all moving in the same direction, and so that's good.

MR. HAYMANS: Okay. Thank you. We're going to start moving forward now with the list of presentations, beginning with the Ocean Technology Session and, Ken Childress, if you will go ahead and come forward, as we get set up for you, and Roger is going to introduce him. Michelle, did you have a comment?

DR. DUVAL: Thank you, Mr. Chairman. Just a request that the presentations that are being given by the folks here today, as well as the one that Roger just gave, if those could be posted online, that would be great. Thanks.

MR. HAYMANS: Great. Thank you. Roger, will you introduce Ken, please?

MR. PUGLIESE: I would like to introduce Ken Childress, who is the founder and Chief Operating Officer and Executive Vice President of Ocean Aero. Through some of our collaborations over time and in reviewing technology, involvement directly in oceans meetings, I had the opportunity to collaborate and talk with Ken and some of his other staff over the years about one of the most cutting-edge, advancing technologies in AUVs, and I invited Ken to provide a view of what

potentially can be available for extended deployments, some of the most cutting-edge monitoring and activities, and, actually, he will touch on an opportunity we may have for a test bed in the South Atlantic. With that, let me hand it over to Ken.

MR. CHILDRESS: Great. Thanks, Roger. I really appreciate the opportunity to come down here and talk to you folks. Cocoa Beach isn't a bad place to be. Next stop is San Diego, and so right now I'm running a pretty lucky circuit. I understand we only have about twenty minutes or so, and I could literally drone on and on about this stuff, and so I will start Mr. Apple right now, so I have a reminder in front of me.

We are Ocean Aero. We develop what we believe are some of the world's most unique unmanned maritime systems, basically small systems, easy deployment, long-range endurance, hybrid, totally environmentally-friendly systems, and I'm going to show you one of them here today.

This is what we refer to as the Submaran S10. S10 stands for submersible to ten meters. This is part of a line of vessels that we are planning and will be releasing over the next couple of years. It will be followed by a vessel we refer to as the S200, which will be submersible to 200 meters, and will be fully navigable underwater as a UUV or an UAV type of system, as well as be able to sail the surface like the S10.

These vessels are designed to be very rugged. They are designed to operate in Beaufort Sea State 4, and they are capable of submerging if the weather gets rougher than that, unless you want to leave it out there, and then you're risking your boat, but they have been in some pretty rough weather in our testing, and they have come through with pretty much flying colors. We've broken about everything that you can break on them and fixed it and made it better.

This is part of a three-year development process that we began in late 2012. It actually didn't get going until about March or April of 2013, when we gained our first funding. The project has been completely privately funded, up until last year, when we received our first contract from the U.S. Navy, believe it or not, to build a forty-foot version of these vessels, and so they are very scalable. That's another point there.

The vessels are autonomous and unmanned, and I make that distinction because autonomous vessels -- You can count a predator airplane as an autonomous vessel, but it takes a two-man crew to fly it, and so that is not necessarily an autonomous, unmanned vessel. These vessels can be preprogrammed for mission, planned, waypoint, released, and let go for months at a time with very, very little attention being paid to them, and a single person could monitor literally dozens of these boats, and so it really is an autonomous and an unmanned system, and the goal over the next several years is to make them smarter and smarter as we go.

The vessel is relatively easily deployable. I will show you that here in a minute, and they are -- We call them sensor and payload agnostic, and so we can run quite a wide array of sensors, and I will give you a few examples also. This is really kind of an eye-chart, but the point here is that the market for these kinds of vessels and the applications for these kinds of vessels has been growing steadily over the past dozen years or so.

I began in the autonomous surface vessel business in 2004. At that point in time, people looked at you like you had a third eye when you told them that you were going to build an unmanned sailboat.

Not only that, at some point, you were going to teach it how to submerge. Everybody knows you can sink any sailboat. The trick is bringing it back to the surface.

Because the market has expanded and because there are so many applications and the sensor payloads are moving our way, the guys -- We work a lot with Teledyne, not only the blue view folks, but parts of other Teledyne Marine. We have run many Teledyne sensors on these boats and tested things like ADCPs and DVLs and CTDs and other types of fluorimeter systems. The list kind of can go on and on. The only real requirement is based on weight and power.

We are going to be testing some multibeam echosounders, and the agnostic part comes in in that we're not only going to test Teledyne systems. We're going to test some of the other vendor systems too and compare what types of results we get with different sensors on our boat. In that sense, we are, but we really are glad to have a great partner in Teledyne. We're actually housed in a Teledyne building, and so I don't have to go too far to find the guys that do the ADCPs and that kind of stuff.

From a basic spec standpoint, it is a totally wind and solar-powered system. There is no oil, gas, alcohol, hydrogen, helium, or any other combustible on the system whatsoever. It is capable of a surface speed sustained of up to five knots. We need about fifteen knots of wind to sustain five knots, but, in three knots of wind, we can sustain two knots, and so it's a very capable system at a wide range of wind. It does submerge to ten meters and carries 23kgs of payload, and that's in three different payload compartments. I will show you in a minute where those are at.

It actually carries 1,000 watt hours of battery system, and it can carry as much as 2,000 watt hours of battery system, but the standard is 1,000, and we can produce 300 watts of peak power with about a constant fifty watts of power available. Our vessel will consume about eighteen of those watts, and so abut thirty is available for the payload, and that's quite a bit. That will run most fairly high-consumable hydrographic payloads, and so that works out pretty well.

It's a very stable system. It does have an auxiliary thruster, and it can be programmed to run multiple missions over time, and so it can do more than one thing. It can, as they say, walk and chew gum, and so it's a very, very scalable, flexible system. It's just about fifteen feet long. The wing sail, when it's up, is about nine feet. When it's down, it's just a foot-and-a-half off the water.

It has a draft of just over a meter, and so it's very shallow water capable. We ran some interesting mission tests in Bay St. Louis, Mississippi, not too long ago. I don't know how many of you are familiar with that, but you can go a couple of clicks offshore out there and never be in more than about eight feet of water, if you've got favorable tide, and we ran missions out there and didn't have any problems with it.

The standard configuration for the vessel, it has its own navigation system with GPS, anemometers, boat speed indicators, IMU/compass, and so we can determine things like wave height, frequency, wind direction, wind speed, boat speed over water and over land. All those types of things can be used to compute a lot of different variables, as well as communication. We run iridium, cellular, and Wi-Fi, and that really is just a function of range.

Our identification locators we have is an AIS. We have both the listen system and a selective broadcast AIS, so we can tell people where we are or not, and we can listen to any AIS-

broadcasting vessel in the area. We also have a MetOcean iBCN iridium beacon, in case everything else goes away. The MetOcean comes on and it tells us that, hey, I'm still here. I might be dead in the water, but I'm still here. Then it goes on and on. Basic data of air temp, pitch and roll, position and heading, surface speed, surface water temperature, and those are all hotel data, and so that's stuff that you're going to get off of the boat all the time.

We have had to play with and develop a unique buoyancy system. I had a submariner, an older submariner, one time take a look at this thing and he said, well, you've just got to think pre-World War II submarine and that's basically what you guys have done here, and that's it.

The sinking a sailboat, you can see where the ballast tanks are. They're both fore and aft. Since this picture was done, we actually now have gone to a single fore tank up here. Instead of the two tanks, we now have a single tank, and that's simply because we don't need two tanks. We found a nice diaphragm tank system that works really well.

We have our own -- This is a patent-pending wing-control system that both raises and lowers and actuates the wing rotation. The main mast of the wing rotates 360 degrees, and the trailing wing, of course, can go to 360 degrees, 180 degrees either way, so that it can fold and fold down into the wing glove. Payloads are right here, on both sides, and there is also another payload back here, in the backend. Then the battery system. Other than that, you're looking at the primary systems on the vessel. There is not a lot of complexity here, and that's another thing that helps us make it successful.

We look at a single platform multifunction. A perfect example is we have a lot of folks that we're talking that run, for example, both a liquid robotics wave glider and a 200-meter Iver UUV, and they may have many of both, and so our concept here was, gee whiz, why not build a system that can do both of those things and then you have a single system. You've got one command structure, you've got one network, you've got one set of common payload requirements, and the vessels actually are swappable. They can run on the surface or below the surface.

This depicts our future Submaran S200 capability, but it gives you the idea here of what we're doing as a product and a product line and where we're going. It's to try to make it easier for both us and the user to operate offshore unmanned systems down to 200 meters and, in our research, and I know you folks know a lot more about ocean research than I do, but, in our research, we have found that about 70 percent of the ocean data-gathering applications happen in the top 200 meters of the ocean. That's where a lot of the interesting species live and that's where a lot of the interesting business goes on. That's where most of the commerce is conducted, and it's where people seem to be very interested about gathering data. Yes, there's a lot of interest about deep-dive data, but we're going to leave that up to the Gavia and the Bluefin and those guys, and so that's where we're going to operate.

The vessels will be very useful in say area surveillance applications. We have equipped these things with hydrophones to listen. We have equipped them with cameras to take pictures, and we have equipped them with intelligence to respond to certain things that are going on around them, and so they make a really nice little patrol vessel out there.

The fact that they can sink and get out of the weather or get out of the way is a plus. It keeps them from being vandalized, stolen, hauled away, carried off by another boat, attacked by Somalis. Any

of those things can be avoided if you are watching the vessels and controlling the vessels and the vessels are doing the right things, and so it's pretty handy.

Detecting surface and subsurface contacts, we can advance toward or contact or communicate the position of that contact, provide visual confirmation, via mast-mounted cameras, and, as I mentioned, submerge to avoid detection.

We have done a lot of work with Teledyne's ADCP systems, current survey. This is just an example. We typically, because it's easy for us to operate it between three and five knots, it allows us to overcome pretty stiff currents ourselves, which is important when you're doing current survey. Because we're wind and solar-powered, we have a long operational timeframe, which is really nice. You can put us in the water, and, even if it takes us two or three days to get to the survey zone, we can still spend a lot of time gathering data and then coming back and providing that data back to you without anybody ever having to go out to launch or retrieve a vessel or anything like that. It's a significant impact with regard to operational costs.

Then, as we move along, we will have more and more submersible operation capability, and so, the more submersible we become, the more useful that it does become, and Teledyne -- When we tested these first ADCPs, we literally strapped them onto the boat with like metal straps and put them out there and tested them and said, hey, these work. They don't quite fit in our payload bay, and Teledyne, being a really creative company, said, you know, if you give us about three or four weeks, we will design the right enclosure that will slip right into your payload bay and then you will have your ADCP that will just snap in and snap out. They said they would do that and they did do that. We just took delivery of the first one, and it's pretty cool, and so that's why it's nice to be able to work close with these sensor partners.

Communications is a huge application for this thing. We can equip a vessel with both hydrophones and acoustic modems, so that we can listen to things that are going on underwater, whatever those things you might be want to be listening to are. There are, as you know, a wide range of hydrophones and acoustic underwater systems that can be tuned to listen to just about anything.

I recently read an article where they are listening to grouper spawn or something with acoustic listening systems on unmanned systems, and I thought, hey, that's pretty cool. We work with a company in Seattle called BioSonics. I don't know if you guys have ever worked with them, but they've got some great sensors for finding fish, tracking fish, telling you what they are, where they are, how many of them there are, how big they are, and all that other kind of stuff. It's a great opportunity there.

Then the other nice thing is this technology, of course, allows you to embed a lot of sensors on the ocean floor, so if you guys ever get into the situation of working with embedded sensors, we can communicate with them. The hydrophones can talk to the embedded sensors, and we have actually done that for various applications or worked with it with like seismic systems and that kind of stuff.

This is inside our building facility in San Diego, and I took that snapshot because it basically just shows you how big the payload bays are, and what we've done with those is we now have an insert that snaps in from the bottom of the boat, and so the payloads are built inside the insert and then

they go in from the bottom of the boat into this space right here, and so, that way, we basically have payload modules, if you will.

We can have them configured with one set of payload and then, if you want to take that set of payload out, you just take the module out and put the other module back in and you're off and going, and so we can design and configure those custom payload modules for the customers, so you don't have to muck with sensors out in the field. Just snap them in and snap them out. This, of course, is one of our launching ramps, which we will show you on the video here in just a minute.

This is a launch vessel. It's basically our launching system. They really are -- It takes about three guys, really, to operate one of these things. We have two twenty-foot trailers, and we can roll two of these into the back of the twenty-foot trailers. They're about eight feet wide, and so we can roll two of them into the back of the trailer. Then, when we're ready to launch them, we just pull them off, pull the out of the trailer. We have a little winch mounted on the trailer that we can hook a safety line to, right here, and then we just let it go and two guys walk it into the water. The thing floats right off of that, and we'll show you a little demonstration of that later.

This also can be used as a launch cradle for a vessel. Basically, it can stand on top of a deck and the Submaran can be picked up just a little bit and then the dolly wheeled out from under. The dolly can be rolled out from under the Submaran and the Submaran then can be hoisted over. It only weighs about 350 pounds, and so a standard low-end davit can pick the boat up and put it into the water from a deck or from a shore launch, and then it can be picked back up and dropped back down on its dolly on the deck and secured and driven away.

We are working with a system now where we're actually going to pick up the whole top part of the dolly and it will separate about right here. We will pick that up with the davit and put it into the water and then just float the Submaran off it. Then when the Submaran comes back to recover it, we will put that top part of the dolly back down into the water, and we have a sensor in the front of the boat that tells it where the dolly is, and it will drive itself right back into the dolly and then you just pick it up, and so that will make it a lot easier, especially for rough water recovery and that type of thing, and hopefully not have to put a man in the water.

I would say for recovery right now, out in the ocean, you would have to put somebody in a RIB and bring this thing up alongside the boat and let the guy in the RIB do the hookup and then bring the boat up, but we're working on that issue too, and so the development process.

We are right now in preproduction, which means we are actually putting out proposals and talking to customers about shipping boats, and we will begin shipping boats in the second half of this year. The vessels are capable of open ocean waypoint navigation, autonomous tack and jibe. They can run straight lines, and so the cross track is only about three meters, and that's by using its hybrid sailing and motoring capabilities, and so it can motor sail on a straight line, pretty much regardless of what the wind or the wave conditions are.

It is autonomous. It does "go to" and "loiter", and I will show you a loiter thing here in a minute, and we have tested it with towed bodies and mast-mounted payloads, and so it's been through a wide range of testing. These are just some operational pictures here. This, you might notice, this setup up here is a camera and anemometer system that we developed, and that was largely because,

number one, we couldn't find anybody who had an anemometer that would go to 200 meters. If you ever come across somebody that needs a submersible anemometer, have them give me a call and I would be happy to sell them those too, but it was -- We developed it ourselves.

Then we also were looking for a camera that would do 360-degree pictures, and we found a few of them on the market, and they were either way too expensive or they were kind of under development and weren't quite ready, and so a couple of our engineers just say we can do that, and so they built their own, and that's now common equipment on the top of the boat.

It does submerge. Unfortunately, I don't have a video of it submerging. I have a video of it coming out of the water, but, the day they were doing it, they didn't do a really good job of videoing it. We're actually have some more stuff done this week, as I speak, but you can see here the wing is folded. It's just sitting out here in the water, and then it starts to submerge. You can see here is the tip of the wing right here. Then, finally, right here, this is just kind of the shadow of the boat and, the next picture, you see nothing, because it's going down to ten meters.

We've done a lot of testing. We are in San Diego, and so we live close to SPAWAR. SPAWAR has a really nice ocean testing tank up at their facility called TRANSDEC. I don't know if any of you have ever been there, but it's a really cool place. It's about thirty to forty feet deep and it's not quite as big as a football field, but about two-thirds of a football field, and that's where we did all of our submergence testing, and it's been really good to have those guys working with us. They're smart guys.

There's a picture of it in the tank. It's really hard to get pictures of these things when they go underwater in the ocean. We don't put divers out there or put people at that kind of risk right now, because it's kind of risky, from an insurance standpoint, but we will, but we did in the tank.

These are the differentiators. It's a hybrid design. It's sail, electric, and buoyancy gliding. It's faster, typically, then most of other competitive unmanned platforms. By that, I mean platforms that scavenge their energy and don't have motors and are about the same size. It does have a high degree of autonomy and ease of deployment, and its submergence capability makes it unique in terms of getting out of the weather or getting out of the way. It gives it some stealth and survivability.

Just a real quick look, you know we developed our own user interface. You can see typically here you are retrieving data that's standard data. It's course over ground, speed over ground, velocity made good, true wind speed, true wind apparent, true wind direction, and then you have a sensor interface down here, where you can click on that and you can actually see the data that the sensors are providing to our system. Some of that data is just captured and then relayed to your system. It just depends on how its configured.

You have mission planning capabilities, so you can tell it, okay, here is your waypoints I want you to hit. What I want you to do is I want you to go out here and mow the grass like this and hit these waypoints and then start over. Then I'm going to give you an out-of-bounds. If you get out here, you're going to start squealing at me and telling me that you're someplace that I don't want you to be, and so we will put you back on course.

Then we'll just keep track of that, and we know who you are. This was a bay sonar scan application, where we were just developing some sonar scanning things. What we're doing is we're building patterns so that you can, for example, define a beginning waypoint and an ending waypoint and then pick a pattern and decide how far apart you want those waypoints to be, so you don't have to go in and put every waypoint in. We are making the configuration as simple as we possibly can and give you the ability to go out there and run a course.

This was an actual active mission course. We put the boats out here and tell them, okay, what we want you to do is run this pattern for two days or something like that, and don't ever deviate from this pattern. They will go out there and run this pattern, and this is what we call a loiter pattern. It's just kind of a little butterfly, where the boat runs out and he goes through this waypoint and turns around and comes back, and this distance right here can be anywhere from a hundred meters to a thousand miles.

It doesn't really matter, and so if you want this guy to loiter in -- I think this is a 1.5, from here to here, mile course, and so you can imagine if you're patrolling and you just want him to do this. He's never going to really get out of his listening sensor or viewing sensor range, from one end to the other, and so he's pretty well covering a pretty big piece of territory here at all times, and so it's kind of nice.

Here's an example of a days' worth of this kind of sailing, and so you can see how closely repetitive it is. It stays where you tell it to stay. Now, this is over an all-day or twelve-hour period, and we don't determine what the wind, the current, the weather, or anything like that is when we put these things out there. We just tell them to go out there and stay on this course, and so there was variable weather on these days that we test these things, and so the results are really good in terms of their consistency. I just have a quick video that I want to run for you and then we will have a couple of questions, I guess, if you have them, and I will be here the afternoon and evening, if you want to chat.

MR. HAYMANS: We are pretty much at time, but we would love to see the video.

MR. CHILDRESS: It only takes about a minute. I will just let it run and we will be done.

MR. HAYMANS: Wilson, if you have one right now, go ahead, while he's getting it --

DR. LANEY: You knew this one was coming. How much does one of these things cost? I realize it will vary depending on the payload, but, generally speaking, what's the range?

MR. CHILDRESS: The base system cost is about $325,000 for the surface to ten-meter vessel. We also will provide a system as a service, where we actually will operate the boat on a daily rate for you and just give you your data. We usually like to contract that for about a month at a time, or we also have lease packages, especially some new ones for research and academic institutions, that are really affordable. You can lease one of these things for about $120,000 a year.

These are just a few clips of the boat operating. This is kind of a typical day right here. I think we were having about eighteen to twenty-knot winds and some chop when these particular pictures were taken, and we were sailing pretty gracefully, at around six to seven knots, all the time. The

boats maintain a really nice course. This, I believe, is South San Diego Bay or somewhere in that area, heading out toward Point Loma.

MR. HAYMANS: I will ask, while its running there, so the avoidance capability. If it takes eight minutes to submerge, that's not a real quick avoidance.

MR. CHILDRESS: No, it's not a real quick avoidance, but it knows if something is coming from anywhere. If it's listening for other vessels and it's submerging to avoid, it knows that they're there anywhere from two to five kilometers away.

MR. HAYMANS: So a power boat, I mean it's running near shore and you've got a power boat out there that's clipping along at thirty knots --

MR. CHILDRESS: He would be really lucky to see it, even it was only halfway submerged.

MR. HAYMANS: That's the point. He probably won't see it.

MR. CHILDRESS: No, and, in fact, once the wing goes down on these things, we chase them around all the time out in the ocean, and our guys sometimes have to get within a couple hundred meters, if the wing is down on the boat and the boat is just adrift, before they can even spot it. They're relying completely on GPS to tell them where it is. Once it's gone, it's gone, and that was a little clip of it towing these really radical tow fish. I call them bass lures, but they were made to generate drag, so that we could tell how big a towing body that we could tow on them, and they can tow a pretty good range.

DR. LANEY: That prompts me to ask, because I saw it on television, but have you configured the hull so that it's resistant to gnawing by a great white shark, for example?

MR. CHILDRESS: A great white shark would do us in. It's a highly-reinforced, impregnated fiberglass structure, and so you can literally hit it with a sledgehammer and not break it. Now, I don't know. We haven't been hit by a shark yet, but it will happen. I think smaller sharks probably wouldn't have much of a chance with us, but if you got hit by a big one, it could hurt it.

MR. HAYMANS: Thank you, Ken.

MR. CHILDRESS: Thank you, all, very much.

MR. HAYMANS: That was a very informative presentation. I think that's a sense of what the rest of the day is probably going to be like. Ken is going to be around. If you have questions, please catch up with him. Next is --

MR. PUGLIESE: We had a change. Teledyne, we've been collaborating with them for a while to pin down exactly who is going to be doing the presentation. It went just about every level of corporate headquarters to figure out the appropriate person, and they brought somebody in local here, and I will let John introduce himself.

MR. HAYMANS: We are talking autonomous 3D mapping.

MR. PUGLIESE: Just a quick note. As related to how I talked about some of the collaboration and opportunities, at the last Oceans 2015, what really jumped out was seeing some of the newest advances in everything from the small, deployable multibeam capabilities to literally unmanned capabilities that you could place on vessels as well as the real advancements on 3D mapping capabilities and the processing of the water column, fish distribution, et cetera. With that, I will hand it to you.

MR. ROBERTSON: Thank you, Roger. My name is Jon Robertson. I work for the Teledyne Marine Division of Teledyne Technologies. I've been with the company for just over seven years now, and I have been focused on the blue view product line, mainly, but I have been broadened to work on some more of the underwater acoustic imaging tools that we manufacture, and so I want to give you a brief overview on the company, Teledyne Technologies, and then kind of go into the acoustic imaging side and show you some of the new features that we have and a little bit of the data deliverables that we can provide from our equipment.

Teledyne Technologies is a very large corporation. It's about a $2.5 billion a year corporation. It's focused on many different areas and different markets, like aerospace, defense, geophysical, and, what we're going to be talking about, the marine division. The marine division is about between a $500 and $600 million a year business unit, and we like to show these different extreme environments that we operate in, because it really shows how Teledyne has a corporation is very focused on reliability and very good, strong product lines, and we do very many different types of testing for these different environments.

We have navigation and imaging systems on the Curiosity Rover on Mars, as well as the Doppler velocity log systems on the Nereus vehicle that has gone down to the bottom of the Mariana Trench as well. Again, they're very different extreme environments, and our equipment has been tested and put through the paces, and so we have very reliable systems.

Focusing on the Teledyne Marine side, we have twenty-three individual brands, separate brands, that are broken up into five different sectors. Interconnect focuses on cables and connectors, dry mateable connectors and also wet mateable connectors for subsea equipment. The majority of offshore oil and gas infrastructure has our wet mateable connectors for controlling different valve systems and things like that.

Teledyne Instrumentation manufactures different types of acoustic instruments, such as CDL, Doppler velocity logs, acoustic releases, motion reference systems, things like. Seismic is focused on manufacturing acoustic geophysical instrumentation, and Teledyne Vehicles, we have a broad range of different deployment vehicles for the different type of sensors that we manufacture, such as the AUVs, surface vessels, remotely-operated vehicles, and things like that, and so we like to call the vehicle side the deployment platforms for all of our different types of sensors that we put on these vehicles.

What we'll be focusing on today is the Imaging group, which manufactures different types of underwater imaging tools, from two-dimensional imaging, real-time imaging sensors, to different types of 3D products as well. I've got a brief video that kind of introduces -- The sound is not going to work, but that's okay.

I will just go through the intro portion of this. The acoustic imaging group is comprised of five companies. Four of them are sonar manufacturers and one is a software manufacturer. I will just go through a little bit of this, because the sound is not working well, but this is an example of a multibeam echosounder on a remotely-operated vehicle doing pipeline inspection, collecting 3D bathymetric data, and autonomous AUVs using the forward-looking imaging sonar for navigation and obstacle avoidance.

These are manned surface vessels or unmanned surface vessels collecting data for hydrographic surveys and bottom imaging, seafloor mapping, and also lots of port and harbor inspections. A lot of civil engineering applications with our 3D products, looking for scour and undermining of different infrastructure around bridges and pier walls and things like that. I am just going to go ahead and move on.

As I mentioned, we have four different brands that manufacture acoustic imaging devices, multibeam echosounders, single-beam echosounders, real-time, forward-looking imaging sonar for navigation, 3C mechanical scanning sonar systems, and Teledyne PDS is a manufacturer of data collection software for all of these different types of sonar systems. It's a very customizable program that, for specific applications, such as dredging or navigation, things like that, you can have specific, customizable packages put together for your specific application.

Again, many of the products we manufacture can be deployed a plethora of deployment platforms. A lot of the autonomous vehicles these days are using our forward-looking imaging sonar for navigating around obstacles and avoiding targets that they're driving up to, so they don't run into anything. Then our multibeam echosounders and profiling sonars are used for seabed mapping and things like that. There is a few companies that manufacture diver handheld units that are battery powered and use them for navigation as well.

To focus in on kind of what you guys' applications are for seabed imaging, we use the multibeam echosounders for collecting bathymetry sonar, which is basically a three-dimensional point cloud of an area. We have different types of systems for the different depth ratings, shallow-water multibeam echosounders and deepwater multibeam echosounders. For very deep water, we have systems -- Teledyne Atlas manufacturers a system that will go to a full ocean depth and be able to image the bottom of the Mariana Trench.

The multibeam user interface is -- This is the display, and so you get a real-time image of your 3D point cloud as well as a waterfall history image of the backscatter information. These are the kind of the two things that we're going to focus on today, is different advantages of these two datasets that the Teledyne software team and equipment engineering team has made some late advancements in these two data collections.

This is the user interface. Down at the bottom left-hand side here, we have our sonar controls. This is your range settings and your pulse width and the amplitude or power of the source level we're putting into the water, and our gain controls.

Water column data is all the information from the sonar all the way down to the seabed, and we have very good algorithms for bottom detection, and we get very nice, clean data on the seabed, but, a lot of times, there is information in the water column that we want to utilize, such as structures or fish or things like that.

The challenge with collecting and recording water column data is the sheer volume of data, of space, that it takes to collect the whole dataset, and so we've come up with a couple of ways to reduce that amount of data that is recorded. We call it compressed water column data. It's basically user configurable on what specific data in the water column you want to collect, so we can reduce the amount of volume of data that is recorded, based on your specific requirements, instead of recording all the acoustic information in the entire water column.

One of the things that we do with the water column data is we take the -- Here's an example of the multibeam echosounder and a single beam from the multibeam echosounder sending out a signal and hitting the seabed. We call the point that is the most intense return, that's our primary detection, and so we have our primary detection and then, if we use the water column data to do a multiple detection, we can select a point along the same beam, and a second, third, or fourth location, based on the information that's along that beam.

That gives us the advantage of utilizing that information. I've got a few examples I will show in a minute, but another way we use that water column and multidetect feature is by changing the way we select points in complex areas, and so this is an image of the seabed here, and then we have a piling or a pier wall or something like that, that structure. What we want to happen is the signal to go out and hit the target and return. Then we get our primary detection in that location where we want the point to be selected.

In some complex environments, we send out a signal and it is bounced around and it creates a detection to be selected in the wrong location, and we call that multipath detection, and it introduces gaps or multipath points to be selected in the incorrect areas, and so, by utilizing that multidetect feature, we can do a software filter to only select the first detection or first return of that area. Instead of having the data come back with holes in it, we get a nice, clean dataset. Here's an example of data collection without multidetect on and then also first return multidetect on, and so you can see how the data is a lot more full and usable for the area that you want to be imaging.

Another way we can use the multidetect feature is to image things in the water column. This is an example of natural gas naturally seeping out of the seabed. If we were just using the primary detection algorithms, we would just get a nice flat, three-dimensional image of the seabed, but, by turning on the multidetect function, we get what looks like weeds growing in the water there from the bubbles seeping from the seabed.

A few other things is we have multidetect on with fish in the water. Here, you can see, on the right-hand side, is with multidetect off. On the left-hand side, it's with multidetect on. Fish are actually very good acoustic return objects, because of their swim bladder, and they -- You can see, on the right-hand side, the fish are actually the primary detection. They are selecting the points there because they're actually more acoustically -- They're giving a bigger signal return from the fish than the seabed, and so the fish are the primary return. Then, on the left-hand side, is with multidetect on, and so we're getting a good image of the seabed and the fish.

I know we don't have a whole lot of kelp in our area here, but this is another good example of mapping an environment based on the water column information we're seeing from the multibeam echosounder. Again, these are all three-dimensional images. The bathymetry data is a three-

dimensional image, and so you can go in and take measurements, volume calculations, and things like that.

This is a data example of the recent oil spill, I guess a few years ago, in the Gulf of Mexico. There was submerged oil patches floating around. Not necessarily floating, but it was neutrally buoyant from all the chemicals they were pouring into the oil as it was coming out of the well, and so it was kind of just floating around right above the surface, and they were able to map out where those were floating to and kind of get an idea of where it was going.

I like to use this one. This is just an interesting image of a submerged tree that we found in a lake. Without the multidetect feature, it would just be very sparse and it wouldn't see all the branches as well as we do here.

Another feature that has had some advancement with the Teledyne multibeam echosounders is the utilization of backscatter information. With traditional backscatter, it's very sensitive to sonar settings. As I was showing you before in the user interface, you have your gain, pulse width, and your source level power settings. By changing those, you are changing the way the sonar is actually sending the signal out into the water, and traditional backscatter is very sensitive to those changes.

We have come up with a way, based on a very high level of manufacturing tolerances and after-manufacturing testing, to -- We know, very precisely, how those changes in those settings are affecting our sonar, and we can add -- Basically, we compensate for those changes very well in our system, so that after, post processing the data, you don't have to do any adjustments for changes in those settings afterwards. We call that normalization in our system. It was specifically designed for seabed classification.

The way, as I mentioned, in traditional backscatter data, when you change the power of the source level going into the water, the backscatter information comes out differently than it does without the normalization. What that does is it introduces artefacts, whether it's in the line up of the multiple passes or in the same -- This area could be the same seabed composition as the area next to it, but we're getting a different type of return based on the different sonar settings, and so we compensate for that.

Also, the nadir artefacts, we get a very intense return from the center, but now we can compensate for those changes. I have kind of already spoke on those items here, but normalized backscatter, we get multiple -- We get the bathymetry information, the three-dimensional point cloud, bathymetry information from the survey, as well as the backscatter strength. This is a dataset with normalization introduced, so we don't get that artefact of the nadir in the center, as well as a very good correlation between different track lines along the survey as well.

Then, based on that backscatter information, we can do a seabed classification, and it's basically changing the -- This is just an image display classification, based on the intensity of the returns themselves, so we can decide whether it's soft sediment or muddy seabed or if it's hard material, based on the intensity of the return that we're getting from the seabed, and so that's how the backscatter information is utilized.

I will see if this will play, but I might have to -- I wanted to show a couple of videos of 2D forward-looking imaging sonar with some fish in it, since we're at a fisheries council. This is a video example of a 2D forward-looking imaging sonar that is mounted on an ROV. We're getting some acoustic noise here from other acoustic devices in the water with the sonar, but you have about a thirty-five-meter range imaging an offshore oil rig there. Then, in the foreground, you can see there's lots of fish swimming around.

This is just a video of this data recording. If you were able to play this back in the control software, you can do a stop, pause, play, and fast-forward, just like you would in the video, but you can zoom in and take point-to-point measurements and take snapshots and different things like that, to be able to maybe try and characterize what type of fish they are or take a snapshot and count how many fish are in that individual acoustic ping as well.

Then I've got another video here. This was data collected off of a boat with a 2D sonar mounted on a pole. This was actually in Tampa, Florida, right on the Intracoastal Way, underneath a bridge actually, and so we had these -- You can see the pilings here of the bridge. Then I was reviewing the data the next day, and actually saw -- I think it was a school of tarpon that were just kind of hanging out below the bridge there. As I mentioned, you can stop and pause it and record a dataset and take measurements of different areas and targets of interest. That's all of my presentation. If you have any questions --

MR. HAYMANS: We have about five minutes for questions, and I will first, real quick, apologize to the committee. My calculations were off a little bit. If we give every presenter thirty minutes, we're going to run right until the six o'clock line, and so I'm not going to take a break, and so get up when you need to, but I want to make sure we give all the presenters the time that they are allowed. Go ahead, Michelle.

DR. DUVAL: Thank you, Mr. Chairman. I am not on your committee, but you did say that could zoom in and take point-to-point measurements, and so you could actually measure the size of fish, presumably?

MR. ROBERTSON: That is correct, yes. In the last video --

DR. DUVAL: I'm not used to looking at stuff like this, and so it's sort of hard to telling the pilings.

MR. ROBERTSON: What you're looking at is a -- This is a forward-looking imaging sonar, and so the array is pointed in front of a vehicle or a boat, whatever the deployment platform is. We have 130 degrees wide, and the image you're seeing is a top-down areal view, and so it's kind of hard to see up on the video here, but, as you zoom in, you can see there's a target here, and that is a fish. You can select the measurement tool up here and click in two spots and this one is a -- That's a two-meter-long fish, and you can change it to feet as well.

MR. HAYMANS: That's pretty easy on a six-foot tarpon, but when you're looking at multiple grouper or snapper species, it's pretty tough to distinguish between them.

MR. ROBERTSON: Yes, it is. The resolution is -- This is from a 900-kilohertz sonar. We do have a 2.25-megahertz sonar as well that we have done some -- It is higher resolution, and you can do some, I guess, better classification of what a fish species would be, and a lot of people use it.

They know the characteristics of how different fish swim and interact in their environment, and so that's one way, but you can't visually say, okay, that's a red snapper and that's a mangrove snapper, really. That is a challenge.

MR. PUGLIESE: One of the reasons we wanted to look at some of these things is they're advancing so fast. I think the real interesting thing, while that jumped out at me, is some of the newest, cutting-edge areas that Teledyne is investing even more, in terms of processing, because, as we were discussing having this type of review, they purchased CARIS, which is one of the biggest processing -- So they're even going further, and so some of the questions we're having now, hopefully some of those can be in structuring the way and tailoring some of those outputs or the capabilities. Some of these types of things, I think, are actually realistic to think that we could begin to see the capabilities built into the newer systems.

MR. ROBERTSON: That is very true. We do a lot of engineering towards specific applications. Like you said, CARIS is a very good processing software, and they have very customized solutions as well, and so we do custom kind of software packages for specific applications very often.

MR. HAYMANS: Imagine putting this technology on one of the submersibles we saw and sending it to one of our special management zones during what we think is the spawning event and actually capture it. Will Heyman will be out of a job.

MR. ROBERTSON: Yes, and you can do kind of a fixed-position monitoring system. I can't tell you the details on it, because it's for a specific customer, but you can develop a package that's basically battery powered. It has a small processor onboard and it's deployed into a specific location with the 2D imaging sonar and have it ping maybe ten pings every hour, to kind of get an idea of what's going on in that environment, kind of a fixed monitoring position system to just get updates on what's going on in those areas.

MR. HAYMANS: Michelle, last question.

DR. DUVAL: Thank you, Mr. Chairman. My question was going to be similar to Wilson's. How much do these technologies cost that would allow you to do something like what Doug was saying, to do specific fish measurement?

MR. ROBERTSON: The 2D forward-looking imaging sonar you saw, it depends on the model and the depth rating and things like that, but anywhere from $25,000 to about $45,000. We make quite a few different frequencies and depth ratings. There are a few companies that do rentals of our equipment, but we don't do any leasing directly.

MR. HAYMANS: The secret is find the Homeland Security tie-in. Thank you very much. That was very informative, and I appreciate it. We look forward to maybe some future work with you.

MR. ROBERTSON: Yes, thank you. I appreciate the time and definitely, yes.

MR. HAYMANS: Next is going to be ROV Advancements and Acoustics and Dr. Cherubin. Again, I do apologize for not taking a break. Just go when you have to.

DR. CHERUBIN: Hello, everyone, and thank you for having me today with you here. I am an Associate Professor at the Harbor Branch Oceanographic Institute, which is part of Florida Atlantic University, which is also the host of the Cooperative Institute for Ocean Exploration and Technology, which is basically supported by NOAA, and so we do a lot of advanced development and research on new sensors for applications to fisheries, but also for the Department of Energy and for other -- You can imagine the Navy applications.

I am the presenter today, and my contributor is Fraser Dalgleish, who leads the engineering team who contributes to the development of those sensors, and I am going to show you a few of the applications that we've been working on.

Basically, to take an approach that makes sense and appeals to everyone, I am going to talk to you about the ROV and AUV surveys of the deepwater reef ecosystems at the edge of the West Florida Shelf, the Southwest Florida Shelf, which is basically in the Pulley Ridge area, where they have the new HAPC.

I guess you know some of the names here. The mission scientists are John Reed, Fraser Dalgleish, Sherry Pomponi, who is the Director of the Cooperative Institute, and Stephanie Farrington, who has designed a lot of the classification software for the images for all the organisms that were captured through the cameras.

The major goal of this mission, which is the Pulley Ridge Connectivity Project, is to characterize the mesophotic and deepwater reef ecosystems across a variety of habitat along the edge of the Florida Shelf, and so it's not only Pulley Ridge, per se, in and of itself, but it's also what's north, east, west, and south of Pulley Ridge, and there is a lot of variation in the habitat. The depth of operation for all the systems that we've been deploying is between seventy and 200 meters, and so it's fairly deep compared to the usual shallow habitat that you can find on the shelf.

The approach is to use both the ROV, here the Mohawk, and I'm going to go over the capabilities in what follows, and also the AUV, the Bluefin 12, that I'm going to describe here and characterize several of the capabilities that were presented earlier. We used both the ROV and the AUV to characterize the sonar images that are captured through the AUV with videos and still images of the benthic communities that are captured with the ROV itself, the Mohawk.

Basically, what happens during the mission is that we first send the AUV out to map the bottom, the benthic habitat basically, and to create basically a navigation map for the ROV to use during its mission. That's the Bluefin 12. You can see it's pretty big. It's about twenty feet long. It's a pretty big ROV, and you can see on the side here that the payload on this AUV is the side-scan sonar, and that's what is used to map the bottom. This Bluefin 12 is built and designed by Bluefin Robotics.

I am going to go over the specs of this AUV. There is basically a tail section, a battery section, and a payload section. All of the sections are free-flooded. The tail section contains the main electronic housing, the radio antenna for surface communication, and the acoustic model for underwater communication, and so the great thing about this system is that you know, in real time, where your ROV is and you can actually, just like for the surface AUV, you can actually pilot it on the course that it will follow, using this acoustic communication system. The AUV is actually

positioned and tracked using a pole-mounted acoustic communication system, based on the Sonardyne AvTrak system. Maybe some of you know this tracking system.

We can add up to three 1,500 kilowatt hour lithium ion batteries with an operation time of about less than twenty hours. In the payload section, we have a high-resolution side-scan sonar. Now we are not looking at multibeam, but side-scan sonar, and also a downward-facing HD camera, and so basically it's to overlap images of the habitat with sonar images. Those sonar images are used to generate GeoTIFF charts for ROV navigations.

That is the sonar, which is made by Solstice. I gave here the link to a web article about the description of the capabilities of this sonar. I won't go into the details here, but, basically, it's a portable system that you can put on an AUV. The resolution is about 2.5-by-2.5 centimeters. The range is about 100 meters on each side of the AUV, for a coverage of about 1.6 square kilometers, and for about a six to eight-hour mission. In six to eight hours, you can coverage about 1.5 square kilometers square of area.

The sonar provides both sonar images, and so basically a 3D map of the seafloor with bathymetry data. To get the height from the seafloor, it uses a LIDAR, and it hovers about eight meters above the bottom and also has an HD camera with a timeframe of ten images per second.

This is the kind of images that you get at about a 2.5-centimeter resolution. This is on the West Florida Shelf, and you can see here numerous holes, and these holes are actually red grouper burrows. If you zoom down on one of those holes, you can actually find the ones that have fish nearby, by zooming on the hole, as you can see the shadow of the fish, the acoustic shadow of the fish.

This is another image that shows actually a bunch of boulders laid out on the shelf, and you get a very good idea of the relief of the bottom and the structure of the different habitats basically that are composing that bottom, and then you can use Fledermaus software to recreate this 3D image of the bottom with the boulders, and we have overlaid here actually the track of the ROV around this habitat and around those boulders, and so that's how you can pilot your ROV based on those 3D maps that you get with the AUV.

Then also you can get some bathymetric maps, like the one here. As you can see, there are some issues, especially on the edges, because of multipath and also changes in the sound speed the further away you go from the system, and so you get some deformation at the edges of the swath, basically.

With the HD camera, you can really capture what is below the AUV, and so you can see here -- I wouldn't say it's a red grouper. It's probably another type of grouper, but you can definitely recognize the lionfish that are actually invading those red grouper burrows more and more.

Like any system, there are some limitations. As the one you saw here, there are some issues with the edges of the sonar maps. While the AUV is in the water, there is no real-time video analysis like we have with the ROV, but you can imagine that would be feasible, now that we can locate and communicate with the AUV in real time, and also there is no habitat characterized based on the automated image overlay on sonar data, and so that would be basically the icing on the cake.

You would get your sonar images in 3D and then you can overlay the space, just like you do with your iPhone basically, those images taken by the cameras and video cameras, on the sonar maps.

That's why we use the Mohawk. The Mohawk will come and actually take those still images and footages, basically, of the habitat and the different marine organisms in those habitats, and so, instead of the habitat characterization with videos and images during the mission, they were conducted with the Mohawk, based on navigation charts provided by the Bluefin 12 AUV. The Mohawk is also equipped with a tool skid and a manipulator arm for biological sampling, so you can actually check what you see and grab some samples from the bottom. That's the approach that has been taken, where you use both the sonar and then the video and the still images to provide a complete description of the habitat that you are surveying.

What are our future developments? You can easily imagine that it would be nice to maybe be able to integrate both, so both the sonar and both the cameras and overlay both information in one system, to be able to get a direct understanding and knowledge of the habitat that you are surveying.

I am going to talk a little bit about the new generation of side-scan sonar on AUVs and UUVs, and you can see here, in this image, it shows how the sonars are now installed into these AUVs, and it's about the same approach that was taken on the Bluefin 12 AUV. Basically, a few companies starting making those side-scan sonars that are small enough to be able to be carried by an AUV or a UUV, and I cited here those two companies, the Klein Marine System and the Edgetech 6205. If you go on the websites that I listed here, they have actually developed UUV and AUV-compatible side-scan sonar that provide resolution up to a few centimeters, even to the millimeters for, I think, the Klein Marine System. Then you can overlay on that the bathymetric information, so that you can get both relief and bathymetry.

Future developments is now we collect those images, and how do we advance our classification of the huge amount of information that is being streamed from the system, and so I am showing here some very recent developments that we've been able to achieve, thanks to some funding from the DOD and the DOE, where we actually use, instead of the classical video imaging systems, laser systems, and so LIDAR basically, to observe animals in their environment in almost any type of light conditions. It could be at night, but it could be also in reduced visibility, due to turbidity in the water column, and so that's why you have those turbidity levels, from top to bottom, where the turbidity is increased.

On the left column, you see the raw data here from the fish. It's called a Fish Identification LIDAR System, and then the process data from this LIDAR system, and it has a level of recognition that can allow you to identify species, and so we're working on developing methods to do this classification in actually real time. That classification would allow you to actually get an estimate of abundance, relative abundance, of the different species around the system in the water column.

The type of question we are asking right now, that we are trying to work our way to answer, is can we operate video and still images from transects on sonar maps, how can we do that maybe in a processing manner or in real-time? Can we develop classifiers for marine organisms and habitat types, based on either still video, but also LIDAR technology? Can we build 3D maps of both habitats and marine life? Probably we could use some help from the marine people to be able to do that. Then can LIDAR imaging replace conventional videos and photos?

I think that's what we are aiming for, and you can see here that we started getting into the classification algorithms and then we have applied it to, for instance, dolphin. You can imagine you need a library that shows the animals in different positions in space, but also in size, and so we have been working on a few specific cases, like dolphin, mammals, fish, and turtles.

In terms of the AUVs and UUVs, what are the future? Some companies, like Riptide, have come up with very small-sized AUVs and UUVs that can also be equipped with, if you can imagine, a side-scan sonar that you can deploy together to conduct comprehensive surveys of huge areas, basically. Now, instead of having one AUV, you can actually do adaptive sampling and strategic sampling to cover a larger area with multiple coordinated AUVs. That's one approach.

The other approach is to think about -- To take the Bluefin 12 AUV and the Mohawk ROV and then bring them together into a hybrid AUV/ROV, and Bluefin has come up with one of those systems, which is the Bluefin U-4000. We were supposed to test that system during one of the Pulley Ridge cruises, but we had some issues with the technology, as always happens, and so we had to delay, and we haven't been able to test it yet.

You can imagine these different systems being applied to conduct adaptive coordinated sampling for composite overlapping surveys encompassing large areas. Also using LIDAR or video habitat images in real time by using post-classification and image rendering to create these overlays of actual real images for real-time classification, based on a 3D sonar map of the bottom. Basically, you can image the concept of the iUUV, to be able to, just from your iPhone, explore the ocean.

I will leave it open here, and I just want to add one more thing. It was mentioned earlier about the grouper tracking with acoustics project. I am actually the VPI on this project, and we're using a wave glider with an algorithm that enables you to detect and classify grouper sound in real time. We are exploring the shelf edge during spawning aggregations. For now, we are going to classify red hind, yellowfin grouper, black grouper, Nassau grouper, and we are getting now into goliath grouper and red grouper, with some data that Devin Mann, formerly at USF, gave us to work on. I will stop here for today.

MR. HAYMANS: So you're saying you can detect that those animals are present based on their sound.

DR. CHERUBIN: Yes.

MR. HAYMANS: But, as of right now, you wouldn't be able to detect the numbers of those animals.

DR. CHERUBIN: It's something we're working on. We're developing a software. It's something that already exists, but just applying it to fisheries, where you can actually position in space each vocalization. If the fish are not moving too much, we actually can track the sound and know, in space and time, where the vocalization is coming from and then get an idea of how many fish in the water by overlapping all those vocalizations.

MR. HAYMANS: We wanted to count fish. I guess there's a way. Are there questions? We have just a couple of minutes. Are there questions? I think there are no questions, only because everybody is blown away. Wilson.

DR. LANEY: I will try and ask one. Laurent, you said you have got the acoustic signatures for a number of different species of grouper. Do you have any sense for what I guess you would call it the acoustic library would be for different species now? Are there efforts to -- I know like you can go to the Cornell site for birds and you can listen to or download the acoustic signatures of all the birds. Is anybody working on that same kind of a library for fish?

DR. CHERUBIN: Carrie Wall at NOAA, who is in charge of all the acoustic data, we are actually working with her and maybe putting a proposal together to try to establish a library of those species, for the sound made by those species.

MR. PUGLIESE: I guess, related to that, Laurent also serves on our Habitat and Ecosystem Advisory Panel, specifically for some of this transfer of technology and capabilities and the ability to look at different things. One of the things with Ecospecies is we had talked about possibly building some of those capabilities in there, and so hopefully, with this continued dialogue between all of these different efforts, that type of a capability will come to bear, and we can hopefully transfer some of those technologies you're using at Pulley Ridge to connectivity and research on the Atlantic and some of these newest cutting-edge systems, which is really the newest stuff that I've seen.

DR. LANEY: A follow-up. Do they make distinctively different sounds during spawning, so you can definitely say, yes, this one is spawning versus that one over there is not?

DR. CHERUBIN: No, but it's more like if we go to the aggregation that we know they are spawning. We can actually identify which species are actually on the aggregation, and some of the aggregations in the Virgin Islands, you're going to find the yellowfin gets joined by the Nassau right now, and so you can distinguish between the two species, and some other aggregations in Puerto Rico, you're going to have the black groupers coming around or sometimes the tiger grouper, and so you can distinguish between them, and you can also use the sound to search for those aggregations. If they exist, the fish will be making those vocalizations, and you can identify the aggregations, and so that's a new tool that we actually propose to search for new aggregations that fishermen don't want to disclose, for instance.

MR. HAYMANS: Okay. Last question from Jack.

MR. COX: I was just curious how far the range is on listening.

DR. CHERUBIN: We have worked with some of the divers on those aggregations. The depth is about between 130 and 150 feet, and you can hear them sometimes at the surface, and so you get easily a seventy-meter range, I would say from the fish.

MR. HAYMANS: Okay. I mean I see the obvious application to the listening is parking a station in the middle of the spawning area and letting it listen. I mean that's pretty unobtrusive to the fish. You're not running something back and forth through them, but, if you park a listening station there, that's -- Thank you very much.

DR. CHERUBIN: My pleasure.

MR. HAYMANS: Next, we're going to have a presentation on Unmanned Aircraft Systems as Tools in the Ocean by Dr. Patrick Halpin from Duke.

DR. HALPIN: All right. How are we doing? Is everybody still hanging in there? Okay. Let's see if we can make this a little more interactive. I'm going to talk about unmanned aircraft systems. Roger asked me to do this a few months ago, and it's an area that I've just been breaking into and, at Duke, we just set up a drone lab, and one of my colleagues, Dave Johnston, is actually directing that.

Maybe just a little introduction here, but Dave has set up what's called the Unoccupied Systems Facility at the Duke University Marine Lab, and he is dealing with aerial drones, but we also deal with many other technologies, many of the ones you've already just heard about, and so we're going to focus right now on the aerial systems.

I run the Marine Geospatial Ecology Lab at Duke, which deals more with the analysis part, and so we're kind of joining our forces now to look at analytical capabilities and how we can use new and emerging technologies to help improve our modeling and ecosystem modeling capabilities. I have also been a long-time member of the Habitat Protection and Ecosystem-Based Management Advisory Panel, and so there's a direct link, when I do end up showing up at the meetings, and so we're really interested to see how we can bring these tools to bear in the Southeast Region.

Really, the goal is try to combine these two labs together, looking at new technologies and looking at the analytical capabilities. What I would like to come away from this afternoon is to get some better ideas on priorities for using unoccupied vehicles for data collection and analysis, specifically for fisheries management. We have a lot of different kinds of coastal and marine applications emerging, but, right now, we really haven't gotten too deep into the fisheries side, and so I think it would be really interesting to get people's ideas of what they think are new applications and priorities.

There's lots of stuff to do. I mean there is many, many different issues in the coastal and marine environment, like habitat degradation, sea level rise, harmful algal blooms, endangered species, marine debris, fisheries declines, illegal fishing, and that list could go on and on and on. We are finding that there's lots of new technologies now that are letting us approach these topics in a more detailed way that we didn't think was possible even five or ten years ago.

I deal a lot with remote sensing, and at different scales, and so the diagrams here, and I am sure you can't read the fine text up there, and so I will let you know what it means, but just look at the pictures. At the very highest level are satellite remote sensing platforms, and satellite remote sensing platforms are really wonderful for a lot of data collection. You get large area coverage, often global coverage. They give us continuous, contiguous records of information. There's a lot of information that we rely on in ocean analysis and marine analysis from satellite imagers.

It's kind of hard for somebody at fisheries council to think that, yes, we're going to go and pop up a new satellite for you guys. I am actually on the National Academy of Sciences panel that's planning the next ten years of satellite imagers for NASA, and so if you all have ideas, let me know, because I can slip those in, but these are huge, multimillion-dollar missions, and they kind of work on a very long timescale.

The next one down are aircraft, and setting up a project to bring aircraft onboard to do observations is doable, but it can be fairly expensive and sometimes dangerous, and so it has its own limitations. The third level down there are drones, and drones are something that -- I actually worked in a drone lab in the 1970s, and so they started out many, many years ago, but now drones are things that you can actually buy at the local hobby shop, and so the affordability of this technology is really, really changing.

Then below that we have looking at detailed surveying, and so GPS surveys and kinetic surveys and things like that, and so really four different scales. I am going to focus on that second-from-the-bottom, that drone scale.

A few things. In our lab groups, we do a lot of work in coastal habitats, and getting aircraft to survey habitats can be pretty expensive and dangerous. One of the just facts I have there is that, between 1937 and 2003, 66 percent of the deaths for wildlife biologists were from accidents with aircraft, and so it is something that actually people don't think about, but it's a big liability when you're trying to do low flights over coastal environments. Also, we have been doing some surveys in Canada, and we found that we were able to do the same surveys with drones for 20 percent of the cost of fixed aircraft, and so that's some pretty big price differences.

We held a meeting last year, and so this is pretty emerging stuff. We held a meeting at Duke looking at coastal and marine applications of drones, and this is just some outcomes from that meeting, and I have a summary document that, if anyone wants, we can post a PDF file that describes that, but we got a really good representation of the academic communities, commercial companies, federal and state agencies, and a lot of interest. This is an area that people are really interested in exploring.

The new facility we have set up is at the Duke Marine Lab in Beaufort, and so it's in your region. It's a research facility, but also a teaching facility, and so one of the points I'm going to make is that this is actually training center for these kinds of applications, and so it literally got kicked off last year, and so it's barely a year old. The Duke Marine Lab touches into lots of different aspects of formal education, marine research, community outreach, and a lot of platform and sensor testing. We have links into our engineering school and other groups, so that we're able to do a lot of R&D on our own.

The kinds of platforms we're looking at here are a bit different than the things you've heard about. I actually do a lot of work with other kinds of underwater platforms, but, today, like I said, we're going to focus on the aerial ones, and these deal with fixed-wing and multiplatform, and so these are just a couple of examples.

This is looking a multirotor examples, and some of these can range in price from things that you could kind of get at the hobby store for a few hundred dollars up to $50,000, but still, compared to things that cost $3 million or $5 million, they're actually fairly cheap. These things are under development all the time, and so when Dave was sending me the list of here is what he is currently using, by next week that might be different. I mean this is a really, really rapidly changing field. For the fixed-wings, this is one example here, a senseFly eBee. It's a fixed-wing platform that can over a lot of area, and so there is different tools for different kinds of jobs.

There is a lot of different kinds of applications. The coastal applications, there is many, many kinds of beach surveys that can be done, post-storm damage assessments, high-resolution coastal mapping, beach erosion, marine debris, and I could just go on and on. I think there is a lot of really very, very intuitive applications on the coastal side.

For more offshore applications, there is different kinds of habitat surveys, potential fishing effort surveys, if you were looking for pots and traps and things like that. Finfish surveys and oyster beds and spawning areas and sargassum surveys, there is a lot of things we can think about of how we might do detailed measurements on the surface, and so these are areas we're just breaking into and thinking about how these can be applied.

We do have a fair number of ongoing projects. We have a project I will show you some on looking at some seal population assessments for both NOAA in the U.S. and DFO in Canada. We have some estuarine research reserve habitat mapping projects. We have seabird and shark detection projects and sea turtle projects and some photogrammetry projects, and this list is growing.

Some of them dealing with marine animals are counting animals or doing biological samples. This is an example from actually two related projects, one in Canada and one in the U.S., where we're mapping sea haul-out sites, and these are things that used to be that you had to have teams of wildlife biologists go out there and stand around and count animals on the beach. Just about a year ago, we worked on using Google Earth imagery to count seals, and now we're actually using drones, and so, within the last year, we have kind of leap-frogged from one technology to another, but this allows us to get extremely detailed population samples and get snapshots of areas that have thousands of animals and be able to do that very, very efficiently. This is just showing an example here of a haul-out site.

The kinds of imagery that's captured is actually a mosaic of many, many different images, and I have a bunch of videos of these things, and I could show them to people offline, but the idea here is that, when we show you an image, it looks like one contiguous image, but it's actually thousands of images that are captured and then mosaicked together. This allows us to build different kinds of data products, including three-dimensional mapping and topographic mapping.

Just to show you the little snapshots in the inset there, we're showing some close-ups. If we zoom in on one of the close-ups here, that's showing some gear. The colorful things there are some backpacks and stuff. If you look over in the upper-left corner, that's some seal sex going on. We didn't seem to be bothering them. That's some seal porn. Sorry.

We can also put thermal imagers on, and so I know it's probably hard to see, but all the little white, high-intensity dots there are thermal imaging, and this allows you to get much more accurate counts, because you're able to look at the thermal bodies, and you might be able to differentiate a mother and a pup, animals that may be hidden or camouflaged, that you wouldn't get from a regular aircraft survey, and so combining the different technologies together is very, very helpful.

One of the things we have been testing is what's the effect of running drones over the beach sites, and we have done some pretty detailed analysis of that, and it's one of the few times in science when we're really thrilled to have no effect, and so those flat lines there are showing you that it had no significant effect on the seal populations, and so the demographics and their movement,

and so that's something that we really wanted to make sure, is that we weren't disturbing animals and influencing the kinds of counts.

That was showing one example of seals. This next example is actually getting in the water, and here is doing some surveys for sharks. One of the things we've been doing is using decoys as a way to train the imagers, and so what you actually can see on the beach are a bunch of turtle decoys that are lined up there. I know it's probably a little bit hard to see on the screen. In the water, we have a shark decoy. This is a picture of the decoys in the boat, and so they are weighted down with bricks. We put those out because it allows us to know exactly what the size and dimensions are, so that, when we're running an imager, we know that, okay, that's exactly a four-foot-long object. The little picture in green there actually shows a decoy and an interested curious shark that came over to see what one of his friends looked like, and so one is real and one isn't.

This particular work got lots of attention. Actually on Memorial Day Weekend, they were running news articles in the local newspaper and on NPR, because it's the great kind of story they want to have on Memorial Day Weekend about sharks in the water and everybody be scared, but they were very interested in the fact that we were actually able to run these drones out over the beach and be able to go out and find sharks offshore while people are swimming in the water, and so that actually caught a lot of attention, and so maybe good or bad. I am not sure.

Other applications are we're able to detect and get very high-resolution information on sea turtles. We do a lot of aircraft surveys that we work on for counting offshore turtles. The problem is that, in an aircraft with a human observer, it's often extremely difficult to get down to the species level. Often, you will just get a note saying that three hard-shell animals were seen, and so, here, we're able to get extremely detailed, centimeter-level photography and be able to get down to the species level, and so that's a very big improvement.

Now, we do a lot of work with marine mammals, and this is looking here at a whale, actually a whale with some damaged baleen sticking out, and we're able to actually get biological samples, and so this is actually some cool stuff. It used to be if we wanted to do a biopsy on a whale that we would have to go out in a RIB boat and take a crossbow and shoot the whale and have it bounce off and collect the bolt back again. Now we can actually land a drone and take samples right off the surface of the animal, which is pretty cool. If you can see it, there is a helicopter drone with just two little swim floats on it that keeps it from sinking in the water, and so there's some pretty easy stuff you can do.

This is just looking at some high-resolution photography of a mother and calf pair. This kind of imagery doesn't just make cool pictures, but it allows scientists to be able to look at the health of animals and get biomorphic measurements at pretty high detail and a whole lot of stuff that would have just been extremely difficult to do even a few years ago, and so there's a lot of information there.

We are doing a lot of work on extremely high-resolution coastal geomorphology, and this is just showing some examples. Like I mentioned, these are the results of taking mosaics of thousands of images from flying a drone over an area, and, depending on the height and the aircraft and the camera systems used, getting down into the centimeter level detail of resolution, and so this stuff can be very, very effective.

Some of the things we're really interested in, and I will show you a few more examples, is looking at post-storm damage and things like that, where you could go into a site the day after a storm and be able to fly drones over an area and immediately assess the damage and not be having to wait for aircraft or other longer-term projects, and so this gives us a very, very rapid response. This here is showing an example at the end of a barrier island. It's a similar kind of very high detail, and we're able to look at change detection and over-wash and things like that.

Another area that has become of interest is looking at marine debris and being able to do detailed beach surveys. Where you normally would get volunteers to walk down a beach and look at trash, we're able to actually fly surveys now, and what you can see is that -- In the image, you can actually see pieces of styrofoam or something, but you can actually zoom in and be able to actually classify what they are. This might be just for regular debris assessments, but if you had an accident or an incident, you could actually fly a drone on a beach very quickly to look for parts or damage or pieces of an aircraft or things like that.

The main thing we're interested in here is to think about what are the fisheries management applications, and so I've just got a couple of ideas here, and I think I may have mentioned a few. Oyster bed and restoration surveys and looking, from the surface side, at nursery habitats for fish species and I mentioned sargassum surveys and monitoring remote MPAs and looking at recreational fishing effort.

I put a bunch of question marks there, because I think it would be really interesting to get some ideas back from people of what they think could be interesting. I have been trying to stay out of the enforcement side, because that's all sorts of ideas that could come up, but I don't want to come across with the first thing that comes out of people's ideas are Big Brother applications of we're going to fly this drone over the top of your fishing boat and watch you all day. What we're really interested in is what are the environmental, science, and management applications that can come out of this?

In addition to doing R&D research, we are running courses and running summer courses at the Duke Marine Lab now in these drone technologies, and so actually the summer classes that students can take, they build a drone and they get to keep it, and we have more advanced training to get people up to their pilot's license, and so we're trying to work this into not just being R&D work, but also a training facility, and we were able to get all of our FAA exemptions done, which is a huge bureaucratic nightmare, if anyone wants to know.

Just some final thoughts here. We think there is lots of coastal applications, and these are in addition to the many really cool underwater ones. All the technologies we were seeing earlier are things that I love to do as well, but we're actually looking, in addition, kind of supplementing the things you can do with sonars and things underwater, with what are the visual things you can do with unmanned systems above water, and so I think there's some pretty interesting applications that we haven't really tapped into yet. All right. That's it.

MR. HAYMANS: Thank you very much. I will just ask you, right off the box, I got my my COA on Thursday. It took me seven months to get our COA, and how long did it take you?

DR. HALPIN: Longer than that. The Duke Marine Lab also has a Marine Corps airbase nearby and all sorts of things, and so it was a lot of procedural issues, and so it takes a long time to get the paperwork done.

MR. HAYMANS: I will just tell the council, just for basic information, is there's an awful lot of entities out there using these devices who have skipped all the steps that the FAA requires to go out and get a COA, including some very well known institutions in my own state, and I have been pressing them to go the full route to do that, because all it's going to take is -- We lost three biologists a dozen years ago in a whale incident, and that was tragic, but all it's going to take is one of these things to fly into one helicopter or one aircraft and it's going to shut everything down, and so it is great technology, but I encourage everybody who is using them to dot the I's and cross the T's.

DR. HALPIN: We absolutely went the full route to get our site completely certified. Also, one other thing I didn't mention is Dave Johnston directs the center. One of his senior staff that he hired in was a retired Air Force pilot who was a drone commander, and so we actually have some people with very, very significant experience.

MR. HAYMANS: I did notice, in some of our pre-meetings, and I didn't bring that with me, that perhaps you all flew altitudes greater than 400 feet on some of your projects.

DR. HALPIN: Depending on the projects and what they're going after, but most of them are lower altitude than that.

MR. HAYMANS: Because the FAA restricts 400 feet, no matter the COA and no matter the permit, and so that's why I was curious.

DR. HALPIN: We are generally under that.

MR. HAYMANS: All right. Questions?

DR. LANEY: Pat, obviously the drones have great application for things that you can see and count, but what about sub-surface? I am assuming you could put -- I know the ASMFC did some work using LIDAR in aircraft to begin assessing whether or not we could detect and quantify Atlantic menhaden schools in Chesapeake Bay, and so has the technology with some of those type of devices advanced far enough that we could actually fly transects and begin to count schooling fishes, at least, that you might be able to see within the --

DR. HALPIN: Those are areas that are under investigation, and so the LIDAR packages are fairly heavy, and so, as the technology becomes more miniaturized, it becomes easier to put them on unmanned aircraft, but that is one of the kinds of applications, and so water-column-penetrating LIDAR is one. Once we get past that -- We're still, I think, somewhat in an R&D phase, but that's what people are investigating, and so you're spot on exactly one of the apps.

DR. DUVAL: Just that I read the workshop report that you all put together, and it was interesting to me that the Parks Service wouldn't allow or didn't seem willing to allow for the launching of UAVs from Park Service land, because it would certainly be an amazing tool for them, given all the Park Service land that we have on the Outer Banks of North Carolina.

DR. HALPIN: The issues there, I think, were not wanting to set precedent, but it's one of these things that we'll see whether or not that changes or how controlled that is. I mean I think their concern is on letting anyone in to do those things, and they worry that it will explode, but I still think it's an open question. I think if they can make the case to them that it's being done safely and it's for research purposes -- I think that was just an initial reaction.

MR. HAYMANS: The recreational use is out of control, and that's where most folks are --

DR. HALPIN: I think there is a fear of that. The legal entities are concerned about allowing research drones may be the first step to having recreational systems.

DR. DUVAL: So I commend you all for the workshop that you put together trying to address not just the exciting cool uses of drones and their applications, in a coastal sense, but also, at least from a local perspective, getting all the different entities sitting around the same table, to make sure that all the legal channels are being pursued, and especially around where we are, in Carteret County and the adjoining areas, with all the overlapping military airspace and everything.

It really is a significant issue, but, in terms of applications for us, I certainly like the idea of trying to measure recreational fishing effort. I think it would probably -- It might be a little bit tricky to do, in terms of distinguishing amongst boats. Well, maybe not, given some of the resolution that you have shown here.

I think about some of the management that we have in place right now or some of the efforts that the State of Florida has had to go through when we had a red snapper season, and so it seems like this might be, depending on the cost, a much more effective way to try to get a handle on that type of effort for short-term pulse fisheries like that.

MR. HAYMANS: The one thing you didn't mention was, at least on quad-copters, is the very limited flight time. I mean it's tough to count effort in twenty-minute segments. The fixed-wings, you can get a lot more flight time out of.

MR. PUGLIESE: To what degree are -- I mean fixed-wings are part of the whole package, and I remember one of the most cutting-edge ones that I had seen was Applied Technologies. They were using it in Africa to do monitoring of elephants, and that's where they actually got into integrating the flight characteristics, so the vehicle could take advantage of thermals and rotational signals. You talk about thinking about advancing where any of the signal blocking would occur, and so I assume that's part of the -- That definitely had an amazing amount of time.

DR. HALPIN: There is a lot of missing planning that can be done to really do your best to extend things, and so the coastal environment -- I mean the biggest problematic area is if you have any high winds kick up that can just take you out, but there is a lot of interesting applications, and so this is an area that -- I don't think it's the thing that's going to solve all the problems, but I think there is kind of niches where this can help fill in and could be really productive, and it's something that can be done fairly cheaply, and so that's kind of a niche market for this work.

MR. HAYMANS: Quickly, because we've got four presentations and two hours to go.

DR. LANEY: Just one more quick one. Has anybody put a hydrophone on one of these things yet? I mean if you can land them on whales and collect whale tissue and whale snot and so forth, it seems to me that you could pretty easily put a hydrophone on one and you could then shoot it out to Gray's Reef. Is George Sedberry in the room anywhere? You could shoot it out to Gray's Reef and have it drop the hydrophone and listen for ten or fifteen minutes and then zoom it back.

DR. HALPIN: There is many potential applications, and we would have to sort through how you would do that, but also working in conjunction with an existing hydrophone array or things like that. I mean that's where these things could be really interesting. It's not just thinking about it as an isolated piece of technology, but a piece of technology in a whole suite of other technologies. That's where you get the biggest bang for your buck.

MR. HAYMANS: I assume you are going to stay around for the evening for additional questions?

DR. HALPIN: Unfortunately, I have to fly out really, really quickly, because I got stuck on jury duty tomorrow morning at 8:00 A.M. in Durham, North Carolina, thank you very much, and so I have to cut out of here around 5:00.

MR. HAYMANS: I am going to chat with you via email with some questions. Thank you very much. That takes through halfway. That's the Ocean Technology Session. We're going to move into the next one, which is Ocean Investment and Collaborative Sustainability with the Emerging Role of Citizens, Business, Non-Profits, and Government in Conservation. We have seen this guy before. We are going to try to hold him to thirty minutes.

MR. BOSTON: Putting on a non-profit hat for a moment and someone who supports a state agency and works with non-profits around this state, for me, the -- I talk about P3, which is public, private, and non-profit partnerships. Ultimately, if you're going to move to citizen science, if you're going to have a vision that includes getting industry involved, whatever that industry is, if you're looking for deeper projects for projects and investment, our view of what the landscape looks like for who might be interested in investing in our oceans and our fisheries I think probably needs to change.

A little broader, and that's always scary, but it's just a thought for you. I think about P3. I think it's about more dollars, more influence, and lots of partnerships, and that's what it really comes down to, but we don't see Facebook investing in our oceans. I don't know why. They invest in other things. We don't really see Microsoft and the big corporations really rallying to the cause of the fisheries or whatever, and I think those are part of us probably having maybe not the horizons that we need to in terms of getting industry and others involved in thinking about investment that we could use. That's just a thought for you. It's always scary, particularly as government entities, to think about the private sector's engagement, but I think it's important.

The value of citizen science is something that Brett Fitzgerald is going to come up and talk about, some of the tools that have been invested in in Florida. If you think about Audubon and their bird counts that they do annually in December, I mean they have a set protocol nationwide, and people hit the streets and identify the birds and fill out their forms and turn them in. It's all web-based, and they do a national bird count, and it costs us almost nothing as a nation.

You think about our ability to start with the technologies that have been presented this morning and other technologies and the ability for us to start using citizen science in the fisheries I think is

going to be really important, and whether those citizens are guides or charter captains or the fleet itself, I think figuring out how to create even better and stronger partnerships and leveraging the technology I think is going to be real important.

There are challenges, of course, with citizen science. I mean scientists want to argue about the validity or the accuracy of the information and are they using the same protocols and are they trained and all those issues come into play, clearly, and I have heard those arguments all along, but if you think about catch and release, for example, it's a great practice, but we've just lost a lot of data. There's no landing, and so we lose a lot of data, and so how do you capture that data?

The other piece that I really like, that we'll talk about a little bit, and I think that Brett Fitzgerald is also going to talk about, is tournaments. I have been a real fan of why don't we have photographic tournaments and can we do that and what would that look like? We could gather some data, and we're going to have lower mortalities, hopefully, from doing those things and so some of those technologies, I think, are going to come before us now.

To me, the role of the technologies that you've been seeing can be applied to citizen science as well. In fact, it might make the citizen science better and more accurate. You've got lots of people on the water. The idea of expensive blue water excursions, they are expensive and they are time consuming and you only get so much boat time, but there are thousands and thousands of anglers out there, whether it's the billfish tournaments or the marlin tournaments, but they're out there on the water anyway, and if you had technologies like hydrophones and some of these other technologies we've been looking at, and they were just willing to drag those along with them, then suddenly you've got a lot more ocean coverage, the ability to do a lot more mapping, et cetera.

I think getting corporate involvement to make the investments in the technologies that we need and reaching out to NGOs and citizens and getting them engaged in helping us collect that data with the technology that's at our fingertips and really starting to rethink about our models for data collection as moving from people to probably technology and taking advantage of vessels that are already out there.

I saw a demonstration recently, and I will finish with this, but I saw a demonstration recently that was pretty cool, and it kind of gets to what Pat said. We need all of these technologies working together, and it was the first simulation where there was a motorized vehicle on the ground and there was a drone in the air and there was a vehicle in the water, and they were actually autonomous working together to direct actions with no human intervention, and so now you take an aerial drone, whether it's on fixed wing or something else, directing where the hydrophones or where our mini diving sub is going, and, suddenly, from the air we spot a school and we redirect, but all of that happening without anybody having to steer, and I saw that happen, and it was a DOD experiment, and so it will be a while before we see it, but it was pretty, pretty cool, and it's there.

I mean the technologies are there to start to do those kinds of interactions, and so it will change citizen science if we can start to leverage these technologies, and so I encourage everybody, as we go through the afternoon and the break this evening upstairs, when we have a chance to talk, to be thinking maybe more broadly about what we can accomplish with our citizen science and leveraging the technologies, some of which are as simple as iPhone technology that everybody has got, and how that can really start to factor in.

It doesn't sound like science, but it is science, and it's probably the future of science, particularly, I think, finding a willing technology partner that will start funding some of this stuff that we know we need, because it's expensive. Mr. Chairman, with that, I will yield my time and take any questions, if anybody has any.

MR. HAYMANS: Are there questions from anyone? I take it that Gregory is coming up?

MR. BOSTON: He is not here. I apologize. I did a follow-up, and I won't go into it, but, no, and so that saves you -- We just got forty-five minutes.

MR. HAYMANS: Okay. Then let's do this. In that case, let's take a five-minute break, for those who need it. It's 4:08. What is reasonable? Come back at 4:15. It's a seven-minute break until 4:15.

MR. HAYMANS: If we can get at least the committee members, if not the rest of the council, to take their seats, we will get started. I hate to be this way, but it's a lot packed into this agenda. Roger, is there anything we need to do, other than get started?

MR. PUGLIESE: I think we're ready.

MR. HAYMANS: We're ready. Okay. I will just briefly introduce Brett. Two years ago, I was at ICAST in Orlando, and, across the aisle from me, was this guy, Brett Fitzgerald, and he was telling me about iAngler. We got to talking about it, and I was like, you know, the council needs to hear that presentation. Then I found out that Luiz used him with some data in a snook assessment, and I was like, you know, the council really needs to hear this presentation. It only took two years, but I am happy he's here, and so, Brett, the floor is yours.

MR. FITZGERALD: Thanks very much for inviting me here. It's Brett Boston's fault if it goes bad. I recognize some of you, and I'm thought of to be a pretty nice guy, but I want to warn you that I brought my daughter, Ava. She's a tough one, and she's the fisher in the family, and so if you ask any hard questions, I am going to sic her on you.

It was really exciting to hear the earlier presentations and the ways that all these different types of technologies are going to come together, and clearly it is going to happen and it's going to be because of situations like this, where you pull them all together and then somebody has an idea of how you're going to use it to really kind of get to a point where we're assessing our fish and managing our fish in a much broader way, and I think this is really exciting.

What I'm going to kind of talk about here is the genesis of this citizen science program that we had that kind of came about because of a need for sort of a fisheries management process, and so I will have to talk about that a little bit, just to explain how we got to where we are, but hopefully you will find it to be interesting and you will come up with some thoughts on how we can tie this in together as well.

The way this all started here in Florida, and what we're talking about here is called the Angler Action Program, and the idea is that fishermen are going out and recording their catch, and so some of this narrative is familiar to some of you, because I've told it a few times, but generally what happened was, in 2010, along much of the east coast, we had a historic cold kill, and

particularly in South Florida. It affected a lot of our game fish, particularly snook, and it killed enough that a lot of fishermen and a fisheries biologist here in Florida really had no idea how much of a hit the population took.

There was a need within FWC and FWRI for fishermen to try to provide some information, and so we went about getting the people involved that knew how to build databases to help us put something together that might be usable at the state level and beyond, and that's what started with the Angler Action Program.

That started in 2010, and we were collecting data that was useful to the state as soon as that same fall. We had thousands of hours of snook-directed fishing that was based on an old logbook that FWRI had been using, some of the same data points, and so that was built kind of from the function side of what was the scientists needed.

Over the years, we have kind of refined and worked on form and come up with some different additions and bells and whistles. It's still sort of Fred Flintstone technology compared to what you saw earlier, but what's neat about it is, and this is kind of a Luiz analogy, is it creates a situation where you can have an infantry of data collectors out there. If you build a tool that's simple enough and that's accessible and you create a motivation for fishermen, they will get involved, and you can find ways to make this data become very useful.

How do we get anglers involved? This photograph, by the way, is from an area in the Lake Worth Lagoon called Snook Islands, which is a very large, probably the largest, restoration habitat project in Palm Beach County. It becomes important later in the presentation, when we come back around and talk about how this technology can provide benefits to the ecosystem and get fishermen involved there.

We talk to a lot of fishermen, and we go to fishing clubs, and it's a lot of face-to-face conversations. This is a true grassroots type of growth. We have raised this money to build this thing ourselves, and we go out and we recruit anglers almost one at a time. It's a handshake type of deal, and you explain what it is and what it isn't, and a lot of times we talk about trying to get some accountability for recreational anglers and data collection.

Over the years, we have learned that one of the motivations that we can use to pull people in is to turn this into a very powerful personal fishing log, where they can enter information like tides and temperature and lunar phase, and those are all filterable fields within the system that they can now track within their own fishing trips to help them become a better angler.

We also found that this is a way to help improve accuracy of information, and explaining to them that, if you're doing this for a personal fishing log, you are not doing yourself any favors by fibbing on your fishing trips. Also, this is a great way to introduce the importance of zero-catch trips, which obviously is a very critical part of any angler database.

This is where the rubber meets the road. It provides a service which satisfies a lot of different needs, and like I said initially, it was FWRI. They wanted to know what people were catching as far as snook goes, what and where, and habitat mapping, this is an old slide. This is something that I, a few years ago, could see, okay, well hopefully we're going to get to a point where we're

going to be able to do some kind of functional habitat mapping, and you will see that we're actually getting to that point.

Brett talked a couple of minutes ago about the risks of citizen science and collecting angler data in a way that's different than the way it's been done traditionally, and so this is just basically my introduction here to say that I know. I didn't know when I started. I didn't know much about data collection and fisheries management, but I know more now than I ever wanted to, and I have realized that, just like you heard earlier, this is not ever going to be a panacea, but it is definitely something that can be a very functional tool in the toolkit to help with everything that we've talked about here of habitat mapping, ecosystem, and fisheries management.

This was kind of neat. This was one of the first external studies that was done on our database, where Kai Lorenzen's lab at the University of Florida looked at the percentage of mangrove habitat, based on county, and the catch rate of snook. Basically, it was just looking at the relationship between the amount of mangroves and the catch rates of snook and anglers in the Angler Action Program.

It was great. Now, she presented this at a BTT symposium down in Fort Lauderdale, and she was quick to point out, at first, that this is not in any way saying that these mangroves are the reason that the snook are there. There's a lot of reasons that mangroves and snook do well in the same environment, but it was just neat to me, because it was the first study outside of just fisheries managers trying to bean count fish and force it into a fisheries management process. I said, okay, now we're moving in that direction where people log in their fish, what they caught and where they caught it. People were thinking of it outside the box of what we had, and habitat was really what my foundation is interested in.

This is a slide that I show to a lot of fishing clubs, and you see on one side there is the trout logged and one side is snook, and they are pretty similar. You see, like around Tampa Bay there, and there's a lot of dense areas here, but what was interesting to me is that, in Palm Beach County, there aren't a lot of sea trout logged and there's a lot of snook there. In my opinion, the reason for that is the type of habitats that are available there and the type of habitats these fish need.

The reason that this stuck out in my head is at the West Palm Beach Fishing Club, they have their own kind of IGFA leaderboard there that -- That club has been around for decades, and they have line classes for different species of fish. One of the things I noticed the first time I looked at it was the sea trout records for line classes, from 1970 and earlier, were all caught in Palm Beach County. Any sea trout record caught after 1970 was somewhere else in the state.

Since I have lived there, the catches of sea trout in Palm Beach County are pretty slim, and the reason there is that there is -- What do sea trout need? They need seagrass and a certain type of habitat for them to thrive in the area, and snook are a little bit different. Their needs are different, and so I thought it was kind of neat that you would get a visual like that that shows the change in what we're catching and habitat needs.

This is just kind of like from -- Now, 2012 was the first year that we allowed -- We started off just with snook. When Dr. Mueller at FWRI said, yes, we need your snook data, and we had already outgrown our database three times in the first couple of months of collecting data, and so it was a

mess, and we were like, well, what do we do? Do you want us to format it and make it all look nice? He said, no, don't touch it, for god's sake, and just send it.

We sent it and he used it right away. They were real excited, and it's specifically the discard data, the distribution of the discards, and the size of the discards. Those are the areas that it plugged into the stock assessments for the State of Florida right away, and, when you're looking at a species like snook, which is primarily discards, that ends up being a lot more important than it might be for other species, where people are harvesting a lot of fish and they get data at the dockside.

The point was they said, you know what, we would like you to start collecting data on some other game fish, and they gave us a list of six. We immediately started working on expanding the database and pulled the same researchers in from FWC and some from NOAA and Texas Parks and Wildlife, to try to figure out how we could introduce these other species in a simple way that's not going to introduce a bunch of biases and it's going to ruin our snook data.

We got all of that sort of figured out, we thought, and, as soon as we were almost ready to unroll it, they said, forget what we said, we want everything you've got, from bluegills to blue marlins, and let's just get it all, and so that's kind of where we are now. We just keep expanding the list of species. If anglers come up with catches that we don't have, they submit a form, and, within a day, it's in the system with a photo ID for people to look at, and it expands just that fast. We had I want to say fifteen new species entered last weekend from a tournament that was very specific, and it was fish that we didn't have in there, and now we do.

This is a slide that fishing clubs, for some reason, they really like to see. It's tough to see where you are, but the big take-away from there is, in the angler action program, we're close to probably 75,000 fish now. The green are fish that are discarded and the red are fish that are harvested. You go from most-frequently-caught species on the left there, and it's sea trout. They are the most caught. Snook is the most targeted, but they're not the most caught, but you see the majority of the fish, even for sea trout, which is -- People think of it as a game fish, but if people go out to catch sea trout, you think of it as a fish they want to bring home to eat. The vast majority of people who are logging in this system are letting those fish go.

Offshore fish like dolphin, the majority of them were harvested. Spanish mackerel and bluegills, and those fish aren't recorded as frequently. Freshwater fish are starting to creep up more now that there is tournaments going on, but the point here is that the more information you can give back to fishermen, even if it's not something that's going to help them specifically become a better fisherman, I have found that it's information like this that helps engage anglers. They see their data being kind of laid out to them visibly in different ways, and it's something they can relate to. They start to say, okay, I can relate to this in some way. For some reason, it motivates them to log more.

A couple of slides here to show you just what it is that the anglers see. This is the website. We have now designed a handful of apps that feed data into this database. Angleraction is the website that it all kind of goes into, and the first smartphone app, iAngler, has been out there and now that's the dinosaur, and iAngler Lite is the new one. Up in the Chesapeake area, they saw how the state was using the data and Maryland said this was great, because, when we were building it for down here in Florida, we didn't really know for sure what we were doing. We were hoping maybe by now they would find some use for it, but, because the map was laid out and because FWC was

so willing to be open-minded and kind of go out on a limb and found some benefit, without overstepping and saying, yes, it's the fix-all, but here is where we're going to use this thousand-slice pie of a stock assessment and these two little slices are where this data can be used right now.

Maryland came back and said, yes, I want this data on these six or seven species in the Chesapeake area, and so we skinned an app for them, and it collects data. Guy Harvey saw what was going on, and he said, how can I get involved? He ended up skinning an app called Guy Harvest Outpost. Now, when you stay at an Outpost, you get brochures from them that they have their own app that feeds data in the same way, and the apps all kind of have the same feel to them, and they all feed data in the same way.

The point is that angler comes in and they create a user name and password, so no one else can see their information. It stays private for them, but they can go back and review their old catches. They can pull out information and they can filter their trips, like I said, based on species caught. If I want to see every time I have come up to Brevard County and caught more than three snook, but less than six, because I'm kind of lazy, and see what the tides were and what the sunrise and sunset and water temperatures were, it will pull just those trips out, so I can try to replicate those in my next trip that I come up.

It does ask anglers to create a profile. There is basic information that has to be used for a stock assessment. For habitat mapping, there is maybe some more things that we want to get, but there is minimums. All of these data fields are put in here, and a lot of these are upgrades that have come because anglers have come back and said, hey, this is really cool, but it sort of sucks too, because I have to do this every time, and so we take those comments and say, all right, how can we integrate this guy's displeasure and not do something that's going to make the scientists put their hands up and walk away.

You come up with these data fields that allow them to move along and record their trips a little bit quicker, but make it more efficient. If you have a typical fishing trip, that's the profile information you put in, but it's all -- You have to go through and review it each trip, to make sure it's the same, number of anglers and time spent fishing and where you were, what county you were in, that sort of information.

This is kind of a screenshot of what an angler sees in his app. They open the app and you see that green button here. That's start a new trip, and it's just that simple. They get a hail-out, and this particular app, this is the new iAngler Lite. You fish by locations. What most anglers like about this is they can add a location and they can name it. It saves it. If you call it one of your favorite spots, it will save it in your library. Any time you go to add a location and you start to type it in, it will pull down a dropdown of your favorite locations, and you can pull your own information out in that way.

This is your list of favorites, if you want to just see your list of trips that you've put in that you've logged as a favorite spot. Once you have started your trip, you put your location in. If it's a new spot, you just press this button and it tells you where you are. You can name it there or you can wait until you go home and go to the website and do it.

You see it does truncate the visual of the lat/long here. That makes them feel a little bit better. It does save the information all the way out, but it's not something that anybody is going to see, and

then it's just that simple to log a fish. The screen has a spot where they touch that, so they can take a picture. If they already took a picture of the fish and let it go, they can open the app and they can pull the picture off of their camera roll.

Your location, the name of your location, if you need to change your location, you just back up and hit a new location. Your species, you touch it and they get a list. It shows the most frequently caught fish by that angler or, if it's a tournament now, it shows the targeted species. You click "other", and it shows everything we've got in the database, and we're up to 175 species or so. They can enter the length and they can enter the weight. The time that the fish was caught is recorded.

There is some information here that the researchers wanted, whether it was kept or released. If it's released, this field stays, the release condition. This is where anglers can say whether or not they used a descending device, if they're fishing offshore. This might say that they were eaten by a predator and where the fish was hooked. There are kind of defaults here of hooked in the jaw or the stomach or that sort of information. Again, that's just information that's very easy to collect.

These fields are really easy to change out if you had a concern with this app or you wanted to add to add a field to it. It's something that's very easy to do. Anglers get a receipt of the fish that they have recorded on their trip. They don't need to take a photo. We encourage them to. They don't need to give their exact location if they don't want to. It's a minimum of the county. We ask that they do. When they want to go to a new location, they just press that button. If they're in a new spot, the same thing. If it's a spot they know they're going, they can put it in by name. If it's a new spot, there they are. This allows you to synchronize your trips, and this is how you end your trip, so you've got a rough estimate of how long they were on the water fishing that day.

The Guy Harvey app and the Chesapeake Catch have slight variations, but all of the variations go through biologists like Bev Sauls and some other people that kind of eyeball it for us, to make we don't stray too far away, and the main data fields stay the same.

From that, we have developed a tournament system here, and this has really taken off. I will be honest that this is the importance of getting fishermen involved when you design these types of tools and you want to make something functional. The reason why the original iAngler app is not used by a lot of people is we tried to do everything with it. We tried to create a way in that that you could use that app for a tournament and make it a one-size-fits-all app. I took it down to a tournament in the Keys, and it was real high-priced redbone tournament down in the Keys. Gary Ellis has been a champion on letting me use his tournaments as guinea pigs.

I started to explain it at the captains' meeting and realized, while I was saying, that these guys aren't going to use this. I was saying this sucks, and so we realized we had to come up with something that was a little bit different, and so we did the same thing. We got fishermen involved, we got researchers involved, we got the programmers in the room, and we sat down and said, what's it going to take to build something here where we can make a tournament app that's going to allow people to do catch, photo, release, catch information that you want, that's functional enough that you will actually use it during a competition, and it satisfies everything we need, and so that's how this was kind of developed.

Now, I will tell you that we've got -- I think there's like fifteen tournaments running right now, today, around the country. Next weekend, there is one in Canada and they're just popping up all over the place, and it collects the data in a way that I think is going to be really interesting.

This is a tournament that's going on right now down in Lake Worth, and this was something that I was really super excited about. This, again, came about based on a need. Palm Beach County and the Lake Worth Lagoon, and you saw that photo of the Snook Islands. We spent a lot of money doing a lot of habitat restoration. The Lake Worth Lagoon, there are sections of that that have been notoriously known as dead zone. There is just nothing going on there.

The county has slowly been chipping away and doing habitat restoration, which is time consuming and extremely expensive, and it just so happened that another different day, at the West Palm Beach Fishing Club, and I saw a paper on the director there, Tom Twyford's desk, and it was a statement of need from the county, saying we've got to figure out a way to survey anglers to see where they're fishing and what their catching, because people that are paying for these restoration projects, us going back and saying, hey, it's really pretty and it works isn't enough anymore. They need some kind of data.

From that need, and from the West Palm Beach Fishing Club's willingness to step up and say, yes, you know what, we'll pony up prizes and this is important to us, and so this partnership kind of came together with FWC and from Jim Whittington saying, yes, we need information in there and here's what we need and different groups saying, yes, we'll chip in and *Coastal Angler Magazine* promoting it, but it came down to a point where now we've got a tournament that's going to be done probably every month.

Every quarter, there will be a month-long data derby, and these fishermen are recording the species they catch, exactly where they caught it, with a photograph, so that they can start to see what habitats are being used by the fishermen, what tourism and fishermen dollars are being spent on what types of habitats, what habitats are holding what kind of fish at different points in their life cycle, so we can figure out if we really want to start to tailor make habitats in here that will maybe bring sea trout in, what's it going to take.

Almost the trumping thing here is that it's fishermen getting involved, and what's really been fun here -- This was not intended to be a kid's tournament, but the top five people on the leaderboard is people in the youth division. It's their parents taking them out fishing, and all the dads and moms have sent emails saying that I've been trying to get my daughter fishing for six years, and she wants none of it, but now that it's a competition, boy, she's pulling on my shirt everyday and she wants to go. It's getting people involved.

Yesterday, we had a volunteer party, and about a hundred of our volunteers showed up, and the woman from the county who kind of spearheaded this, she said, man, our biologists and the people that do the artificial reefs, they're so excited to see the big fish being caught, and there is sea trout being caught in there and there is snook and flounders and big jacks and all those catches are on projects that they did, and so they feel real excited and justified to see that.

For me, who is wanting to see all of this stuff get tied together, and I am wanting to see this start to be used in ways for ecosystem-based management, where we start to see where these prey species, these forage fish, are. Those little snappers that the kids are catching, that the snook are

eating, that's gold. All the stuff ties together, and it's these fishermen out there having fun and they're the ones collecting the data.

The technology helps, that we have the ability to timestamp the photos if we need to. You've got a lot of that information that's verifiable right there. We've put a system in here where you can overlay -- If you have a known measurement device in there, you can zoom in on the photo in the tournament and you can take -- Like there is a tournament that used a poker chip. It's an inch-and-a-half, and you can measure out that poker chip as an inch-and-a-half and then put the points on the ends of your fish and help make sure that they're not cheating on their fish sizes. It's not perfect, but it's another way to help kind of verify the length data.

I talked about Chesapeake Catch and Guy Harvey Outpost. iAngler Lite is our latest app. All of this stuff is constantly being upgraded, the website -- I was just talking to the programmer for an hour on the car ride here about what we need to do to get that up to speed. The top right little icon there, that's the CCA Star Tournament, and that's just a little plug for the way this technology has really, I think, come to the rescue.

CCA Star in Texas is a massive tournament. It was 40,000 fishermen last year. It targets all of the superstar game fish along the coast, and it's 101 days, and it's a kill tournament. Again, Florida, CCA Star Florida, and their director, Lisa, was like, how can we work with you, and so we basically gave them our technology and helped shape up an app and build an app for them that allows them to change the Star Tournament here in Florida to a catch and release.

Not only are these fishermen now, this year, as of yesterday, and so it started Memorial Day weekend, but over 35,000 fish have been logged in that tournament alone. Over 4,000 anglers are involved now. They are taking a photo and they're submitting that fish-by-fish information. It comes into the database. I mean it's just a great opportunity here to get these people involved, and, again, I never said, but the reason why I wanted to build a tournament app in the first place was not to start a new database, and it is. It's a different type of survey, and so we don't include that data in the same one as the voluntary guys going out, but my hope was that I could get 10 percent of those fishermen to start logging their recreational catches, so that we could build that database. As it turns out, the tournament database has its own value, and it's going to end up being its own animal, and, for things like habitat mapping, it's going to really, I think, be a powerful tool. That's where I am.

MR. HAYMANS: Thank you very much. Great presentation.

MR. FITZGERALD: It's good that there's questions, because I was going to say, if there's no questions, I am starting from the beginning and I'm going to keep going until we get questions.

MR. HAYMANS: We have about five minutes. I have a couple. It's all voluntary data. Have you been able to see -- Have you analyzed the data enough to see if there's differences in levels of reporting between various fishermen, fishermen of different --

MR. FITZGERALD: Avidity?

MR. HAYMANS: Yes.

MR. FITZGERALD: There is a study going on now -- There is actually two studies going on now. One is the University of Florida Lab, Kai Lorenzen's lab, and they're doing a very important study that I need to check up on and see where we're at, but they're basically just surveying the anglers to find out their motivations and get an idea of who is it that's logging and what's the psychology behind it, for a number of reasons. How are we going to recruit more anglers and is this going to represent who is out there, but that's one of the questions they're asking.

Now, there is another lab there, Dr. Ahrens, Bob Ahrens, and his lab -- That's a five-year study that was funded, I believe partially, through NOAA and FWC. They're tackling some of those questions, and it's, like I said, a five-year study. The first year, that analysis was just looking at catch rates. He did look at avidity by number of trips logged and that sort of thing and try to do some type of comparison there.

He found that it was a broad range of fishermen. You've got some that log every trip. I've got one fisherman who has logged a thousand trips now. He goes to fishing clubs in southwest Florida and all he does is talk about how he uses the database to plan out his fishing trips. Now, he's a retired biologist, and so it's kind of not fair, but it's pretty cool that he actually uses that, and he fishes twice a day. He uses his app to plan out where he's going to go, based on his success rates.

That study, the author's name is Ryan Chorley, and he finished his PhD, and that should be published in *Fisheries* in the next couple of months, and the main point there was to look at the catch rates of redfish, snook, and tarpon compared to MRIP survey data. What he found there was, yes, there is a spatial bias, because, like I said, I'm going to fishing clubs and I'm recruiting fishermen. Where I live in Palm Beach County, we have a lot of numbers. The Tampa Bay area, I hit of lot of clubs over there and down in the Naples area, where I have board members and activity.

Those areas, the data held up really well, but you couldn't look it state-wide, because we haven't been able to get up to the Panhandle and up into Jacksonville. There's just stretches where it's just not known enough yet. Like I said, we're still growing, but that's really the next step, is how do we get to the point now where we get endorsement? What is it that's going to motivate these anglers to get them involved? I think that's really the next big step, and I don't think it's going to be that big of a reach, but I don't know if I answered your question.

MR. HAYMANS: MRIP was the next question.

MR. BREWER: I'm Chester Brewer. I can't believe we haven't met.

MR. FITZGERALD: I think we had lunch once eons ago, and we didn't meet, but you defended me once at a fishing forum years ago, and I appreciate that.

MR. BREWER: Oh, yes. I vaguely remember that. That's back when I was doing that stuff. I have stopped now. I got in too much trouble. There are some members of the council who have expressed a real interest in the sort of citizen science initiative, which is exactly what you're talking about. How difficult would it be to design an app that could be used from North Carolina to the Keys, is the first question. The second question is how many people do you think you would need to have involved so that you could start generating meaningful data? I will stop with those two.

MR. FITZGERALD: Your first question, it's done. The app is global. People are using it all over the world now. Between the different platforms, I don't know the exact number now, but I would say we're somewhere between 15,000 and 20,000 people that have taken the time to go in and create a profile, which means make a password and enter the information to build a profile. Maybe half of those have used it at least once, and it's kind of funny how the numbers just start to drop off.

Some of that is, like I said, our old app was pretty clunky and kind of hard to use. Some of it is some people only go fishing once every three months, and so that research from Kai Lorenzen is what's going to be interesting.

Now, the answer to your second question, there isn't a single answer to that, because of the different ways that the data can be used. If you're looking at the holy grail of abundance and effort, I don't know the answer to that question. I know we will get there, but I don't know the answer to that. If you're looking for can it be used in a stock assessment in some way in the State of Florida, for sure. It's been used for snook three times now and red drum last year and sea trout this year.

Again, we're talking very select pieces of that. Without me understanding how this data was going to be used and understanding as much as I did about stock assessments before going through like the MREP education program, I know a lot of us thought, hey, this is going to replace MRIP, and what a ridiculous thought that was. It's never going to take anybody's job away. It might create more work, but the idea is that it's going to help. It's going to create resolution, and, as long as it's being applied in some way, I think that that's -- Now, in the State of Florida, you've got 10,000 fishermen that feel invested. They feel like, hey, the data is -- That's my data. They can't say that's bad data anymore, because that's my data that's being used, and so not only that, but it creates a direct way to message these people.

You've got people that you can reach out to when you have -- You have people who are already engaged in the process, who have taken the time, and so it's ready to roll, from your first question, at a global level. For the second question, it just depends on what level and how complicated that particular need is.

MR. BREWER: We have a desperate need, a desperate need, to get a handle on the bycatch mortality for red snapper.

MR. FITZGERALD: Yes.

MR. BREWER: Can this system be used to generate data that would be helpful in that regard?

MR. FITZGERALD: Well, I am not really qualified to give you a definitive answer on that. I will tell you that I believe absolutely yes. I don't think it's that far away, and I think that the system is flexible enough that if there needs to be a couple of adjustments made that it can happen on the fly and be done.

I do think there is a motivation out there. I think fishermen in that particular group understand the need, and I think they would be motivated to participate, and so I don't think it's that much of a stretch. If they felt like there was a system in place that they could be a part of, that they could

begin to trust, I think those are the two biggest hurdles, and I think that we've established that over the past six years.

Our data has been used. It helped reopen the snook fishery, and I think that we've kind of made people understand that what we're doing is collecting numbers and they are what they are. You can be ready to deal with the answers that they give you, the stories that they tell, whichever way it goes, but I think trusting it is the big step.

MS. MCCAWLEY: I'm just going to give a little testimonial. As Brett talked about, this has been a really great partnership with the FWC. It started with snook, since it's primarily catch and release only, and us trying to get a handle on the size and the numbers of those discarded fish. Every time we would do a public workshop, anglers were saying how can I help and how can my data be part of this process? Now we're doing this with a lot of our state species, and the information is going directly into the stock assessment. It's been a really big help for us.

MR. HAYMANS: Michelle, last word.

DR. DUVAL: Along those lines, I think probably, Chester, one of the key pieces of information that we don't get right now is the depth from which these fish were caught. That goes a huge way towards making -- At least being able to apply some discard mortality estimates that have been obtained through other types of studies, and so if we knew how many and from what depth anglers were capturing those fish and having to discard them, that would be a huge help, and so that's where I see an app like this could really be helpful.

DR. LANEY: Just a follow-up to Michelle's question, Brett. It seems to me, if they're using smartphones for this, and the smartphone is automatically logging the location, then it seems to me, if you plot those, you get the depth, I mean if you've got really good bathymetric maps. The key there would be able to plot it on bathymetric maps, and you should be able to generate the depth, as long as they are staying in the same location.

DR. DUVAL: I mean I'm just thinking about -- I mean you've put a tremendous amount of effort and resources into development of these apps, and I am just thinking about, for anglers who are very wary of sharing any kind of location information whatsoever, then just saying how many did you release and what was the species and what depth did you capture them from and where was the hook placement. Like those four very easy things I think would go a long way towards providing useful for us, Wilson.

MR. FITZGERALD: I agree, and I think that there is a -- Each angler, there is a level of trust that comes up. They create a user name and password and they send their first trip out, and they don't give a location most of the time on their first trip, but it's interesting to see. After five or six times of logging and they become sort of fluent with the process, they start adding more information in.

I do think that it's -- It has to be thought through, because it's very critical. If you make location mandatory, people will walk away if there's mistrust, but if you create a panel survey or some type of a mark and recapture type of study of anglers, and you pull from red snapper fishermen or a given population, I think -- I don't want to get too far away from what we're talking about here, but I do really believe that that's the next step and it will happen.

MR. HAYMANS: Brett, thank you very much. I think, amongst all that we've heard so far, I mean this is the closest fruit that we've got that we can start using.

MR. FITZGERALD: Thank you very much. I appreciate it.

MR. HAYMANS: Thanks for your presentation. I'm trying to get us going. We've got two more presentations and just over an hour. Next is Habitat Ecosystem Tools and Roger and Tina Udouj.

MR. PUGLIESE: I am just going to open up the session that we have had a long-term standing development and relationship with Florida FWC, back when it was FWRI, in building our spatial information systems and tools into the future, and collaborating with Tina on advancing this has been key to support all of our habitat and into the future ecosystem activities in the Fishery Ecosystem Plan.

I think what Tina is going to provide is kind of where we are and where we're going with the next generations of some of the systems. The technology continues to evolve. One of the greatest things is that, for our investment and working with them, we get to have the benefit, as Florida advances in their applications and use of technologies online, we kind of ride on the coattails, and so we're getting a lot for our investment, and especially with all the individuals that have been involved directly with FWC. With that, I want to hand it over to Tina.

MS. UDOUJ: Thanks, Roger, and thanks to the council for inviting me to participate today. It's an honor to be thrown in with the technology group, and it's a hard act to follow, and I know it's five o'clock and it's dangerous territory, and so I am going to be quick and brief, and hopefully it's easy to follow. As Roger mentioned, we've been working together for quite a while to compile and create and host GIS data and non-GIS data relevant to your management needs.

Throughout the years, we have improved the web presence and data accessibility by employing the latest technologies. We started back in the dark ages with a product called ESRI ArcIMS to serve the data, and it eventually transitioned to ArcGIS Server, which has been scalable and has been in use for quite a while. Then it was followed by the Web ADF, the Flex, JavaScript, the particularly technologies to serve web applications, and the last topic that we're exploring right now is using ArcGIS Online.

An overview of my talk, I'm going to go through the digital dashboard that we have developed for the council, and we'll touch on some tools that are available in the Habitat and Ecosystem Atlas. We will look at the SA Fisheries, which is a new JavaScript web application, and then we'll look at a couple of examples of how we're using ArcGIS Online to serve data.

First, the dashboard. It serves as a one-stop shop for all SAFMC GIS data and their applications. It integrates links to collaborative projects and builds connections with their regional partners, and it also enhances accessibility and visibility of state and regional efforts.

The entry page serves as a launchpad for the different web applications we've developed there along the bottom, and they are the fisheries and species occurrence, regulations in managed areas, there's an application geared toward EFH and EFH HAPCs, and, finally, the Habitat and Ecosystem Atlas.

The main purpose of the dashboard is to provide the GIS data in a variety of formats, and so those are accessible through map services, a data catalog, ArcGIS Online, there's a marine traffic page, and then story maps. The map services page provides a brief overview of the various services that are accessible in the atlas, and this slide -- I won't read it all, but it just describes the different map services and the data that they are serving, and I was just curious -- While I was sitting here this afternoon, we have about 500 data layers that are accessible through the map services that we have compiled over the years.

Just a further explanation of what a map service is exactly, is that it makes the map features and their attribute data available in a variety of client applications. As I mentioned before, we have developed web applications for the council, using Flex and JavaScript. You can pull in an SAFMC map service if you have an ArcGIS software yourself, such as ArcMap or ArcView. You can use Google Earth to use these map services, and you can also, if you have an ArcGIS Online account, or even if you don't, you can use map services to create your own web maps and apps.

This is just an example of the endpoint for a map service, which describes what the service is, what kind of data it's serving, and then a breakdown of the individual layers. This one, just due to the screen size -- I mean there is 120 layers in this particular map service, but we're only seeing the first fifteen there.

The dashboard also has a data catalog page, where you can access zipped shapefiles, KMZ files, and the metadata associated with the GIS data layers. This marine traffic page, I didn't create it, but I just pointed to an AIS service that constantly is online, and so this page just grabs that map service and shows you what kind of ships are out off the coast, and I don't have a legend there, but the different colors represent like cargo or cruise ships or the different types of vessels, and so it's kind of a fun page just to check out on your own.

Then this ArcGIS online page, we're just beginning now to explore the capabilities that are available, and so this page is just kind of at a beginning point, but we have two examples that we're working with. The first one is a web map that we're looking at artificial reefs and the second one is an MPA map story, and I will show both of those in a little more detail following.

Finally, there is a partners page that recognizes all the partners that the council collaborates with and a projects page that highlights different projects that the council is directly involved in or is interested in collaborating with further. Finally, a contact us, a feedback option. If you see something on the dashboard or through the map services and you think there is something better or another data source or just any comments, you can provide those here on this page.

Now, just quickly, I will kind of step through a few of the tools that are available in the Habitat and Ecosystem Atlas. This is the first page that you would see when you link to it, and it provides a quick overview of the data there, and I will just go over the tools, the basics, of the interface. There is a zoom sidebar in the tool functions, which you can use to scroll and zoom on the map. It explains it there in this graphic. My favorite thing to use when I am looking at the atlas is the scroll bar on your mouse, which allows you to zoom in and zoom out. It's much easier than going over to the left and clicking on it, and so that's just a tip.

On the right-hand side, there is the layer list. These are all the map services that we are serving of managed areas, fisheries, EFH, habitats. There is tons of data here. It's overwhelming, but you

can basically find lots of information, and there is options to zoom to a particular map service, change the transparency, move the map service up or down within the legend, and get further information if you aren't sure what the map service is serving.

The toolbar, I'm going to go over some of the tools that are accessible. The first one is a find location, and so if you have an XY coordinate, you could click on the little pin button, but, for our example, I have just typed in an address, and this is the council's headquarters in Charleston. It returns a variety of results, but you usually pick the top one and it takes you right to that location.

The next tool is a search using graphics, and so you can select a few different layers, marine protected areas or SMZs, the deepwater MPAs, and you can select features on the map using these various tools. You can just click a point or you can make a line or draw a circle or a rectangle. Here, we will draw a circle and then the map gives you the features that are in that particular area. It returns them in red.

If you click on one of the returned features in this list, it will zoom to it and this one has a hyperlink. This little orange arrow means there is a hyperlink associated with that data, and that means that there is a picture that is associated with that feature.

Another search function is you can search data through attributes. In this, we can search the danger or restricted zones in the areas, and the wildcard is the percentage sign. If you just type "danger%" and hit "Search", then it returns areas that are considered, where there is military training going on and everything. Then there is also more details on the particular polygons.

You can also select features based on their location. In this example, we're using a different tool. It's a pin, and there is a variety of layers to choose from, but, for our example, we're going to choose from a reef fish abundance layer and find them that are partially or completely within deepwater MPAs.

What this does is it highlights the points from the reef fish abundance surveys that were in the deepwater snapper grouper MPAs. If you click on the table, you can click a point in that table and it will give you information, more information, about it. You can export the results to a delimited.txt file, and so this is a nice tool. I really like it.

Just a few tips. The more you zoom around the map, your browser caches those images and then it will be a little faster. Don't turn on too many layers at the same time and, if you get lost and you don't know where you are, press F5 and you will go back to the beginning.

Now I will show you the new application that we've built using JavaScript. JavaScript is really kind of taking over. The last application was built using Flex. Unfortunately, ESRI is probably not going to support and further that technology, and so we're looking at ways to keep up, and so this is using the latest modern web technology. What's really nice about it is that it runs on any device, and so you can view it on your desktop or tablet. Roger is very happy that his iPad will like these applications better and/or your smartphone.

It's pretty easy to work with and customize through a web app builder, where you can select the widgets or tools that you're interested in adding, and there is a variety of themes that come that

you can use to make coding very, very simple. The toolbars are here. It's the same kind of layout, where you can get more information by clicking on stuff.

The first thing that you can do is you can click on a particular layer. This is the coastal survey stations for 2014, and you can either popups, which provide information when you click on the map, you can open the attribute table, or you can view the description, which is kind of like the metadata for the layer.

The first one, enable popups, as I mentioned, it would show the attributes of a particular feature when you click on it on a map, and so it's very useful. You can get more information for that point. The attribute table function displays the features of a layer in a tabular form, and all of the current visible layers of the map are shown, and so you can tab through these different selections and it would show the table for that particular layer.

Within the attribute table function, there are options to show selected or related records. You can filter the data. You can show and hide columns. The columns that you're not really interested in, you could go in and turn off. Then, finally, you can export data to CSV.

I am going to just show how you can filter the data using the species common name, and I picked black sea bass. Now my table is filtered to show only sixty-one features, and I doubt anybody noticed previously, but the coastal survey, they collect a lot of data, and that table had 13,000 rows before, and so it's just narrowing down and looking at the data that you're interested in by using the filter function is effective.

I really like the chart widget that comes with the JavaScript API. It makes it easier to observe possible trends out of the data, and so I have created several predefined chart functions that are accessible, and we're going to look at the 2014 longline shark abundance data. Here again, you can use a spatial filter to limit the features that are returned, and so I have drawn a circle where -- I'm interested in this area here, and so I drew a circle and then hit "apply" and a chart is returned for you that shows the breakdown of the species caught, and this arrow indicates that there is another chart available. This pie chart is also interactive with the map, and so if you were to click on the blacknose shark piece of the pie, then you would see that it comprises 27.5 percent of the shark abundance in that circle. Then these red squares in the map show you exactly where those blacknose sharks were caught.

The queries are kind of similar in the same way as the charts, in that they're predefined, and so you can go in and search your survey of interest. There is coastal survey, Pamlico Sound, the longline survey, and the reef fish. We're going to use the reef fish abundance, again, and you can query by the common species name. There again, you also have an option -- It's hard to read, but you could spatially filter these results, but I kind of want to see the big picture, and so we're not going to apply a spatial filter. The left panel shows the list of results that are returned. At the top, you see there is twenty-seven counts of data, and then the blue circles show you where those locations are. Clicking on one of those items in the list will zoom to a particular feature.

Quickly, we will talk about ArcGIS Online. It's kind of a new way for ESRI, I guess, to get more people involved in using GIS. It's very easy to create and share maps with defined groups or with everyone, the general public. It's hosted through ESRI secure cloud services, and it provides an easy way to customize maps, apps, and templates.

First, I will talk a little about the web maps that ArcGIS online offers. They can be created in a few basic steps, and they are accessible through standard web browsers. It plays with all the major ones, Internet Explorer and Mozilla Firefox and Google Chrome, and it's easily shared through links. You can embed web maps in websites and you can also, through the interface, create your own map-based web application.

This map is a map that I put together just to show artificial reefs in the region, and so we've got North Carolina data all the way through Florida, and we are also displaying the special management zones in this map. There is a very simple toolbar at the top, where you can share your web map, as I mentioned before, with the URL links. You can print the map or you can measure distances, if you want to see the distance between two SMZs, and there is a bookmark function.

You can also use the smart symbology that's built in with the ArcGIS Online to change how a map is displayed, and you can do that through -- There's a little icon here that's a circle, a triangle, and a square. If you were to click that, you can change the symbology of that layer, and there is something called a heat map option. This shows the artificial reef density for Florida, and so the blues and the purples are low areas of density and then these areas of yellow and orange, those are where the artificial reefs are highly concentrated. I thought that was kind of a neat way to look at the data.

With the ArcGIS Online, there's free accounts that you can -- You just go on to the website, ArcGIS.com, and you can create a free trial period account and create your own web maps, but you're going to be limited with your functionality. At FWC, we have invested in ArcGIS online, and we have an organizational account. I am just going to show the features that, if you do have one, some of the things that you can do with that functionality.

My tools, I have a lot more to work with now. I can add data to the map. There is an analysis button. I can change the map. I can go in and add more data. There is a directions functionality, which we're out in the marine environment and that doesn't work, and the measure and bookmarks tools are still accessible.

One of the great things that you can do is just go to the "add data" button and use -- There is something that ESRI has created called the Living Atlas, and so they just have tons and tons of data and different base maps that you can add to your web map, and so, since we are interested in bathymetry, I thought I would show how easy it is to add a bathymetry dataset to your web map, and so this is how it came across at first, and I was, well, I really don't like that black and white and gray stuff, and so you also have the option to change the symbology of that layer with these predefined renderers that ESRI provides, and so I selected the cartographer renderer and changed it to something more like we're used to when we're looking at bathymetry. The bookmark function is just a quick way for people to jump to an area of interest. If I select the South Carolina artificial reefs layer, it zooms the map to off the coast of South Carolina.

Another function that comes with an organizational account is you can do analysis with your data. We will just step through an easy example of the summarize within tool. What we're going to do is we're going to summarize the South Carolina artificial reefs that are found within special management zones, and so this tool then provides a new layer that you can add to your map that

shows an aggregation of South Carolina artificial reefs to SMZs, and so the larger circles are the SMZs with a higher count of artificial reefs found within them.

As I mentioned before, you can share your web map, and this provides you a -- You can say, oh, I don't want everybody to see it and I just want the South Atlantic Council's Habitat AP to view it, and, working with Roger, we can get you the generic password, kind of, so that -- We're kind of working with FWC's account, and we have to figure out a way to share maps, but if you just say that everyone can view it, then that's not a problem, but, to have the South Atlantic Council Habitat AP group, I would assign like a generic kind of user ID and password and we could share it with that group. If there were data-sensitive issues, then we could work around those and only the Habitat AP would view the map.

This I like, too. The URL that it provides is short and sweet. It's not crazy long, and so you can just copy that URL and send an email to somebody and say, hey, check out my web map, or, as I mentioned before, there are options where you can embed the -- They give you the code to embed a map in your website or you can create your own web application through this function.

Finally, I will talk about the story map concept. It's kind of a new approach to creating maps, where you can combine your maps with narrative text and images to tell your story. You can showcase your organization's projects and plans, and it's a great way to engage and educate the community and decision makers.

This first story map was built for the deepwater marine protected areas, and I built this several years ago, using a template, and it probably took a day to create. The text, I grabbed from a South Atlantic brochure. The images were a little harder to get. We didn't have an image for the artificial reef MPAs and so I just used this image, but, anyway, it's a great way to learn more information and for users to see what it looks like and why we're protecting this and why we care.

A newer format that I'm working on now is a tabbed story map, where users can click on these tabs along the top and then a different map is displayed, and so this first one shows the SMZs. The text helps describe why SMZs are there and then links to the federal regulations are provided. They can zoom in and zoom out and click on features and get information, and it's an easy way to quickly see and visualize the different managed areas that the council has.

A picture is worth a thousand words, and you can incorporate images and you can incorporate video. I just think the story map is a really easy way to share a lot of information through one application. In my presentation, I have just provided all the links to the applications that I discussed, and I am happy to take any questions you might have. Thank you.

MR. HAYMANS: I am impressed. Eighty-eight slides in under thirty minutes. I am impressed. Are there questions for Tina?

DR. LANEY: Tina, when you create a map, is there some way to output it then in a JPEG file, for example, so you can use it in reports and things like that?

MS. UDOUJ: Yes, there is a print function on all of the applications.

MR. HAYMANS: I don't know how much any of you have -- I know we rotate council members on and off at varying times, and we've seen the dashboard for now about five years. It's continuing to improve. I love it to be able to go and look at nothing but depths of various areas and the line contours and look at the depth over that. There is so many useful tools about it. Did you have something, Roger?

MR. PUGLIESE: Just that that's one of the challenges with this, is that it's continually evolving technology and information and availability and the ability to distribute it. We had some talks last year directly with the ESRI's Chief Scientist, Dawn Wright, about evolving and looking at how the ArcGIS and some of the things she showed on ArcGIS Online, how we go and -- I was going in there thinking that we were just going to jump right in, and it's a reality check on balancing between some of the newest technologies and some of the things on the services that really provide this information into the future.

We're going to shore up a lot more, I think, of maybe user-specific access to things, so if an individual wants to look at it for a research aspect or different aspects, there may be some ways to tailor how you go in there and the realigning of maybe the layers and different things, everything from the simplest to maybe the more complex, and then other access to detailed information, which has always been a challenge with trying to get to some of the more detailed with researchers.

This is, again, connected very closely to our activities with the Fishery Ecosystem Plan and how some of those may be able to draw -- One of the biggest things too is that, in a lot of other forums, where they're using some of these different pieces of information, EFH distribution and species and different things, what we really ultimately want to do is have this be the point-to site, so that that gets consumed by the Landscape Conservation Cooperative, if it's looking at it for the blueprint, or when the Governors Alliance was looking at layers for that, so those become the ones, instead of it regenerating and creating things that are not up to date, and so I think that's a challenge, but I think there's a lot, and it's advancing pretty significantly and new generations, I think even this next generation of 10.3, is going to advance it further, in terms of us being able to quickly adjust the structure and the capability of the system.

MR. HAYMANS: Tina, thank you so much.

MS. UDOUJ: Thank you.

MR. HAYMANS: For our last presentation in Applying Emerging Technologies and 21st Century Data Gathering and Presentations, we have a presentation by Jim Morley on the Ocean Adapt Climate Tool. Jim, I'm sorry that you are the last one on the straw, but --

MR. MORLEY: Thanks to the council for inviting me here and having me here today and staying late. I'm here to talk about Ocean Adapt, which is a website that really brings together and summarizes a large amount of fisheries-independent trawl survey data from around the country. It offers a really easy to use web tool for tracking long-term distribution changes in marine species, and so it follows really nicely from the previous talk, in that it really streamlines complex data sources and makes it a lot more open and accessible.

The site was developed by Malin Pinsky up at Rutgers with partnerships with NOAA Fisheries, including Roger Griffis and Jon Hare. Ryan Batt and myself are both post-docs in Malin's lab,

and we have contributed, in various extents, to the data curation. The site has been funded by NOAA Fisheries and through Pew and then from the university itself.

Today, I'm going to start just by talking a little bit about climate change, something you've probably heard a lot about, and just why temperature is really important for marine species. Then I'm going to actually go to the Ocean Adapt tool and click around a little bit and show you how it works. Then I'm going to finish by talking a little bit about some of the work we've been doing in the Southeast in showing how the near-shore assemblage is really sensitive to climate variability. Then I will finish by talking a little bit about what's to come within the next year on Ocean Adapt, and that's predicting distribution changes into the future.

Over the last century or so, global temperatures have risen by about two degrees Fahrenheit, and much of that has occurred in the last three decades or so. These are maps just showing temperature change from those indicated years compared to a baseline period in the middle of the 1900s. These are the more recent decades. As you may have heard, 2014 and 2015 were both record-breaking years for global temperature, with record low amounts of Artic sea ice, and so temperatures are changing quickly, and that's really important for marine species.

That's because the vast majority of marine species are ectothermic, which means their body temperature matches the sea water that they're in, and that's very significant because metabolic functioning is really defined by temperature, and so, for this example, I'm showing the minimum amount of oxygen required for any theoretical fish to survive, just to perform the most basic of metabolic needs. It increases with temperature.

I will superimpose on that a curve that's showing the maximum amount of oxygen this individual can obtain from the environment, and it's a dome-shaped relationship with temperature, and this is really a function of the gills and the circulatory system of fish. As temperatures get too warm, the gills essentially get maxed out and they can't obtain enough oxygen, and that puts the individual into oxygen debt and stress, and this is really the fundamental reason why fish and ectotherms are so tied to their temperature.

It's in this intermediate region where there is a surplus in oxygen. They're obtaining more than they need for basic needs, and that's what can be used for digestion and growth and really being successful among competitors. If a fish finds itself outside of that range, then it's major physiological stress.

We identify this range in temperatures as the thermal envelope of a species, and this is really based on really well-known principles about how ectotherms relate to temperatures, and temperature really provides or really creates the broad geographic boundary where any species can exist.

Different species all have their own somewhat unique thermal envelopes, and here is just a couple of examples from the Southeast, Spanish mackerel and butterfish. These thermal envelopes can be estimated using fishery-independent survey data. In this case, the statistical thermal envelope really is relating to the range in temperatures where the predicted catch is expected to be a little bit higher, and estimating thermal envelopes in this way is really useful, because we can look at long-term shifts in species distributions and see if they relate to how that species thermal envelope has shifted across the seascape. Are species following their preferred temperatures, in other words?

What this plot is showing is each of these individual points is representing a different species. These species are coming from all over North America for this. On the X-axis is the rate at which that species thermal envelope is shifting across the seascape. If it's to the right of that vertical line, that species preferred temperatures are shifting northward. If it's to the left, they are shifting southward, due to climate change.

On the Y-axis is the actual rate at which the actual fish or whatever are shifting across the seascape. If it's above that horizontal line, that means they're shifting northward. If it's below, it's southward. As you can surmise just by looking at this, there is a really strong relationship and species distribution shifts -- They are really shifting the distribution to stay within their preferred temperatures, as climate change changes the geographic location of that thermal envelope. There is a near 40 percent amount of variation explained from this one single factor, and it's pretty impressive in ecology.

Changing distributions are very important in a fisheries management context. First of all, they occur much more rapidly in an era of rapid climate change. Shifts in distribution can result from changes in stock productivity. In other words, changing ocean conditions might affect, increase or decrease, the productivity of a stock in any one region, and that can lead to a distribution shift towards the more productive region, and so distribution shifts can sort of be a symptom, in that sense.

They can lead to conflicts between states and management regions, and we've been hearing a lot about conflicts between the Mid-Atlantic and the New England Council over summer flounder, scup, and black sea bass, as those species are shifting into New England waters. Then I guess you guys have had your own conflicts with blueline tilefish and then maybe cobia as well. They can also affect fisherman behavior, and hopefully I will have time to show an example on that.

The graphic I have here is just -- It comes from an article from the *Wall Street Journal* last month. I just put that on there to show that changing species distribution has been getting national attention, a lot of press, and I also put this graphic on here because the *Wall Street Journal* got the data for this graphic from Ocean Adapt, and so the website has been getting a lot of good attention as well.

This is an example of how shifting species distribution can affect fishermen's behavior. This is work from Talia Young, who is a recent PhD grad from Rutgers, and other folks. She analyzed VTR data from the Northeast, and, for this example anyway, she looked at large trawlers hailing from Beaufort, North Carolina, and these guys are mainly targeting summer flounder and croaker.

Each one of these squares is representing a geographic center of fishing effort in a given year. The lighter squares are from the past and the darker squares are from more recent years, and so you can see, in the late 1990s, this fishery was centered around North Carolina. In modern times, now they're centered all the way off of New Jersey. As the summer flounder stock has shifted northward, the fishermen have followed in great distances.

Now I am getting more into the web tool itself. As I mentioned before, Ocean Adapt is really designed to track long-term shifts in species distribution. There is over 600 species represented on the site, and these include fish, invertebrates, and sea turtles. The website is really great, in that

it streamlines a lot of different survey data from different sources, and these are large datasets in different formats, and each requires a different amount of quality control.

The methods for tracking distribution change are based on peer-reviewed, published methods. We update it as new data becomes available, and it's really -- We're going for a broad audience, and so fisheries managers, fishermen, and the general public themselves. I should say that the site isn't necessarily tied directly to climate. There's not much mention of climate on the site. It's just about distribution shifts, because distribution shifts can occur from multiple other sources, like fishing pressure, for example.

These are the trawl surveys that are pulled together for the website. Each of these red polygons is representing the sampling footprint of each one of these different surveys, and some of these surveys go back fifty years, and I will talk a little bit more about the survey that is local, the SEAMAP South Atlantic Survey, although you guys probably are pretty well aware of how this survey operates, but just in case.

The SEAMAP survey has been going on for about twenty-five years, through South Carolina DNR, and they've had really consistent sampling throughout that time, sampling spring, summer, and fall, and the survey is restricted to really near-shore waters, and so between four and ten meters, and so that's one limitation, but it has a really good latitudinal range and good data coverage. The survey area is split into twenty-four strata along the coast, and you might be able to see these as those individual green bars that run and down the coast.

The way we calculate distribution changes for the site, I will give a couple of examples. This one is for king mackerel during the spring season. There is an example of a map on the left, and that's a distribution map for king mackerel in 1997, during the spring. Each one of those reddish-orange circles is representing the relative biomass of one of those strata, and then you seem some blank areas there. That is just indicating no king mackerel were caught in that area.

I won't go into the pretty simple statistic that we use, but the central rate is just the latitude at which the center of biomass occurs, and it's based on those biomass estimates in each of those strata. For this particular example, king mackerel have shifted southward by about 110 kilometers per decade over the series, and I should note this is the SEAMAP survey, and so these are mainly one-year-old mackerel in this case.

Not all of the surveys are tied so closely to the coast, and here's an example of the Northeast survey. This survey covers the whole shelf. You can see those little gray X's are just indicating areas where there was no lobster caught, in this case. For these types of surveys, we can get not only a latitude of center of biomass, but we can also see how depth has changed over time, and I will show you an example of that when I'm looking at the website itself. Lobster are a species that have shifted quite a bit.

Now I'm going to exit out of here and show you the website. It's a really simple website. This is the home page. You are free to click around on it yourself. You can get to it if you just type "oceanadapt" as one word on Google. There is four areas to launch from on the home page. We have some background information and instructions, which I won't go into, and there is blogs that are updated here and there, and the blogs are targeting sort of a more broad audience. They are put together by undergraduates at Rutgers.

You can download data. You can download the raw survey data, at least most of it, I think, and you can also download data that is in various stages of being processed, individual species and so forth. The major area of interest is this explore data and the regional data, especially.

Here, in this dropdown menu, you can choose what region you want to look at, and so I will show you the Southeast. This is the SEAMAP data, the Southeast in the spring, as indicated by the little icon over here. Then you can choose what species you want to look at. There is a lot of species here to choose from, and they are all -- There is some inclusion criteria there, based on the abundance, and so I will choose cobia.

This is the time series of cobia distribution in the spring. In this example, you can see the cobia in the SEAMAP survey have shifted northward by about two degrees latitude over the course of the survey. Then, if you scroll down further, there are distribution maps available. The map just kind of continues through the time series over and over again, but you can stop and click it and drag around and look at how density has changed. Cobia are a little bit more of a rare species. Other species, there is a lot more being represented there.

I will show you a different example from a different region. In the Northeast U.S., where there have been some major changes, we will look at -- Red hake are really moving. Here is an example for red hake in the Northeast, and they have shifted -- They have kind of maxed out how far they can shift, as they're in the Gulf of Maine now, but, because this is a survey that operates on the entire continental shelf, you can also see a change in depth. You can see this species exploding into the Gulf of Maine up from the Mid-Atlantic.

One last thing I will talk about on the website is there is an option for the species at the top, where it says "all", and what this is showing is just all of those species averaged together and their rate of shift. In the Northeast, you can see the assemblage of all those species as a whole has shifted northward and into deeper waters. By comparison, in the Southeast, it's a shorter time series, and so it's kind of hard to see any larger trend, but maybe some evidence of a small shift to the north.

Now, for the last bit of this talk, I'm going to talk about some of our work in the Southeast and give you a preview of what's to come on Ocean Adapt. Starting here, this is a map of sea surface temperature changes over the last hundred years or so, and you can see that temperature increases aren't uniform across the globe. It's more of a mosaic, and there are some areas that are warming faster than others.

I also show this map because, if you look in your home region, that temperatures have been relatively more stable, as compared to the rest of the globe, and so I think that's one reason why you guys haven't been seeing the huge changes that they've been seeing up in the Northeast, but, as I will talk about in a minute, I think that's going to change, and potentially soon.

Because of that, we were really interested more in climate variability and how it affects the coastal assemblage. In particular, we were interested in winter climate variability, because year-to-year variation in winter temperatures were a lot more variable than summer, like twice as variable, and so we thought that winter might be really an important season for defining species distribution. I am going to walk you through this, and I know you're scratching your head right now.

This analysis is based on the SEAMAP survey, and we looked at eighty-three different species, the ones that were relatively common in the survey. We calculated annual estimates of biomass during the summer throughout the whole sampling footprint of the SEAMAP survey for all eighty-three species and, as expected, summer biomass for a lot of these species bounces around a lot from year to year. There's a lot of variability.

We wanted to see if any of that variation in summer biomass could be explained by temperatures during the previous winter, because winter is a really variable time of year. What the graphic is showing are each one of those bars is representing an individual species, and so there is eighty-three bars there. They are stacked from the most northern species, and so species that are a bit more temperate, down to the more tropical species down in the south.

For each species, the red bars are showing that species as a positive relationship with warm temperatures. After a warm winter, those species are more abundant during the summer. The blue bars are the negative relationships. After a warm winter, those species are less abundant after a warm winter. I will let you digest that for a minute.

I will show you a couple of example species that hopefully drive that home. I will use bluefish here for representing a northern species, and I will use bonnethead to represent a southern species. For each of these new plots, each one of those points is representing an annual estimate of summer biomass, throughout the whole sampling region. There is twenty-five points there for twenty-five years.

This is related to the average winter temperatures from the previous winter. For bluefish, you can see they are less abundant after mild winters. On the other hand, bonnethead are more abundant after mild winters, and so it's interesting in itself, but the interesting thing here, overall, is that, as you progress from the more northern species to the southern species, you see this shift in their relationship to winter temperatures.

This really suggests that winter temperatures can act as a strong biogeographic barrier for those tropical species, and we expect that, as temperatures increase, there is going to be a community shift towards more tropical species, as these species do well after winter, versus the northern species are less abundant after winter. It's important to note that this analysis is really based on year-to-year variation. There is no trend, and so it suggests that this community will respond rapidly with projected changes.

What I am showing here are temperature projections for this region, and this is feeding into what Ocean Adapt is going to be adding soon. Each one of these time series lines is representing a climate projection model, and there is thirteen different climate projection models, and they each have a different color.

This can be visualized as to a range of possible outcomes with climate change in the Southeast Region. The top graph is averaging temperatures within the MARMAP and the SEFIS survey program, and the bottom map is averaging temperature within the SEAMAP sampling footprint, and so the top is basically representing predicted temperature increases on the continental shelf and the bottom is predicted increases in the near-shore.

On the continental shelf, there is a predicted average increase of over two degrees Celsius in the coming century, and it's a little bit warmer in the near-shore, about three degrees. While that seems like a really long time for the temperature to occur, these rates of temperature increase are very similar to what has been seen in the Mid-Atlantic the past few decades, and so the continental shelf is actually really similar to what's been seen recently. The near-shore projections are even warmer than what's been observed in the Mid-Atlantic, and so there is potentially major changes for this area to come.

The last thing I'm going to talk about is what we are going to be adding to Ocean Adapt within this next year, and that's predicting distribution changes into the future for a large number of species all over North America, and these predictions are based on those thermal envelope models that I talked about earlier and also on the climate projection models, a summary of which I just showed on the previous slide.

Unfortunately, we don't have any preliminary data for the Southeast yet, but we are going to include the MARMAP survey for this. We weren't able to do it for the distribution, and so we will have projections for a lot of the important reef fish species that you guys are interested in. I did use a species that you're sort of interested in here. This is the Mid-Atlantic stock for black sea bass, and so the South Atlantic will be a little bit different, but the top-left figure is just showing the predicted increase in latitude in the coming century, and all those gray lines are just different projection models and representing a range of possibilities.

Then the two maps are just to visualize that. You can see that black sea bass, with climate change in the Mid-Atlantic, are expected to really benefit from warming. Their area of suitable habitat will increase, and they will probably expand even more so into the Gulf of Maine.

Just to wrap things up, once again, Ocean Adapt is hopefully a useful management tool for you all. Marine fish are shifting rapidly in an era of climate change, and Ocean Adapt just provides data that hopefully assists with adaptive management in whatever small way it might, and it's important to note the fisheries, at least the number of fisheries that have been analyzed so far, tend to lag behind these distribution shifts, which could indicate, in some instances, economic loss. Distribution shifts are really important to consider in an ecosystem management framework. One example is shifting distributions could affect really important trophic linkages and so forth.

Then, to close, just a few notes about expectations about how fishery management might change in an era of rapid changing climate, and the first one is really a recommendation, I guess, towards a logical first and relatively simple step that the South Atlantic Council could even take towards a more climate-based policy, and that's just developing bioclimatic indicators for the region that could be presented to the council or provided to the council once or twice a year, and it could just be a page of updated information.

These indicators could include temperature summaries and precipitation and that sort of thing, but I think it's also important to include biological indicators of known climate-sensitive species, and you guys could put these together with available survey data, with SEAMAP and MARMAP. I just have one example here for white shrimp, which is a really known sensitive species to winter kills. The graph is just showing the annual biomass off the Carolinas during spring and how it relates to winter temperatures, and that is a logarithmic scale, and so the species is actually even more sensitive than what might be indicated. If you develop an index for white shrimp, for

example, and you see a series of years where this index is increasing, it might suggest that the -- It might serve to indicate that the community as a whole is shifting towards more warmer-water species.

Then the last two are expectations. Increase coordination between councils, and, like I said, you guys are already experiencing that, and so I don't think I need to belabor that point. Also, I think it's really important and hopefully becoming easier to track changes in species distribution through time, because changes in distribution can indicate other potential difficulties with management and, again, as I mentioned before, changing conditions can lead to productivity changes in a stock, and that can affect your predictions of how a stock might respond to fishing pressure, which could lead to overfishing or it could also lead to economic loss to fishermen. That's it. I would be happy to answer questions.

MR. HAYMANS: Very interesting. Thank you, Jim.

MR. COX: That was interesting. I guess North Carolina better start getting our spiny lobster traps ready, but, seriously, do you have any recommendations for policy, for maybe something that Roger touched on earlier?

MR. MORLEY: Policy for specific species? Not necessarily. I mean my analyses have really been sort of a broad-based approach, looking at all the species and assemblage responses, and so I guess I wouldn't feel comfortable giving any policy recommendations for specific species.

MR. HAYMANS: I would ask though, with some of the SEAMAP data of those eighty-three species, some of them had very low occurrence in there, right?

MR. MORLEY: Yes.

DR. DUVAL: Jim, I am curious if some of the work that you all have done through Ocean Adapt, especially, maybe more so, in the Northeast, since there has been greater changes in species distribution shifts, but, in terms of the cooperation with the Northeast Fisheries Science Center up there, working with any of the stock assessment analysts, to try to incorporate some of these distributional shifts into some of their assessments -- I mean they're set up a little bit differently than we are down here in the Southeast.

They are able to have sort of turn-of-the-crank updates to their assessments on a more frequent basis, but I was curious if there had been any collaboration with folks up there, that you were aware of, in terms of trying to incorporate this type of modeling into the assessments, because I think that would certainly help to inform development of these annual bioclimatic indicators.

MR. MORLEY: I am really not sure what level of collaboration has been going on. There's a number of people working on this project, and different people are sort of focused on different areas, and so I'm not sure.

DR. PONWITH: Just to that point, earlier, Roger had mentioned that we were collaborating on the climate regional action plan, and one of the elements in that table that we've developed is to conduct climate vulnerability analyses, and we're trying to get ourselves set up to do that in 2017. It's something that the Northeast has already completed.

Those climate vulnerability analyses can use patterns like this to understand the sensitivities of these animals in terms of the impact to them, and that would help guide us also in being able to set priorities for modifying thresholds in stock assessments for changes in distribution for these or the distribution and densities of these animals relative to climate. That very thinking is something that we're working on even as we speak in developing the regional action plan.

MR. MORLEY: Great.

MR. HAYMANS: Thank you, all, for your attention. I am just going to say if there is no other business to come before -- First of all, thank you, Jim, very much for bringing up the rear, so to speak. It's a bad position to be in, but we do thank you. There is no other business before this committee, and the committee is adjourned.

(Whereupon, the meeting adjourned on June 13, 2016.)

Certified By: _____ Date: _____

Transcribed By:
Amanda Thomas
August 2, 2016

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