ERDC-EL

Moderator: Courtney Chambers

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12:56 am CT

Courtney Chambers: Okay, at this time I'm going to give you today's speaker on oyster habitat suitability index benefits modeling. Dr. Todd Swannack is a research biologist with the US Army Research and Development Center with over 12 years of experience in the development and application of quantitative ecological models. Dr. Swannack has co-authored the textbook "Ecological modeling, a commonsense approach to theory and practice," and has written over 40 scientific publications focusing on applying ecological modeling tools to ecosystem development and the population dynamics of threatened and endangered species. Currently, Todd is the team lead for the integrated ecological modeling team and their research focuses on developing state of the art approaches for addressing the environmental issues facing the US Army Corps of Engineers and Army including oyster restoration in the Chesapeake Bay, the appropriate application of ecological models for USACE projects, coupling hydrodynamic and ecological models and how to communicate models among other things.

Okay, additional information about Todd can be seen in his bio that's going to be posted on the learning exchange along with today's PowerPoint and recorded meeting. We're very happy to have you with us today, Todd. At this time, I'm going to give you the presenter rights, enter listen only mode and then we can begin.

Operator: All participants are now in listen only mode.

Dr. Todd Swannack: Hello. Courtney, can you hear me?

Courtney Chambers: Yes, I can.

Dr. Todd Swannack: Okay, cool. Great.

Courtney Chambers: I'm making you the presenter right now.

Dr. Todd Swannack: Okay. Great. Thank you. Thanks for the opportunity to present to this group. I see a lot of familiar names on the participant list, so hey. For those I don't know, thank you so much for dialing in and I look forward to talking to you about some of the research we've been doing for the last three years.

I'd like to give a shout out to my co-author and partner in scientific crime, (Molly Reef). She's a research geographer with the environmental lab and she helped with a lot of the geospatial processing developed some of the algorithms for that and she's on part of this Webinar, too, and will be available to answer questions afterwards. So thanks again. And so we'll kind of get started. What I'd like to do today is talk about some of the work we've been working on to develop some suitability based models for oyster restoration throughout the Atlantic and Gulf Coast.

This was a project that was started about three years ago. And we have finished up the suitability indices modeling actually just this past FY and are continuing to work on some - developing some benefit algorithms to help determine environmental benefits of oyster restoration and that should be finished in February and you should see a report on that shortly.

So- let's see, so one of the things we're dealing with globally is oyster abundance has changed. It's - and this is having some impact not only on the commercial fishery but also on the environmental benefits that oysters produce. So oyster (eggs) provide tremendous environmental and economic benefits. So the fishery is pretty big. It's hundreds of millions of dollars a year but at the same time, oysters are ecosystem engineers and they provide a lot of environmental benefits. They filter water. They provide habitat. They also provide (cover) for storm surge protection. So you have this really interesting species that's found in estuaries and along the coast that actually have tremendous economic benefit and potential but also their presence in the water actually helps protect our coastlines and increase biodiversity at a local scale.

So we're kind of faced with this idea of how do we balance these two out, the economics and the environmental side? So there are different viewpoints on how to restore oysters and maintain a fishery and some of our group's other work focuses on trying to look at those tradeoffs but this particular work is focused on how to determine where good areas for oyster restoration would be.

So it's worth having an ecosystem restoration project and oysters are a component of that. You can use this model that we've developed to help identify a kind of target specific areas where ecosystem restoration for oysters can occur.

So oyster restoration is pretty important throughout US waters. And from the planning side, we need to be able to plan restoration projects efficiently. That's, you know, we need to be able to determine where suitable habitats would be and we know a lot about where oysters are in certain parts of the world, for example, in Chesapeake Bay, we have a pretty good idea of where oysters can exist.

But as you move outside of well-studied areas, we don't really know where we can restore oysters - or we don't know that as well as we would, like, in our highly studied site area in Chesapeake Bay.

And then not only that but we also have to understand the environmental benefits that we're getting from restoration projects. We're reaching a point, not only as an organization but in the scientific community as a whole where we want to be able to quantify something more than habitat restored. So we can go in and we can restore a reef and we can say we put this reef in, but now we're interested in actually understanding the quantification of the environmental benefits that are occurring. So how much water is being filtered? How much carbon is being sequestered? How much phosphorous and nitrogen are being pulled out of the system or cycled through? And we're trying to figure out how to kind of couple not only the beginning stages of a planning project, like where can we put the reefs, but also what's going to happen, although we want a better idea of what's going to happen when we create that habitat.

So we want a full kind of holistic system view of what's going on. So the - for the first part of this research and the part that I'm going to focus on today is it's - we need to identify where good areas for oyster restoration is. So we need to identify the general relationship between the species and environment.

This is a very typical habitat suitability approach so given, in certain environmental conditions, is that good or bad or the species we're interested in restoring and in this case, it's oysters. So we need to determine, you know, the potential locations for suitable habitat, and we need to be able to do this in a way that utilizes existing data. We need to be able to do this in a way that's scientifically defensible and the way that we do this needs to be completely transparent to people outside the Corps of Engineers.

So when we say we have chosen this area, we need a scientifically defensible and transparent quantitative methodology to present to interested authorities or stakeholders and say this is what we've done. We followed these steps and they can recreate the areas that we've chosen so that we can start facilitating open dialogue and discussion among stakeholder groups that are interested in restoration.

And this kind of helps in all - speaking candidly, everybody kind of plays nice and gets along when we're very transparent about what we're doing. At the same time - and this is the research that we're about to finish now - you know, we need to understand, then, what environmental benefits result from restoration.

And what we've done is we've taken some work from (Carl Cerco) - work that's being led by (Carl Cerco) and Mark Noel who developed a relatively complex systems model for Chesapeake Bay system and they've taken out the oyster components of their model and we're looking at specific environmental benefits of oyster restoration.

But the idea is that this - you have some environmental variable and you have an environmental benefit associated with that, and that's the difference between the grid, the green and red dots. But then if you do a particular project where you restore more oyster reefs or whatever, then your baseline environmental benefit actually starts to increase and this actually - what we're doing is we're filling you in on how to quantify water quality benefits of oyster restoration.

So when this project first got started, we sat down and tried to determine the best way to approach coming up with a transparent quantitative methodology for oyster restoration. Rather than develop a suitability model in-house at ERDC, we decided to have a workshop with oyster experts that are throughout the US in order to understand the critical environmental factors for restoration.

And again, this is all part of facilitating scientific sensibility and transparency. And the idea is we pulled in oyster experts from not only within the Corps but also USGS and some academic folks to sit down in a room and talk about just oyster ecology for a day and a half and to develop a conceptual model of how we thought the system worked and what kind of - how the oysters were related to specific environmental parameters.

And by doing this, with - there was about 20 or so people there - by doing this we were able to get consensus on a conceptual path forward from the group of experts throughout the country, and again, it - the group contained academics, other federal agencies and a lot of USACE folks who dedicated their careers to oysters.

So we developed this conceptual model and we use this as a template for our quantification of suitability - for our suitability model, then using that template, we developed a quantitative based habitat suitability model, that's what HSI stands for, through oyster - for oysters throughout their distribution. And then on the backend, and the stuff we're working on now, finishing up, is we developed a benefit algorithm to determine the benefits of potential restoration projects or project alternatives.

So here's the conceptual model. If you look at the one on the left, this is the conceptual model for oysters. One thing I'd like to point out is (Tomma Barnes) facilitated the modeling workshop and put together the report and wrote the report and actually developed the conceptualization of this system.

So if you look at this model, it's relatively complex and it had most of the interactions that the group could come up with from our workshop. So it was a relatively intense two-day workshop. And we came up with all the potential ways oysters in their environment (will act).

One of the problems on the modeling side is it incorporates all of the possible interactions. You're developing something that's almost computationally intractable and it also, you know, looking at every specific interaction, decreases the - we wanted something relatively simple that was still defensible and so you have some - you're faced with developing something that was really complex.

So we sat down with (Tom Soniya) from University of New Orleans to - he's an oyster modeling guru - and further refined the conceptual model and realized that we could actually get a pretty good idea of where good habitat for oysters was based on two parameters based on whether or not they're a suitable substrate and that's what you see on the graph on the right side, the figure on the right side and the small box, and different values of salinity.

So oysters are intimately tied with salinity. They're viability depends on it at different life stages and by parsing out salinity into three specific variables, which I'll touch on in a second, we were actually able to get a pretty good idea of how oysters would respond to local environmental conditions based on salinity and the suitable substrate. And in this case, substrate is called cultch. That's what oyster people call it but what a cultch is, is just hard substrate where oysters can grow. Okay, so this - these figures represent the quantification of the suitability models.

So we took a variable - the cultch and that's the top left, and then we had three different salinity variables. We looked at the minimum annual salinity, the main salinity during the spawning season and then the annual salinity throughout the year. And these captured different aspects of the life history of the oyster. For example, the salinity during the spawning season focuses on the larval component of oysters. Oysters have a (bi basic) lifecycle and while the adults are sedentary and don't move, their offspring or larva are actually motile and they can actually move in the water column and they're kind of like (patha) particles. So - but they're also really sensitive to salinity changes and it's different for the larva in adults so we had to represent - we had to capture those patterns in the oyster life history as they related to different salinity variables.

And you can see from the shape of these curves, that they're different. So different life stages of oysters actually respond differently to different salinity regimes. And that makes sense when you think about the differences in the way larva in adults work. So these - this - these four curves actually represent about 22 different equations on how oysters are related to the environment or the simplified version of the environment that we have.

And I'm going to flip and show you some of these equations. So this is pulling out one of the variables. And this is the mean salinity during spawning season. And you can see the graph on the bottom is what's called the step function. Any time that graph changes direction, that's a step. And you can break that down into a series of linear equations. What this does is actually represent quantitatively how each particular salinity regime is related to a - the life stage of that critter and in this case we're talking about the larval form.

And normally, HSI models just show you the curves and the quantification is based on a look up table like a series of if/then statements - if the salinity is five, then the suitability is low or high. And suitability in this case is quantified between 0 and 1 with a 0 being not very suitable or not suitable and 1 being essentially ideal or perfect.

And you can see here that when salinity is between 18 and 22, your habitat suitability is perfect but anything else, it's a little bit less than optimal. And so what (Molly) and I decided to do was rather than just show the curves, we realized that we could actually break out each individual linear component or each equation because what this does is it facilitates transparency and it also allows you, on the back end, once you're finished, to go in and alter specific functional relationships at specific salinities.

So right now, based on the literature values and expert opinion and scientific information that's available, you - we think this is the best shape of this curve but later, we can actually - if more data becomes available, we can actually go in and change one of these equations very simply by just altering one specific component of the look up table or the graph or the line. So this allows it to kind of be a little bit more transparent when we're communicating this to stakeholders because they can actually look at individual segments of these lines.

And so we did this for each of the four graphs that you saw. So what you do, once you get the suitability curves developed and you write your equations, you then combine them into a composite score, and in this case, we're calling it the RSI value or the restoration suitability index, which is just the geometric mean of those four values.

And what - we use the geometric mean because if any value is not suitable, so that - like, if one value (sucks) for oyster habitat, it wipes out the rest and say, okay, we need minimum annual salinity of 18 to 22 if it's at the zero value then the suitability at that particular location would be zero regardless of what the others were.

So once we developed the model, we brought in - we started looking at different areas for case studies and we realized that for oyster restoration, particularly from the Corps of Engineers standpoint, I mean, we're looking to restore oysters, I mean, throughout its distribution, you know, from New York all the way down to, like, in Matagorda Bay in Texas and even further south than that, so you know, the Atlantic and Gulf Coast.

And when you talk about oyster restoration in general, the first thing people thing about is Chesapeake Bay. Chesapeake Bay is a well-studied system. There's been a lot of data gathered there and a lot of modeling studies that have been done there as well. But as you swing around and you get further south and you get into the Gulf, you don't have that high fidelity data available. And so what we decided to do is to develop - to use two case studies looking at different data resources and different data types, so look at the Lower Rappahannock River in Chesapeake Bay but then also we did a case study in Western Mississippi Sound and the Gulf of Mexico.

And those two areas had really different data - different types of data available. And the reason we did this is to show the flexibility of the model in different systems. So we wanted to be able to have something that was useful throughout distribution of the Eastern oyster.

So I'm going to show you kind of what we did. In Chesapeake Bay, we had a lot of data available. We had salinity values from high fidelity, hydrodynamic models which we used the CH3D model output so we were able to extract the annual mean salinity, mean salinity during spawning season, a minimum annual salinity for three years of a long term modeling study that represented an average year, a low flow year and a high flow year that captured different extremes and salinity values of average conditions.

Our cultch values are the substrate values where from NOAA's Chesapeake Bay, (basic) habitat integration data sets as well as some use space reefs that we got from the Norfolk district and so this is a really high fidelity benthic data set that had a lot of character - that was characterized at a really fine scale.

So you can see, these are two examples. This is our study site at Chesapeake Bay. You can see on the left, these are our habitat sites and then on our right, this is an example of the salinity for the mean annual salinity. We have salinity values for each of those three different variables that I mentioned before. And once we get all of those accumulated and then we put them in a GIS framework, we're actually able to run that restoration suitability index for each grid cell within the model.

On the left-hand side, we ran the four parameter models and you can - if you just kind of take a quick glance at it without paying too much attention to the colors, but the bluer - the darker areas, the better the habitat and as you move to the yellow, it's getting worse.

You can see that the habitat changes over time. So these are three different years for the modeled study. And then on the right-hand side, you can actually see that this is without the cultch variable. So it's just the salinity only habitat suitability model.

And what you can see, salinity changes in different - there's different salinity (for) suitability for oysters depending on the year. So what this says is that the habitat is really dynamic and if you look at - if you compare the left and right figures, you can see that when you add cultch or when the substrate is considered, the figures get lighter, which means that the graph - I mean, the overall suitability for the area is getting less because oysters have to have cultch to survive according to our model or for it to be suitable.

And when you take - when you add that to the model, you really need a whole lot to make the entire area suitable. But the important thing with these graphics is that the habitat is dynamic. And so if you're going to restore a particular area, the take home message from this graphic is you can't just base your results on one year. You need to look at a series of years or you need to look at an average over time to get a general idea of what's going on.

So in the Gulf of Mexico, we actually had different data sets available. We didn't have the high fidelity, hydrodynamic models available for this area. And that's common in a lot of areas throughout the US waters. We don't have hydrodynamic models available. They're expensive to develop and it's - with sticking to the smart planning paradigm, you know, we don't have time or money to be able to go in and run hydrodynamic models. They're expensive to set up. They take some time to set up and so we're, you know, we're working on the three by two by three paradigm and, you know, we have to come up with a way that - the challenge with this particular (stay) was to come up with the methodology that allowed us to get away from being forced into particular parameterizations using hydrodynamic codes.

And so here we actually use some GIS from the state of Mississippi as well as NOAA for the cultch layer. That's what's in the top left. And then we used NOAA's oceanographic data center and we got some average values over the course of years for salinity. So we looked at the mean salinity for this particular area based on some gauge stations and some other stuff that I don't quite understand what they did. But we were able to get a lot of NOAA data that looked at salinity changes over time to give us an idea of where potential oysters - oyster restoration habitat would be.

So if you look at the top left here, the results for the HSI, and again, you can see the difference on Figure A and B. You can see the difference in the four parameter model A and the three parameter salinity only model B. Again, adding cultch change - or adding substrate changes the way that the model looks. And we were able to - one of the cool things about the Gulf of Mexico data set is we were actually able to get an independent data set to validate our model which is a mapping - the mapping of the commercial reefs which you see in orange which is - was collected in a different way than the data we used to parameterize our models. So it was kind of a check to make sure that our model was actually working given that the data (warn) is higher - high quality as in Chesapeake Bay. And you can see the orange overlays is pretty low with the other - with the higher suitability areas.

So one of the things that we noticed almost immediately is that the results for both Chesapeake Bay and the Gulf of Mexico were - the results were highly variable (when a percent) cultch was added.

And in order to facilitate scientific defensibility and transparency, we realized - (Molly) and I realized that we needed to go in and come up with a methodology to kind of quantify exactly how the model changed and how the results changed when you added different variables. And the model needed to be evaluated more thoroughly to be able to - we couldn’t just present these results and say, “Okay, here it is.” We needed a way to evaluate it and to quantify that evaluation.

So we ran a sensitivity analysis for each site which is a little different than what’s been done for a lot of HSI models. In general, HSI models are developed and very little evaluation has gone into them. And historically HSI models has kind of taken it on the chin because they're not as thoroughly evaluated. There's been a lot of work done recently in the scientific community that says basically HSI models are all right, but you have to be more transparent with your evaluation and you actually have to evaluate your model thoroughly including running a sensitivity analysis.

And so we did that. And this is a little - let me - I'm going to kind of walk through this graphic but what we did is we ran the four parameter model, the - so we put all those things together, the - and ran the model and got a suitability index. We then ran three parameter models and then looked at how that changed when particular variables were added to the model. So on the top left, that's - this is what happens when you add percent cultch to the model. We're comparing the model with cultch to without it - or without it to with it.

And when you add percent cultch you get - you can see that the percent - we looked at the percent change in suitability values. You can see that there are - the dark blue areas are areas where the HSI - overall HSI value changed by greater than 150%.

And you can see that it changed pretty dramatically. There was a lot of change in the system and that yellow color is - that it changed between 90% and 50% on the negative end, so that the suitability actually got worse when cultch was added to the model. So - and you can - the take home message here is that the model itself was really sensitive to that percent cultch variable and so this provides a quantification of what's going on with that by adding those different variables.

And you can actually - we've done that for each of the different components looking at what happens when the mean salinity spawning season was added.

That's Figure C, when the mean annual salinity was added and the minimum annual salinity was added and that's B and D respectively.

So just like I said, the percent change what - of how the HSI values changed over when you added different variables. And, again, percent cultch with that variable in there actually really affects model results.

So we did the same thing for the Gulf of Mexico and we got the same results, percent cultch really you saw a higher percentage change when cultch was added to the model compared to when other variables were added.

So what this is saying is that the percent cultch is a pretty important variable and, you know, we need to look at that a little bit more in terms of the way that the line was formulated and the parameterization because it does have a pretty big impact on the model itself. So, you know, kind of the - kind of some take home messages from this, we do feel that this simplification of a complex system was successful for identifying suitable locations for oyster restoration.

In Chesapeake Bay, we were able to get - we had a lot of high fidelity data. We're confident in those data. We're actually capturing where oysters were. In the Gulf where we had lower fidelity data, we were able to independently validate. Our model was actually predicting where good oyster habitat was.

And, again, the orange in this picture, represents an independent data set we used to validate the model. Oyster habitat is dynamic. It does change from year to year. So one caveat we have with applying this model to oyster restoration, is you do need to be careful by using just a single year's worth of data because that may not be the best location for oyster habitat the next year.

So looking at multiple years or kind of a climate based approach where you average years overt time, that may be a better idea. We were able to capture general trends in oyster habitat, what years were worse compared to moderate years. This does kind of emphasize that we can use these simple models with available data to reflect what's actually going on in the natural system. The model is really sensitive to a particular variable. In this case, it's percent cultch.

The parameterization here was a simple linear relationship, so areas without any hard substrate were consider unsuitable. So that's one of the reasons it was so sensitive. It's just there wasn't any hard substrate in a particular grid cell. Then that suitability value was zero which effectively removed it from the suitability equation overall.

So there're a couple of points here. One is if you're interested in applying restoration to a particular area, like if you're planning a study and you want to see what it's like to restore this in a particular area without substrate, you need to go in and add some substrate in the GIS layer, like, create a little polygon that represent a substrate so you can actually see how the model would work.

Say, okay, we're planning on restoring here, here and here. So we put in some simulated reefs and then the model will help kind of refine that quantification. The other thing that identifies with this percent cultch is it's not really known ecologically the exact relationship, like, how does suitable habitat change with percent with the amount of oyster shell or hard substrate on the ground?

And that's identified as a future research topic in the field. But once those data are available, one of the cool things about the approach that (Molly) and I developed is she can actually just go in and change that equation very simply and then rerun your model and it won't take that long. The framework's already set up.

So this approach is flexible and adaptable. You can use multiple data types and as new information is available, you can go in and fine tune or reparameterize. And part of the reason we wrote out all the different equations, rather than just say here's your four look up tables or four HSI curves, we have each step function represented as a linear approximation between two points.

You can, as new information becomes available, you can fine tune each of those different components. And it is important to fully evaluate the model. The sensitivity analysis allows for a deeper understanding of the model results.

But it also helps quantify your uncertainty and helps make more informed decisions. So knowing that the model is really sensitive to percent cultch is kind of identified for us but if you want to restore novel areas or new areas, you have to go in and actually say we need some hard substrate in here even if it's just in the computer, to give us a better idea of what's going on in the system.

The modeling, you know, our future work, as I mentioned, we're almost finished with our oyster benefits model and this is being led by (Carl Cerco) and Mark Noel and then, you know, on the research end on kind of the nerdier side, exploring different functional forms of the model equation. These should be evaluated to see how suitability changes based on if you shift the shape of those currents or shift the - each equation and see how the model actually responds.

So that's kind of where we are. That's all I've got. I would be more than happy to take any questions. (Molly) and I would sincerely like to thank you for being able to do this work and also to be able to present it to you today. So thank you.

Courtney Chambers: Great. Thank you very much, Todd. At this time, we're going to return to interactive mode.

Operator: All participants are now in interactive talk mode.

Courtney Chambers: Okay, so at this time, feel free to ask any questions you might have. And remember, you'll need to take your phone off of mute first. It sounds like somebody's phone is already off of mute. We do have some excess background noise. Please keep your phone on mute until you're ready to ask a question. Thank you.

(Angie Sowers): Hey, Todd. This is (Angie Sowers).

Dr. Todd Swannack: Hey.

(Angie Sowers): How are you? A quick question. The equation that (you showed) for the HSI model, those were developed based on data from across the whole geographic range of oysters?

Dr. Todd Swannack: Yes. Yes, yes, yes.

(Angie Sowers): And did you see any - I'm wondering if there's geograph- if there're differences in those equations based on, you know, Gulf of Mexico or Chesapeake Bay populations?

Dr. Todd Swannack: Yes, that's a great question. And so we didn't - so one of the things we were trying to do is come up with a generalized model that was applicable, at least, in the kind of a really broad scale, like - so the equations were the same.

So we didn't explore differences in that. And that is something that probably should be done as further refinement. We view this model as, like, a first step as - to identify areas that are good but should probably be (ground truth) before you go out and spend millions of dollars on restoring a particular area. So, you know, we haven't explored the geographic differences in parameter values.

(Angie Sowers): Okay. Thanks.

Dr. Todd Swannack: Yes.

(Ed Brown): Yes, Todd, this is (Ed Brown). Just an observation. In Florida we - the researcher, he applied a temperature model because the breeding sea- or the spawning season is much longer. And if you get one or two successful periods, if they don't get killed off, you have really a successful season. But this is, like, on the edge of the tropics though.

Dr. Todd Swannack: Right.

(Ed Brown): And we had another big driver we had. This is, you know, this is just food for thought. But South Florida, the water is controlled so much because of the lake and just the monsoonal type cycle. So we added a couple drivers. But again, that was more based upon the, you know, the local circumstances.

Dr. Todd Swannack: Yes, and so was that a (swan E) model?

(Ed Brown): Exactly. Right.

Dr. Todd Swannack: Yes, okay. Yes, and so - and that's a great point. And, you know, one of the things is that, like so for example, like, you guys know your system really well and know that those are important drivers.

Well, the point of this is that this is actually flexible enough you can add that in. If you know specifically that local conditions are particularly important, like, temperature or the controlled water, right, you can actually add that in as a variable to this and take other stuff out. I mean, the framework is actually really, really adaptable.

(Ed Brown): And we were kind of forced to have all that data because it's just - usually you don't have it to, you know...

Dr. Todd Swannack: Right. And - yes, exactly. And so some of the - like, and you guys have a lot of data down there and so it's - you know, everybody - every system - one of the challenges with developing a simple ecological model is that every system is different so we have to try and capture the essence of the system.

And so, like, I completely respect that your system is, like, has some fine - has some nuances that others don't. But at the same time, we're confident that we could get close -one of the things I would like to do is actually compare this to what you guys have to see how, you know, how close it actually is. That would be pretty fun. So maybe we can do that.

(Ed Brown): Oh yes. Yes, I didn't mean that as kind of...

Dr. Todd Swannack: No, no, no.

(Ed Brown): I was just trying to stimulate the conversation, you know.

Dr. Todd Swannack: Yes. Yes. No, I - don't worry about it. I'm - yes, so I take that as - that would be kind of a fun thing to do. So we'll look into that. Thank you.

(Ed Brown): And I had one other question.

Dr. Todd Swannack: Sure.

(Ed Brown): The other one was just, you know, kind of get the conversation going. But you've got water quality parameters. Can this conceptually look at the benefits of the actual oyster, you know...

Dr. Todd Swannack: Yes, great question. Yes, so the work that we're doing on the benefit side is almost finished. But what it will do is it will take - so let's say you have X number of oysters or X amount of oysters, it will - the model that we're developing for that, which is, again, this is Carl Cerco and Mark Noel's work, we'll be able to actually start looking at, like, the amount of carbon sequestered, amount of nitrogen or fixated or removed. He has, like, 15 different water quality parameters that are actually looking at benefits over time.

(Ed Brown): Right, okay.

Dr. Todd Swannack: Yes.

(Ed Brown): Okay, that - yes, thanks.

Dr. Todd Swannack: Yes, sure.

Courtney Chambers: Great. We still have plenty of time. If anyone has additional questions, feel free. You can also use the chat feature if you're more comfortable typing in your question. Just be sure you send that to everyone.

(Jody Cressell): Hi, Todd. This is (Jody Cressell) with the (Eco PCX). I just wondered where we were at with regard to model certification. And then you mentioned the flexibility. I just want folks to be clear that, you know, we'll certify probably the version that you have and then any modifications, we would encourage those modifications but we would have to technically review those modifications.

Dr. Todd Swannack: Right. Yes, thanks. So we sent the report to (Nathan) and he's supposed to be pursuing the first steps of getting this thing certified. So it's been submitted to you guys.

(Jody Cressell): Okay.

Dr. Todd Swannack: Yes. And then that's - you know, that's a great point and we'll make sure to include that in the report or whatever comes out that, the USACE report, about the certification, you know, making sure that if you modify it, it needs to be technically reviewed again. Thank you.

(Jody Cressell): But do you have it set up so, like, if they have, you know, if in Florida, they want to use those - if they add a component and they want to use those over and over again, that that can be incorporated and documented so then we could certify that modification?

Dr. Todd Swannack: Yes. Yes, we - I mean, it's - yes, it's set up to do that. And then, you know, and this goes into the kind of what I was talking about with (Ed), is I would like to see how these things compare because I think that's part of this, is how much better are you getting - better or worse are you getting with applying this and applying a different model?

Because that's, you know, that's something we need to consider too. And if both models are developed, it's not - it's relatively easy to do that, so - and I'm just curious about that on the nerd side, so yes.

(Jody Cressell): Thanks.

Dr. Todd Swannack: Sure.

Courtney Chambers: While you're thinking of any additional questions you might have, I'm going to send the link to the gateway where we post these archived meetings for your future reference or if you've missed any past meetings, you're welcome to go there and you can listen to them through a Windows media file. Any other questions for Todd this afternoon?

Woman: Todd, you focused on salinity and cultch. Can you discuss the reasoning for not including dissolved oxygen?

Dr. Todd Swannack: Yes. So it...

Woman: You almost got out of here easy.

Dr. Todd Swannack: I know. I know. That's - yes, that's actually a really great question and it's something we debated. And what it boiled down to was kind of, like, looking at data availability, kind of across the scope of what was available, and so we made a decision to look at - we just made an executive decision to just look at the salinity values and cultch for data availability reasons.

And it - you know, what we need - like, to more thoroughly evaluate this, we should look at dissolved oxygen but, yes, we just made the decision not to include it.

Woman: Okay. That's understandable. I understand the, you know, you want good data to base things on.

Dr. Todd Swannack: Right. And - right, yes. So...

Courtney Chambers: All right, well, thank you all very much for your questions and for the discussion we've been able to have about the topic. Todd, it's been a great presentation. Thank you for taking the time.

Dr. Todd Swannack: Thank you.

Courtney Chambers: Do you have any final comments before we close?

Dr. Todd Swannack: Yes, I do. Thanks. I just want to thank everybody again for participating. Please do not hesitate to contact me if you have any questions or comments. (Molly) and I will be more than happy to discuss anything as it relates to our work or other work or whatever. Yes, but please - thank you. Please contact us and thank you again. It was fun.

Courtney Chambers: Great. Thanks Todd. And participants, thank you all for joining. That helps make this a successful Web meeting.

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