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NORTH ATLANTIC COAST COMPREHENSIVE STUDY OVERVIEW
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>> Thanks, everyone for your patience. This is the regional office. I want to welcome you all to your session today.

We will be presenting on the North Atlantic Coast Comprehensive Study. Take it away. One reminder, please do mute your phones.

>> Good morning. This is Amy Guise. I'm the chief of the Planning Division in the Baltimore District U.S. Army Corps of Engineers and I was also -- am chief of the command center for the North Atlantic Coast Comprehensive Study.

So thank you for the opportunity to share some of our findings and details of the study with you here today.

I do want to just send regrets from Roselle Henn, who is the regional lead for the U.S. Army Corps of Engineers. She's actually on a plane. The logistics did not work for her to be involved. I'm just going to make a couple opening remarks on her behalf.

the North Atlantic Coast Comprehensive Study was a great opportunity to work with many interagency partners and certainly that includes the U.S. Fish and Wildlife Service on coastal resilience planning, and we certainly thank the U.S. Fish and Wildlife Service for all the coordination that went into producing the Planning Aid Report that accompanies this study, which was a major product. The Planning Aid Report being a major product that came out of this two-year effort. We look forward to additional opportunities to support with you throughout the northeast region and we appreciate the time you're taking today as part of the client series to learn a little bit more of the information that was collected and the science that was brought to bear on coastal planning and certainly that can certainly just sort of spearhead and catapult us into those next resilience planning efforts? We know this type of planning and analysis is not done. It's not static, so we look forward to future partnering opportunities with you. Thank you.

>> DAVE ROBBINS: Thank you, Amy. This is Dave Robbins, I'm the project manager for the North Atlantic Coast Comprehensive Study. I serve as a project or a study

manager here in the Planning Division in the Baltimore District, along with Amy, under her supervision and I participated in ecosystem restoration studies over the course of the last seven years. Again, I served as the project manager on the North Atlantic Coast Comprehensive Study. I'll be part of the presenting team here today, but before we get started, I just want to give a couple tech -- provide technical overview. Hopefully we don't have any more challenges going forward, but, again, I want to reiterate what Leah mentioned. Please mute your phones. This is an open line. We want to be sure we can reduce any static or other interference as we go through the presentation. Another item to note is we are recording the presentation and the audio as well. This information will be made available following the conclusion of this event. As well as the opportunity here today for some dialogue. However, we want to get through the presentation first and give an overview of the North Atlantic Coast Comprehensive Study and then following our presenters' discussion here of some of the topics that we want to cover, we would have a question and answer period around 12:00 today. So we'll look to have an half hour discussion. So, please, be on mute and ask your questions during the appropriate Q&A session. We'll be sure to queue the appropriate time to do that. You would like to ask a question during that Q&A period, use the chat box feature via the webinar, and if you would like to ask a verbal question, avoid talking over one another, indicate in the chat box you would like to ask a verbal question or something similar to that effect.

So without further ado, we'll talk about the North Atlantic Coast Comprehensive Study. Again, myself, I'll be providing the overview for the study, and then we want to get into a few technical discussions with other presenters here today. Tomma Barnes served as the environment lead for the North Atlantic Coast Comprehensive Study. She is currently the chief of the planning formulation economics section in the Pittsburgh district. She has been a planner in the corps for over eight years working in areas including Florida, New Orleans, and Wilmington, North Carolina before taking her current position out there in Pittsburgh. Tomma has a Ph.D. in oceanography. She'll be providing an overview today of the U.S. Fish and Wildlife Service Planning Aid Report, the specific document completed by the service for the Corps of Engineers as far as this study, as well as other information that we created with respect to environmental resources and cultural resources as part of the study.

Also here to talk today about Natural and Nature-based Features is Dr. Kelly Burks-Copes. Dr. Burks-Copes is a research ecologist with the U.S. Army Engineer Research and Development Center, the environmental laboratory in Vicksburg, Mississippi. Kelly is part of the multi-disciplinary team tasked with the characterization evaluation and integration of the Natural and Nature-based Features featured into the multiple lines of defense strategy. Kelly has interdisciplinary ecology from the University of Florida. Those are the representatives today, and without more introductions here we'll go ahead and get started.

So just an outline of the presentation, I'll be talking a little about the background, findings, outcomes and opportunities. The coastal management framework, that was a primary product generated as part of the study, which identifies flood hazards, exposure and risks. We'll talk about opportunities for risk management measures, as well as an overview of a few of the technical products that support that coastal management framework, and we'll get into two specific discussions that Tomma and Kelly will cover

as well.

The background following Hurricane Sandy, Congress passed an act which presented the Corps of Engineers authority and funding to complete the North Atlantic Coast Comprehensive Study within a few-year time frame. We recently completed the study as of January 2015, and the goals of study were, again, to provide the risk management framework that is consistent with and supports a resilient coastal community, to support the robust, sustainable coastal landscape systems, taking into account future scenarios, including sea level rise and climate change scenarios to reduce risk to vulnerable population, property and infrastructure. A little about the background. This was not a typical corporation of engineers decision document authorizing design and construction. As such there is no NEPA document that was completed as part of this effort and it is not a USACE application. Basically we wanted to complete the study to develop a comprehensive plan to address vulnerable coastal communities from coastal flood risk that could be used by a whole host of users and practitioners, including federal, state, local, NGOs, academia, et cetera. Looking to formalize and present a consistent approach to address coastal flood risk across the North Atlantic region and part of doing that we want to integrate the stages of science technique and conduct an extensive collaboration as part of the effort, including federal, stayed, tribe ball, NGOs and private industry stakeholders as part -- as we conducted this study. We did that along the way through webinars like this, as part of our interagency stakeholder effort over the course of the fall and winter, 2013 and 2014. We had a collaboration webinar series once we had draft analyzes, again, having a webinar to solicit input and feedback.. And ultimately validate some of the information coming out of this report. Overall we wanted to end up with the coastal management framework, technical various products that would assist all levels of government to make decisions going forward.

Some of the findings of North Atlantic Coast Comprehensive Study is that some of the general findings is this is a shared responsibility to address coastal flood risk across all ownership. We think the approach to increasing risk over time as a result of climate change and sea level change impact along the coastal environment.

And we also wanted to address some of the keywords here. We've been hearing about in terms of resilience and sustainability, by thinking about the combination and blended measures to ensure the redundancy and robustness of various coastal communities in terms of flood management plan or other measures in place to address risk and also thinking about increasing risk over time, again, as a result of climate change structures. Opportunities, again, some at of the outcomes and opportunities from the North Atlantic Coast Comprehensive Study was that we wanted really to emphasize and address future risk with improved pre-storm planning, again, utilize the framework to identify what is the current risk, exposure and risk in various coastal communities but then looking out and thinking about climate change adaptation, addressing future risk and the various tools and other information as part of the study. We also want to think about prioritizing critical infrastructure. We saw as a result of Hurricane Sandy, particularly in New York City metropolitan area, the critical infrastructure being damaged causes extensive indirect damage for critical services being down for a period of time. So we want to ensure that in the line of causation that we prioritize reducing damages to those critical infrastructure assets.

And as far as the rebuilding effort, we wanted to think about, again, from a systems

perspective and a combination of measures ensures redundancy components and futures are in place as part of flood risk management plans and also by doing that encouraging design, flexibility and adapt management over time to ensure that as more information becomes available in terms of climate science and other information, that that can be incorporated into our adaptive management plans and ensure that communities can be adaptive over time to address that increasing risk.

Also there were -- we advanced areas in nine focus areas, these are areas of the North Atlantic coast that did not have a corporation of engineers study or project ongoing at the time Hurricane Sandy occurred, so these are focus areas going forward we wanted to present as areas of risk that would warrant further analysis by the Corps going forward. So that's just, again, an opportunity.

So now talking about the coastal storms management framework. As far as the framework, the framework is intended to be a series of steps or methodology that can be replicated at various scales. We termed the scales one two and three. As far as North Atlantic Coast Comprehensive Study we completed the tier one analysis for the entire study area from Virginia to New Hampshire. And so as part of that tier 1 analysis we wanted to identify where is the flood risk? What is the flood hazard? By doing that we used mapping. We want to know, what are the consequences, who and what is exposed to that flood risk? And then there's exposure risk and vulnerability, those concepts. We weren't able to get into concepts of vulnerability because of the scale which we were working, however that's something to consider going forward. And once we know where the flood risk is and what are the potential consequences and probability of those consequences occurring, what are the appropriate strategies and measures to address those risks? Again, present a myriad of opportunities or measures for coastal communities to consider to start thinking about avoiding or preserving those communities over time by means of structural, nonstructural program management, a holistic measure to addressing coastal risk.

The structural, nonstructural and Natural and Nature-based Features measures, we want to make sure this information was available and what is not available to identify what those gaps are in order to, again, further the science as far as this effort to ensure that communities are making risk-informed decisions over time.

Here is just a snapshot of the Coastal Storms Management Framework. We completed the nine-step process as part of the tier 1 scale. It's customizable for any area or watershed repeatable and transferable to other areas as well. We want to make sure this is a consistent approach that all users and practitioners from planners and emergency managers, et cetera, could use this information and the methodology to ensure that consistent approach in dealing with coastal flood risk.

Here is just a presentation of our planning regions, the 39 reaches that the study area was broken into based on physical properties, including the flood inundation mapping and other physical boundaries identifying different breaks in what these planning reaches would be.

Within each of the planning reaches we conducted analyses, the first identified, where is the flood hazard? Across the entire study area we were able to use the slosh data, which is a model to identify hurricane events from categories 1 through 4, maximum event, to identify the first extent of inundation corresponding to the storms and this was, again, consistent information across the entire study area so we used this to

characterize a component of coastal flood hazard. Here is an example of the Maryland-Chesapeake area.

We used the 1% floodplain taking into account climate change and sea level rises and also wanted to design considerations that our local communities are using to rebuild from Hurricane Sandy, adding some level of free board. We selected the 100-year plus three feet as future conditions, that will align with conservative estimate for sea level change going forward and consistent with some of the conservative estimates of what communities are using to incorporate into their freeboard analyses. For the 100-year plus three floodplain inundation, we use surrogate because there was some areas, for example, here in the New Jersey Delaware Bay coast line that did not have a consistent data set for the 100-year FEMA special flood hazard area 1% floodplain.

So we wanted to characterize what that future with the 100-year and that's why we used the category 2 maximum. And for more frequent event, the 10% floodplain we were able to acquire water surface elevations as part to have stage frequency analysis of 26 gauges and the North Atlantic Coast Comprehensive Study area we updated stage frequency and pulled out 10% sub plain water surface elevations and interpolated a map across the entire study area and that represents a more frequent higher probability flood event to characterize flood risk from a more -- from a high probability flood event. So that's the flood hazard, those are the three components to characterize flood hazard. Now we want to think about the second question: What are the assets that are exposed? What are the consequences of the exposed flood hazard? We characterize by three indices. We is infrastructure and the number and various critical infrastructures that are subject to flooding and potential consequences. We also characterize socioeconomic groups to have populations that may be relative higher exposure than others, including for example, people under two and over 65, non-English speaking populations. That was information generated from census data and environmental cultural resources, various critical habitats that could be exposed to flood hazard, erosion, wave action, et cetera, and those three indices were generated as far as a GIS analysis to ensure three separate independent evaluations of expose sure and we pulled it into a composite.

Pulling all those three components together, what is the overall exposure across the study area? Here is a characterization, again, of the Maryland Chesapeake Bay area of population and infrastructure. You can see in the black water area, lower shore of tidal wetlands, predominant feature.

Social vulnerability, not many people living in the black water area, so you don't see that.

Environmental and cultural resources exposure, you see a very high quality habitat down here, so you see some of the relative higher exposure results here as part of analysis, and pulling it together, composite emphasizing population density and infrastructure, again, you can see pulling all the three we saw into one index, you can see what is the composite exposure of the relative exposure to that flood hazard, again, the consequences. This is considered across the entire study area. So if you're thinking about this, you need to think about this was a relative comparison across these -- all these three indices from Virginia to New Hampshire. So that was the hazard, exposure. Now let's talk about risk. What is the probability of flooding that consequences that we might see those consequences occur? So by doing that, again,

we pulled in various inundation bands from the 10% 100-year plus free and category 4 maximum maximum, those flood hazards show what is the relative increase and possibility of the consequences to occur and that resulted in our risk assessment. Again, if you refer back to the 10% floodplain you'll see that the higher probability that generally higher risk because the probability times the consequences is resulting in that relative higher risk as a result.

Shifting gears, talking about the existing future conditions evaluation sea level change as part of the Corps of Engineers procedure. Again, our evaluation to evaluate sea level change, low, intermediate and high scenarios, and adopted high scenarios for 100-year time frame going -- as well as the year 2100 to look at what those change in mean sea level scenarios are based on those three scenarios in terms of the water surface elevation increase, and for each of the states for that data was available we compared the Corps of Engineers analysis to those at the state level or even after the jurisdiction level if there had been sea level change scenarios adopted by various states or local municipal Tis and compared some of the Maryland field change assessment that was recently completed back in 2013.

So now we know the flood hazard exposure risk. What are the opportunities to address them? We talked about the strategies. Within the strategies of avoiding the risk, accommodating to the risk, or preserving, various measures are broken down into structural and nonstructural and more programmatic management measures, and so this information is presented in the report and we pulled from the document that was published back in September 2013, the Coastal Risk Reduction and Resilience Report using the full array of measures. We pulled a lot of information out that document here. We want to emphasize Natural and Nature-based Features. Kelly will speak about this, but we wanted to note that Natural and Nature-based Features offer extensive ecosystem goods and services as well as management benefits to coastal communities, we want to make sure we didn't over-sell the ability of a wetland to produce five feet of storm surge, for example. We want to make sure we caveat the thought about Natural and Nature-based Features within the appropriate setting or siting of those features within the landscape in order to achieve various objectives for doing or considering them.

So we conducted another GIS analysis to identify the potential suitability of where these various features would be located. Again, calling your attention down here to black water, wetland suitability predominantly here, but again, using these criteria of other GIS data, we were able to complete that analysis and present in this document as well as the report that Kelly will speak to here in a few minutes. Corporation and climate change into the study, we wanted to emphasize the sea level change scenarios. We mapped the sea level change scenarios for the Corps of Engineers high scenario for 1500 years and we wanted to make sure that the thought about climate change adaptation planning for community use this document in thinking about some of the concepts that for long-term planning you really need to start addressing going forward, including nonstationarity. Not using the historical record to make linear interpolation of what that historic record would be.

So thinking about how things can change over time that we didn't necessarily see in the pass.

Uncertainty, climate change and sea level change is new science relatively, still a lot of

research ongoing and needs to be completed before things can really get solidified in terms of addressing some of these uncertainties. That's why we really want to emphasize a range of future scenarios starting to think about flood risk management strategies to address that increase in risk that that may cause.

And also thinking about further inland from the coastal environment, thinking about the precipitation pattern from climate change. How does precipitation affect hydrology and how does temperature change affect habitat and other features, as well as combining that interface with those estuary and fresh water tidal areas, how does that affect increasing mean sea level and some of that tidal influenced area? So a lot of things to start thinking about going forward and more importantly adaptably managing as this information becomes available, to really start addressing that future risk.

A quick thought for each of the framework steps there are various technical products generated. We'll touch on a few here, including the high fidelity model completed from Virginia to Maine. This was a domain metric, Virginia to Maine and part of the coastal hazard system presents extreme high water levels for 3450 storms and synthetic storms as well as nonstructural -- excuse me -- tropical storms included in the simulation. And as far as the website here on the screen, Coastal Hazards Systems, approximately 19,000 save point locations are available to pull out results. Coastal Program Guide is an opportunity to present all the states, what are the opportunities for various programs out there to -- for states and other localities -- and coastal communities to address and plan for the storm -- address some of the issues that occur during a storm event and how do you recover from a storm event? And finally we -- for today's discussion we'll talk about the U.S. Fish and Wildlife Planning Aid Report. And Tomma will talk more about that.

>> TOMMA BARNES: Good morning, everybody. So I'm going to talk a little about the Planning Aid Report.

This report was prepared for the Corps of Engineers by the Fish and Wildlife Service to have a discussion in the report of vulnerable areas from Virginia to Maine, the vulnerability to storm surge and sea level rise over the next 50 to 100 years. Next slide, Dave.

Okay. The efforts from the Fish and Wildlife were red with regional inputs from New Jersey, New England and Maine field offices. The report is laid out into two sections. The first section they discuss -- it's kind of a general discussion, I guess, of the threats of -- that sea level rise poses for natural ecosystems in the northeast, specifically it's broken down into tidal marshes, ocean coasts, estuarine and coastal bay shorelines and coastal bay aquatic habitats.

So you have a discussion of that and vulnerabilities. And that section of the report includes these habitats will be affected by accelerated sea level rise. These effects are complicated because of the dynamic nature of these systems, but in general the sea level rise will increase coastal retreat and result in wetland loss. They also conclude that uncertainty in forecasting effects on a particular species is even greater because of the need to consider the specific species habitat relation.

Next slide, please.

The second section of the report identifies biological resources, habitats expected to be vulnerable to the harm of storm surges and includes specific geographic locations. The primary focus here was on identification of important sites for bird nesting or bird

feeding. And areas that are utilized by T&E species.

The vulnerable habitats in the section were determined by their potential for physical change correlated with their landscape position and geomorphic characteristics.

The second section also describes the risk of coastal national wildlife refuges, from coastal storm surges includes a consideration of risk to habitats as well as to the actual refuge facilities. It also goes into particular steps that these refuges are currently taking to reduce these risks. Next slide, please.

So the report also includes several of these maps, and they cover all the states in the North Atlantic region. This one in particular is the New Jersey area and you can see that the map includes the National Wildlife Refuges and the water bird nesting colony, shore bird stopover and several inter-species habitat areas. And also habitats for threatened, endangered and proposed species, which is what in red there. There's one of these for every state in the northeast. And you'll be able to find those in the report specifically. You can go to the next slide, please.

So that kind of in a nutshell is what is contained in that Planning Aid Report that was put together. It's a great report. It has a lot of information. It was -- the team that worked on it did such a great job because we came in and gave a really quick deadline, you know, it always takes a while for everything to get up and running, but, man, they knocked it out. So if any of you guys are on the phone, thank you so much, and great job.

So in addition to that Planning Aid Report, I had a team of environmental scientists that worked on putting together what we called the environmental and cultural resources condition report. This report looks at or contains information on existing coastal and cultural resources and it includes information on impacts to those resources as a result of Hurricane Sandy. The report also goes into a discussion of possible impacts in the future over time to sea level rise and increased storm activity and intensity without action. So it's kind of like that future without present condition. What is going to happen if we don't do anything to help prevent these impacts?

Next slide, please.

This report, which is one of the appendices to the main comprehensive study, also contains a separate chapter on cultural and tribal resources. So there's a discussion there that goes into a lot of detail about some of these resources. It also lays out everything, the environmental and the cultural in bulleted lists, and we did that so that users -- we try to make it very user friendly so that folks could come and take this report and pull it off the shelf and use it, extract information, and insert it into their NEPA compliance documents or other reports that they have to create. So as projects come on board, I should make it way easier for someone to put together an EA or an EIS, because the information is all in one place, and you may just need to add some real project specific stuff in there.

It's presented by state, the states are broken down into specific locations, habitat types and/or species, if they're important, again, some key stone species in that state, we try to add discussions on those two.

And so those kind of in a nutshell is what we did on the environmental side for this comprehensive study, and Kelly will speak next about the nature-based solutions that they've evaluated and then I guess it will be time for questions after that.

>> KELLY BURKS-COPES: Thanks, Tomma. So this is Kelly, and I'm going to talk

about the Natural and Nature-based Features effort that we undertook in the report itself that you can maybe download and read the crazy 500-page thing. There was a need to identify, as I said, Natural and Nature-based Features that could contribute to the recovery effort. We had to go through literally a discussion of what these features were, what kind of data you need to basically assess the performance of these features, take on some case studies and talk about the effectiveness and the utility of services. And when we take on the new concept of natural features and how they might contribute to the kind of multiple defense strategy, we also acknowledged that there are -- this is a new frontier and there's a lot of policy indications for taking on such an act and we need to kind of lay those out and then put forward a proposed recommendations or path forward how we might do better Natural and Nature-based Features and actually the implications of what putting Natural and Nature-based Features on the ground could entail.

So the report is out there. It's a separate report from the NACCS study because it's so big and it had so much material we thought it was useful and necessary to split it out. So you can find that report -- and this is a screen -- it was finished in January. You can find it on the comp study site or the nature site, because a lot has to do with nature. It's split up into big categories but I think we had approximately 11 chapters, so I'm going to give you a little detail about the inside chapters, the one that focus specifically on ecosystem goods and services. So could you change the slide for me, Dave?

You probably see the -- a face called the Green Report or Green Paper on what Natural and Nature-based Features are and how the Corps of Engineers have been looking at these green infrastructure ideas and how we caveat these and what we can possibly use them for. I've only listed five here. There's actually 30 plus features that we looked at in the report. We did emphasize the idea of not only putting these kind of greener features into play, but doing the kind of combination blended solution of these green features as well as gray features, and once you put them together, they are not a linear edition. They oftentimes kind of do an exponential improvement on the landscape, so that's what we tried to focus on for the bulk of the report. We also tried to tackle the idea of the fact you may need -- you may be able to deploy Natural and Nature-based Features, if you have enough room and if you have got the flooding risk somewhat under control with the gray features. We talked about where you might position these on the landscape, and at the back of the report are some maps that show where Natural and Nature-based Features exist in the study area now and where they can potentially be placed for various reasons, for various performance regions. So I've got two websites there. I think Dave is going to provide the slides. You can contact me and I can provide them as well.

If you'll change the slide for me one more time.

In the report we've got these steps, the strategy for implementing Natural and Nature-based Features and the recovery for any of the sites we're looking at in Sandy. But realize we can use this same structural application framework on the coast line or inland to deploy Natural and Nature-based Features. It's basically an engineering perspective of how you could snug in Natural and Nature-based Features into traditional engineering solutions. So it starts very straightforward with, you know, identifying who is in the game, who are your stakeholders, who are your partners and the authorities you can use. Then we go through kind of a standard scientific approach to finding the

physical characteristics of the setting and identifying and addressing, you know, kind of solutions, what is vulnerable now and whether or not it's resilient. It's actually opposite coin. You're vulnerable and you're resilient and somewhere in between you flip a coin. After you know what your level of vulnerability is and what your charge is for resilience, you can actually go into setting up objectives, setting up alternatives, and then defining performance metrics to quantify the return on investment of using Natural and Nature-based Features either in addition to or on their own, and you can use that to compare and contrast, taking this kind of initiative. We show an example in the next chapter of how one might go about putting those into play, and Dave mentioned before there's sort of a tiered approach to the NACCS study. There's kind of an emulated tier approach in the Natural and Nature-based Features report, and I'll talk about that a couple slides down.

Once you select your recommended plan, you know, if they have Natural and Nature-based Features in them, you can go ahead and work in the implementation, the instrumentation, you know, using and elaborating on those kind of features or practices, and then implement it. And it has this -- the framework has the traditional adapted management feedback loop. You put it on the ground and go out and monitor and assess what services are provided, and ask whether you've met the expectations and if you haven't, you can go back into the feedback loop and start asking why. Did it work or did it not? Why not? That's where you can employ the adaptive management strategy.

So on the next slide, just -- I'm sure you guys are aware of it. We didn't have just one stakeholder or one particular partner. We partnered and have, you know, literally 50 or more stakeholders that were involved in the process. I know Dave mentioned it, but realize that we only had approximately six months to pull this all together and start reporting it out so we could go into stakeholder sessions and start vetting these ideas. And so this is just a snapshot of the stakeholders and the partners that we involved in this process. So in the next slide, the report actually talks about, you know, there's probably 10 to 15 different kind of geomorphological settings that we're talking about putting these Natural and Nature-based Features into. We had an entire chapter characterizing those and talking about what form they must take and what function they provide in these kinds of settings.

As I mentioned, we have basically mapped those out and that's a whole appendix in the report. Every city reach has those maps. At the back, one of the appendices is a cost table. What it might cost to deploy these features based on past studies that have used these solutions in and out of specific objectives, for example.

Realize that we're talking about -- when I showed you the kind of at-a-glance Natural and Nature-based Features, we're not only talking about wetlands. We're talking about do you know, we're talking about a variety of features that you might put out there alone, but could also be kind of combined with a traditional structure. So to be able to tell folks what they're likely to encounter in terms of cost, whether it's going to be more costly or least costly, we have to look at it in terms of not only construction, but long-term maintenance. Realize that Tomma talked about this kind of climate change sea level rise issue. The assumptions have been that karma is going to be stationary. We now know it's not. We're going to see and experience novel situations, things we've never seen before, and the great infrastructure is somewhat built for a stationary

environment. It has particular design specs. They're set to be able to resist and be able to protect, but with sea level rise, that puts another threat multiplier in place, and gray structure may not be adaptive. Whereas green structure, this Natural and Nature-based Features solution, might be more adaptive and might offer some protection to gray infrastructure if you're using blended solutions. So we have to talk about that in terms of maintenance costs.

Typically, as you know, they take the first hit. And so they might be wiped out with the next storm, but they provide protection as a result of, you know, being that front-line barrier. So we need to account for putting them back after they get -- take this first hit, sacrificial in nature, of course.

So on the next slide we actually get into vulnerability assessments and how one might go about assessing the vulnerability of a setting with and without Natural and Nature-based Features. We offer some suggested metrics and actually an assessment protocol that you might use to assess whether you're vulnerable or not. On the flip side, the other side of the coin, we came up with some solutions of how we might enhance resilience with Natural and Nature-based Features and then how we might deploy that in not just a scientific setting but actually handle or deal with the cultural setting. People are going to have to be engaged to be able to deploy these kinds of features, and we have to condense or actually explain and help the community identify where their vulnerabilities lie and the potential solutions that they might be able to use to buy down some of that risk, and that's what we talk about in this chapter. So on the next slide, it should be the community -- oh, so this chapter has a huge appendix attached to it, which uses the metrics that we assess vulnerability with to run down the landscape and map out where the vulnerabilities are. The second half of that chapter then talks about the resilience time line. And then this last slide is talking about how you convey the vulnerability in a public forum, how you actually handle this kind of exploration of risk and resilience, and we talk about the kind of pairing the resisting, the adapting and recovering afterwards. With the idea that Natural and Nature-based Features can be plugged into this evaluation, and so we show kind of a hypothetical workshop setting of what you might do to ensure that the community is thinking holistically about their risks, their resilience and what they might be able to do to maybe adapt in the future. And then we play out kind of a hypothetical example of filling in tables that assess their infrastructure fragility and also assess how much Natural and Nature-based Features can contribute not only to resistance but also to ecosystem goods and services that are offered the other 364 days a year or when the storm hasn't hit. So that's one of those things that we're really kind of keen on, these natural features provide so many more ecosystem goods and services than the gray infrastructure or the traditional infrastructure, and oftentimes those don't get accounted for when you're focused entirely on flood damage reduction. And so we emphasize the idea of how many other services these features provide and how one might go about assessing them or quantifying them.

So on the next slide, Dave...

We give the self-assessment stuff and we show how one might go about rating each of those as you're going through the process. And talking about this kind of bouncing back application, where you're looking for sort of a natural recovery as well as, you know, put the spade in the dirt and replace what you've lost.

So on this next slide...

Sorry, there's a little bit of delay.

The resilience section is actually kind of described around this diagram. What you have in play now, what you're expecting to see in terms of storm stress, storm stressors and drivers, and then what you might put in to be more adaptive and resilient, how you can start planning for and evaluating the futility or the actual positive effects of putting in different features in different places, and the idea is to basically compartmentalize those risks, basically start culling them down and focusing on what is very important to focus on and then come up with a way to rapidly deploy decision making practices to make those kind of choices. Possibly during the storm but probably better done before the storms happen.

So on the next slide we leap into an evaluation of the ecosystem goods and services metrics, with the idea that whether you deploy these gray structural features or Natural and Nature-based Features, we assess those from a systems perspective. We look at the composition and structure of those features and what kind of processes they require or contribute to and the long-term they provide from having those particular features, those particular compositions in place. That gives us the goods and services. So that's how we actually layout what ecosystem goods and services might be provided by assumption. Those are then tied to specific benefits for human well-being, and the human benefits are perceptible. So you actually have to ask or find out what others feel the human benefits are in terms of how they value them. And so the values are -- they're somewhat fluid. They're based on everything from what the economy is today or then and what other things are more important to those folks at the same time.

By doing this loop, this half of the loop, we get information that actually can inform policy and provide guidance for decision making. Which is looped back in to putting those features on the ground again. So you get kind of the circle of evaluation and application and then, you know, looking back and making sure we're capturing exactly what we were focused on in terms of our objectives.

So on the next slide, we did this very quickly and very simply. We mapped out approximately 21 ecosystem goods and services and they range from, of course, this kind of flooding benefit, flood control or flood protection benefit, but not exclusively. We had aesthetics in there, and biological diversity, carbon sequestration in there. We looked at recreational benefits and food provisioning. We looked at groundwater supply. We looked at things like the education and cultural heritage, having, you know, these kind of features in play, and what kind of water -- clean water provisioning they might be able to provide.

So what we did was for each feature -- there were 30 of them -- we mapped out the component structure, ha the feature looks like -- what the feature looks like and what it provides in terms of functionality. We tied that to these 21, if possible, services -- not all features provide all 21. So we had to kind of streamline that out.

Those services then provide one benefit or multiple benefits, so we tie those in. And then at the end, what our task was to provide a series of metrics, quick and dirty, kind of landscape level metrics that could be assessed very simply that would provide at least a semi-quantitative evaluation of the performance of those features in the landscape.

Now, if you click it one more time, you're going to see that there are multiple features that provide -- oops, can you go back one?

Multiple features that provide possibly multiple aspects of those features that provide possibly different functions and therefore different services and therefore different benefits that then need a metric. So we have tables and tables and tables, and an entire appendix is dedicated to basically decomposing what these features could provide and what kind of metrics one might use to quantify the return.

So on the next slide is just -- on the next click is just another kind of example of what was done.

This is an example of putting depreciation action in place, actually, and what kind of function that provides, what kind of services we can expect to get, how the human population around that area then would perceive the benefits antibiotics how we might go back quantifying those benefits so we can put them into a plain comparison.

On the next slide then is kind of how we tackled the metrics quantification. First of all, we realized that this is not just for the Corps of Engineers, that other folks in the region might go about -- region might go about recovery efforts. So what we were trying do is come up with a series of approaches that could be used inside the Corps or outside the Corps to put numbers on these features.

So the first we talked about -- this is the tiered approach that we kind of paralleled with the NACCS here. If you don't have a lot of time and you don't have a lot of money, you can actually convene a workshop of experts and you would have them go out qualitative what they perceive the return of investment would be on benefits. And this would be the plans and echo system services that this would provide. You would do multi-criteria analysis and get one value that you could then use to compare and contrast plan after plan.

So that's level one. Quick and dirty, cheap, fast. But not necessarily very quantifiable. Level 2, which if you click, it's going to show you level 2. Something called causal mapping, which basically says, if you put -- if you are after a particular benefit, then how do you trace that back to the future? How do you draw that correlation to the future and obviously solutions are going to be blended, so you get different benefits base on the different array of measures or features that you're putting into play. What you're trying do with causal mapping is map out the direct line from putting in a feature to providing the benefit, and you draw this in a spaghetti diagram and it can be quantitatively assigned values, but oftentimes that's done with literature as well. So it's level 2. Semi-quantitative, still capturing performance. It's very visual, but it gets overwhelming.

So we went to the third level, which is quantification of the metrics themselves. We used several ways of doing this.

One way to do this is to take the monetized wrap. You want to put a dollar value on the features, so we explored the idea of using value transfer methods and we came up -- we looked at literature and found out -- you know, or table-ized what we found in the literature in terms of values for these different features. We didn't put a lot of effort in this because it's still so scientifically new, on the frontier, and probably not robust right now. So we moved on to something that is more in line with standard Corps of Engineers planning approaches, which is a non-monetized assessment. We used something called Ecosystem Production Functions, which is basically -- you guys know HEP and the procedures and you know what HSI or the index molecules are.

This is a form, but it's human habitat and we're asking a question, you know, what kind

of features -- how do I go about measures those from a landscape perspective, you can use mosaic or patch analyses or basic engineering design specs or how high should the do you know be and how long does it need to be, and does it have to be contiguous or not. You can assess kind of a suitability index for each of the features for each of the ecosystem goods and service function. This is much more quantitative. It's based a lot on the engineering manuals. It has a lot of biological information coming out of things like the suitability index. We basically developed approximately 72 individual performance metrics that are already -- they use readily available data that we put our hands on right at that moment, so we focused on that, and the one thing I want to say is, remember that this is a library. It's just the beginning. It is not an end-all. We had approximately six months to pull together all the metrics. We could have done - - we could have used ten more years to pull off more metrics, but it's a good start, okay? So if you click one more time...

Oops.

All right. That was kind of the meat of the ecosystem business services with metrics development. We went into -- in the last chapters of the report we went into a focus on how one might go about deploying those metrics in an evaluation framework. We also put an entire chapter in on how one might go about performing or using the concept of regional management to provide sources of materials for the Natural and Nature-based Features and we even used U2N2, which is kind of an optimization package. Because look at where the surface of say where sediment are and how one might optimize the utility of that material for creating or putting out these kind of do you knows and nurse beach activities. If you dredge here, what is the optimal place to put the dredge material? So it's kind of a unique simple case study to show the benefits of optimizing and looking at these ecosystem goods and services from a very practical standpoint. The last thing we did was chapter on case studies that we had done already focused on before, the NACCS grouped hired us to work on these metrics, and they were basically looking at a series of preserves -- I think it was just three. Jamaica Bay, Cape May Meadows and South Charles. That looked at the aftermath of Sandy and how we could quantify the ecosystem goods and services that were lost, so they could basically reassess what they should put back and talk about monitoring in the long-term so that if another storm hits they can determine, you know, whether they position them and built them in a manner that provides resilience and actually can survive the next storm, but also what kind of protection they offered and what kinds of goods and services they offered the rest of the year to those communities.

So if you click one last time, a couple of things were done to socialize these concepts. We had a series of policy implication workshops where the ideas, the concepts of Natural and Nature-based Features were introduced. When we talked to the stakeholders in the room about the technology, the science and the engineering and technology, the tendency is there are gaping holes that need to be filled. These things are providing significant challenge in terms of policy and implementation that we need to lay out or map out better. Natural and Nature-based Features and the second theme, communication issue, these features are nebulous. People just don't know how to get their heads around it. Believe me, the court hasn't figured it out either. We're still grappling with this problem. But the deal here is they're perceived as sometimes more expensive. They're perceived as not very effective. And what we need is to, you know,

apply science and engineering technology to better understand what the return on investment might be and then we need a communication plan, a way to outreach and start working that would be traditionally tending to use infrastructure and start talking about the benefits of doing a combined approach. And last but not least, it's inevitable when you're on the frontier and preserving these sort of new concepts, that the only way this is going to happen is if you have a massive amount of institutional coordination and that your leaders are behind you. And so we talked about in these workshops what would be needed to broaden the understanding and characterizing landscape to basically facilitate or at least make it easier to facilitate their use on the landscape.

So the last slide -- I think this will be my last slide, if you can click it for me.

Support is laid out in these different boxes. Each box has a chapter. At the very end we start talking about what is next, what do we need to take on next? Obviously, and forever scientists always think you should expand, but beyond that -- you go back one real quick?

We talked about, you know, handling the uncertainties and reducing them. The need at the very end for more disciplines to be involved in this, more organizations to be involved in this. Recognizing that, you know, we're basically positions things in the landscape that is very dynamic and these natural systems don't provide any kind of benefits right off the bat. They have to actually mature and grow. So we talked about kind of time line that is going to -- how you have to tackle that and integrate that into your planning. But last and not least -- I mean, this is really important -- is that we need a bunch of demonstration project sites where we put these things out and we test them, we actually can start building evidence about whether they work or whether they don't, why they work, why they failed. When should they be deployed? And literally communicate that through a story line and provide that to all of the folks that are interested in taking this on and folks that maybe don't believe in it and how we might convince them otherwise.

So the last slide is kind of out dated, but we'll talk about this.

I'm on kind of a covert working group on Natural and Nature-based Features. We're doing this all kind of on our own time. I don't remember how it started, something about having a beer and talk about these things and finding out that a lot of these agencies were working on this, including yourselves and that it's ridiculous to leave it at the wheel. We should all be sharing information and potentially working together to fill the gaps. There is a Natural and Nature-based Features working group that involves -- it's not limited to these folks, but these are the big characters at the table.

If I use acronyms, I should probably find you and buy you a beer. I'm sorry about that. But there is a lot of ecosystem goods and services -- I've got a short list of things going on here in our town, in our lab and we're collaborating with groups of folks who have grants to put Natural and Nature-based Features in play. We're operating on expertise and coordinating with them. And as Dave mentioned, these focus areas are coming online, so there will be an opportunity to test the information that we've put together in this big report, and, you know, lessons learned and start summing this information. I think -- I don't know if there's one more slide, Dave.

Okay. So there's no other slides, but let me point out that, you know, this is a frontier. We made some great strides here, but there's so much more we can do and we welcome any collaborations with yourselves. We're excited what we're seeing coming

out of your shop and that's all I'll say on that.

Dave, I hand the talk back to you.

>> DAVE ROBBINS: Thanks, Tomma, thanks, Kelly. We really appreciate the presentations.

We have about 20 minutes for Q&A session, so before we get into the Q&A session, I would just like to remind everyone again, before you speak, just let me know if you're interested in asking a very question, but before you do, please keep your phone on mute to avoid anyone talking over one another. I'm just going to go ahead and get back to the -- any questions anyone would be interested in submitting, use the chat form many the webinar interface, but if you would like to ask questions there in the auditorium, I know Leah, there may be a few people there. We can take questions from your phone. But if you would like to ask questions verbally, just use the chat box and say you would like to ask a question or put a question mark to indicate and I can call on you to ask a question.

So with that, Leah, maybe I can pass it to you and see if there's any questions in your space.

Before you come online, I see a note. If you would like to ask your question.

>> Yeah, this is Ann heck from Fish and Wildlife Service.

I think this is probably a question for Kelly. I should state at the beginning that I'm a biologist, not an engineer and not a coastal morphology expert, but I've been reading some papers recently that are considering the longer term impacts of do you knows, and I noticed those examples prominently in your examples of Natural and Nature-based Features, and they're indicating that although in the near term they may reduce over loss and flooding, that these very features over the long term are promoting lower and narrower islands so that when flooding does occur, it's more catastrophic and more difficult to protect the features that -- or the infrastructure that was intended to be protected by these features. And I'm wondering, you know, if you're planning horizon is looking out beyond the medium time horizon at the longer term effects of some of these potential foliations.

>> KELLY BURKS-COPES: I completely agree with you. You know, the Corps is kind of the queen and king of do you know building. We tend to do it a lot. One of the things we're going to have to do -- and I'll talk to that in a minute -- we need to establish goals and objectives and build to those goals and objectives. And so if it is a consideration or a concern, then that certainly is an aspect of comparing and contrasting designs or plans to go into that particular space.

The one thing that I will point out is that the Corps of Engineers -- I can only speak to us. I can't speak to the other stakeholders involved, but the corps tends to look at planning scenario horizons from the time of conception to approximately 50 or 100 years out, and so with the recent projections of climate change, for example, we're starting to hit that window, where we might actually see some effects of climate change and some effects of sea level change.

And so what we need to do and often don't do well yet is do adaptive management, kind of monitoring into the long term and what we do know and do tend to do is look at both the positive and negative aspects of implementing any design. So the only thing we're limited on is how far into the future we can implement monitoring and we can basically establish triggers in our adaptive management plans. We go back and say, okay, we

expected to get this point at this moment in time. We go off the monitor and come back and say we missed it, and ask the question why. That's when we oftentimes encounter conditions like you're mentioning.

So it does require kind of a longer ranged vision of planning and implementation to be able to capture some of these novel events that we're going to see, but I have had -- yes, I, too, had heard there was some negative impacts of do you know building, but I do know that you know, we are aware that and engineers are aware of it and if you establish goals and objectives that say we don't want it, we can design to that. One of the things I want to point out, I too am not an engineer, but I understand engineering minds that if you tell them what you want they can build that design. But you have to tell them that's one of your objectives and then they take a new tack basically. Does that answer your question?

>> Partially, but it's probably a longer discussion that involves looking both at some of the literature as well as tackling some of the situations on the landscape where perhaps we can already see some of these impacts beginning to manifest themselves. But I just wondered if it was -- whether it was part of your discussions and how those things are going to be factored into your planning and recognized as -- and disclosed so that the people who are assessing the alternative solutions are able to appreciate not what only some of the potential up sides may be but some of the potential nature risks might be.

>> KELLY BURKS-COPES: Right. And I think Dave may be able to speak or talk to this a little more, because the recommended plans have not been formulated yet but on the website there are discussions about how one might evaluate the potentiality of putting natural features in. You want the speak to that, Dave?

>> DAVE ROBBINS: Sure, Kelly.

So as far as the scope and process, we would identify goals, objectives and constraints, and that's where we would put it out and things we want to consider as part of the measure screening and planning formulation process. So taking into account the various metrics associated with those objectives and constraints, we want to find that we do include some of those thoughts about combination measures incorporating at NBF, that would be the opportunity to do so and we definitely -- you know, as far as the focus areas are concerned, going forward, although we haven't received any funding at this point, we were presented in FY15 president's budget for three of the nine focus areas through C funding for subsequent investigations and it's likely we would build some of the points in the North Atlantic Coast Comprehensive Study including the work to further the Natural and Nature-based Features component of coastal flood risk management as part of that combined solution set that we were talking about and emphasized particularly in the reports that we talked about today, but you know, we really want to, again, throw out the fact that the Corps of Engineers is evolving and looking to modernize some of these discussions and emphasizing decisions and as part of that collaborative nature in achieving that we want to reach out and, again, work with our stakeholders and partners to really define what those -- what the ultimate outcome is as far as the goal and then devise those appropriate objectives and constraints and the metrics associated with each to ensure that we reach that end state. So hopefully I didn't go off on a tangent. Did I answer your question, Kelly, and Ann?

>> Thanks very much, Dave.

>> DAVE ROBBINS: Leah, are there any other questions from the auditorium?

>> You hear me?

>> DAVE ROBBINS: Yes, I can hear you.

>> I have one question here in the audience. Just a moment.

>> DAVE ROBBINS: Excellent. Thank you. Could you please state your name before answering, we would appreciate it.

>> Sure, this is Jeff Brand with fish and wildlife and I used to manage a... [inaudible]... so we looked at a lot of these issues. This goes back to Ann heck's question a little bit. How much consideration was given to offshore and to the kind of offshore sand bars that could be considered a resource for the do you knows or -- but they also serve very important purpose in their place for shore birds and, again, as barriers offshore. How is that looked at in the study?

>> DAVE ROBBINS: Sure, this is Dave. I'll take a stab at that. So we didn't necessarily do any quantitative analysis as far as this study to address that, however, as part of our corps collaboration effort we did discuss with the Bureau of Ocean Management what are the potential bar areas, if there's discussion about broad or widespread considerations for do you know building, for example, I think that's -- that topic has come up. What are the sources of the sand, you know, the bar areas, where are they going to be? And so as part of the council we recognize that and one of the tech products we generated as part of the study and published separately, similar to Kelly's report on Natural and Nature-based Features we presented the conceptual region sediment budget for the North Atlantic and attempted to identify, you know, again, at the very large scale at the conceptual level where those sources and sinks may be across the landscape. We did look to acquire some of the data out there that you referenced, Jeff, in your question, but the ultimate conclusion of that is that more detailed analysis would be necessary, a more detailed regional sediment management investigation you know, in coordination with DON, and we presented that as an opportunity in the report. If you read the report that's noted in there. That's definitely something out there. We acknowledged it. We couldn't really get into a level of detail that would be appropriate to address that subject, you know, within the two-year constraints to complete our study, but definitely a big deal. You know, we had some -- and BOM is part of the collaboration effort. Somebody commented specifically on that. So we wanted to make sure we presented in our document that, you know, sources of sand would be important and potential impacts of attempting to acquire and use those sources or those resources as well.

So Jeff, did that answer your question?

>> Yes.

>> DAVE ROBBINS: Excellent. Thank you. Appreciate your input there, Jeff.

Leah, any other questions from the auditorium at this point?

>> We have one more question.

>> DAVE ROBBINS: Thank you. Again, please state your name before asking the question, please.

>> This is Andrew Millikin, coordinator of the FCC, and thanks for doing this webinar. I think it's important to get this information to the Fish and Wildlife Service partners. I have a general question related to that and specific question if there's time. I wanted to get the thoughts of your team about what you're thinking is about how most effective deliver this to different partners who have different levels of technical expertise, being a

comprehensive study, it's also really big and, you know, can be pretty overwhelming to some partners and so I guess I want to get your thinking on how you're thinking how this can be translated via shorter documents or websites or maps that people can look at and understand and use and, you know, what would your advice be to us if we're working with partners, how do you think that we might most effectively try to do that? So that's my general question.

>> DAVE ROBBINS: Thank you. I'll take a stab at that. So I had a note here that it's hard to hear questions. So basically, the first piece of Andrew's question was how to effectively deliver some of the results here, the framework and all the technical products to various levels of government, for example, that may not have the technical expertise to get in some of these analyses. But the thought is this framework would be transferable and various products could be used at that level, but agree we definitely acknowledge there are varying levels of understanding of how -- for that matter, but also actual resources to be able to start really thinking about this. So we did -- we do note that in the report that there are various technical services programs out there from the Corps of Engineers' perspective that can assist you know, various communities, including the floodplain management services program, planning system states, these programs are typically cost shared but offer an opportunity for the corps to work with our communities at a more local level. The other thought on that is that, again, the coastal program, with that thought in mind, we wanted to make sure that we had some sort of product that could be useful for the communities to, you know, kind of thumb through and for each state the coastal program, there are other programs and information current as of January so that they can reach out and acquire some of these services going forward.

The other question there was, you know, how to translate it.

Again, everything is going to be different. You start taking a look at risk in New York City and compare it to eastern shore Maryland, it's very different. So a thought that the framework is -- you know, the steps are -- to the point where it's -- you know, it's repeatable in all areas and it at varying scales, so ultimately getting to the same results of identifying what are the flood hazards? What are those critical assets that are exposed to that flood hazard? And then what are the opportunities to address it in the form of, you know, thinking about long-term perspectives, adaptive management principles that Kelly alluded to, the fact that incorporate rating those other benefits, not necessarily flood damage reduced but if there's a way to combine the appropriate and redundant solutions, for example, Natural and Nature-based Features, so that there are other benefits that are there to support the community.

So really looking to kind of incorporate the various tenets that we present here and translating it out is the intent and hopefully that you know, among all the information that is available, that point can get across. But as far as advice, the last point that I'll speak to -- answer your question there, is advice to fish and wildlife. We definitely want to please promote the work that Fish and Wildlife completed as part of the North Atlantic Coast Comprehensive Study. As Tomma alluded to, it's a very comprehensive and good report to address vulnerabilities to the biological resources and habitat within the region with respect to, you know, storms and sea level change impact and stressors, you know, that's going to have a big impact going forward as well, for example, you know, habitat converts, for example, to open water, we see some of the future sea level

projections come to fruition, will's going to be changes in the biological resources and how they utilize those habitats. If something is gone, what is going to happen as a result? How does that affect the economy you know, of the surrounding communities, et cetera.

So those are -- those are things to really tout that report. We really want to emphasize the collaborative nature, you know, as part of the work that we completed here, and the work that hopefully will be useful for some of those communities that are -- that will need to accommodate the future risk over time as opposed to those -- you know, a lot of communities really depend on the water and they're not going to really go anywhere any time soon. So basically how would you want to accommodate that risk and emphasize, you know, the natural landscape conservation principles along with the Natural and Nature-based Features that provide that ecosystem goods and services to not only to the habitat but the community overall. So hopefully that answers your question there, Andrew.

And you asked -- we have a couple more minutes. I have another question in chat, but if you could ask a quick question, Andrew, we'll try to cover that.

>> I'm not sure how quick mine is. Go ahead and take the chat question if there's time.

>> DAVE ROBBINS: Excellent. Appreciate your flexibility.

So what are the plans for introducing these frameworks and data at the individual district level? How have districts been responsive? How can they be integrated into existing storm damage projects ongoing.

At first we'll talk about the level.

During Tomma's presentation, she went into the fact that she had a team to work through the Environmental and Cultural Resources Conditions Report, and that was a very standard theme as the Corps worked through the completion of study. Definitely a team of teams, over 200 people from the corps worked on this study in one form or fashion. So the team of teams pulled from various resources across each of the five districts in the North Atlantic Division of the Corps of Engineers, including New England, New York, Philadelphia, Baltimore and Norfolk, but we also pulled from our research agencies, including ERDC, the Engineer Research and Development Center that Kelly is affiliated with. You know, there are various laboratories that participated from there. The Institute of Water Resources, Corps of Engineers, another research component of the Corps of Engineers agency that really contributed well. And then also Corps of Engineers staff from outside of our North Atlantic Division. So we've really been pressing forward with reaching out to and coordinating with our districts, the status of the study as it was being produce and executed. At headquarters level there's been a lot of discussions about -- and in division level about being able to reach out and do the post-NACCS coordination effort. That's some of the things we're talking about now today as part of that outreach collaboration effort to, again, trying to reach audiences and being able to present, you know, in general, here is the information, here is where you can find the information, you know, and for specific audiences, such as these, what would be the appropriate information that you would, perhaps, find useful going forward. So, again, a lot of information is available, you know, at the district level. Districts have definitely been responsive, Tracy. A lot of the districts were real interested in working with us and it was a priority among all the districts working on this effort. We're really looking to push forward the information.

The technical products generated as well as coordinated in the work that districts are using, for example, numerical modeling that we researched as a technical, that's high fidelity extreme waves and water levels. So that is available to save time and money on hydrodynamic modeling efforts for individual studies that are just getting started, some ongoing and perhaps they might not have a point in time where you can really incorporate the work, but nevertheless, again, we had ongoing discussions as we were completing the study, the technical products I referenced, the numerical modeling, the Natural and Nature-based Features, we also updated or completed investigation in economic depth damage functions component as well, so a lot of information and technical would help the various districts and are being incorporated into ongoing efforts. So hopefully that answers your question, Tracy.

So maybe -- it's 12:30. We'll take one more question and adjourn. Andrew, if that was your question or if there is someone else who would like to answer a question in the auditorium.

>> I'll ask it, but if it looks like a longer answer, I can also take it -- I can also do it via email. I just wanted to hear a little more about the Ecosystem Production Functions and how you see people using those and easier to point me to where that detail is, I can do that, if it's going to take a while to get into that.

>> KELLY BURKS-COPES: This is Kelly. The NACCS report is the first place to hit, it's basically -- I think it's Chapter 4 talks about the procedure to assess Natural and Nature-based Features, and then there's an appendix at the back that provides those decomposing tables that basically list out by feature what kind of services might be, you know, presented and how one might go about measuring them. The ecosystem direction functions have two steps, one is building response model, basically how one sees a lift, if you put a natural feature on the landscape and the second part of that function is if necessary a way to monetize the benefit. And you don't have to monetize the benefit. You can stop at the first step and you just compare the cost of filling it in to the return on the investment in terms of each of the services or if you need to do monetization, you have use value transfer or -- I'm for getting the word where you actually put out surveys and ask what people -- it's called willingness to pay. And there are, you know, hundreds of papers out there that talk about that. The Corps tend to stop at the ecosystem function at the first step, the response measurement.

The idea is, you know, think about it as a HEP model. Think about it as how you use -- the evaluation procedures to compare and contrast the different benefits you're likely to get out of, you know, changing management at a reserve or actually establishing a new reserve there. I'm not completely familiar with everything you guys do, but that's kind of how it works.

The idea at least for the corps is we need to not only account for the potential flood damage reduction methods that might come out, because they might be very minor, but what is more interesting to us is this kind of omission of quantifying the other benefits that are derived, by putting features on the landscape. What kind of services or benefits can you get because of increased diversity? What kind of services might you get because you improved water quality in the landscape or actually increased aquatic storage?

These are the kind of things that we don't oftentimes account for, and introduction studies, we oftentimes only account for these in ecosystem restoration studies. And

that's because we use benefit cost ratios most of the time in our flood damage reduction recommendations. So we're having to get our arms around this accounting of benefits that we oftentimes just overlook and that's why we're referring to stretch out with this concept of ecosystem production function. Does that answer your question?

>> Yes, it did and I'm going to go take a look. If I have more questions, maybe I can email you. But thanks, that was very helpful.

>> KELLY BURKS-COPES: So the other -- it's not my stuff -- my team's stuff is definitely work looking into, but the other thing is Rick Bennett is running a pretty big project in your agency, and he also has a lot of these materials and ideas about how one might go about utilizing ecosystem business function metrics to make better decisions, and the last group working on it pretty heavily is the Nature Conservancy and NOAA are both significantly advancing this ecosystem production. And a subversive working group, we're not getting paid to be on but making a lot of ground on. If you want to join us or get engaged, please let me know.

>> Great. Thank you. We have a delay on our mic, here, but thank you.

>> KELLY BURKS-COPES: Sorry.

>> I'll pass the mic back to Leah.

>> I think we're out of time. Thank you so much to David and Amy and Tomma and Kelly, we really appreciate your time and effort and --

>> KELLY BURKS-COPES: You're welcome.

>> You'll be hearing from us in the future.

>> KELLY BURKS-COPES: Excellent. Thanks.

>> DAVE ROBBINS: Thank you very much, Leah. And thanks to all for participating today. We're excited about being able to talk about the work our agencies did here. Thank you very much.

>> If you can send the information when the recording is ready and posted.

>> DAVE ROBBINS: Sounds like a plan. Thanks very much, Leah, we'll be sure to do that and be in touch after this meeting. Thanks very much.

>> KELLY BURKS-COPES: Bye.

>> DAVE ROBBINS: Thank you!