Predicting Climate Change Threats to Estuaries in the Pacific Northwest

Transcript, October 25, 2012 Webinar

Ashley Fortune: Good afternoon, everybody, from the U.S. Fish and Wildlife Service National Conservation Training Center in Shepherdstown, West Virginia.

I'd like to welcome you to today's broadcast of the "National Climate Change and Wildlife Science Center Climate Change Science and Management Webinar Series", a partnership with the National Climate Change and Wildlife Science Center and the U.S. Fish and Wildlife Service National Conservation Training Center. Today's broadcast will be presented by Dr. Deborah Reusser and will be focused on predicting climate change threats to estuaries in the Pacific Northwest.

We'll introduce our speaker in just a few minutes, but first I'd like to remind you of a few logistical details. First, all of your phones are currently on a global mute, and will continue to be so throughout the duration of the presentation. After the completion of the presentation, we will open the conference up for questions, and I will give you instructions for how to do so.

I'd like to welcome Dr. Shawn Carter, Senior Scientist with the USGS at the National Climate Change and Wildlife Science Center in Reston. Welcome, Shawn. Would you please introduce our speaker?

Dr. Carter: Gladly. Thank you. Thanks everybody for joining us today on our third installment of this webinar series. Dr. Reusser joins us from the USGS Western Fisheries Research Center at the Marine Hatfield Science Center in Newport, Oregon, where she's currently a research geographer. She began working with the Survey in 1991 as a student intern, and has remained with the Survey ever since.

Her research interests include ecoinformatics and biogeography. She's currently engaged in research that seeks to quantify biogeophysical patterns of organisms and also to explain how species distribution and abundance patterns may be altered by climate change. It's certainly relevant to what we're going to be hearing today.

With that, I'd like to introduce Debbie. You have the floor.

Dr. Reusser: Thank you very much. We've already presented the title, "Predicting Climate Change Threats to Estuaries in the Pacific Northwest." This research could not possibly be possible without a great deal of help from many, many partners, including three Oregon universities, several nonprofit organizations, a few Oregon state agencies, some small businesses, and our federal partners, especially EPA and Fish and Wildlife Service.

Estuarine ecosystems provide important functions and services to society. They're for primary production, carbon storage, nutrient transformation, shellfish production, fish habitat, bird habitat, shoreline protection, and biodiversity.

These ecosystems will be impacted by a suite of climate drivers that vary by habitat and geography. The ones I'll be talking about today are sea surface temperature and sea-level rise, with secondary effects that may be caused from changes in temperature, precipitation, land-use/land-cover, and air temperature.

This is just a stoplight approach to looking at how habitats might be affected by these impacts. For example, the inner tidal area, the tidal flats have the potential to be impacted greatly by many of these stressors that we'll be talking about today.

The objectives of the project were to develop baseline data, models, and tools to predict the impact of climate change on habitats and ecosystem services in coastal estuaries of the Pacific Northwest. All of these data and information products are needed to look at the effects of climate change in estuarine habitats.

As our products become available, you can find them at the National Climate Change and Wildlife Science Center website. This is a direct link to their products. The first thing I'll talk about today are the products that are currently there. The first one is sea surface temperatures.

At the beginning of this project, we went through and collected all of the advanced very high resolution radiometer (AVHRR) data for a 29-year period of time from 1980 to 2009. Then we subsetted the data for the near coastal area, about 16 kilometers within the coastal area. We also added ecoregion fields so that we could evaluate mean monthly temperatures at an ecoregional scale.

This is a graph of the mean monthly temperatures for each ecoregion. On the left hand side are the ecoregions of the Japanese and Asian coastlines, and on the right side are the graphs for the ecoregions on our own West coast.

Just as an example of some of the analyses that we did, you can take a look at this. Right off the bat, you can see that most ecoregions in the Northwest Pacific have a much broader range between minimum temperatures and maximum temperatures for a single ecoregion than we do on our coast.

This is important for looking at species distributions and, in particular, environmental matching for species that might be moving around the world by a lot of different mechanisms -- most recently, the tsunami debris.

You can imagine if you're a species that lives in Japan. You're used to having to survive temperatures that have a very broad variance; it gets very cold in the winter and very hot in the summer. You arrive on the Oregon coast like all the animals that did on that big dock that arrived a couple of months ago. Now you only have half as much temperature variation, and it's much milder -- right in the sweet spot of temperatures that you really like to survive in.

Those species are probably not going to be stressed by their environment. They're going to be much more willing to thrive. It becomes a greater threat with all of the potential debris that is coming our way.

These data have been made available in a variety of different formats at that URL. You can go and download the data sets in text or database formats for the North Pacific. We also did some analyses of the North Pacific. That was published in PLoS ONE. Then we produced the ecoregion sea surface temperatures for the Arctic to compare average ecosystem SSTs in the Arctic rim.

The future science that is occurring now utilizing these data sets, not as part of this project but as a result of making these data available...EPA is going to utilize these data to look at modeling changes in estuarine temperatures and as an input for comparing benthic species richness across estuaries and exploring latitudinal SST gradients as a predictor of species richness and primary productivity.

These data are currently available and can be used for whatever research that may come down the pike later on.

The next piece of the research that we were looking at was sea-level rise. This is a little cartoon to give you an idea of what sea-level rise means to habitat. Wetlands may migrate landward unless constrained by topography or development.

Habitat shifts may occur, for example, from high marsh to low marsh, and the species will move with them. Habitats that may be affected by sea-level rise include seagrass meadows, oyster beds, tidal flats, salt marsh, scrub shrub, and swamp.

Tidal elevation is a key driver to the distribution of these habitats. Vertical zonation of these habitats is a result of environmental stressors and biological interactions. Of course, if you stress the habitats, the animals are going to be stressed as well, and they're going to have to migrate with their habitats. These are all key habitats for fish, fowl, oysters, and crabs.

When we first started the project, the first thing we had to do was select the model. That's not necessarily an easy thing to do. There are a lot of models out there. The first question you have to ask is scale. Are you wanting to model global sea-level rise or regional sea-level rise, or are you wanting to do it at the local scale? One of the things that we wanted to do was model at the local scale, at a single estuary scale.

The next big question is time and money, and they go hand-in-hand. Some of the software is very expensive and some of it's free. The time to learn and use the software is also a critical issue, as well as the amount of energy and effort that has to go into creating the data layers to run the model. All of these things had to be considered.

If you're thinking about doing sea-level rise, there's a very good publication by Mcleod et al. in 2010 that does a good job of summarizing some of the models, what they have been used for, and what the data input requirements are to get us started.

What we decided was to look at the Sea Level Affecting Marshes Model. The Sea Level Affecting Marshes Model was originally designed for the East coast. One of our primary issues that we were looking at was, of course, submerged aquatic vegetation and marsh habitat. It's great for marshes, but as luck would have it, better data is going to yield better predictions. We were striving to do the best we could. That goes back to time and money.

We had some questions that we wanted to answer. We selected an area that we were going to do some sample testing with. The questions that we asked were: How accurately do different vertical data sources capture elevation differences in vegetated marsh? How are plant species in assemblages distributed along salinity and elevation gradients? How well do the National Wetland Inventory classifications of wetlands characterize the estuarine habits in our local area?

The first thing we did was to assess the uncertainty, based on elevation and scale in the SLAMM simulations, and the cost and benefits of high resolution. We looked at LiDAR, IfSAR, an EPA-created bathtub layer, and the digital elevation models. The scale ran from 10 meters in resolution to one meter in resolution.

We found that for processing time, from 10 meter to one meter you went from two minutes to five hours. The digital elevation models are great. You can pull them in, clip them, and put them in SLAMM. They're fairly quick to process, fairly quick to run through the simulation, but it doesn't necessarily yield you the best results.

When LiDAR is available, LiDAR is optimal. If you get the one-meter LIDAR, it can take forever to run, particularly if you're running a whole-estuary simulation. You also have memory constraints and that sort of thing.

One of the things that we decided was that we didn't lose a lot in the results by using a three-meter resolution. It saved on processing time and saved on memory consumption. This publication for the results and the data layers that we generated for the Yaquina and several of the pilot areas will become available sometime next year.

That gave us a handle on the elevation. We also did some ground truthing out in the field to see if the elevations were accurate across different types of habitat. While the elevation may be great in the areas with not a lot of vegetation, in the areas where there's very heavy marsh plants, they found that the LiDAR was not necessarily as accurate as they really would have liked, so we played around with the edges to improve the outputs of the predictions for SLAMM.

The next layer that we looked at was the National Wetlands Inventory and how well the classifications of the current wetland data related to the actual habitats on the ground. Coincident with the project starting, there was a very large meeting of an estuary group here in Newport. It came to light that there was a significant amount of expert knowledge available for both the Newport Yaquina Estuary and the Alsea Estuary about 16 miles up the road. There were several others, but for these two, particularly, we were most interested in.

The data were not available in a format that we could use to input into the SLAMM model, so we contracted with a small consulting firm, Green Point Consulting, to take the information that they had collected over the years and utilize their expertise to help us improve the wetlands inventory for these estuaries based on their local knowledge and all of the field studies that they had done.

For example, that one small area that we had been doing our test sampling in -- the area that you see in yellow, marked "saltwater" -- was actually coded in the NWI as "tidal fresh." This makes a significant difference in the kind of habitats that this will transition to, because this is nearing the area where the intrusion of salt is going to migrate. This is also a very important area for Coho salmon, both for spawning and rearing habitat.

The other information that it improved was to identify areas that are currently diked that were not coded as "diked" in the NWI layer. This is also important for identifying changes to salmon habitat. The assumption is that if it's diked, it probably is going to stay protected as sea-level rises. It's not going to actually turn into different habitats. The assumption is that as long as possible, they're going to continue to keep it diked so that the water doesn't inundate. This kind of information was greatly enhanced by the data that was provided from Green Point Consulting.

The data, the layers, and the methods will be coming out in an Open-file report. It's in revision now. We're hoping to have it out before the first of the year, available on the web and links to it at the National Climate Change and Wildlife Science Center.

The next piece that we are looking at is salinity. Salinity is the measure of the amount of salt in the water. It's an important factor determining where plants and animals are located in the estuary. Salinity is highly variable in both space and time.

When you're looking at the ocean, and you increase sea-level, it changes the tide range. It also changes the intrusion of salt, but we have a confounding factor, also, in the changing of the timing and quantity of stream flow. To get a handle on these particular functions...

We also have one more complicating factor. On the West coast, many estuaries are of different types. We have lagoonal estuaries that don't get a lot of freshwater input. We have estuaries that get a lot of freshwater input in the winter and a lot of marine water in the summer. Then we have river-dominated estuaries where you still have a lot of input from the ocean, but you have more freshwater input.

What you see here is a graph of the difference between a marine-dominated estuary and a riverine-dominated estuary between winter and summer. You can imagine how complicated it gets when you try to model the winter changes, the winter flow and the summer flow, and the changes in the input in fresh water. Looking at the marine-dominated, you see that the salt goes all the way up past 20 kilometers from the mouth of the river, whereas in a river-dominated estuary it only travels about 10 kilometers.

In the main stream of the river, Cheryl Brown at EPA modeled, assuming a steady flow, the salt coming from the mouth of the estuary. Looking at this, you can see that as you move from the mouth of the estuary up into the river portion of the estuary, the changes in the salt intrusion increase until you get to Location C, where it's increased about the same amount but it goes up further as sea-level rises.

The black line is the present sea level, the red line is with a 30 meter sea level rise, and the green line is a 60 cm sea-level rise. If you assume a steady flow -- the flow doesn't change -- when you get to the middle of the river at Location B, you're going to have a much higher salt content in the water than you currently have now.

Looking at how that affects marshes and the intrusion of salt in the marshes, even a slight elevation in sea-level will result in the increase in salt delivery to the wetlands. The magnitude of the salt delivery in the wetlands will be a function of the time of year, the river discharge, the location of wetland in the estuary, the elevation of the wetland, and the magnitude of sea-level rise. Here you see with a one-meter sea-level rise, the salt intrusion into the wetlands increases more as the time cumulates.

Salt is important because the distribution of the submerged aquatic vegetation, the seagrass, typically occur in a very narrow range. It is driven by salinity and the turbidity, or the light amount it receives in the water. As the sea-level rises, it gets deeper and the amount of light that's available is decreased. Seagrass is going to be affected by how much, where it's at and how far it can migrate.

Marsh plants are also sensitive to elevation and salinity. Here's a picture of the diversity of the marsh plants within Oregon estuaries. From low marsh to high marsh, your diversity changes; and from freshwater to saltier water, your diversity changes. You can imagine how the salinity is going to change the distribution of these plants.

We had the modeling for the salinity. What we needed was to add inputs to that model to identify how that salinity is going to change based on changes in stream flow. The Oregon Climate Change Research Institute provided data from the NARCCAP, the North American Regional Climate Change Assessment Program, for downscaled climate data, to Portland State University and EPA -- with funding from this project -- to do downscaled modeling for the hydrologic processes for the pilot estuaries.

They modeled changes in river flow based on precipitation from inputs from the climate data that they got from the Oregon Climate Research Institute and the precipitation from PRISM. They came out and they combined it all into a...This is a summary graph that provides us information about how flow is going to change on a month-to-month basis.

For these four estuaries -- the Willapa in the north, the Yaquina, which is a marine-dominated estuary, Coos, and Coquille, which is a river-dominated estuary -- they provided the outputs for their predictions in changes in flow. This report will be coming out sometime before the end of the year. It's in press right now. It's been through review.

What you see in this graph is all four of those estuaries and how the flow is going to change by month. From January through September, with very few exceptions, we're going to have less riverine input; but from October to December, we're going to have increased input.

I don't know how many of you are from the Pacific Northwest, but you probably know that it doesn't rain a lot in the summer. The fact that it's going to rain less, that's disturbing. We hadn’t had any rain in two months until October. It started pouring down rain about the 20th of October, and we don't get a lot of sunshine.

Having the idea that it's going to increase is a little bit disturbing because we get a lot of rain -- an average of sometimes 50 inches. Getting more rain in the winter when we already have a lot of rain could produce quite a lot of challenges.

This report is finished. The outputs from this give you an idea of where I've gone. I've been scrambling all over the place.

To give you an idea how this is all coming together -- Portland State modeled the future hydrologic flow. They provided inputs to EPA to model predicted changes in salinity patterns. Those salinity patterns are being input into developing models to predict the distribution of SAV and marsh plants.

We're working with Warren Pinnacle and the developers of SLAMM to build modules that will utilize these salinity patterns now to provide outputs that show changes in distribution for tidal flats and submerged aquatic vegetation, which currently is not in the SLAMM modeling software. That's important for West coast estuaries for all the reasons I explained before.

Another recent benefit that I just learned yesterday was that, I believe, Fish and Wildlife and Ducks Unlimited have provided funds to migrate the SLAMM modeling platform to a 64-bit operating system to handle higher resolution data and to have less demands on the resources of the computer to allow us to create better predictions. The modules that they are developing to incorporate into SLAMM will probably be finished by the end of December.

We should have something released in the SLAMM package for other people to be able to use it to model changes in distribution and habitat for SAV and to output layers of changes in salinity patterns and output changes in elevation patterns to use as inputs in their models for predicting other distributions of habitats and species. We're excited that this is going to be coming out. This is a work in progress.

Another element that is part of this research. When we worked with the Green Point Consulting, we had a workshop. Laura Brophy came out and gave us a one-day field orientation on plant identification for EPA and USGS biologists, and really moved us forward in collecting information on the Oregon marsh plants and the distributions of those.

Chris Janousek has had the lead on building information about the marsh plants, the distribution of marsh plants, the assemblages of marsh plants. He has several projects in collaboration with USGS. They're going to be coming out very soon. One is in prep, and this is sea-level effects on plant growth.

They see that we have the potential to observe a loss in plant growth, even for lower marsh species, and that sediment accretion and coastal food webs may be impacted by loss of productivity. This graph indicates the above-ground biomass related to sea-level rise based on their experiments.

Another publication that's in press is the identification that shifts in plant species composition might be seen. There may be a loss of high marsh habitat. There'll be a reduction in plant diversity, potentially, and an increase in algae in the tidal marshes.

Ducks Unlimited, courtesy of Mark Petrie -- I see he's online -- has already modeled sea-level rise for the estuaries in Oregon and come up with a percent change for existing habitats on the Oregon coast. Looking at an increase in salt marsh and traditional marsh, a decrease in low tidal or mudflats, a decrease in freshwater tidal, and a decrease in freshwater based on their accumulative outputs and a sea-level rise of 0.69 meters by 2100.

These changes and the vulnerability to sea-level rise may vary by habitat. Again, this information is from Ducks Unlimited. The seagrass will increase; the tide flats may decrease; the low salt marsh will increase; the high salt marsh will decrease; and the tidal swamp and tidal fresh marsh will also decrease. These are expected to vary by estuary, as well.

These are some of the example management options for some of the wetlands that we've talked about and their preservation. This is from EPA's Climate Ready Estuaries Program. We can allow the wetlands to migrate inland, we can promote wetland accretion by sediment introduction, or we can reduce or prohibit hard shore development. Each one of these options comes with benefits, and some of them come with constraints.

The biggest constraint is private property interests and how homeowners are going to react to being told what they can and can't do on their own property. Some of these options are very costly. Permitting and costing may prohibit some of these actions from taking place.

There are still a lot of important ecological questions. A lot of research that still needs to be done.

For instance, How important are organic inputs to accretion? Accretion has been a big unknown in this area. There is research currently going on. EPA will probably have something out in this next year. They are collecting data to identify accretion rates in different habitats. They're finding that different habitats have different accretion rates, even when the elevation changes and when the habitat changed, the accretion rates are different.

Where SLAMM takes a single or one or two accretion rates, it may be that that becomes a grid of accretion rates based on habitat information from either the wetlands categories that are available or higher resolution information that exists for estuaries.

Another question is, How will other coastal stressors interact with the sea-level rise and affect these organisms? For example, air temperature alone could cause the temperatures in salmon habitats to cause more days in a given year to be outside the scope of when salmon can spawn. The fewer days they can spawn, the more stressed they will become. Air temperature and reduced flows will cause those days to shrink.

With that, I will take any questions.

Ashley: Excellent presentation, Debbie. Thank you so much. I'm sure we have a couple questions out there. If you have a question, you can use the "raise hand" icon that's between the participant list and the chat box. Once you raise your hand, I'll call on you by name and you will press star six to take off the global mute. Don't forget to unmute your own phone, as well.

You can also chat your question into the chat box. I will read it out loud for our audience, and Debbie will be able to answer it. [silence] There's got to be one question out there. [silence] Excellent. Laura Brophy, you may ask your question now.

Laura Brophy: OK. I think I'm unmuted?

Ashley: Yes.

Laura: Thanks for the great, great talk, Debbie. It was a pleasure to work with you on this. I am interested in the questions of accretion and sediment deposition, especially in the middle and upper estuary where alluvial processes are so prominent. It's not as much of a question as just something that I expect you and others will be thinking about as we move forward with these predictions.

The precipitation patterns you're describing are even more extremely seasonal than we currently have. Currently, our formation of tidal wetlands in the upper estuary, much of it is event-driven during big storm events. It sounds like those areas may become even more event-driven depositional patterns. It may be that we'll see a really different kind of accretion process occurring in the upper estuary. Something to think about with the modeling.

Dr. Reusser: Yes, was there a question? Did I miss it?

Laura: Ah, was there a question in there, Debbie? [laughs] Tell me if you plan to bring an accretion grid into the SLAMM model during the development of these new modules or if you're going to leave that for later.

Dr. Reusser: That's going to be left for later, but some of the information that I've been seeing from preliminary results that they've been collecting. Interestingly enough, you talk about three centimeters a year, not a really big issue. Then you have something that comes down the line, like the flood that happened in February. You see 10 inches has been dumped in one area.

I think you're right. I think the extreme events may be driving some of the results that we're not capturing in some of the sampling that's occurring. I'm not sure if they've figured out how to account for that or whether they're putting out more things to collect the information. That's not really been clear to me.

I agree with you. Yes, the patterns are going to get even stronger than they already are. It may be the extreme events that drive the significant changes that make determinations on where the habitats move to.

Laura: Yeah. Thank you.

Ashley: We had a chat question from Rob Walton that says, "Do you have any time frame for the changes?"

Dr. Reusser: Which changes?

Ashley: Rob, if you'd like to follow up, you can press star six to unmute your phone. [silence] Or you can chat it in.

Dr. Reusser: Most of the predictions have been calculated to 2100. The changes that you're seeing are what's going to happen between now and 2100, over the next 88 years.

Ashley: Does that include the sea-level rise?

Dr. Reusser: There were four different sea-level rise numbers that were used. One of the things I didn't go into is sea-level rise on the West coast is very specific to where you are. If you're in

Astoria, Oregon, right at the tip of the mouth of the Columbia River, the land is rising as fast as the level of the sea is rising. The amount of inundation that's going to happen in the far northern part of Oregon is going to be insignificant.

As you move down the coast, in Newport, Oregon they expect that the sea-level rise is happening faster than the land is rising, uplift on the coast. We're going to see from one to two meters in 100 years. I think the IPCC current predictions were at, like, 0.69, but they've modified those in recent years to be higher, and could be as much as two meters in 100 years.

The predictions are all over the place. When you get to Coos Bay, the changes in sea-level rise are actually expected to see...The land is sinking, so your sea-level rise is going to actually be greater in southern Oregon than it will be in Newport.

You see a lot of different predictions. I probably covered four or five in different aspects of the presentation. In the finite flow models, she used 30 centimeter and 60 centimeter for Yaquina Bay. In some of the information that Mark Petrie is showing, they used a 0.69 average for all the Oregon estuaries.

It would be difficult to say. The predictions are all over the place. Don't buy a house near the edge. That's not where I'm at. [laughs]

I have a chat question. “Could I mention briefly the ongoing vulnerability assessment for coastal species that we're leading, and how it ties in with projects today?”

Like many things, they're building blocks. The Species at Risk project is another building block. We are hoping to have vulnerability assessments on a broad scale. For example, given rockfishes and the number of rockfishes that currently exist on the coast and their abundances, how many of those are less common to rare, what are their distributions along the coast, and what percentage of those are at risk.

We're currently working with -- just about finished -- fish species on the Pacific coast from the Chukchi Sea to the Gulf of California. We're only looking at the Subhashree species for this kind of an analysis. The crabs, we're also doing in a select group of crabs -- the two crabs and another species of crabs -- and the bivalves. We've had several workshops with experts to get at their perception of what the abundance patterns are relative to that group of species.

For example, if you're picking samples, is this particular species more or less abundant within this group of species than another species, and how does that change up and down the coast, so that we can get at a relative abundance for these groups of species. How that relates to the work that has been ongoing with the sea-level rise is that the habitats that we're looking at in the estuary and the coast...

If you happen to be a species that's moderately rare or rare and your habitat is threatened, you are going to be much more vulnerable than a species that's common and real happy and in very large habitat-niche environments.

In other words, if you can live from inner tidal to 200 meters, and you can live in sand and rocks, and you can live in all kinds of temperatures, and you're found from the Gulf of California to the

Beaufort Sea, good chances are you're probably not very threatened. But if your niche is threatened and you're fairly rare, those are the species that are going to be at higher risk.

The outputs and the habitats -- that stoplight approach that I showed in the beginning -- give it an overall rating on the habitat, and then the abundance gives it another rating. Then the breadth of distribution and the number of ecoregions it's found in give it another rating.

Those ratings get combined into a vulnerability assessment for groups of species. We're developing the tools to be able to do broad assessments for large numbers of coastal species. Long answer to a short question.

Ashley: Excellent, very good.

David: Ashley, this is David Patte. Can I have a follow-up?

Ashley: Absolutely.

David: Hi, Debbie. This is David. Hey, I just wanted to mention on sea-level rise. On all the various projections, global rates have been updated in a new West coast analysis on sea-level rise. There are actually a number of workshops in Oregon and Washington that are actually happening this week and next week and the next two weeks to communicate those.

It's a National Academy of Sciences, National Research Council product. I don't know if there's a way to circulate some links. I can send that to you, Ashley.

For Oregon, there was also a study. I think you're absolutely right about the vertical land movement. It's so different. In northern Oregon up to the Willipa/Astoria area...Central Oregon has seen some negative vertical land movement. The very southern part of Oregon below Coos Bay has actually seen some vertical land movement uplift. That's a publication by Kumar, et. al., 2011. That was published about a year ago.

Dr. Reusser: Thank you.

David: Not a question, just some information.

Ashley: Thank you, David. Are there any more questions?

Dr. Reusser: I see Laura's hand up, still. Is that still from before?

Ashley: I believe so, but if you have a follow-up question, please go right ahead. Otherwise, you can press the "raise hand" icon again, and it will put your hand down. [silence]

I saw that Darrin Sharp had his hand up for a moment. Darrin, do you have any questions? [silence] All right.

Ashley: Go ahead.

Darrin: This is Darrin. No question right now, thanks.

Ashley: Perfect. [silence] I'd like to thank you very much, Debbie, for your presentation. Also, I'd like to thank everyone that attended today.

The next presentation for this series will be on Tuesday, November 13, 2012 at 3:00 PM Eastern time with Jeffrey Kershner. Please stay tuned for an announcement. Thank you all again for attending.

Dr. Reusser: Thank you.

Transcription by CastingWords