

the Canadian government and elsewhere, what we see is that with declining sea ice in the Arctic region in the Arctic Basin. A substantial degradation of the optimal polar bear habitat throughout the circum arctic some areas in deed in the Canadian archipelago that by midcentury, shows some increase the potential increase in optimal polar bear Habitat, but substantial decreases throughout the circum arctic. Again in response to sea ice decline and climate change.

Another example is the degradation of permafrost, and I won't go through all the details, but suffice to say here in the blue record, we see a decline of permafrost area, and volume in terms of millions of kilometers squared and the projected based on different carbon emission scenarios, for human carbon emission to the atmosphere from the global climate models, and what we see is a dramatic change increase or acceleration into the future by 2100 of permafrost thaw and degradation throughout the Arctic to the point where only Greenland and parts of the Canadian archipelago are projected to have any real substantial permafrost by the end of this century. This has significant impacts on Native communities on oil and gas pipeline infrastructure and on road and transportation networks, as well as many other things with human and economic significance.

Going back to where Connie was and he ended with the issue of about 1 meter of sea level rise or more by the end of the century looked extrapolating the rates that we are seeing today with the accelerated loss of ice in Greenland and Antarctica. If we were to look in the Gulf Coast area around Louisiana, what we have done here is to show an inundation map, an area where today, based on the land surface today what would be underwater with 1 meter of sea level rise, and we can see how significant that is with New Orleans down in here. The economic significance of this as well as just the social significance is huge. So those are changes that are already occurring. They are changes that are occurring that at what might be the start of an abrupt change event. They may be part of just a linear change of climate brought on by the combination of both human and natural forces.

What would happen, what would these changes look like, how would we adapt, how would we mitigate something that had a rate that was an order or to magnitude greater or even a magnitude of total change, an order or two magnitude greater than what were seeing today. Those are some of the future science challenges about the science of abrupt climate change. And things that we are working on with our partners like Rick Rosen at NASA or at NOAA and the climate change science program, is developing better ways to forecast changes in state. These are state changes in the environment and the physical system that we are looking at. Can we forecast better the accelerated rates of these changes? Right now our modeling capabilities deal with linear changes, not nonlinear accelerated changes like Connie had mentioned about sea ice. Same with the climate models and the response models. We need to better link those changes of state and system response like we have with the polar bears and sea ice decline. We need to look more at system thresholds and their

potential triggers. Those tipping points that may be out there that may be the sentinel, the early warning system of the changing climate and abrupt climate change events. And all along throughout this we need to develop better adaptation and mitigation strategies for dealing with this kind of significant change.

We're not saying these changes are going to occur, but we want to make sure that we are prepared that if they do occur, we have strategies for how to adapt and to mitigate them. And finally going back to the Department of the Interior's climate change task force.

One of our key visions in the development of a climate effects early warning system. A vision in which we have an integrated national capability for monitoring across the country at all scales of both time and space focus on early detection and forecasting to support adaptation and mitigation strategies so that there aren't any surprises, and that we can do something about it before the damage is really done. We want to develop an information, dissemination, and decision support system that is truly useful to decision makers, not just science that is handed off to them, but science that's integrated seamlessly with the decision-making process. And then finally for next generations and beyond, I want to make sure that we leave the capacity and the start, the legacy of development of protection plans for sustaining our national trust resources through early detection of change.

So Dan Kimball will get up next, and I know Bill will introduce him. But I want to, when you see Dan and his talk on Everglades, think about that change that linear change in the significance of what he is about to show and then think about what that would be like with a magnitude or more greater change in rate and magnitude. Thank you.

00:32:43:00

Bill Werkheiser: Thanks Tom. Our next and final speaker for this morning is Dan Kimball. Dan is the Superintendent of the Everglades and Dry Tortugas National Parks, and I think you'll see in Dan's talk that Dan will take this information, all the scientific information presented by Connie and Tom and translate that into some real world examples of things he has to deal with on a day-to-day basis. As the park superintendent, Dan leads the park's involvement in the restoration of the Everglades. He has served as the chief of the National Park services water resources division. He has been the acting Superintendent of Zion National Park, and assistant to the National Park service deputy director. Dan?

00:33:51:00

Dan Kimball: Good morning, my name is Dan Kimball, Superintendent of Everglades and Dry Tortugas National Parks, and I just want to thank all of you for coming, and I'd like to thank the U.S. Geological Survey for the invitation to be part of this panel today. Following Connie and Tom's presentations, I'd really like

to offer some thoughts at the ground level, and from the perspective of a land manager that is managing a park every day and really a like to focus on three things.

One is the vulnerability, regardless of whether were talking about the IPCC or some bigger numbers that was just been alluded to. The vulnerability of places like Everglades and Dry Tortugas National Parks, particularly with regard to sea level rise. Second, I'll talk a little bit about the expected effects of climate change on both the natural and the built environment, and I'll use the two parks here as examples of that built environment, and finally a number of actions that we've taken to learn about, mitigate, and adapt to climate change.

A little bit of orientation here, this is the map here for Everglades National Park. This area right here, is surrounded by Big Cypress and Biscayne National Parks over here. It's a very large place, 2300 mi.², is the third-largest park in the lower 48. The only parks are bigger is death Valley and Yellowstone. A little bit different park. It's at the very end of a long peninsula and its surrounded by close to 7 million people, right at our doorstep. One area I'd like to point out here, that I'll be talking about in a few minutes is Florida Bay. A very sensitive area of the park about a half million acres, and this is also the largest wilderness area east of the Rockies. I'm also the Superintendent of a little park, it's a 100 mi.² out here 70 miles to the West of Key West called Dry Tortugas National Park. It's a 19th-century Fort, and I'll show some photos of that in just a second. This is the photo on the left here is the classic Everglades, the river of grass. It's flat as a pancake and 60% of the park is less than 3 feet in elevation. Maximum elevation in the park is 11 feet. I lived in Colorado for 30 years, and I drive, this is a sign on our main park road. It identifies one of the key features in the park.

One of our major land forms, It's the divide between the two major drainages in the park. Taylor slough and Shark River slough. And that tells you kind of what we are faced with a major divide in the park elevation, 3 feet. This is Dry Tortugas National Park, Fort Jefferson in this area right here. It's a 19th-century Fort, and what I'd really like to point out here is it's surrounded by a moat wall. That's kind of our last line of defense. The park also has a spectacular tropical marine resource or reef system. That is also very sensitive to climate change. Particularly temperature.

We've been looking a lot at climate change information and projections and as you heard this morning, the numbers are changing almost weekly, and we focused on the IPCC, the last report, the 2007 report, that talked about seven to 23 inches with six different models. Talked about it, excluded, it had a footnote on future dynamic changes that could occur, which we have heard this morning are occurring, and really no rate of change projected. But the data in South Florida, we've had about 9 inches of sea level rise in the last 75 years. Also, something that we haven't heard about to much this morning is we're talking about a temperature increase as well. And then something very important to us in

South Florida, this increased cyclonic activity, i.e., increase in hurricanes in intensity and frequency. We've done some basic overlays of the park, we took the 7 inches and overlaid it on our topography and also the 23 inches. With 7 inches, in this kind of aqua color is areas that are inundated. About 10% of the park under the 7" scenario, and you start to look here under the 23 inches above 50 to 60% of the park is now not freshwater resource, but is a marine resource. In terms of habitat, we tried to simulate what's going on with the help of our partners with the U.S. Geological Survey. This magenta color is the shallow freshwater Marsh. As you can see over here in 2100. This is the 23 inch sea level rise scenario. That's basically gone. It's much more over a marine system. You see the mangroves over here on the coastline have now advanced onto the landform of the Everglades and the high ground. And then there is an area right here that is kind of a dark green. Those are the pinelands, that's the last remnant of pineland community in South Florida. And you can see over here, that would be gone, would be inundated. Pictorially this is kind of what it looks like this is what looks like right now.

This is the classic short hydro period fresh water marsh, would probably transition to something like this more of a mangrove dominated and saltwater dominated environment. Probably have fewer of these alligators, and perhaps more of these crocodiles. Crocodiles are more of a saltwater species. One of the concerns we have is this is the Cape Sable seaside sparrow. A number of you probably have heard about. It's an endangered species, and a number of their subpopulations in the park under the 23 inch scenario would be eliminated.

We've gotten some help from the U.S. Geological Survey to look at some mangrove distribution, you can see the red, black and white mangroves going from the historic, where we are right now, this is actually a meter, you can really see the advancement to higher ground and that's quite a change. And then it's not only just what happens on the surface, a big issue is what happens to groundwater. We've got something we call saltwater intrusion. The Miami Dade County is very concerned about that because we get all of our water from groundwater our freshwater system that's fed by the Everglades and if you get a higher sea level, you get the salt water intrusion, and that's kind of where we are today.

We've been getting help from the U.S. Geological Survey to really look at this salt water interface, and as the sea level comes up, you get more intrusion and more impacts on the freshwater well fields. We are also concerned about coastal erosion. This is the area out in Cape Sable. A pretty sensitive area out in the very western part of the park and out in this area there is a lot of green sea turtle nesting, and we are concerned about how higher sea levels would affect those species.

And then I'd just talk for a minute, wanted to mention that the initial slide about Florida Bay. This is a very sensitive area, and when you look at increases in

water level, and also increases in temperature we could get increased algae blooms. The increase in saltwater would likely result in an impact, an adverse impact on sea grass and a number of other adverse impacts. And this is one of the premier fishing spots in the United States. Florida Bay. And recently the national wildlife Federation and Florida wildlife Federation did report that is actually, if you have a chance to look at it, it's on the Web site. It's called An Unfavorable Tide.

This is probably the best assessment of impacts of sea level rise on fishing. Because we would look at a change in species, this is a great bonefishing area, and right now they are estimating that fishing in Florida Bay is about a \$70 million per year increment to the Florida economy. So we are very concerned about fishing and we have fishermen that are very concerned about sea level rise. We are also concerned about effects on our built environment. This is an area that we call flamingo. It's our only overnight accommodations in the park and you can see here that they are built very close to the Bay and are concerned about the sea wall. We also have 40 backcountry "chickies" in the park that would be subject to sea level rise. These are the campsites, because there's really nothing, no place to camp that is dry.

So we built these quite a few chickies around the park, and we've had to rebuild them after the cavalcade of hurricanes that we have been faced with. Out at the Fort, I mention this moat wall. You can see that we've got about 4 feet of freeboard on the moat wall that protects the Fort itself. And we are continuing to monitor the effects of sea level rise on the moat wall. We are also seeing the coral bleaching in the park. The increases in temperature and to that spectacular coral resource that I was talking about. There are some upsides with climate change.

We get questions a lot of questions about how do I access the Everglades, well you can see here that if you got a veneer of more water, there will be more access. We're also looking down at Florida Bay. Our Rangers say, if we had additional 2 feet, we wouldn't quite deal with these groundings that we see every day out there, and so I guess there is an upside. And then it wouldn't be an Everglades talk if I didn't spend a minute talking about our python outbreak in the park. We have caught over 200 pythons, that's an invasive species. You can tell here, you have probably seen this one, it was a classic one that was on the Internet, where python tried to eat a six and a half foot alligator, and I guess it was just too much. But it gives you an idea of what we are faced with in the park, and we are estimating, now, based on the densities we are finding that there could be 150,000 of these in the park.

I've asked our biologist if climate change could solve this problem. And they said no, Dan, they seem to do just fine in saltwater, and they really like hotter environments. In fact, take a look at this slide, this is a USGS slide, this is the current distribution right here. If you look at the changes in temperature that have

projected by 2100, this is the suitability range for the python. You notice it comes right up here to the D.C. area, so get ready.

Lets talked for a minute about hurricanes. There, as has already been mentioned here, is quite a raging debate about hurricanes in terms of intensity and frequency. There are a lot of people that are saying yep it's happening, take a look at the last few years. There are others at the National Hurricane Center, Max Mayfield and others that are just saying nope, we're just in a multi-decadinal oscillation every 40 years we get in a batch of hurricanes, and that's where we are.

So this climate change publication that we put out, we spend quite a bit of time dealing with the hurricane issue, because I think that is the one that we always get asked at the park. We really are trying to provide a balanced view. I'll tell you one thing, whether they are caused by climate change or not. One thing we know is that with increased sea level is that we're getting just like New Orleans, we're getting storm surge. This is out at Dry Tortugas when hurricane Charlie came in in 2004 we sustained quite a bit of damage at the park. This is hurricane Wilma following hurricane Katrina brought in 9 feet of storm surge into flamingo, and this is our flamingo lodge that's still currently closed, not because of wind damage, but because of storm surge.

So what are we doing about all of this? Well one thing we are doing is where doing everything we can to advance the comprehensive Everglades restoration plan. This was the historic flow path, a large amount of freshwater came out of Lake Okeechobee. Today we are looking at a system that is designed for flood protection and water supply, where we're taking large amounts of water and sending it to tide with these arrows, and then we are bringing small amounts to a canal system, and a piddly amount into the park. We are trying to implement something we call a planned flow, which is bring water down and restore this flow. And my point here is that to respond to all the climate change impacts, particularly sea level rise, we're trying to bring freshwater in to basically be a barrier to that saltwater that is coming into the system.

It's really important, and when we do that we will get a healthier ecosystem that is more resilient to climate change. It's not cheap. The numbers have changed since I put this slide together. It's not 11 billion. It's probably 15 billion and it's going to take a while, but we look at this that it's the way to at least attacked this in some way is to restore the ecosystem and get a healthier and more resilient ecosystem. We are doing the same thing out at Fort Jefferson at the Dry Tortugas. This is the park, this is Fort Jefferson that I showed a picture of. We've set aside with the state of Florida 46% of the park is in no-take Marine reserve. There is no fishing in there, you can't anchor, we're really trying to do everything we can to protect the fragile coral system there. And we're hoping that again we'll have an ecosystem that is healthier and more resilient to climate change.

We are doing a lot of science, this is our research and supply vessel out at Fort Jefferson, the motor vessel Fort Jeff, and it's doing a lot of science, taking a look at that research natural area, the no-take marine reserve area and were also doing a lot of monitoring within the park. The USGS within the park and right next door has close to a hundred gauging stations like this that are looking at water flow, water depth, changes in sediment, changes in vegetation. So we are really trying to learn about how climate change is affecting us right now. We are also adaptively managing.

This is a cottage that was down at flamingo after the storm surge at Wilma, after Wilma. That's in the process of being demolished, and a replacement we're looking at elevated structures like this. We're also looking at the effects of storm surge. We had some docks down at flamingo. We've learned by exactly what happened. These were traditional docks. They are like this today, they haven't been reopened yet, that's a safety hazard. Very close to that we had floating docks on the other side of a plug and they came through the storm just fine so from now on we're building floating docks. And then at the Fort, we're working hard to restore the moat wall, we're doing everything that we can. As I said, this is our last line of defense, and we are also doing a lot of things to restore the Fort itself to make it more resilient to hurricanes. This was not caused, this was exacerbated by storms, but we just received word that we are going to start our second phase of the restoration with a \$7 million Fort wall stabilization program. We are doing some mitigation. There are some canal's that were cut. We're getting a lot of saltwater based on that 9 inches of sea level rise into the freshwater backcountry.

We had some failed dams, and we are in the process in certain cases, we decided it's important to mitigate, we can go in and re-plug these to try to get the saltwater out. And we are also doing another quite a few other things. We're working hard with a climate friendly park's program, we've inventoried our emissions into the park, sustainable designed, we are trying to do everything we can to green up park and importantly lead by example. We are part of the Department of the Interior's climate change task force that was referenced earlier. And another thing that I'm pretty proud of, we're part of a local Miami-Dade climate change advisory task force, where the county realizes that we are in a very vulnerable place, and they've pulled together a lot of various interest to try to figure out the things we can do to really mitigate and adapt to sea level rise, changes in temperature, and also hurricanes.

And finally we're doing a lot of education and outreach and whether it's the nightly news, whether it's this climate change publication that I talked about. There was quite a, we were interviewed in a big part of this recent backpacker magazine, and it seems that about every three days the Miami Herald runs an article. So, we are really using the parks for a platform. And finally just to summarize, the resources at the parks are really are very vulnerable to climate change. We're monitoring, learning about climate change and potential impacts.

You can see even this morning with the recent information, where trying to keep up with the science, which is a huge challenge in and of itself. We're restoring resources to make them more resilient to climate change and as I've noted today that we're taking mitigation adaptive measures as appropriate. And finally, and this is a really important part of it, is educating the public in using the parks as a platform to talk about climate change and the challenges that these very vulnerable places have. Thanks a lot.

00:50:35:00

Bill Wekheiser: Thank you, Dan and thanks to all our speakers, where I thought was a very interesting briefing. I hope that after our short time together you have a better sense of what abrupt climate change is and what it might mean to you. I also hope you a better sense of how the information that the USGS and others provide can help you as you make your decisions to help ensure a healthy planet, a sound economy, and a secure nation for future generations. Now before I bring the panel up for questions, I'd just like to make two announcements, one is that there are a series of handouts on the table over here. If you had not had a chance to get those, please do, they are very interesting. And the other thing is that our next briefing in the climate change series will be held in November, and the topic will be the effects of climate change on wildlife and human health, and we look forward to that. At this time, I'd like to bring the panel, the speakers up to answer any questions you might have.

Any questions?

Question: I'm wondering when we are talking about climate change in the debate we're focusing right now on CO2. Shouldn't it be water and a little bit more (?) realistic in encompassing discussion than just picking one of the major (?), but it's not necessarily the whole story?

Konrad Steffen: If you talk about CO2, that's one of the causes and it is probably one of the most important ones. We have methane. We a lot of other causes that you realize are equally important. But the cause is still, the amount of (?) CO2. But what is actually the affect of it is sea level rise has many different applications.

Question: But as the public policy debate goes forward to it, would you agree, I sort of think it should be run to the majority of things, even though CO2 is the greater of the cause, but again, it would be a shotgun approach (?).

Konrad Steffen: (?) especially when I talk about sea level rise. Most people don't realize this is the global average that in some regions it will be much higher. Some regions will actually have a minus sea level rise, where the ocean is predicted to go down, but that's quite complex.

Tom Armstrong: Can I go ahead and answer that. To add to that question, it is

a broader more holistic issue, than even greenhouse gases. When we talk about mitigation, and a lot of debate, and a lot of discussion is occurring, and rightly so, on, how do we mitigate CO₂ or greenhouse gases in the atmosphere? Keep in mind that the IPCC 4th assessment report that just came out, showed the emissions scenarios for the global circulation models for CO₂, a wide range of scenarios from worst-case to best-case. But regardless of the scenario picked, over the next 40 to 50 years, CO₂, in terms of atmospheric concentrations, will pretty much stay on the same increased trajectory regardless of what we do. And it doesn't mean we shouldn't be talking about mitigation, but that's one prong of a discussion on policy that also needs to include adapting over the course of the next 40 to 50 years to the inevitable change that will occur.

Question: Just following up on that, I'm wondering if you have any sense in how much tropospheric ozone or Arctic haze, as well as deposition of soot and aerosols that might be contributing to the rapidity or loss of sea ice and glaciers?

Konrad Steffen: There is actually just a new, there is a new study going out that looks at the soot count, and it has been shown that due to the wildfires that have increased in Alaska, for example, we get more soot on Greenland as a direct link that the soot is actually distributed (?) reflectivity of the ice sheet, which enhances the melt. So there is a direct link between the increase in soot and the increase in melt. The causal effect is not understood, we know the dynamics of the atmosphere (?) very good link. In addition, we just finished a study that showed in Colorado. I live in Boulder. The increase in early melt is directly linked to the drying of the West, because you have a very dry surface that picks up the dust puts it on the snow and the snow gets darker. You have an earlier melt. We lose actually that water storage that we usually have in the spring much earlier, so the whole system there is changing.

Question: In the study of the meltwater, (?) was going on, I wondered, what kind of a program can you imagine of expanding the study to the point where, in some future year you could consider effectively plugging the hole like that? Or more actively trying to slow the process? I know it's too early to understand what's going on, but...

Konrad Steffen: Actually you cannot really plug the system. Moulins are something that we have known for many centuries. They were started actually in the 1800s on the glaciers in the Alps, and that's a natural system that the water reaches down and we cannot stop it of melting its way down. We actually were asked by some people which make some studies in the Alps, how can we reduce the melting of the glaciers because some of these cable car systems are anchored in the ice in they are actually able to put some highly reflective blankets over a glacier part which reduce its melt, but that's not a solution for the Greenland ice sheet. Its way too big, and we cannot interfere with that kind of a large system so I don't really see a solution. It's not plugging an outlets, because it melts its way down every year, that's what we realize now.

Question: In terms of the USGS efforts to expand their work on forecasting climate change and providing information on, let's say, how impacts in ecosystems or areas like the Park Service, or the park areas. How much of that work through CCSP in the collaboration with other agencies like NASA or with NOAA?

Tom Armstrong: A lot, in fact I was just going to say what you said at the end as my response to question. It really, in terms of linking climate forecasting to response, USGS's strength is really in understanding the responses in the terrestrial and freshwater and coastal ecosystems. But our partners at NOAA, like Rick Rosen and others at NASA, The U.S. Department of Agriculture, NSF. The 13 partners of federal agencies that are part of the climate change science program are coordinating to work more closely to establish joint priorities on topics like abrupt climate change to link the strengths of all the different agencies so that we have better climate forecast linked to habitat models or ecological models across all these agencies. So, CCSP is a great focal mechanism for doing that.

Question: You talk quite a bit about 1 meter sea rise and mentioned that there are models that indicate it could be as high as 7 meters. I wonder if you could talk a little bit more about the discussion among scientists trying to reduce this variability?

Konrad Steffen: I think the increase of 7 meters (?) that model is a potential increase in case the whole West Antarctic would disappear. That's not the case in the near future. The point we would like to make is the current IPCC report is based on the melting of the ice sheets. But it has no dynamic component that the ice is moving faster into the ocean, and that's the more recent observation we do and the upper limit for the pure melting of the ice sheets and melting of glaciers give an indication that thermal expansion in the ice will give you at the maximum about a half a meter sea level rise by 2100. We do see however that the dynamic is almost two thirds of the signal right now, and purely based on that kind of a response, we see the upper limit of half a meter is not sufficient as an upper limit, it can be easily 1 meter or more. We also make the point that we cannot model it yet, because we only start to understand the process of that dynamic motion. So that is the current understanding. I'm going off to actually Sydney tomorrow, where we have an IPCC meeting, where exactly this cause, how can we make a better forecast for the sea level, because it is currently inadequate.

Question: The Superintendent spoke about a 35-year plan, that I think is tending to help adapt, or perhaps mitigate rising sea level, and maybe I'll put Connie also on the spot, sorry, but does he have 35-years based on what you are seeing now going on, is that a realistic timeframe for people to be reacting to abrupt climate change and are these plans being staged in a way that if things are to really move much more rapidly, we're flexible enough to adjust?

Dan Kimball: Well, you have raised a really good question. We have even in the last month, we have gotten together with the Corps of Engineers, the South Water Management District, The Department of Interior and a lot of other local partners as well and really tried to look at the ecosystem restoration, the plan as I had up there, with different sea level rise scenarios, and we're just cranking those into the models now to look at full performance to the system. Right now we are sending about on average about 1.7 billion gallons are going out of Lake Okeechobee to the coast, the overall goal, as I showed, is to move it to the south. It's not just important from the standpoint of the ecosystem. We need to bring that water in to replenish freshwater supplies for the lower East Coast of Florida. Where those storage areas are, are very high. Now I'm not sure they get a to Tom's, the 7 meters, but the storage areas that are a key component of increasing storage for the Everglades, the restoration effort, are high. Now they are going to be high and wet. That's the idea, and so those in almost any scenario makes sense. To question is, is what are the performance benefits on the fringe and particularly in projects like there's a project in Biscayne Bay coastal wetlands that is very, very low, next to Biscayne Bay, and almost under any scenario, those features of the project are questionable, and those are being evaluated very carefully.

Question: In the past, mitigation has been the main point of discussion when we are talking about climate change strategies, and I was wondering if that adaptation has just kind of recently come to the forefront? so I was wondering if you could possibly discuss If the whole adaptation research and also strategies for the future?

Tom Armstrong: Well, I'll give it a shot and I'll let you talk about the specifics. One of the key elements of what we're doing with the climate change task force at the Department of the Interior is looking at adaptive management strategies for dealing with climate change. As I mentioned earlier with the question before, there is no doubt that over the next 40 to 50 years, adaptation will be a big part of our land and water resource management challenge and our policymaking at the Department of the Interior. The DOI task force is comprised of three subcommittees. I chair the Science subcommittee. Abe Hasvold from the deputy Secretary's Office chairs the Land and Water Management subcommittee, and Bob Faber from the Solicitor's Office, chairs the Legal and Policy subcommittee. All three of those subcommittees are interacting together to bring science, resource management, and legal and policy issues together to develop adaptive management and mitigation strategies. I'll let Dan talk about the specifics, but it's what you just asked in terms of the question is really the focus of what we are trying to do. Bring better, more science, more current information, as you saw it's dramatically changing, quickly changing to the decision-making process and to adaptive management strategies.

Dan Kimball: I showed a couple slides of some of adaptive management we are

doing with a built environment. One of the other things we're looking at is exactly how we do some adaptation with natural systems. One of the things that we have been talking about with our partners with the South Water Management District, the Florida Fish and Wildlife Conservation Commission in terms of adaptation. You need to provide some migration routes if the water is coming up, and we try to link natural areas. I would use that as example of adaptation. We are also looking at kind of a wide range of other mitigation measures for example, at Cape Sable, Seaside Sparrow. Talking to the Fish and Wildlife Service, maybe we ought to think about translocation of (?) species and...just some examples for you.

Question: I apologize, I arrived in late so you may have covered this. But, California passed its Senate Bill 32 last year, and the governor has been active speaking about it and sets the goal of reducing gas emissions by 2020 to their 1990 number. As a part of that debate, a key issue has been can we modify the development patterns, we're talking housing communities, more compact development to reduce the footprint of communities and emissions from live trucks and cars, (?), Can you just comment upon that as a strategy? Does that make sense? The League of California cities is currently involved in California with discussion with environmental groups and State Legislators on trying to focus on a development footprint strategy as a key aspect of implementing SB 32 over the next 15 weeks.

Dan Kimball: I'll just touch on it from the standpoint of Miami-Dade County, and the task force that I'm lucky to be part of. One of the things that they're looking at is exactly the footprint, not only our carbon footprint in the county, but also our footprint from the standpoint of where we continued to build, whether they're condos or whatever they happened to be the developmental footprint, and there are recommendations we have a built environment subcommittee that's really looking at the kind of where we should, in light of sea level rise particularly in Miami Dade County. Do you continue to build in areas that are vulnerable like I pointed out? We are soon going to have a web site for that task force, and I think a lot of the things that you talking about, we're trying to address in Miami-Dade County and the Board of Commissioners is very concerned about it. The other thing that happened recently is the governor Christ held a climate change summit and passed a number of Executive Order's in terms of the carbon footprint for state facilities and there are a number of, a green team actually that's led by the Secretary of the Department of Environmental Protection for the State of Florida, Mike Sole, that's coming up with very specific recommendations for Florida, to advance a number of Executive Order's that the governor signed.

Tom Armstrong: Can I add to that bill? I actually personally applaud any effort to try to reduce the footprint of our carbon footprint. The Department of the Interior is working on energy efficiency strategy to reduce its carbon footprint. I think all efforts are admirable, but I think there is another side that we need to also keep in the context here. What we talk about with climate change today, the

global teleconnection is huge. What's done locally is important, and we need those efforts, but we have to realize that the Globe needs to do something as well. What China does, what India does, what the United States does, it's all equally important. One of the things that USGS, we do regularly is to provide an energy assessment of the energy mix in the total energy needs forecasted out about 30 to 50 years. Current trends right now in the most recent energy estimates are that energy demand will go up, especially in China and India, but globally by 30 to 50% over the next 50 years. That energy has to come from somewhere, and right now, the energy mix prediction is that it will come from coal, which is one of the worst of the greenhouse gas emitters. So the change in that energy demand has to be taken into consideration when we look at any CO2 mitigation strategy.

Question: Yeh, you know, Dan, you mentioned that bringing in new freshwater into the Everglades is to help with the mitigation, and because it's going to make it a more viable ecosystem, and withstand the changes. I have heard other sides talking about this is what we need to do across the board, that we need to reduce the other environmental stressors to the greatest extent possible, to help these ecosystems adapt, and survive, and thrive in a climate changing world. And Tom, he just mentioned the problem with coal, and so we see a lot of other problems like acid deposition, deposition of Mercury, and there are consequences to that as well, so what extent does the work you are doing in providing policymakers with that kind of information, what else can we be doing in terms of reducing other emissions? A lot of focus is on CO2 and rightly so, but, what else should we be doing to make these ecosystems more resilient?

Tom Armstrong: What I really want to focus on on your question is really the whole issue of carbon sequestration. Because it also goes back to acid mine deposition and other issues related to the environmental degradation of carbon and fossil fuels. But, on the carbon sequestration component of that, the USGS has put together a national assessment, a methodology of accessing the nation for geologic sequestration, looking across the country at the geologic framework including abandoned mine lands to figure out where would be a good place to put CO2 that is currently in the atmosphere or injected back into the atmosphere, re-injecting it back into the ground. The plan is to develop the national assessment over the year and then to carry out a national carbon sequestration, a full assessment of geologic sequestration over the next two years following that. But there's also a plan for looking at evaluation of bio-sequestration as well. But part of that is also looking at how carbon, in terms of abandoned mine lands, or acid mine drainage, impacts the environment, and there are links to climate change with that as well.

Dan Kimball: That's a good question. There is a lot more to the Everglades restoration than just bringing freshwater into the lower part of the system. If you think about the ecosystem restoration, it's kind of like a three legged stool. You've got, what we call getting the water rights, quality, quantity timing and

distribution so we know, in addition to bringing that big flow vector down the water needs to be in the proper quality, particularly with respect to nutrients. The second thing that we need to do is get the habitat right, and so that means if we're going to bring water in, we need to deal with exotic wildlife and exotic vegetation and wildlife like those pythons I showed today. We need to take care of that as well. And the other thing is part of the restoration, we need to recognize that it has to be compatible with a built environment. That 7 million people that I was talking about, they are not moving. So we have to develop a restoration plan that provides for flood protection and water supply. That's the trick is doing all three things, but it gets, it's a lot more than flow, it gets to a lot of things you are talking about with quality, timing, distribution. There is a lot more to restoring the ecosystem than just bringing the freshwater. The beauty of bringing the freshwater is that it can bring down, just like John Adornato, the Regional Director for the National Parks Conservation Association, has been talking about, is if you can bring that freshwater head in. That's one thing we really can do to stave off the sea level rise that we talked about this morning.

Question: I would like to ask you both from your personal experience, with the Everglades, and also more broadly, and maybe some you want to (?) it's my impression is that the climate change science program funds research and is not, for the most part funding programmatic operations, having to do with, perhaps, I don't know whether this is true for the Everglades, but looking, if you were a park manager somewhere else understanding what the impacts of climate change might be on the resources that you are managing and figuring out how to adapt or mitigate your gas emissions. So my first question is is that true, are there, do climate change science program funds actually go to be used for backwoods kind of programmatic kinds of operations? If they're not, do they come out of your programmatic budgets and what's the adequacy between the two of those for what you know about personally, that your sense more broadly of the adequacy of the funding for agencies that are supposed to manage federal resources?

Tom Armstrong: In terms of the climate change science program, it's actually part of the mandate of the U.S. Global Change Research Act, and the reauthorization of the act. A big part of what we are doing is not just doing the basic fundamental research, although that's a critical component. There is the "so what" of the research, and that is the conveyance and transfer of science information in a manner that's usable by decision makers and policymakers. Right now, the question is still an important one, because at the climate change science program, in my experience as one of the principles for the Department of the Interior, is that each of the individual 13 agencies has its own operating budget for how it handles information dissemination and decision-support. It's not really effectively coordinated through CCSP, we do have human behavior and decision-support interagency working group that is sort of waxed and waned over time, like climate. But it's one that we all of the 13 principles agree needs to be reinvigorated, revitalized and their needs to be coordination of those individual operating budgets across the 13 agencies in a more unified way so that the end

goal is greater than the sum of the parts. We're not there yet, but we're getting there.

Dan Kimball: One of the things we have in south Florida, is we have an integrated science plan that includes the research that is being carried out by USGS, Fish and Wildlife Service, and the National Park Service. We have our largest group of scientists in the National Park Service at Everglades National Park. A lot of them are working on the restoration, but they are also working on a wide range of other things, including climate change. We are also fortunate in the Everglades. We have five USGS scientists that are stationed at the park and every two years we take a look at the science plan, and we work with (Terrence) "Rock" Salt who is our lead person for the Secretary, Department of Interior for South Florida. And as we work on this integrated science plan, I would envision that the next round, there will be a lot more, we are learning on this, the whole business with climate change, and I would think that the science plan would be much much more focused on climate change and what it means to the restoration, but I think we have a good seamless operation in south Florida, with the researchers that are involved in climate change.

Question: I just ask, to what degree do you think that that is true, in less high-profile areas. For example, the rest of the National Parks, or the Fish and Wildlife refuges, or others, I mean is this, is that being taken care of in a widespread way or is it just specific to your location?

Tom Armstrong: The DOI climate change task force is taking up that issue of integrating across it's resource management bureaus and USGS, the issue of information dissemination and decision-support. It's one of the basic tenets of what we are trying to provide to the Secretary by this December. So we're taking a more, just like with CCSP, we are trying to take a more coordinated and unified approach to it.

Bill Werkheiser: Okay, I think we are about out of time, thank you gentlemen. Thank you for coming out and we will see you all in November.

01:16:30:00 End