Tom Gohring: So, with that, we're going to jump in. We have two hours, nine panelists, and I want to thank the panelists on behalf of our community and SAFCA. Thanks for being here. They covered a tremendous amount of technical information yesterday. They represent a very diverse set of technical disciplines and Emir just covered that same level of diversity throughout the participation here. Just, because we're -- we don't have time to ask each panelist to introduce themselves. I have put together for you, a little helpful visual icon for each of them.

So, first of all, we have Alison Berry, and she talked about roots. Now, my visual icon does not necessarily represent the key point of their talk, it's just a thing to help remember. So, Dr. Berry here are your roots, and we have a little piece of tape here, here are your roots. And Maureen Corcoran, did a literature review, so here we go. Dr. Shields also talked about roots, but I didn't want to use the same icon, so I did Google images and this was the only other root image I could come up with.

Chris Peterson is over here. And he talked about trees, of course. And so we have the -- well actually he talked about trees falling down. So, well just put this -- okay, Dr. Sherman talked about motorboats. Ah, Dr. Haselsteiner talked about Oktoberfest. Dr. Dwyer talked about [W-thee] and it took me about halfway through his presentation to figure out that was not water closet.

Now, Dr. Gray talked about a lot of the same things. He talked about vegetation and roots and stuff, but one the things that really struck me about your presentation, Dr. Gray, is you had a part where you talked about pros and cons, and so I'm giving you a little balance, because you were talking about relative -- and then they added Bill Bouley at the last minute, and so I don't have these superior graphics capabilities, but he's going to talk about earthen dams. So, that is your panelists, ladies and gentlemen. Thank them for being here.

And with that, we're going to jump into the questions. Laura told you about how your questions will end up, up here. But we have prepared a couple of questions, just to get the ball rolling. Panelists, as you answer these questions, I would like you to not -- I would like you to attempt to not answer the question vegetation -- question mark-- as a yes or no answer. I would like you to talk about vegetation pros and cons. And along that theme, my first question is, imagining that we were to keep vegetation on our levees here in Sacramento, under what condition is that vegetation particularly harmful or create bigger risk, under what conditions does that vegetation represent relatively small risk or no risk? So, with that, we'll start at the end, and we're going to work through the panelists and answer that question.

What conditions vegetation good? What conditions vegetation bad?

Chris Peterson: Want to start down here. Well, this is a chance I guess for me to say something as a bit of an outsider to a lot of the technical issues. Like Steve, I'm, as an ecologist, sort of outside the domain of stability and erosion and so on. So, but speaking of the person just having heard a lot of talks here, it strikes me that vegetation good or bad, comes down to a few really simple issues. On the bad side, there's the issues of being able to inspect the levees and the surrounding areas for things that people need to look for, the boils and cracks and whatever.

The vegetation from what I can gather, despite conflicting reports, I think there's a bit of a majority thing that vegetation is helpful in terms of stability and erosion. And, of course, closer to my own domain, certainly trees do blow over and when that does happen, they will be pulling up a root ball, so that's probably on the negative side. On the positive side, of course, as we've heard a little bit about, but maybe haven't been presented here, is simply the esthetic issues. I mean the Mayor talked a little bit about that yesterday.

People like to go jogging and so on, and have the trees on their levees. How we can quantitatively measure that, I'm not sure, but certainly that comes in on the positive side. And certainly, as an ecologist there's the flora and fauna benefits from having the vegetation on the levees. And so those are the pluses as to providing that habitat.

Ronald Haselsteiner: As, we in Germany, who have got only one condition, and that is a safe dike. And we -- we try to preserve our safety factor. So, when you have got wood with the vegetation on the dike, you have to conduct protection measures as root barriers or whatever to ensure your safety factor. There's no difference between a reservoir dam, or a levee. The difference in Germany's only the [annuity] of your design flood. For a reservoir dam, we have got 10,000 years, for a dike 100 to 200 years. But in the design, there is no difference between a levee and a reservoir dam.

But what you should or what we take into account is that when you have got wooded vegetation on the levee, the costs will rise or double up, or will rise to four or five times compared to that cost when you are clear of the dike. Okay.

Doug Sherman: As an academic I have to start by hedging my statement. My practical experience in research on levees has been limited to work in the delta end. The levee situation in the delta, I think in many ways is fundamentally different than that faced in this area, and farther north along the Sacramento River. Someone yesterday made the comment that the levees here are piled with sand. In the delta, they're basically piled with mud on unstable background. They're always holding water back. If you drive along the crest of a lot of the levees, you'll see [our QA] cracks in the road crests, showing you that the banks are slumping.

Under those conditions, anything that stabilizes the water line is good. And my second caveat is, my research is confined to what's going on right at the water line. It's looking at erosion caused by river flow, by boat

wakes, and wind waves. And although boat wakes are easy to blame because they're such unusual punctuated events, old man river's rolling along all the time moving bits and pieces. There's no doubt at all, that vegetation can stabilize the water line. So, can [rift raft]. Those are policy decisions about what you want that edge to look like.

Vegetation is good because it can reduce the impacts of boat wakes, wind waves, and river currents on bank stability. It can stabilize it by locking the materials up. It can prevent the wake or wave energy from being dissipated on bare earth, and it can dissipate or reduce or reflect the incoming energy. Rocks can do that as well. The downside of vegetation, I think there's only a downside in those locations where you have large trees, and when a tree fails, and you open up bare bank areas.

Douglas Shields: If we look at the list of issues that we've identified here, off course, it's been identified many times before, vegetation on levees. The list I come up with is rodent slope stability, seepage, windthrow, inspection, conveyance, flood fight, habitat, and erosion by water. And what I'm hearing, and based upon the literature, larger vegetation is a plus when it comes to rodent control. It's a plus when it comes to slope stabilization. Unknown with regard to seepage, but there really doesn't seem to be a problem.

There is a huge problem with levees in this area with seepage, but it doesn't seem to be related to vegetation. Windthrow is a negative. The bigger the vegetation gets and past some threshold, it's a real liability with regard to windthrow risk. Inspection it's a negative. Vegetation makes it harder to inspect levees, but you can spend more money and hire more people to do the inspection. So, that's one way to address that issue. Conveyance, it doesn't appear to affect conveyance in general, in this particular setting, in these channels.

Flood fight is an issue on the landside, vegetation on the landside in particular. Vegetation would be a negative there. Erosion by water, vegetation apparently is a plus as far as erasing erosion by water. I do not see evidence for local scour around tree trunks that -- maybe you've seen that. I haven't seen it. And habitat, what we've learned about habitat is that vegetation's a plus on broken bands, [unintelligible] bands along the river are more valuable. And the nearer the water, the vegetation is, the more valuable it is. So, that's kind of the waterfront, as I see it.

Bill Bouley: I'd like to see peace in the world. Basically with publication 534, the main issues with vegetation were the ability for a dam owner to inspect and observe any problem areas on their structure. A lot or private dams don't have a very large cross section, so if trees are allowed to establish themselves, the possibility has been proven that the roots will grow right through the embankment, and possibly allow seepage paths, rodents and other burrowing animals to live in the embankment, and make it that much more difficult to see problems that are occurring.

As you walk these structures, if there's heavy brush, you're not going to see your feet below your waist. Some people have that problem at midlife anyway, but I'd rather not step in an area where there's a pile of rattlesnakes waiting for me. I'd rather be able to see what's going on at my feet. And slope protection, you want to look for slope failures, cracking and other problems that could be occurring. Wet spots on the downstream face to the dam. And frankly, I don't think you can see those areas, if you've got heavy brush growing. You'd be stomping around, but you might miss a spot.

Donald Gray: Since I've been given the scales of justice as my icon, I'm going to put on my blindfold and help the scales a little bit. The bottom line on the scales of justice, is that I think the benefits of woody vegetation on levees, particularly on the water side, greatly outweigh the liabilities. Some of these alleged liabilities are incorrect. The best example is the notion that

trees attract burrowing animals, and I think the presentation by Dr. Van Vuren yesterday, clearly established that this is not correct.

Ground squirrels who are vigorous burrowers prefer grass. Other potential liabilities which have already been mentioned such as windthrowing, lack of access, etc., can be either prevented or mitigated by a variety of techniques which include selection, the use of a low woody species, location and placement of vegetation and management techniques such as thinning, pruning, and [copathane].

John Dwyer: Well, getting back to the original supposition that we're -- we have to live with the trees, then I think it becomes a question of location, location, location. And I would say that at least on the good side is that from the river side point of view, stability and habitat needs can be met. While I do realize that in highly urbanized areas, being able to see those areas, at least in areas along the river where the levee may be at risk is very important.

I would also say that part of -- if you're going to be left with the trees, part of your inspection should be the assessment of hazard trees or trees at risk, not only from public safety, but from a levee point of view as well. So, those should be managed and taken of.

Alison Berry: I agree with the two previous speakers on general approaches. That -- it seems to me, one of the major risks and harmful aspects of trees on levees right now is removing all of them at once. It think that if we can develop a staged program of management which would include tree inspection, as Dr. Dwyer was saying. Take some of the lessons and tools perhaps from urban forestry. Their tree inventory techniques. Their individual tree hazard inspection criteria, which could be modified to take into account the very important safety conditions along levees.

For example, I think trees growing on slopes, would have a higher hazard rating, than trees on the berm just simply because of circumstances. I think one can look at the condition of the tree. Does it pose a hazard in some way? What are the functional considerations of the tree? Are there species, particular species or functions for Swainsin's Hawk habitat or whatever, that -- and other kinds of criteria, whether it's an invasive tree species or not. And then, I think we need to have more information about which -- are there trees that are bad actors in terms of root growth into levees, or trees that are not so bad. So, those kinds of questions can be -- so there's a scientific component of it, but also I think a management -- a strategic management component.

And again, another thought that occurs to me is, it's important to assess the condition of the levee in relation to tree growth. Whether trees can grow into levees, sort of depends on the compaction level of the levee and other -- and whether you've got protection slurry walls and so forth. So, those are some key issues I think to be taken into account.

Maureen Corcoran: Well, even though Dr. Macari didn't ask how many geologists were in the audience, I'll have to answer this as a geologist, so I really feel like I'm the only one here. But part of the question -- oh good, thank you. There's power in numbers. Remember we're not as good in math, but we still have a contribution to make. But I think -- I'll have to answer this as a geologist and that part of the question I know with soil composition.

So, of course, why you all are thinking hydraulics of the river and the trees, I'm obviously thinking of the geology, the geologic setting, the soil composition. So, I think one thing we have to look at is that what works in an area with a sandy levee, is not necessarily going to work in an area that has a lot of clay. I live in Naches, Mississippi. We have a natural levee there called the Naches Bluff. It has a very large clay composition, and it holds together very well, unfortunately when it rains, and then you see quite a few failures along the way.

So, obviously what we have in one part of the United States is not going to fit in another part. So, I would like to keep in mind the soil composition and also the geologic setting like I mentioned earlier. We heard this morning about Oxbow Lakes. So, there again, looking at the geologic setting, the big picture, in that context I think would be very helpful.

Tom Gohring: Thank you. Very insightful. The next question is the flip side. If we were to aggressively remove vegetation from our levees, what conditions are particularly problematic? What areas are we sure to run into problems? What areas are maybe not so much of a problem? And again, we'll start at the end. Doctor?

Chris Peterson: Okay, again sort of outside of my domain, but from what I've heard from a variety of speakers it strikes me that the biggest issue is how quickly the roots decay, and what effect that has on soil integrity and stability. So, this idea of shrinkage of roots that have died and what happens as a result of that strike me as probably the biggest things to be worried about. And from what I've heard, it seems like there's still a great need for finding out how quickly the roots die, how much they shrink, how this influences piping of water through the levee and so on. So, that's probably, in my opinion, the biggest issue, but it strikes me as the biggest question mark also.

Ronald Haselsteiner: First of all, we did a lot of wood clearings in Germany, the last years, and what we experienced is that it is difficult to get all of the roots out of the dike. The roots are extending very widely, and after a few years, certain types of trees were growing again from that root. They did not die, but they are growing again. And so, normally we succeeded then for a proper refurbishment measures, that we rebuild the whole dike. We removed the whole dike with vegetation, and then we rebuild it without rooted soil.

Douglas Sherman: If by vegetation we're referring to trees, again on the water side of the levees, it's critical to replace it with something. Bare dirt is probably the least desirable option. At the water line if you remove vegetation, it needs to be replaced by something else. One thing we haven't talked about is the larger vegetation issues associated with grasses and shrubs. If you have bare soil banks when it rains, some part of that levee will move down the hill toward the water.

Rain splash erosion, I know it doesn't seem very important in an environment like this, but even though it doesn't rain very often, when it does rain sometimes it rains very, very hard. Every rain splash moves unconsolidated material downhill. If it rains hard enough, stuff washes down. And there have been a few occasions where we have observed rivulets forming across levee banks as material washes down. So, if not vegetation, then you need to find something to try to cover otherwise bare soil.

Douglas Shields: So, if you aggressively remove the vegetation what conditions are problematic? I know if you're in a fight, you're not supposed to help the other side, but I think we have a problem in this symposium, in that the way the question's been posed is vegetation or no vegetation. As I read 534 and Title 33 and all this other stuff, the question is what kind of vegetation? Can you allow any type of natural succession to occur or must you have side-forming grass, or can you have some type of non-big tree regime community on the levees that's not side forming grass.

We know in this climatic regime, in this set of soils we've got here, we're not going to get side-forming grass unless we irrigate the daylights out of it. So, if not trees, then what? And maybe the question ought to be, is if we aggressively replace the large trees with X, but it's up to the folks pushing the white paper, my friends and neighbors, and former employer, to say what do you want to replace it with? Can you come up with an assemblage of plants that achieves a lot of the benefits that we have with

the large trees now? Can you come up with some sort of a scheme like we see in Germany, where you have different vegetation targets for different parts of the structure in different situations and so forth.

I'm getting off the subject. What the research that we did shows is, if you take the vegetation away and don't replace it with anything else, if you don't rebuild the levee section with better soils, then you will destabilize the slopes under worse case hydrologic loadings. You will destabilize the some of slopes under worse case hydrologic loadings. That's [unintelligible].

Bill Bouley: One of the areas I meant to put down on my notes is, when you do remove the root ball and recompact that soil in that area, now you've created an area that's compacted to modern day standards, where the rest of your dam may not have been built to those standards initially. So, you might have a localized area that's well compacted next to other surrounding areas that aren't as well compacted. So, now you've got a changed condition that could be a problem down the road. But, you know, it's repaired.

Donald Gray: Well, I would echo the observations of my colleague, Doug Shields. The extent that woody vegetation, the roots of vegetation reinforces and stabilize the slope, it's removal, certainly wide scale removal clear cutting is going to decrease slope stability. This has been pretty well established when I -- my very first research project at the University of Michigan, was to look at the effect of clear cutting on the stability of slopes. Now, admittedly, these were natural slopes, forested slopes, but the findings there were clear. Over time, when you lose the reinforcing affect of the roots and the transpiration benefits of the vegetation, you have increased frequency in amount of slope failure. So, unless you do something when you cut those trees down, you can expect decreased stability of the slope.

John Dwyer: Well, one problem that I can foresee would be the cost factor. And I would say to you, and my suggestion would be, is to consider -- not consider it as a piece meal solution to your problem, but consider it to maybe be a fix to the whole system in terms of reconstructing and rehabilitating your levees. And it also may be looking at relocation of those levees, where feasible. Of course, the other problem is the one of "not in my backyard" syndrome, and I think we've already talked about that and that will be a concern that I think has to be dealt with on a case by case basis. Even as the lady with the CORE did her inspections.

Alison Berry: I agree with previous comments that a massive tree removal would lead to have rather dire consequences in terms of soil stability. Even in forest management, we could learn -- take some lessons also just from forest management, in terms of clear -- even when there's clear cutting, there is a replacement program, or restoration ecology would be another source of information on strategies for removal and replacement, emphasizing the replacement again. In any case, just say again, rather than massive removal, really a staged removal and replacement strategy would be the most effective. Replacing vegetation takes many years to do, to figure out the right species, to test some things.

To then place them, and make sure they're established. So, just talking about it could take a year. No, but in other words, if you -- taking a little bit of a long-term vision in terms of how to handle. Then I think that that should be coupled with, as I've said, an inspection program to determine which -- where are the bad actors, and where are some trees that are relatively benign, in terms of their impacts. And then also, establishing valid management practices which can even -- sort of an integrated management plan. Which is inspection, removal, replacement, but also modifying through pruning and other kinds of techniques; buttressing has been mentioned earlier. So, there's a -- I think we can draw from a wide range of tools in carrying out some of these objectives.

Maureen Corcoran: I don't have too much to add to what everybody else has already said, so that's the nice thing about being the last person on the panel. But obviously, yes, a phased approach would be the best, and I definitely agree with that, and I think we also need to consider what some other countries on the international guidelines are applying such as the environmental options. And to include the botanists, the people with expertise in those areas, and not just rely on the engineers. So, I had to say that.

Tom Gohring: It's okay. A round of -- my next question is for Dr. Haselsteiner, Doctor [unintelligible] -- that's just the only German I know. Actually, my next question is for Drs. Shields, Gray, Sherman and Haselsteiner. Can you talk a little bit about engineering solutions for -- and Dr. Haselsteiner, you've talked a lot about this already so -- and feel free to repeat yourself -- and some of the engineering solutions that we can incorporate to help us live with some of our large vegetation?

Ronald Haselsteiner: I think I told you yesterday about the experience we made with this cut off milled board wall, that we use as [center ceilings]. We applied on dikes with big trees on both slopes, and where we have to take into account and failure of which slope -- whatever, which slope, the water side slope or the landside slope, and then this reinforced cut off wall, has to be at the load that both slopes have gone in [and stands] this wall. It's like a heavy measure, and some of the ecological guides says that this is a flat retaining wall, but if covered by a little embankment, but this is the way we treated to keep our safety factor in the right position.

Douglas Shields: I guess I'm next on this. I don't have any really grand new ideas, but it seems to me that the effort should be in trying to vegetate the berm and the bank with the natural, the woody species, and confining the vegetation on the levee slopes to smaller individuals. Obviously, there's a great deal of experimentation and demonstration that could be done in this area starting right away. One thing that I'm interested in, and I imagine that

some of you operations people could answer this question, is what sort of community can you maintain if you mow periodically, instead of burn. And I'm thinking her about mowing it rather long periods with the like [bush hocking] type equipment as opposed to annual or semi-annual burning. That might be something worth looking into.

Douglas Sherman: I don't have anything I think really novel to add to this to discussion, but just a point I'd like to emphasize. That the primary role of the levees is to offer protection to some population or resource behind them. From an engineering prospective, if you have appropriate design criteria, you can build a structure with very low probability of failure. Once you start relying on organics however, as part of that system, you introduce a whole other level of uncertainty, that makes it hard to get compatible usage.

If we knew that the trees would live for a hundred years, and they would grow to a certain size, and then stay there, it's one thing. Trees die. If you introduce vegetation as a structural element for protection, you now have a situation where you have much less control, perhaps much less certainty over the long-term viability of that solution. So, it's just not easy. I think it's important to recognize, we try to treat levees as multi-purpose structures, that really, fundamentally, they're single purpose structures.

Donald Gray: Well, one part -- a necessary compound of a solution is to have good analysis. And I think that we need to recognize that soil root systems are just another form of reinforced dirt, which is a topic which is well known to geotechnical engineers. Reinforced earth is just a granular matrix with tensile inclusions. And so a root system can be analyzed in exactly the same way that geotechnical engineers analyze traditional forms of reinforced earth. Chris Peterson gave us some analytical tools to analyze the problem and come up with solutions -- the problem of windthrowing. So, this is yet another area that is subject to good analytical techniques.

Douglas Shields: I'd like to respond if I could to something that you said Doug. You said vegetation introduces another element of uncertainty, and I won't quarrel with that, but I would like to say that the idea that soils are time-invarianted, that a earthen structure is time-invarianted. We can put it there, and it's going to be the same a hundred years from now, is also a false notion. Levees settle, soils crack, things erode, things move around, and so vegetation is not the only thing that ages. Earthen structures age, engineers age -- it's just part of the --

Tom Gohring: Would anyone else on the panel like to address that issue before I move to my next question. Great. My next question is about monitoring. So, if we are going to have some form of vegetation on our levees, what type of monitoring programs should we be thinking about having to keep an eye on them, to forewarn us of problems to come and avoid them? Let's start with Dr. Corcoran. And I don't have a dog and a stray feeder Doctor.

Marueen Corcoran: You could like in the south with those kind of comments.

Tom Gohring: Yes ma'am.

Maureen Corcoran: Okay. As far as the tools that I believe we can use, it would be a -- like I mentioned before a cumulative effort. I think better monitoring of these areas is definitely needed. Of course, what a lot of that boils down to unfortunately is money, the cost of -- to inspect these levees. I think that's the hold up of a lot of this right now. I think it shows with the participation that we have in this symposium, and the fact that it even is occurring, means that everybody's interested in this. Very interested. And it won't be a flavor of the month to disappear next week.

And I think in order to keep that going, we do have to come up with better solutions on a monitoring program, and so I guess to sum up my rambling here, is that to implement a better monitoring system using scientists and engineers to do that.

Alison Berry: We're talking about monitoring the vegetation, I assume that's what the question's about. Really, again, I think there are a lot of -- we know quite a lot about -- there are bodies of knowledge about tree monitoring and vegetation monitoring programs. Inventories -- there's tree inventories, and vegetation inventories, and then there's very methodical inspection programs that can be developed, based on existing knowledge and information. These might be every five years, or some kind of a cycle. And then there's a set of priorities that are established. This aspect of the vegetation needs attention now. This aspect can be looked at in another year or two. So, there's a prioritization process, and then an implementation phase. Again, with an integrated management approach.

I think one of the parts of this question are, what information do we -- what tools do we need that we don't have now, also. And again, I think understanding where roots are growing in relation to levees is still a question. We need some more inspection tools for that. We can do a root crown inspection, we can look at the base of trees or shrubs or other vegetation, but there's -- we can't -- it's very hard to see underground. So, I think some of these tools that we would like to develop -- ground penetrating radar, may offer some potential, but -- air knife is another -- so one can do some partial inspections. So, these kinds of things I think, still remain to be developed.

John Dwyer: Well, I'm sure California has an inventory of their forests, just like the other states, and agency in charge of that's the U.S. Forest Service. Sometimes the states kick in money to beef up that inventory, but they conduct what they call a forest inventory analysis, and I believe it's on a five year schedule. They do 20% of the state each year and are able to come up with interim reports at years three, four and five. They'd be a good source for training. That's part of their job. State private is to train people on their system for hazard rating, and that'd be one agency I'd look to for that kind of training service.

Donald Gray: Monitoring is not my forte, but I suspect there are quite a few remote sensing techniques that could be used or investigated. Certainly, the health of your vegetation is important and I understand that that can be gauged from things like infrared surveys and maybe other techniques such as ground probing radar, which Alison spoke about yesterday, would be a possibility.

Bill Bouley: Yeah, I just added on to that, if you're going to allow the slopes to be overgrown with vegetation, I've got slope indicators, inclinometers, things like that could be put in to the slope. We'd have to rely heavily on data from the under drain system, to see if flows through the embankment are increasing. In addition to ground penetrating radar, we'd probably have to go through with probes every now and then to verify that there's not voids within the embankment from plant activity or burrowing rodents, because we don't know how deep some of those burrows go. And likewise, remote sensing, oblique photographs and other methods to monitor the condition.

Douglas Shields: I think it's an awful lot of work to chase tree roots, and to find tree roots. And the ground penetrating radar is exciting technology, but I think a basic point, what Dr. Berry said, it has quite a ways to go. I think based on [unintelligible] what we know now, if we have a tree growing near a levee, we ought to assume that the roots are in the embankment at least in areas that are not past some compaction threshold. I think when the soils get dense enough, and where you have a cut off slurry wall, that you're not going to have roots penetrating that. But you can have roots in the thing, and really, I'm not too worried about roots penetrating an embankment. I'm much more worried about water penetrating an embankment.

And I'm thinking that you could have networks of pressure transducers out there, so at least during high flow events you'd have a really good handle on where the water is in the embankment where seepage problems

appear to be developing. And you could have this telemetered and that might be very valuable in flood fight and then evaluating performance of the structures over the long-term.

Ronald Haselsteiner: As I told you yesterday, we have got the need of the obligation to check all our dikes, one per year. To inspect it, kind of monitor it. And so, what can you check when you've got the tree on the slopes. You could check the tree, what you can see. You can say, okay, this is big, this is height, it's got this diameter. You cannot check the roots. You cannot check the health. Maybe you need in biology, that can check the health, and you cannot check the stability. For checking the stability of every -- of one tree, I think you need two engineers, two special skilled engineers, and it will take one hour I think to make something like a stability analysis.

And then we have got 8,000 trees -- you know what that costs? So, my opinion or our opinion is, you have got -- when you have got trees and you try to monitor it, you have maybe limited information by the monitoring, about the real threat they bear. But you have got an explosion of costs. And therefore, we try to design our dikes for a minimum of monitoring efforts. And on the other hand, additionally to that, you have to respect what are you doing during floods and then, maybe you have got all your landside slope wooded, then you cannot control it properly. So, you have got a risk you cannot assess.

Chris Peterson: Okay, I think the tools do exist that are already in development, and being parameterized in other areas to quantitatively come up with estimates of probability of windthrow anyway. So, such tools -- and I have to disagree with Ronald a little bit. I don't think it takes two engineers two hours to do an assessment -- one hour, okay -- for a single tree. Although it certainly depends on what level of certainty one wants in terms of knowing the probability of windthrow for a particular tree.

If you -- the more detail you need, or the more certainty you need, of course, the more information you would need. But there are tools that are in existence that I mentioned in my talk yesterday, that have been developed in the U.K. and in Scandinavia, for predicting probability of windthrow for particular trees, given their size and species and soil conditions and topographic conditions. And based on what I've heard here, I would strongly advocate for developing and parameterizing those models for the levees here as well as elsewhere. I was talking with Mike Stout about the opportunity for research, or maybe it's just passed us by and on the Gulf Coast, and I hope that'll be pursued by some of the agencies here.

Tom Gohring: Dr. Berry, you had a reaction during that -- did you want to hit that topic? Monitoring the cost -- cost of monitoring -- no?

Alison Berry: : (dvd 6), audio 45:52 Oh, no. I think Dr. Peterson addressed it.

Tom Gohring: Okay. Lizette, I'm ready for those questions, any time you're ready. While Lizette brings them up -- while Laura's bringing them up, can I just -- a real quick down the line, the top one in your mind -- the top single biggest data gap in this issue. Dr. Corcoran?

Maureen Corcoran: Now, that's a loaded question. But, I feel like the biggest gap, and I have to say I probably have referenced everybody on this panel, in the mass of literature reviews that we've done, but the consensus seems to be is that the areas are site specific. So, I believe the data gap that exists is the fact we can't take a study that we did in Sacramento and apply it to the Mississippi River. And so, we need to look at that. The other issue, is the fact that -- and Dr. Berry's the expert in this area, is that not all types of vegetation have been addressed.

I think Dr. Shields, and Dr. Gray brought that up too. Not only on the vegetation type, but also in the geographic type area. So, like I said, that is a loaded question. It's hard to come up with just one answer that yes, this does exist. But the fact that, and with every good research, like I mentioned yesterday, there's always a list of recommendations and future research that needs to be done, and that's what we found consistently, in everybody's research is that every area needs to be addressed individually.

Alsion Berry: Yeah, I would really agree with Dr. Corcoran on that. Regional -- there are clearly regional differences and patterns that would have very high priority. I think more information can be -- one information gap again, is management strategies for the integrated approaches and so forth. So, I think, I see that as another key area. Also the question of stability in relation to vegetation. But I think the regional patterns and also what kinds of integrated management tools can be brought together.

John Dwyer: One thing that came out of our little field trip that I thought was kind of interesting. With all the different techniques that you try here, it seems to me like some information's needed on, if you want to keep vegetation -- is what species do you use, and how do you get those to regenerate? You look for natural regeneration or some type of artificial regeneration, and then what methods would you use to achieve that on the ground? And furthermore then, how to kind of manage that vegetation through time.

Donald Gray: Well, one data gathering priority is certainly root architecture and distribution, and different types of soils and environments. And that's a really formidable task, because you can't see the roots. The trenching method, which seems to be [profile wall] or trenching method, only gives you a two dimensional picture of the root system. So, that's certainly a formidable and challenging area for getting a lot of information.

Bill Bouley: I guess one of the things I was going to point out is, whatever's come up with has to become something that's understood by the dam owners that are out there, who aren't always technical people, who rely on experts to provide them with the information they need on what species would be acceptable or not acceptable to these environments. We certainly don't want to advocate using saltcedar as a wave suppression tool. It's been a disaster wherever we've got it growing in the western United States. So, whatever we come up with, it should be something that's clearly understood by also the non-technical community that's going to have to implement it.

Douglas Sherman: I think clearly we need to know a lot more about boat wakes, and I think that anyone who has money to spend should talk to me after this. I had to get that in. More seriously, Dr. Corcoran, can you remind us of how many [unintelligible] journal articles you found on levee vegetation.

Maureen Corcoran: It was about 18, but some of that was the same research that had been presented at [unintelligible].

Douglas Sherman: So, about 18 articles on levee vegetation. It's kind of hard to talk about what our research gaps are when you put that number in context. Basically, that means we know almost nothing about it. One of my other research areas is wind blown sand. That literature comprises more than 10,000 scientific articles, and we still don't understand that topic very well. If you're talking about a literature that involves 18 articles, it means that we know almost nothing specifically about that problem. Now, [unintelligible] we can go larger literatures or technical reports that expand that, but it means that despite a lot of generalized understanding here, and I'm not dismissing the value of what we've heard -- the reason we can't address some of the simple controversies is, we don't have the actual levee specific, vegetation specific knowledge to make an informed decision. So, you're starting with almost a blank slate from a scientific perspective.

Ronald Haselsteiner: From my point of view, I think there's one thing that should be researched and this is the over topping influence of vegetation -- wooded vegetation during over topping. One of the speakers yesterday mentioned that he noticed that the breach length of wooded dikes, of breached wooded dikes are quite shorter than the breach length when a dike was not wooded. This is an effect that maybe has got some practical use I think.

Chris Peterson : I think we need to know what the roots are doing. From what I've heard, that strikes me as -- although I agree that 18 articles is next to nothing. There's certainly a lot of unpublished knowledge in the heads in this room, and in managers and so forth. But certainly in terms of the written or published knowledge, I think we need to know where the roots are going, how far they're going in, how far they're going up, what angles they're at, how they're distributed. And it's really difficult. That's why we don't know that very much even outside of levees, just in general forest ecology -- we don't know where roots go, very well either. So, it's a tough one.

Tom Gohring: Thank you. First question from our studio audience and any panelist may choose to engage this question. How do explain the difference in findings regarding distribution of roots in levees, between California, Eastern U.S., and Europe? Yeah, I think -- I'm going to guess that what's behind that is we heard some presentations yesterday that talked about in fairly wet climates, those roots are climbing right over the top of the levee. What we've observed in some places here in our arid climate is they're staying more localized. Any --

Alsison Berry: Well, I could just -- I think you've got the nub of it there Tom is, certainly in Mike Stout's discussion yesterday, those roots growing right up in the clay cap on the levees in Louisiana, is not terribly surprising. Roots will grow in clay soils very nicely. So, that and they're -- certainly they have a completely different moisture regime. They have rain all summer.

Whereas, here in California, we don't have rain from April through November. So, we have a very different soil climate.

As the season progresses, of course, the soil profile dries out, so roots die. They don't survive where conditions are not favorable such as moisture conditions. So, even if they may grow up on top of the levees, they might -- they're likely to die, so not really proliferate. So, -- and even in the top part of the profile, it looks as though that may be a drying out phenomenon as well. Again, I mean I have to echo what people have said. We do need to know more about these regional differences.

Tom Gohring: Anyone else want to attempt -- if not, I have a question that says, Dr. Shields and Dr. Gray have stated, "Tree roots to not create seepage problems based on their experience." Is this the opinion of the panel? I guess first I should ask Dr. Shields and Gray if that's really what they said.

Douglas Shields: That's not exactly what I said. I said we didn't find any evidence for root induced piping. We didn't find any evidence for it. That's what we said. And I showed one slide, and I said, "These qualitative observations are all that this study yielded. These qualitative observations are all that this study yielded on the question of root induced piping."

Tom Gohring: How many folks on the panel -- just a show of hands -- would strongly disagree with that statement? That we don't have evidence that roots induce piping.

Male Voice: I don't understand that.

Tom Gohring: You don't understand the question?

Male Voice: Right.

Tom Gorhing: Who thinks that the evidence exists that roots induce piping? Who thinks that evidence doesn't exist? So, we don't know one way or the other. Next question. It appears that FEMA manual 534 entitled "Impacts of Plants to Earthen Dams" is the chief technical basis for the Corps proposed vegetation management policy. Can you comment on the technical basis on the conclusions contained in this manual? Who'd like to take a stab -- I think we should let our rep from the Bureau take the first stab.

Douglas Shields: Let me -- what I said yesterday is what I just referred to. At the beginning of this panel discussion, I reviewed all the issues. And I said, "Based upon what we know now, roots don't induce piping." And maybe that's what the questioner referred to was the statement that I made at the beginning of this. Engineering judgment at this point in time, roots don't induce piping. I'll be willing to say that's my opinion. Now, based upon the research, we have no evidence and so your conclusion is strictly true. We don't know one way or the other. I think a good bet is that there's lots of seepage issues out there -- they're not tied to roots. That's my opinion.

Tom Gohring: Thanks for clarification. Mr. Bouley?

Bill Bouley: Now, back to the question. When we put together the manual, we also had people who were foresters, mammal experts and stuff on burrowing animals, so it wasn't done by engineers in a vacuum. We had a multi-disciplinary group established. We also had Kim [Coder] from University of Georgia, who is our forestry expert. And it wasn't done in a vacuum. So, the science was evaluated and it was just -- there wasn't a whole lot there.

Tom Gohring: Anyone else care to comment on that question about their opinion or understanding of the scientific basis for that report?

Chris Peterson: Just a thought on that one. I was looking through that manual, which I just recently became aware of. It struck me that there was, as a scientist

looking at this, there was a lot of opinion, or informed opinion, whatever, and not as much quantitative data. And certainly, Kim Coder's a nationally recognized expert, but if we rely too much on what Kim thinks as opposed to actual quantitative studies, then we have a risk there.

Donald Gray: At the risk of my personal safety, quite apart from dam safety, I'd like to make some comments. The first issue is to what extent this publication which deals primarily the safety of dams, which are structures holding back reservoirs with essentially a constant head of water, are relevant to levees. Similar structures but only subjected to occasional hydraulic loading. Certainly none of the levees we saw two days ago in the Sacramento area -- they were all high and dry, and did not have a [preattic] surface in them.

Well, I've read this document fairly carefully. In fact, I have it in front of me right here. A technical manual for dam owners, impacts of plants on earthen dams. And my general impression of this report, is that it represents a pre-conceived conclusion, in which evidence, basically just chasing evidence to support this pre-conceived conclusion. And it tends to rely excessively on anecdotal evidence, surveys, and a lot of unsupported assertions. A classic example of an unsupported assertion was the statement in the report that, "woody vegetation encourages burrowing animal activity."

And we know from the presentation yesterday, that this is not a correct statement. Along the way, a huge technical literature is simply dismissed, or at least not cited, which establishes that woody vegetation on slopes improves stability. Another problem with this publication was the resort to, what I would call "ad hominem arguments." Ridiculing, putting down people with a different opinion. Another -- an example of this ad hominem approach was the doggerel verse which was read to us yesterday during the symposium. I've actually prepared a detailed evaluation paragraph by paragraph evaluation of the FEMA manual,

which I would be glad to pass on to anyone after the symposium, if you just give me your business card.

Tom Gohring: Thank you. My next question. Dr. Gray recommended planting trees on levee slopes to increase stability. What would be the big dramatic affect -- difficult handwriting, sorry -- what would be the big dramatic affect on the upstream channel and on the opposite bank for a channel and levee designed with or without vegetation on the float? I may have butchered your question and please forgive me.

Donald Gray: I'm not sure that I understand the question. This sounds more like a hydraulic --

Tom Gohring: Oh, a hydraulic affect. It's hydraulic, yeah. Let me try it again. Let me try this again. What would be the hydraulic affect on the upstream channel and on the opposite bank for a channel that has large vegetation?

Donald Gray: I can dodge this question because I'm a geotech engineer. I'll defer to one of my hydraulic colleagues.

Douglas Shields: Well, I believe that that was the topic of Dr. DeVries presentation yesterday. And he's extremely well qualified to discuss this, but the bottom line is the Sacramento River, and of course it varies a lot from reach to reach, and most of the major rivers in this area -- if we vegetated the banks, and if we vegetated the river where slopes of the levees -- the vegetation would occupy only a small part of the wetted perimeter. And therefore, the net effect on conveyance would be small. It would vary from reach to reach, based upon reach specific -- and also it would vary with stage obviously, but bottom line is, it would be small because you would only affect a small part of the wetted perimeter. In narrower channels, or channels where you're going to vegetate the entire cross section, it's a completely different situation.

Douglas Sherman: The conveyance capacity may not be reduced very much, but there is often an intended consequence. A recent paper by one of your former colleagues, [Sean Bennett] deals with steering rivers by designed plantings, and one thing that you do -- this presumes that there's some minimum width exceeded, that large stands during floods will slow the flow slightly. And what happens is it forces the main current toward the other bank. And so, there may be unintended consequences of that on the opposite banks in terms of increased flow velocities and potential scour across from the wooded stands.

Tom Gohring: My next question is, does the technology exist to inspect the levees through vegetation? Apparently not.

Douglas Shields: Well, Bill was referring to his fear of snakes, and if you'll get a Cabela's catalogue, they have snake chaps in the Cabela's catalogue.

Tom Gohring: So, the answer to the question is Cabela's catalogue. Thank you doctor. A follow up question from the same person is, is there -- I'm going to rephrase it -- is there an inconsistency in a policy that promotes rock protection on levee slopes, since you can't see the levee slope under the rock? Next question -- anyone want to take the test?

Douglas Shields: I don't that there's an inconsistency there. The sorts of things that you're looking for when you inspect a levee, you would be able to see if you just had plated the surface with rock. So, I think that it's hard to argue that the levee is more inspectable if you have vegetation growing on it. Any kind of vegetation, and the more vegetation, the less inspectable it is. The question is, how much effort are you willing to put into the inspection? But, no, I don't think the rock is going to conceal very much that you're actually looking for in the way of surface erosion, [unintelligible], differential settlement, or seepage, boils, those sorts of things, are probably not going to be concealed by the rock.

Tom Gohring: Dr. Haselsteiner, could you please explain the complications with removing vegetation from levees, as it pertains to your countries environmental laws? I think this is more of an institutional question, rather than a physical question.

Ronald Haselsteiner: Let me tell you about a few experiences we made conducting a few flat refurbishment measures. There was a dike, completely wooded, near Rosenheim, that's near Salzburg [unintelligible] and it was completely wooded. And before a flood, we would not allow it to clear this dike. After the flood there was no claim from the nature authority that we couldn't do it. And we cut down, I think, 8,000 trees without any claim after the flood. Because when one of this nature guys would chained himself to a tree, he would be beaten up by the inhabitants behind the dike. But --

Tom Gohring: That's called public participation right there.

Ronald Haselsteiner: But normally, it's not as easy, so our authorities claim or want a flood every three years. It seems to be the remembrance time of the people. But normally, you've got -- you have to, as I mentioned yesterday, you have to leave a few trees every hundred meters as a kind of [wicktim] to the nature.

Tom Gohring: If you had to save a large tree or trees on a lower slope of a levee, what are the engineering solutions such as a slurry wall, placement of a rock berm, and will these engineering solutions satisfy the U.S. Corp of Engineers? I don't that anyone on the panel would venture to answer to that. Second question. First question -- what engineering solutions could you use if you had to save a big tree?

Chris Peterson: Tom, I'll make a -- in order to save the tree, I think that's how I'm hearing it, if you want that tree to stay there and reduce it's chance of falling over or whatever, there's some obvious things to do, which Dr. Gray and Dr.

Berry, and myself all mentioned yesterday. If you want that particular -- some heritage oak or whatever -- you can decreases it's chance of falling over from wind anyway, by reducing it's [sail] area. That's probably the single most important thing. And depending on the circumstances, if you're allowed to, you could increase -- you could decrease it's chance of getting blown over by having other things around it. Some smaller trees or shrubs that would deflect the wind up over it. Now, that's probably a pretty extensive amount of effort for a single tree, but it depends on how important that tree is to you. In Athens, Georgia we have a tree that owns itself. So, there's -- some trees are really pretty important. But you decrease it's sail area or you could do things to deflect the wind up over it.

Tom Gohring: Dr. Berry, would you --

Alison Berry: Yeah, I agree. You can't do a root crown inspection to understand where the root system is growing. That would be a non-destructive method. And then, take any steps you need to protect the bank from root incursion. But one has to establish first, where is the root system so that you're not cutting the root system. I've seen some preservation efforts where they simply either cut the root or added fill or did some kind of practice -- cut the roots very close, such that the tree ultimately died from the care that's being given to it. So, one has to take steps in that regard.

Tom Gohring: Great. My next question's a long one. Are there strategies involving creation of suitable plant habitats for desirable species that would be self-sustaining and avoid committing future managers, to intensive vegetative management? I'm going to invite the panelists to really dream here. Can you imagine creating a [unintelligible] --

Douglas Shields: This question goes to the idea that I raised earlier. Instead of talking about veg or no veg, let's talk about the kind of veg that we want. So, I think it's an excellent question. However, I think that there is no such thing as self-sustaining vegetation unless we're willing to accept the climax

community that Mother Nature wants to develop out here. So, if we want something different than that climax community, there's going to have to be some kind of management that is employed. Clearly, there may be smarter, more efficient ways to manage than we're doing now.

Tom Gohring: So, just as you would say, it's not a question of veg or no veg, it's also not self-sustaining or not self-sustaining, but it might be the intensity of management requirements down the road. Understood.

Chris Peterson: Tom, I'll make another comment there. And not being from California, some of the California ecologists might want to elaborate on this more, but basically the way I'm hearing that question is the restoration question -- vegetation restoration, and typically in restoration ecology, we talk about restoring processes that would maintain some sort of vegetative community. And unless the processes -- so this is sort of elaborating on Dr. Shields comments -- unless the processes are restored, then it won't be a self maintaining sort of community. And so it's more of a question of whether all the other factors that influence vegetation would be restored in this sort of circumstance, but the nutrient cycling and the rest of the eco-system which probably, almost certainly the answer is no. So, I think it's probably unrealistic to be thinking about a self-sustaining system in this sort of a context.

Alison Berry: Yeah, I would agree with that. I think what we're looking at is more of what we have in an urban forest, which consists of some sort of wild land components and some very highly regulated components. And so, sort of a mix, and it's something we can't really just plant and walk away from, but will have to keep returning to and monitoring, inspecting and modifying.

Tom Gohring: And Doctor did I hear you describe earlier that if you have that as your vision, and clearly there are a lot of questions we have to answer about what's the right mix, and how it's going to perform -- did I hear you

describe a process wherein you could transition to that from one vegetation type to another without having to rip it all out and start over.

Alison Berry: That certainly would be my vision of this situation, and certainly a possibility. That we take a longer view -- a five or ten year management view to get this program rolling -- unrolled let's say, that would involve discussion, and development of implementation plans that include an inspection program, a replacement -- a removal and replacement program, some ecological restoration components obviously along banks are going to be essential. And then, a sort of a regular system of inspections and action.

Tom Gohring: My next question is about -- skips to the issue of replacing the function of roots in the water, which is to often used -- to help provide habitat and more favorable velocities for endangered aquatic species. What are the issues with replacing those roots with LWD, which I guess is large woody debris? So, what are the pros and cons of replacing those roots with placed debris and a follow on -- what are the risks if that debris comes loose? What are the risks to downstream levees and other structures? Again, I apologize if I've butchered your question.

Douglas Shields: Well, number one, large wood and riparian vegetation are not interchangeable. A large wood doesn't provide shade in the same way that riparian vegetation does. It does provide a lot of functions, a lot of values in the rivering system. But you don't get shade, you don't get input of leaves and insects and that sort of thing that you get from riparian vegetation. Placing large wood in large streams and rivers is becoming increasingly common. The issue of hazard is real. The answer if site specific. I think the solution is to anchor the material. If you're in an urban or semi-urban situation to anchor the material so that what gets away are smaller pieces that break off, and are not going to cause a problem.

Tom Gohring: Anyone else on that one?

Douglas Sherman: I want to support that answer. I think that installing large woody debris in some kind of relatively secure manner is much better than nothing along the water line. I don't think it's a good substitute for the natural vegetation. I just think it's better than nothing.

Douglas Shields: Also, the natural vegetation does provide erosion control. It stabilizes the bank against a fluvial erosion. Large wood will deflect some of the higher velocities, but it doesn't bind the swell in the same way. It doesn't have the flexible lay down properties that the live vegetation does and so forth.

Tom Gohring: My next question comes from Seattle. We heard about sand and clay. What about glacial till and lift -- is that how you pronounce that? [Lurst], thank you. I haven't read that since [unintelligible]. Glacial till and lurst components, in fill materials in levees as we have this in the northwest United States? Is there a geologist in the house?

Maureen Corcoran: You're exactly right on that, and I guess we've been focusing on Mississippi and California, but what needs to be considered also are the deposits -- regional deposits. And I guess this kind of brings me to another idea I've been sitting here thinking about after listening to all these questions, and this is a question I guess I have to the panelists and everybody else that's out here. We know a lot about the geology, like you said, in Seattle we know we have glacial till and lurst. Mississippi lurst, sand and clay. We know soil. We know plants. We have a lot of information, but it's not been put together. We all agree on that. And I'm not a GIS expert, but to me, it seems like a -- but I know some people in the audience that are -- it seems to me, if it's feasible, to put this in a type of GIS using imagery that can help identify vegetation types and be able to use that as a foundation for future studies.

Because right now, we have engineers doing engineering work, botanists doing excellent work on plants and so on, but the problem is bringing this

altogether. And so, I don't know if that is something that is -- because every state has a GIS. I mean, Mississippi has a GIS. I know California does. So, I guess my way of thinking is, we can sit here and talk all day, but until we put this together and make some sense out of it -- we have a certain plant that's going to grow on clay, grow best on clay, and it is going to have different dimensions, so, anyway, I guess that's a long answer to that -- to the glacial till question, that definitely needs to be considered, but I'd also like to posse that to the audience and people on the panel too, if that is something that's feasible.

Alison Berry: The GIS components?

Deleted: Female Voice

Maureen Corcoran: Yes, or the glacial till.

Douglas Shields: I'd like to make a comment on that question. I think that Maureen was thinking at the landscape scale. Maybe looking at the very small scale, there have been studies done on root reinforcement of different kinds of soils. And the recent work done by Dr. Natasha Pollen that's been published in the last couple of years, and some more work that she's got coming out, looks at root soil interactions as a function of soil properties and soil moisture. Basically, roots reinforce soil. Now, there's a lot of equations that you can get into, that take it a lot further than that. But basically roots will reinforce those other kinds of soils too. Clearly, the answers get much more complicated when you scale up to the size of an earthen embankment or up to the landscape scale.

Tom Gohring: With that, I'm going to start switching to wrap up mode. We do have a couple of more questions there, but I think they're for the most, hitting issues we've already covered. I want to give the panelists and opportunity to ask one another a question or two. After that, I will ask each of you to make any concluding remarks. So, and inter-panel questions? [Unintelligible] Dr. Corcoran, can I ask you to do -- any last minute

thoughts you have, you can sum up the things you -- oh, I'm sorry, Dr. Haselsteiner.

Ronald Haselsteiner: I had a question to Mrs. Corcoran -- you were in Dutch, in Holland, you were in Japanese -- you were in Japan, but you missed Germany.

Maureen Corcoran: I did mention Germany. I mentioned it yesterday in my presentations that there was German guidelines and that you were going to talk about that. We do have someone that can translate it, so if you would be nice enough to send it to us, my German is a little rough.

Ronald Haselsteiner: Like your Chinese huh?

Maureen Corcoran: Yeah. I think my Chinese is better than my German. Oh, and that is something that I'd like to add too -- on the -- I probably will get 500 emails but my email address is in the program, if anybody -- I've had several people come up and tell me they do have some documents that aren't easy to access and they would send it to me. So, I don't really expect to get 500 emails, but if everybody does or someone does have documents that perhaps you don't think we -- or are not easy to get in the -- or easy to access, please by all means send them to me. We don't want to exclude anybody.

And I have noticed that no one said anything about my GIS question, but I wasn't thinking about really from a landscape point of view, because I'm constantly thinking really below surface too. I was thinking about the interaction of different vegetation types in the different types of the till, the gravel, and so on. And also, I'm sure probably a lot of people know, but for those that don't, the lurst which is pronounced several different ways, and it is a German word, it is wind blown silt off of glaciers. So, it does have a lot of silt components.

Alison Berry: I would just add on the GIS question, I'm not a GIS expert, but there are, as you indicated, there's a lot of GIS work that can identify or is working to identify vegetation types in relation to different conditions. Even different -- not -- again at a landscape scale, but detail within vegetation type systems. Very powerful, remote sensing techniques such as [lidar] and so there. There are people like Susan Houston, at University of California - Davis, or -- but that's just one. There's a million -- there's quite a few people. The state itself has very powerful GIS maps, lots of information available. So, I think that's a very viable -- for large scale information.

In terms of the question on glacial till and lurst, I don't know exactly what you're aiming at, but from a tree -- a root stability standpoint, that's a very good system. A rock and lurst combination is quite stable. Roots will penetrate that, but they'll be fairly well anchored. Now, that may not be the -- what you're asking, and I hesitate to say anything. That's why I didn't say anything before, because I really would like to know more about those particulars, but I'd be happy to talk more about that.

And I just want to add, in terms of information, if anyone's interested in urban forest management kinds of contacts and so on, I think that I can help with that as well, or there's other people in the audience, Rob [Curson], and Steve [Chaney] and [Jeff Hart] and others. There's quite a bit of -- I think Kim Coder is really a very well respected, but there are folks in our regional area, who can help. There's an urban forest research center, U.S. Forest Service that's located at UC-Davis, so there are a number of resources there too.

Tom Gohring: Dr. Dwyer, some closing remarks?

John Dwyer: Well, yeah. I guess I would -- I guess this meeting has provided a wonderful venue for exchange of ideas, but I wonder what will happen as we all go back to our jobs -- I go back to teaching. Are we going to just

feel good about this and walk away from it, and nothing gets done? And I think we've all had experience with that. And so, how do we get beyond this meeting in this setting, in terms of providing an ongoing mechanism for exchange of ideas. Because I think you've got a wonderful process in place, wish we'd have had it. So, I guess that's my concluding remark is, how do you carry on this dialogue and how do you carry on this involvement as you meet these challenges?

Donald Gray: I found that participating in this symposium was a really interesting and worthwhile experience. It certainly exposed a fault line, or gulf or divide between the two different approaches or world views -- what you might call conventional engineering versus soil bio-engineering, engineering on the other hand. And I hope that we take -- that we're able to bridge this gulf or divide and that's what this symposium offers -- the opportunity to do that.

Bill Bouley: I guess in regards to FEMA 534, on the Impacts of Plants on Earthen Dams or even dikes. If any of you have any critique or changes you'd like to see in it, you can either write to ASCSO or FEMA, and Dr. Shantz will review those, and if we have to reconvene and put in an addendum to allow for biogrowth at the upstream toe of dams, or the downstream toes of dams, in lieu of toe drains, we can always consider that for future revisions. But, my email's not in the proceedings, so you're out of luck.

Douglas Shields: The current situation in this region is, I think as we heard earlier today, something that evolved over 150 years or more, And therefore, it is unlikely that the situation will be completely resolved before the next flood, which is what we're all working toward and thinking about, and looking for. Particularly today -- the historic significance of today should be noted. So, it seems to me, maybe I'm a bit pessimistic, but somebody's going to sue somebody here pretty quick. And I'd just like to encourage everybody involved, before the lawyers get involved and impose a

thoroughly irrational solution, that the powers that be get together and agree on a pilot study. Perhaps a rather long segment, a mile or more of levee, and get -- let the technical people get in a room, and shut them in there, and then let them brainstorm and come up with the best of all possible worlds to achieve environmental values and public safety.

If I were one of those people, I would argue for large wood at the water, large trees and so forth, in a band there along the bank and the berm. I would argue for a mixture of small tree shrubs and bunch grasses on the riverward slope that should be maintained by cutting at rather long intervals, meaning say one to five years, and irregular bands. And unimpeded roadway at the top. The landside slope maybe some annual grasses that can somehow live in a [unintelligible] climate -- I'm not too sure about that landside slope. And no swimming pools at the landside toe.

Douglas Sherman: From my perspective, it's been really interesting to listen to the debate, particularly about the role of larger vegetation. And I want to talk to you a little bit about some of my own personal musings about this tension between habitat esthetics and safety. I've worked in the delta for a bit more than a decade now. I'm getting toward that part of life where I think about where would I like to retire. I often think about communities like Walnut Grove, or Isleton, or Locke. A lot of attraction is the -- what charm they're might be in those communities. But also, is this notion of the tree lined waterways, the recreational boating, the fishing and the wildlife. It's a beautiful area.

I balance that pretty quickly when I go to these fantasies about -- with these four points. Having -- and again, in the delta, unlike the levees here, they're always hydraulically loaded. Most of that area is 5, 10, 15, 20 feet below mean sea level. So, those levees are different. They are dams. They're different than the levees up here. Having to rely on a levee for personal safety and property safety sucks. As the surprise failure of the

levee in [Jones Track] a couple of years ago, under non-flood summertime conditions with no vegetation suggests -- you should never presume that you are safe. Continuous maintenance of those levees, in particular, is required. Somebody has to do that all the time.

The fourth point. Unless we go into a regime of rapid global cooling, and rapid [unintelligible] fall, that will not get better.

Ronald Haselsteiner: First of all I want to encourage you, all of you, everyone of you, to contact me. I can provide you a lot of German [unintelligible]. And secondly, I want to thank SAFCA for the invitation, and maybe we get it done to translate a few of our standards into English, that you can all get information from us, from Germany. Thank you.

Chris Peterson: I think I'd say a closing thought is a single word, and that's prioritize. I guess I stole that maybe from Dr. Berry. But it strikes me in trying to address sometimes conflicting concerns between esthetics and flora and fauna and public safety, that a wise course of action over the next number of years would be -- regardless of what's decided in the near future as to whether vegetation will be removed from all of the levees, or part of the levees, or whatever, it's not going to happen tomorrow. And it strikes me that the smart thing to do, would be to decide which areas are most at risk for public safety reasons, and to do that in a quantitative and informed fashion.

Tom Gohring: Panelists, thank you very much. Ladies and gentlemen. Please, we're going to break for lunch in a second. Emir has a couple of things to address, but panelists, my sincere thanks. I find you all completely intimidating and I've enjoyed spending the podium with you for a few minutes.