Transcript of Panelists' Discussion and Q & A and Audience Q & A

Session 1: Overview of the Lower Mississippi River Basin

Doug Daigle: To recap our question process again, we will take questions initially from our panel, and then, we'll ask the audience to pass written questions to the center, where they'll be picked up, and if there is time remaining we can take questions from the floor. So let's start out with our question panel again. It's Phil Bass with the US EPA Gulf of Mexico program and Dr. Jim Fouss with the US CA agricultural research service in Baton Rouge.

Phil Bass: Thank you, Dennis. When looking at your trend analysis, I can understand how you are using the State's data, the EPA's data, your data to develop trends. How do you plan to use the NPDS point source data in evaluating trends?

Dennis Demcheck: That would be a question for Richard Rebich[1], I don't really know. He's the one who is actually doing the statistical analyses. I wish he were here to answer that. I can get you in contact with Richard.

Bass: I have a follow up question for Dennis. Talking about trends and loads, you also refer to concentrations saying that the concentrations weren't really much different. What focus do you have on the flow volume, in terms of these trends?

Demcheck: The volume? I'm sorry, the volume of what?

Bass: The flow volume in the streams, for comparing the nitrate or the phosphorus.

Demcheck: Well, we'll certainly document that. These reports are really designed to generate discussions as sort of a starting point, so, I'm not really sure how to answer that either. The trend reports from all of these major river basins will be the starting point for questions like that

Bass: Related to that, do you partner with anybody to do monitoring both on existing conditions and after best management practices (BMPs) are installed, within the same time-frame?

Demcheck: That would be an ideal use of these reports and studies, but that's not really going to be our job. Our job is to document and to assess and when there is, and if there is an area where the best management practice being implemented or considered being implemented, and this report can help, we'll certainly be there, but it's really not our job to assess, to give really a critique on how well best management practice is working.

Bass: Dr. Turner, your evaluation of the Atchafalaya, looking at the nutrient load that was coming in versus what was going out did not show much of a reduction, and that was

[1] Please verify author's name

obviously disappointing for those of us who hoped that the Atchafalaya offered a solution. Does your evaluation take into account any additional loading in the basin that might account for some of that?

Turner: The source of nitrogen is not suspended matter. The river's volume is huge and the population density so small relative to the basin that when you do a back-of-the-envelope calculation per capita, you get x-amount of loading per capita for phosphorus and nitrogen. If animals are included, you will get a higher number. It doesn't amount to much. There is also some county data which you assume is spread fertilizer data, and if you assume it is spread evenly, it doesn't amount to much, it can't add much to it. So, we've tried to address those within-basin sources. We did atmospheric sources but I can't image those add much. So it doesn't look like there's within-basin source it could import.

Bass: Not any significant NPDES discharge or industry that might contribute.

Turner: There might be some, but it is a third of the Mississippi River, so there is a problem in doing load estimates for the Atchafalaya, which is that, there is an unbalanced flow in and out that the measurements are not equal. And so, there's a way, it has to do, I think, with stage discharge relationships, which have to be always updated because of the sedimentation rate, we've got elevation throughout the basin. So that's a problem with doing a total load estimate, which is why I did a concentration one.

Fouss: My question is similar to what you're referring to. You mention that the concentrations weren't much different, but you were really kind of then saying the load reduction too was a function of a flow volume, and have you looked at anything that would actually reduce concentration? With the inflow…

Turner: Do you mean some activity, some management intervention?

Fouss: Yes

Turner: No, I was just doing a straight bookkeeping of samples that were within one week of each other and also for a river that size I did not anticipate much because there's only a few days of travel time. Oh, I should add a little detail that even when you looked at data that were clearly out of bank, as opposed to in bank, there was no difference on these relationships.

Fouss: The only way you'd really reduce the total load is to reduce volume

Turner: Is what?

Fouss: Reduce the volume of flow

Turner: Yeah, or increasing.

Fouss: That's what I wanted you to say, cause that's drainage water management. Had you, have any of you explored or taken a look at anything that would relate to nutrient management, where's some change in practice in the way nutrients are applied on cropland…fertilizers.

Turner: I didn't look at any management in enrichment centers, no.

Fous: Well, you're looking at situations at a status quo…

Turner: Correct

Fouss: …but at the same time looking at the possibility of changing the way the nutrients are applied on cropland, what impact that would have?

Turner: Within the Atchafalaya?

Fouss: On any cropland

Turner: Well people have done that. Absolutely. I'm not sure I quite understand the question, but that has been the basis for interpretation about land, water quality and land use relationships throughout the basin, including whether it's tile drained or not, you know, the holding time within the basin, the size of the receiving basin, the intensity of crop use, the kinds of crops, there's a list. I know that there's one study in Missouri where a small addition of wetlands within the watershed had a big impact on Nitrogen, coming off it, disproportionately so in the beginning.

Fouss: One last question, did you not have some, I was thinking Bill Mitsch mentioned this, there had been examples where the reduction of nitrates by diverting through wetlands is far greater than what you were reporting here.

Turner: It would be a really longer discussion but I'll address part of it, which is, that you have to pay attention to concentration. If the amount of nitrate in the river, no offense, is low, I mean that it's not high relative for other reasons, but it's low relative to sewage treatment plants and waste water applications, it might be ten or twenty or even higher, and concentration makes a difference. MacKnight's book make a clear case about having a, I forgot what the term is but, alright, it's trying to squeeze blood out of a rock. At some point its so low, it's hard to scoop it out of the system. So there is an effective concentration: so it's easier to take it from 10 milligrams per liter (mg/L), to 2 mg/L than trying to get it down from 2 mg/L to 1.5 mg/L. And so there is a saturation effect, there's a Halisment[2] relationship, if anyone likes to deal with that stuff. You have to be careful about extrapolating.

Bass: Well Steven, in my opinion, based on my experience in environmental controls and pollution controls, the farm bill conservation acts offer a great opportunity to affect some of the changes in non-point source that we've been able to achieve in point sources.

[2] Please verify term. Unclear from tape.

I think a very effective environmental law, it's not couched as an environmental law, but I think it offers that opportunity. You've done, I think, a very good job of evaluating some of the effectiveness of some of the things you guys have been able to institute/ institutionalize in your conservation practices. Do you plan to use any of that to enhance the program to concentrate some of your resources on higher priorities? Let's cut to the chase on hypoxia, put the money where the real source of the problems are as they relate to hypoxia.

Fouss: As soon as they appoint me chief of the NRCS. Until that time, I don't know how much impact I can have on the programs, because they are obviously USDA, but we hope to. That's the idea behind this partnership. I think traditionally all of us have been, you know, USGS has been a science agency and NRCS is a management agency and a farm agency, so the recognition is that there's a collaboration there that allows our science to play a role in the management decisions of those programs to make them more effective and I think that's really been the big push from OMB and others, is you know, how do we get the most bang for the buck for the taxpayers that are footing the bill for these programs, because they aren't expensive anymore.

The whole idea behind this is not to critique history but to identify effective ways to restore these systems and particularly at landscape scales start looking at these relationships at a larger spatial scale so we can understand the cumulative effects of individual practices. Then if we want to recognize opportunities to maximize things like water quality removal, well that only happens at certain locations in the landscape and if we don't recognize where those are and what the drivers are, then we just planted the trees or created bird habitat or fish habitat, without potentially getting the water quality benefits we're looking for. So, I think the overall goal is to be able to help identify those kinds of relationships that the program can use.

Bass: Well, just a comment as much as a question to follow that up. First of all, I agree completely, and one of the challenges to me has been the political challenge as the farmers see these conservation activities on the table. It seems to me that a lot or some of the management decisions have been equal distribution rather than putting a larger share of the money where really the real problems are. And then understand what practices work in different basins. In Mississippi, for instance, you can't treat the delta like you treat the tiny woods. There's going to have to be different practices there, and getting some of the agencies and some of the leadership to recognize that has been somewhat difficult. But you guys should be commended for what you are doing.

Turner: Thank you

Fouss: This is for Steve. You mentioned a couple times the before-and-after effect. Comment, if you would whether your collaborative type work is related to this, where you have a paired type projects where the before-and-after is conducted in the same time frame.

Faulkner: Well, what we are trying to do is, with enough observations if we have a cropland that is adjacent to the WRP (and effectively they are all the same land owners, so that just happened to be a little lower, wetter side that they put in the WRP) then we are hopeful that we can look at was occurring in that cropland, still occurring and that was probably the likely condition prior to the implementation of the conservation practice. It will be more effective where we can go and back and look at historical data for flood storage, bird habitat and things like that, where we can on the same piece of land look at before and after. And the other problem that we have a little bit with that is, you probably recognized and most of the audience would too, is that during the initial phase of WRP in 1992, practices were very different than they are now. So we are unable to distinguish whether the effect is from time or from the way the thing was built or planted or things like that. So, we don't have a before-and-after measurement where the conservation practice is installed in the same plot of land but we are hopeful that we will have enough commonality with current ag practices on adjacent WRP land, that we'll be able to quantify those differences that way.

Fouss: I want to add to that the additional information you get from modeling before-and-after conditions.

Faulkner: The additional information on modeling.

Fouss: The models, I'm thinking particularly that you could, I know it's kind of a simulation situation, at least you could simulate the same weather patterns for the series of time, so you wouldn't have a difference in weather patterns for the so called theoretical study period versus the actual.

Faulkner: Right, Right. I didn't have time to go into it in a lot of detail, but the real goal of the indicator models, I think, are for the agencies to be able to predict the quantity of those services without having to do another research study and measure all those variables that we will hopefully distill those down to a rapid assessment approach of those surrogate type variables that can be measured by NCRS personnel or others, on a more timely basis. They can get an estimate of what those services might be and particularly for comparison purposes, rank potential projects within a ranking system, that kind of thing. So I don't think, at least at this stage, we'll be going into a quantitative predicted model that goes back, you know, back tracking on weather patterns and things like that.

Daigle: We have a lot of questions from the audience, that's great. I'll start with one for Dennis. How would you deal with the point sources that do not have permit limits in PCS, can you establish loads from SIC codes and discharge?

Demcheck: Well you could that, but that's really not a USGS objective. We're the data guys. I think there are other agencies and institutions that can do that sort of estimation. The thrust of what we are doing with these major river basins is to use data to look at trend analyses and these estimations can be done, but I think other institutions would be more appropriate venue.

Daigle: All right, for the benefit of the audience, I have to admit that I don't know what those initials stand for. PCS is? I don't want to put you on the spot either. Permit Compliance System, and SIC is? Standard Industrial Code, thank you.

Demcheck: It would be a really rough estimation and we at the USGS are far more comfortable with data-based trend analyses than estimations.

Daigle: This one is for Steve, actually a couple of them. How many acres do the eight Arkansas and eight Louisiana WRP and CRP sites comprise?

Faulkner: I assume they mean the experimental sites that we have. I don't have that number off the top of my head. We had a minimum size of a hundred acres. So, the minimum size for the experimental site would have been a hundred acres. I don't think we had any that were bigger than two hundred. So, I am pretty sure it's 100 to 200.

Daigle: And they are also asking what scale, in terms of acres, will the functional indicator models be developed?

Faulkner: All scales. Let me think about that: it depends on how rigorous the analyses are with respect to our assumptions and the outcomes. It would be ideal if we could have two scales, one patch and one landscape, so we could make predictions for individual sites as well as those for cumulative impacts across a larger landscape if we could do that. The current thinking is that it would just be at a site level that those variables that control that service would then be evaluated and quantified in a kind of rapid assessment that could be used in an evaluation for prioritizing those locations for placement in conservation practices, ideally to get the most bang for the conservation buck. But I would have to say that, let me caveat that with the fact that I'm doing the science part. NRCS and FSA will make those decisions on what they want to do with the results. I don't want to get ahead of myself.

Daigle: One for Dr. Turner. You didn't mention that the Atchalaya river basin is largely channelized and this has important implications for nutrient removal. What are the prospects for increased nutrient removal through better distribution of flow through these weapons?

Turner: Well, there's a possibility for doing things differently and if you wanted to segment the river and drive it out of its channel, which is there because of the strength of the flow, you would have to put some engineering. It's possible you could hold some more retention, put some walls in and divert it someway and spread it out. So, that's a possibility, you'd end up trapping more sediments, of course, and more phosphorus as a result. The thing is that when in the existing channels, when you separate only the ones that are out of bank compared to the ones in the data proved out of bank, do the input and output, you don't get any difference.

Now, it maybe that only five percent is going out of bank compared to what's in the channels, but we don't see it yet. It's a possibility. It would require some heavy duty engineering though, because the slope is not that great, it's a depressional basin, so you have to figure out how to get it out of the channel, which is driven by its massive flow. The morphology of the channel is there because of flow discharge is high. So that would be a considerable engineering feat to get it out. I'm sure Morgan City would be concerned about all that. That's the down stream recipient of the flow. The stage discharge is curved. It's going up every year, every time you open the basin, the stage discharge changes at Morgan City and they have to raise their levees down there because of that stage going up.

Daigle: This one wasn't addressed to anyone in particular, so I'll just ask, you know, each of you take a shot at it if you want to. The lower Mississippi River Basin and others represent different geographic areas than those in the *Goolsby, et. al.* assessment. How will the results be prepared for comparison? It doesn't specify which.

Demcheck: I'll take a brief shot at it. The Goolsby report does address the entire Mississippi River Basin, a basin scale assessment, and it does include data from St. Francisville to New Orleans. I think that its not so much pairing, its not the way I would phrase it, it's more using that basin scale assessment and then interpreting the effects downstream. I wouldn't really consider pairing it.

Turner: I'm not quite sure, a couple of people have looked how the lower Mississippi Basin, this is the one you have to do by subtraction because of the position of the water flow in the stage. The estimates from a couple people have agreed pretty well together. But, the one thing that comes up is that even though the basin is a smaller geographic area, it has a pretty high yield per unit area. So that has some consequences to the local people, to the local watershed issues that you have such intense use, you have pretty high yield of Nitrogen coming out for each amount of land, even though the amount of land isn't that large relative to the whole Mississippi River. So, it would be important locally for that issue and the second is if you are looking at best management practices, it's a great place in this basin to find examples, which Steven is doing, on how to improve water quality through land management issues, management or investigations.

Daigle: Another one for Steve. Will a final product be recommendations for overall restoration goals for the lower Mississippi Valley?

Faulkner: Yeah, I think certainly we would anticipate that the comprehensive nature of this approach will give us a data set that we don't have currently as far as how these conservation programs quantify those services at both patch and landscape scales. So I would anticipate we would have something to say about how we go about restoring formerly forested wetlands in these alluvial valleys, particularly with respect to hydrology. I will probably talk more about that tomorrow.

Daigle: Another for Dr. Turner. If six percent total Nitrogen removed reduction is insignificant, how much reduction would be considered significant. I guess they're referring to the figures.

Turner: I guess, I'm not sure what, relative to what? I mean, six percent is small relative to a hundred percent. I have a little trouble understanding that, but… I can't remember the six percent, I said eight percent, but anyhow, every little bit helps of course, but in terms of the total problem, if you're looking at a possible six percent solution and you don't have it yet and you have ninety-four percent of the work with you, you ought to look at the whole. I guess I don't like the word "insignificant", I'm not sure I said that.

Daigle: Next one is also for Dr. Turner. Did I understand you correctly that wetland loss in the basin has no influence on hypoxia on the Gulf of Mexico?

Turner: No, no. That was about the coastal land loss. The estimate had to do with the land on the coast being lost, you know, turning into open water, it peaked in the '60s. It's now down to less than ten square miles per year. So it had a peak to it. It's the coastal wetland loss and whether that material, when it goes from the organic material that the plant, you know, underneath the plant that has Carbon and Nitrogen in it, whether that material is significant or not, and that's what the budget was about. Of course, wetlands in the Midwest and elsewhere would be a significant part of any restoration effort for a variety of reasons besides Nitrogen removal, and it has a lot of nuances to that including the positioning etc. That would be an incorrect assumption.

Daigle: Another one for Dr. Turner. If diversions are not moving sediment and nitrogen…

Turner: I got what?

Daigle: If diversions are not moving sediment and Nitrogen to the areas that need to be rejuvenated as wetlands, how can we get sediment and nutrients in to these areas? That is how the question is phrased.

Turner: Well, I didn't get into…do you mean like diversions, river diversions, I mean that's another seminar, How to Restore the Coast. I'm going to punt on that. I can't do justice to that in this conversation.

Daigle: Okay. Okay, the other questions were pretty much repetitious of each other, so, we have a little bit of time left if there are any questions that anyone wants to pose from the floor. We have one more? Okay, and then from the floor if anyone has a question, we have a few minutes left.

Fouss: This one is for Dr. Turner, one of those questions prompted this, I didn't ask it. In terms of the nitrate going down through the Mississippi River, have you tried to quantify the percentage from the upper basin (what I call pass through) versus that

contributed in the lower basin, that goes through to the Gulf? Like, is it eighty percent coming from the upper basin just passing through here to the Gulf and then we contribute another twenty percent or?

Turner: You know, I should have printed off the slides, but it was on the slide. I think you are asking how much comes off of the lower, yeah, and it would be…get it off the slide. It could be, the reverse of what I gave. It's probably seventy to eighty percent.

Fouss: Ok, I remember the slide now. I wasn't sure that was the number you were talking about, okay.

Len Bahr: Len Bahr, the Governor's Office of Coastal Activities. Just some comments, Gene Turner and I have disagreed for years about the potential Nitrogen sink of the coast, and Phil, you seemed somewhat disappointed, I guess, that the Atchafalya basin, for example, has been described as not having much potential. The folks, Ron Lawn, and others at the LSU Wetland Bio-Geochemistry Institute, who seem to think that is quite an amount, quite a significant potential. It is channelized largely. It has been managed by the Corp of Engineers primarily for navigation in flood, the Atachafalya basin is a flood passageway for the Big Flood. It has been prepared for many years for a flood of flow volume of the whole Mississippi system (three million cubic feet per second), which is unprecedent volume of water, but it is basically managed for that and for navigation. It's highly changed, it's nothing like a natural system, and a lot of the people who have looked at it, Charlie Demas and others, and said it does have enormous potential, it would require some engineering, as Gene said. Within the scope of change that we're talking about now under the restoration program and flood protection program, we're talking about massive changes in the way the lower river flows through the delta. Today at noon there is going to be, I think, a brief description of a plan that was recently put together by about forty-two scientists and engineers for massive replumbing of the lower river, and whether or not you disagree with it, in terms of that. There are three processes that could theoretically eliminate some of the nitrates before it gets in the Gulf of Mexico, and those processes are burial, denitrification, and uptake by healthy coastal forests and marshes. The fact that the physics are going to be changed has got be a huge bearing on this, and Don Boesch and lots of folks and I have talked about what the implications are. We don't even know. We're talking about abandoning the birdsfoot delta. The river, we're talking about releasing all the water before it gets to Southwest pass on the east side and connecting a lot the Atchafalaya basin before it gets to Morgan City, so there are big changes in the works, big engineering changes and I think that we need to come grips with that and use the best science we have to at least come up with estimates of the implications because, you know, that is what is being talked about and Katrina brought that home for so many people. These changes are being seriously discussed and I can not help but think that the implications for nitrate dynamics are real. So, it's coming.

Daigle: Thanks, very brief, we got one more, we have about a minute left.

John Day: Yeah, I'm John Day, from LSU, and I am also one of the co-authors on the Mitsch report that was mentioned earlier. And just a few comments, not a question really

on the significant wetland uptake. Jean showed that any diversion in Louisiana has a minor effect on nitrogen in the river, and that's certainly true. We've been studying in Canaervon for a good many years and what goes in there, there is a significant reduction of nitrate when water goes into Canaervon, and what Bill Mitsch and I and some others talked about was the distribution of wetlands over the whole basin. If you take Canaervon and you put it up anywhere in the US in the Mississippi Basin and remove all nutrients coming from that size area, it would not have a significant impact on the overall river. So what we said is you need to put wetlands all over the basin that has the kind of limits talked about. You need to locate them very carefully because the WRP often haven't been located with nutrient removal in mind and Steve talked about an area of, I think you said 900,000 hectares proposed, something like that? Well that's about five percent that Bill Mitsch and I, and others estimated, would be needed to reduce nitrate concentration by half. It would reduce the loading to the Gulf by fifty percent. And of course you get, as several people have already said, you get all sorts of other benefits that Steve listed when you do that. So, you know, you shouldn't take on particular area and say that's not going to have an impact because it's cumulative effect of all those that restoring sort of the natural, some of the naturals in the basin. And, wetlands in combination with agronomic practices, drainage practices are going to be how we solve this problem, and it's going to be a solution distributed over the whole basin. Ok, thanks.

Daigle: Thank you. Ok, it's time for our break, and we will start back promptly at 10:50 on the dot, so break fast. Thanks again to our speakers and question panelists as well.

End of Session

Transcript of Panelists' Discussion and Q & A and Audience Q & A

Session 2: Current Status of Nutrient Monitoring in the Lower Mississippi River Basin

Nancy Rabalais: We were cheating off of each other, seeing what questions were available (!), so I'm going to ask one. I know that you all have been collaborating for a long, long time and that you share data, because this is a two member dog and pony show. I know that they talk a lot together because they are always giving talks together; I'm not sure who is the pony and who is the dog. My question is, and I know this is beyond your capabilities, but is there some way for heads of agencies to try to have some consistency in methods? Dugan mentioned different lab methods, and I'm not sure how comparable these data are if there are different lab methods and different types of collections. It seems like we could have more stations if there were consistent ways of doing everything, and then we would not have to both be doing the same thing. That is one of the points of the Ocean Action Plan, to have better coordination among agencies. In this case, the agencies would be USEPA through [Louisiana] DEQ, and U.S. Geological Survey (USGS). Any thoughts on that?

Dugan Sabins: Yes, that has been on my mind for many years. I think that we are at a point to where we can begin to do some very close laboratory coordination. One factor is that just for logistics and financial reasons we don't carry some of our analysis to the extent that the USGS does. We do not do volatile parameters, except for the organic compounds, and we do not do dissolved parameters, except for the metals. So, our nutrient data is limited to total nitrate-nitrite, total Kjeldahl, and total phosphorus. Quite frankly, I guess we have used comparable methods for some of these, but it would be good to sit down and look at them. Of course, we both do a broad sweep of compounds, as you saw, beyond nutrients. But maybe there should be an opportunity to work specifically with nutrients, in particular, since that is one of the more important concerns. So I think that is a good comment.

Peter Tennant: Since Nancy mentioned the Ocean Action Plan, and I was on the steering committee for that,…(partially cut out, no microphone)…you have hit on an important point. That is why we have a National Water Quality Monitoring Council (NWQMC), and that is what we have been wrestling with for a number of years, is to try and standardize, to the extent we can, some of the products that we produce, For instance, the National Environmental Methods Index (NEMI) is available on the website and gives you insight into what the different methods will do. Just try and make sense out of this, because you are dead on. We all go out and monitor for a specific purpose, and we all have particular tests that are right for those purposes or particular monitoring designs. What we have tried to do in the National Monitoring Network, rather than invent a whole new suite of monitoring, is to take advantage of what is out there and come up with ways that we can piece those together into a network that solves as many of those monitoring objectives as possible. It is a big challenge, and it takes a lot to get it done, but it is

certainly something that we need to do, because none of us is getting any more resources to do our jobs.

Rabalais: Do I have a similar statement from Darrell Brown, wherever he is, from EPA? He must be out. Dennis, I am really pleased that you all have additional stations, but I have a question concerning the station locations. Given what Dugan just said about there being not that much difference in changes, particularly in nutrients, from upper to lower, and I know you are glad you got those stations, but was there any thought given to placing any stations in locations where there appear to be gaps in data?. I was on the USGS National Stream Quality Accounting Network (NASQAN2) panel, and we went in to advise, but it had already been decided what was going to happen, so we just said, "OK we have met." But this go-round, was there any consideration given to putting a station in that huge stretch of the lower Mississippi River above the Arkansas line to complement the other stations? Everyone keeps saying it is the place with the least amount of data, so why not trade off, although you are pleased to get the stations, and why not put a station there? Maybe USGS has to answer that question again.

Dennis Demcheck: Those are national level decisions, and I would actually like to know some of those answers myself. I am just going to have to say I do not know.

Rabalais: OK.

Demcheck: A site is being reestablished at Belle Chasse (LA), a NASQAN site. Our parochial concerns have really been our lack of monitoring of the industrial corridor and the lack of sites to help answer wetland restoration questions. So frankly, we put more of our local time and effort into reestablishing Belle Chasse than we did into adding our voice to the problem of the gap between Illinois and Louisiana. Ultimately, that was the push and pull of local issues versus national concerns. Personally, I am glad we are getting Belle Chasse back, I wish someone else would work on that big gap. One quick comment would be that the river is so huge that it terrifies agencies, and they always say, "We want someone else to do it." Because your piece, my piece, their piece of the puzzle seems to be so small in comparison to the scope of the Mississippi River Basin that they always say, "Well, maybe the U.S. Army Corps of Engineers (CORPS) should do it, maybe the Federal Government should do it." It is always that someone else should do it. It has just been an ongoing problem.

Rabalais: Well, perhaps one of the recommendations coming out of this symposium is to put pressure at the federal level for a station in that huge gap that we keep recognizing.

Demcheck: One of my colleagues in the audience has a comment I hope, Janice Ward? Help! Reinforcements are on the way.

Janice Ward: Thanks, I can address a little bit about what is going to be going on in the Mississippi with the monitoring. For USGS, we have heard two messages over the years. (1) We needed to get farther downstream and to be able to measure what is going out of the basin. And (2) we have also been very concerned about doing a better job with

nutrient loadings, which has translated into the real time analyzers. So those were our two highest priorities. We have moved on those priorities for this year. Starting in the fall, there is going to be an activity to take a look at all of our stations in the Mississippi Basin that are funded currently under the NASQAN program. We are going to do a more in-depth analysis about what that monitoring and those trends are telling us and how we could better utilize those resources. At that point we will be able to address some of the gap areas, where we did not have good information in the past, or little information. There is always a potential that we might be able to say, "Well, there are a couple of stations we have been monitoring historically that are providing us limited information, and there is a gap in another area which we really should address." So over this next year, beginning in the fall, we are really going to take a look at that through a detailed analysis. I cannot tell you now what those results are going to be, but we are going to undertake that. Just keep in mind, funding keeps going down. So, it also involves, perhaps, dealing with funding decreases. But that is the bigger picture as far as what is going to happen with the monitoring in the Mississippi.

Rabalais: I have a question on fecal coliform counts. This one is basic, and everyone is doing it. Does everyone measure it the same way?

Demcheck: Probably. We use membrane filtration. It is reported the same way.

Rabalais: The fact that fecal coliform counts have gone down is notable; in fact, I think the Clean Water Act has been recognized as being very successful for these sorts of things. The numbers are still above drinking water standards, I noticed, and they are certainly over the level for harvesting of oysters if those waters are moved out of the river and into somewhere else. You can use chloride to solve the drinking water problem. This is not a nutrients problem, but it is part of the river we might want to use, and what are your thoughts about how to get the fecal coliform levels down even further? Is that possible?

Demcheck: The only thing you can do is to hold the water. You can reduce the fecal coliform if you can hold that water for three days, and this is really important for the oyster beds. But that is sort of a management alternative that is beyond my expertise. Slowing down the water would be the way to go.

Sabins: I guess I would just add that I am not an expert in this area, but I do know some of the folks who have been modeling. There is a predictable die-off rate. The test that we have also is somewhat generic. Some of the positive tests for coliforms reflect some other types of bacteria that shows on the plates. So we would say, of course, that the tube goes straight down and the main concern would be whether the tube placement is appropriate given the locations of discharges or diversion projects. We have followed the cities, and they are doing a good job on various types of coliform reductions, or, well, actually, bacterial treatment at plants. So, all we can do is continue to work with them on this and maintain that level of treatment. But we will never get rid of certain counts of fecal coliform in such a huge river system as the Mississippi.

Sabins: The one corollary to that, and Dennis and Nancy are both right, is the fact that the Mississippi has some of the lowest bacterial counts of most of the streams that we sample now. That is usually hard to understand, but that is how far we have come on the river.

Alan Lewitus: I will follow up on that. Those counts were for the Saint Francisville? Is that right?

Sabins: Mine were, yes.

Lewitus: And have you looked downstream from there?

Demcheck: There is a slight increase, though not nearly what it used to be in the late 1980s, well actually in the late 1970s. Before New Orleans starting increasing the effectiveness of its sewage treatment, there would be a huge spike at Belle Chasse, where concentrations would go into the thousands—I mean very dramatic. That spike went away when New Orleans started more effectively treating its water. A similar thing happened in Baton Rouge. We used to have a big spike at Plaquemines, and once Baton Rouge started upgrading its treatment effectiveness around 1988 that spike also went away. So there is a small increase, but not what it used to be.

Lewitus: Dugan, I am not sure if I got your last point or not. You were talking about Morgan City, and did you say that there was a trend towards reduction in nitrogen as you go down the Atchafalaya?

Sabins: Yes, I was just drawing the same kind of analogy that we see on the upper river. There is a marked decrease in nitrogen concentration south of the confluence where the Ohio River comes into the upper Mississippi River. We see the same thing when the diversion channel carrying a third flow from the Mississippi joins the Red River to form the Atchafalaya. When we sample at Morgan City, which is 100 miles downstream, we note that difference in nitrate, total Kjeldahl nitrogen (TKN), and the total nitrogen (TN) numbers. Compared to the difference we see on the main stem river, it is fairly significant. In earlier discussions, both in what Gene's data showed and then what Lynn discussed, it was pointed out that the concentrations change in a fairly straight line from where the two rivers join at Simmesport to Morgan City, where there is currently very little movement of water off the main stem of the river. So we may have options right now for lowering concentrations by diverting water off the main stem and into the back swamps where perhaps some nutrient uptake can occur. So the nutrient concentrations from the top of the river to the bottom do not change very much, because the river has not dispersed the nutrients out. But already, it has this built-in decrease because of the effect of the Red River.

Lewitus: And the upstream station on that is where?

Sabins: We have an historic station at Krotz Springs, if you remember, that is about thirty miles from the junction, and Dennis and company have a station at Melville that is

about twenty miles, and Morgan City is one-hundred miles down from the mouth, well at the bottom of the river before it flows into the delta. I was looking at the Lake Providence data; we can look at Lake Saint Francisville, also, and contrast that to Morgan City to show the differences.

Lewitus: Dennis, do you have the USGS data comparable to that, and does it support that trend as well?

Demcheck: Yes, we do, and it is very comparable.

Lewitus: But otherwise, like in the Mississippi, there are no real differences in nutrients along the course, is that correct?

Sabins: Yes, you saw it, remember, looking at the Lake Providence data compared to Belle Chasse. It was just about 0.17 parts per million (ppm) compared to 0.7 ppm for Atchafalaya.

Lewitus: Dugan, when you showed that table, it seemed like TKN could be a large percentage of the total nitrogen? Right?

Sabins: It could be more of a factor. Interestingly enough, we have looked at the Red River because of this apparent reduction impact, and the Red River almost has a higher TKN than the Mississippi. But it is a figment of the drainage patterns and of the watershed that the Red River is draining compared to the large Mississippi. There are interesting nutrient dynamics going on there. We are still looking at the data to try to figure it all out.

Lewitus: How about related to discharge into the Gulf? Would that imply that organic nitrogen might be a significant part of the pool?

Sabins: That, I cannot really say. I think we have to look at it a little more closely. The TKN also has the ammonia fraction in there, too. So we would have to look at it a little more closely to see what that is telling us.

Lewitus: Are you and/or is USGS measuring dissolved organic nitrogen (DON) separately from TKN?

Sabins: Which one?

Lewitus: DON, dissolved organic nitrogen?

Sabins: As I mentioned, we are not doing any dissolved fractions, but I think Dennis did some.

Demcheck: Yes, we are doing dissolved.

Lewitus: By difference?

Demcheck: We do both. I would have to check. Some of them are direct and some are by difference.

Lewitus: This real time data, or near real time data, how near real time is it? Is it that you collect the data when you go out and change the system? Or is the data telemetered into the lab?

Demcheck: Oh, it is satellite telemetry. It is within an hour.

Lewitus: OK.

Demcheck: It is very close to real time.

Lewitus: And all you are getting is nitrate? Or do you have other things coming in?

Demcheck: At our Lake Pontchartrain sites we have had as many as twelve parameters coming in. Nitrate is the only water quality parameter, but we have dissolved oxygen, pH, water temperature, turbidity.

Lewitus: And how do you calibrate the nitrate system?

Demcheck: It depends on the instrumentation you buy. The system that we are using has an internal standard of 1.0 milligrams per liter, and it calibrates itself against that internal standard every 12 hours. We also take environmental samples and use lab analyses of the nitrate bags to see if there is any degradation in the bags during the deployment time. So, basically it self-calibrates. It is really remarkable when it works.

Sabins: In that regard, Nancy are we going to be able to maintain the station you had at Cocodrie?

Rabalais: It is at Audubon

Sabins: Audubon Park

Rabalais: I was just going to ask Dennis about that, because Rodney Powells had a nitrate meter out at Autoban Park, and I do not know whether you know when it works. But if it does work, have you all compared data for overlapping time periods to see if your real time data supports the fact that there is not much change in nitrate levels from up river to down river? I know it only covers the portion from Baton Rouge to New Orleans, but still have you all done that?

Demcheck: We hope to. Our Baton Rouge nitrate monitor went in yesterday.

Rabalais: OK. All right.

Demcheck: We have not had a lot to compare to in the Lake Pontchartrain system. The main result of our Lake Pontchartrain nitrate monitor is basically putting numbers on what we already know. That most of the nitrate going into Lake Pontchartrain occurs in very short intervals, event related. But we are putting numbers onto theory. But yes, once we have the Baton Rouge monitor operational, then that is going to open a lot of areas of inquiry. And, yes, we are aware of Dr. Powells' site.

Rabalais: Do you have anything? Go ahead.

Lewitus: Urea—is anybody measuring it? Are there plans to measure it?

Demcheck: We do not.

Lewitus: Because it is an important part of fertilizer application. I guess Gene was talking about the increase in use. Do you think that would be a good thing to include?

Sabins: Are you talking about what might be discharged by industries on the river?

Lewitus: Well, I am talking about getting a handle on long term trends.

Sabins: OK. I know we have never monitored for urea per se in the river. We do have ammonia, TKN, and nitrate-nitrite, so that is all we have to go with.

Lewitus: It is just a fairly new concern. That is, a realization that urea might be an important part of the whole nitrogen pool coming in from fertilizer and also stimulating phytoplankton growth.

Sabins: Well, yes, the nutrient cycle is very complex, and this is probably a good point.

Lewitus: Dennis, on your nutrient-adjusted trend analysis, from your previous talk, can I ask you to give us a tour of your application of that for all the nutrients we are talking about here, in terms of what kind of trends you are finding in the lower basin system?

Demcheck: Well, Richard Rebich and I are just looking at that now. The data analyses and the trend analyses are just now coming back in the last month or so. So I don't yet have anything to report other than the usual. Once we do a flow adjusted vs. unadjusted analysis, I expect there will be kind of a head scratching moment when the arrows (trends) come out both up and down. A major use of this report is really going to be the opportunity to look at the conflicting up and down arrows and do some head scratching and try to figure out why the results looks one way when we were expecting them to look different. Most of the trends are showing up to be very small. The upward trends are small, the downward trends are small, and most show no trend.

Lewitus: Do you see differences, and maybe this is too complicated a layer to put in there, but are you seeing the same kinds of differences when you compare site to site or station to station?

Demcheck: Well, we hope that will be a product for a follow up report.

Rabalais: I have one question from the prior session, too. Is that ok? For Dennis.

Demcheck: OK.

Rabalais: Since you didn't understand my writing, or you could not even read my written question, I apologize. The question is, according to your map your Mississippi River basin areas are different from the ones that Goolsby had. In other words, you had four major basin areas, and he had six or maybe even nine, and in the river basin, five had streams, particularly many in Texas, that don't even drain into the Mississippi River. I was wondering how you were going to compare the trends analysis among these different geographic areas. How are you going to be able to compare what Goolsby did with what you are doing now?

Demcheck: Oh, I see. It is going to be hard. I do not have an easy answer. Comparisons have been a perennial problem. The question is, where do you draw basin boundaries and how do you compare results to another report. I don't really have a pat answer for you. I think it is going to be hard.

Cliff Snyder: Doug, I had a point of clarification on the urea comment/question from Alan. I am Cliff Snyder with the Potash and Phosphate Institute. Urea is increasing in use relative to anhydrous ammonia as a nitrogen source in the United States and Mississippi Basin; however, urea hydrolyzes very rapidly when it makes contact with the soil, and converts readily to ammonium form. As a consequence, it is subject to the same transformation processes as any other ammoniacial form. So it is conceivable that a very, very small fraction of the nitrogen making its way to the water courses could be in the actual urea form, because that transformation is very rapid in the soil system.

Lewitus: I think some work from Pat Glibbard[3] might argue against that. in terms of how much urea actually enters into the estuary. Maybe that is a more local source than we are talking about here.

Snyder: I am thinking more in terms of fertilizer sources, than perhaps urea from urine from human waste. There may be a difference of transportability by virtue of the processes that occur before it makes its way to the water courses.

Doug Daigle: OK, in the time we have left, I am going to try to get through as many questions that were handed in as I can. The first one is for Dennis. You mentioned a lack

[3] Please verify name.

of monitoring stations in the lower Mississippi basin. Were you referring to USGS stations only, or including other states?

Demcheck: USGS only.

Daigle: It seems that Dr. Turner's interpretation differs from Louisiana DEQ for St. Francisville to Morgan City for total nitrogen reduction from inlet to outlet in the Atchafalaya basin; does Dugan Sabins have an explanation?

Sabins: Well, I think that is really not a conflict. I think Gene was saying that once the concentrations are set after the Red River mixes with the Atchafalaya, that from that point to Morgan City there is virtually no change. I think I said the same thing. What I was saying is that there is a difference between the concentrations in the river[4] and the concentrations in the Atchafalaya once the Red River has mixed with it. I do not think we are in conflict there.

Daigle: The next question is, how much monitoring is being done in the lower end Mississippi basin by other states for nutrients?

Demcheck: I think I said that we have been working with Arkansas, Mississippi, Tennessee, Kentucky and even the state of Missouri, and there is very little monitoring that those states are doing or have done.

Daigle: This question is directed to Dennis. The slides showed 51% of the nitrogen coming from the upper Mississippi. This is very different from the Goolsby report. Where did the data come from? Could you touch on the differences?

Demcheck: That pie graphic did come from the Goolsby report. I am trying to remember; it has been a while since I looked at that aspect of it. But basically the majority of the nitrate comes from the upper Mississippi, whereas the majority of the river discharge comes from the Ohio River confluence, so there is a disproportionate amount of nitrate coming from the upper Mississippi River compared to its discharge. What we are talking about is the corn-belt region. Basically, putting it in a nutshell, most of the water comes from the Ohio, and most of the nitrate comes from the upper Mississippi. That was from the Goolsby report; there is what we called the Mid-Continent Study, which basically produced a lot of data in 1991 and 1992.

Daigle: Where in Baton Rouge will the online nitrogen analyzer be located?

Demcheck: It will be right there at the casino dock. It looks is like a big paper clip. Basically, downtown Baton Rouge.

Daigle: They ask if the data will be available to the public on a real-time basis.

[4] Speaker did not mention which river.

Demcheck: Yes, it will.

Daigle: Dugan, would it not be more effective to establish nutrient water quality criteria in the near-shore waters of Louisiana that would be protective of the state's waters as well as provide a target for up-river nutrient reductions that would reduce the extent and duration of the hypoxic zone?

Sabins: If we could do it. That is an extremely complex task, needless to say. I think the way I usually discuss this is to say that we're dealing with a very complex system. As a matter of fact there is a meeting today at noon, and some folks are probably over there now, on "America's Wetland". The whole area down there is so complex, it is changing as we speak. Marshes are disappearing, barrier islands are disappearing. We have a three mile limit to try to delineate all that, survey all that, and to come up with some kind of limit is a long term effort. We are committed to looking at it, because that is part of the mix. We are working with the other Gulf States, who also need to do it for their coastal waters, and we are also working with "America's Wetland" and the coastal restoration programs to see what is going to transpire when we divert the river and experience the resulting nutrient flux associated with that diversion. It is something we are interested in, and we are going to be working on, but that is a very long range and a very complex problem to tackle.

Daigle: I think we have time for one final question. The assumption in monitoring rivers is that the water is well mixed. Does this hold for the lower Mississippi for both dissolved and particulate forms, or is it flow-dependent?

Demcheck: Well, that is a complex question. The river is not well mixed if you talk about sediment. There is a difference top to bottom if you talk about any constituent that is attached to sediment. There is a lot of turbulence in the water, a lot of dissolved oxygen, so the river is fairly well mixed as far as dissolved constituents. There is very little difference in dissolved constituents left to right or up and down. For something that is related to sediment there is a difference.

Daigle: Thank you very much. I appreciate all the questions and the interest in this session. Thanks again to our speakers and the question panel.

End of Session

Transcript of Panelists' Discussion and Q & A and Audience Q & A
Session 3: Municipal and Point Sources

Peter Tennant: I want to echo something Dugan said earlier about the efforts of the municipal folks especially. That's really a story we're not really hearing up basin. I just want to express my admiration for getting the facilities back online. I think its something we can't give enough recognition to. One of the impacts is the displacement of people. I understand that Baton Rogue is now the largest city in Louisiana and with all these additional people, how is that affecting your waste flows, your ability to treat sewage? Is it really noticeable in your operations that there are more people contributing?

Jorge Ferrer: In the beginning the only impact was the traffic. We were doing great, but it slowed down and I haven't heard complaints at the treatment plants, on the extra gallons a day. Neither with solid waste collection.

Dugan Sabins: I think a lot of the credit is due. We have three treatment plants that are well managed and they were in good working order. We were able to slowly maintain treatment even with the increasing use with the landfills. Jorge got a special award for all the work he did on increasing capability in the landfill. A lot of it was due to good management.

Larry Beran: I would like to focus on hurricane impacts just a little bit and probably go to Sarah with the first question and that is, with the first meeting you had after the hurricane and obviously the focus being on responding to the hurricane. Was there something that came to mind in you that said, "Boy, I sure wished I had finished this before the hurricane?" Something in the way of addressing the nutrient issue?

Sarah Mack: As far as nutrient issues before the storm? That hasn't been a huge issue of ours as of yet. I think even our contractors that were looking at the plant expansion? They weren't even addressing nutrient treatment even though in our permit it said that we would implement TMDLs by 2010. I know industries have already implemented them. So I think it was something we probably would have addressed in the future but we hadn't gotten there yet. We were still really trying to come into compliance with consent decree issues.

Beran: So just a quick follow up then; has the hurricane altered that thinking at all?

Mack: Absolutely. I don't know how to exactly say it lightly but we are still in a very, very critical restoration need. I think that you can't really understand what kind of a state our system is in because you can't see it. We lost our entire fleet. We had 1400 employees before the storm. Immediately after the storm we had 300 and no equipment. We had 80% of our staff lose their houses or their homes. So we are still in an urgent restoration need and that's what's coming to come into play. As far as trying to deal with the consent decree, we are not even at that point yet. We are still addressing damages in

many areas. We don't even have our collection system in New Orleans at all. Until you can pump out, you can't address those damages.

Tennant: Kind of a techie based question, but in discussing nutrients and BMP's and such upriver, there is a lot of concern about the reassessment and what it's going to tell us about response routes and the sense that the BMP's that you select are critical to which nutrients? Something that will work for phosphorus might not work for nitrogen. How does that play out with foreign sources? How does it affect your planning as far as your facilities whether you are looking to reduce nitrogen or phosphorus or both?

Ferrer: On nutrients, on the treatment plants, we really don't have enough data. We only get it sometimes, and it depends on the amount of rain we get from infiltration or inflow in the treatment system but it's not enough. I guess last year or even, since we started. I don't have enough data.

Mack: I didn't go into too many details because I think a lot of this will be addressed tomorrow in the nutrient and wetland session, but usually nitrogen is the limiting factor for wetland assimilation of wastewater. Sometimes phosphorous depending on the season but usually it's nitrogen. And in most systems, it's about 80-90% assimilation capacity and you can optimize that. And so, that's why I think it's important to use it as a model so that there are both economic and environmental incentives for municipalities. We are so limited by economics so we have to consider some of these innovative processes. And if enough municipalities look at wetland assimilation for tertiary treatment, it can have a direct effect on (nutrient removal).

Tennant: There are so many benefits to the wetlands approach, why *wouldn't* somebody consider the approach? Is it the absence of available land for the system? I can't think of any other reason why it wouldn't be in the prime consideration for advanced treatment.

Beran: Richard, can you expand on the Exxon perspective, and the oil and gas industry? During lunch I slipped over to another conference going on. There British Petroleum had a month ago partnered with "Americas Wetlands" on a coastal restoration effort. One of the comments after the meeting was that there was nothing mentioned about the environment. It was about the restoration of the coast and using sediments to rebuild, so it was great to see interest in the environment in your presentation. My question to you would be to you is how transferable are the efforts that you have underway not only to the oil and gas industry but other industries that in the aggregate may make much more of a difference than depicted as just being 1/10 or 1%?

Richard Cotton: First of all, every refinery operates probably a slightly different treatment plant. There are many that are probably just like this and benefits from this understanding. Our large century refinery in Beaumont has a lagoon system treatment, where they naturally denitrify, so there is not a lot of information and learning we can translate directly to them. On the other hand, our old Bay Way refinery in New Jersey, (I am not sure who owns it now), just got a call last week. They heard what we were doing and want to talk more with us. What we have done is very simple. It is just breaking the

mindset that has been prevalent in industry for 30 or 40 years and that is that a little bit of dissolved oxygen is good. The more the better. And so you just got to realize what you have to work with. We do not have a fine sense of how to control this system.

We basically have to send our operators out to shut down 100 hp motors and they might have to go out 30 minutes to an hour later and turn them back on. But if you develop a policy that you want to practice from a corporate or company perspective, you can get your people bought into it. That's what we have been able to do. That's why I like to share this presentation. Maybe somebody out there is listening and says, "Gee you know, we have been running with 3 and 4 parts per million dissolved oxygen for years. Why don't *we* try the same thing?" And you can do it, as I have demonstrated, without sacrificing permit compliance and that's a key thing. You don't want to shoot yourself in the foot when you try to do a good thing.

Tennant: What I think I heard you say, Richard, was about bringing waste from another facility to yours to help the way along, which has always been an area that has intrigued me. I believe about 15 or 20 years ago there was some legislation passed to try and set up an interstate organization on the lower Mississippi that would have a waste exchange central operating component, did I hear you right in that was the case?

Cotton: Yes you did. We have a Baton Rogue chemical plant next door to us and actually they have some units inside our refinery. They have one unit that produces waste water that is high in methanol which they pump up half a mile to another treatment plant for treatment. And we are going to take that waste water and feed it into our system, and process it through to our plant. You have to be careful with this because LDEQ and other environmental agencies are real careful about allowing you to get into the treatment business (because this water would itself be hazardous waste if you didn't have your own waste water treatment process to deal with it.) You have to be careful with the regulation but you can do it if you are careful.

Tennant: This drags me to Sarah's closing line about not waste the resources out of place.

Cotton: The other side of the coin is that water can sometimes be a solid, hazardous waste. But those are the rightful waste rules.

Tennant: We know about that upstream when we get snowed.

Beran: Jorge, you were speaking about public education and apparently there is quite a significant effort from your company perspective. Two things, and I think you maybe have addressed it, but I maybe wasn't listening right for it: how do you evaluate the effectiveness of your public education effort especially since it is such a sizeable part, and the second part of that would be, if the public is not receiving this education, what do you have to do to offset their inability to assist?

Ferrer: I want to make sure that we start comparing data this year to see the effects of our public education. I'm talking about the known point sources. That's why you see those charged 2004 and 2005. 2004 is my baseline data. That's one point. The other point being the concentration of the events we do. Rain events. Not just Nitrogen and Phosphorous but also suspended solids and TSS.

Beran: I guess the second part of that is if the trend does not improve as a result of the education, what you are prepared to do to keep the trend downward in the non-point source arena.

Ferrer: I never have considered that but if it reaches that point, we will have to intensify our public education and also some of the cleaning efforts like street sweeping and controlling sediments from construction sites running off during rain events. Construction is the main culprit.

Dugan Sabins (Reading Audience Questions): Have you considered operating the two aeration basins in series and making the front end of the first basin a dedicated anoxic zone?

Cotton: Yes and no. We have considered installing curtains in each of the basins so that we could create a separate anoxic zone. The problem we are dealing with is right now the driving force for making capital investments is not there. The real driving force for making improvements is reduced TRI (Toxic Release Inventory) and there is no driver, no regulatory driver forcing that investment. So it is hard to get our management excited over a four to five million dollar investment in this area when we think there is still a lot of improvement we can do by fine tuning our low DO operational mode. Good question. I've never been asked that question, but I know what you're talking about.

Sabins: When you decrease the nitrate emissions did your ammonia emissions increase?

Cotton: Not appreciably. If you look back, the ammonia emissions for 2005 were only 4% of what was allowed by the permit. Normally we have detection on the ammonia leaving the plant.

Sabins: I'll just add on (Richard was alluding to it in his earlier answer) that he has agreed and some of the other industries have agreed to work with us on sharing this treatment technology and I think I mention the BASF corporation gave the patent rights of their nitrogen reduction process to the Water Environment Research Federation. So I think we have a little team working together under the Task Force (with the EPA and the states) to educate other industries on this process. We will definitely take you up on that.

Sabins: The last serious questions, Sarah, are on Wetland Assimilation and I can help out with some of them. When you are proposing waste water into the St. Bernard Marshes, and we see only a positive effect on the marsh restoration, do we suspect any damage will result?

Mack: No. These treatment systems have been demonstrated throughout Louisiana and other places around the world and we haven't found any negative kind of effects from any of these. This simply leads to restoration of wetlands.

Sabins: And I think that more citizens of St. Bernard Parish certainly need to ask these questions and they need to get them answered. I think that some LDEQ staff are out here with me today, Gwen Berthelot, sitting out there smiling, she has personally been meeting with the St. Bernard Parish officials even with Parish president Junior Rodriguez to talk about this and to assure the citizens of St. Bernard that, none of us would be willing to pursue this if we thought there would be some serious harm to these valuable wetlands down there. And we realize that this is the front line and that was the point we were making of course. These marshes that separate the levees along the Mississippi River Gulf Outlet from the back protection levees of St. Bernard Parish and the Ninth Ward for that matter. The wetlands in between represent a vital buffer that could help sustain them in future storm surges. We hope that this very controlled and managed waste water assimilation project will have nothing but a positive effect and we will set up monitoring programs to ensure that that's the case. Some of the other questions I have here go along the same lines. One of them is talking about the ultimate goal of constructed wetlands. (Of course we're really not talking about constructed wetlands in this sense.) But the commenter asked whether the constructed wetlands are concerned with nitrogen removal or whether the reduction would create an environment where de-nitrification capacity is maximized. Is that the goal of our project? And I think the answer is definitely yes.

Mack: Yes, and instead of using constructed wetlands, it's natural wetland assimilation. So the wetlands do it on their own in a low oxygen environment which facilitates the de-nitrification process.

Sabins: And what we have done (Dr. John Day is the one who has provided a lot of the scientific background to understanding this) is we are very careful to take the MGD flow of the facility, knowing exactly what's in the waste water, and we use modeling calculations to match that MGD flow with the size of the wetland that would be necessary. So that we are certain the assimilative capacity will be appropriate and that all the nitrogen, most of the nitrogen and phosphorus will be utilized and not exported into another system. Every time I talk to John about this, he reminds me there is 20 years of experience out here on cities such as Thibodaux and Breaux Bridge, Amelia. Even a small St. Bernard experiment back before the storm showed us that we have a system that works if we pay attention to detail, and we intend to do that. The other question here is, "do any estimates exist as to how much nitrogen and phosphorus will be removed on the project?"

Mack: I know we are supposed to stop, but its 80-90%.

Sabins: I have 2:45 right up. Plus we were a little late starting. Well there is one last here to give everybody their due. Is the wetland assimilation proposal intended to use wetlands to remove nutrients only or other pollutants as well?

Mack: There is data that wetlands can be used to remove metals. In situations wetland assimilation also displaces the salt water intrusion and protects on that level and adds sediment to counter subsidence along with the nutrients to help them grow.

End of Session

Transcript of Panelists' Discussion and Q & A and Audience Q & A

Session 4: Tributary Watersheds

Richard Ingram: My first question is for Richard Coupe. Richard, what additional research do you think is needed to accurately quantify nutrient loads and identify sources in the Yazoo Basin?

Richard Coupe: Well, sources would be more difficult to do, because we only have the one cycle reflecting continuous data as well as discharge. If you were trying to figure out whether you had a split between the delta portion, the agricultural portion of the basin, and the uphill part, you would have to have your sites located where you could differentiate where it was coming from. You would have to have sites further up in the basin. Currently there are not any. There are very few gaging stations in the delta portion. Of course we have the reservoir where the water is controlled, so that would be easy to do.

Ingram: In your abstract you mentioned that you were going to be looking at some ancillary data. Have you had a chance to look at that?

Coupe: Yes, we are going to do that. I actually had that in my notes to look at that; kind of a follow up on a question that was asked of Dennis Demcheck this morning. He was filling in for Richard Rebich, who works with me and who is actually writing the report. The trends work that we are doing is actually a national effort. Databases—such as Best Management Practices (BMPs and how much they have been used), all kinds of agriculture data, the NPDES permits—all that is being aggregated into a national database and is going to be available, well, is now available, as a GIS coverage. So the idea behind these trends reports is that we are not just going to put out a report that gives a trend, and actually we were told we were not to do that. If we have a trend, we need to be able to explain where that trend came from. So, once we have identified a trend in concentration, or flow-adjusted concentration, then we will go back to the ancillary variables and see if we can figure out what might be causing the trend or give some explanation for it. For example, in some of the preliminary data for the Yazoo River basin, if you are talking about the trends of phosphorus, I could see no indication as to why there would be, at this point, an increase in concentration of total phosphorus, so that is something that needs to be looked at further.

Ingram: I'll just follow up. Our (Mississippi's) nutrient reduction showcase project, that is sponsored by the Lower Mississippi River Sub-basin Committee, is at Lake Washington. One thing that we found while we were collecting our data for our nutrient [criteria] development, was that some of the large ox-bows in the delta portion have very high chlorophyll concentrations. As a matter of fact, Lake Washington, I think, was right at 60 milligrams per liter (mg/L), So far, the average that we have seen at some of the

other large lakes is around 12 mg/L. Would you care to give us your thoughts on why we are seeing such large concentrations?

Coupe: You know, I was drifting somewhere else; I'm sorry! Are you talking about chlorophyll in the lakes, and why we see such high concentrations? I have not done a lot of work on the lakes in the delta. I think it has to do [with flow]; you see a little bit of that in the streams when they go down to low flow and the sediment kind of drops out a little bit. When that happens, the light penetration increases and so you do get a bump up in the chlorophyll rate. I think that is probably part of what is causing that in the lakes. All the waters in the delta are very heavily sediment laden, but if you slow them down you will actually get some of the sediment to settle out, and your light penetration should increase.

Ingram: You know another thing that was interesting, that I thought you did a really good job pointing out, was [about] the phosphorus levels. There has been talk about the high phosphorus soils that we have in that area.

Ken Brazil: This [question] will be to both the speakers. In general one of the things that we are beginning to see, not in the delta per say, but in the northwest part of Arkansas, is that as the population growth occurs and there are changes in the landscape, including changes in stream morphology, over time, that the streams tend to incise and also the hydrograph has changed with the changing land use and landscape, and that 7Q10s may actually in the long term be decreasing. I am wondering whether any of your research looking at the combined effect of non-point BMPs with point source discharging on loadings to the stream, or in particular Dr. Moore's work on modeling future growth in the Loosahatchie River basin, has shown whether the stream would be able to assimilate the increased waste load flow resulting from the population growth and development? I am wondering whether you saw any trends? You actually reported that you saw the 7Q10 higher than the state had reported. So, has any of your work shown whether any non-point treatments, and maybe land restoration efforts or wetlands-type retention areas, would help moderate and restore 7Q10s and the hydrographs to historical patterns?

Larry Moore: Well, in terms of point source impacts on the Loosahatchie, again we looked at low flow conditions. Considering the facts that I mentioned, they are increasing their level of treatment, even though we are going to increase the flow rates over the next 20 years by about seven times. We are trying to maintain at least the point source loads about where they are now. Again, the non-point loads are a major portion of the total nutrient loads to the river. In the Loosahatchie watershed, I know there are some conservation tillage [practices] going on as well as some BMP implementation. But I think there is a ways to go yet, especially when you look at the numbers coming off of Beaver Creek. I cannot really address this. Again, I will tell you what happened in our scenario; the state had used so many years of data of hydraulic information on the Loosahatchie to develop their 7Q10, and the USGS went back and looked at a much longer data set, and that is why they came up with such different 7Q10s. I do not know if I have answered your question of not.

Brazil: Yes, and then this was to kind of lead into—has there been any discussion in your area about nutrient trading, if you will, between point sources and non-point treatments?

Moore: A little bit of discussion about that. Of course, we are still waiting on the state to do the TMDL on the Loosahatchie River that has not yet been completed. Again, these municipalities have ammonia limits, but we are anticipating that once the TMDLs are done that there will be total nitrogen limits and total phosphorus limits. When that is done, the opportunity for trading between point and non-point sources should be enhanced. Basically, if the POTWs can maybe pay for the implementation of some BMPs on some of these agricultural lands and be allowed to discharge a little more nutrients to the stream, it makes a lot of sense.

Ingram: Dr. Larry, can you tell me, what was the basis of the original impairment listing?

Moore: OK. Yes, I really did not get into that. The lower Loosahatchie is very well impaired in terms of water quality for aquatic life, for about the last fifteen miles of the river before it flows into the Mississippi River. The main reasons for the impairments are some chlorinated organic compounds that have been measured in fish tissue, primarily chlordane and dioxins, and also in the sediment. You cannot measure it in the water column. Other problems are siltation, pathogens, and then habitat alterations—I did not point this out either, but the Loosahatchie has been channelized throughout most of its length.

Ingram: I though it was interesting that the wastewater treatment facilities appeared to be all within their permit limits. Is that right? And I think seven of eight of those were lagoon systems. What we found in the Yazoo River basin, especially in the delta, is that a number of those municipal facilities, who all in the 1990s went to the mechanical activated sludge systems have had a lot of trouble since then staying in compliance. It was interesting to me how well the lagoon systems were working. That is one of our challenges in Mississippi, working with those systems to help them get the resources they need to comply with their permit requirements.

Coupe: My comment on that is that lagoon systems are great for small towns. They are low maintenance, they are mechanically simple, and they are consistently good in the amount of removal that they get. It is just that normally we are talking about 75%, 85%, maybe 90% removal of BOD and suspended solids, and a well operated mechanical plant will get, should get, about 95% BOD and suspended solid removal. But many of these small towns do not have the operational expertise. If an activated sludge plant goes bad, your effluent quality can deteriorate really quickly, so lagoons are ideal for small towns. Unfortunately for these small towns, the state is coming in and saying that as much as the towns are growing, lagoons are no longer usable and they are going to have to go to the mechanical plants.

Doug Daigle: Are there any questions from the floor? We have not gotten any written questions, but we can take questions from the floor if there are any. Following up on the nutrient trading question, I also wondered whether anyone has considered whether there is potential for trading in your watershed, or whether there is potential for trading in Memphis, which is a huge source comparatively speaking for municipalities.

Coupe: Right, and for those of you who are not familiar with the treatment situation in Memphis, we actually discharged raw to the Mississippi River until 1975. That is when we put in our first treatment plants, but now we have two large activated sludge plants. Normally the minimum requirements for a plant that size are 30 mg/L BOD and 30 mg/L suspended solids (SS) monthly average. But about twenty years ago the city of Memphis went to EPA Region 4 and said, "since we have a very high strength waste coming in and we are discharging into the Mississippi River, we would like a variance." So the monthly average limits for BOD and suspended solids for the two Memphis plants are about 40 mg/L. There is no limit on nitrogen, no limit on phosphorus, and no limit on fecal coliform, so neither of our plants disinfect right now, but I think that is about to change.

Daigle: OK. Are there any questions from the audience?

William Dean: This question is for the gentleman from the University of Memphis. I understand that the non-point source loads were not accounted for in the model analysis. Does the existing data provide sufficient confidence that the proposed increase in the point source DO limits will not result in DO levels below the water quality standard?

Coupe: OK, yes, again, the critical time for the point source dischargers is at low flow. When we have storm events, what we have seen, even though the BOD is fairly high in storm events, is that water is moving so fast and there is so much turbulence and reaeration going on, that the DOs tend to stay fairly high. So the critical period for the point source discharges is during the low stream flows, low velocities, when the reaeration rates are lower. Under those conditions which are not impacted to a great extent by the non-point sources, obviously, and low flow periods of July, August and September, water quality is still going to be reasonable good. Now again, the limits we saw of the 25 mg/L BOD, 5 mg/L ammonia, 5 mg/L DO—if they discharge those levels, then the total amount of nutrients going to the Mississippi River is going to increase, because, again, the flows are going up by a factor of seven over the next twenty years. But again, under low flow conditions we still should be able to maintain dissolved oxygen at our goal of a minimum of 5.5 mg/L. And from our little bit of storm water sampling that we have done, again, we are getting higher nutrients, higher BOD concentrations, and very high DO. But then downstream at some of our stations on the Loosahatchie, after the storm event occurred there were some fairly significant drops in DO because of the levels of organics that had been deposited by that past storm event.

Dean: OK. If you do not mind, I have one more question. I understand that you used the QUAL2K model instead of the modified Streeter-Phelps model, and I know that the key here is having sufficient field data. It looks like the input parameters and output parameters were sufficient for using either model. I was wondering if you could

elaborate a little bit on why you still chose to use the QUAL2K model, and whether you would likely see any different results if you used the Streeter-Phelps model.

Coupe: Well, basically at the time we did the study, the state and EPA wanted us to use QUAL2K because they felt it was a much more sophisticated and proven model. And again, as you saw, we measured reaeration rates, we measured water quality, and we measured time of travel, so we had some good data from the river from our study. So again the state and EPA wanted us to use QUAL2K, and we did use it. Then later the state said "well, we just want to go back and double check to make sure that the numbers that you came up with are OK." So they went back and used our good field data and used their own Streeter-Phelps model and basically verified that the numbers that we had come up with were valid. The EPA was satisfied with that. The EPA scrutinized our QUAL2K run stream very carefully; I had to send our run stream to them. All our constants and coefficients that we used for modeling were reviewed thoroughly by EPA, and EPA came back and said it looks like what we did was OK.

Dean: Thank you.

Coupe: Thank you; any other questions?

Unknown speaker: Could you comment about what is the major impact factor impacting the differences between the BOD_5 and the BOD_{ult} (ultimate)? There are many people running water quality parameters, and mostly they run the BOD_5.

Coupe: I am not sure if I understand the question, would you repeat it please?

Unknown speaker: What I am trying to say is that there are a lot of laboratories, and for the water quality monitoring they only monitor BOD_5. In comparison, you are also doing the ultimate BOD, 120 days or 60 days or whatever you are doing. I was just wondering what is the major impact factor that is impacting the differences between the BOD_{ult} and the BOD_5? Is that the quality of carbon or nutrients or something else?

Coupe: OK, now I understand; I appreciate the question. Yes, what we found was that the ratio of the BOD_{ult} to BOD_5 was about 5:10. If you calculate your BOD decay rates, they were only 0.02 to 0.04 $days^{-1}$. So my answer to that question is that the organics in the stream that are being degraded are background organics in the stream that are very slowly biodegradable. Then when you consider what comes out of the effluent of the municipal wastewater treatment plant, the easily-degradable stuff has already been removed. So, what is in the effluent is more difficult to degrade. So the more difficult-to-degrade organics from the effluent and the background organics in the stream that are relatively slowly bio-degradable, I think explain that phenomenon.

Daigle: OK. If there aren't any more questions our schedule calls for us to move directly into our final session, which will be two papers on Ag management.

End of Session

Transcript of Panelists' Discussion and Q & A and Audience Q & A

Session 5: Agricultural Management and Practices in Lower Mississippi River Basin Watersheds I

Doug Daigle: Dr. John Westra is with the LSU Agricultural Center and is also an active member of the Louisiana Hypoxia Working Group, which meets every month in Baton Rogue. And Michael Sullivan is with the Natural Resources Conservation Service with the USDA and is in charge of the Mississippi River Basin.

Mike Sullivan: Dr. Girouard, first I just wanted to say I really appreciate you taking your time to come spend with us today. It's nice to have a producer here today to share with us. Could you give a little bit more information on your micro-watershed project as far as where you are in the process? Have you identified the key problems that need to be addressed?

Ernest Girouard: Thank you for the question. We have proceeded to the point where we have a draft plan for our watershed. It's been circulated among all the cooperating agencies. We received comments back and we're in the process of compiling all those comments and putting them together. Just to go a little bit further on how we are operating this watershed, everything goes through our conservation district. Our board OK's everything before anything is done. The only thing we have not done that is coming down the pike very shortly is a memorandum of agreement with our conservation district and all the agencies involved.

LSU, for instance, is in charge of the Master Farmer program. Through that Master Farmer program they've been able to obtain some monitoring equipment. They have provided 5 monitors to our project free of charge. We have them in house and all we have to do is install them. The University of Louisiana (Lafayette) has done some water quality monitoring in our conservation district, and just completed a 319 grant study using some of the same parameters we're going to be looking at. They have written a 319 proposal to do the monitoring in our watershed using the LSU monitors.

[Louisiana] DEQ is providing expert advice along with NRCS as to what we need to do to demonstrate that these conservation practices are improving our water quality. They have been with us from day one. We have an excellent working relationship with DEQ. In fact, in our conservation district in the last 16 months, we have been able to obtain two 319 grants, totaling approximately 1.2 million dollars, and we have spent all that money in a hurricane ravaged area in about 16 months. And that's federal dollars. Our producers and land owners have matched those federal dollars one for one, so we've done a heck of a lot of conservation work in our district along with the NRCS program money that comes to our district, which is about $370,000 a year.

Hopefully we will have another 319 grant that's going to be approved shortly, in which LSU has applied to work with the center on micro-watershed for outreach efforts. This

will be an effort to educate all the producers, home owners, and businesses in our conservation district about all the practices available to us. NRCS is one of our partners. We sign a cooperative agreement with them every year. This provides secretarial help, program assistance, and a technician in the office. We share the office with them and they are our partners. We work very, very closely with them. They have helped us through the years and they are right there with us in writing up the proposal for this micro-watershed.

We hope to have the project well on its way with the monitoring in a little over 2 years. We're going to use the first year as a base monitoring effort, and our plans are to run this project 5 to 10 years. So we'll have some really good results that we can rely on.

Sullivan: If I can just follow up. Larry, do you see this micro-watershed process as something that can be replicated in other small watersheds and eventually help reduce nutrient loading in some of the lower basin and beyond?

Larry Beran: Right, that's what we're planning on, and I'll just discuss one instance where we've done this. The Arkansas Farm Bureau, you've heard a little bit about this. You've seen on the maps where there are plenty of nutrients up in northwest Arkansas sitting on the Illinois River (where there's a scenic river and a scenic highway over on the Oklahoma side). Dr. Girouard and I addressed the Environmental Committee of the Arkansas Farm Bureau a while back, and they were very eager to learn from the micro-watershed project in Louisiana. We're going to be getting something underway there soon—same thing in Kansas. We're going to be getting a micro-watershed project underway there because what you're going to find is geographic differences. Here in Louisiana we're dealing with rice and crawfish, but in Kansas it's pork, and somewhere else it might be poultry. So we're going to be trying to get the diversity in the early project with the expectation of being able to aggregate.

Sullivan: One thing that's always difficult is deciding which watershed to work on. And I appreciate the description of the four watersheds they looked at within the SWCD. But from what you've seen, Larry, (like from some of the information that Jerry provided showing the red dots and some of the discussion earlier with the EPA looking at the hundreds of watersheds), could you see using that kind of information with local leadership types to come up with areas to work? How would you go about deciding the watersheds to work in?

Beran: I talked earlier about how it's difficult to have a community feel when you get too large. So when you take on something the size of the Mississippi River Basin, it makes it very difficult to have a sense of community. But the more you can bring the data together, (for instance it was encouraging to see what Jerry and them were doing), and at the same time understand what Daryl was talking about earlier today on their efforts. But these efforts standing alone and being used independent of one another would continue to weaken our efforts. So from the producer's standpoint, I would encourage these data sets be brought together as much as possible to unify and communicate that data.

John Westra: I'm wondering if I can follow up with a question for both Ernest and Larry, and maybe you can ask for answers specifically for your micro-watershed, Ernest. What kinds of activities have you guys participated in get the producers actively involved in this process so that they're aware of what you're doing and that they have buy-in? Especially when, for example, you're monitoring, you find hot spots, and those are going to probably be associated with specific producers or specific parts of their farm. How you anticipate their response to that?

Girouard: We have some real progressive producers. Quite a few years ago there was a trend to go to no-till planting of crops. And what we did in our conservation district was buy a no-till drill from locally raised money, and leased that drill out to anyone of the cooperators who wanted to use it at a charge of $5 an acre. It took us 3 years to pay for the drill and the drill is still in excellent shape, so we are really happy with that investment. Irrigation water leveling is a practice that's done in our area. And what that is, is to land grade the rice paddies within the levees, straighten out a levy, or remove some levees, but it's a practice that is specific for rice farmers. To be able to do that, the producers need to have the land grading equipment. But before they can do any work, they need to have the land surveyed and an estimate made of how many cubic yards they have to move it. Plus, most of the time you have 3 or 4 different options as to what's the most efficient way to do it.

We invested $24,000 in some surveying equipment with money we raised locally. This is all money we were able to raise through our district. We provide that surveying service to our producers at no charge. We now have 2 of those systems in our district on two vehicles and we have the capability of putting that equipment on a 4-wheeler, which we also own (we purchased that with local funds). We can't keep up with the work. This is saving the water quality. Water quantity and water quality are making efficient use of what's available to the farmers. It reduces the labor and irrigation of their land. The yields have gone up. Word has spread of opportunities for cost sharing available to our operators and right now it's a steady stream of operators coming into our district. We don't even have to advertise. They're already knocking on the door asking for help.

Westra: If I can follow up on that…from the farmer's perspective, in addition to having successful BMPs, in terms of saving them money or increasing their yields, are there any other factors you have seen in your watershed or as a producer that are going to encourage producers to use BMPs if they're not using them currently?

Girouard: Peer pressure is one of the biggest things. One farmer sees another one doing something and sees the beautiful crops growing weed-free and sees less water used. The peer pressure is great. That's one thing. Another thing is that we have a lot of ongoing educational programs through the Master Farmer Program and continuing education. The Master Farmer Program has an environmental segment with 8 classroom hours where they have to learn all about the Clean Water Act, how it's being implemented, how it affects the producer, and how the producer can do things to improve water quality. Then they have to pass a test.

Also, the producers in our district have the opportunity to have rapid diagnosis of diseases. Most of our producers have digital cameras. We take those digital cameras in the field with us. If we have a disease we can't diagnose, we take a digital picture, bring it to the computer at the house, send it to the agricultural experiment station at the county agents office, and within minutes we have a diagnosis and a recommendation. We can do the same thing with insects and just about anything you can name. So now we have very, very rapid diagnosis of a problem with a recommendation by a certified technician, so we're not guessing.

Another thing that we have available to us right now are these GPS handheld units, where we can measure acreage and draw straight lines. Our farming operation is like a lot of others in my area—where we'll take samples every 2 ½ to 5 acres, and then we will apply the fertilizer according to what's needed in the small 2 ½ to 5 acres, rather than applying it uniformly across a field. Our culture has changed, and the producers are adapting to changes.

There's one other thing I neglected to mention about our micro-watershed. One of the first things we wanted to do was have a public meeting of the individuals in the watershed. We sent out a letter to every home owner and every producer in that watershed, and we had a public meeting. And there were over 40 producers and home owners who attended the meeting and expressed a desire to participate in our micro-watershed. That was important to us because we didn't want to develop an entire plan on our watershed without allowing them to have some input. We showed them our concerns and what we wanted to do, and then they had the opportunity to voice some concerns and have some questions answered. And now we're going to have a micro-watershed steering committee. And that committee is going to help us determine what direction that watershed is going to take in solving the water quality problems in the watershed.

Sullivan: I've got a couple of questions for Jerry: You mentioned that the development of the nutrient management plant was voluntary. How fast are we going? Is there some point at which within the basin there will be nutrient management plans on all of the crop plans or on some large percentage?

Jerry Lemunyon: Well Mike, again, it's a plan, right? At one time or another we've all made resolutions. So we continue to change our resolutions like producers continue to change their planning. I think at some point all farmers will have a plan of their operations, whether we formally document it, as we do in the USDA, as a plan. But certainly farmers, as Ernest said, know their material, they know what they're doing and they will have a plan. I think our livestock operations will come forward first, simply because there's more pressure on the livestock producers to get their nutrients in order and they have more pressure of applying nutrients. You know, eventually, we're all going to be 165 pounds.

Sullivan: Well, one of these days when we all have those plans and they are implemented, how much cleaner will the water be in the watersheds and the Mississippi River?

Lemunyon: Yeah! That's a good question [laughs]. That's one of the efforts that we've now invested some money in—this Conservation Effects Assessment Program, CEAP. We want to know not only how many plans are written or how many acres of land we've leveled, but actually what did the impact of that land leveling, nutrient planning, and conservation tillage have on the water supply? I think we heard this morning we're having a tough enough time in this country monitoring the main stems of our streams. So monitoring each individual farm field is out of the question. But we will do enough modeling with verification by monitoring that we're going to get a grasp on this. And I think this is the effort of CEAP. CEAP wants to do this modeling effort and then try to validate that with some, (as Ernest is doing), on-farm monitoring.

Sullivan: One of the problems we're having with the current re-assessment process is that we don't have good measures of outcomes to look at. So we're going back and we're just looking at programmatic measures or practice measures. Do you see (with what we're doing with CEAP) that at some point we should have some better outcome measures that can be used based on a wide array of agriculture activities?

Lemunyon: Absolutely. You know, we've bragged for years about the number of acres that we've completed and the number of dollars that we've spent. Again, that doesn't show quantitative output. We have to turn that around, and I think that the computer model will process some of this stuff and show us the trends that are going to be available, and then again follow through with some monitoring. Very interesting data, this developing wetland habitat. It wasn't just that you develop the acre of habitat; it's that the CEAP project now wants to know how many frogs are out there bleeping in the night. So it's the frog that's really the impact out there, not the number of acres you put out in the wetland.

Westra: Can I ask another question related to that, Jerry? Being an economist, I have to ask a question about the cost of these conservation practices as they're implemented and then the benefits associated with that. Is that part of this process, and what kind of information are you going to be gathering from that?

Lemunyon: Almost definitely—that's the first question Congress asks every year. "For all the money we're giving you and the practice you're putting on, where are the benefits?" So the national CEAP project hopes to get at that. First, we have to find out how far it's implemented and how effective that practice is at solving a certain resource concern, whether it be nutrient or sediment losses. And then we can kind of back calculate how much it costs us to do that. And it's not going to be a national number, I don't believe. I think each site, possibly each minor watershed, is going to have their own cost benefits that they're going to develop. Doing some things in some parts of the county is very inexpensive, but sometimes it's very expensive to get that quality resource down.

Girouard: That's where monitoring comes into effect. You identify the hot spots, you treat those hot spots, and you don't treat the whole watershed. That way you can get the biggest bang for your buck and correct the problem. And we haven't been monitoring and that's why we have to get down to it. And we have to get down to the monitoring with no repercussions to the producer, and that's the one thing we tell all our producers that cooperate with us: it's voluntary. If you have a problem, we can help solve the problem before regulation, and if a problem is identified, we will not go in and report that problem and turn them in. They'll have the opportunity to correct whatever's wrong in their farming operation, and this will therefore eventually prevent additional rules and regulations and costly permits down the road.

Daigle: Okay, I think we have time for one question that we got from the audience. This one's for Larry Beran: I did not observe the consumer as a participant in your micro-watershed community. It seems to include only agency, university, and producers, but not consumer. Please comment.

Beran: Hmm, not a consumer. I guess a part of me would like to think that we're all consumers but, I'm just trying to think what that consumer is looking like. Is that person out here?

Lemunyon: Probably just someone who doesn't use water or soil or plants in their life. I don't know who that would be.

Beran: I guess I might bring up a consumer. A consumer called me last night. It was my son from Dallas, Texas, and he's one of my ultimate consumers. And he called to ask me if I was watching CNN, and did I know that Louisiana was disappearing at the rate of one football field every 38 minutes? I believe that was the way he phrased it. And I said, "Yeah, son. I'm down here in the midst of it." But what this consumer taught me, and what this question brings up, is that the question is right. We don't always have all the right people, all the necessary people at the table. We don't always communicate our stories to all the people or all the consumers. So I guess in answering that question, I would just close with this group as a whole. Every time I'm around a producer or go to a meeting I learn a lot. But unless that consumer is at the table, and that's why that was a very valid question, or is at least is aware of what Dr. Girouard is doing in the watershed, we will have fallen short of what it is we were trying to achieve. My son does not have *Soybean Digest* or *Dairy Herd* or some magazine like that on his coffee table, but yet somehow he as a consumer has to get that story.

End of Session

Transcript of Panelists' Discussion and Q & A and Audience Q & A

Session 6: Agricultural Management and Practices in Lower Mississippi River Basin Watersheds II

Martin Locke: Okay, Tim, I guess we will start with you. Your presentation seemed to be mostly about planned research rather than what you have already done. If you would like to defer some of these questions onto Jim Fouss or somebody else, that is okay. I am curious about the Cabin-Teele watershed; it is one of the focus watersheds for hypoxia. About how many farmers are involved in that watershed? Are the conservation practices voluntary? How is that all set up?

Timothy Appleboom: There are roughly fifteen major farmers and probably another fifteen small farms. The practices there are voluntary, and the farmers do what they want, but generally they follow the guidelines of the National Resources Conservation Service (NRCS) as far as best management practices.

Locke: So there is a good mix of "conservation," versus other practices?

Appleboom: Right.

Locke: In general, what kind of acceptance has there been in Louisiana to these kinds of practices that you propose evaluating?

Appleboom: As far as in Louisiana, I do not know. Jim may know that.

James Fouss: Can you repeat that question?

Locke: What kind of acceptance of conservation practices has there been in Louisiana by farmers?

Fouss: Well, probably the NRCS can address better than we can how accepted those practices are. In that project, we are looking at trying to get them to evaluate and adopt practices that integrate with what they are doing now, particularly in the areas of drainage water management and cover crops. The key thing is that they do get cost sharing on quite a few practices there, such as their tilling practices, according to the NRCS. We would hope the cost sharing also would be approved for implementing drainage management in those ditch systems, particularly during the winter season, the off cropping season.

Locke: Have you been looking at, or will you plan to look at, vegetation in ditches and how that might mitigate?

Fouss: Yes, particularly related to the in-stream processing of smaller ditches. We know that the smaller those channels, the more effective they are in terms of in-stream

processing of nitrate. But we will also look at the whole ecosystem. We are going to need additional people cooperating on those aspects of that project. We will probably be calling on Oxford for part of that.

Locke: You have been talking about doing some work with Annualized Agricultural Non-Point Source (AnnAGNPS) in this watershed. Is that something that is starting?

Fouss: Yes, that is really a two-prong project. The field part is to collect data to kind of calibrate AnnAGNPS, that is, not validate but to calibrate it, and we're looking at it from the standpoint of using AnnAGNPS to look at where best to apply different practices and what potential benefits could be achieved from applying those different practices. There is always a question in those kinds of watersheds, small watersheds, of where do you apply the practice first, so that it will have the most effect? It all comes from this bangs for bucks question. We do know from many of the projects, not our own research, but other projects, that if you are applying practices someplace that is generating less nitrogen into the main streams, that gets into the river systems, in the stream systems, if you place those practices some place where it dumps straight into the major streams versus applying the practices up channel somewhere where it dumps into smaller streams or so forth, but the ones that dump into the major streams have the biggest impact on reducing nitrogen down the stream. We do know from the experience of other projects, aside from our own research, that the biggest impact on reducing nitrogen impact downstream seems to occur when the practices are applied at a location where the nitrogen input is dumping directly into the main stream, rather than somewhere in the upstream tributary watersheds. If it dumps straight into the Mississippi River, it is very likely the nitrate dumped from that subwatershed will make it all the way to the Gulf. If it dumps into a subwatershed up in the basin someplace, and goes through all kinds of channels and small streams and rivers before it gets to the Mississippi River, its contribution to the hypoxia in the Gulf is probably not that significant. So where do you put the effort first? Closer to that big river.

Comment [j1]: Awkward; checked the audio tape to try to understand his meaning; the next sentence is an attempt to rewrite with the intended meaning.

This project on a small scale ought to demonstrate that. I think Tim made the point, too, that the effect of using wetland diversions in some of these streams through those smaller areas will be far greater than some of the wetlands diversions on the major streams. Dr. Turner, you made the point yesterday that when you get low nitrogen going through a wetland, you do not have much left to take out. But if the practice is near the source, where you have a large discharge of nitrogen, say from an agricultural area that has some subsurface drainage that is not controlled, diverting that to a wetland can have a major effect on reducing nitrogen. We are saying, from this study, controlling that drainage plus going through a wetland from that discharge could have a major impact of reducing nitrogen. We hope to be able to demonstrate that. Hopefully the model will also demonstrate that, by calibration, to show the effect of scaling this thing up.

Eugene Turner: To follow-up on that, you mentioned there are roughly thirty farms, fifteen active and maybe fifteen a little less active. About how much of the total acreage of the watershed is in those farms?

Appleboom: Off the top of my head, I would say that probably about seventy percent of the watershed is now in agriculture, whereas about ten years ago it was more like eighty to ninety percent. WRP and CRP lands have taken a large chunk of the watershed back into wetland and forested area.

Turner: How are you going to look at experimental treatment vs. non-treatment? Is there going to be something like 10% of the land treated? You are somehow looking at a before-and-after treatment, right?

Appleboom: Oh, correct.

Turner: So how much of that land is actually going to be treated?

Appleboom: Well, we plan on having side by side treatments. In the drainage water management case, we will have side by side fields, in which one will have drainage water management applied, and the field next to it will not. Then, in the case of the wetland diversion, we have areas where there are side by side channels, where one will be a wetland and one will be just be a dredge channel, so we can compare side by side results.

Turner: Good, okay. I also have a question about a common problem, and I do not know if it is a problem in this case, but how are you going to establish the baseline? We have had talks about water flow affecting concentration, and you have to normalize it somehow. So, how long will a baseline be going on so you can actually tell the effects, or how will you go about telling the effects in a clear way? Two of your projects have trouble with this.

Appleboom: Right. Generally the sites we have chosen for side by side comparisons have the same soil types, and are farmed by the same farmers, so we will have the same management practices, same fertilizers, same crops. So we're going to be using the side by side comparison of differences of one field compared to another field.

Turner: So you will not have a "before" reference condition?

Appleboom: We are not going to have a base line, per se; we will have a comparison of two fields.

Turner: So this design is a reference comparison, not a before and after?

Appleboom: Right.

Fouss: This is one point of focus that I often try to bring up for this research. We are trying to do them at the same time. I often try to bring this up to people during monitoring projects. If, during a monitoring project over, say, five to 10 years, we also could apply a particular practice that we think might solve a problem, and check for the effectiveness of that practice over that same 5 to 10 year monitoring period, we would have the background or baseline data for that 5 to 10 year monitoring period as well as

the data to evaluate whether that management practice worked. To have the background or the base in the same timeframe as you are doing the research is very powerful. We have enough trouble getting money to do a little part, so to do them side to side is even more difficult. But from a research standpoint to do them in the same timeframe is very important.

Turner: All right, I am not asking for discussion, but it would be nice if they could switch them after awhile and do both. But I want to ask another question; will you be able to close the water budget on any of these sites? In other words, will you know how much went in and how much came out, and truly know all the sources and sinks for where the water is entering and leaving the site?

Appleboom: We should be able to do this on the whole watershed itself. We will have a little bit of a problem with seepage from the Mississippi during high water flow. But during normal flows we should be able to close the water balance out fairly well on the entire watershed. In the smaller plot sections, the diversion will be fairly easy to closeout, because that is just measuring input versus output, and there are no side channels or anything coming into it. So those will be fairly easy to close out. Regarding the field studies of the drainage water management, we have isolated those fields enough that we should be able to get fairly good results for closing out the water there.

Locke: Fine, thank-you. Scott, in your study, what kind of conservation management was imposed on the field that you labeled conservation? Is it no till, or reduced till type of crop?

Scott McConnell: It was a no till field.

Locke: Strictly no till?

Scott McConnell: It was one of the leading no till producers in our region, Bill Teter[5]; he has been a proponent of no till crop production for many, many years. We actually used his fields to do our studies.

Locke: How long have the streams been under no till? Do you know?

McConnell: Typically, Bill will periodically have to repair fields, for instance at the ends where he begins his irrigation. Sometimes the irrigation streams will ditch out the furrows, maybe as long as ten or fifteen feet into the field. So, I would say he routinely tills probably once every three to five years; but no more often than that.

Locke: But this particular field had not been tilled?

McConnell: No.

[5] Please verify name.

Locke: OK. I am curious, and maybe it is my confusion as you were talking, but you estimated runoff based on rainfall because you could not measure it?

McConnell: Right.

Locke: Concentrations from the runoff were determined on a set volume? I mean, you collected the same amount?

McConnell: Yes.

Locke: If I understood you correctly in terms of total load, did you use the same estimated water runoff value for both?

McConnell: Yes, we did.

Locke: Why was that?

McConnell: It may not be entirely legitimate, because there may be more infiltration under conservation tillage, but we assumed that would be less than 10% and not a huge factor. This would be especially true when we had those deluge rainfall events; in those cases I would guess that the runoff is nearly identical.

Locke: Really?

McConnell: Yes, because there is no time for infiltration.

Locke: Well, I will ask a similar question to what I asked Tim. What kind of acceptance in the Arkansas Delta has there been for conservation management? Not necessarily no till, but other various practices?

McConnell: In the southeast region acceptance was pretty good until the early 2000's. I would say it was above 50%, maybe approaching 60%, in the early 2000's. It has probably slid a little bit since then. I do not think it is quite as extensive in practice now as perhaps it was a couple of years ago, and that is unfortunate.

Turner: Well, I will follow up on that then. Cliff Snyder may have answered this, but what is the impediment to getting more conservation tillage? What is it do you think for this region?

McConnell: I think it is producer education.

Turner: Just education?

McConnell: That is what I think. If you can show a producer that he can conserve the soil and save money, or certainly not spend any more money in his production operation,

then he will probably adopt conservation tillage methods. One of the things Bill Teter did, and this was through a large scale operation in which he actually put his money on the line, and not just a study or a test, was to show that he actually could produce crops more cheaply using conservation tillage. That was a big, big tool to get adoption of conservation tillage by producers. But since then Bill retired and we lost that tool or example for producer education.

Turner: I may have misunderstood, if you could share the microphone with your friend there? I had the idea that the other reason was that you had less return, less … production?

Comment [JM2]: Some type of production, lint or lent?

Cliff Snyder: In the one study in Tennessee, that's right. No till works on some soils better than others. It can be rather site specific, depending upon the nature of the soil, as to its effectiveness. Now part of that is, too, the length of time the studies are run. Typically when we look at comparing these tillage systems with one another, a couple of years is inadequate to really compare these systems, as you have indicated, Gene, with the work that Jim Fouss and others are doing with drainage,. We really need to have probably five to ten year studies to really make significant conclusions about these comparative effects. One of the things I agree with Dr. McConnell about, regarding what is hindering the greater adoption of conservation practices, conservation tillage in particular, has to do with what happens in the fall when we harvest our crops. The gentleman from Louisiana can attest to this. When you harvest rice, if you drain that field and you get wet weather conditions before you can get in there and get your crop harvested, the soil becomes wet again and you rut these fields when you harvest. This impacts their physical condition, and then we have to go in and smooth those fields to be able to plant optimally. So these fall weather conditions have a significant impact on whether our conservation efforts are going to be successful or not. We cannot predict the weather, but it takes time and is regrettable because of these rutting effects. We have 60% in Arkansas, and we have a fairly high percent in Mississippi and Louisiana, of our acreage of cotton, soybeans, and corn, and of course all of our rice acreage, that is irrigated.

McConnell: I would say this, too. You mentioned that Cliff's two year study indicated that—or I guess it was Don Howard's study, wasn't it?

Unknown speaker: His study was a six year study.

McConnell: Okay, Well, I have a five year study where we used conservation tillage techniques. We actually did till some. We dug up the old rows, but that was the only tillage operation that we did. This was a five year study where there was basically no significant difference between conservation till cotton yield and conventional cotton yield. We were very careful in our management of the crop as well.

Turner: I have a question on just a small detail. I saw the pipe coming out, but I could not see where the intake was. That was not below ground, was it? Was there some type of grate on the other side?

McConnell: Which are you referring to?

Turner: I understood that you had a pipe where you were measuring the sediment coming out of the pipe.

McConnell: Right.

Turner: But I could not see where the intake was.

McConnell: It was just on the other side of that berm.

Turner: But it was just on the outside on the surface?

McConnell: Right.

Turner: Okay. Now, the other thing was, cotton is awfully harsh on the soil,right? You do not have perennial cover on it. I am just wondering what might be the next available crop that might be better for the soil system or soil health? What is the alternative crop? And what is the tipping point between using cotton and something else?

McConnell: Many times that is not just an economic question. It is often a landlord question, especially if the landlord owns the gin and is providing chemicals, or sells chemicals, for crop production. If he is in those businesses, too, he may plant cotton regardless of what the price is, if you want to farm this particular piece of land.

Turner: So the socio-economic structure and tenant land ownership relationship is very important.

McConnell: In my region that is very true.

Snyder: Gene, I would like to comment on that. I think there is a misperception out there that cotton is a less sustainable crop than soybeans or corn or something that is a high residue crop. I think of studies that have been conducted at Auburn University, one of the longest continuous cotton production systems in the world, where crops of cotton have been produced at that site for over one-hundred years, and the crop yields and the soil characteristics are better today than they have been any time since their inception. It gets down to how we manage that soil. It is not the crop per se, but how we manage that crop that really determines whether we are doing positive things or negative things to our soil quality.

McConnell: We would agree with that.

Locke: One think to look at is the location of the studies. Don Howard's study was probably done around Jackson, Tennessee, right?

Snyder: That is right, on a fairly erodable soil.

Locke: My point is that different types of soil in which cotton is grown have different dynamics.

Snyder: Right. Another part of the issue between till and no till in that study, I think, was that continuous traffic patterns contributed to some compaction in that no till scenario. In addition to that, when we do not till it and then apply our nutrients to the soil surface, principally phosphorus and potassium (and that was a phosphorus study) we probably had some positional unavailability of that phosphorus that was applied to the soil surface that limited the yield response in the no till scenario. In other words phosphorus was not available down near the root development zone; instead it was lying closer to the surface, which hindered the crop response to phosphorus and limited the yield in the no till scenario compared to the conventional till scenario.

Locke: Let me switch gears a little bit and continue with you, Cliff Snyder. You talked about the equivalence of the various soil tests and everything being saved for phosphorus equivalent to Bray-1. [Possibly BRAE 1?] Can you elaborate on the relationship between some of those soil tests and water quality parameters, or water soluble phosphorus?

Snyder: Our soil tests methods have been developed to give us a surrogate measurement of what the plant might see during the growing system. The soil test extractions are done in a fairly short term period of time in which we combine the soil with an extraction solution and then measure the amount of phosphorus that has actually been removed from the soil particles by the extraction solution. That is correlated with plant nutrient uptake, or nutrient concentration, or yield. These methods have shown, in some cases, particularly for phosphorus, that sometimes they are well correlated with the "water soluble" phase. There are also bio-available, algal-available phosphorus extractions methods. Typically what we see is that these soil test phosphorus results, irrespective of method, result in fairly high soil test phosphorus levels. The higher that level, the greater the potential is for higher phosphorus concentration in runoff or drainage from those fields. There are some people who suggest that you can use that soil test as an indicator of environmental impact. Well, that may be true if every single area of the field has direct hydrologic contact with the stream. But it is those areas of the field that are really near the water courses, where the water is moving across the soil surface away from the field, that are most prone to having an impact, So, the soil test for phosphorus, in and of itself, is really not that good an indicator of the risk for potential loss of phosphorus. You can have a high soil test phosphorus versus low soil test phosphorus, and that is not always indicative of environmental risk. Instead, different states have worked with a tool that we call the Phosphorus Index that integrates soil test level as a component part, but also integrates crop residue, cover, slope, erosion, and some of the hydrologic characteristics of individual soils. We are promoting that tool as an alternative to using a soil test phosphorus level in and of itself as an indicator of risk of phosphorus loss.

Locke: Okay, you hit on my next question, and that is, how we can properly assess the relationships between the results of production type parameters, like soil tests and yield, and those that are more geared toward water quality?

Snyder: We have some challenges, Martin. You have hit on what I think is in my career one of the bigger challenges. We have some fairly good production research looking at dose response studies by crops for nutrient inputs. Unfortunately, we do not have as much data as we would like to see on the environmental fate or impact of those nutrients. I am a little envious of the people like yourself who have been involved with pesticide fate and residue study over the years. It is very difficult to find the money to do that in the fertilizer industry. We have endured considerable downsizing. I will just take this opportunity to point out for those who may not know it, and this was mentioned yesterday I think by Gene Turner, that 70% to 90% of the cost of nitrogen fertilizer is related to natural gas prices. Well, in the United States since 1999 we have lost 22 nitrogen production facilities, and that amounts to a 20% reduction in nitrogen fertilizer production capacity. Seventeen of those 22 plants will never be restored to production. We are now importing as much nitrogen fertilizer into the United States, as we produce. That is a consequence of the economics of production and some demand relationships that relate to worldwide markets. So, there is a dilemma when we have challenges in being profitable in producing crops, to find the revenue to be able to do the environmental impact studies that are needed. They need to be married together better than they have been in the past toward understanding agronomic impact as well as environmental impact. You raise a good point, Martin.

Locke: I do not know enough about soils to do anything other than gardening, but I like what I understood you were trying to do. You had a statewide "F minus R" type of budget in there, including manure. I was wondering about the variance on those measurements; could it be taken from a statewide down to a county level? Or some smaller level to find the outliers on this?

Snyder: We would really like to do that, Gene. One of the challenges is the way fertilizer consumption and use are reported. The unfortunate thing is that every single state does not report fertilizer tonnages. It depends on individual state laws, and not every state requires reporting on a county level basis. Secondly, in some counties, depending on how rural an area is, there may be one fertilizer dealership that serves four or five counties.When they report their tonnage, they stand out as a big red mark on the map, and it does not give us a good indication of what is being used in a given county or given watershed. So we have a scale issue there, and it is a concern. But, yes, that would be great to be able to move to that scale of confidence in our nutrient budgets. There has been some effort. I mentioned Dr. Nathan Slate[6] at the University of Arkansas who published work in the Journal of Environmental Quality, I guess it was last year. He looked at nutrient budgets within Arkansas, using an approach similar to the one we use for North America, on a state level basis. He looked at some of this nutrient surplus in the western part of the state from animal waste, principally poultry litter, and what we

[6] Please verify name.

might do to be able to move that to eastern Arkansas where there is demand. So he looked at the supply/demand, input/output balance, and he found that basically we could use all that manure from northwest Arkansas in eastern Arkansas and still have a deficit of phosphorus based upon current soil fertility levels and crop removal. The challenge is to do that in an affordable manner.

Locke: Cliff Ochs, you had a slide where you showed soil nitrate in the soil core mesocosms, where you had low denitrification. Could you speculate on some other loss pathways for nitrate, such as uptake by microbes, or sequestration, or leaching, other such things. You have some balance differences there.

Cliff Ochs: Yes, leaching is a possibility in general, except not in that data that I showed, because that experiment was done in tubs or tanks.

Locke: Right.

Ochs: Uptake by microbes is a possibility; uptake by algae is a possibility, at least in some of the surface water. We did not observe that or check for that, but it is certainly a possibility. Beyond that, I do not know. Whenever you are working in containers, there is the possibility of sorption of materials to the sides of the containers as well. I do not know if that would be an issue with nitrate as much as with ammonia.

Locke: Okay, I just remember seeing that and was curious.

Ochs: What you observed is correct, that the rate of decline that we saw in nitrate over the course of that experiment was greater than we observed as a rate of denitrification. So that cannot explain those declines.

Locke: Could you comment on the phosphorus loss, or the phosphorus dynamics in your system? You measured it, but you did not really address it too much.

Ochs: Well, there is a good reason that I did not address it too much. In fact, did I even show that data?

Locke: At the very last, in terms of loss. Erosion loss is where you estimated it.

Ochs: Yes, that was estimated. I can tell you how we came up with that value. Basically what we did was look at the amount of phosphorus that came up into the overlying water over the course of the experiments. Then we asked ourselves, if all of that phosphorus leaves the system, then how does that amount compare to phosphorus concentrations in what was coming out of the system in runoff. So, basically, we compared concentrations of phosphorus in overlying water versus concentrations of phosphorus in runoff from the field, and we just simply assumed that if you have the same amount of water leaving the field, where do you lose the most phosphorus? That is how we came up with that value. We did find over the course of the experiment, although I did not show these data, that initially upon flooding, there was an increase of phosphorus in the water column over the

soil surface, and that, like the nitrate, it tended to decline over the course of the experiment in the flooded mesocosms. Again, is that uptake or re-sorption? I do not know.

Locke: You had a nice discussion of the nitrogen cycle, and I just wonder if you were able to close the nitrogen budget on any part of these experiments where you included DON, particulate nitrogen, and, for example, nitrogen fixation? Are you sure that did not happen? Or, is it something you would like to look at? There are a couple of open ended things that you may have done, but I just did not know if you did it.

Ochs: Yes, the goal would be to close the budget, figure out where everything is going or coming from. I was very curious as to whether nitrogen fixation might be occurring in these fields. We did not measure it, and we did not see, in these experiments or in the fields that we were working in, any masses of algae. But I think that would be possible, at least in warmer weather, and that would be an interesting component to the study.

Locke: So some of the lost nitrate does not have to be de-nitrite, it can go into other forms. It should not necessarily be described as the disappearance of nitrate because of de-nitrification. It could go into things that were not measured.

Cliff Ochs: It could be immobilized by organisms.

Snyder: But I would like to add something there, Gene. In my twenty-five plus years of working in the field with farmers in the mid-south region, unlike other parts of the country, we do not think of leaching losses as being one of the major loss pathways of nitrogen loss from farm fields. More and more scientists that I visit with around the mid-south region feel that one of our major loss pathways in our soils is through de-nitrification. I point to some of the research by Dr. McConnell, where he has measured nitrate nitrogen in long term cotton nitrogen studies down to ten feet in the soil profile. When using an optimal rate of nitrogen fertilizer, he is not finding high residual nitrate nitrogen in the profile. Furthermore, there is not a long carry-over over time. Scott, you may wish to speak to this more than I, but in many of our soils we have a clay layer not too far from the soil surface, and we have winter conditions with high moisture content into the spring. When it warms up in the spring, we have conditions which really are ideal for de-nitrification. Even though the fields may not be completely flooded, they still may have a low oxygen status, particularly in that area of the soil profile where the nitrate has moved during the course of the winter months. So that is a factor. We wish we could close that loop, we wish we could recover that denitrification loss, but that is, we think, and I think your study indicated, too, that that is a fairly significant loss pathway.

Doug Daigle: Okay, thanks, we are actually out of time for the questions. I am sorry we did not get to any questions from the audience, but I would encourage you to correspond with the authors. Scott's information was left out of the program, I think, through an oversight, but it will be in the proceedings, and if you contact me I will be happy to connect you with him, unless you want to just come up and talk to him now and take advantage of that opportunity. Okay, we are going to reconvene promptly at 10:05 for our

next session, so let us all enjoy a break and we will see you at 10:05. And, thanks again to the speakers and question panelists.

End of Session

Transcript of Panelists' Discussion and Q & A and Audience Q & A
Session 7: The Role of Wetlands in Nutrient Cycling

Ken Teague: …A lot things come to mind. One is you showed the difference in de-nitrification potential within natural forested wetlands verses restored areas. And the thought occurred to me that that might have some implications for decisions regarding protection verses restoration. Do you have any thoughts on that?

Stephen Faulkner: Yes, I agree 100%. I think if you look at any of the suite of eco-systems services and certainly the water quality functions are at the top of the list you cannot not beat mother nature as the commercial said. It is clear, we have looked at a lot of these systems across the different landscape positions and different types of landscape systems, depressional verses riparian thing and the natural systems are always the highest. When all other variables are the same, you are just looking at the eco-system structure.

Teague: A quick follow up to that, kind of along the same line of questioning, I guess, with respect to priorities for restoration and the potential for restoring or modifying hydrology to take advantage of natural forested wetlands verses re-vegetating former agricultural fields with respect to their potential for nitrogen removal.

Faulkner: You mean, as far as which we would place the priority on?

Teague: Yes.

Faulkner: Well I think again where feasible if we can use a natural system that is not already in the system in terms of the hydrologic connection. In this part of the world what is left is the wettest. So in many cases it may be just disconnected from the source and we just have to reconnect it to the source. But in a lot of cases it is already getting some of that flow. And in a small watershed context I think we would think about if it is already connected and it is doing what it is doing at that scale then if we need to enhance or increase that capability within that watershed. We have got to look at a expansion of that capability which means private land restoration.

Teague: One more quick question and then I will turn it over to you. Towards the end of your talk you had a really important point about what goals are being set, or what is driving restoration efforts there. Habitat verses water quality. Do you have any suggestions for decision makers as to how to close that loop or elevate the priority being placed on water quality function verses habitat function?

Faulkner: Well I think that is an issue that we constantly struggle with. Because I do not know that we can say that one eco-system service is more valuable than the other. I mean that gets into a chicken egg kind of approach. But I think my opinion is that we have limited opportunities in the landscape to effect the water quality restoration, enhance those services. You know, we can create habitat in a lot of ways. We know how to plant

trees. We know how to match species to sites. We know how to dig holes in the ground. So we can do a lot of those kinds of restorations in a lot of different locations. But I am a firm believer in the hot spot approach to landscape processes for nutrients and water and I think we need to have an effective mechanism to identify those and then if we are going to have water quality improvement as a goal then those are the places that have to receive that kinds of attention.

Piers Chapman: Steve, speaking with you for a bit; you pointed out that even after thirteen years the restored forest is still less effective than the natural ones are. I mean they [natural forests] are so much more efficient, or they seem to be so much more efficient than any other type of vegetation. So does that matter? And are you in fact surprised that even after thirteen years we have not gotten back to a normal level of what the normal situation is?

Faulkner: I was surprised after thirteen years, but again the design was to minimize any other variability. So it is the same landscape, the same soil type, it has essentially the same hydrology and the initial hypothesis was that it was a—you know when we compared Ag back to natural systems and when there is that lag in building up soil carbon and available carbon we though that it might be that process. So I was a little surprised that after thirteen years we saw that much difference. I understand that your other question is does it matter? Well, I think it does. Again depending on what number we are going to use, if we are going to calculate acreages needed and things like that and make assumptions about how much reduction or removal we are going to have to meet certain targets then—we cannot just assume—that initially they would not be the same. But I think the general assumption is that there would be some point at which they would coalesce and be the same. And I do not know that we are going to see that in a forested system for that process.

Chapman: Well, I mean is the rate still going up?

Faulkner: Is it still going up? It is hard to say. I do not think I have enough data to say that because we have not followed the same sites enough through time. We basically have been looking at different sites so they have different other variables that effect the rate. The other issue in the lower Mississippi Valley (LMV) is that thirteen years is pretty old for reforestation. The oldest plantation we were able to find, there is a thirty year old oak plantation on the Red River Wildlife Management Area just above the old river control structure and we are sampling that site to. So that will be another data point. That is a thirty year. But I think that is the oldest reforestation site in the LMV that I am aware of.

Chapman: Okay, of you try to do this on a bigger scale, how much land is actually available in the lower Mississippi that you could use for this?

Faulkner: Well I think ultimately there are about 10 million hectares that was cleared. But that is just a raw number. I do not know if it was this conference or others, maybe it was the Memphis Forest Service conference, you know there is a whole host of

constraints at other levels. For instance counties and municipalities do not want to remove that land from a tax base, so there are currently limits on how much acreage in a parish or county can be put into these conservation programs. They are constantly, in the LMV, over subscribed so there are many more people who would like to be in the program than there is money to pay them for. So ultimately those are going to be the controls over how many acres are available than just pure land base.

Chapman: Yes, no I meant taking these other constraints under consideration. Is it likely to be effected by the increase in the cost of fertilizer? I mean the E.U. for instance pays farmers not to cultivate fields. Which to my mind is nuts, but it keeps the price of produce artificially high. The U.S. subsidizes their farmers to produce stuff at four times the world price. How long can we keep doing this?

Faulkner: Well, I am going to get out of my pay grade pretty fast by answering that question. But I think in general the conservation programs are increasing in popularity. I mean they are a mechanism by which those kinds of monies can be transferred at the societal level for goods and services that can be provided and I think it is an effective mechanism in our current environment. The other key is not just to focus on water quality, I am sure there could be a benefit in some certain instances, but certainly when we take areas that are sources of either nutrients, sediments, or greenhouse gasses and put them back into a natural system we are going to accrue more than just an incremental increase in water quality removal there is a whole host of those services that are going to be quite valuable to communities. So I do not know that the price of fertilizer will directly affect it one way or another. I think that it is going to be an approach that is going to continue to receive positive push at several levels because there are a lot of benefits that can be gained by it.

Teague: John, do you have any recommendations, policy recommendations you might make from a scientific perspective to policy makers based on your findings…your predictions as far as the Action Plan, the hypoxia Action Plan specifically?

John Day: Well, you know the main conclusion I would draw is that we need to find the most efficient way to achieve these goals in terms of energy use. Because I am convinced that this is going to happen and that is the main thing.

Chapman: Okay, yes—well then this is both to John and to Rob. Using sewage effluent to restore wetlands and things is great. Given the price of energy is going to go up, we presumably have only a small window to use in terms of time to build other structures like this. Do you think that we should basically start a large effort on putting in diversions now while we can still afford it?

Day: Whatever we do that is energy intensive we need to do it (I would say) within this decade. And that means building diversion structures whether we even use them right away. And it means if we are going to pump sediments long distances I think that is going to have to be done within this decade. If this comes to pass and there certainly is growing evidence that it is going to come to pass.

Robert Lane: As far as using wetlands for assimilation of effluent I think that will come very naturally as energy goes up because tertiary treatment of waste water is very expensive, the water quality is only going to go down as cities grow and this is a very cost effective means of (1) restoring the area and (2) improving the water quality. So I see this as a natural progression in our society to use the natural resource base that we have in order to clean the water that we need to in order not to have the water quality problems that we see currently.

Day: Jae Young-Ku[7] who was a post-doc at Louisiana State University (LSU) before he went to Texas did a study and found out that conventional treatment was four to six times more energy intensive than waste water treatment. And Mike Ogden who is in New Mexico did a study and said for every kilogram (kg) of BO carbon you reduce as BOD reduction in sewage treatment using conventional treatment, you put two to three kg of carbon into the atmosphere as CO_2. So going to a more efficient way of dealing with wastewater not only do you put less into the atmosphere, and you wind up sequestering more because you are burying it and putting it in trees for example.

Chapman: But presumably there is a maximum size to the city that can really cope up with this if you have to keep within these (fifteen and three) limits for nitrogen and phosphorus. And I know we have huge areas of wetlands in southern Louisiana but I mean even those presumably could not take a lot of the effluent from the population because they are in the wrong place, or whatever. Or the loading rate would just be too high.

Lane: I believe that southern Louisiana is not as dense as a lot of areas in the country and we have comparatively a lot of wetlands. So southern Louisiana might be a better situation than a lot of the country. Maybe creating wetlands might be an alternative for other areas.

Day: Sarah Mack, yesterday in her presentation talked about treating 65 million gallons a day (MGD) for New Orleans.

Lane: I would disagree the statement that there are not enough wetlands to treat the wastewater we have in southern Louisiana.

Teague: Good. Specifically with respect to the implications of this technique for nutrient loading into the Gulf, and hypoxia, I know there is lots of questions about whether nutrient loading to the coastal basins actually contributes to Gulf hypoxia, but it is obvious that a similar—the same technique could be used for discharges that currently go into the river have you guys, are you aware of any facilities that do currently discharge into the river that are considering this technique or have you though about the potential application to those kinds of discharges?

[7] Please verify name.

Day: New Orleans, Saint John Parish, Saint James Parish are three of them and Jefferson Parish.

Lane: And Saint Bernard was going to its wetlands near the Violet Canal. But I guess they decided to go back to the river. But it has the infrastructure to go to the wetlands, the plant is right on a large wetlands.

Teague: What kinds of studies have been done to look at some of the other potential water quality considerations associated with the discharges of the pollutants etcetera?

Lane: The DEQ requires that every five years we analyze for metals and other parameters. Every five years we go through and analyze for those types of affects that we are not looking at on a monthly basis.

Teague: And there really have not been any problems?

Lane: No.

Day: The DEQ is currently in the process of trying to develop a generalized statement on the types of wetlands that can be used for this. And there are certain types that cannot be used. Very oligotrophic wetlands, for example. One of which would be for instance these pine flat woods north of Lake Pontchartrain that are really oligotrophic and have herbiferous plants. Those would not be appropriate. Some of the recent information on floating marshes might suggest that they might not be appropriate, areas near oyster reefs and such as that would not be appropriate. So this is not a panacea and you can not use all wetlands and as Rob showed, we put these things in at a low loading rate. We were looking at benthic populations for awhile, but at these low loading rates we found very little— very subtle impact if any on benthic populations and we just published a paper on this. So the DEQ was requiring monitoring of benthic populations for awhile, but they have dropped that mainly because of this very low loading rate and the lack of a demonstrated effect of these loading rates on these benthic populations.

Lane: Another consideration was that we had to carry out a two year study before any type of discharge was allowed and part of that study was looking at any industrial dischargers and usually that is the limiting factor; that industrial dischargers are not allowed to—if they are discharging some sort of heavy metal or something that would be deleterious to the environment that is excluded.

Chapman: Rob, one last question then. Talk about the Bruce Ardens Martinville planned releases where you said you got or they were going to be discharged into areas that have levees around them. Are they going to change the hydrology by removing some of these levees?

Lane: Yes, and there is going to be an output, it is not just a basin. Yes there is an input. We look at the natural hydrology of the gradient and then form an output; which is normally going to the canal it normally would discharge into.

Clifford Snyder: I had a panelist question, since John was moved from this afternoon's session to now. If I understood Robert Lanes information on loading rate, for effective eco-systems wetlands—eco-systems function—15g/m^2 for nitrogen and 3g/m^2 for phosphorus if I do the calculation correctly that is about thirty kilograms per hectare per year (30 kg/hect/yr). And that phosphorus is not being lost or de-nitrified so it obviously is being bound to vegetation and being taken up by vegetation in that wetland eco-system. What is the anticipated lifespan of such a wetlands system from a phosphorus vantage point? From the vantage point of nitrogen it looks like it could function to perpetuity. But what do you think is the feasible limit for wetland function for filtering out phosphorus when you consider that kind of a loading rate and the vegetation uptake and once those trees get to be mature they are fairly tight nutrient cycling system within that forest eco-system?

Day: Almost all the wetland we use are in the coastal zone and have a high burial rate. And they are burying 1-3 grams (g) of phosphorus per square meter (m^2) per year. So that is going down. And as long as the wetland is intact, that is a geological storage. But the interesting thing is that the Breaux Bridge site is not a subsiding wetland like that and does not seem to be building up like that over time and that has been functioning over fifty years we are still getting 70%-80% phosphorus retention.

Snyder: I am bewildered by that considering the use of our annual agronomic crops, and their harvest removal, and the nutrient input off take because the cycling does not make sense to me. We are putting more in than is being removed or taken up on a yearly basis yet you do not see the discharge and I am having a hard time accounting for that.

Day: Most of it is being buried.

Snyder: But you said Breaux Bridge is not being buried yet you are not seeing a lot?

Day: Well, assimilation into the trees.

Snyder: How long has that been in place? Did I understand you to say that it has been discharging for fifty years but you have been monitored it for the last ten?

Day: Yes

Day: I guess what we really do not know at that site is if there is soil build up. It is outside the active area of the coast that is actively subsiding. So if you go to inland wetlands that are not subsiding then those values would probably come down.

Faulkner: Can I follow up with a quick question? Richardson has the one gram (1g) rule that he kind of developed. But you feel that, I mean I did not see any loading rates above one gram.

Lane: Yes we put 15g-5g as our maximum, but we really are down to 1g-5g.

Faulkner: You are below 1g for phosphorus.

Day: I would disagree, 3g and 15g are our maximums, and we felt you could go above 1g because you bury it. And probably if you did not burying then you would have to go down toward that.

Faulkner: Well I think Richardson's contention was that even with burial, you could see an eco-system change above 1g, and that was mostly based on the Everglades work. It was not a loss of phosphorus to the system, it was more of a shift of species and other impacts that may or may not be appropriate for a system. But I was just curious.

Day: Well the thing is that most of these wetlands that we are dealing with are shifting anyway because they are in the Louisiana coastal zone. We have not seen, for instance typha come into any of our sites, and that is one of the general effects of loading and I think that has to do with low loading rates.

Faulkner: Yes you are still below one on all those.

Doug Daigle: [Reading audience questions] This one is a little lengthy. I will go through it quickly, it says—for John Day—the Black Sea is again having problems with hypoxia as eastern European economies countries join the E.U. and are getting funds to re-concentrate energy and fertilizer use. They quote a study. Other studies have predicted continued rise in reactive nitrogen availability for at least 50 more years, even considering conservation measures and that this will be worse for South and Southeast Asia. These two points indicate hypoxia and eutrophia will continue to increase. Thoughts on this scenario 50 years verses 20 years.

Day: My point is that if energy prices go up to where fertilizer costs go very high, then farmers are going to cut back. I mean you can look at—there are projections that the world energy use is going to be twice or four times what it is now. But I do not think that is possible. The main point I was making was that if fertilizer prices go up to the extent that they start affecting the ability of farmers to purchase it then the use is going to go down and that was the reason of the example of the Black Sea. Certainly if the economies over there start using more nitrogen fertilizer again it is going to get in and the hypoxia will go, if energy is not limiting and if some of the more optimistic economic forecasts occur then yes this is going to continue.

Daigle: Question for Rob. Is there a relationship between hectares of wetlands used for assimilation verses million gallons discharge (MGD) of wastewater?

Lane: Sure, there is a pretty straight forward calculation to determine your loading rate. I—my loading rate that I have been using is grams per meter squared (g/m^2) per year. There is a—what do you have to multiply times? Do you know the calculation off hand John? Multiply times 10 or something to get the vector?

Day: Well, if anything it is how much you treat it. How much secondary treatment there is. Because the more secondary treatment you have the cleaner the wastewater is. And so the loading rate takes in the volume of flow, it takes in the concentration of nutrients in the wastewater and it takes into consideration the size of the wetland; so all of those things. Concentration is only one factor, area is only one factor and you put them together and loading rate integrates those.

Daigle: This one is for the whole panel. Given that talks that show de-nitrification is higher in spring than fall and winter, how much nitrogen reduction could be achieved by eliminating fall/winter fertilization and manure application?

Faulkner: Well, I am not sure, but I think certainly most of the data we have shows that de-nitrification rates are very low so that is not going to be a mechanism for removing excess nitrate that is coming off of those fertilizations. But I do not know what the actual rates would be. I do not know how much that is.

Daigle: This one is not specified so I guess it is to everybody. But it sounds specific. Your de-nitrification rates are in N. How did you actually quantify de-nitrification? And they ask what about NO_3 loss, N_2O production, NO_2…other forms?

Faulkner: Well we measure using a settling[8] block, which blocks the conversion of N_2O to N_2 because it is hard to measure N_2 when you already have a lot of it in the atmosphere. So we are measuring it as a production of N_2O and we just convert it to the molar ratio to get an N basis so that they are all the same. Most of the—I mean there is probably some loss in some of those systems the ones we do intact cores, we do not expect any loss in terms of the nitrate leaching out of that system. But the majority of those processes are—is the de-nitrification that is the dominant—so there may be some a hundred on the far end of that number where the nitrate loss might occur but most of all it is occurring as de-nitrification. We use a Bunsens coefficient to calculate how much of that is being dissolved in the water to correct for that.

Daigle: I have a couple of minutes left I wanted to exercise my prerogative and ask just a question to John. Following up on your paper from someone who is also involved in this policy work, is it fair to say that you could have a scenario forecast in terms of the specific effects on hypoxia of the higher energy cost but in the near term you know with the risk we are facing to our coastal fisheries maybe you would not have hypoxia in 20 or 30 years, but you might not have the fishery we have today if we do not keep acting in the near term. Because there are some trends that could—some folks are worried about the ethanol surge that would happen, if that is going to lead to a big increase in fertilized acres. A lot of concern about that no definite answers.

Day: Absolutely, I do not think that we should stop working on trying to solve the problem of hypoxia. And to me the solution to the problem of hypoxia is the solution to all the negative changes that have taken place in the Mississippi Basin. Having to do with the loss of diversity in agriculture, the massive loss of wetlands, the highly efficient

[8] Could be Acetylene.

drainage of the landscape, excessive fertilizer use, channelization and dyking of the Mississippi River, the shrinking of the historic flood plane. We are trying to deal with all those and at the same time maintaining the agricultural community. Certainly we should not try to stop. I mean, even if there was no hypoxia, these are things, the restoration of the basin and delta I think we should continue to work on. I think that is true.

End of Session

Transcript of Panelists' Discussion and Q & A and Audience Q & A

Session 8: The Distributary Region of the River: Obstacles and Opportunities

Andrew Barron: Restoration is a huge issue with our system. Again, I'm Andrew Barron with Barataria-Terrebonne National Estuary Program. Our program is all of the area between the Mississippi and Atchafalaya Rivers, so we have a pretty big area (it's about 4 million acres). That's the area of the state that's being lost faster than any other place on the planet. At least it was before Katrina came through. Not that we are upset about that. [pause] So, I was just really curious about the presentations by Nancy Rabalais and Rob Lane because one is specifically focusing in on Davis Pond problems and then one with Caernarvon. I'm not that familiar with Caernarvon but the major difference is that we already have wetlands there receiving the waters, whereas in Davis Pond it is essentially an open-water system. And I would just like each of you all to discuss what the implications would be for the other diversions we have planned for coastal restoration.

Robert Lane: The one planned in Hoek Canal to go into the Maurepas swamp is a perfect example of a type of diversion that we need to implement where there is a large expanse of wetlands before we hit any large lakes, such as Lake Maurepas. This lake will be impacted from that diversion whereas a project like the Bonnet-Carre Diversion is a very poorly planned project that diverts water directly into an open water body, where we would expect all types of water quality problems that Nancy was explaining in her talk, that we are seeing in Lake Cataouatche.

Nancy Rabalais: I'm not privy to all the engineering plans for the codes so I can't really quite put my mind around all of them and what they might do to water quality. But there is a ponding area for the Davis Pond Diversions that holds the water in a large area and it's not removing the nutrients. These are of course bottle experiments. We can do them out in the field, which would be the next step and/or do the same sorts of experiments with water that's coming through the Caernarvon area, so we would have some ability to compare the areas. From our deployed meters, we haven't seen any real changes in salinity, which was the purpose of the Davis Pond Diversion, although it's not fully operational.

What you are diverting water for makes a big difference in how you would divert it, and when you divert it. I thought it was encouraging that the Caernarvon could be manipulated to reduce high chlorophyll, but are they actually going to do that? So we can manipulate these diversions in lots of ways to do lots of different things, and not always is it going to be a fair trade-off between some of the issues that might be negative impacts and some of the issues that might be positive impacts. All I can do is echo what a lot of other people have said, which is that we have to place our understanding of how the systems respond somehow into what seem to be very engineered systems, and that would be my hope as we move into the future.

Barron: I guess what I take from some of these presentations is that it seems like we should definitely try to, if we are going to use diversions, use them as a restoration tool. If we are going to use diversions I think we need to be very careful about either (1) discharging into areas where we already have existing wetlands, because that's where you're going to get the most good as far as preventing any harmful algal blooms from occurring, (that goes hand in hand with nutrient reduction), or (2) make sure that we build wetlands first before we put in any diversions into those areas. So if we have open water, I think we should use tools like pipeline sediment delivery, for those of you who know my program and know me, that's our party line, but we believe that's the most effective and efficient way to build wetlands. (That, again, goes hand in hand again with nutrient reduction.) I think there should at least be a high amount of wetlands in areas where you are going to be discharging or diverting water from the river.

Steve Ashby: I have several specific, technical questions, but I think I would rather hold those and talk to you later about them. I want to ask a three-part question in general to the panel and then leave time for the audience to have their questions addressed as well. And this is really more of a conceptual type of question from a systems perspective, and Dr. Rabalais just really talked about it in her response and Dr. Kim eluded to it a lot in his presentation. Part one of this would be based on what I saw on the phytoplankton presentation. My experience has been on inland systems, where for years we dealt with nutrient water control issues. Would you care to speculate on further up the trophic structure, changes you might expect, or a changed phytoplankton composition? Do you expect any change in the zooplankton or fisheries? So that's part one.

Part two is really related to that because we're talking about water management in response to that here. It's apparent that our management opportunities for soluble constituents would be very different than for particulate types of constituents. So, from a systems perspective, are we looking enough at the total sediment budget of the lower Mississippi as we start to look at different types of diversions? Rob kind of addressed that as well with his answer.

Finally, part three: what kind of thought should be given to trade-offs where we are really trading services for functions as we manage systems for specific types of things. I hope that's not too much, but these questions are for everyone.

Rabalais: With changes in nutrient components in estuarine water bodies, you will, as we've seen, change nutrient ratios. And changes in nutrient ratios will cause changes in phytoplankton community composition which will effect zooplankton community composition, and will affect fisheries (at least that's been the link in several heavily entrophied areas). There are several examples of how trophic structures would change with changing nutrients. You are going to see a shift not only in the types but in the sizes of plankton, both phytoplankton and zooplankton. You are going to see shifts in types of diatoms that support the food web to more flagellate forms which are not as often grazed or as easily grazed.

The second part of your question had to do with soluble and particulates and looking at Lower Mississippi River sediment storage and availability, and I'm really not qualified to speak on that. There are a lot of people who have looked at both the sediments available in diverted water, which is pretty minimal, and the bed load in the Lower Mississippi, which since the suspended sediment discharge has gone down, the fines that we would like to have in the wetlands aren't as numerous as they used to be and the bed load is more sandy now.

As far as tradeoffs, I think I said that. You're going to divert water or construct something for some reason, and I don't use the word "win-win" at all, which is used often a lot. But I'm not going to be making these decisions. All I can do is show what might possibly change, but it's not even just the construction part versus the natural system, and we need both because people don't want to be flooded again, and we need the natural system to sustain living resources. But it's not even just a difference of those aspects. What do people want from the landscape in which they live? And those people are also important because their economy and their livelihoods are dependant on whether they can be a ship captain and operate a vessel in the Mississippi River or if they own a barge operation that brings crops down from the mid-west or if they depend on trapping or if they depend on craw fishing. So it's not just constructive versus natural. It's who's going to benefit from all this and how do you take all of that into account as well. And to be quite honest, I'm not sure how that happens.

Paul Kemp: Well I won't pretend to answer all those questions. I think one thing that almost everyone understands is that we need to re-attach the river to the delta in order for it to survive. I'm coming at this from more of a geological perspective. So how that happens, how carefully we do that, and how well we do that is the question. Or, if we don't do it, how quickly we move away and how high we build the levees. So, I guess we can't really leave these questions hanging there. We have to actually resolve them because that is the information we need in order to move forward. So, these are all very good questions and my only hope is that we not leave them as matters of speculation—that we actually move forward quickly to gain the understanding that we need to manage these systems better. We're not doing a great job right now.

Charles Demas: I think Nancy answered the first question very well—what's going to happen with the biota. It's got to change if you change the different nutrient composition and availability. When we start talking about managing the Mississippi and the Atchafalaya, we have to figure out where we are putting these diversions. Are they going into areas that can benefit our overall goal of reducing nutrients without harming them? For instance, the floating marshes—it appears they don't react too well to high nutrient concentrations. So maybe diversions into those areas aren't a wise idea. I think there's a challenge out there to the wetland scientists to determine whether or not we should establish wetlands first and then the diversions. What kind of wetlands could take the Mississippi River or the Atchafalaya River inputs and grow from them rather than be harmed negatively? So those are questions I think we need to start looking at before we start saying "diversions are great." Diversions are great if they are in the right place. If they are in the wrong place, they may be doing more harm than they are doing good.

We're going to have to start thinking outside the envelope here on where we're putting water. I like the idea of piping sediments to those areas where we can use them, and I think that it's going to result in a lot faster land building than a proposed third delta because that's going to take 50–60 years. You have people you have to deal with, you've got land rights. We're dealing in the Atchafalaya basin and some of the folks on that group are here. We un-masked the plan in 1982 and we're still not moving dirt or opening channels. We've got three experimental areas that have occurred in that time frame. We're just dealing with the basin. You've got all these different users, which is why I put that slide up of what the basin generates. You've got all different kinds of users along the coast as Nancy said. We've got to consider the river all the way up to Minnesota. What we do down here and what they do up there impact each other. It's going to take a lot better communication from the scientists to the managers, the managers to the public, and the public back to the managers, on what exactly we want this coastline to look like and what we're willing to agree to or compromise to, to achieve those goals.

Lane: I think I have an answer to the question, though it has been answered pretty well. I just want to comment on the sediment question. There has been a lot of speculation that the nutrient concentration has gone down in the last several of decades due to dams. What I'd like to ask is, what was the sediment concentration 500 years ago? I would suggest that it was much lower than what it is right now. What we have now, or what we did 100 years ago, with elevated sediment concentrations due to land clearing and farming has been decreasing now. But before human civilization there were beaver dams all over up the tributaries. There wasn't as much sediment running off, and so the actual sediment concentrations in the river were probably much less several hundred years ago. So I just want to make that statement.

And also, my statement about the spoil banks and the channelization—the Atchafalaya River is channelized. Water is not getting to surrounding wetlands. The same thing is happening in the basins that are receiving Mississippi river water. Contrary to what Nancy mentioned, in Lake Cataouatche, nutrients are being taken up there. It's just that there are such high loading rates, that you don't see apparent decrease. Those are my comments.

Andy Nyman: I don't have much to add except that the scale of the problem is going to require action on the same scale and that's both in time and space. And so I don't think we should rule out solutions that take 50 or 60 years, because it took 50 or 60 years for us to get where we are. So the fact that the delta might take a long time, to me, does not mean that we should rule it out.

Barron: This question will be for Paul and Charlie. Within the Atchafalaya River, as far as the riparian wetlands taking up nutrients, we saw that it was fairly low. You have a large volume of water moving through there and I was wondering what amount of that water is actually interacting with those riparian wetlands throughout the year? What

percentage of time is the water going to actually interact with those wetlands in order for any sort of nutrient uptake to occur? Paul, you want to lead off with that?

Kemp: Well I think Charlie gave the answer in terms of the volume, 5% nutrient reduction, and I don't know what the time scale was on your studies or Andy's studies, but my experience is that, depending on temperature and things like that, the reduction can be pretty rapid, and so it operates…it's a microbial process that has its own time scale. So in general, probably for the systems depending on the loading, the reduction in nutrients in some ways is driven by the through-put. And so, if we do have water moving with nutrients in it, then we will have nutrient reduction. These systems are set up to do that. Did you want to add something to that?

Demas: Yeah. Paul mentioned something that we need to also think about—moving water into and out of the Atchafalaya basin. One of the things we look at is water temperature. Typically, over-bank flooding occurs when the water temperature is quite low and therefore metabolic rates are going to be very low. And we did some work similar to that small graph I showed of how water was processed as it went through the back swamp. One, it's high flow and it's is moving through there. There's very little reduction that goes on because there's very little residence time. So, temperature plays a major role. If we wanted to get more reduction, you could argue, "well lets put it in when it's warmer," but the problem with that is we don't want it in there when it's warmer because then those areas go anaerobic. And we need the aquatic resources that we are very interested in. So it's an interesting problem and I'm not sure there's one solution to it. It depends on where you're going to put the water and how long you're going to leave it there.

Doug Daigle: [Reading audience questions] Let's take a few questions that have come in from the audience. These are generally for individual members of the panel. The first one's for Andy. Why don't you think the missing 6% water can be lost to evapotranspiration?

Nyman: That's certainly a possibility, but we have more net rainfall than evaporation in south Louisiana, and given the long term of that record, I'm guessing that it's not evaporation, but it could be.

Daigle: The next one's for Nancy. In your nutrient limitation experiments, are there steps taken to simulate anticipated light availability under conditions of Mississippi River diversions, i.e., potentially high turbidity?

Rabalais: Yes, because we worked with the natural water and sometimes it was turbid and sometimes it wasn't. So, we basically take the water as we get it. So we've had the range of those situations. And also turbidity doesn't often prevent particularly a harmful algal bloom from occurring because many of the cyanobacteria have the ability to move closer to the surface to get more light, so that's a complicating factor as well.

Daigle: This one's for Charlie. Is there any evidence that NO_3 loading is contributing to low DO in back swamp areas?

Demas: That's one of those cause and effect things. Is the low DO a result of the denitrification that's going on, or is it the cause of the denitrification going on? Denitrification occurs under anaerobic conditions, so it's very difficult to tell if it's a major cause of the low DO, but it's very much associated with it.

Daigle: The next one's for Rob Lane. If you agree there are no negative consequences of Caernarvon, then how much wetland gain is happening from the diversion in terms of wetlands per year?

Lane: First of all, I never claimed there are no negative aspects, and I'm not sure about wetlands gained. There are some numbers that DNR put out, but I didn't calculate them and I don't think it's my place to quote them.

Daigle: This one's for Charlie. Why, given all the land use changes and dams in the Mississippi river basin, have the flow rates, discharge of the Atchafalaya and Mississippi Rivers stayed steady?

Demas: Okay. We have a very managed system throughout an entire region, but flow rates have stayed the same if you look at the long-term patterns. And just because land use has changed doesn't mean the amount of precipitation running off has changed. Where the impact is showing up is on the sediment, and where we see a lot of that is due to bank stabilization projects. A lot of the banks along the tributaries going into the Mississippi are highly erodible material. And a lot of the bank stabilization projects have resulted in a lot less sediment getting into the water than was normally being transported. So I don't think the land use changes have resulted in a decrease in run off. What it's resulted in is a decrease in the amount of available sediment.

Daigle: This one's for Nancy. Predominance in cyanobacteria in the long-term lake mixture experiment is scary because once established, these toxic species sometimes can be the dominant phytoplankton for months. Are there examples of other lakes in the lower basin where thick, green blooms are persistent?

Rabalais: In the lower basin? Not in the lower basin. This is primarily in the upper basin in the fresh brackish—but the stated intent for the building of Davis Pond is to move the 5% isohaline down towards Grand Isle, which would definitely freshen the whole system. I'm not sure that will ever happen, but the experiments do show that as the system freshens in these 10 liter plastic carbides, these harmful species do go up. There are other harmful species that don't cause green scum in the lower part of the bay. They are present, but so far there's never been any health-related issues associated with them. Whereas we have had some health associated issues with some of the cyanobacterial blooms in the upper basin.

Daigle: This one isn't addressed to anyone in particular: "Does the Atchafalaya Basin not suffer from subsidence? Why wouldn't its sediments to the back…marshes" they may mean back "swamps."

Nyman: I think that's one of those things that people in the basin (besides the cypress swamp) value. They don't want to see it convert over to bolling[9] hardwood so they don't want the sediments back there.

Demas: Yes and no. One of the problems we have with the basin is it stays flooded for extended periods of time. So for instance, in the area just north of Flat Lake (which is the Flat Lake down at Morgan City and not the one bordering it), the cypress is stressed because they're flooded year round. There's no regeneration going on. What's interesting is if you talk to some of the really old timers out in the basin, they always said the basin went dry every year when they were young. When it was dry, that's when you got your regeneration. They also feel that a little sediment is good and I think a lot of us feel the same way—that we need some sedimentation to occur in the back swamps simply so we can get regeneration of the cypress. So yeah, there is subsidence going on in certain areas that are isolated, it's resulted in stress for the cypress trees.

Daigle: Alright we have a couple of minutes left. We can take some questions from the floor.

Len Bahr: I want to ask Paul, or comment I guess. I think there's another potential benefit of what I see as what you've outlined as a true multi-purpose project. It's terribly exciting to listen to. I think one of the things that has not been brought up in the discussions that I've been privy to so far is the potential if you move more Atchafalaya River water to the east, the salinity regime in the Acadiana Bays areas could be somewhat increased more towards an optimum oyster habitat, which would perhaps allow the restoration of the shell reef in that area that would be sustainable. And I like to think that's a possible spin-off of what you've proposed. So I just wanted to throw that out.

Kemp: Well, I haven't gotten to that level of analysis, because the system has so much variability in it from year to year, and the whole area is freshened over many years. So I'm not sure this 10% diversion to the east would have a big effect on the western base. I mean the people out there certainly feel that way but I don't know whether that would be within the threshold to start more sustainable oyster culture back out on the western base. By the way I do have a few copies of the report here if anyone wants more information of that Atchafalaya outlet proposal.

Demas: One additional comment on Glenn's statement about freshening up the area. When we did a report on managing when to get more water into the back swamps, one of the major complaints we got were from the salt water commercial fishermen and salt water recreational fishermen. They were worried that we were going to ask for too much

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fresh water post-June on and impact their fisheries. So there was a lot of resistance to any kind of increase in flows down the Atchafalaya during the typical low water.

End of Session

Transcript of Panelists' Discussion and Q & A and Audience Q & A

Session 9: Future Trends

Doug Daigle: It is worth remembering that the plan originally called for Dr. John Day's paper that you heard this morning to be part of this panel, so you may want to keep that in mind. And I also realize that for the third and final time today I forgot to introduce the question panel. We have Dr. Cliff Snyder from the Potash and Phosphate Institute who spoke this morning and Dr. Len Bahr from the Governors Office of Coastal Activities in Louisiana. Gentlemen, I will turn it over to you.

Len Bahr: OK I'll jump in. The audience will certainly be struck, as I am, that these two presenters have two extremely different backgrounds and roles. That is probably good for the context of this symposium. Neither one has been introduced in any detail and I do not know these guys' biographies but I have known both of them for a while and I think very highly of both of them. They come from extremely different backgrounds and have different roles. Ed Russo is now working with the U.S. Army Corps of Engineers. I do not know his title, but he is with Vicksburg and he is intimately involved in the plan he described very briefly for you. This is the restoration plan that is under development right now. It is of great importance to everyone who lives in Louisiana south of Interstate 10, and it is very important to the nation. Ed is a Civil Engineer, a very bright guy. Since I have known him, he has been involved in the issues we brought up earlier today by several presenters; the issue of pipeline conveyance of sediments to offset the landscape deterioration that we are feeling, and so on.

Dubravko Justic is a nutrient dynamics expert with enormous modeling capability. Correct me if I am wrong, I do not think that you have been involved in the restoration effort, or the planning of the effort. I think you are pretty much aware that we are contemplating massive re-plumbing of the lower river. Dubravko, I would like to hear you speculate on, to the extent that you know the magnitude of the changes in the Mississippi River management, the effect on hypoxia, and water quality issues on the shelf into the future. Are we really able to use the Atchafalaya basin and make the changes in the delta?

Ed, I would like to hear you speculate on the connection between water quality issues and restoration. Because, those of you in the audience who are not aware of this, there are plans and high level discussions that I have been privy to in the last couple of days that have not even mentioned water quality as having any connection at all. So, I do not know whether that is clear enough. I think it would be fun to hear you guys talk about it.

Dubravko Justic: I think I can start. Well, it depends on what you want to do. We recently had this big workshop on hypoxia and I talked about modeling. And I think we had a fairly good consensus among different models that in order to bring hypoxia below that 5,000 square kilometer (km^2) running average, that significant, really major, reductions in the nitrogen flux are needed. And perhaps, reductions in other nutrients; I

did not talk about phosphorus. Maybe you will need to reduce phosphorus as well. And, when I say major, I am talking anywhere between 30%-45%, perhaps 50%. That is big; this is not like 1% or 2% which you can do locally with one or two targeted projects. So, that is as far as hypoxia goes.

Climatic forcing again is unpredictable—if we end up having 4% increases in temperature, then we may end up having a gulf coastal system that would be more stratified than at present. Stratification is something that is extremely favorable to hypoxia development. If we get a bigger flow associated with increased temperature stratification, then we may have a system that will shift toward having even greater potential toward hypoxia. At that point, it becomes impossible to tell what actual load reductions we may need.

As far as other projects are concerned, I have been involved with some diversions, notably with the Caernarvon diversion. And to me, one of the biggest problems is that people somehow expect that a single diversion will solve all of the problems, that it would somehow miraculously manage salinity, that it would build land, that it would prevent eutrophication, and that it would strip nitrate out of the water. I just do not think that is possible. I think if you want targeted projects that will do one or two things, then diversion has to be planned for that purpose. I just do not think that a diversion that was designed for salinity control will build any land, and it does not seem to happen.

Bahr: Well, let me just jump in again. I know that came up in the last panel. I know that the Davis Pond diversion project was justified on the basis of salinity control. That is absolutely true; Nancy and others said that is the way it was justified. I happen to think that was a naïve justification for a project. But that is the way it was. That is no longer being said. The diversion systems we are talking about now are no longer being justified on that basis. And, what I was trying to get you to comment on was the idea which, all of a sudden is discussed widely, is abandoning the Birdsfoot Delta. If all of the water of the Mississippi River, of the lower Mississippi, were exhausted before you got to the head of the passes, what do you think the implications of that would be on hypoxia, the set up of conditions for hypoxia, and stratification?

Justic: I cannot speculate about that because there are many things that can happen. Without running models and very carefully studying that in the model system, I have no idea. I can tell you what *can* happen. First of all, the Mississippi River is not just a little tiny stream that flows and does nothing to the ocean. The Mississippi River is such an enormous force that when it enters the Gulf it creates a current. This is called the Louisiana Coastal Current. And if the Mississippi River is somehow cut out before the birth of the delta, maybe that current would go away, maybe we would not have that current system any more in the Gulf. So that is an interesting possibility for management to think about what to do with the river. And then what happens to fisheries, and all the larval transport? So I am not even going to speculate because there are many possibilities.

Clearly the Birdsfoot Delta has totally different characteristics compared to the Atchafalaya. On one hand, you have a system where the Birdsfoot Delta, especially the southwest bed, discharges the water into a fairly deep region over the shelf. And when the water actually never comes in contact with the bottom, it spreads. Being lighter and fresher, it stays on the top of that heavier salty water and spreads like oil, and we have diffusive plumes that go like an oil drop on the water and just spread over a large area.

In the case of the Atchafalaya, we have a totally different system, where in a shallow region a lot of re-suspension keeps that plume in contact with the bottom for a long, long time. So they are completely different biogeochemical systems. And now, if you want to move water from the Birdsfoot Delta to another region, which would have the same characteristics as the Atchafalaya, the only thing I can say is you are changing the biogeochemical structure of the Gulf as a whole. Now, whether that would be a benefit or a detriment to hypoxia at this point is very difficult to say, but it would affect a lot of other processes and it would probably affect fisheries as well.

Solution for hypoxia? Well there is a simple one. Build a superstructure that would shut down the Southwest Pass, channel the water straight through the South Pass and out it to Cuba or something and you may—you will probably—solve the problem of hypoxia, but you will probably ruin the Gulf fisheries. So again, I don't know, there are many ways to think about it.

Bahr: That might not make Florida very happy.

Edmond Russo: In our process, what I did not describe to you because of the short nature of that presentation, was that some of the evaluations were performed to get where I think we are going here. And that would be using our hydro-modeling capability of surge and waves, which we are ratcheting up right now, to be able to quantify the performance of restored and existing coastal features in terms of vegetation and also various features such as barrier islands, shanears and so forth. How do they perform in a synergistic way with different scenarios of protection features like levees to achieve the multi-purpose performance that we are looking for? Once we know, that will tell us rationally where those features should go collectively and why. That is ultimately important to be able to explain to lawmakers to get the funding needed to build those features.

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Once you know that information, you can use a lot of the science and engineering coming out of these forums here to tell us how to use these river resources: fresh water sediment, nutrients, that are being disposed of offshore. How do we leverage those for restoring the structure and function of the coastal eco-system and maintaining it at that same time? Because you reduce the export of those resources offshore that caused problems in terms of hypoxia and otherwise; you harness those for productive purposes of restoration and protection in a way that addresses the concerns of people that live in coastal Louisiana. But even far beyond, by achieving objectives that concern people here in regard to the Gulf of Mexico. So I think you really start to make lemonade out of lemons in that scenario—treating a lot of different things at the same time—it all really fits together.

Cliff Snyder: I would like to preface my question by raising a point here: I thought it interesting, Dr. Dubravko, that you partitioned your modeling into basically three component periods of time. And as I looked at those data, certainly you made the point that we are seeing more climatic variability than in the past. Now when I heard Ed Russo make a comment here, I believe I understood him to say that your objective is to work more with the risk-based decision framework rather than a cost-benefit assessment. Well, given the uncertainty in the climate and the desire to be risk-based, how do we resolve the dilemma that we really have more uncertainty than we did twenty years ago?

Because we are seeing more climatic variability, the question is, how can you use your model to give us the confidence associated with trying to minimize that risk, from the environmental vantage point?

And then as an engineer, Ed: How do you resolve that, and what kind of data do you need from Dr. Dubravko to help you gain the confidence to get that risk at a manageable level?

Justic: Well, there are at least four components of variability or uncertainty that you are talking about. The first one is the general long-term global climate change. We know very little about what will happen in the next fifty years. It is very difficult to comment about that because it can go either way. So, I think that we can certainly follow the general circulation model and keep track of what the climate scientists are telling us. But that deliberation is not going to be particularly useful or productive.

Where I think the effort to reduce the answer could go, and should go, is studying climate variability phenomena that we know affect the present climate and we know have affected climate for the last few centuries. And, in the case of our region, which is the Mississippi River watershed, there are at least three, climate phenomenon and they have very interesting names so I will tell you those names and acronyms. One is called AMO, which is Atlantic Multidecadal Oscillation. That has a cycle of about 65 to 80 years, and it is evident in the increasing or decreasing temperature of the Atlantic Ocean. And it is clearly related to the increasing or decreasing run-off in the Mississippi River watershed. There are good papers out by Ephraim[10] and others which show that, for example the cold AMO phase would increase Mississippi River precipitation on the order of 10%. Ten percent water is a lot of water, and that publication looked like a pretty strong analysis. So AMO is something we should keep track of.

The second thing is what is called North Atlantic Oscillation. NAO is a slightly different index that mostly relates to the pressure over Greenland compared to the pressure over the central North Atlantic. And that also has high and low phases, but it is not multidecadal, unlike the AMO, NAO is monthly or annual. And the NAO website has a nice chart with that index for the last fifty years. Again, association appears to be during the drought and flood years. There is some indication that all during flood years ('73,

[10] Please verify name

‘83, ’93) there was a positive NAO phase. So North Atlantic Oscillations were at a positive phase during those flood years.

And then finally, the third thing that you are all aware of is the El Niño Southern Oscillation Index. Although it’s not clearly demonstrated that the positive phase or the warm phase, which is El Niño itself, is associated with flood. 1993 for an example was a warm phase of El Niño, so was ‘73 and so was ‘83. And guess what—1988, which was a drought, that was cold phase—La Niña. So without going into these complicated deliberations over what happens in the next fifty years or one-hundred years, we can do a lot of things just by carefully studying what is known about climatic variability in the present time, and then incorporating that into our models. We develop what you call an uncertainty envelope over those calculations and I think we will then do that more and more intensively in the future.

Russo: In our planning effort we are recognizing the need to conduct long-term planning. Like I had mentioned, we have had problems with short term planning, i.e., limited utility and relevance of projects that have too short of a design life. And that has manifested itself in some of the problems we have had recently with hurricane protection. So the dilemma is coupling that with the notion that if you plan a project that has a one-hundred year planning horizon, of course you have to deal with that uncertainty because it has a wider and wider envelope into the future. We have to plan on what we *do* know: that subsidence will continue, sea level will rise, and hurricanes, at least in the near decades, will be more frequent and more intense. We know we need to plan for those things.

In the investigations we will do in the next eighteen months, we are going to conduct investigations into modeling—to the extent that we are able—with a relatively low level amount of analysis that can be done in such a short period of time. With a view—as real project components would become authorized by congress, as part of the comprehensive plan phase components that may come out in time—that there would be more detailed investigations to fully develop those components to a level of detail that we can bracket the uncertainty and present plans that are rational and defensible, considering all the factors that we do know in documenting those.

But to the extent that we believe uncertainty will be inherently involved, those plans need to have regular review in their development and implementation period. A one-hundred year period for adaptive management is foreseen. As we learn more as those projects get built and operated, we need to continue monitoring the situation and be flexible enough to perform adaptive management to make course corrections to not let the projects become irrelevant and dysfunctional as they age. These are very important things that we have not done very well.

Snyder: Thank you. I think both of you make very good points. As I think about the revision to the Action Plan, and we have a 2015 goal of 5000 km^2 or less of hypoxia area, and I think about the uncertainty, it seems to me that here we are in 2006, and maybe we do not need to have such a long range goal, but maybe we need to have some immediate

goal and reassessments at points in time. Because we are moving with uncertainty into the future, because we are in places we have not been before, it makes it extremely difficult to model, predict, and determine risk assessment; because our margin of error or our margin of uncertainty actually increases over time.

Bahr: For those of you who were not here to hear John Day's presentation, and I know Ed was not, and I do not know whether Dubravko was or not, there are three elements of uncertainty that we are talking about. One is, Dubravko really laid out the two extreme climate models affecting river flows—maximum flow of the river. Second, the sea level change scenario has a huge uncertainty also from climate change. And third, John Day laid out the huge uncertainty in the price of oil. He was warning us that in laying out these massive engineering projects we should take into consideration the fact that oil prices may go up to $150 a barrel in the next ten years. And the cost of moving sediments and doing other kinds of things is going to become prohibitive.

Ed, given those three things, what elements of the planning process that you are playing a major role in over the next eighteen months would be particularly sensitive to those? For example, just take the flow that Dubravko outlined—that ranged from 20% less peak flow in the river to 30% more or whatever the numbers were—what part of the plan that is under development would be affected or influenced by that? If that is even possible to answer.

Russo: Yeah, I think I am going to hide behind the answer he gave. I think you need to have more detailed modeling and investigation to have answers for particular scenarios that you would be evaluating to really give an answer that would really be on target. I do not think I could answer that without some detail.

Bahr: Yes, I am sorry we are at the end of the day on Friday and we are into the realm of unanswerable questions.

Daigle: OK. Let's open it up to the audience. Does anyone have a question that they would like to pose? Please feel free to approach the microphone.

Justic: I guess people have had enough.

Daigle: Well, it looks like we have reached the conclusion of the symposium, and several people have asked what the next steps are. I want to say first that we certainly hope that it has been a benefit to you, certainly through the connections that you have made here with other folks, as well as the information that you have learned. And we mentioned earlier, this is part of the re-assessment process that is going on for the national hypoxia Action Plan—there will be proceedings—and you will have access to them, and they will include everything that has been said today as well as the presentations themselves.

And of course for the Lower River Sub-basin Committee what happens here is going to be used in the continued development of nutrient reduction strategies for the Lower Mississippi River basin.

End of Session