Freshwater Diversion

A Public Forum

FRESHWATER DIVERSION

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Moderated by
Jerald Horst
Louisiana Sea Grant Marine Advisory Service
Louisiana Cooperative Extension Service

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WELCOME

Deano Bonano
Deputy Chief Administrative Assistant
Jefferson Parish President's Office

Good morning ladies and gentleman. Jefferson Parish and Parish President, Tim Coulon, are proud to sponsor today's program. The freshwater diversion projects were initiated in order to save one of Louisiana's most precious resources, our coastal marshes. However, never before has a program that was implemented to benefit everyone in the state created as much confusion and in-fighting as diversion has over the last two years. No one disputes the immediate need for large scale projects such as diversion to help save the marsh that exists today and to rebuild the marsh that we've already lost. Many saw freshwater diversion projects as an immediate fix to the problem of coastal erosion. However, few people really understood how a diversion works or what its impact would be.

Jefferson Parish has experienced the loss of more coastal marsh than any other parish in the state of Louisiana. Freshwater diversion and other projects to save the marsh are of vital importance to Jefferson Parish. The elected officials of the parish are duty-bound however to listen to the concerns of the people whom they were elected to represent and their voices are being heard loud and clear. Many people are not pleased with diversion. They are frustrated and angry because they feel that no one has taken the time to educate them and to listen to their concerns about freshwater diversion. The parish believes that education, cooperation, and communication are needed to make freshwater diversion acceptable in Louisiana. The government and the scientific community can have the latest, greatest information available on how to save the marsh, but if John Q. Public does not understand, and more importantly, does not support the implementation of that science into programs to save the marsh, all these efforts will be rendered useless. The reason that we're all are here today is to start the process of communicating and cooperating.

Today you will hear from scientists, land owners, and commercial and recreational fishermen about how diversions have affected their lives so that we can begin to communicate and cooperate. Our coastal marshes are not only a vital part of our state's economy and our culture, but are truly what sets us apart from the rest of the country. Thank you all for coming, and I hope you enjoy the forum.

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Jerald Horst, Moderator
Sea Grant Marine Advisory Service
Louisiana Cooperative Extension Service

Our first presenter is Dr. Paul Corell. Paul Corell is a Wetlands and Coastal Resources Specialist with the LSU Agricultural Center's Cooperative Extension Service. He has 13 years of experience as a marine advisory agent in Southwest Louisiana headquartered in the Cameron area. His job is to extend research information to the public on wetlands, coastal restoration, and wetlands policy. He is currently a regional coordinator for the Coast 20/50 Program. He is a winner of the EPA Environmental Excellence Award for Region VI, and is the author of a widely distributed and multiply reprinted publication, *Wetlands Functions and Values*. Paul is an LSU graduate.

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PEOPLE AND THE COAST

Dr. Paul Corell

The coast provides food, it provides a wonderful diversity of cultures, thousands of jobs and income, and a lot of recreation. We considered it a wasteland for many years, a mosquito-infested no-man's land, and now we're recognizing this wonderful region for what it provides both in market goods like seafood and oil and gas, and nonmarket benefits like flood protection, hurricane protection, and wildlife habitat.

The seafood industry is really what a lot of people automatically identify as being very important to coastal people. We have a large economic base centered in the seafood industry, primarily the shrimp industry. The diversity of the sizes of boats, types of nets, is varied across the coast. It's a hard way to make a living, and it's also very risky, but these fishermen, both men and women, take up this profession so they can be independent and work on their own schedule. They are independent business people, coming from all walks of life and many different nationalities. They are not just facing land loss, they are also facing regulations. Turtle excluder devices have caused tremendous turmoil within the industry and they're still causing turmoil. Regulations regarding fish excluder devices are also on the way to being implemented now. The seafood industry provides jobs for fishermen and processors. There are many communities that have a large employment in services like ice and fuel.

Our crab industry is very highly utilized, employs a lot of people, and also provides jobs in processing. It has expanded significantly in recent history. The oyster industry has been in turmoil with restoration efforts, because of the importance of salinities in producing oysters. We're facing this conflict on a day-to-day basis with restoration. We have both leased and public grounds where oyster harvesters use primitive harvesting techniques like tongs. Our wild crawfish industry is also very important seasonally in some places every year. These jobs are important as a source of seasonal income to many of our coastal residents.

Finfish, both fresh water and saltwater, are still significant even though many of our saltwater species are now recreational fisheries. There are still quite a few people making a living harvesting both fresh- and saltwater finfish. The recreational fishery is widely regarded as being very important because there are so many participants in that fishery. We see a lot of different species harvested, but the importance of recreational fisheries and wetland resources has begun to be recognized by a lot of users who come from all parts of the coast, all parts of the nation. We have a lot of fishing rodeos and festivals that are tied to fishing, in which many families participate.

Cast netting, rod and reel fishing, crabbing, crawfishing—all of these recreational opportunities have been important to people, but I think that the link with wetland loss has not been fully appreciated through the years. That's something we try to do continuously in Cooperative Extension.

The trapping industry, or a remnant of the trapping industry, still exists, and it has been very important to both land owners and coastal residents. It provides jobs, it provides income, and it also provides an opportunity for wetlands to be maintained as viable and wet because trapping helps to remove some of the older populations of fur bearers like nutria that have caused major problems. Trappers' families work together on these jobs, and the wives and the children often are involved in the continuous day-to-day operation of trapping.

The alligator industry is also very important. It has grown to be the most important surface source of income for the private landowner in Louisiana today. That again is another family-oriented business where everyone works together. We also try to promote appreciation for our coastal wetlands and alligators because with the marshes deteriorating, we can see an impact on the future sustainability of this industry.

We have developed a farming industry through research and Wildlife and Fisheries and we see a lot of farmers and land owners utilizing alligators for aquaculture. Cattle are also important in the coastal area. Agriculture is important on the coast with cattle and crawfish farming. We see a lot of jobs and income that go beyond the coast but link to traditional, maybe previously flooded, wetlands in crawfish and aquaculture. Forestry is also a very important part of our coast. We don't hear a whole lot about it but it takes a long turnover for harvesting of hardwood timber and is still important as a tax base for the parish and also an income for the landowner. The hunting industry is growing by leaps and bounds, especially in waterfowl, but we have a lot more deer hunting occurring on the coast. Deer are plentiful in many parts of the marsh because we have more small banks, more habitat available. Waterfowl hunting is the second most important surface use for the coastal landowner as an income producer. I can't say enough about how important the oil and gas industry has been for producing income for both the state and the landowners, and jobs for the people. We're seeing offshore deep-water drilling expanding, but we still have a significant amount of drilling in the marsh. Mitigation of impacts has been a key issue worked on by the industry in the past and in recent times to try to reduce the impacts of dredging canals. Surface jobs tied to oil and gas are very critical both in providing jobs to the community and also in serving coastal restoration, because oil and gas technology is often useful in the building of coastal restoration projects.

Navigation and ports are very important to the state. We have a lot of people who are employed in ports and are linked to the resources of the coast, be it oil and gas or the shipping of goods and services around the country. Impact has been seen from the dredging of ship channels and access canals but, again, most of this was done prior to the understanding of the fragile system we have and there's much more emphasis on mitigation and the preservation of those resources. We wouldn't build an MRGO, for instance, with the information we have today. The aesthetic values of the wetlands support a growing industry—ecotourism, photography of wildlife, photography of the beautiful scenery in the wetlands, a lot of nature and swamp tours. We see that as being critical to the preservation and conservation of the coast for the future diversity and sustainability of the economic base for those parishes along the coast. Our beaches are heavily used, but because of erosion along most of our sandy beaches, they are high risk areas that will not be preserved or maintained without some direct action to protect and preserve barrier islands. Boating is very important . Not everybody fishes and not everybody hunts, but there are a lot of boating opportunities on the coast. Many of our residents do skiing and swimming and just enjoy the out of doors in a boat. Our drinking water supplies are also very critical to the coast. We do drink a lot of the water that comes into the coastal zone and it's very important that we understand that this is an important issue in why we need to maintain our coastal wetlands. I think many of you have seen some of these projects, but we're utilizing wetlands in many parts of the state to help in removing pollutants so that we can have better water quality in the Gulf of Mexico and, in one way or another, help to address the issue of nutrient enrichment and the hypoxia situation. But at the local level, say Thibodaux for instance, wetlands are being used as filters and this technology is something that has a lot of applications in many of our residential areas along the coast. Opportunities for research and education of our youth, university students, are beyond compare along our coast. We do a lot of education in the field. You can often only teach certain aspects of biology and ecology by being in the field, and we try to do that. Universities utilize this coast as a resource for teaching our future leaders and our future biologists. We need good qualified people to help us in this effort.

The stewardship idea is growing. I think Jefferson Parish has an outstanding Christmas tree project and it is helping people to understand you can make a difference. The state of Mississippi wants to join in with Jefferson Parish. Other states are calling us now and the rest of the nation is starting to catch on. We want to help. We want to do our part. We want to clean up the beach. We want to make things better, and there is an atmosphere of cooperation that, I think, is growing. But we do have a crisis, a major national crisis, at hand. In this slide you see areas that have converted from vegetation to water since 1956, and that trend continues today. We are all here because we know it's an issue of tremendous importance. In the marshes south of your communities here in Jefferson Parish are some of the most badly eroded areas anywhere in the country. So you have a major challenge ahead—*we* have a major challenge ahead—in the marshes of south Louisiana, in particular the Terrebonne and the Barataria basins. Our beautiful marshes are looking more and more like open water areas and bays and we are losing a key source of food for fisheries, habitat for wildlife, and the wellspring for wetlands-related jobs. I think we need to realize that it's not just happening automatically, there is a key food-chain relationship that we have to remember. Vegetative wetlands are critical to the continuing provision of energy for all these resources that we all depend on.

Landowners tell me, and this has been shown in surveys and studies I've done, that they'd like to keep their land, but "if we see deterioration, I'll give it away." What good is land in public ownership that provides no tax base, no jobs? The landowners want to start giving it back to the parish. We don't want that to happen, that's why we maintain a partnership with landowners to provide the public goods and also the private goods for the tax base. The storm buffer is something that everybody benefits from whether they go in the marsh or don't go in the marsh, and that's one thing I always try to tell people. You can say I hate going out in the marsh, but you're getting the benefits from the wetlands because storm buffering benefits are always going to be provided. Do you pay for those? No. But it's something that should make you concerned and interested in coastal restoration. The public has gotten involved. You have the Barataria-Terrebonne National Estuary Program, the Lake Pontchartrain Basin Foundation, CWPPRA, and federal and state partnerships. Things are happening, good things are happening, but there is a lot more need for projects if we are really going to stem the tide. I think Sue Halse told me if we implement all the CWPPRA projects that have been approved, you're only going to reduce loss projections by about 15 or 18 percent. Is that acceptable? That's the question. The state is addressing permitted losses, low land loss through mitigation, so now we have to address the nonpermitted process losses, and that's the majority of the losses, 95 percent.

The future without action is pretty bleak, so we have to take some action. What action do we take? Diversions, marsh management, barrier island restoration, planting of vegetation. It's going to be a variety, but we really challenge everyone in the state to look at this and realize there will be conflicts. Anything we do will cause dislocation of traditional fisheries. Whether we do something or not, fisheries are going to move—they are either going to move farther north or farther south, but we're going to see impacts with action or without action. But with action, we can sustain a base of productivity. We are going to see some issues of public access. We are going to see concerns about private property rights. Water quality is an overriding issue that we see as very critical to this whole process. People are concerned about the water quality in the Mississippi River. There are concerns about money. We need a lot more money and really don't have much opportunity for getting funds unless everyone works together.

I'm going to stop there and just say that in the Cooperative Extension Service, we are committed to continuing to challenge Louisiana citizens to really develop the leadership that is going to be required to address this issue now and into the future, both with adults and with the youth. So, anything that we can do, anything we can help with, we stand ready to do that. Thank you.

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Jerald Horst, Moderator

Our next speaker is Dr. Sherwood Gagliano. He is the president of Coastal Environments, Inc. This is truly a one-stop consulting firm when it comes to wetlands and wetlands issues. They specialize in natural systems management, archeology, coastal restoration, and monitoring. The business is 24 years old. Prior to that Dr. Gagliano spent 14 years at LSU, where he was an associate professor in the Department of Marine Sciences. Dr. Gagliano was the first scientist to measure and recognize the extent and consequences of coastal land loss and I think it goes without saying that all of us recognize Dr. Gagliano as the father of coastal management as we see it today. He has his terminal degree in Geography from LSU.

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SITUATION OVERVIEW

Dr. Sherwood "Woody" Gagliano

Thank you very much Jerald. It is a pleasure to be here today. I would like to say that it's a little discouraging. I've been lecturing and talking about diversions and erosion for 30 years now, and it is really discouraging to see the controversy that's arising over our attempts to use the very best tool in our arsenal, not only to fight coastal erosion, but to restore the functions of the natural systems in coastal Louisiana. I congratulate Jefferson Parish for having this forum to clarify some of these issues and to help us refocus on what we really need to do here.

We live in southeastern Louisiana in the delta plain. It's the product of land building processes of the Mississippi River delta that have been going on for thousands of years. While the Mississippi is the father of all rivers in North America, it's also the mother of the land that we live on, the mother of marshes, and the mother of estuaries. Our landscape is low-lying. We live on the ridges, and we harvest the resources from the basins in between the ridges. What we're really seeking here is some sort of plan that will allow us to maintain our communities and still allow these natural systems to function as they did in the past. The problem, and everybody knows the problem, is that the land is sinking and eroding away. The barrier islands are disappearing and our cities and infrastructure are in danger. We've all seen projections of where the seashore is going to be in 50 years. We know how frightening it is because we are losing these productive areas. It is equally frightening, I think, because our communities and agricultural base and industrial base are also now being threatened.

I think the classic example of what's happening can be seen along the corridor of the Mississippi River in Plaquemines Parish, south of New Orleans. Below Pointe a la Hache, on the east bank of the river, things are still pretty much in a natural condition. The river is overflowing its banks. It's building new land. It's building up ridges. It's driving the natural systems. Whereas on the West Bank we've contained the river with levees to protect us from flooding. We've contained the back side with levees to protect us from storms. We've disrupted things. We've directed the flow out into the gulf and as a consequence, the land is eroding and the land includes all the things that I've said before—the barrier islands, the estuaries, and the fringing marsh. Here we have a view looking north along that corridor. We see the communities, the industrial facilities, the agricultural land, and the fringing marsh that protected these things for hundreds of years but as we all know now that is eroding away. That same process is happening along Bayou Lafourche and on the ridges south of Houma in Terrebonne Parish and many of our communities are being threatened. We must now think in terms of multiuse management, maintaining our infrastructure while still allowing management of natural system functions. We've known that erosion has been going on for a long time, and we are not doing a very good job of preventing it. However, we are making significant steps. We've had a series of programs, first by the state and, more recently, the CWPPRA program, which is a joint federal and state effort, to really address the problem. We're applying our best science and engineering to find solutions, but we're still falling short. We now realize, as Paul said and as the researchers recognize, that CWPPRA, as now conceived cannot restore coastal Louisiana. In fact, we can't really restore the coast the way it was, even to the way it was in 1950. We're going to have a tough job holding a smaller coastal zone and preventing the natural systems from completely collapsing and using the Mississippi and the Atchafalaya to help us do that.

This is a complicated slide, but it makes an important point. The green on this slide shows land loss rates from 1880 to 2068 and, as you all know, the land loss rates peaked in the seventies and have been declining somewhat since then. But, at this point, we've lost about a fourth of the total land area in the coastal zone. We've lost functions of the natural system. The reason that it's declining, in part, is that there's just not as much land to erode. If we converted this to a percentage graph we'd see that it's not declining at all. Our challenge is to start building new land and to bring this decline curve down faster so that we can reach a no-net-loss situation. To do that, we've got to use every tool in our arsenal. We've got to use regulations. We've got to use a whole bunch of other techniques, reef zone building, wetland management, barrier island restoration and maintenance, and most importantly of all, we have to use diversions of the Mississippi and Atchafalaya rivers. Without river power, we don't have a chance. If we have problems in doing that, we have to, as a society, work those problems out and figure out how to do it without affecting too many people.

Now to the real meat of my topic. When we talk about diversions what we're talking about doing is getting water and the sediments and nutrients that it transports out of the river and into the estuarine basins adjacent to it. We have three basic types of diversion. We have siphons which are like big soda straws. When the river is high, a siphon allows gravity flow across the levee through the corridors, and into the backfall areas. We have control structures for the purpose of freshwater introduction and we have a concept that we've only applied by accident called controlled delta building. We have most experience with siphons. Plaquemines Parish, in particular, has been building siphons for many years in conjunction with the Louisiana Department of Wildlife and Fisheries. These structures were first recommended in the 1890s to benefit fur trapping.

Caernarvon and Davis Pond, for example, are outgrowths of legislation that was passed by the U.S. Congress in 1964 for that purpose—just to introduce fresh water into the basins. Our technology has increased. This is a multibarrel siphon built by Plaquemines Parish on the West Bank. It introduces water during high stage of the river into an out-fall canal, which in turn nourishes a vast area of marsh behind. A lot of this technology is home grown. There is an engineer in New Orleans named Prescott Follet who was a pioneer in the development of siphons.

The control gate type is demonstrated by Caernarvon and Davis Pond. These have the same purpose. They are not designed to deliver sediment but nutrient-laden waters to enrich the marshes and to push saltwater out of the estuaries. Prior to the construction of Caernarvon the freshwater/saltwater line had progressed from way down in the basin right up to the back slopes of the natural levee of the Mississippi River. We've measured that and documented it. We know how disastrous it has been, and Caernarvon is designed to prevent that.

In some areas we have freshwater introduction—for example, there's an area in Terrebonne Parish where we get accidental introduction through leakage along the Gulf Intracoastal Waterway. What we see happening there is that floating vegetation is crowding into the open water bodies. They are being colonized by marsh grasses. Without some maintenance, all of the open water bodies in this area will close off as a result of the fresh water and nutrients that they are receiving.

Vegetation has a tremendous ability to build and maintain land if it's in a protected situation and it gets the right kind of nutrients. Historically we had hundreds of thousands of acres of floating fresh marsh that were maintained and built entirely by vegetation and its ability to offset subsidence and to build land. Much of the Caernarvon Basin, for example, was occupied by vast carpets of unbroken marsh and there were very few surface water bodies until saltwater intrusion destroyed that land. Why fresh water diversion then? To compensate for our blockage of over-bank flooding. We built levees, we prevented over bank flooding. To create border zones and mixing in the basins and, importantly, to drive the ecosystems, the trickling of this water through these basins is the same phenomenon that occurs in the Everglades. It drives the ecosystem and it is absolutely fundamental to maintaining its productivity.

Now, moving on to control subdeltas. These address another problem. Our most critical erosion problem in southeastern Louisiana occurs in this area along the coast. It happens that sinking along our coast is controlled to a large extent by faulting, the downward movement of blocks that are bounded by fault zones. These fault zones and these blocks are sinking at different rates. This area is sinking at about a half foot to two feet per century and this purple area at two to four feet per century, and in the lower delta even higher than that.

What that means, for example, is that if you live on Bayou Lafourche and the land that you live on is only three feet high and every 30 years it sinks a foot, you're in bad trouble. So we have to constantly off-set this. The way that occurred under natural conditions is that the river found the holes. It was a chicken and egg kind of situation. The reason that the river periodically changed position in its course through time—this map shows a 5,000 year sequence of delta lobes—was that as the delta built out into the Gulf of Mexico, it became inefficient because of the gentle slope. If a hole opened up adjacent to an existing delta, the river jumped into the hole and starting filling it. The hole is produced by this sinking phenomenon. The sinking is still going on, but the filling is not, and that, in a nutshell, is our problem.

Those those big loads that I just showed you each took about 1,000 to 2,000 years to develop. So, from a practical standpoint, we really can't hope to build the big delta loads, but when we examine them more closely, we find that each one was built as the result of a sequence of depositional events. Each one of these is called a subdelta and each one has a time frame of about a hundred years. So we see that those are manageable from the standpoint of human events.

When we examine them more carefully, we learn a lot of valuable lessons. One of the best examples, the best places to look, is in the lower delta, the bird's foot delta, where a number of these things have developed during late prehistoric and historic times. Each of these episodes unfolded as a result of the river's breaking into what had previously been a bay and building a subdelta sequentially until the bay was filled. Then it became abandoned as the river moved on.

West Bank, for example, was a bay prior to 1839, and it started the fill sequence at that time. This series of maps shows the historic sequence. Here is the bay in 1845. By 1875 it had been substantially filled. The fill continued until about 1922. In modern decades, the delta has been deteriorating, and the fill has been eroding away. When we examine that, when we measure the areas and other things, we find that its fairly typical and gives us a good model of how subdeltas operate.

We see here the initiation in 1839 and this graph shows land building. It peaked at 75 to about 80 to 90 square miles. It has a total life expectancy of about 150 years, but during this first period from 1839 to about 1940 or so, it was building at a rate of about one square mile per year. Now that's pretty good. That's better than we can do with any artificial project. We can't even come close to that with dredging or any other kind of mechanical project.

When we look at all the subdeltas, the historic subdeltas that I showed on the earlier map, here's West Bay. When we combine all those we find that during historic times, they were growing at a coastal rate of about two square miles per year, and they peaked at about 200 square miles of new land. So this tells us something. It tells us that the river can really build land, it can build it fast, and it builds it very systematically and predictably.

We know a lot about subdeltas because we've studied them for geological purposes, mainly to understand oil and coal bearing rocks. We've taken a lot of cores in the delta and we've worked out sequences of how they fill, what they're filled with. The short story here is that each subdelta produces a pod of sediment and that pod becomes capped with organic peat deposits, with shell and with reef-building organisms. Through time these pods build up and fill the holes and form the building blocks of the land that we live on.

We have another good example of a subdelta that man created accidentally. When the Corps of Engineers built the Atchafalaya floodway, they found that the natural outlet through the Atchafalaya was not large enough to accommodate predicted floods, so they dredged a canal called the Wax Lake Outlet through a ridge on which the cities of Houma, Morgan City, and Franklin are located, the Teche Ridge, and connected it to a bay called Wax Lake that was an arm of Atchafalaya Bay. They did this in 1940 and since that time this has become a major branch of the Atchafalaya River. The upper part functioning like a river has filled the bay and, as many of you know, it has now built a substantial subdelta in the Atchafalaya Bay. Here's the channel and all this land is land built in what was once Wax Lake, but the reason I show it here is because it's a natural levee.

These little crevasses are building a ridge like the natural levees along the Mississippi upon which many of us live. Another important thing about delta building is that it drives a sequence of changes. First the land appears, then the land becomes vegetative, createing habitats for fish and wildlife. All these things tell us then that we can actually design, manage, and engineer artificial subdeltas. We can train the river, make it go where we want it to go. We can predict what it's going to do. We can predict how fast it will build up land and so forth.

I and others have proposed creating a sequence of subdeltas by building new conveyance channels in various parts of coastal Louisiana, adjacent to the Mississippi, and even a new channel adjacent to Bayou Lafourche, to create a belt of subdeltas that would stretch across the coast. This would require a reallocation of the flow of the river. Most of the river water goes down the mainstream, some down the Atchafalaya, and virtually none into the Barataria Basin or the Terrebonne Basin where much of our erosion is occurring. But, a reallocation would create a branch that would deliver water and sediment into that critical area. This, of course, would be very controversial. It would require changes in the way we conduct navigation. It would disrupt some existing fisheries, but in my opinion, it's something that we really have to do. Not only can we create this band of controlled subdeltas, but we have the ability to manage them. We know that as the deltas build they drive this cycle of early to advanced deterioration and our whole fishery and wildlife sequence in the delta is tied to this. It's this dynamic cycle that really creates the diversity that we enjoy in our fish and wildlife. What I would propose is that our goal should be the creation of a series of these controlled sub-deltas, engineered, if you will, and managed so that at any particular time, the subdeltas would be at different stages in their sequence. We could insure that at any one time across the entire coast of Louisiana, we would have a rate of conditions that were similar to those that existed historically before we messed up the system.

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Jerald Horst, Moderator

Dr. Denise Reed is an associate professor at Louisiana Universities Marine Consortium, also known as LUMCON. She has been there nine years. Her expertise is sediment dynamics in marshes. She has extensive research experience in the area between the Mississippi and Atchafalaya rivers. She obtained her Ph.D. from the University of Manchester in Geomorphology. Denise will discuss a comparison of systems with and without freshwater influence.

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COMPARISON OF SYSTEMS WITH AND WITHOUT FRESHWATER INFLUENCE

Dr. Denise Reed

As Jerald mentioned, I work for LUMCON, Louisiana Universities Marine Consortium, and for those of you who don't know the area, we're located at a marine lab in Cocodrie south of Houma in Terrebonne Parish. I see the marsh out the window everyday, and as a resident of the coastal zone, I'm keenly interested in these issues, not just professionally but also personally.

As a research scientist working in the coastal wetlands, I look for patterns and try to understand what's going on in order to make more effective projections of what might happen in the future, and also to learn things that can be used to address problems now. What I'm going to do today is tell you a little bit about two parts of the coastal marsh. One of the good things about being a researcher based at LUMCON is that I do get out a lot in the marsh and see different places. We conducted a study that was funded by the U.S. Geological Survey in two locations. One was south of the Atchafalaya, south of Four League Bay, and one was close to Cocodrie.

The brown zones on this habitat map are both salt marsh areas, so we're comparing two of the same kinds of marshes in different areas. One is relatively close to the out-fall of the Atchafalaya River, and gets a lot of freshwater inflow, even though it's a salt marsh. It gets fresh water during the spring when the Atchafalaya River is high, but also a lot of saltwater during the fall when the river is low. This is the same situation that we find in areas over here, south of Houma, which are very well removed from the Mississippi River. Of course the removal of those areas, or the separation of the areas south of Houma in eastern Terrebonne from the Mississippi, is a relatively recent phenomenon, in geologic time. I'm a geomorphologist, and that means that I study how land forms develop and why systems look the way they do, so we look frequently at fairly long time scales. It's a bit like being a recent geologist, if you like. So, we looking at an area down here and an area over here in the study that I'm going to describe. The area south of Houma has only recently been isolated from the Mississippi River. This is a map that Dick Castle provided to a publication I edited a few years ago that shows this big shaded area. It shows the part of coastal Louisiana that was flooded by the river in 1874. Now you probably know there were already some levees on the Mississippi River in 1874, but they weren't very big, they were isolated. It wasn't a coordinated system like the one we have now, and during big floods water would spread into the coastal zone. What came with that water, of course, was probably a lot of mud and whatever else was in the river at the time. During spring about 150 years ago, sediment used to spread over large areas of the coastal zone.

This is another of Dick's diagrams showing the same kind of pattern. It shows that in the mid 1980s a lot of water did go down the Atchafalaya, a lot of water did follow the mainstream of the Mississippi down through New Orleans, but also there were lots of points at which water could get out of the river into the coastal system. We contrast that with a scenario today where basically the water, as it moves through the coastal zone, is largely confined to the main river channels.

Therefore what we're going to do today is compare an area that gets water from the Mississippi River with an area that is distant and hasn't had any water from the Mississippi River for a long time. Here's another map because I want to make sure that you can follow which side is which as we go through. This site over here is called Old Oyster Bayou and the site over here, south of Houma, is called Bayou Chatigue. I'll call them the one close to the Atchafalaya or the one south of Houma or whatever to try and keep track of them as we go through the comparison between systems. I should say that even marshes in coastal Louisiana that don't get any sediment directly from the Mississippi River do still have sediment being deposited on them. Woody Gagliano has done a good job of describing how the land is sinking across this part of the coast and how, if you're living in Golden Meadow, you've got a problem because the land is basically getting lower. The good thing about the coastal marshes is that they have a mechanism for balancing the deep position of sediment on the top of the marsh and organic accumulation. Obviously if sediment is coming down the river and getting into the marsh, that can help that process. But even marshes that are a long way from the river, like these down here, do get some sediment , and that sediment doesn't come directly from the river. It gets reworked from these big coastal bays during events like cold fronts. Before a cold front passes, we get strong winds from the south or southeast. So when the front is up here around Baton Rouge or up toward Shreveport, the wind is blowing from the southeast. So if there's a marsh up here, the wind is blowing straight across Terrebonne or Timbalier Bay. These are shallow bays, as you know, about six or eight feet deep. Even relatively small waves pick up sediment from those bays and push it up into the marshes.

The story I'm going to tell is not one of sediment in this area and no sediment in this area. It's a story of sediment coming from different places. That's perhaps the bottom line, and I've given you the backdrop already. So why did we decide to look at these areas? We decided to look at them because this is a land-loss map, a blowup of part of what Paul showed earlier. Everything that's red or orange on here was land in 1956 and changed to open water by 1988. But this area up here, these salt marshes were having lots of problems. Lots of land loss in the area whereas the salt marshes, close to the Atchafalaya seem to be doing quite well. Let's see what they look like.

First of all the marshes south of Houma, those close to the lab in Cocodrie, you can see the fairly degraded, sparse-looking vegetation. If you look at it on the ground, again you can really get an idea of the really sparse vegetation and soupy kind of soils. You don't step off that boardwalk because it is very difficult to move around. You'll see incidentally in all of these slides that there are ponds, big pools in the marsh. We were examining the dynamics of these during the study. If you look at the surface of the marsh and take a survey profile across it, between the bayou and one of these ponds, you see it is hummocky.

Comparing these marshes with the marshes over by the Atchafalaya, you can see looking at them from the air, a much more contiguous spread of vegetation, a much more even look to the landscape. If you look at it on the ground, it is much firmer. The vegetation is more dense. You can walk across this marsh. I think these people are actually standing on a platform. We try not to cause too much disturbance, but it is possible to walk across the marsh surface here. And, if you do the same kind of profile across the marsh surface, you see a much more even topography. What we did in these two areas, what we're trying to do in this study, is find out why they are different and document the differences between them.

We used a technique for looking at sediment deposition, which is to lay little traps on the marsh surface and go back two weeks later to pick them up and put clean ones down. These have just gone down and are nice and clean. After two weeks there will be sediment on these. We pick them up, take them back to the lab, weigh and measure them, and put fresh ones down. We do that every two weeks to try and find out when the sediment is being deposited in the areas and how much is being deposited. The other thing we do is work out how high these areas are and how often they flood.

Now we're going to see a little bit of data. On these slides, the red is the site close to the Atchafalaya and the blue is the site nearer to Cocodrie, the one south of Houma away from any sediment that comes directly from the river. The tide comes in and goes down in these areas. They're tidal salt marshes and for the area close to the Atchafalaya, is the average length of each flooding event is 10, 12, 15 hours, something like that. The tide comes up, the tide goes down. The tide comes up, the marsh floods for a period of hours, and then its drained, and exposed again. At Bayou Chatigue, however, there are many periods when the tide comes up and doesn't go down. Of course, it's not because the tide doesn't go down, but because the marsh surface is so low in there that even though the level of the tide goes down, the marsh is still covered in water. And so what that means is the soil stays saturated for a long period of time. The marsh elevation is really very low compared with the area close to the Atchafalaya. This slide shows the results of the monitoring we did every two weeks, the sediment deposition between the two areas. Now you might expect that the place close to the Atchafalaya would have more sediment than the other area, but as I explained earlier, there are storms that can bring sediment into these marshes that are isolated from the river.

We actually get more sediment being deposited in the marsh close to Cocodrie. The degraded marsh, the one that looks like it's falling apart, actually has more sediment being deposited on the top of it. This is from February, 1992, through September, 1993, and it's about every two weeks during that period. And, you can see that the actual cycle or the time that sediment gets deposited in the marsh is different between the two areas. What you see on the area closest to the Atchafalaya is a peak in April and May, 1993. That seems to be very closely associated with the spring rise in the Atchafalaya that year. So, you say, where was it in 1992? Actually 1992 was a relatively low flow year. There wasn't much of a spring rise that year, and so we didn't get much. It seems as if the sediment deposition at Old Oyster Bayou is quite tied to cycles in the river, except for the period in 1992 when Hurricane Andrew struck. That's why there are some missing data points unfortunately. Whereas the patterns that we see at the site away from the Atchafalaya, near Cocodrie, are much more tied to winter storms, hurricanes, and rain. And so we see that the inputs to the marshes close to the river are very directly related to cycles of the river.

We do several other kinds of measurements. And there are two techniques that we use for that. One, called accretion, measures how much material, how much thickness of material, collects on the marsh surface over a certain period of time. We did this study for two years, and what we found at Bayou Chatigue, near Cocodrie, was that we had over 5 cm. in new material on top of the marsh, in two years. Whereas over by the Atchafalaya only about 2 cm accumulated. We measured accretion with traps. If there was a bigger accumulation on the surface at Bayou Chatigue, why is it falling apart? The key is the elevation change. We use a different technique that actually tells us what the elevation of the surface is and how that is changing between these two areas. What's happening at Bayou Chatigue is that, even though an enormous amount of material is being deposited on top of the marsh, the actual elevation isn't going up. There's more material being placed on the top but the surface isn't actually rising because it seems that the plant structure in the area is just collapsing. The root zone seems to be collapsing. We're putting more and more material on top, but we're not actually going up because the subsurface is going down. When I say subsurface, I'm talking about things that are going on within the top one or two feet of the soil, within the plant zone really. The plants are really suffering very much. At Old Oyster Bayou, there is really not much difference between the amount of material that gets deposited on the top and the elevation. When you add more on the top, the surface goes up, which is what you want to happen and what you would expect. When you measure plant material above the ground—the stems, the leaves—there's actually not that much difference between the two places. And, in fact, you might see less in the area near the Atchafalaya. The big difference comes in the roots, in the belowground biomass. We have much more root material at the Old Oyster Bay site. Those plants are doing a whole lot better. So, why are the plants doing a lot better? I'm not sure that we know exactly why. I'm not sure that I can tell you it's anything in the sediment. or the nutrients, or the fresh water, or any of those things. What we know is that we have two areas that are basically the same. There aren't any oil and gas canals in these areas. They are relatively pristine. They have the same configuration of pond and bayou and are about the same size. The difference between the two areas is the river input. When the sediment comes in and where it comes from.

That's the kind of thing that makes me believe we really need to seriously look at diverting fresh water and what good it can do. I'm not trying to build new land with it here. I'm trying to hang on to the marshes that we've got. What we know is that the loss rates are less in areas that the river is going into, over there by the Atchafalaya. And, we know from the data that I've shown here that the marshes are doing very well. Now, I am not though, however, as a resident of the coastal zone, going to advocate just letting it loose and getting it down there. I don't want water in my backyard in spring anymore than you do. And, I don't want Hurricane Andrew in my backyard anymore than you. So I want those marshes there for different reasons and I want to try and do something with the river to keep them there for those different reasons. I think we have some opportunities with the river to help our marshes look nice and healthy like this, as they are over by the Atchafalaya, rather than like this which all too frequently is what we see when we go up in a small plane in Terrebonne parish, and of course in Barataria.

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Jerald Horst, Moderator

Allan Ensminger is a private wetlands consultant and owner of the Wetlands and Wildlife Company. He is a wildlife management biologist. As a consultant, he provides technical advice on wetlands to coastal land owners and managers. Sometimes we forget that those vast wetlands are owned by somebody, that they aren't just wide open areas. He has been a consultant for 13 years and was with the Department of Wildlife and Fisheries for 30 years, ending his career as chief of the Fur and Refuge Division. If I may editorialize just one second, I can say that probably Allan has spent more time with his feet in the marsh, walking the marsh, than almost any other speaker in this room today. Mr. Ensminger.

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COASTAL LANDOWNERS' PERSPECTIVE

Allan Ensminger

Thank you Jerald. To those who watched my limp coming up here, I can say my days of walking the marsh are about over with. I'm here today representing a company that all of us in this room are familiar with, Louisiana Land and Exploration. I hasten to say that that's an ex-name, as the company has been purchased by Burlington Resources. Burlington Resources is a land company that evolved following the Civil War as a result of a transcontinental railroad that was built from Lake Superior to Puget Sound. President Lincoln made huge land grants to Burlington Railroad Company to accomplish that. They sold off some of the properties in order to construct the railroad but maintained ownership of extensive holdings. In the early 1950s, oil and gas were discovered under some of Burlington's property in North Dakota and they obviously got into the oil and gas business. Early in the 1980s they bought out some small oil and gas companies. El Paso Gas was one of the early purchases, and that increased their oil and gas presence. In the late 80s they purchased Diamond Shamrock, which many of you are familiar with in the oil and gas industry, and ended up with some extensive offshore oil and gas income. Their most recent purchase was the Louisiana Land and Exploration Company.

Burlington is a company of about 12 billion dollars in value and, I think, paid some 3 billion dollars for the Louisiana Land and Exploration Company. The purchase of LL&E gives Burlington the largest reserve of oil and gas of any independent company in the United States, amounting to trillions of cubic feet of gas and billions of barrels of oil produced on an annual basis. My hope, as a citizen of the state of Louisiana and certainly as a consultant with a vested interest, is that Burlington will have the same land ethics and concerns as LL&E about the coastal marshes that they now own. Louisiana Land and Exploration Company owned 660,000 acres of land in Louisiana, much of it in Jefferson Parish. Only a small amount of LL&E ownership was not coastland.

Not only Burlington, but all coastal landowners have a tremendous stake in stemming coastal erosion. Coastal erosion, as Dr. Gagliano, Dr. Reed, and Dr. Coreil have pointed out, is not a brand new thing. In geological terms, it has been going on since the process of building coastal marshes began. The process of abating loss is what I think we have got to really direct our attention to. As Dr. Gagliano pointed out, we can't expect to restore our coastal marshes to what they were in 1950. I was fortunate enough in the early part of my career to be able to fly aircraft. I've spent probably some 4,000 hours in my career flying back and fourth, and most of that time was across the Louisiana coastal marsh. And on each flight I was astounded to see our marshes just gradually subsiding and disappearing. This was particularly disturbing in the areas around the mouth of the Mississippi River. Those areas from about Myrtle Grove south—it looked as if the world had fallen out from under the marsh and it disappeared and turned into open water. The astounding part of that was that we had a tool next door for slowing the losses down and eventually freshwater diversion came along. But it has been agonizingly slow. As Dr. Gagliano pointed out, Davis Pond and Caernarvon were authorized 20 years before any construction was ever done. It's almost a situation of too-little-too-late.

I think that from a landowners' standpoint, we could probably say "the more the merrier and the quicker the better," but certainly we understand and recognize that that would have a huge socioeconomic impact and affect huge areas of our coastal area. We feel that the coastal 2050 program being launched by the Department of Natural Resources is long overdue. We all need to take part in that, sit down and put our thoughts together, and provide the Department of Natural Resources with our ideas as to what we want to see our coast look like. Certainly from my standpoint I want to see a pintail and a mallard in every pothole. Rick Hartman and Rubison want to see a redfish in that same pond. Well, sometimes that can happen and sometimes it can't. But, as other speakers have pointed out, all of us have to give a little bit, and certainly I think that the landowners stand to gain huge benefits from being able to hold onto their property.

Those benefits project back to you as the public in the form of taxes. I strongly suspect if we'd look at Jefferson Parish's tax rolls, the properties now owned by Burlington Resources would make up a huge percentage of the land tax from this parish, not counting industrial and developed areas. Certainly those are critical. Many people have suggested tax incentives to have landowners be more aware and participate in restoration. As of this date, I don't think I've ever talked to a single one of these large landowners who was interested in a tax reduction. They pay taxes on that property out there and probably the surface income from their property in the form of fees for duck hunting, fur trapping, and alligators does not even equal the amount of their tax burden, but certainly they understand that there is a responsibility to the school system, the roads, the infrastructure, and the political needs of communities for those taxes.

One of the other questions brought up was this benefit of hurricane protection. I moved down to this area back in the mid 1950s and experienced hurricanes Betsy and Camille, flooding huge areas down the Mississippi River in Plaquemines Parish. As a matter of fact, I landed a float plane on the football field in Buras and over in Chalmette during those storms. It's obvious that those poor people were living inside a basin, in a bathtub. Luckily for my house in Belle Chasse, the water didn't go over the levees, but we were only a millimeter away from being flooded in Hurricane Juan. The parish administration recognized that and started a very aggressive levee enhancement program in those parishes and have brought those levees up to what they consider a substantial height. I caution here that those levees may not be high enough. Sooner or later, if we get one of these Hurricane Juan systems that move into our coastal areas associated with winds of 150-200 miles an hour, it will flood huge sections of this metropolitan area.

Landowners are very much in favor of freshwater introduction and for these freshwater and other coastal restoration processes. I have been a member of the Louisiana Landowners Association for a long time. I served as chairman of the Wetlands Committee, and I would say that a third to a half of our time at our monthly board meetings is involved in discussions of land loss and coastal restoration activities. So large landowners are very much interested in the same issues that you are here today. They are a little more removed from the bay and the fisheries than you are, but as Dr. Coreil pointed out, without vegetated marshlands, those resources are in extreme jeopardy of being lost. Dr. St. Amant, whom I had the opportunity to serve under for many years as our Assistant Secretary, did his Ph.D. work in Barataria Bay back in the 1930s and one of the things that he pointed out at that time was that the isohaline line in his lifetime had moved as much as 15-20 miles north, in Barataria Bay. While that seems to be a relatively insignificant movement of the isohaline line, it really represented a huge, traumatic change in the ecosystem out there.

Ted O'Neal, who was my boss when I went to work in the area, had walked these marshes in the 1930s and produced the historic map that many of our modern day studies are based on. The types of maps that Ted Johanan and Bill Pomasano and Dr. Chabreck did in the 1960s serve as the base for our coastal restoration activities. In the process of laying that 1968 survey, those technicians were basing their daily observations on Dr. Gagliano's advice and on the old maps that O'Neal had produced. Their daily activity didn't coincide. So, Dr. Gagliano, I think, finally pointed out to us, as technicians, that subsidence was so rampant at that time, and land loss was so rampant, that we were completely confused as to the process that had taken place during that short 20 years between when Ted O'Neal had spent extensive time in the marshes and when these technicians made the very first quantitative survey of our coastal marshes.

The marshes as they existed in 1968 cannot be restored. I have always been a proponent of trying to pick a target date and trying to manage our marshes back to that, but I realize that that's totally unaccomplishable. We have to just try and hang on to what we have left today. If we are able to do that, we will have left a mark in history as being miracle workers. So certainly freshwater introduction, as Dr. Gagliano has pointed out, is a major tool that we must use and we must use it with some common sense so that we can have the least amount of adverse impact on the various resources. Thank you.

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Jerald Horst, Moderator

Emelise Cormier works for the Louisiana Department of Environmental Quality, where she oversees the Clean Water Act mandates and the state's Water Quality Standards Program. She identifies water bodies with pollution problems and that includes mercury. She also works with the Nine Point Source Pollution Program and the Fish Contaminants Sampling and Testing Program. Ms. Cormier is a graduate of LSU.

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MISSISSIPPI RIVER WATER QUALITY

Emelise Cormier

I will talk to you today about DEQ's monitoring of the Mississippi River and give a few insights about the quality of the water in the Mississippi River. Then I'll be glad to answer any questions. I'll try to make my presentation fairly brief.

The Louisiana Department of Environmental Quality's Office of Water Resources maintains several different monitoring programs of the Mississippi River. Of course, the Mississippi River is a high priority with us because it provides drinking water for over a million and a half people in the state of Louisiana. I know there are a lot of concerns regarding the quality of the river water with respect to diversion, so I hope I can help ease some of those concerns today, clarify some things and allay some of the fears people may have about Mississippi River water quality.

Our key monitoring program of the Mississippi River is what we call our Ambient Monitoring Program. We also monitor toxics in the Mississippi River through various different programs. One of those is the Early Warning Organic Compound Detection System, which is fondly called EWOCS. The Ambient Monitoring Program consists of six sites up and down the river starting at the state line at Lake Providence, proceeding down to St. Francisville, near Plaquemine, Lutcher, Belle Chasse, and Pointe a la Hache. At each of those six sites we collect one sample once a month at midstream. In years past we were collecting samples at both banks of the river. After many years of doing that type of monitoring, we took a look at the data and found that we had no statistical difference in results from one bank to the other, and it was a very resource-intensive process to get out there and collect samples at both banks at six sites along the river. So in 1991 we changed our scheme a little bit and we took advantage of the ferry boats. That way we didn't have to deploy boats into the river and get from one side of the river to the other. So our people get on the ferry boat, go out, take the sample at midstream, and it's a lot less intensive effort. With those samples, we look at 25 different parameters. These data are available through DEQ and if anyone is ever interested in acquiring it, you can give me a call there. Eventually the data will be accessible through DEQ's website as well.

Some of the parameters we look at include pH, dissolved oxygen, temperature, turbidity, total suspended solids, nutrients, metals, and bacteria. Just in a nutshell, the Mississippi River water quality is good. The key parameter that frequently shows up as not supporting the standards that we've established for the river, is bacteria. And yet the bacteria counts in the river are much lower than many of our other water bodies in the state. The standard for swimming is 200 bacteria per one hundred milliliter and typically in the Mississippi River those counts are below 200, sometimes above in the range of 300 to 500, but usually below 200. With respect to metals, we don't exceed our standards. In nutrients, when you compare the Mississippi River with many of the other bayous in the state, it is not really any different. So, I think overall we can say Mississippi River water quality is good with respect to these parameters which we consider our conventional parameters.

A lot of concern with respect to river water quality is with the toxics, and I'll talk a little bit more about that. This map is here to give you an idea of the location of the monitoring sites. One of our toxics monitoring programs looks at volatile organic compounds at each of those six sites, which we are monitoring once a month for the conventional parameters. Again, those sites are St. Francisville, up at the state line at Lake Providence, Plaquemine, Lutcher, Belle Chase, and Pointe a la Hache. We look at about 25-27 volatile organic compounds like taluwene, benzine, dichloroethane, and trichloroethane. And at two of the sites, St. Francisville and Pointe a la Hache, the one site being above the industrial corridor and the other below the industrial corridor, we also look at 85 other priority organic pollutants. Most of the time, we do not detect anything in those samples. I think we could say, although I haven't sat down and really calculated it, that 95-98% of the time those are nondetectable, and we're measuring them at parts-per-billion levels. We also look at BOC's right next to a number of facilities between Baton Rouge and New Orleans. This is done at about 16 different facilities. We have a boat that goes out and collects a sample just above the discharge point and just below the discharge point, right near the bank where these facilities are discharging. In this program we are also analyzing for volatile organic compounds. And, again, with this program, most of the time, we do not detect anything at all in the samples. This also is done once a month.

We have also done some fish tissue contaminant monitoring. In the 70s there was a lot of monitoring done looking for pesticides in fish tissues, because there were a lot of fish kills in the river in the 70s. Monitoring was being done specifically for pesticides, chiefly the old pesticides that have now been banned. From about '78 to '86 the Water Pollution Control Division, which is now part of DEQ, conducted pesticide monitoring in fish tissue statewide on a routine basis. In about '86 we had to discontinue that because of the drain on resources. But we had an opportunity in 1990 to take another look at fish tissue contaminants in the Mississippi River through a federal grant. So we collected samples from the river from 1990 through '94, a total of about 154 samples, and analyzed those fish tissue samples for a number of priority pollutants.

When we started this study we were analyzing for over a hundred different priority pollutants. That included metals and included PCBs, the older pesticides, a few of the new pesticides, and a number of other semivolatile organic chemicals. After the first two years of study, and looking at our results, we detected very little in most of those compounds.

In doing this study, as we do in any of our fish tissue contaminants work, we try to collect composite samples. That is, we'll use more than one fish to make up a sample so in a sense we're getting a broader picture in looking at the results that we get. We typically use at least three to five fish to make up one sample. We analyze the filet tissue because that's what people consume and we are concerned about the public health implications of contaminants in fish tissue. We try to group those samples by size class, so we never mix a very large fish with a bunch of small fish. And, when we do happen to catch an extremely large fish, we will analyze that one by itself.

So, after the first two years of that study, and seeing that we weren't detecting a lot of the compounds we were analyzing for, and that analysis was costing us nearly $1,000 per sample, we decided to cut back on the compounds we were looking for. That would allow us to get more samples analyzed with the funds we had left for that study. We reduced it to the compound groups that we were detecting in the fish, chiefly the metals, the older pesticides, and PCBs. In the last year we looked only at those compounds. The metals were not detected at levels that were of concern with respect to human health. Mercury was of key interest because that is a hot topic and it's something we had begun to study statewide. Mercury concentrations in Mississippi River fish are very low, much lower, in fact, than in many places in the state. One half part per million is our alert level. Fish from the Mississippi River that we sampled in this study averaged .06 part per million of mercury, so mercury was not a concern with respect to Mississippi River fish. PCB's were detected in only six out of the 154 samples that we collected. This was one thing that surprised us. We expected to find more PCB's. We expected to find a lot more contaminants in general. So we were pleased with those results, and where we did detect PCB's they were at very, very low levels. With the pesticides, again, what we detected were the older banned pesticides such as DDT, DDE, dialtran, and toxaphene. Toxaphene was detected in only a few fish and at very low levels. All of these were detected at very low levels, much lower than what we were finding back in the late 70s and early 80s. We hope these will continue to go down over time. We did risk-assessment evaluations of these results. That is, we calculated potential increase of cancer occurrences in the population and determined that there was no need for an advisory regarding fish consumption from the Mississippi River. We looked at the average overall levels during the sampling period for all the various compounds and did not see that there was enough of a potential risk to human health to warrant any recommendations for reduced consumption of Mississippi River fish. At present, we are continuing the statewide mercury monitoring program. We are not doing any ongoing studies of fish tissue contamination in the Mississippi River. If resources allow it in the future, we hope to be able to revisit that and compare results with what we found in this study in 1994.

Finally, the Early Warning Organic Compound Detection System is a cooperative program that we initiated around 1984 with several industries along the river and some of the public water suppliers. The purpose of this was to monitor water quality problems resulting from spills in the river. That would allow us to issue an alert in the event of a threat to the drinking water supply and to public health safety. We now sample at nine sites. The way this works is that the facilities participating in this program collect the samples at their facilities, analyze them for volatile organic compounds, and send the data directly to DEQ via computer so we can monitor continuously what's going on in the river. That's five industries and four waterworks between Baton Rouge and New Orleans. The samples are collected twice daily at all the sites, and at two of the sites they are now collecting samples hourly. Again, with this program, in 95-98 percent of the samples collected we detect nothing at all. And when we do, it is usually the result of a spill on the river. We have a computer modeling program that allows us to plug data into the computer. We can tell it what concentration of a particular compound was detected and at what point along the river; and the computer will calculate how long it takes for the plume of the spilled pollutant to progress down river. And in that way we can alert communities if there is a need to shut down their water supplies so that the contaminant is not drawn into drinking water. Here is a map to show you where those sites are along the river. And with that I'll close and I'll be glad to answer any questions.

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Jerald Horst, Moderator

Our next speaker, Mr. Bob Meade, is a retired hydrologist, recently retired. His career of 40 years was spent with the U.S. Geological Survey. His area of expertise is how major rivers carry, store, suspend, and resuspend sediments. His experience is not only in the Mississippi River, but in the Amazon and Orinoco rivers in South America. He also has expertise on Mississippi River contaminants. This morning he will discuss sediment availability in the river as obviously river water will divert sediments. The question is, how much is available to divert? Mr. Meade.

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SEDIMENT AVAILABILITY IN THE MISSISSIPPI RIVER

Bob Meade

I want to get your minds out of Louisiana for just a moment and look up river a little bit. And to put the point on that, I bring you greetings from Jefferson County, Colorado, which is where I pay my taxes. What I want to talk about is the sediment that comes down the river, where it might be coming from, why there is less of it coming down the river now than in the past, and what some of the contaminants are that accompany those sediments. If we have time, I'll pick up on the point that was raised in the questions to Woody Gagliano's talk about pumping the water out of the river and where you should be pumping it from.

First, let's start with a general hydrologic picture, where the water comes from in this system. When you start from the mouth of the Mississippi and go up the river, if you are a hydrologist or a geographer, you soon realize that we've been sold a bill of goods when we were told that the source of this river is Lake Atasca, Minnesota. If you take the piece of the river that goes the farthest, you end up in Montana, and if you take the piece of the river that is bringing you the most water—the hydrologist's definition of what the mainstem of the river is—the source of the river would be in upstate New York. But you can see a good bit of the water, more than half, at the confluence where the upper Mississippi comes out of the Ohio drainage system. And down at the bottom is the Atchafalaya diversion. About 25 percent of the average flow of the Mississippi River is diverted at Old River and it joins in with the Red River and goes down the Atchafalaya.

Now let's talk about the distribution of the sediment, where the sediment comes from, and where it is going. Most of the sediment that's carried by the river is in suspension in the water rather than being pushed along the bottom. And most of that comes from the western tributaries, particularly, under present conditions, the Missouri River. But, it wasn't always that way. The picture on the right is the same diagram I showed you superimposed on the map on the previous slide and the picture on the left is how things probably looked around 1700. The picture on the right is based on about 12 man-years of effort on the part of the Army Corps of Engineers at Vicksburg—lots and lots of records, all compiled, evaluated, and cross-checked for quality. The picture on the left I dreamed up in the shower. Because it's my estimate, I think it is as good an any, and better than most. But anyway, the point of this slide is that, and I think there is a consensus on this, the amount of sediment being brought down the Mississippi now is about half of what it was under natural conditions, under pre-European settlement conditions. The diminution has been in the western tributaries, particularly the Missouri, and the Arkansas. There's some compensation by the addition of sediment from Ohio River drainage, which is probably an effect of deforestation of humid areas of the Mississippi River drainage basin and the conversion of forestland into cropland, which of course adds sediment to the system.

But there's been a major diminution in supply of sediment to the Mississippi River and particularly to the Mississippi delta within the last 200 years. However, this major diminution happened very recently. Actually, most of it has happened since World War II. The main reason for it is the construction of reservoirs, particularly in the western states, to impound water for irrigation for hydropower, for flood control, for a consistent supply of water, say in the upper Missouri, for navigation in the lower Missouri and so on. As you fly over the west, you can look out the windows and see a lot of these things. This slide was taken on the Cumberland River, not far above Nashville. You're looking down the Cumberland into a reservoir, in the springtime when the mud is flowing in the river and you can see the mud in the part of the river nearest to you. As you go down the reservoir, the water gets progressively clearer, which means that the sediment is settling out, which is analogous to the kind of process you people are talking about using down here to rebuild salt marshes.

Reservoir construction is going on in the upper parts of the river, both in the humid and the arid parts of the river basin. The spectacular example of this is the dams and reservoirs that were built on the upper Missouri River right after World War II. This slide shows the mainstem of the Mississippi and here is the Missouri . Right after World War II, starting in the early 1950s, a series of reservoirs was completed in the upper Missouri River, and the sediment loads in that part of the river dropped drastically. The records start about 1940, and go in some places up through about 1980. As these reservoirs went in, one after the other, the sediment loads dropped drastically, almost down to zero here at Yankton, South Dakota, and by a very large amount at Omaha. You can follow this all the way down the river to the station at Baton Rouge, which has been moved and is now in Torbert Landing. But it's roughly the same station and shows the same record: a drop of about 50 percent in the amount of sediment being brought to this part of the Mississippi River and this part of the Mississippi delta.

So you've got half the sediment coming down this river system that came down 50 years ago. When you look at those graphs that Woody showed you of West Bay, the growth curve starts to drop off at just about this point right here. I don't know if that's mere coincidence and a mere convergence of other factors, but it struck me as I was looking at your slide this morning that reservoirs must have had something to do with it, that you very suddenly and very abruptly had half the sediment coming down the Mississippi that you had previously.

Besides the construction of reservoirs, there are other things in the upper river system—engineering projects that have had strong influences on the amount of sediment coming down the river. The other major factor is the construction of dikes along the sides of the river that are built to train the river into a narrower, deeper, and faster channel. This slide shows what the lower part of the Missouri River looked like in 1833 according to an artist who was there, a Swiss artist named Karl Bodner who was a very good draftsman and did not invent the landscapes he painted. He painted what he saw. And you have a snarly, snaggy sandbar, a snag ridden river channel. Lewis and Clark's journals, for example, talk about Eureka, particularly the Clark entries. There are a lot of descriptions that sound very much like what this picture looks like. This is a picture of a stretch of the Missouri River in September, 1934, and except for all those snags, the river looks pretty much the way it did when Karl Bodner went out there with Prince Maximillian in 1833.

The aim of the engineering of the Missouri River is to convert something like this into something that's reliably and consistently navigable. The pictures I'm showing you were assembled by Norm Stuckey, with the Missouri Department of Conservation. What was done in the 1930s through much of the Missouri River was to put in a series of wing dams to control the channel, to narrow the channel so that all the deposition would happen in one part of the channel and all the scouring would happen in another part. The channel would become self-scouring and make itself deep enough for consistent year-round navigation. So this is what it looked like a year after that first picture, after they first put in these structures. Ten years later it was filled in and vegetated. This is a kind of upstream analogy to what you are thinking about and have been talking about down here in the marshes. Another ten years and the structures became so well established that opportunistic vegetation was cut out and farmers put in hayfields and began to use this as agricultural land. The last picture in the series here was taken at pretty much the same site, in March 1977. It is a completely transformed landscape, but this sediment is no longer coming to Louisiana. There are many places like this along the mainstem of the Mississippi, as well as up the tributaries where this process is happening.

Those are the major causes of the reduction of sediment supply down to this part of the river from the mainstem of the Mississippi. So what's coming down now? The sediment that's coming down is also transporting contaminants. In the study we just completed on the contaminants in the Mississippi River we detected inputs from various activities in the upper river—agricultural, industrial, and municipal. All these companies get into the river with the suspended sediment and interact with it. They get deposited on the bottom, and then get resuspended depending on the flow condition, and so you have coming down the river system, not only sediment, but the contaminants that it's transporting.

What are some of these contaminants? They are the ones, of course, that prefer to travel in the adsorbed state on sediment particles rather than in true solution. Atrozine, for example, comes down in true solution. Many of the nutrients like nitrates, for example, come down almost completely in the dissolved state. Others, like lead, PCBs, and DDT, travel on suspended sediment particles. If you put lead in water with sediment in it, by a proportion of a hundred thousand or ten thousand to one, the lead will go to the sediment particle and be absorbed on that sediment particle. If you collect a water sample and filter it the way a lot of water samples are filtered for chemical analysis and you just analyze the filtrate, the part that no longer has the sediment in it, you're not going to find the lead. If you're looking for lead, look on the sediment. If you're looking for PCBs, look on the sediment.

We recently completed a study of the pollutants in the Mississippi from Minneapolis down to New Orleans. We found higher concentrations of lead and PCBs in the upper part of the river because the twin cities are a major source of pollutants, and you don't have very much sediment in that part of the river. What PCB and lead there are go on the sediment, which has high concentrations. These fairly high concentrations persist, particularly metals, down the river but in terms of human use or human consumption they are not considered toxic once you get away from the twin cities. On the other hand, other highly organic things are, such as hexaclorobenzine, which smells a lot like some of the things that you smell when you're in a plane flying from Baton Rouge to New Orleans. Hexaclorobenzine is not very concentrated on sediment in the upper river. You get a big input of it as you cross the mouth of the Ohio River because the Ohio River sediments contain a lot of this stuff, but the big increase in hexaclorobenzine is right down here in the lower part of the river. These concentrations were found at two sampling stations, at St. Francisville and at lBelle Chasse. So that tells you something about sediments. Sediment is still picking up these adsorbed contaminant compounds in this part of the river.

On average, about 120 million tons of sediment per year comes down the Mississippi River and about 80 million tons a year comes down the Atchafalaya. So those are roughly the quantities you have to deal with, but those are the annual averages. Now if you're thinking about taking sediment out of the river and putting it somewhere, you might give some thought to the times of year during which most of the sediment flows. Are you just going to open up a hole in the levee and let the water flow through all year, or are you going to think about doing this seasonally? Those times when you might want to do this are times when the sediment is more concentrated in the river, because as the sediment concentration goes up in the river, you get more sediment per unit amount of water than you're letting out of the mainstem. As it turns out, the times when there's the most sediment in the river are times when the water level is high or rising anyway. On average, in the lower mainstem of the Mississippi, the highest sediment concentrations are on the rising limb, as the river is rising. Because there really is a limited amount, even if there's a hundred or two hundred million tons of sediment a year. There's a limited amount of sediment there, and there's more of it moving when the river is rising than when the river is falling, because the river is scouring up these little pockets of sediment that have dropped during the last low water.

High water in general is probably a better time to be taking sediment out of this part of the river than low water because at high water you have a higher slope, a steeper slope, in the river. Between Baton Rouge and Head of Passes, when the river discharge is high, 27,000 cubic meters a second is the highest curve. That's almost a million cubic feet per second. In the lower river, you have a quarter of that, because the lower end is controlled by sea level, which fluctuates only half a meter. The upper end at Baton Rouge goes way up during high water and way down during low water. So the slope is much steeper at high water than it is at low water. It's the slope that tells you how much energy is available in the river to scour sediment. When the slope is low the section of the river between Baton Rouge and Head of Passes is a sink for sediment. Sediment is being deposited out. If you get on a boat at low water in Baton Rouge and watch the water all the way down to New Orleans, or maybe down to Belle Chasse, you'll see the water get clearer and clearer. If you do this during high water, you won't see that because instead of depositing sediment in the lower part, the river is actually scouring out that sediment that was deposited when the river was low. Here we're looking at graphs of the amount of sediment being discharged by the river. Where it says zero, we're approximately at Baton Rouge, and where it says five, we're approximately at Head of Passes. When the water discharge is less than average the sediment discharge actually decreases, which means the sediment concentration is decreasing. When the water discharge is greater than average, the sediment actually increases down the river. The amount of sediment carried by the river gets greater and greater because the river is scouring out the old stuff that was deposited during low water. So think about when you want to take this water out and don't pass up the opportunities that the river gives you, either on the rising limb of the discharge or during high discharge when, as it moves farther downriver, the sediment becomes more and more concentrated.

What part of the water column do you want? Even if you choose the season of the year you want and decide to divert the water during the rising stage or during high water, what part of the water column do you want to put your siphon into? The answer to that is down at the bottom, because that's where most of the sediment is moving. Here's a picture of a cross-section of the average river, and in terms of this kind of physics, the Mississippi is certainly the average river. The water velocities are highest near the surface and they decrease toward the bed and toward the banks because of bank and bottom friction. The distribution of suspended sediment is different from that. The highest concentrations are near the bed because not only are the silt and the clay more or less uniformly distributed top to bottom in the water column, but sediment is being remobilized and dropped, remobilized and dropped, off the bed of the river. In this part of the river sand is fairly fine, and if you want it you've got to get down near the bottom to take it out of the river. At least bias your sample so you can get the most. Bias your intake so you get the most sediment through your pumping effort.

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Jerald Horst, Moderator

Dr. Nancy Rabalais is a full professor at Louisiana Universities Marine Consortium, also known as LUMCON, where she has been for 14 years. Dr. Rabalais' name is almost synonymous with the hypoxic, or dead, zone, as it is called, in the Gulf of Mexico. She is an expert in water quality and nutrients and that's what she is going to discuss with you today, the effects of nutrients in river water. Dr. Rabalais.

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EFFECTS OF NUTRIENTS IN RIVER WATER

Dr. Nancy Rabalais

I've been asked to talk about the good, the bad, and the ugly. What nutrients do good, what nutrients do bad, what they do offshore, and what they do inshore. I hope I can do justice to all of that in the amount of time that I have to talk to you today. It's always a pleasure to follow Bob Meade on a program because I don't have to explain to you how immense and complex the river is, with both the water and the sediments that it carries and with the other constituents that come with it. I'll focus today on nutrients. We know that most of that water delivered to the Gulf of Mexico through the Bird's Foot Delta flows to the west, so that most of the freshwater sediments and the nutrients that are delivered by the river end up to the west of the Bird's Foot Delta. These important nutrients—the nitrogen, the phosphorus, the silica—fuel the food web that supports the extremely productive system that we have. The one of most concern in the Gulf of Mexico is nitrogen, and it primarily controls the productivity of the system offshore. The other two nutrients have some tuning points on what kind of productivity we have. The phytoplankton that grow, the smallest forms are eaten by the zooplankton, the zooplankton are eaten by the larval fish, the larval fish feed even bigger fish, and we have a tremendously important productive fishery in the Gulf. Some of that material gets to the bottom—it's not eaten by the fish—it gets to the bottom and supports our fisheries through a different sort of food web. So it is important.

The amounts of nutrients delivered to the Gulf are directly proportional to the amount of productivity that occurs offshore. These data are from the area offshore in the Gulf of Mexico over the low oxygen zone and show that as the amount of nitrogen increases, the primary production increases and as the concentration of nitrogen increases, the primary production increases. Phosphorus has also been shown to be important in the same way in that as the orthophosphate increases the overall production of the system also rises. Too much of this production is detrimental to the water quality of the Gulf of Mexico. These materials sink to the bottom. There is not enough consumption of these materials in the surface waters and the bacteria that decompose this material on the bottom eventually reduce the oxygen to the point that it is detrimental to living organisms. As a result, there are large areas of hypoxic bottom waters that form in the Gulf every summer. These waters start to form in the spring. They are widespread, persistent, and severe in the summertime. They start to break up in the late summer and early fall as hurricanes, tropical storms, or cold fronts mix up the water. These areas extend from the river delta well over to the upper Texas coast. They occur from very near the shore, near the beach, to 50-60 kilometers offshore, from five feet of water near-shore up to 180 feet offshore.

We are concerned because in these low-oxygen bottom waters, you don't catch any fish or shrimp when you put a trawl over the side. Our definition for low oxygen is 2 mg/liter. These are trawl data showing that when the bottom oxygen falls below 2 you don't catch any shrimp or fin fish. So this is why we're concerned about it. When you look at the frequency of distribution of hypoxia over the many years that we've been looking at it, you can see that there is a higher frequency of occurrence of this down plume of the Atchafalaya discharge and down plume of the Mississippi River discharge which tells us that the system is intimately linked to the discharges of the river. Statistically you can show this same thing, that the highest production in the surface waters follows one month after peak discharge of the river and the worst oxygen deficiency falls one month after that.

So it is not just a picture of what happens, there is a very strong statistical correlation. And, since 1993 with the flood of the river, we've had extremely large areas of low oxygen, up to 18,000 kilometers squared—'93, '94, '95, '96, and '97. And this area has pretty much doubled over the last five years compared with what it was over the previous seven to eight years' worth of data where we've consistently mapped the same area over time. This doesn't tell us what it was like many years ago, but we have sediment core data from the area where we have surrogates of oxygen deficiency and productivity that tell us that the system has actually changed over time, primarily since the 1950s with the major changes in the water quality.

The Mississippi River water quality has changed dramatically. Since the turn of the century, the 30s and 50s, the nitrogen concentration delivered to the offshore area was about the same. Starting in the 50's there was a doubling of the nitrogen concentration. The data for phosphorus are not as good. They start in about the 1970s, but from the 70s to the present, the phosphorus concentration in the river has also doubled. Over that same period, the silicate concentration has become lower because of activities in the water shed. The nitrogen-to-silicate ratio determines what sorts of phytoplankton can grow offshore. And this has implications for both hypoxia and the harmful algae blooms. The other thing that's happened in the river is that we now have more nitrogen in the spring than we used to historically, say at the turn of the century. And this has implications for the best time to move water into various areas.

We're concerned about hypoxia because of how it affects fishery resources. Some things die; most things move out of the area if they can, forced out of their suitable habitats and into much less suitable habitats. And when they do, they're susceptible to increased predation, especially by two-legged predators with shrimp trawls. Once the low oxygen rises and they move back into these areas, they do not have the same resources they had before they left because the animals in the sediments have basically been wiped out. The early life stages, particularly of some of the shrimp, are likely to be affected. We don't often see dead fish on the bottom, and when we do, it is on the rare occasions when these low-oxygen masses hit the shore, trap the fish, and kill them because they can't get out of the way. Those things that can move do move out of the area, but those that cannot start to die as the low oxygen starts to get progressively worse. First the larger forms die and then eventually the worms and all the microorganisms that live in the sediments and require oxygen.

This is how low oxygen, in theory, affects the shrimp catch. In this slide, the green is the outline of the low-oxygen zone in 1985, a one-time picture. The red, the orange, and the yellow show the catch of brown shrimp in these areas over the whole summer. There is a mismatch in data here, but it's a picture of what might be happening. And it looks as though the low-oxygen zone is concentrating the shrimp near-shore and moving them to the west where they are being caught. It's also keeping the shrimp from moving farther offshore into what should be suitable habitat. Similar sorts of diagrams have been done for many years. One of the more recent ones is 1994 and you see the same sort of phenomenon, except that the low-oxygen zone is much larger and there are many fewer shrimp. There is some indication that the shrimp yield is going down. There are lots of reasons shrimp yield could go down besides hypoxia, but there has been a noticeable decrease in shrimp yields. This diagram just shows that, as the frequency of hypoxia increases the catch also decreases.

Harmful algae blooms are another side effect of increased nutrients in the Gulf of Mexico. Four toxins are produced by harmful algae in the coastal waters of Louisiana. Two of these appear to be related to nutrients. One is a diatom, which produces an acid that causes shellfish poisoning. It is distributed in the same area where we find the effects of nutrients on the offshore areas of the Gulf of Mexico. Their distribution and their numbers are related to the discharge of the Mississippi River. You can see peaks every spring, increases in these organisms in the surface waters. There was an extended peak in 1993 when additional nutrients were delivered to the offshore waters and another peak with continued delivery in '94.

I'm often asked what we are going to do about this. Is it just going to go away? Can we put big air stones down there as in an aquarium and put more oxygen at the bottom? That's not going to do it. And the other question that we're often asked is, "Can we send the water elsewhere?" I'd like to address that next by first of all showing where the sources of the nutrients are and what they're from. These are U.S. Geological Survey data. Most of the nutrients that are loaded into the watershed come from the upper part of the watershed and most result from agricultural activities. It seems to me that the solution to hypoxia is in the watershed, for developing better practices for managing and reducing nutrient loads in the watershed and for doing a better job of landscape management. The changes in the severity of hypoxia offshore have not been over the long term when channelization of the lower river occurred. They have been over the short term, since the 1950s when changes in river water quality began to occur. So the solution to hypoxia is not river diversions. You can have lots of other reasons for river diversions, but solving the hypoxia issue is not one of them. Diversion sends the problem elsewhere, either into the extremities of the low oxygen or into the bays, and there are not enough of the appropriate types of wetlands that can actually absorb these nutrients to make a difference.

I'm going to talk about what nutrients do inside the estuaries in relationship to productivity and water quality. Data from a transect through the Barataria waterways from Barataria Pass all the way up to Bayou Chevreuil show us that there are plenty of nutrients already in our estuarine waters. The upper line on this slide is the amount of silicate that's in the water. And this open circle is the amount of nitrogen in this transect. This is an annual mean average for sixty plus stations along Barataria Bay. There are a lot of nutrients in these waters already, as well as a lot of response to these nutrients. Chlorophyll, the phytoplankton, is representative of how much production is in the water. Chlorophyll levels from offshore into the upper part of Barataria Bay and Bayou Chevreuil are extremely high. These are algae blooms, and some of them can cause problems. And over time we've been putting more and more nutrients into these waters, mostly from land shore based activities, agricultural activities. And we have stimulated the production of our waterways in the estuaries and these waterways are showing signs of increased productivity, such as increases in chlorophyll biomass over time. And these numbers right here are the changes in the Barataria ecosystem over time with regard to the amount of chlorophyll biomass that's present. It's also obvious from sediment cores that we've done in the lower end of many of these systems is that the natural processes of assimilating these nutrients is not keeping pace with the amount of additional nutrients that are coming in because the surrogates for production have increased over time with the increases in the nitrogen in those systems.

How does the nutrient content of the water in the river compare with what's already in these bays? These two panels show the amounts of nitrogen and silicate that are currently in the Barataria system and in the Mississippi River water adjacent to these systems. This is a comparison of the nitrogen, the phosphorus, and the silica of the Mississippi River with measurements taken in Lake Pontchartrain in the 70s and the 90s. You can see that the river's nutrient content is much higher, a hundred times higher, with regard to nitrogen and dissolved inorganic nitrogen. Phosphorus is about twice as high and silicate goes anywhere from 30 to 50 percent higher. These are going to have the same effects in the bays that we see with these nutrients offshore. You're going to see an increased chlorophyll biomass. You're going to see increased turbidity, which may affect submerged aquatic vegetation. You're going to see shifts in phytoplankton communities as various nutrients become more dominant in the system. Food webs are going to be altered. Some of these are going to lead to low oxygen because they are less preferentially grazed and they are going to get to the bottom and decompose the same way they do offshore. The result of that sometimes is fish kills and with these phytoplankton community shifts sometimes you also have harmful algae blooms that can lead to loss of fishery resources and, as we've seen recently, adversely affect human health.

There are several examples of nutrient additions to Lake Pontchartrain as a result of diversions through the Bonnet Carre, leakage, or other experiments. These are cumulative nitrogen loads into the Lake Pontchartrain system. The one of recent interest to us is what happened last year, resulting in an extremely high chlorophyll biomass, adding far more than did previous experimental or natural diversions of Mississippi River water into Lake Pontchartrain. The same relationship, the more nutrients, the more production, as we saw offshore. In June of 1997 we got massive blooms of blue-green algae, the cyanobacteria, both anabena and microcystus. Two kinds of them were in the system and the chlorophyll levels were extremely high, reaching 800 mcg/liter at some points during that period. It was shown that these organisms were extremely high in concentration and that they also produced toxins that could be harmful to human health. There were health advisories put out for Lake Pontchartrain as a result of the presence of these toxins in the water. This slide shows the time course of the growth of these algae, as well as the amounts of nutrients that came into the system in the form of nitrogen and those that came in the form of phosphorus. You can see a dramatic increase in the rise of this particular anabena species with a drop-off later in the year after the nutrients were taken up by these organisms. There were also some resultant fish kills.

I'd like to close with saying that there are good constituents in river water and there are some that might cause harm. It's not a simple "yes we divert it" or "no we don't." That's a simple question and a simple answer, but what happens when we do it is not so simple. We have a lot of technical data that can help us at least to realize what we're doing rather than ignoring what these data are telling us and hiding from the facts. Thank you.

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Jerald Horst, Moderator

Buddy Pausina is a third generation Louisiana oyster farmer and has been for 37 years. He attended Loyola University in business and has an associate degree in accounting. He has been president of the Louisiana Oyster Dealers and Growers Association 11 times. Currently he is chairman of the board of the same association. He is past president of the Shellfish Institute of North America and is a member of the Oyster Leaseholder Damage Evaluation Board established within the Department of Natural Resources. He is also a published author with several technical articles. Lastly, something that's near and dear to my heart: About 20 years ago, Buddy and his family were very much involved in attempting to develop a quahog fishery—the large, Mercenaria clam—in the state of Louisiana. He truly is a pioneer. Buddy is here to talk to us about oyster industry concerns.

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OYSTER INDUSTRY CONCERNS

Ralph "Buddy" Pausina

I'm here to speak about some concerns of the oyster industry as it is affected by diversion projects. I'm going to confine my remarks to Barataria Bay. That's the area I'm most familiar with and I think of most concern to the people here today. About 100 to 150 years ago people started picking up oysters wherever they could and bringing them home to eat. Then they found that they could sell them and they started businesses that way. We'll call these people the opportunists. Later on, a lot of people found that if you started moving oysters around for various reasons, they could manage the oysters, or farm them. So you have two different groups of people operating within the industry. The industry itself has gradually moved from the coast inland because of saltwater intrusion, erosion, subsidence, and a number of other factors. We started out a long long time ago when most of the fishery was all opportunistic. There was very little farming. In 1896, a biologist named Moore was doing some studies of oyster resources in Louisiana. He was aboard a Navy steam vessel which was charting the waters to produce the coastal geodetic charts we use today. He recorded that in Barataria there was a fishery that operated for a big cannery, and in 1896 there was a crevasse that killed the entire crop in Barataria Bay, destroying this fishery and putting the cannery out of business. What happened was that once the fresh water came in, all the oysters in the bay were destroyed. This is a natural and the first recorded one that I've found. In the lower portion of the bay the next year, there was a tremendous crop of oysters. It takes about two years until oysters reach a marketable size. At that time these opportunistic people started selling them until there was an over abundance of supply and prices dropped. Somebody said, "Why do we have to sell all of them right now, just because they are there? Let's move some of them in other places where the salinity is lower and we'll slow the growth down and then sell them later on." The farming process was developed in this way. In this situation, some people are still opportunistic and some people are farmers and the practices established in the moving and transfer of oysters are continued today.

In 1906 the same gentleman, Mr. Moore, along with a man named Polk, made a statement that Barataria Bay was too salty for oysters, as all the reefs were extinct and the bay would never support a fishery. Well, it's almost 1998, and there are fairly decent fisheries still operating in Barataria Bay, but it's a true farming process, with people doing things in an orderly controlled manner and not just depending on nature. In 1912 Bayou Lafourche was shut off from the river and that increased all the saltwater, causing the fishery to move farther and farther inland. The farther inland, the closer to people, and the closer to people, the closer to pollution.

In 1914 there was a crevasse at Cornelia, which reduced the oyster crop, and everybody had no sales for two years. Then there was an over supply and finally the situation returned to normal. In 1923 there was a break in the levee along the Mississippi River, flooding out Barataria Bay. The same thing happened again: no sales, over supply, and then normal situations. In 1925 it happened again. In 1960, '68, '74, '82, and '90 we had really wet years and these same things happened. In all the upper regions of the bay, the oysters died, while the lower region was oversupplied with oysters and prices were low. After five years the situation went back to normal. These are all normal situations that we in the business expect, and we know they're going to happen, and we allow for it.

Planned diversions are something human beings do and human beings control. Our concern here is that human beings controlling this diversion act in a responsible way. Our concern is that the human beings divert water when diversion is needed and not when it's unnecessary. In other words, in a dry year let the thing soak and in a wet year hold it back. Do those human beings have the ability to say, let's just cut it down a little bit because we really don't need it? In between, there you're going to have degrees. We need so much, or we need a little more, a little less, and the bay will handle that and control it. Will the human beings controlling the diversion accept the consequences of their actions?

A concern is the health of our oysters and the bad publicity when we have problems. The way we operate under the Health Department is a preventive system. If you cannot show that the water is perfectly safe where 95 percent of your oysters grow, you close. It's not if it's polluted you close. If you can't prove that it's not, that it's clean, you close it. One of the guidelines is the shoreline survey. The shoreline survey states if there is a possibility that something could get into the water, you close. With a diversion, whether the water is good or bad, you're putting it out there. The Health Department guideline says if there is a possibility that something could be in that water that could cause a problem, you close. So it's a serious concern because it depends on the judgment that something might occur. Whoever's making that judgment has to really be responsible for what he or she is doing.

Another concern is that when you put some water at the top of a system without having something controlled at the bottom, it's going to flush right on through and all you've done is drop some mud out and killed everything in the meanwhile. So our concern is that the water should go through on a gradual basis so that it can do some good, or the most good. I thought one day that as the barrier islands erode away more and more, some day there's going to be a year when on the upper end we're going to have losses because of too much fresh water, and then we're also going to have losses on the lower end because of too much salt. The barrier islands are washing out, and there's really no way to contain this stuff. On July 4, 1997, salinity at Manilla Village was below 5+ parts per thousand, at Bay Baptiste 7 parts per thousand, and Middle Bank 10 parts per thousand. Labor Day, that's two months later, salinity at Manilla Village was 20, Bay Baptiste 25, and Middle Banks 30. Two months later, the oysters died at Manilla Village, about 30 percent, and above Manilla Village 100 percent. Two months later Bay Baptiste and Middle Bank oysters were dying from dermo which is a saltwater parasite. In this short time, this has occurred so there's really something wrong and it needs a serious look at doing something with barrier islands in conjunction with freshwater diversion so we can get the most use other than just mud or silt out of the diversions.

Another concern we have are these algae blooms. We've had some bad publicity over the last two years on the east side of the river with some blooms like that and my understanding is that Barataria Bay is getting really close to the critical number for being closed.

I guess that the bottom line then is that the oyster is an immobile organism. It doesn't move and it pumps so much water it reacts very quickly to what happens around it. When it dies there are other creatures in a similar situation that also die. The other organisms are mobile and they are displaced. When you kill an oyster you say, well it's just an oyster, but there's all kinds of other things involved in that. The oyster gives you a good indication of what you're doing to the rest of the environment.

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Jerald Horst, Moderator

Glenn Thomas is the Habitat Program Manager with the Louisiana Department of Wildlife and Fisheries, one of the more important jobs in the department because without habitat you don't have fisheries. He has spent three years in the department's prime research facility, the Lyle St. Amant Laboratory on the island of Grand Pierre. His job is maintaining habitat for marine fisheries production. Prior to working with the department he spent two years with Department of Natural Resources' Coastal Restoration Division. Prior to that he spent two years as a biologist with Coastal Environments, Inc. Glenn has a Ph.D. from LSU in Wildlife and Fisheries Science.

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SALINITY TOLERANCES OF FISHERIES SPECIES

Dr. Glenn Thomas

My talk is going to be a little bit different from what's on the agenda, but I will also address the issues that are on the agenda. What I want to talk about is long-term fisheries production and the implications of freshwater diversion. As previous speakers have mentioned, we're looking at a tremendous amount of marsh loss in Louisiana and I'll probably talk about Barataria Bay as much as anything. Barataria has got among the highest loss rates in the state. As you can see, the loss rates on this map are in red and orange. In the Barataria Basin they occur in a big "U" shape, particularly heavy in the zones flanking the sides of the basin and the middle portion of the basin. A lot of people are quite familiar with the areas in which the desirable animals are harvested. In particular these are the larger and more mature animals. They're looking at shrimp and fish that are migrating, or feeding, or spawning. They see the habitat where these animals live now, but sometimes they don't see too much of the area where they grew up. The nursery habitat for most of these animals is more often the interior zones of the marsh, in relatively unaccessible areas. They are the smallest bodies of water, and the areas with the most edge, the most interface between marsh and water. This chart shows the typical life cycle of an animal that spawns in the Gulf or initial waters. The larvae are carried by currents into the estuary where the animal matures and then returns to the open waters of the Gulf or the bays. In particular, I'm interested in talking today about the part of the life cycle that's occurring at the northernmost reaches of the estuaries.

The '78 habitat map for Barataria shows salt marsh up to the middle top of the estuary, with a considerable portion of brackish marsh behind that, and intermediate marsh behind that. As you can see, by 1990 there's tremendous amount of breakup both in the salt marsh and in the brackish and intermediate marshes. This is just a chart of the conversion of open water and the loss of the edge as the marsh breaks up and converts to open water. With edge being so important for fisheries production and habitat, we see that as marsh converts to open water at about 30 percent, you're at your maximum interface length and you would expect to see fisheries usage of the marsh perhaps at a maximum as well in this zone. Once you get into 50, 60, or 70 percent open water, the interface length drops tremendously and the usability of the marsh for fisheries production declines as well.

I'm going to talk now about statewide sampling by Wildlife and Fisheries. Here are nearly 8,000 trawl samples taken between 1991 and 1996, and broken down by temperature and salinity. We need to remember that these are not commercial trawls. These trawls have a very fine mesh bag that catches all the animals, particularly a lot of small animals that a lot of people don't see. Most of these animals in these samples are sublegal, subharvestable animals. You can see that brown shrimp catch in these samples which are taken from 16-foot boats (many of the samples are far up the estuary) are particularly high at about 25-30° and all the way down to .3 to 2 parts per thousand salinity, particularly to 5 parts per thousand salinity. The only difference between this one and the last one is this is a log-transformed number. It reduces some of the variability in samples that have tremendous outlays one way or another. I'll probably use these numbers more than the others. With brown shrimp you see usage of the marsh down to .3 parts per thousand salinity, particularly between .3 and 10. That's during the warmer months. In Barataria Bay the nursery usage during May and June is in the zones, with 5-10 parts per thousand and less. So you've got nursery usage throughout the estuary, but it is also heavily used all the way to the northern part of the estuary. White shrimp, again nearly 8,000 samples and even heavier usage at these low salinity zones. Pretty considerable catch per effort at 0 to 0.2 parts per thousand salinity, highest numbers at .3 to 5 parts per thousand salinity.

Those catches were made during the early fall. Blue crab showed heavy use of the fresher zones of the estuary during all portions of the year. Again, these generally are small animals. For the blue crab you can see that the whole estuary is used, but the heaviest usage is in the northern part of the estuary. Brackish and intermediate marshes are experiencing a tremendous amount of loss. Here are seine samples for specks. This is a ten-year data base, about 6,000 samples. A fine mesh seine was pulled right along the edge of the marsh, catching generally the smallest animals. You can see that the highest catch per effort for specks was in the 5-10 parts per thousand salinity range. You've got juvenile trout throughout the estuary, all salinity zones of the estuary, but you also have usage all the way down to the fresher zones during the warm months of the year. These small animals, of course, are using the entire estuary for nursery, almost always occurring right up next to the marsh edges and using the entire estuarine zone for nursery grounds.

This chart shows one-inch bar gill net samples, nearly 10,000 samples. These animals are 10 inches to a foot long typically. A little bit of range, of course, but that's what mostly occurs in one-inch gill nets. And you can see that there's particularly heavy representation of the animals at the higher temperatures and higher salinities. These are animals that are maturing. They're heading down into the salty areas of the bay for their first spawn. In the two-inch gill net samples, these are trout that are pretty good size animals by and large. And you also have heavy usage of the lower part of the estuary during the warmer months, but you have some foraging activity going on in the winter up into the fresher zones as well.

Red drum is a little bit different. These are the same samples, looking at the very smallest animals. You're seeing the young of the year animals during the cooler months when they are first showing up in the samples. They're using the whole estuary with a little bit heavier use in the lower portions at the very small ages. These are the cold months of the year here and there is some usage all the way up the estuarine zone. When you look at the slightly larger animals taken in the smallest mesh gill net samples, by far the heaviest usage is in the very freshest zones, 0 to 5 parts per thousand during the animals' first summer. So, all these animals that were using most of the estuary as nursery zones, have shifted to some degree and are growing and feeding in the fresher zones of the marsh. Here's an even stronger representation of the larger red drum doing the same thing—foraging, growing, in the fresher zones of the estuary. Atlantic croaker in the trawl samples are pretty well distributed throughout the estuary, but there is heavier representation in the freshwater zones.

To show you that not all species use the estuary to any great degree, there are a couple of examples of animals caught in the samples that aren't estuarine-dependent animals. The striped anchovy is one. It's only seen in the samples taken at the highest salinities and the highest temperatures with very very little use of upper estuarine zones. It's an animal that is not estuarine-dependent, doesn't really use any part of the estuary as a critical zone for its life cycle. The Atlantic cutlass fish is another example of an animal like that. It occurs in the saltier areas of the estuary during the warmer months in particular but exhibits very little use during most of the year and no obligatory use.

So we have seen that the fresh areas of the marsh are very important, that zones with .3 to 5 parts per thousand are major nurseries for brown shrimp, white shrimp, blue crabs, sea trout, reds, and croakers, and the freshest zones are particularly used by white shrimp, blue crabs and Atlantic croaker. Of course, there are also species that don't use the estuary to any tremendous degree.

When we look at what's happening in conjunction with marsh loss, these are real data plotted and projections for the future. This shows loss of the interface, the marsh edge, the important zone that's used by many of these animals for nursery habitat. And we can see that marsh edge went up tremendously during this time, but as time goes on and marsh breakup occurs, there's expected to be a tremendous drop-off in the amount of interface length available for nursery habitat in the estuaries. There is debate about what the slope of this line should look like, but there is no question that physically, as these margins break up, we're approaching maximum interface length. And we're looking at tremendous losses if marsh loss continues at the same rates.

The goals for long-term fishery production should be to reduce marsh conversion to open water in order to maximize the edge, the interface links, and the total amount of vegetative cover in the marsh. Maintenance and restoration of interior marshes are goals through which habitat quality and nutrient cycling can be improved.

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Jerald Horst, Moderator

Our next speaker is Mr. Chuck Vilarrubia, a natural resources geoscience supervisor with the Department of Natural Resources. His expertise is in wildlife and wetland ecology, endangered species restoration, and data analysis. Prior to his work with DNR, he was an environmental consultant in South Florida, where he worked with the impacts of development on wetlands in estuaries and ecosystems. His topic is one of interest to everyone, which is the Caernarvon fisheries data monitoring results, Caernarvon being the one diversion project that is operating at this time.

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CAERNARVON FISHERIES DATA MONITORING RESULTS

Chuck Vilarrubia

I'd like to present to you today some of the monitoring results from the Caernarvon project. As you all know, Louisiana has a serious land loss problem. The Barataria basin loses over a thousand acres a year. Since the 1930s it has lost over 45,000 acres per year, and it is projected that in the next 50 years another 45,000 acres will be lost. This has resulted in changes in the estuary. The estuary is more open and subject to an array of processes. The fresh and brackish interface has moved inland to where there is very little fresh and intermediate marsh left in the estuary. Another consequence of this has been changes in fish and wildlife habitat and distribution. As has been mentioned, the oyster zone has moved inland over the years to areas that were historically fresh and not conducive to oyster production. The same is true of brown shrimp.

Some general observations about monitoring data. We have seen general land loss reversal, general increases in wildlife abundance, and increases in freshwater species, as well as the majority of marine species. There has been increased production in historic reefs and also in shrimp and crabs and the greater distribution of these organisms. The main species affected is the brown shrimp and an operational plan is looking at the recent discharge to address that issue. We're seeing that constant evaluation is important, and that monitoring to reduce erosion is also important. Timing with respect to the life histories of the species, as well as water levels and out-flow management are important. It seems that we're restoring some of the function back to the ecosystem. We're seeing increased biodiversity and production of vegetation that pushes food and materials through the estuary.

Some of the questions that have come up: Why is the marsh being re-established? Is it due to sediment or vegetative accretion? Why has oyster production increased on the seed grounds so much? We think it may be food-related as well as the salinity issue. What are the effects of fresh water and turbidity, which can influence submerged aquatic vegetation and phytoplankton? What are some of the overall economic impacts? Some of this is indirect, such as the effects of applying ten miles of extra marsh to hurricane protection to New Orleans.

Caernarvon was authorized in 1965 and was built in 1991. The operational plan for Caernarvon is overseen by the Caernarvon Interagency Advisory Committee (CIAC) which is composed of state and federal agencies, the local governments of Plaquemines and St. Bernard, and local interests such as landowners and fisheries. This gives you an idea of the operational history of Caernarvon. The interagency committee approved in the beginning a salinity-based plan that was based on the Review Guide Relationship of Salinities to Oyster Production. Then in 1993 and '94 it was modified to allow 8,000 CFS in the winter months to get more sediment in for land purposes. Just last month the interagency commission authorized a new plan, a flow-based plan, which was unanimously approved. We still have some of the salinity targets in this plan.

This chart gives you an idea of the discharges that have occurred through the years. In 1991 when Caenarvon first opened, there was a lot of fresh water so Caernarvon was opened frequently. This table gives you an idea of the volumes that have been put out from Caernarvon. The highest was in 1994 with 75 trillion cubic feet of water. The new 1998 levels will be about 80 percent of that, just distributed somewhat differently.

There have been three years of preconstruction monitoring and four years of postconstruction monitoring. This slide gives you a view of just some of the stations that have been examined. We have about nine years of data on Caernarvon now. We're continuing to monitor throughout. We'll now get into some of the data. With respect to white shrimp in the seines and the trawls, we see that white shrimp have generally benefitted from the diversion which was expected because white shrimp can tolerate fresh water. Also according to some of the other data we have, catch in most stations increased, indicating a broader base for the shrimp. Landing surveys also indicated the same thing—greater production after construction. The result for brown shrimp is a little different. Brown shrimp generally decreased postconstruction, because they are a little more sensitive to the fresh water. Again, the landings also decreased. There was no clear relationship between April salinity and shrimp catch trawls, and there are all sorts of environmental factors that may have affected things during this period. The number of blue crabs in the seines and trawls is generally down. However, if we look at a broader view of the data, we see that there is no clear pattern of catch and salinity. Blue crabs are fairly tolerant of salinity. It has just been shown that the annual landings increased 44 percent. There were more crabbers out there postconstruction. Also, the catch-per-unit-effort of the boats, pounds per day, increased about 80 pounds postconstruction. And there are crabs in more areas after construction than there were preconstruction.

Menhaden generally increased postconstruction. With respect to some of the saltwater species, red drum both in the seine and trawl data and generally in the landings data also increased. And the same is true for specks. In oyster production, most freshwater diversions have been conducted for oyster productivity and ever since the late 1800's, they've been used for this purpose. And, the seed and sack oysters on public seed grounds increased dramatically during this period. This graph also shows a dramatic increase as well as a dramatic change in patterns. In 1974 after the flood of 1973, we see an expected increase in oyster production on the seed grounds. The same thing is true of 1979 and 1980. But then there was a natural crash in 1991 and in '92 we see the expected increase, but it stayed high after that, after Caernarvon started, so this is a dramatic change in pattern with high levels of oyster production following the freshwater diversion. Again, we feel this may be due somewhat to fluid being pushed into the estuary.

With respect to freshwater species, largemouth bass, as expected, have done quite well postdiversion. More habitat was created for muskrats, the intermediate and brackish marshes that the muskrats prefer. The same thing is true for alligators. They don't nest in high salinity or high brackish marshes. And the same is generally true for waterfowl. Again those types of habitats and submerged aquatic vegetation that is food for the waterfowl have increased. With respect to vegetation, you can see there was very little fresh marsh in the basin prior to Caernarvon. It was mainly saline and brackish. That has changed postdiversion to a higher percentage of fresh and a lower percentage of saline marsh.

The land loss issue has been looked at through air photography. These slides show the nine sites that were analyzed. For three years of Caernarvon diversion you can see from the plots that there is a greater land-water ratio postdiversion. This occurred in all of the nine areas that were sampled. We had a total of 406 acres or 5.9 percent per year. We did have both land and water change both ways, but it was a net increase across the board. Sediment concentrations are higher in the spring and winter, as has been mentioned before. The amount of sediment being put out there depends also on the flow that is being discharged. In 1996, 151,000 tons of sediment were discharged into the estuary. Sediment grain sizes were fairly small, mainly clay material that generally stayed in transport, at least for the June and August sampling that we have. As far as water quality goes, recent analysis by the FDA and CBC has shown that the recent virus problem was due more to local sources than to distant sources, such as Caernarvon or other waste treatment plants. Also judging from the water quality monitoring done by the Corps and also from work done at LSU by Dr. Davis' students, we see no particular evidence of water quality degradation or putrification or fish kill. Some coliform levels were higher in the upper basin, but they return to normal in the lower part of the basin. We don't know how Caernarvon affects red tide. Caernarvon was opened at a higher level in an attempt to mitigate red tide, in the '96 red tide closure zone, and the red tide did not extend into the Breton basin during that time.

There are many consequences of land loss, including loss of habitat, changes in fish and wildlife productivity, and threats to our investor and domestic infrastructure. Biologists have long felt that loss of habitat will ultimately result in loss of fisheries and wildlife productivity and eventually lead to a collapse. The Caernarvon interagency committee, which establishes goals for Caernarvon, intended it to reduce marsh loss, enhance marsh vegetation, and promote fish and wildlife productivity. I think that the monitoring data show that Caernarvon is a success in fulfilling these goals.

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Jerald Horst, Moderator

Our next speaker is Mr. George Barisich, a third-generation commercial fisherman with 23 years of full-time fishing experience, and 10 years of part-time fishing experience. He fishes primarily east of the Mississippi River. He is currently serving as president of the United Commercial Fishermen's Association and is a newly appointed member of the Caernarvon Interagency Advisory Committee. He serves on the St. Bernard Parish Coastal Zone Management Committee. He has served on the governor's task force on shrimp management, and he's a member of the board of directors for the Louisiana Wildlife Federation. George has a B.A. in social welfare and psychology and has one and a half years of law school. George is going to speak about Caernarvon's impacts on fisheries, a commercial fisherman's perspective.

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CAERNARVON'S IMPACT ON FISHERIES: A COMMERCIAL FISHERMAN'S PERSPECTIVE

George Barisich

Good afternoon. I want to take this opportunity to thank the sponsors of this forum for inviting me here today to explain some of the real effects of the freshwater diversion project. I especially want to thank Mr. Horst for his introduction. However, all these panels and boards that I sit on are not what make me qualified to represent the commercial fisherman's side of this controversy. It is the fact that I'm a third-generation commercial fisherman. My grandfather was one of the first oyster farmers in the state. I have fished commercially from the western border of Louisiana to the eastern border of Mississippi. I head the largest statewide commercial fishing organization in the state, with collective knowledge that is more accurate than that provided by today's computer systems. I've traveled across the country defending Louisiana's commercial fishermen by repeatedly knocking holes in governmental theories and policies that will ultimately mean the demise of the commercial fishing industry as we know it today if they are not altered. Some people will not like what I am going to say today, but I've built my reputation on presenting the facts as they are, not what we would like them to be.

When Jerald asked me if I would be interested in being a speaker, my first question was what do you want me to present? When he asked me to give the commercial fisherman's perspective on the effects of the Caernarvon freshwater diversion project, I immediately agreed, because this is one of the first times somebody wanted to hear what I had to say instead of trying to ban me from attending meetings. My first thought was if the people controlling this project had sought our opinions before the project, about the changes in waterflow, maybe we could have averted some of the damage to some of our natural resources. Government listening to commercial fisherman? I'd like to see when. History has shown us that this does not happen until after what we predicted occurs. Unfortunately for us who make a living out there, it's the government's mistake, but it's our lives that suffer. You see, no matter how many mistakes these people make, they get paid every week. And, in many instances, there are manipulations of fact so these people can perpetuate their own jobs. I know the first argument I'm going to hear is that there were public hearings on diversion and that advice was sought from oyster fisherman. History has shown us that public hearings concerning commercial fishing issues are an exercise in futility. You lose work time to present useful information, but nine times out of ten, it goes in File 13. The money and politics that come with the coastal restoration movement supersede any other interest. Had not Representative Odinet and Senator Dean pressed to have a public meeting about the vast damage caused by the increased flow rate of the 8,000 CFS and, most importantly, the unexplained sickness from oyster consumption from that area, the fishermen from that area would have been faced with the prospect of future years of lower production of our renewable natural resources. However, because there were people other than commercial fishermen in the crowd, that is recreational fishermen, marina operators, consumers, and legislators speaking up, something was done about it. Well, that's another slap in the face for commercial fishermen.

The problem is some of these agencies misrepresented some information or gave us some information that causes a problem for us. For instance, a letter was put in the Baton Rouge *Advocate* saying that white shrimp production had increased over several hundred percent because of the freshwater diversion project, and I disagreed with that. It became a very controversial subject. The problem is, I was partly right. White shrimp production did increase that year, four times what it usually was. But the increase came from another part of the state, nowhere near the freshwater diversion project. So here you had some information that was true, but it was used to project a false picture. And when the general public reads something like this, they say, "Well, you're crazy, the newspaper said 700 percent increase in white shrimp production. Why are you lying sir?" Because they'd read governmental studies and surveys, so they believed it all. But it wasn't true. The shrimp, the white shrimp in this particular issue, came from the northern part of the marsh, nowhere near this area, only because there was an easterly flow of wind caused by two tropical depressions back to back. That's where the white shrimp came from. And, I know, I was there, I fished it.

Everybody says we're always crying, but if things were so good we would all be buying new boats. We wouldn't be losing our homes. So, that gives you some of the background—not as much as I wanted to—of how unjustly commercial fishing interests are being treated. And you have a better understanding of why Louisiana commercial fisherman are fed up with meetings and government, which explains why we do not have more fishermen here today.

I will concentrate the rest of my time on the effects of the project. First, this is not a freshwater diversion project. When this water comes through those pipes it's just below some waste treatment plants, and it comes with the runoff from many other states. You must remain cognizant of the fact that this is Mississippi River water. It is not fresh, pretty rainwater. Second, this project was designed as a water flow project, not a sediment carrying project. So it will not build land in the same manner as a spillway, as a lot of people think, a fact that the public was conned into believing under the guise of coastal restoration. Third, the project as originally designed, did put oysters back on state grounds, normally referred to as the back bay area, which was one of the primary goals of the project. However, the lease holders paid a higher price and experienced an almost total loss of production due to oyster mortality, pollution line closures, and a population explosion of mussel growth unmatched anywhere in the state. Here you have a swap off. More oysters on state grounds, no production from private leases. Good or bad? That depends on who you are. If you are one of the lease holders, it's terrible. You're out of business. If you're a fisherman who fishes way outside, it may be good for you. Fourth, it was estimated that the brown shrimp production would show a slight decrease white shrimp production would increase. Here is where the biologists completely missed the boat, so to speak. Let's face it, they weren't even on the pier. The reduction in brown shrimp production was significant in the first years of operation, with a greater reduction coinciding with the increased water-flow rate as dictated by DNR. To compound the negative impacts, the increasing white shrimp production never happened. In fact, according to my members, there was significant decrease in production as well as a smaller size of shrimp being harvested.

The first argument I get on this issue is that state records indicate a production level higher than our forecast. The problem is that this is statewide production. There is no way of knowing where the white shrimp come from unless the fishermen are consulted. Nobody called me. Personally I know production levels are down in the area simply because there are never any boats working in that area anymore. Prior to this, a gentleman by the name of Corky Perrett, who used to be one of the head biologists at Wildlife and Fisheries, would fly over the whole state the opening day of shrimp season. Since I started running this organization I got a phone so we call each other. I said, "Corky, where you at?" He said, "I'm over Black Bay." I said, "How many boats you see?" He didn't answer. I said, "Answer me, tell me how many you see." He said, "I see three boats." This was opening day of the brown shrimp season, after the first 8,000 CFS. That area used to be chock-a-block full of boats. Not any more.

I contacted the local buyers and they informed me they purchased 20-30 percent less the first two years when the diversion project was at low flow and up to 50 percent less after the flow was increased to 8,000 CFS. This marsh area is a critical marine resource nursery habitat that no longer supports the juvenile populations it once did. Thus there are lower production levels. It's as simple as that. It is my understanding at the Pointe a la Hache area they do not produce enough shrimp anymore to even keep a buyer down there. You don't need a computer to tell you something's wrong. Just open your eyes. Historically my dad and I shrimped in the California Point area for white shrimp from October all the way to Christmas—big white shrimp. I haven't made one drag in the California Point area in four years. I've tested it. I went looking, but never did find anything. I don't go there anymore.

The next question you may be asking yourself is what are the area fishermen doing to cope with these changes? Number 1, they're losing their boats. When they lose their boats they're losing their homes. They've got to go find another job. And most of these people are too old or too set in their ways to go ahead and get another job. Who is going to take a 56-year-old man and tell him okay, I'm going to train you to flip hamburgers? It ain't going to work. Some of them are doing seismographic work, but that's in limited quantities. Only certain people get the jobs. One person, Corky Melorene at Melorene Seafood had converted what once was parking space for his commercial vessels into covered slips for sports boats—adding insult to injury. But, you got to make a living. Indeed, what usually happens, you move to another area. That's the easier answer, but that causes another problem—over-capitalization, too many boats in one area. They wipe it out and they do catch quite a few, but the pie is split into too many pieces to make enough profit to survive in the industry. Now with more diversions being planned for other areas of the state, you will see more of this over-capitalization effect taking place as competition for the remaining productive areas increases. The end result is more fishermen will fall by the wayside. Moreover, history has shown that the government doesn't care how many of us are forced out. I was even told by an official, "Son, you are a dinosaur and an expendable industry. Get out while you still can." Think about it. That's a pitiful commentary on the demise of an industry that has been the backbone of the economy and culture of our great state. I don't believe this is the case though, and I guess that's why I'm here speaking to you today, hoping that you may get involved in turning the tide that is flowing ever strong against the commercial fishing industry.

The diversion created a whole new area for bass fishermen. That's nice if you're a bass fisherman, and I have nothing against bass fishermen. But there are millions of acres of fresh water with bass in them already. Why ruin my brackish water resources in order to take in more bass fishing areas? After the current population of the area has moved out about 15 miles to a more open-water fishery, we've increased expense, equipment, time, and fuel which means less profit. We no longer have a bayou site crab shedding industry while the water is still flowing. Now we have to haul water and recycle water to shed crabs and they don't taste the same. You have another heavy expense that, unlike most other businesses, cannot be transferred to the consumer.

Along with the fresh water came an explosion of mussel growth. The result is almost no oyster production from what used to be some of our most productive oyster grounds. Moreover, the mussel clusters, which get to be as big as bowling balls, in shrimp fishing equipment are a nightmare. The combination of the TEDs, those ridiculous turtle excluder devices, with mussel clusters equals significant shrimp and gear loss. So once again you've narrowed down the area where I can productively trawl. I'm starting to know what the American Indian felt like being chased from one spot to another.

Where do we go from here? In summary, if you're a landowner close to the project or bass fisherman, the diversion is for you, but if you are a fisherman dependent on the resources from that area or an oyster lease holder in that area, be ready to move, or adapt, or learn how to tighten your belt a couple of notches because you're looking at more years of lower income ahead. Projections say it will all be gone in 50 years anyway if something isn't done. You may or may not believe this. Only time will tell. In 50 years if I'm still here, I'll be 90, and it will be interesting to see what transpires. I hope I live that long. I wonder if there will be even one commercial fisherman left in 50 years. Finally, government has got to get out of this posture that they know it all. Moreover, when a project like this is involved, tell the truth. Expose the good, but expose the bad also. If one group is going to suffer economically for the supposed overall good, do a couple less studies and use that money to compensate these people for their real losses. Thank you.

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Jerald Horst, Moderator

Our next speaker, biologist Nash Roberts III, represents the recreational fishing and, to a lesser degree, hunting industry. He is the owner of Fish Hunter Guide Service and has personally fished recreationally for over 45 years. He is also an owner of Nash C. Roberts, Jr., Consultants, Inc., and has been with that firm for 27 years.

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CAERNARVON'S IMPACT ON FISHERIES: A SPORTSMAN'S PERSPECTIVE

Nash Roberts, III

Normally I'd say I'd rather be fishing, but I couldn't pass up this opportunity today. This is a great chance to tell you what I've observed out there. It may not agree with what others have seen, but I spend a lot of time out there, both fishing and hunting. My son is hunting this morning out there and fishing midday after the hunt on guided trips. So we get to see this maybe in a different way than most other people see it. And I think there are some good points and some points that may not be that good about this diversion.

First of all, the last couple of days have been kind of cool, windy, with low water over at the Delacroix-Caernarvon area, not the kind of day you'd go out and fish. There are light winds, clear skies—not a great duck hunting morning either. If you went out there this morning at Delacroix and launched your boat, but you came back in to the dock this afternoon around two, you'd still be waiting to get your boat picked up. I'm going to move on. I just want you to think about that for awhile.

When they open the diversion, it runs hard. At the end of December, January, February the river water comes down through almost all the way to the twin pipelines. It's a north-south pipeline that runs down to Oak River. Most of that area on the inside there is basically unfishable. It's off-colored river water and colder than the regular marsh water at that time. Fishing just basically shuts down on the inside. In summer we have a problem with a large algae bloom each year. It gets a green color and you actually see the algae in the water, much like what was observed in Lake Pontchartrain this summer. It's been our experience that we cannot catch fish during that period. The water's pretty, but it's got the green algae floating in it. We have not been able to catch any fish during that period.

Another problem, which is maybe not entirely caused by the diversion, involves the aquatic grass that grows up during the year. Over the last three summers, particularly in '95 and '96, we've had strong high tides. Some of those tides have pushed water up over the road toward Delacroix. What that has done is burn the aquatic grass in the outlying areas. And when that happens, the grass dies. I've seen Forest Lake a solid mat of grass. You could catch a limit of bass in there with no trouble. A month later the grass was gone. And still, after that initial burning, it has not returned yet to that area. And that has shut down the fishing. The water is off-colored and soupy looking. Its foul, it smells. Fishing is extremely difficult in that area. Most of that area is between the twin pipelines and Caernarvon.

Let's talk about some of the benefits that we've seen. Number one is the large amount of bass. The fishing is the hottest spot in the state right now, and, it has been for a couple of years. Talk to any bass club, any bass fisherman—he's going to Delacroix, 12 months out of the year. I don't know how the place takes the pressure, but it's a tremendous fishery. The size of the bass is great. Most of the tournaments are in the spring when they're catching spawning fish, four or five pounds on average. I've been a bass fisherman all my life, fished the bass pro tour, fished the bass classic. I would have lost my house betting I'd never see bass fishing like I see in Delacroix right now. It's truly amazing. I don't know what the introduction of the Florida strain would do in that area if anything, but it's a tremendous fishery right now and it's over a huge area.

As far as speckled trout, I really don't see any major detrimental effect on trout fishing. We have a super fall fishery. It starts in November and, depending on the cold weather, it will go right through probably the middle of January. If we don't get any very strong cold fronts and low temperatures, it will go into February. But we lose the good fishes once that river water gets down into the upper end of Oak River. It goes through the lower end of Grand Lake, out of Orange Bayou, and into the upper end of Oak River. Before the diversion that was an excellent area for fishing, but we lose that late in December and in January when that river water gets in there. Little Lake, Grand Lake, those areas go first. The river water gets to them first. But the fish move down. They move a little farther south and the fishing is super in Pointe Coupee or Third Bay, those bays down toward the lower end of Oak River. So I don't see any detrimental effect. It does push them or displace the speckled trout a little farther south in the fall and winter, but hasn't affected the fish and the fishing is still great.

The other thing is the trout in the summertime. Well, let's say late spring, early summer. I haven't noticed any detrimental effect there. We're still fishing the outer edges of Black Bay, just at the marsh interface with the bay. Fishing was super this spring, as it was in the previous springs, before and after the diversion. So I don't think the diversion has affected that time of the year for us. Most all of the fishing in the Delacroix area in the summer is primarily in Black Bay along the interface of Black Bay and the marsh. And it was excellent. Big trout, great fishing, just a tremendous crowd of people trying to fish out there. So I don't think it has hurt the trout.

The diversion has had an unbelievable effect on the bass, but the fish dearest to my heart is the redfish. And something has gone wrong with redfish. I don't know what it is. We did fabulously well on redfish well inside the marsh, the deep marsh, very close to Delacroix, between Delacroix and Caernarvon, the first two or three years. But the last two years, particularly after we had that high-salinity water move in and burn the aquatic grasses out there, it's been very difficult to catch redfish. I'm there sometimes four and five days a week, and I can't find redfish. On occasions, we can catch them below the twin pipelines, Grand Point Bay, Bay Lafourche, those areas down there. But it is very difficult to find any fishable concentrations of redfish in the interior marshes. At least it has been for the guides who work with us. So I don't know if this has anything to do with the diversion or whether the redfish just have not come into that area the last couple of years. But they're not there and I don't know the cause. I can't catch 'em and I don't see 'em. We're fishing a foot of water. If they're there I'd see them. I don't blame this on the diversion, as something else may be causing it. But the diversion definitely has not affected the trout fishing, and the bass fishing is tremendous.

Duck hunting. Boy, try to find a duck lease in that area. It's the hottest spot in the country. We take all our charter trips in that area, but until recently I rarely saw an alligator. Now you can't get rid of 'em. They follow every crabber in the upper end of that area trying to get any bait he throws away. It's great for clients from out of state or even from New Orleans who don't get the opportunity to get out there.

We have a most vibrant marsh. If you haven't been out there and looked at the marsh in that upper end that's been strongly affected by the fresh water, it is fabulous. It is gorgeous. It is so healthy it's hard to believe that the change has taken place since that diversion was opened. It's worth taking a ride out there just to look at the wildlife and look at the waterfowl in that area. Another thing about aquatics in the water. These are the plants that grow in the water, the grass that grows in the bays, and has a strong filtering effect. For two days, we've had good, strong north and northwest winds. You would expect all these shallow bays and flats to be churned up, to be muddy and unfishable. We can beat the wind, we can get a stronger trolling motor, we can put another jacket on if it's cold, but we can't beat muddy or off-colored water if it's windy. You don't have that problem at Delacroix. That grass breaks the wind, stops the bottom from churning up. You can fish if you've got the right equipment, you can fish in the wind. The water is crystal clear and breathtaking. The bass you catch are black. If you do catch a redfish, it's copper colored. They're brilliant. So those are the benefits that I see.

In closing, if you want to judge an area, see what the sports fishermen or hunters think of it. Take a ride down there any morning, but try to go if you can on a Saturday or Sunday morning and take a look around if you can get close. Look for a parking spot in one of these parking areas for the marinas. I dare you to find one. They don't exist.

As I said in the very beginning, if you came back to the dock today around 2:00 o'clock, you're probably still waiting in line to get out of the water. Now what kind of environment would cause a sportsman to tolerate that? I won't wait in line to buy food to eat, but I'll sure go to the Caernarvon area or Delacroix Island to go fishing or hunting even when I know I've got to sit in this line for an hour to get in the water. Then I've got to sit in line an hour to get out and put up with all these characters around there. I'd do it everyday, and that's all I can tell you. It was a good area before, but it's a better area now. Thank you.

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Jerald Horst, Moderator

Our next speaker is Dr. Ivor Van Heerden of the Center for Coastal, Energy and Environmental Resources at LSU. He spent one year as Assistant Secretary for the Department of Natural Resources and has conducted a great deal of research on the Atchafalaya delta. He served as a consultant on environmental issues in several African countries. His area of expertise is the development of management plans.

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OTHER MARSH RESTORATION OPTIONS

Dr. Ivor van Heerden

What I'm going to be talking about was produced under contract to the Barataria, Terrebonne National Estuaries Program in the production of a wetland owners' manual. I'm going to address some of the causes of wetland degradation and then talk about some of the other restoration techniques. I'm going to end with a look at the applicability of the different techniques.

If nature had its way, Louisiana's coastline would be straight from Texas to Alabama. So we're sitting on a very, very dynamic area. There's always going to be a strong interplay between physical forces that want to create wetlands and those that want to destroy wetlands. Here is an estimate of what is going to be lost over the next 50 years based on Corps of Engineers data and data from the CWPPRA plan. This is an earlier product from the Geological Survey. No matter which one is true, we are looking at a very serious situation in this state. So it's very important that we come up with restoration techniques and that we apply them. But in applying them we look at the good of the whole rather than the good of the individual because everyone of us in this room has a stake in what's going on out there, not only for ourselves, but for our children and grandchildren.

We all know how Louisiana was formed. It was through the addition of sediment. Working against that are a number of important factors that have always been there. First, there's subsidence. Basically, we've got to add 1.4 cm. of elevation on average across the coast. There's been some very recent work done looking at subsidence rates in more detail across the coast, and we're seeing that within individual basins, we can have ranges within a few kilometers from 1 cm. a year to 3 cm. a year. So there can be a threefold increase across a basin within 20 kilometers. This is an example down at the coast, Port St. Philip. You can see somewhat - it's an old port, about 200 years, and the based somewhat below the present ground level.

Another important factor affecting our coast that we often neglect is the impacts of hurricanes. Hurricane Andrew showed us a lot of things, especially in marshes that were stressed. This is an example of very rapid marked break-up of the marsh surface as marsh material was ripped out and removed farther inland. Here's an example of a semifloating marsh that is being pushed. The wind was blowing in this direction. You can see it's all being pushed up here against the manmade levee, and the net result is a huge open area of water. I've been going through some data from Hurricane Andrew and this was an enormous impact in many areas. Here's another example of a water body that opened up—I'm just trying to point out that we need to be aware of some of the important features that reshape our marshes. Here you can see thick pieces of marsh that have been turned over and moved, in this case, about 2 kilometers. One of the good things about hurricanes is it did move a lot of sediment throughout the area. Here you can see the sediment that came up a bayou, flowed over the road, and settled into people's back yards. And in this area there were 9 inches of deposition.

Okay, so we have natural causes of wetland loss. We also have causes due to man, often because of impounding. Here is an area where there was an attempted farming exercise and the net result is we now have a large square open body of water. We've also had the dredging of numerous canals and not always have we very effectively dealt with the consequences of them. We have a lot of data on the causes of wetland loss. This is a recent study from LSU in which they've utilized GIAS expertise and systems to try and work out exactly what were the mechanisms of wetland loss for different areas, thus taking the wetland loss maps a little further. Very briefly, lack of sediments is the number one cause, then come lack of fresh water, lack of nutrients, drainage disruption, pipelines, navigation canals, and so on. Submergence, both natural and ponding because of man impounding areas, results in a rise in water levels and the loss of surface expression; then comes saltwater intrusion, and inundation.

Okay, other restoration techniques. We have spoken a little bit about barrier island restoration. Channel tide gates—any type of gate on a navigation channel or large water body to affect the discharges up and down the channel. The beneficial use of dredging materials, and I think this is one of really big tools that we're not utilizing to its maximum. Breakwaters, dikes, walls, all have a role to play. Artificial structures are something I've always been interested in. Artificial seaweed—I've done some work on it and we now have a commercial manufacturer starting to manufacture artificial seaweeds. They should be on the market in about six months. Concrete mats—something we don't see a lot of here, but I'll look at some results from overseas. Plants, soil gaping, marsh management, and terracing, where we start with an open waterbody, scoop up some of the bottom material, and create ridges, and in this way encourage vegetation and some sedimentation. Fences—the Christmas trees are one fine example. Sediment inducers—you create a system whereby you reduce wave energy or reduce water currents and try and get sediment to drop out of suspension. Water control—it's all by supply rods and vegetation plantings, trying to re-establish vegetation in areas where perhaps it has been lost or where there's an opportunity to really get a good ending. I'm not going to go through all of these, just make a few points and get into the applicabilities.

Breakwaters or hard structures are one option. This photograph was taken down on the coast on south barrier islands right after hurricane. This is one of the breakwaters; the water was over top during Hurricane Andrew by about three or four feet. Its impact, its benefit, is perhaps questionable. In fact it does reduce wave energy, but it has an impact on sediment movements within the coastal zone. It is certainly a tool in the toolbox and I'm sure there are many occasions when it could be applied. When there is a lot of change, a lot of sediment movement, we see a lot of sand worked up over the beach in these wash-overs into back areas, suggesting that another technique for barrier island restoration could well be to add sand and then maintain this rollover process. Here is another example where we've had an abundance of sand—this is again after Hurricane Andrew. There was very little erosion and, in fact, some beach providation. We had an abundance of sand. Tidal gates—this is an example of a lock just below Port Allen, not really in place to control salt water, but nevertheless a structure that could be utilized in changing salinities or affecting water flows from one area to the next.

This is a similar structure over in west Louisiana built to help maintain freshwater levels in Grand and White lakes. When they were originally built there were high salinities, or higher than were wanted, in the Port Laronge and Vermillion Bays. Now that isn't the case, but nevertheless it's a large-scale structure. It can have navigation benefits, at the same time be used to regulate salinities or water movements from one basin to the next. Dredging—I think we've learned from the Atchafalaya delta that we can create natural looking lobes with dredge material. Here's an example where we build long lobes by adding sections of pipe at a time. You can see that each different length of pipe created these sausages that have very low elevation, low slopes, and were very quickly colonized by all the local marsh plants.

We can put the material not only in long sausages, but anywhere we want to, basically because it is in a pipe and we can pipe it to what we want. We know enough that we can mimic nature in the placement of this material.

This is in Atchafalaya Bay. I draw your attention to the shapes of some of these dredge disposal areas. The design was to try and mimic the natural environment. This is a natural delta layer in that system. So it is a wonderful tool and not only can we rely on material that is dredged from navigation channels we can potentially look at moving material out of aggregation areas. There are parts of Atchafalaya Bay, for example, that could be mined and the sediment pumped into the western Terrebonne marshes. There are sites on the Mississippi River where we could be doing the same thing. It's a relatively cheap way of creating new land.

Again, another slide of some sea walls. In this case, again after Hurricane Andrew, it has protected this section of coastline, but because of wave refraction, this whole area of the island blew through. So we have to look at not only what happens when we have a breakwater or a seawall but what happens in the areas adjacent to it, be they up-drift or down-drift in terms of sediment movement.

Now this is an example of some work I did in southern Africa. This is an area with a six-foot tidal range, a very similar sedimentary and ecological environment to coastal Louisiana. These are the Swanson marshes of Zululand. And, this was an area in which, because of boat traffic, erosion was very severe. And, what was done in this case was sloping of the bank and placement of armorplex mats. These are concrete blocks joined together by stainless steel wire. When this particular mat was photographed, it had been there about eight years and you can see it was starting to break up. But, it had maintained the bank. We have in this particular area not only small fishing boats but also super tankers that move in and out, so there is some very high wave energy. This is a very effective tool for maintaining the banks of such areas. This is another example where the bank was relatively steep, and this has also been in eight years. In other areas where the slope was more natural, about 15˚, mangroves were starting to come in. In fact, the local wildlife department has gone in and is planting mangroves in each one of these areas. The use of concrete mats is a technique that may not apply in Louisiana.

Marsh management projects, in which we have an impoundment but we actively manage water levels and structures, can vary in size. One of the often heard negative consequences of marsh management is that people feel it's keeping them out of their wetland areas, it's restricting their usage, especially recreational fishing. Unfortunately, when you create such areas, you have to do a lot of monitoring and you have to have an active program of maintenance and upkeep. In this case, the levee had broken through, hadn't been sealed, and the net result was that this area was flooded with water. So there's a tool that can be used, but again must be cared for. Here is an example of a small area of a marsh management project. It was impounded, it was filled with saltwater during Hurricane Andrew, and there was no way to drain the water. The result was that the grass surface was badly burnt, if you will, by the saltwater. Something we've got to realize is that at times of hurricanes we need to have ways to perhaps drain these impoundments very rapidly. I recently worked with some landowners who were doing marsh management projects and one of the things they were interested in is what a marsh management project will contain when you have an accident such as a gas well blowout. We need to put plugs in the right places to seal one waterbody from the next. In this slide you can see shoreline erosion, which is very common in Louisiana and it would be more effective to put the plug right here. It's a very useful and relatively cheap technique. Here are examples of plugs that perhaps should have been located a little farther down the channel. Fences, Christmas trees, and so on—we've seen some that have really done fantastic jobs. Cold fronts and hurricanes have torn some apart, but they are a very important tool in education and certainly some have had many positive impacts. Fences made of wood—again, I've seen examples where these have really worked reducing boat wave energy, and other areas where it hasn't. It's a tool but is not applicable in all incidences. Vegetation plantings help, and also bringing in foreign material. I've been a proponent of this, but there's potential for using other materials to create wetlands, spillways.

Now this is an attempt to try and look at the causes of wetland loss and various techniques. We'll not get into details on the numbers. I want to point out that not all restoration techniques are applicable with all types of wetland degradation. So there are times when one particular technique is more applicable in one area than in another area. So in talking about other options, one needs to be aware of what is the dominant process, what is driving the wetland loss, what is driving the wetland degradation. Then how applicable is the tool that you're proposing. In all occasions diversions came out as a very valuable tool.

Jerald Horst, Moderator

Our next speaker is Dr. Eugene Turner, the director of the Coastal Ecology Institute at LSU. He has done quite a bit of work on the hypoxic, or dead, zone, as it is also known, but is perhaps best known for being the person who developed the link between wetlands and fisheries production. His focus currently is on wetland management from the scientific point of view. He's a University of Georgia graduate. Dr. Turner.

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COMPARING RESTORATION APPROACHES

Dr. R. Eugene Turner

Most of us got into this business, or at least I did, because we wanted to be outside. It shows how intelligent we are, because now we're spending all our time inside studying what's outside.

It reminds me of once when I was out in the marsh and the boat motor broke down. I came back to the dock, and I had left my wallet in the car, which was locked with the keys in it. I needed gas, so I went up to a local guy watching the Auburn/LSU game, and said, "Can you help me?" He said, "Well, what do you need?" "I need some gas but I don't have any money." Why don't you have any money?" I said, "Well, I'm just a poor teacher." He looked at me and said, "Oh, yeah, I recognize you. I took your class. You're right. You are a poor teacher."

What I want to start out with is that we have very different strengths and weaknesses in how we deal with the coast, but we all want this to succeed. And, in science at least, we want to have our assumptions correct. And the role of scientists is sometimes to be somebody who questions those assumptions. But we all make assumptions. Every group of us does. Mendel, the father of modern genetics, was not allowed by his peers to teach. The government bureaucrat appointed by the king apparently had this one wrong. Even newspaper reporters occasionally get things off center a bit. We all have our assumptions which have some truth to them and maybe we miss a few key component parts underneath them. Discovering these assumptions to be true or false, checking them, means taking a risk. Now I think agencies feel a little more uncomfortable taking some risks, because it's very hard to go to the public and say, "I need two hundred million dollars. I *think* I know what's going to happen." The public wants to know that this is what *will* happen. You're more likely to get the money. And there are ways agencies and the universities are structured that constrain them and also make them able to do some things the others can't. Scientists usually make rotten managers and managers generally don't make the cutting edge of science, because for one thing there's not enough time.

There's a major assumption that underlies the state's reasoning about why we lost the coast. But I'd like you to think differently from how the coast was created, how it's maintained. What I'd like to offer is a different assumption, which has to do with the way we've cut up the coast with canals. I'm doing this from the point of view of a doctor. Of a patient who came to a doctor and said, what do we have to fix? He'd say, well what is causing it? You want to make sure that the remedy matches the probable cause or at least that you do no harm. We've all seen the coast as being cut up left and right with canals and hydrologist tracks. When we show these pictures to people out of state, they literally gasp, saying, how did you do this? How did it happen? Each one was individually permitted. In this slide, it's crossing—there are marsh buggy tracks. Individual actions in interacting with the environment have also caused damage. Here, we've compounded the natural functions with an overlay function. This slide shows a natural levee near Alliance, the remnants of it. It's now belowground. We put a spoil bank across here and across there. And what happened? Everything in between went to open water within a few years. Here's an areas that we know was 10-20 percent water and then they put a canal and a spoil bank across it, and within one and a half years it was 80 percent open water. We know that there are some causal relationships between wetland loss and modifying the hydrology. And I would bet if you go to almost any other state with coastal wetlands, you've seen this same thing.

We have changed marsh hydrology. There is as much area of dredge canals as there was in natural channels at one time that formed the marsh. Now let's consider how sediments are maintained. This is a plug of mud from a salt marsh, the habitat with the most sediment content. The reason you only see the small part in there because that's what remains of the sediment. Everything else is water and organic matter. The sediments may stay there, but when you lose 20 or a hundred years worth of that organic matter, because you changed the way the water moved in it, you have lost what has taken a hundred years to build. It's really going to be very difficult to get that back right away, which is what we'd like to do. So, I'm saying is that the organic matter, the living part of the marsh, is extremely important to how the marsh is maintained. And when we mess that up, we will cause the marsh to be gone, but it's very unpredictable. I can test that sediment hypothesis. I can test this hypothesis now with data we have from 1930 to 1990 in Barataria. Here's Barataria, a system that has about the same hydrology, same geology, in the sense that it was formed in the same 500,000-year block. Waters move in and out of it and it's a system in and of itself. I could do this for the other systems, which will have slightly different slopes, but if you take the land loss in those areas over the last 50 years, you see a relationship between canal density and land loss. It is a really tight fit considering the variability of what else is going on in the basin. There's a direct relationship. Where we've altered the hydrology a lot, the land loss is very high. Where hydrology is little altered, there's very little land loss. You can see this in every basin. Using the same data, you see that land loss is actually higher in the area nearest the coast than in the areas farther north. That's saying that the land loss per unit canal is higher at the southern part than it is in the northern part of the basin because the hydrologic motion is stronger in the south. The tides are higher than they are in the north. This is evident in every basin. That says to me at least that the saltwater and freshwater inductions at the top are not that significant because the curve ought to go the other way around. It's saying to me that these other factors that we all put on our list of possible impacts—subsidence, sea level rise, salinity—are not as strong because you would have noise on this graph. There would be a shotgun pattern. The implication is that these impacts that are local, maybe within a mile or two of the spoil bank and canal, are there on a small scale. And if you help the plants along to build up that organic matter, maybe we can fix the coast a little better.

These are nine salt marshes in southern Barataria Bay and here is the area of basically open water that does not include canals. And here is the area including canals. Over time when they had a rise in dredging they had a rise in land loss. When dredging stabilized, the land loss stabilized. In fact, it went down a little. When the dredging picked up again, land loss picked up and stabilized again. So, there is a mechanism to explain this in terms of biology and physics. So I would say deal with this.

Now, about diversions. I'm not saying I'm for or against diversions, but I'd like to look at the assumptions of how we go about these things in all projects. The main thing I'm going to conclude, and I'll say it now, is that I would like to see a lot more small projects. I'd like to look at some assumptions about diversions. One is, if you divert it here there's nothing that will have to be answered. There are consequences to answer. It can't be a free lunch for everybody. Somebody downstream is not going to get that sediment or water or whatever benefit it brings.

The next is to scale what we can do with the river. If you look at the rates that we have historically built on the coast, it's on the order of a thousand acres, less than a thousand acres, for the whole coast. That's what we are trying to replicate. The five-year CWPPRA Project proposes that they can build 1200 acres a year which is not going to stop loss for the whole coast. If you think you can come up to the speed of mother nature, you're not going to get more than that, I don't think. I think sometimes we get the idea that the river diversions can help the whole coast because it can stop 25 square miles of loss a year and repair it at that rate.

We do have some experience with diversions and we are now at a point where we can compare some numbers. There are diversions of this size and we have much smaller diversions, in this case, very small diversions, just a small percentage of the route, less than 1 percent. So we have numbers on some large diversions and some small ones, and we have ones that are proposed in CWPPRA with some estimates in between. So I'd like to go through how they compare. This is the amount of river diverted and this is the land gain proposed or actually known. And, I'd like to point out something, that the more you divert, the more you gain. We expect that, we would hope that. But, there's an important point of this graph which is that if you go from .1 percent diverted to 10 percent, you go a hundredfold, but your land gain only goes from 10 hectares a year to 100 hectares a year. In other words, it becomes less efficient. This graph suggests that we should maybe think about building a lot of small diversions rather than a very large one. You get more land gain per unit effort. The second issue is the cost as they get bigger. These are data from the CWPPRA report for restored and created wetlands and the cost goes up, as you would expect. The larger the structure you're trying to build, the larger the cost. The cost goes up a lot faster per increment in the size of the project. It gets less efficient and more costly to control natur. The more nature you're trying to control, the higher the cost. Now these are the numbers. They're not mine, I didn't make them up. If you combine those two together, which is a lesson for the project because we're never going to have enough money, I think they'd come to a strong conclusion that we should be building, looking at, a lot of small projects. As much as we're now looking at the very large one, look at a lot of small projects. There is no kind of scale with this. The cost per hectare gain with the large projects is not getting cheaper, it's getting more and more expensive. The larger projects of several million dollars a year are costing $10,000 to $50,000 an acre or $100,000 an acre. The very small projects that we have from CWPPRA or other funding systems are $10 to $50 an acre. Which is more effective in terms of money? I think this is an argument again for using small projects. Small projects are going to cost less, and you may get more land out of them. In the long run, of course, with diversions you are using less water for the same amount of gain, so you have fewer problems with salinity and nutrient additions.

What are some other small, cost-effective projects that I'd like people to try? One is backfilling. We have thousands of canals that are abandoned. The restoration rates on those we know, and they are a thousand dollars an acre or less. This compares with the average CWPPRA price of 50 or some number like that. Once you scrape down a spoil bank and fill it in, you are replacing the natural hydrology. And it may have some indirect positive benefits.

People have broken small portions of the levee and let the system do the work rather than trying to engineer the system. The restoration rates on these might only be 1 percent a year, which may be frustratingly slow, but that's the same rate as Caernarvon. There is some natural restoration going on which I think supports the idea that we could break down some of the spoil banks before it's too late and it's too far gone. It looks like there is some natural restoration of the marsh going on because the spoil banks after 50 or 60 years start falling apart. And some of the water is moving back and forth, re-establishing its flow. We have some estimates. It's a hundred dollars an acre—minor surgery.

The land in this picture was a farm in 1915 and fell apart sometime before 1930. This land fell apart October 12, 1961. It had subsided and the organic material shrank up. It's now several feet deep. This area has recovered because the natural hydrology was restored in time. There are many other agricultural impoundments on the coast where we could do that as well. The cost for a 1 percent a year gain, which we have measured at several project sites where we removed 10 percent of the levee, is about a dollar an acre. There are thousands of small projects that are possible, and you can learn from your mistakes. You don't want to make a mistake with a two-hundred-million-dollar Caernarvon. You really want to make sure it's thought through because it's going to jeopardize your other diversions. But with the smaller projects, you can afford to make more mistakes because you've got plenty more little ones to try. Planning time for small projects is very short, and they are extremely cost effective.

NMFS has a project for a few million dollars building small crevasses on the coast. At the known rates of 50 crevasses at four or five hectares a year, is going to generate with 3 percent of the total project, 50 percent of the benefits. Now that's cost effective. I'd say, try it. Do more of that. The bureaucracy for small projects is going to be very different than from the bureaucracy for a large one. To have a large diversion you have to have a lot of people involved, a lot of structure, you worry about navigation if you're using a piece of the river. And so you're going to have the Corps involved in a different way than if you have only a landowner who tries things on his own with a little bit of assistance. In regard to the site impact, if you deal with local hydrology and that caused your loss, you're dealing with a one to one correspondence between cause and effect and restoration. When you have large projects, you're not so sure about that. The indirect impacts, if you make a mistake with a small project, are very small because you're dealing with small areas. I think that the basic assumptions underlying the rationale for small projects are correct—that local hydrology has driven loss rates and the problem should be addressed at that level.

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Jerald Horst, Moderator

The next presentation is where diversions fit into the overall restoration picture. Our speaker is Dr. Len Bahr, who is the executive assistant to the Governor in the Office of Coastal Restoration. He holds a Ph.D. in coastal zoology and ecology and has had ten years of experience as an associate professor at LSU. He also spent two years at the Louisiana Department of Environmental Quality. Dr. Bahr.

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WHERE DIVERSIONS FIT IN THE OVERALL RESTORATION PICTURE

Dr. Len Bahr

In my opinion, without a diversion plan as a centerpiece, there is no legitimate coastal restoration program. I'm the fifteenth speaker on the agenda, and almost everyone has, one way or another, supported the general idea of diversion as a central plan. I guess Woody was the most vocal in that, but I share his enthusiasm and his view that without it, there's really nothing, there's nothing else.

So what I really want to talk about today is how best to expand management planning for the whole lower river to include restoration. I think we've had for a hundred years a very unstable, two-legged stool that the Corps of Engineers has been trying to sit on. You know, if you ever tried to milk a cow, you don't have much luck on a two-legged stool. The emphasis has been on navigation and flood control, but we really need to add restoration as the third leg. Restoration should be a priority with the Corps of Engineers for its mission of managing the whole river system. This may be radical by some standards, but I think this is the kind of argument we need to engage in. As some of you know, I have to put in my usual plug for *Rising Tide*, one of my favorite books by John Barrett. He summarizes very well a feud that existed in the Corps over managing the river. It went on for a long time and got very ugly and personal. I'm hoping we can avoid that kind of argument over diversions. I think there's a lot more at stake now, but there's a lot more development than there was then and a lot more money at stake. In 1927, the threat of flooding was from the river. In 2050, as the pictures you've seen indicate, the flood isn't coming from the river, it's coming from the Gulf of Mexico, and it's a permanent flood. It's not something that's going to go away in a year or so. I see this as analogous to the recent discussion about a tax bill in East Baton Rouge Parish. It failed miserably. It was proposed to renovate a very degraded school system, which has been deteriorating for over 30 years. Very much like the delta has been deteriorating. An expensive proposition was put to the voters and was trounced 2 to 1. The complaints about the plan were that it was too expensive. Does that sound familiar? It had been designed by elite professionals and experts, you know, and there was not enough public involvement. We hear that a lot and that's a good point. We're trying to correct that. In addition, because of a longstanding consent decree, it had too much federal oversight. And there was Judge Parker, who is often written about in the newspaper. But, the opponents of that plan were very successful. They didn't offer any real alternatives.

And I'm hearing a lot of opposition, or I read about it in the newspaper, but I never see really significant alternatives. There are good small projects, I agree with Gene completely. There are lots of good small projects we need to be engaged in. At the same time, we need to be engaged in some big ones. I represent the governor, as you know, and I talk to a lot of his constituents across the delta. And diversions are almost inevitably seen as the only real alternative we have for saving the coast. In the next 50 or 100 years, we've got to be honest with the public and say, I agree we're not going to save it all. There have been several speakers saying we're not going to save it all, but there's a lot we can save if we get together and don't fight each other until the money is all gone. I talked with a very bright guy I know the other day who is not a scientist, but he restores classic cars for a living. But he's got some real, real street smarts. And his slogan was, if you want to get dirt you got to divert. That sums it up.

This slide shows an old map from 1764. This is not something that I think we'll ever return to or see again, but it gives us something to shoot for. It's a beautiful map that's in Hill Memorial. If you ever get a chance, go look at the whole map just to give you some clue of what this delta system was at one time. It was incredible.

These are the kinds of objections that I hear and I see in the paper. I want to go through them one at a time because I think they all deserve scrutiny. The first is that the projection of future land losses is exaggerated. We hear that. You say, well the loss rate is slowing down and as Woody pointed out, that's because there's not as much to lose. The second is that diversion projects are not cost effective. We just heard some of that. The third is that Mississippi River water is too dirty. I don't buy that. There's a USGS report on the back table by Dennis Stempchek. It's a pretty good summary of what the quality situation is. Four, diversions will cause local displacement. There's no question about that. Fifth, diversions will invite law suits. No question about it. Jack Caldwell can tell you all about some oyster lease law suits. The sixth is that diversion will cause flooding of developed property. Absolutely. It's a risk, something we have to deal with.

This is a 50-year land loss projection map. The work was done by a team of people also along with a science advisory committee that Denise Reed manages and they all agreed on a very specific, very rigorous routine to determine and project loss rates. It was information we didn't have before. We had some rough ideas, but we didn't have this kind of specific information. Now it's not perfect, and nobody says that it is. A major flaw is that it doesn't show you areas that are stressed, but still are not water. The area I'm thinking about is the Manchac swamp. It doesn't show any loss rate or any projections, but let me tell you, it's stressed, and it's not going to be around that much longer unless we give it some river water. The methodology is good. Science doesn't get any better than that. And there's a landscape model, a cells model that was done by a number of scientists at LSU based on totally different procedures. It arrives at very much the same pattern and Paul Kemp has been heading that up. The last incremental time period was from 1983 to 1990. That was shown on this map and that predicts a 60,000-acre loss in the Barataria-Terrebonne systems alone. It didn't predict it. It documented it. The loss rate is projected to continue into the future. This is not exaggeration.

Number two, the cost is prohibitive and effectiveness is unproven. We've already heard some of the problems with some analysis and that some projects were not designed to build land, like Caernarvon, like Davis Pond, like Bonnet Carre. Of those two, Davis Pond is under construction. Caernarvon has been operating as you know, and there is land being built. That was not the design, that was not the original intent, but we're using the numbers that are coming out of these projects with great interest. And what we're learning is going to be applied to our future diversion projects. I spent a beautiful morning two days ago with Marnie Winter in the Naomi Siphon area looking at the effects of Naomi. We hear about Caernarvon. I hadn't heard a word about Naomi, how it was working. It's working beautifully. There is water getting in. There is an area of cypress trees that were so stressed by saltwater they were dying. Marnie tells me she watched these mature cypress trees. They have now just come alive. It's like they've had a new birth. We went out as far as the pen. We took a boat all through the outfall area and found sites you couldn't even get to, they're inaccessible. They've closed over. There is a flow tide developing and it's filling in. We saw in the pen beautiful submerged aquatics, ducks you couldn't count. It's a gorgeous area, and I think we need to start spreading information about that siphon. It's working beautifully. Now what did it cost? It cost six million dollars, mostly parish money. The state came in in 1989 or 1990, I believe, to pick up some of the tab. But the parish, Plaquemines Parish, was so convinced that this was important, they did it on their own. The same thing with Pointe a la Hache. I agree with Gene on one point, about the size of these projects. I would prefer to have a lot of small diversions rather than a few big diversions. I think you have more control. You can turn one on, turn one off. You can take advantage of local situations much better. And so I think there is a good argument that we need to explore on that cost effectiveness thing.

Number three, the water quality issue. I want to show you a little bit of brand new data, believe it or not. I'm no longer a practicing scientist, but I have friends. This is data for Bonnet Carre. As you know we had the grand-daddy of all diversions this spring, and this is not the way I recommend diverting river water, believe me. This is the worst-case scenario. This slide shows that up to 17 percent of the flow of the river was diverted into Lake Pontchartrain this past March. And it was done, of course, not to build land. It was done to protect New Orleans. It was a decision that had to be made. And I think we're going to see more of these kinds of decisions in the future. I think diversions are here whether we want them or not. So let's plan to develop the diversions that benefit the delta. That's an enormous amount of water. Naturally there were nutrients. Naturally there was an algae bloom. I think it's unfair to compare that with diversion projects. We're talking about 8,000 CFS compared with 250,000 CFS. That's not a fair comparison. This is the percentage of the river flow that went into the lake. Now imagine if you had 25 such diversions that would accomplish the same thing, but get water into wetlands first. I can see a really neat scenario here, especially at times when the river stage calls for releasing water to protect people. An old diversion project that was built in 1970 is the Teche Vermilion Project that was paid for on a tax bond by the citizens. It was a $39 million project to pump water from the river to reconnect the Atchafalaya to tributaries that were cut off when they built the west Atchafalaya flood guide levee. I'm sure Emelise Cormier can tell you more about the quality of the Vermilion River then. It was one of the worst rivers in the country. It was filthy. It was stagnant. The river water from that pump, which has a 1300-CFS capacity, has rejuvenated Bayou Teche and the Vermilion River. The people love it. They fish there. This is a good news story. It's out of the coastal zone, so we don't hear about it in restoration, but it's something we need to use as an example. There's good news.

Now back to Bonnet Carre. We saw the nutrients. We know about the hypoxic issue. It's a very important issue. Here is a salinity vs. nitrate graph and these are different dates on which data were collected. The structure was opened, I believe, on March 10 or 15. So this is when it was really starting to flow, and there were very high nitrate levels right at the structure. Salinity at the Rigolets was 4.5 parts per million. Okay, what's happening? There are bad conditions and algae blooms, but the nitrate is being taken up in the system, and not getting out into the gulf. It's not creating, it's not adding to hypoxia. I'm not suggesting diverting that much water into Lake Pontchartrain to solve hypoxia, but I disagree with people who say if we start talking diversion on a big scale, we don't have an opportunity of affecting the situation. What happened to the sediment? How much sediment went out? That's not the way to do it, I agree, but if you did it through wetlands, you could theoretically spread a centimeter of sediment over 300 square kilometers. That would do a lot of land a lot of good.

In regard to fishery displacement, an oyster mitigation bill was passed last year, and Secretary Caldwell is overseeing development of an oyster relocation program that I think will be a great success. My office is contracting with some fisheries economists to do some work on the sociological or the economic impacts of some of these diversions. In terms of the liability question, my boss, Governor Foster, has made it very clear that we're not going to make coastal policy decisions based on fear of lawsuits. We're going to do the right thing and let the chips fall where they may. There are flood risks, I agree. That's something we've got to deal with and I think what that implies is we've got to protect people before we divert the river. We've got to build levees around communities that would be otherwise threatened.

In summary, it is my opinion that the loss rate is real. Diversions have to be the centerpiece if we're going to be effective. Otherwise, we've got to be honest with the people and say, look we can't win. The risks of diverting the river are real. I don't deny there are risks, but I tend to think that they are short-term and they can be dealt with. And if we don't divert, the risk is permanent. I think a major river diversion strategy is minor compared with what we must deal with if we don't take action, a hundred billion dollar loss perhaps. Nobody is talking about global warming, but there are legitimate reasons to think that river flow in the river will increase 20 percent in the next 100 years. Just think. If the Corps of Engineers can't pass Project Flood down past Morgan City right now, what are they going to do with more flooding? We've got to be dealing with this. This is reality or it could be. So how are we going to do it? We're going to have to divert river water. Let's do it the right way, not the wrong way. And, I think basically we need to reconnect the river with the delta, that the river built the delta and the only realistic way we have of saving it is that way.

Jerald Horst, Moderator

Our next speaker is Jack Caldwell, Secretary of the Department of Natural Resources. I think the secretary's appearance here at this meeting demonstrates the high level of commitment that the department has to making things work. And it's a big dedication of time for a department Secretary to appear at a forum. Secretary Caldwell previously worked as an oil and gas attorney, and has been Secretary of DNR for the last two years. He was also adjunct professor at LSU Law School and President of the Louisiana State Law Institute. His areas of expertise are promoting coastal restoration and addressing oil and gas issues.

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CURRENT AND PLANNED DIVERSIONS AND WHO MANAGES THE OPERATION OF EACH

Jack Caldwell

This is truly a remarkable gathering. The idea that so many people could give up their entire Saturday to listen to 17 different speakers on arcane, esoteric, controversial scientific topics is just incredible. But I suggest that there's a reason for that. And the reason is that every one of us here today cares very deeply about our invaluable vanishing coast. And we all care very deeply about the dramatic battle to preserve it and save it with the pitiful funds available to do the job. As you know, we only have $40 million a year. We could use $400 million with no difficulty at all.

However, I want to bring you some good news today. In the first five years of the Breaux Act, we spent $31 million and we built 26 projects. This year we are going to kick off 27 projects in one year for $90 million. That's three times the amount that's been spent in the whole time. If you add in Davis Pond at $105 million, that will be $200 million this year. I want to give you another piece of good news. You've been hearing for years about our sharing in offshore coastal revenues. We've been fighting for a fair share for 40 years. The last time we came within a hair, in 1993. Well, the good news is we're going to make another major effort. When people ask me what I think our chances are, I can only answer I don't know, but there will never be a more propitious time than right now to make the effort. The reason is the offshore is not only on an upsurge, but predictions are that we are heading for a major boom offshore in the deep water. We all know that the impacts on our coasts are increasing. They are more evident and more dramatic than they've ever been. We have a strong delegation in Congress and the fairness of taking care of our coast with some of this money should be apparent to all. So the effort has already started.

Let me tell you some of the things that have been done and are now going on. The Minerals Management Service, as you know, is the federal agency that operates offshore. They have an advisory policy committee of about 40 or 50 people. I'm on that committee as the governor's representative. We met in Galveston and that committee unanimously adopted a plan that I had helped to draft. Of course, I loved the plan. I had no objection to it at all. I helped to write it. This plan has been forwarded to the Secretary of the Interior, Bruce Babbitt, with the request that it be introduced in Congress. On the congressional side, Senator Mary Landreau, who is on the Energy Committee, is taking the legislative spearhead. I have been in communication with her and her staff and we're going to meet Tuesday to design a congressional campaign to get this money. The chairman of the Energy Committee is from Alaska, which will have a large share of these revenues.

And now the best news of all. To let you know how big the game is, the projections are, by MMS, that Louisiana's annual share will run about $100 billion. Our share is much larger than anyone else's. In fact, it's almost twice the amount of any other state, and I have talked to people from New York, New Jersey, Pennsylvania, North Carolina, California, and Colorado, and they all say that's fair. Can you believe it? That's fair, that we get the most. So tomorrow I'm going to Santa Fe, New Mexico, and present a resolution to the Interstate Oil and Gas Compact Commission, which is a coalition of 29 oil and gas producing states, and I'm going to ask for their support of our effort to get our fair share of offshore revenues. I anticipate it will pass because this time we were smart enough to include in the pot-sharing, all the coastal states, all the Great Lakes states, and all the territories. That gives us 35 states and territories on our side. So, will it work? I don't know. But we're going to try.

All right. Now I'm going to which diversion projects we have at present and what's being planned, and who runs them. So you can know whom to shoot at if you don't like the way they run them. We have nothing but good news at DNR these days, and I could talk to you all day about it.

This slide shows the familiar splay delta crevasse or the open crevasse that you've heard so much about. They're the cheapest ones because basically you cut a hole in the levee and let the water run out. However, that's not so cheap on a comparative basis. You've heard of West Bay. That is the biggest one that's proposed and I think the latest cost figures are closer to $30 million. It's down near the mouth of the river and it has been approved as a Proact project, but we are running into monumental land rights and title problems down in that area. But that will be a beautiful splay project and I'm confident one of these days it will be built, but I don't think it can be done without litigation or legislation. This month we are going to sign the contract to build two delta splay crevasses in the Atchafalaya basin, Atchafalaya delta. This is part of this $90 million I mentioned earlier. This is called the Big Island Project, where we're going to cut a canal through an island to pick up the Atchafalaya River sediment and nutrients so it will catch the current and sweep along the St. Mary coast. We think that is going to be a fantastically successful project in terms of cost benefits. At the same time and as part of the same project, we're also going to cut some crevasses on the east side at the mouth of the Atchafalaya delta and we expect that one to work very well, too. Incidentally, this very month we're finally beginning construction on the barrier islands. I had to tell you that because I know you all care about it. We're going to award the first big contract to start rebuilding the barrier islands. Thirty-six million dollars worth will be built this year.

This is Caernarvon. For three years we ran it full blast, 8,000 cubic feet, because they thought it would move more sediment through the thing. And, sure enough it did. However, in the third year, which was last January, things got a little awry, and we think what happened is we got high tides and winds from the south, a lot of rain, and things got royally screwed up. We ended up flooding some duck camps and blowing out some marsh, though we have learned our lesson. We're still on this learning curve, and we have redesigned the flow pattern. I doubt if we will ever see 8,000 feet again. This year's program calls for a maximum of 4,000 cubic feet per second. At the present time nobody can blame us for flooding because the thing is shut down. The river level is below the sill, so whoever's getting flooded, it's not because of the Caernarvon structure. The secret, of course, to Caernarvon is monitoring. We're going to increase the monitoring stations, though the data will be bounced off satellites and come right into our office, and we will know at all times the water levels and salinity levels throughout the whole basin, the lake, Breton Sound.

This slide shows the other siphon. I'm going to run over it very quickly. You've heard a lot about this. These are all freshwater diversion projects in the Barataria Basin. We are going to coordinate all of them. I've heard that there's some concern that we may over-freshen the whole Barataria Basin. That should not happen. We certainly do not anticipate it. The West Pointe a la Hache siphons are being operated by Plaquemines Parish. They have control of those. They're 2100 cubic feet per second each in Plaquemines Parish.

So, we're going to coordinate all of them. We're going to have Davis Pond, which will be able to move 10,600 cubic feet per second. We're going to control that with a finely tuned operational program. We're going to spend eight million dollars on monitoring equipment alone during the first seven years. Monitoring has already started. The Corps started baseline monitoring last year and Wildlife and Fisheries is going to do a baseline wildlife and fisheries monitoring this year. So, when we turn on Davis Pond, we will know what the existing situation is. We will have two to three years of data under our belts. We won't fly blind as we did before at Caernarvon, but will carefully calibrate the system to achieve the results that are decided upon by an advisory committee in which there will be plenty of local participation. As you've heard, at Caernarvon we have representatives of the fishermen, the oystermen, the shrimpers, the recreational fishermen, and landowners—are all represented on the committee that makes the decisions. We're going to do the same thing at Davis Pond. This is a picture of Davis Pond to give you a general idea of what it's going to look like. I've just told you about that with the monitoring. On the advisory committee, federal agencies, state agencies, and local interests will all have a voice. DNR will run it day to day. We're going to be the ones getting the satellite data coming into our office. Myrtle Grove is now under study. Again, we're having land rights problems that were unanticipated, but it has been approved and eventually it should be built if the land rights are not too expensive. This is one that has gone out of commission. Maybe you've forgotten about this—the old Bayou Lafourche diversion that is no longer operating. The river had a crevasse in it and it was one of the Plaquemines Parish diversions that worked well until it just sort of fell apart and it is no longer operating.

This is the White Stitching Diversion project. It's a small siphon project, 250 feet per second. It's one of the earlier ones. It no longer operates because the out canal was silted in and nobody has taken the trouble to dredge it out. It's operated also by Plaquemines Parish. Probably a lot of you are not aware of the diversion at Violet. This is a small siphon that puts 410 feet per cubic second into the marshes between the river and the MRGO, and it does work. It's being operated by the Lake Borgne Basin Commission. This is one I know you've never heard of. This is Old Pecan Island. You all have been duck hunting on Pecan Island. This one controls fresh water from White Lake going into the marshes south of the lake. It was built with state funds and it's operated by the Vermilion Corporation, surprisingly enough. It's operated by a private corporation in conjunction with DNR. This is a planned diversion project at what's called Grand Bayou. This is the intracostal canal. It's going to take water from the intracostal canal and put it into the Terrebonne Basin west of Cutoff, west of the Lafourche Ridge. We're going to cut south from the intracostal canal and make a new type of diversion. This has never been done before. It's fairly inexpensive and will be very beneficial to the whole area. Bayou Lafourche is now in the engineering stage. I'm not going to talk about it too much because we don't have the report, but it's supposed to drop 2,000 CFS at Donaldsonville going down Bayou Lafourche.

The answer on diversions is that they are beneficial, but they have to be carefully handled. Thank goodness we are starting to flatten out our learning curve. We have learned what the secrets are. You must monitor them carefully, far more than has been done in the past. Secondly, you've got to have a flexible management system to respond to what's going on out there. You can't adopt a management system and then forget what happened. That's what happened at Caernarvon, why we had that damage. Finally, you have got to have every interest group that's part of the management of the system in order to build confidence so that everybody gets his say and everybody can be taken care of as well as possible. Because, as all of you know, whenever you fool with Mother Nature almost invariably somebody's toes are going to be stepped on. The idea is don't step on anybody too hard and try to do the greatest good for the greatest number. Thank you.

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Jerald Horst, Moderator

Well, I'll have to admit that is the first time I've ever felt sorry for someone with $40 million to spend, only $40 million. Our second to last speaker is Dr. Bill Good, for seven years the administrator for the Coastal Restoration Division of DNR, where he's in charge of the overall management and direction of diversions. He's an innovator. He has developed restoration techniques including the Christmas tree projects, terracing, foreshore dikes, and wave dampening fences and he has helped develop the technology of diversions. Bill is going to talk to you about an innovative, relatively new program called Coast 2050.

COAST 2050

Dr. Bill Good

Thank you Jerald. The reason that so many people left is not because this is a bad talk or they don't like me. It's because we have given this talk so many places and so many times, many of these people have heard it two or three times already. I would like to take this opportunity to thank Jefferson Parish and the Marine Advisory Board. This is a fantastic forum and I think we need more of these where people can get ideas out in the open and explore what ideas seem to work the best. The more we know, the more we understand, the less we'll fear. I think the unknown is really one of the biggest detriments to something like this. A lot of what we're doing is new. Secretary Caldwell said we've got a learning curve, and it is starting to flatten out. So that gives us a lot of encouragement, particularly when we've seen some technical successes. For example, Caernarvon, albeit there are some problems. We are seeing 5.9 percent of marsh reclamation per year where prior to that we were actually losing wetlands. So a trend has turned around from loss to gain. We are seeing some projects on which people are working together. For example, the conservation plan recently approved, for which the state's match has gone from 25 percent to 15 percent. In an average year that would save the state $4 million which would allow us to plow that into additional projects and make it a lot easier for us to make our match. So there are a lot of good things going on, including 2050.

A lot of people ask me what 2050 is all about. And, it is really about three things. It's about our people, it's about our coast, and it's about our future. Unfortunately many of the people who have been to so many of these 2050 meetings have just left, so it is a little bit of a biased sample, you understand. But those of you who have been to a 2050 meeting or have been at a meeting where 2050 was discussed, please raise your hands. Okay, I see I'm going to have a tough crowd today.

It is a partnership of the state, federal, local, and public participants. We're working together on a single plan to address the problems that we're faced with as a result of land loss in coastal Louisiana. We're using Barataria. You've seen this three or four times already today. This slide represents the loss between 1978 and 1990, a mere 12 years—133 square miles gone, replaced with water. Throughout coastal Louisiana we see average loss rates of 10 square miles per year, 11 square miles per year, what have you. What does the future bring? What does this mean? Some of you here today have done some projections that Len Bahr discussed earlier. And, if we look at what's doing to happen in the future, this map shows in red those areas that are projected to disappear between now and the year 2040. So over the next 50 years we're anticipating continued catastrophic rates of land loss in coastal Louisiana. That means additional water in the estuaries, less land, less marsh grass, etc.

2050 is looking at the entire situation from the "I have to live here" perspective. We're asking the question, what is this land loss going to mean to our communities? You can see, as you all know very well, many of our communities are already affected, much more than they were in the past, by flooding and hurricanes. And, we've talked about that a lot today. What is the continued land loss going to mean to our roads, our railroads, our utilities, oil and gas pipelines? People are starting to realize the significance of that. It's not only a state problem. A lot of the nation's energy comes either from or through coastal Louisiana.

One of the figures that you've seen is what happens as marsh edge is reduced. This slide shows fisheries landings for the last few years collected by Wildlife and Fisheries. What it indicates to some is that we've already reached the peak, and we're into a period of decline. Many associate this with the reduction in marsh edgees has been predicted. What is this going to mean over the next 50 years? What we're looking at then is 527,000 acres lost without CWPPRA, 70,900 acres preserved with CWPPRA, 49,000 acres preserved with freshwater diversions at Caemarvon and Davis Pond. The projected loss prevented by CWPPRA is 14 percent. Projected loss prevented by diversions at Caemarvon and Davis Pond is 9 percent. So, we're projecting to reduce our overall loss rate by 23 percent. As we lose that other 77 percent, we're going to see decreases in flood protection, hurricane protection, and water quality. There will also be negative effects on wildlife populations and hunting, fishing, private property, navigation development, infrastructure, and ecotourism. We're looking at 427,000 acres lost by 2040, an estimated public use value of 4,300 acres per year. This does not include the private use values. Potential economic value attributable to the loss acreage is $36.6 billion. At the current rate of spending, we would spend approximately $2 billion over that same period to address a
$37 billion problem. Obviously the current effort is not enough and we need to do more. The question is what. What do we do? We have a 1993 CWPPRA restoration plan. It's a very good document. We have a 1994 state restoration plan. Likewise, it is a very good document. There have been other documents that address coastal land loss in Louisiana such as the White Paper, plans that have been developed by DNR and parishes. Coast 2050 is integrating those plans, working with the parishes, improving upon these plans, asking for public input, and coming up with something that the parish governments can endorse and something that we can move together into the future with. The basic questions we're asking are: What do you want our coastal parishes to look like by the year 2050? Where do you think we should have freshwater marsh? Where do you think we should have intermediate salinities? Where should we have brackish marsh? Where should we have saline marsh? Where should we have forested

wetlands? Where do we just need marsh of some type? We have a group of people, the public, and parish governments in particular who are answering those questions, and they are actually putting their answers down on a map.

At the same time we have groups of people who are working at the regional level who are addressing other questions: What do we need to do to accomplish those goals? What kinds of techniques? What kinds of strategies? Many of the people who have spoken today in this room are working with us on that. Dr. Len Bahr, Woody Gagliano, Denise Reed, Glen Thomas—some of the best minds in coastal restoration in the state are working on the strategies as well as regional teams. The teams are based in four regions. This is mainly a matter of convenience so that we can administer a coastwide program more simply. One of the things that we've learned, which any kind of a public policy development process like this needs to learn early on, is that you've got to have public participation at the outset. Citizens and local officials often perform a reactionary rather than a participatory role in the implementation of ecosystem protection programs. Instead, local communities should drive the issues and be involved in policy formulation from the beginning. And that has been the case with 2050. It's very much a people-oriented process. We've had enough meetings to make even most seasoned bureaucrat seasick. We're looking at the plethora of parameters that coastal restoration impinges upon, all the coastal uses and resources that we can think of—navigation, development of flood control, transportation, water supply, and fisheries. We're breaking up the entire coast into mapping units. Each of these mapping units has a name, a recognizable place that people can relate to. And, for each of those mapping units we're identifying a set of objectives. What kind of marsh do we need there? We're going to do a lot of GIS overlays. We're overlaying these maps with the projected land loss. We're overlaying infrastructure. We're overlaying fisheries habitat. We've had some fantastic cooperation from the Department of Wildlife and Fisheries from their marine fisheries and wildlife habitat data base. The strategies for achieving those objectives are also being worked on in this mapping unit context. We're developing objectives and strategies. The goal statement of the program is: In partnership with the public, developed by December 22, 1998, a technically sound strategic plan to sustain coastal resources and provide an integrated multiple-use approach to ecosystem management.

The left hand side of this slide shows ecosystem need and technical solutions, the strategies to accomplish the kinds of things that the ecosystem needs in order to become healthy or whole or productive or provide whatever functions are identified by the public. Acceptability to the public would be the objective. What does the public want? What does the public not want? What would the coastal parishes endorse or not endorse? We're still in that part of the phase, the first of the three phases.

The next phase will be when we take our maps of objectives and strategies, and we put those together, and we cuss, and we discuss, and we argue, and come up with those things that happen to coincide in terms of technically sound solutions that are also publicly acceptable. There will be technically sound solutions that will not be publicly acceptable, and there will be things that the public would like to see which are not going to be technically doable. So the following phase, which I expect to be the most exciting and challenging, is going to be consensus building, where we work through that type of discussion and try to achieve as much overlap as we can in terms of publicly acceptable technical solutions that will actually make our coast work. Once this plan is completed, it will serve as a compass bearing for related activities and programs to line up against. As it is now, we have at least two plans on the table. People are saying, will the real plan stand up. Well, this will be the real plan and people will have an idea as to where we're going. There are three things we can do about our coastal land loss in Louisiana. We can watch it—we can just simply let it go. We can react to the change caused by others. Or, we can become a part of the change. I know I'm preaching to the choir—you wouldn't be here if you didn't care. I know most of you are already involved. But it is something where everyone does have an opportunity to participate and to contribute. And the door is still open. We're still asking for help.

This slide of Grand Isle, I felt, was a good example that I wanted to use in closing, of the deep love the people of Louisiana have for our coastal way of life. And 2050 is a means of making sure that this treasure can be a legacy for future generations. Thank you.

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Jerald Horst, Moderator

Our next speaker is Mark Davis, who heads the Coalition to Restore Coastal Louisiana. Mark is an attorney, and prior to this he was general counsel for the Pontchartrain Basin Foundation. He practiced private law for 12 years.

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CLOSING REMARKS

Mark Davis

First of all I would like to thank you all for coming and staying, and I would like to thank Jefferson Parish and the Marine Fisheries Advisory Board for holding this forum. Some of these things happen five to ten years too late. But it is not an excuse not to start, and I would like to see where we go from here. And before I summarize what I've seen and heard, I'd like to suggest that events like this are only useful if they lead to something. We've heard a lot of good questions, a lot of unanswered questions, and I've seen a lot of conversations going on in halls and around the room. And, I think that those are best served if we find a way to continue them. I'd urge that if you have ideas of where we can go with this, how we can get answers to the questions that you may have that you didn't get a chance to ask today, make sure you contact Jerald or Mamie as the original planners of this conference. We will all be in contact to see what the next steps can be.

I think we've seen at least one thing today, and that is that diversions are not a simple issue. But it is an essential issue if we're going to get serious about saving something we care about, and that is coastal Louisiana and our way of life. I think that it is also important to realize that when we talk about diversions we're not talking about one diversion or one particular aspect of our experience with the diversion. For example, all diversions are not Caemarvon. All diversions are not Bonnet Carre. Not all diversions are crevasses. Some are smaller, such as siphons. We have to decide, get a handle, on what we mean by the topic.

Basically when we are taking fresh water out of a river system, putting it back into places where it hasn't been in generations, we're talking about the concept of diverting that water for a new use. And to understand how that's going to work, we have to have an understanding of history. You've gotten some of that today and the context for future action. And I think, as was pointed out earlier, that diversionsare really nothing new here. We've been doing them for years. Jack Caldwell showed us that we've actually had some in the ground, but more importantly, a lot of the things that we have done, we've called them canals, we've called them floodways, we've called them navigation channels, but they're diversions. They had the effect of moving water, fresh or salt, into places there wasn't water before. The fact that we didn't call them that, didn't get realistic about what the impacts were, is a lesson that we need to learn. And I think that's one of the things we heard here today as a lot of people are concerned when we talk about the next generation of diversions. Let's get honest about what we know, what we don't know, who will be affected, and how we're going to deal with it. And I think that is really one of the lessons we have to learn because the effects of those earlier activities are often the things that we want diversions to correct. I think as Len Bahr mentioned, we've effectively got right now a massive diversion system of the Gulf of Mexico into areas where we live, work, fish, and recreate. We have to come up with solutions to that kind of problem. Many of the projects that we have seen, although nominally successful for their originally stated purpose, still have come with a very high price. Sometimes we've seen algae blooms. Sometimes we've seen management issues or trust issues being created over the way the project was conceived or operated. That's not the same thing as saying that diversions work or don't work. That's to say if we do them right, can we do them better?

I think we have to note that when we're looking at diversions for our coast, the context for considering them has to be put in a framework in which change is a constant. Nothing stays the same. We don't do anything—the map continues to change. If we are going to embark on a more aggressive strategy of putting the river back to work, we have to understand that we are going to be, profoundly in some cases, changing the map. The land masses will look different. Land use and marsh types may change. Productivity can change. Fisheries allocation can change. Infrastructure will be affected. Land ownership can be affected. Tax bases, cultures, communities, storm protection, you've heard it all. The one thing that really wasn't mentioned so much is one of the issues often left out: opportunity. As we decide what we are going to do and not do, frequently the thing that leaves first is not a fish, it is not a bridge, it's not a community that has to move, it's an opportunity that never came. When you look at our coast, you realize that if we're going to invest in the future, then we're going to be investing dollars and resources that come from outside our communities. Already we're seeing insurance becoming harder to get. Already we're seeing capital becoming harder to get. I can tell you I used to do investment planning, and frequently people will not consider coming into an area like Louisiana because it's too subject to change, whether it's political change or geographic change. Those are issues that we have to figure out how to grapple with. There is no easy answer to them. If we are going to do something, action is required because the failure to take some action is itself a decision. And it is basically a decision to accept our coast in the direction it's currently going. We've seen a couple of projections of land loss today. Depending on whether you take the most conservative or most liberal projection, it's still a pretty traumatic future we're headed for. So if that's not acceptable, some action is required. The question becomes what is that action? And I think what we've generally seen today is that no matter what your action, diversions are part of the toolbox. Whether it's a single diversion, a series of smaller diversions, a combination of things, whether it's to deliver nutrients, fresh water, or sediment, these are all components of that diversion toolbox. We're looking at diversions in the context of the role that rivers and bayous once played, which we want them to play again, but we have taken actions to shut them off. We're trying not really to divert water, but to essentially restore a hydrologic system to the extent we can. Diversions are just one piece of that. Barrier shorelines are a piece, and hydrologic restoration methods such as reworking canals and spoil banks are also a piece of it. Can you do it all with one tool? Not very many people think you can, but I haven't heard a lot of people saying that they disagreed that it was a legitimate tool. There has been a lot of talk about not being able to trust the people who are planning or operating them. And that is, I think, one of the hardest issues that we have to deal with because it is not a science or technology issue. I think to deal with that we have to get honest about what the next generation of diversions will be. I think we have to recognize that change is a constant. Nothing stays the same. Displacement, liability, water quality issues—these are all very legitimate things we have to consider. But it doesn't mean that those are issues we run from. We've got to figure out a way to manage them. We have to recognize that if this was easy somebody would have done it. Diversions and coastal restoration are not easy and they are not going to be cheap. But that's not to say that it's unprecedented. In fact, highway systems, navigation systems, and levee systems are all public works programs, no more ambitious, probably far more costly, than we're talking about for coastal restoration. And there will be winners and losers, which happens any time you decide where to put the on ramps and off ramps for an interstate highway, when you site a levee, when you decide which businesses to subsidize and which ones to regulate. There is no difference when we're talking about allocating the burdens and benefits. We have to make sure, as was stated several times today, that everything is done in a fair manner so people get a fair shake. It's not always just a dollar that you're going to get, but you should at least be given time to know what's coming and to adjust. Because, again, the issue isn't whether the diversion will change your world. Your world will probably change anyway if we don't do some of these things. And I think one of the things we have to do in order to make some of that happen is to identify accurately those issues that stand between us and the things we want to do.

A good example is water quality. The Coalition to Restore Coastal Louisiana actually helped sponsor a conference several months ago called Clean It Up. The fundamental question is whether the river is clean enough, not only for the things we want to do with it today, but the things we need it to do tomorrow. We're putting it back into places where we have not let it distribute its waters for, in some cases, a hundred years. That the water may be clean enough in the main channel of the Mississippi is not necessarily comfort for people to accept it coming into the bayous, bays, and lakes. It may be, in fact, clean enough, but you're going to need adequate monitoring. If it is not good enough, we should not accept poor water quality in the Mississippi River as a reason to take diversions out of the toolbox. We should take the need to do diversions as justification to make the river cleaner.

There is a general recognition that diversions are a vital tool, but they must be dealt with differently from in the past. In other words, we've got to learn from the lessons of Bonnet Carre, from Caernarvon, from Davis Pond. If you merely repeat the mistakes that you made in the past, it's not really a learning experience. I think we have to recognize that diversions are really part of a hydrologic restoration effort whose goals should be to benefit the most people for the longest period of time. We have to recognize that we don't have all the answers. I think that everyone would probably agree that we don't even have all the questions right now. Let's make sure we're asking the right questions so we get the right answers.

I also think we have to recognize that, again, this is not an issue that's going to be decided by science or engineering. It's hugely important to have good science and engineering, but more than that, it's a question of values, commitment, and trust. If you don't trust the science, if you don't trust your neighbors, if you don't trust the agencies, then it's not going to matter that you've got a team of scientists or engineers who say it can be done if you won't trust them to let it be done. I think the real question then is whether we're going to do diversions and whether the manner in which they are done is really up to all of us.

Let's go back a few years. We didn't have a coastal restoration program to speak of until 1989. We didn't have a federal commitment to any kind of restoration until 1990. And the only reason we have it now is that people like you raised your voices and demanded a response. You didn't ask for a bureaucracy or a program, you asked for results. And so long as you demand results, I think we'll be able to pick and use the right tools. If we don't learn the lessons of the past, then I don't think we ever will build diversions or any other type of project needed for the future. If that's the case, we should be honest that we may be the last generation that knows South Louisiana as it is. We need honest discussion and we have to find a way to do that in more than an occasional workshop. It should be a regular feature of our lives. Speaking for the coalition, I ask that if you have any ideas on how we can help build those bridges, let us know.

I think it is important to recognize that it is up to us. The reality may be worse than the projections indicate. If the global climate change predictions that we're all hearing these days come to pass, we may not have much time. Time is not our friend in this, and we have much to do. I hope as we adjourn today we recognize that the people who have taken the time to show up today are actually not here as your adversaries, they're your friends. Because anybody who cares enough to spend a Saturday talking about this is somebody who cares enough about this issue to help forge a solution.

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