

# **SOUTH CAROLINA ESTUARIES: UNDER SIEGE?**

*Proceedings of a Conference  
Held in  
Charleston, South Carolina*



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**SOUTH CAROLINA ESTUARIES: UNDER SIEGE?**

Proceedings of a Conference  
in Charleston, South Carolina  
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Editor  
Virginia Beach

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The South Carolina Sea Grant Consortium  
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## FORWARD

Better known as harbors, sounds or bays, estuaries are valuable natural resources. They support many species of finfish and shellfish. They act as natural filters and buffer zones between land and sea. They provide shelter for boats and offer beautiful environments in which to live. Throughout history, man has used these estuarine functions to his advantage — for fishing, industry, shipping and a host of other activities.

At the same time, South Carolina estuaries are delicate and finite resources. Runoff from residential and commercial development, diversion of water flows, industrial discharges, commercial and recreational fishing, sewage disposal, and channel dredging are factors which test an estuary's limits as a natural sponge and nursery ground. Diverse and often conflicting activities coexist on an estuary, and lack of proper management could result in serious economic and environmental consequences.

The purpose of this conference, "South Carolina Estuaries: Under Siege?", was to explore the values of estuaries, how they are impacted and how best they can be managed. The presentations of estuarine experts from up and down the East and Gulf Coasts are recorded here, in addition to the discussions of regional and local representatives from regulatory agencies, citizens groups, the State Ports Authority and state legislature. Through this exploration, the South Carolina Sea Grant Consortium hopes to stimulate innovative ideas concerning the responsible stewardship of South Carolina's estuarine systems.

#### ACKNOWLEDGEMENTS

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## SOUTH CAROLINA ESTUARIES: UNDER SIEGE?

### OPENING REMARKS

Ms. Margaret Davidson

Good morning. I'd like to welcome you to the South Carolina Sea Grant Consortium's Conference entitled "South Carolina Estuaries: Under Siege?".

I'm delighted to see the turn-out this morning, I hope that you find the day enjoyable and educational. I'm looking forward to it. Also, I'd like to make a couple of comments. First of all, we are going to ask that you hold questions until the end of each individual session. So if somebody says something that you really want to jump on, try to keep that question in your mind until we reach the end of that session. Secondly, I'd like to encourage you at the break to pick up an evaluation form because we would like to find out how we can make these sessions better for you.

A couple of other things: Because we had so many requests last year for transcripts, we're going to start publishing transcripts of our conferences again, so if you didn't quite get everything today, you can wait a couple of months and we will then have the proceedings from the conference.

I'd also like to tell you that we're going to try something new this year: this conference is really the front edge of a series of activities that we would like to do over the course of the next twelve months. More specifically, we're looking at this conference as a general discussion about estuaries in South Carolina and we hope to follow it up with a series of workshops in three of South Carolina's estuaries: Winyah Bay, Charleston Harbor and Port Royal Sound. Over the next twelve months, we will get together with folks in the community to talk about those things that are concerning them about their particular estuarine system. And so, I would like for you all to keep alert for when we have a workshop in your neighborhood.

I would like to introduce not Governor Campbell (he actually sent the person on his staff whom he considers even more photogenic than himself), but John McMillan, who is the Director of the Governor's Office of Energy, Agriculture and Natural Resources. And not only is Johnny photogenic, he is also a native of Horry County, so he has some natural interest in these types of matters.

After John speaks to us for a few minutes, we will then hear from Dr. B.J. Copeland - he's going to provide us with a bit of an overview as to estuaries. Dr. Copeland is the Director of the North Carolina Sea Grant College Program with which I am somewhat familiar. He is also a professor of Marine Science at North Carolina State University. He's done a lot of work on estuaries all around the country, and also serves on the National Estuarine Research Committee Advisory Panel for the United States Environmental Protection Agency.



Then we will move straight into the session on important aspects of estuaries.

Then, B.J. Kjerfve, who is a Professor of Marine Science and Geology at the University of South Carolina, will talk about geological and hydrological values of estuaries. As an oceanographer, B.J. has been involved with the physical processes of estuaries all around the world, and he's currently conducting some hydrological studies in Charleston Harbor.

The next fellow up will be Dr. William Odum, who is Chairman of the Department of Environmental Sciences at the University of Virginia, and probably the national authority on wetlands ecology. Most of his work has been conducted in coastal environments, which are under stress, and he's very interested in the relationship between those stressed environments and biological production.

And then the next fellow to speak is going to talk to us about the economic values of estuaries, and that's Jim Hite, who is an Alumni Professor of Agricultural Economics up at Clemson. Jim's done a lot of work on economic values, both monetary and non-monetary, associated with natural resources.

And with that, I'll ask John McMillan to start off today's presentations.

## SOUTH CAROLINA ESTUARIES: UNDER SIEGE?

### WELCOME

Mr. John McMillan

Thank you, Margaret.

Good morning, and welcome to this meeting this morning. I'm sorry Governor Campbell couldn't be with you, due to a scheduling conflict. He did send me. I'd like to thank the Sea Grant Consortium and Margaret for its work on behalf of our natural resources. Since its inception in 1978, the Consortium has done a commendable job in ocean and coastal research and education. As evidenced by the attendance here today, the Consortium is putting forth an exemplary effort in encouraging participation in projects pertaining to the coastal areas of South Carolina. By your attendance, you're expressing a sincere interest in our natural resources and great pride in South Carolina.

I'm reminded this morning of our state slogan: "Prepared in mind and resources." It's a little early to discuss the preparation of my mind this morning, having driven all night last night. I'm still sleepy, but I can definitely say South Carolina is indeed blessed with unspoiled natural resources and natural areas in which we can take great pride. However, I feel we must be cognizant and be prepared of the fact that our natural resources are limited.

On the way down yesterday, from Columbia to Myrtle Beach to attend a farmers' conference, I stopped by the McCloud Hospital in Florence, SC to visit my father-in-law, who is battling cancer. He's a very wise fellow. He's been around the block a few times, he said, and he asked why I was coming to Charleston, and what was the Sea Grant Consortium. And I replied, basically, that the Consortium was a State agency comprised of seven institutions of higher learning, and they studied, and did research, and planned for our natural resource development, particularly in coastal areas. And he thought for a minute, and kind of looked over at me and said, "Well, that's real good, John," he said, "they need to plan ahead, 'cause God doesn't make any more land for us." And he was so right, so right in that thought. We are a finite planet here, and we need to plan ahead, particularly in the estuaries and the wetlands areas of South Carolina, where we're so blessed. We need to plan for our future growth.

I'm reminded of a humorous story I once heard about planning aspects, it was a story of a zookeeper who was called to capture a wild gorilla that escaped from the zoo and was in a nearby neighborhood. When he arrived, naturally, there were people on the scene there, and a crowd there, and the zookeeper started pulling out his paraphernalia and pulled out first a baseball bat, and then a bulldog, then a big old net, and finally a shotgun. A young fellow nearby asked the fellow, he said "What in the world do you do with all that paraphernalia?" And the zookeeper said "Young man, anything you do in life, you need to be prepared and have a game plan. I'm going to climb up that tree by that gorilla and get real close to him. I'm going to hit him with this baseball bat and I'm going to knock him down to

the ground, and then that bulldog is trained to run over there and latch onto the rear end of that gorilla until these people can put the net around him and we can capture him." The young man was pretty bright, and he said "Yes, sir, that's a great plan. What in the world is the shotgun for?" And the zookeeper said, "In case I climb that tree, and get close to that gorilla and he knocks me out on the ground, you shoot that bulldog." You got to plan ahead.

The primary goal of Governor Campbell's administration of course, is to enhance economic development of this state. Protection of our environment is vital to the long-term planning for economic stability of South Carolina and must not be neglected. Never before has the need for wise management of our resources been greater than at the present time, as development pressures increase in South Carolina. It is imperative we be responsible in our efforts to preserve our natural resources in order that the quality of life of South Carolinians in future generations be maintained.

Each of you here present today recognizes the indisputable value of our estuaries as natural resources. Estuaries and their surrounding marshlands have served as centers of population and are heavily utilized for industrial development, shipping, fishing and recreation. We have all benefitted from our wetlands and estuaries.

Last night, coming from North Myrtle Beach, Myrtle Beach down to Georgetown, crossing the Santee Rivers, all in the lowland country where I grew up, I passed by McClellanville and just thought how nice it would be to pull in there and stay the night, rather than coming into Charleston and getting up early this morning. It would be nice to buy some shrimp and take them back to Columbia and have a nice meal and I was really thoughtful and thinking how blessed we are, growing up along South Carolina's coast with the natural resources we have. However, there are some estuaries in South Carolina and other states as well which have been exploited. Some have been exploited more than others to varying degrees and in some cases all animal and plant life has been ruined. This is unacceptable. Failure to properly manage our estuary system will undercut our developments toward progress in South Carolina.

With that in mind, Governor Campbell recently requested Charleston Harbor be nominated as an estuary of national significance. This nomination comes under the Water Control Act amendments of 1987. Increasing population in the Charleston Harbor area has placed a great demand on the natural resources provided by the mouths of the Ashley, Cooper and Wando rivers. Long-term planning for economic growth and balancing of our natural resources in the Charleston and Berkeley County areas is essential not only for the area, but the state as well.

Governor Campbell has talked in person with Lee Thomas, the EPA Administrator, about the issues surrounding the estuary program for Charleston Harbor. I sat in on that conversation, and various issues were addressed. Just to name a few that were brought up, were the population explosion on the peninsula, particularly in light of the Mark Clark Expressway which is nearing completion, with the bridges over the Wando. Ground water contamination, saltwater intrusion, inter-basin transfers of

water, the busy port facility, one of the largest ports in the world, the containerization efforts that Don Welch has put on, the United States Navy's presence here, both with its surface ships and the nuclear submarine base and the weapons facility. A lot of issues that will necessarily have to be brought up by many, many entities in working together. The nomination which Governor Campbell seeks for Charleston Harbor will provide federal funding for a five-year period to study the impact of man's activities in and around the Charleston Harbor. A committee comprised of state and local representatives, federal representatives, members of the scientific community, will all make recommendations for developing long-term management programs for this vital area. Because the Charleston Harbor is one of the largest commercial ports in the nation, a management program must be developed which will achieve a national balance between economic development and growth for the port of Charleston, and environmental conservation of our natural resources. The responsibility of protecting and managing our resources cannot rest solely with government agencies.

Therefore, Governor Campbell strongly supports our Water Watch Program which is administered by the Division of Energy, Agriculture and Natural Resources. The Water Watch Program is designed to help citizens better understand the ecology, uses and abuses of their local streams, lakes and wetlands. Through Water Watch, citizens' groups are encouraged to adopt a specific water body, or a whole watershed near their home. In adopting the water body, the group makes a personal, long-term commitment to become stewards and promoters for wise use of our rivers, lakes and streams. Water Watch groups become advocates for the body of water, and are very effective in making the community more aware of the adopted area's ecological value and benefits. We are now in the initial stages of conducting a pilot Water Watch Project on the Little Pee Dee River, which will give private citizens and concern groups in that four-county area of Dillon, Marion, Georgetown and Horry Counties a chance to involve themselves directly, using a hands-on approach in the management and protection of the Little Pee Dee River. Our end goal in developing this project is to have the entire Little Pee Dee, from the North Carolina line down to Georgetown harbor adopted by interested citizens to increase local involvement in water resource management. I would encourage citizens of this area to become involved in the Water Watch Program, and adopt the Charleston estuary in a regional approach to managing this natural resource.

I've mentioned several specific areas where we're taking an active role in the management of our natural resources. Governor Campbell's strong thrust in his economic development concept has been towards smart growth as opposed to shotgun growth. We must continue to strive to balance the needs of a growing society, against the needs for preservation of the environment. And I'm greatly encouraged by the level of participation and interest indicated here today towards that end. Wise management of our natural resources is necessary to provide for needed economic expansion while maintaining a rich quality of life for children of future generations in South Carolina.

I appreciate again the opportunity to be here to represent the Governor in this Sixth Annual Mid-Winter Conference. I look forward to working with each and every one of you in the future. Thank you.

## OVERVIEW OF ESTUARIES AND THEIR NATURAL PROCESSES

Dr. B.J. Copeland

In the newspaper yesterday, there was a cartoon in which a Senator was being introduced to speak to a group, and the person who introduced him said that this person needed no introduction — all you needed to have was someone to tell him when to quit. So I need no introduction, Margaret, but you ought to say when to quit. (Margaret - "I will").

Speaking to a diverse group like this, about a diverse subject like we're talking about, reminds me of an activity that occurred up in Horry County, John, in a small Baptist Church up there, in which the minister was trying to talk the congregation into purchasing a chandelier for the sanctuary. So he called a church meeting, as you would in a Baptist church, with the deacons down on the front row. He spoke for about an hour, hour and a half, on the virtues of chandeliers. And finally, one of the old deacons down front stood up and said "Can I speak in opposition to the chandelier, please?" He said, "Oh, yes, you have that right. Please do." The deacon said, "Well, I'm opposed to a chandelier for three reasons: one is I can't spell it, and I don't think we ought to have anything here we can't spell; the second reason is that not a person in this church can play it; the third reason is that I think we ought to take what little money we got and buy some lighting for this sanctuary." That's the position we're in today. Perhaps by sometime this afternoon we will have shed some more light.

We had a little session like this up at our place one time when Currituck Sound was all covered up with Eurasian milfoil and some of the good folks from up in that area came, and listened all day to the scientists talk about milfoil, day length and growth rates, and nutrients, etc., etc., etc. And this fellow had to go back home at noon. Where I grew up, and where some of you grew up, you went home to eat dinner at noon, you didn't eat dinner in the evening, you ate dinner at noon. So he went home and did that and he came back. He sat down on the front row at the afternoon session. And at the end of the first presentation, he got up and said "Can I say something here?" "Sure, you know this conference is for you folks— you can say what you want to." He said, "Well, I went up to the house at noon, and I passed over the bridge up there and all the milfoil is gone. Best I can figure is that we spent the morning talking it to death." So we'll do some of that, too.

My job here is to give a kind of an overview for estuaries which means that I'm going to tell you what one of them is, I guess, is that right? We'll leave that up to your imagination, and at the end if you still don't know, we'll go out back there together and try to figure that out.

Most of the slides that I will show you today come from North Carolina, which is a smaller territory up north here for those of you who don't know that. We have one of those estuaries of national significance, so I thought I'd show you a picture of it so you'd see what they look like. This is an aerial shot, bird's eye view, so-to-speak, of Delaware,

Virginia, N.C. and you get a little tip of S.C. over here in the corner to give you some perspective, but this is what we're talking about - this is the territory that we're concerned about here today - the estuaries. Now we have them in spades down in our area, in fact over half of the estuarine areas lies in the southeastern United States, from North Carolina to Texas. So we have a large territory of estuaries. These are those areas where the river valleys have been flooded by ocean water, where there is some intermixing of fresh- and saltwater.

Now, estuary is an all-inclusive term. You may hear about them as bays or sounds or harbors, or whatever, but they are all estuaries. Some of which have aged more than others. So they may change their shape some. Now estuaries, by their very nature, are located down at the end of the creek. Up at engineering school at N.C. State, and I presume they also teach a similar course in engineering school up at Clemson, they teach the students that water runs downhill. That's a five-hour course for seniors. And it does, it runs downhill. And down at the end of the hill, are the estuaries. So, this is where not only the land meets the sea, it's where all things that we do on the land meet the sea. And it is the downhill place. So whatever we do and whatever we say about these, we're talking about that downstream end.

Which brings us to the most dominant characteristic of estuaries, the subject that we need to spend some time on, and you're going to hear more about it after a while, but that's the physical characteristics of these estuarine systems. They are physically dominated, on one side by a stream of water coming down on the hill which runs at varying rates of speed, but always in a downhill direction. And it meets the water from the ocean, which is going in both directions, depending upon the time of day. The tidal flux. This sets up a physical mix that is unique amongst each system. And so it is a dominant factor that one must remember, and one must take into consideration, no matter what we do about management or whatever, you must remember that there is a physical interaction. We'll talk about that again in a minute, when I get to what I think is an important functional aspect, and that is the sequence of time.

Now, in the water, coming downhill, are sediments. The estuaries are in the process of aging, all the time. They were established millennia ago, and have been aging since then, so this is geological aging. Our estuaries are getting old. Like some of us people who study them. And the sediments are running downstream, and filling those basins. So that the estuaries in the process are returning back to the stream that it once was. Now along comes man who imposes a different timing, a different aging process, one that is biological and chemical and we can even change some of the sediment aspects. So we change the aging process. But this increase in sediment load is another very important physical aspect of the estuary that we must keep in mind. It's going to be important.

Now here is another characteristic of estuaries (you have to have one of these kind of diagrams in whatever talk you give, so those of you who don't understand diagrams, please excuse us, but these are wiring diagrams). This is a menhaden food chain, which is one of the important aspects of estuaries. But the point here is, to illustrate to you that one of the biological characteristics of an estuary is abbreviated food chains. We don't have all these long and complex food chains that one has in a coral reef community or in the ocean or in lakes, for that matter - but in terms

of the estuary, these food chains are very short. Very close coupling exists between various components of the estuarine ecosystem.

As you can see here, all these menhaden are sitting there, chowing down on zooplankton, some detritus and some phytoplankton, and so forth; it's a relatively simplified food chain. This brings up some very important considerations — as to what happens if you begin to differentially impact part of that food chain. And if you stick around, those of you who have great perseverance, at 11 o'clock we're going to talk about some of the impacts on estuaries and we'll get back to this subject about what happens in a algal bloom situation, for example, when you replace the phytoplankton with blue-green algae, which are not consumed by the zooplankton or the menhaden, what happens in that ecosystem? So the food chain and its characteristics are very important things to know about estuaries if you're going to manage them.

Another extremely important part about estuaries is the fact that around the edges of estuaries are a lot of low embankments, low indentations, shallow, ecosystems, that we call primary nurseries. Now up in N.C., we have 2.3 million acres of estuaries, and 75,000 acres of that is primary nursery. Now that's differentially very important to a few organisms that are important to us. Now many of the animals that use estuaries are spawned someplace else. Many of them are spawned from the ocean, some are spawned upstream someplace. But many of them are spawned in the ocean. In fact, 93% of the commercial and recreational species that we see in the southeast are spawned someplace else other than the estuary and use these primary nurseries as a regular part of their life — 93%. So we're talking about habitat for nearly everything we're interested in. Now nationwide, about 68% of those organisms that we see use estuaries as part of the nursery function. So here in the southeast, we have more dependency upon estuaries than we do in other sections of the country. It makes estuaries even more important to us. We've got a bunch of them, they're important, they're really part of our being. They're important to us economically, and you're going to hear Jim Hite talk about that, and they're important to us as part of our heritage. They're also important to us for the kinds of things you do for recreation and commercial activities and so on. Estuaries are very important.

These little primary nursery areas all around the edges of the estuaries are important. Here is an illustration of what that's all about. Larvae are produced offshore, from the adult spawn. In our case, along the eastern, southeastern shores of the Atlantic coast, most of this spawning occurs in water masses that are bleeding off the Gulf Stream and are transported in different ways at different times. Now we just experienced one of those little bleedings off from the Gulf Stream in which we had a red tide that stayed around for a month, and impacted about half of N.C.'s coastline, killing scallops and making oysters and clams unusable. At great cost. So the same processes that provide us with spawns for our estuaries also provide us with a little bit of Florida's largess. Florida sent us a message: called red tide. We have a lady from Florida here to talk this afternoon, maybe she'll apologize to us — I don't know. But as these larvae make their way toward shore, again the physical exchange, the physical intermixing between the ocean and the estuaries becomes extremely important. These larvae are transformed into various stages of metamor-

phases, to become post-larvae when they enter the estuary and go to the nursery areas, and stay there as juveniles until they become sub-adults, using the productivity and the protection of these nursery areas and then re-enter the adult world after coming back out of the nursery system. That's a very important function. One that is the heart of an estuary.

Now, there are some timing questions. And this is a point that we've got to take into consideration, no matter what we do in those estuaries—the timing. And that's the point that I want to place emphasis on here. There's a timing question that is seasonal — there is a season for everything. The major spawning activity — i.e. brown shrimp, menhaden, flounder, spot, croaker, those kinds of organisms — occurs in the winter months. And they enter the estuary in the very early spring — late February, March.

This chart here is some data from John Miller at our place on some nursery utilization of spot and croaker, just to show you the tremendous seasonality of their use. There is a tremendous blooming of those primary nurseries in the spring. There's another lesser bloom in the fall which has white shrimp and some of the weakfish and so on that utilize these systems in the fall. But the season is very important. Now, up at our place, an example of that kind of problem, this blooming in March of primary nurseries, also coincides with the drainage of the fields in March so you can plant corn in April. Now if you drained those fields in August, the organism here doesn't care. But the farmer can't plant corn in August if he intends to make a crop. I don't know how it is here in S.C., but corn doesn't do well planted in August. So seasonal timing is very important. There's also a timing that is daily. That is, the movement of these organisms back and forth into these systems that has a diurnal pattern to it. As that water moves, and as B.J. can (this is the other B.J. — he's the younger version) but as B.J. can tell you, the water in these systems moves back and forth as the tide moves. You can say, well, we don't have much tide, well that's true, we don't have much tide, but its influence is felt way upstream. Here in Charleston Harbor, for example, the influence of the tide goes up into the Ashley and the Wando Rivers and so forth. You still feel that tidal flux. To the uninitiated, you might not see it, but its influence is on a more than daily basis. The other problem, I guess you'd call it a problem, is that our physical activities are influenced by the changes in the wind, which up in our place comes on about a five to eight-day pattern. So you've got a timing problem that is very complicated. These organisms are coming in here. This curve looks smooth because we've put a data point in here every 2 or 3 months. But if you go out there and look at this thing in some kind of detail (Bill Odum can tell you those marshes and wetlands that he's been dealing with), there's tremendous change in the activity from hour to hour. Some of that's related to the physical patterns that are going on there, and some of it's related to what happened in their history as to how they may have gotten spawned and transported in the ocean.

So all of this hangs together. The timing question is one of daily, weekly, seasonally, and as we've pointed out earlier, one of continuing times through the years that the estuary changes. Now not all nursery areas are created equal. It so happens that in Pamlico Sound, the northern shore of Pamlico Sound, because of the physical make-up of that sound and its



relationship to the inlets and the interaction with the ocean inside the Gulf Stream, makes the nursery area along the northern shore of Pamlico Sound extremely productive. Because there's a physical exchange that's set up there that keeps them operating, and they're very productive. We did some calculations here, using two of our systems as illustrations. Albemarle Sound, which is up by Virginia, is 26% of the state's total surface estuaries. Pamlico Sound is 56% of the total area, being 940 and 2,000 square miles, respectively, in size. They're good-size pieces of the water. Now the catch that can be attributed to those two estuarine systems (this doesn't include some of the ocean catch that could also be attributable to them, so the difference may be even greater), if you calculate that, it turns out that Albemarle Sound provides 14% of the in-shore catch, and Pamlico Sound 78%. The value is even more diverse, Albemarle Sound produces only 5% of the value, because the nursery areas in Albemarle Sound, which is isolated from the ocean primarily, has very little direct physical relation with the ocean. They are very poorly productive, whereas those of Pamlico Sound are very highly productive.

So when you start dealing with Charleston Harbor, Margaret, you're going to have to figure out which parts of it are of one kind of importance and other parts of other importance. So not only do we have a timing problem, but we've got an aerial problem within our estuaries. They're not all equal, and they're not the same throughout.

Well, I wanted to finish this by reading a paragraph that was written in the 1960's by Jerry Schubel. This kind of sums up, I think, where we are and what we should do with our estuaries:

"The great value of the estuarine zone is in its multiplicity of uses. But herein also lies its vulnerability. Estuaries do have the capacity to receive some human, municipal and industrial waste, without damage. They do have the capacity to assimilate some waste heat without suffering persistent ecological damages. Estuaries can support certain levels of shipping and transportation without a loss of commercial and recreational fish landings. Some mineral resources can be extracted from the estuarine zone without smothering shellfish beds. And the biological resources of estuaries can be harvested at certain levels without affecting future use. Estuaries can serve all these uses, and still remain aesthetically pleasing environments for man's recreation. But an estuary's capacity to support these varied activities is finite. The ability of an estuary to tolerate each environmental insult before suffering significant ecological or aesthetic damage not only varies from estuary to estuary, but varies in different parts of a given estuary, as well. And within any segment of an estuary, it varies with time. Uniform, invariant regulations and standards for the disposal of waste, whether they are heat, nutrients, or dredge, are environmentally naive. The only justification for their enactment is that it simplifies enforcement. A uniform

speed limit of 25 miles per hour is as irrational as one of 100 miles is irresponsible. Uniform estuarine regulations are wasteful of valuable natural resources, resources that should be used, and used responsibly. The philosophy of those crusaders, who espouse cessation as a solution to all environmental problems, is not viable. People live, they eat, they defecate, they procreate, and yes, they also even re-create. This is not to imply that we should not insist on good waste treatment, on carefully supervised methods of dredging and spoil disposal, and on controlled minings of bottom and sub-bottoms -- we should. And we should insist on more."

Well, that's the same as it is today -- twenty-five years later. Thank you.

## SESSION I: IMPORTANT ASPECTS OF ESTUARIES

### PART 1: GEOLOGICAL AND HYDROLOGICAL VALUES

Dr. Bjorn Kjerfve

Leif Ericson, Christopher Columbus, James Cook — they all have many things in common. They came from the Old World, they headed to the new lands. And they crossed the seas in storm and good weather. When they came to the New World, they came up along the coastlines, and the coastlines were not very hospitable. And they were trying to find places where they could anchor their ships. So they sailed along the coastlines and with a little bit of luck they ended up in some large embayment where they could get new food for the crew, get water, and get some rest, and safety. We don't know very much about the details of Leif Ericson's exploitations of England. We know a great deal about Christopher Columbus, and certainly during his third voyage he had visited many times in an estuarine system called Puerto Seco (now called Discovery Bay) on the north coast of Jamaica. James Cook, when he discovered Australia, landed in an area called Botany Bay. All these people found it was profitable to find their way into estuaries and take advantage of them because of their safe, protective harbor and the protection from the bad seas.

Not only did the estuaries attract Christopher Columbus and the like, but they also have attracted a great number of people. In fact, if we were to raise sea level approximately 25 feet, we would flood approximately 70% of the world's population, making them live under the water rather than on top of the land. Rio de Janeiro is a city located on a large estuary. In fact, land on estuaries is very expensive, high-priced real estate. Similarly, Sidney Harbor, just north of Botany Bay, is a multi-million person city, located on a major estuary. In fact, there is probably a little bit of Christopher Columbus, Leif Ericson and James Cook in all of us. In the way that we enjoy the sea, or at least to be on the rim of the sea. And that also means that we locate ourselves on an estuary being in close proximity to the sea. That very often means that we live on an estuary, or near one.

What is an estuary? Well, it depends. Every person who speaks about estuaries will define an estuary differently. I think we all agree that an estuary is some kind of a semi-enclosed body of water, in connection to the sea. Salinity is usually either less, equal to, or more than in the open ocean, but it's an interaction zone, where land meets ocean and processes here become very complex. Very often, an estuary is a river mouth, but it doesn't have to be a river mouth.

What we have failed to recognize, I think, is the fact that estuaries come in many different shapes and forms around the world. But, it is a unique environment, and it's common to all the continents. They just look different in different areas because of geological processes, because of man's impact, and because of vegetation. The three major groups of estuaries are a brown river valley type, a fjord type, and a coastal lagoon. The brown river valley was formed when sea level rose and flooded old river beds. The fjord was carved out by advancing glaciers. And the

coastal lagoon formed again when sea level rose and flooded low-lying areas on the coastal plain. And then wind and waves and other physical processes, such as tides, caused a barrier to build and protect this area.

Our estuaries today are no more than 5,000 years old. That means that the estuaries that we know have only existed for 0.0001% of the time that the earth has been here. In fact, an estuary is an environmental baby, if you want. But, we have the possibility and we are strengthened by having the ability to change them greatly by our impact. That doesn't have to be good or bad. In fact, an estuary changes all the time.

The estuaries all formed approximately 5 to 6,000 years ago when sea level had been rising in response to a climatic warming. And sea level rose as much as 140 meters over a 10,000-year span, coming up to approximately the present level. During that time period, the rate of increase of sea level from here was somewhere between 5 and 6 feet per 100 years. Since 5,000 years ago, sea level has stayed more or less constant. Presently it is less constant, because here in Charleston, for example, you are experiencing a rise of sea level of about a foot per century, because of world-wide rise in sea level in conjunction with some form of geologic settling.

It seems like "rising sea level" has become a "catch word" today. Scientists have been aware of this process for a century, approximately. As the estuary has been born by the rising sea level, sediments are coming down via the rivers from the continents, building marine and brackish water wetlands adjacent to the estuaries. In fact, this zone, consisting of the combination of estuaries, open ocean and marine coastal wetlands, is like an ephemeral rim around the continents of the globe. It's our coastal zone and a big part of that are the estuaries. As freshwater comes down into the coastal zone, and on this multi-spectral scanner image from a Landsat satellite, you can clearly see the lightly colored sediment flumes coming out from the Georgia and South Carolina rivers and estuaries. Processes-physical, chemical, and so on - act to redistribute the load that is coming down.

I could tell you a lot about the details of things going on, and there are also a lot of details I couldn't tell you about, but if I generalize, it's pretty safe to say that productivity of the coastal zone is enhanced greatly by the materials coming down from the continents. In fact, if you look around the globe, at the ocean environment, the open ocean is like a desert in terms of biological productivity. In fact, there are only two areas of the ocean where you have good productivity. One, is upwelling areas associated with currents, frontal systems, and the second one is coastal areas associated with runoff from estuaries. And I think Dr. Odum will tell you shortly more about the details of this.

With sediments are coming a lot of goodies. Nutrients, for example, that are attached to the sediments. They go down into the coastal zone, into the estuary, they form the land which the wetlands build, and they fuel the biological productivity. If we put a dam on the river to capture the sediments, you don't do very much, necessarily, to the estuary itself, in the way that rising sea level and the lack of sediments coming in may balance. On the other hand, in areas away from the estuary, you usually do a lot of erosional damage. So things that we do to the control of the water

and therefore the sediments coming into the estuaries may have a large-scale impact on our entire coastal area.

But not only are goodies coming in with the freshwater runoff with the sediments, there are also baddies. You can say the baddies consist of not just nutrients, but too many nutrients, or pesticides, or organic chemicals, or heavy metals. These, I like to think of as poisons coming into the estuary. They, too are being received there. And many of them are being captured within the sediments of the estuary itself. In fact, I like to think of the estuary as a toilet bowl. It's a toilet bowl of all the continents. Every waste product that we generate ends up in an estuary. And we are just hoping that we will solve that by diluting that waste product. Solution to pollution is dilution. Fortunately, we do have some movements inside the estuaries. Tides, winds and the freshwater runoff combine to move water, and baddies and goodies through the system. Observe high tide and low tide -- obviously a lot of water can move during the tidal cycle. The combined effect of the tides, the fresh water runoff and the winds is to cause circulation -- movement of water through the system. If you think of the estuary as being the toilet bowl, this circulation process is like the flushing mechanism. You push the little button and whoosh, you have the water go through the system. And of course, the goodies and the baddies have a way of going with the water.

We spend a lot of effort trying to understand circulation and, associated with circulation, stratification. If you look at the lake example, all stratification is horizontal. It's mostly due to a thermal stratification. And everything you put into the lake stays there, or stays in the sediments at the bottom. However, in an estuary, you are in connection with the sea and you can take some of this toilet bowl water and you can move it back out into the sea. But you hope to do it in such a way that you don't do it too fast, and you don't do it too slowly. If you do it too slowly, you get pollution -- bad pollution. If you do it too fast, you don't have chance enough to take the nutrients that are coming in and fuel all those good things that exist in the estuary that you like to eat.

We obviously have a very precarious balance between not polluting our system and on the other hand having the system reach maximum productivity by having enough nutrients, by having enough aquaculture taking place, by having enough seafood being grown inside our systems. Again, I hope that Dr. Odum will address some of those issues. There is a very intricate relationship between stratification and circulation. We know a lot about it, but there are also a lot of things about it that we don't know.

It's pretty safe to say that technology is very important in driving our science. And we have certainly got a lot of big computers in the past 20 years, and we are therefore able to ask different questions as compared to before. We know, for example, contrary to what the engineers at NC State do, that water doesn't run downhill in the oceans. It only does that on land. In the oceans, in fact, water runs like the lines, topography lines around mountains -- they run parallel to the water. And once you get into the estuary, you are somewhere in between water running downhill and water running to the side, because of earth's rotation effects in addition to the sloping sea surface.

And having computers, and having big vessels, we can get a lot of data. In fact, oceanography is extremely data rich. It's not always the right data that we have, but we have lots of data. It's pretty easy to fill up the five million dollar open ocean program, and really use ships like these and use satellites (this happens to be Skylab) and get tremendous amounts of data and a tremendous amount of interest in this. And the reason that we can do this is everybody thinks understanding the oceans is great. Unfortunately, when we come to the estuary, we don't usually have quite the same resources. And part of the problem here, I think, is the fact that we all live next to the sea. We all have opinions about the estuary and what should be done to administer the estuary in the best way. We all have some vested interest: economic, political, whatever. There are too many conflicts in the estuarine area. And, traditionally in this country, and in most other countries, whereas it is easy to fund large-scale research in the open ocean, it has been very difficult to fund large-scale integrated research in the most important of our marine systems: the estuary. The one that is closest to home.

Another problem that's closely linked to this technological input of lots and lots of data, and that's the fact that there are many agencies and many groups that collect data for the sake of collecting data. And one of the things that is missing is good know-how. And, in fact, know-how is probably lacking as much as dollars are in terms of being able to do very good work on the physical processes in estuaries. Let me give you an example: Charleston Harbor, re-diversion of the Cooper River completed in August of 1985. Corps of Engineers studied for many years, actually since 1942, more or less continuously, what should be done to avoid getting too many sediments settling out in Charleston Harbor. And eventually, the re-diversion of the Cooper River became a reality. Computers and personnel and great effort went into calculating how much freshwater should be allowed over the Pinopolis Dam into the Cooper River and Charleston Harbor so that the salinity at the intake canal at Durham Creek would not exceed the critical volume for the industrial operations. The Corps came up with the magical number 85 cubic meters per second, about 15 to 20% of the previous discharge. When the re-diversion became a reality, it became very clear that the Corps was grossly wrong in their estimate. In fact, the average discharge of the Cooper River is more like 135 cubic meters per second, just to keep the salinity at the critical intake canal point below that value that the industries can tolerate.

So, we did not have enough know-how, in spite of the Corps of Engineers' might, and computers, and dollars. I'm not saying this at all to complain about the Corps of Engineers. I doubt that anybody else at the time could have done a much better job than that. It just illustrates the fact that very simple, basic questions that have direct economic impact dealing with the hydrology, we don't have the answers to them, in spite of our technology. And maybe it's because of the lack of integrated funding for some of the research.

Everybody talks about management of estuaries. Here is Ipanema in Rio de Janeiro, and the lagoon estuary system here in the foreground happens to be a system around which ten million people live. We want to manage it, but it's rather disturbing when you know that there are about nine managers for every ten estuarine persons, meaning one person doing the research. We

can't manage a system unless we have all the facts and all the understanding, and I think that would be the main message that I want to give today. We really need to do very basic kinds of research in estuaries to understand what is going on there, so that we can manage the system for the betterment of mankind. So that we can continue enjoying the aesthetics of the system as well as taking advantage of the system for being a toilet bowl, for doing aquaculture, and for the system to be our food source for seafood and to be able to do transportation and commerce. And we do all enjoy being next to the water. And I hope that we can save these systems for ourselves and our great-grandchildren, but at the same time utilize them in a rational fashion. Thank you.

## SESSION I: IMPORTANT ASPECTS OF ESTUARIES

### PART 2: BIOLOGICAL AND PRODUCTION VALUES

Dr. William E. Odum

Well, you've heard each of the previous speakers refer several times to the amount of fish and shrimp, and various types of food organisms that are found typically in the estuaries, and that's what I want to underscore a little bit next. There's nothing new, obviously, about our recognition of the fact that estuaries are very rich places, in fact, we can go back to look at the Indians' activities and see that they knew this quite well. They came to the barrier islands in the summertime and found oysters and shellfish and whatever fish they could catch. Even the details of some of this are not particularly new. Europeans, a hundred years ago, recognized and published papers in which they pointed out that estuaries in Western Europe were very rich places that produced lots of plant material, whether it was phytoplankton or marsh grasses or sea grasses. Well documented, and they had pretty good ideas about why.

Maybe thirty years ago, late fifties, early sixties, in this part of the world we had fully appreciated that, and documented the fact that fishery catches are dependent to a great extent on estuaries, and this all led in the 1960's, you may remember, to legislation in our coastal states in the late '60's, early '70's in South Carolina, Virginia, most of the other coastal states, to protect our coastal wetlands and shallow estuarine areas. Very innovative legislation, and certainly it has proved to pay off since then. You go back and look at the scientific evidence that it was based on at the time, and compare it with now, that's basically what I'd like to do in the next few minutes. You know, we had the certain general ideas in 1960, '65, '70. How much more do we know now? How much better documented is our information? I'm only going to give you a few examples, because the answer is, in some areas, we don't know a whole lot more, some areas we do. Unfortunately, those details, particularly the ones that we don't have, can be very important. Because, if we don't recognize that, we may inadvertently, or perhaps purposely, do something which may turn out to not be so good in the long run. I'll give you an example or two of that. If you could turn the lights down, I'll have the first slide.

Here we have several egrets, herons, woodstorks, and so on. These birds are feeding on a variety of small fishes and invertebrates, and in fact, they've been feeding in this area for weeks at a time. And many of them have nesting areas nearby where they've been feeding their young. When you watch something like this, you get, with no data and no evidence whatsoever, and probably people a hundred years ago realized, that this is an unusually productive sort of place. There's a sort of intuitive background that we've had for a long time, which turns out, of course, to be quite, quite true. It's the details of how so much food is being produced in estuaries that's a little confusing.

One area that since the 1960's we have a pretty strong suspicion about is how different organisms came into estuaries and utilized different areas. Now our information in this area is much better, and you heard B.J. Copeland



show you some evidence from North Carolina that is very similar. This is showing the life history of one particular organism, the red fish, or we call it a channel bass. And I wanted to point out to you how a single species like this utilizes various different parts of the estuary at different times in its life history. For example, when the very earliest larval stages move into the estuary, they may remain for a month or more in the larger embankments and gradually work their way upstream. In fact, they may go all the way almost to totally freshwater, depending on the species and what their needs are; they may utilize the full length of the estuary (50 to 100 miles long). And then gradually, as they mature and they work their way back down the estuary, they utilize, depending on what state we're in, they may use wetland areas. In Florida they could be mangrove areas, then they use sea grass areas at different times, or they may actually move into tidal freshwater. Of course, there are species which go into tidal freshwater, such as striped bass and alewives and so forth that use other areas for spawning. So we get a very complex use pattern.

Now take this one species, for example, and multiply it by a couple of hundred different fishes; invertebrates, like blue crabs, and animals which stay more or less in the same area, and like oysters and so forth. You get a very incredible traffic pattern here, which we understand perfectly well, I think, in most cases. We've got it pretty well documented. We can then look at specific, what B.J. Copeland called primary nursery areas, and know what's really important to red fish, or spot, or croaker, or white shrimp, or what have you. So in that area, I think our knowledge is pretty solid. It turns out that this kind of research isn't terribly hard to do, but nevertheless, it's nice to have that sort of information.

Now, the next thing that I want to emphasize that has become really apparent in the last twenty years, we suspected this, and in fact, it's the real reason behind most of the coastal protective legislation, and that is the intimate relationship between wetlands, and this happens to be a very low, salinity area in Georgia along the Altamaha River tidal area, which could easily be in South Carolina. The thing that's become so apparent from the last twenty to twenty-five years of research is the intimate relationship between the tidal wetland areas and the life history for these various organisms that I've shown you. You've heard speakers refer to these as areas of refuge, nursery areas, areas where they feed, all that is very clear. What's not clear, and what I'm going to elaborate on further, is exactly how all this plant production, all these marsh grasses and sea grasses and phytoplankton and so forth, how all that is converted into fish flesh. That's the crux of the problem right there -- the actual conversion, how that happens, what's most important and so forth. I'll come back to that from time to time.

One thing has become very, very apparent from research in the last ten or fifteen years, the critical nature of the edge between the wetlands and nearby mainlands and tidal rivers and so forth. If you had to pick one area that you absolutely had to preserve, and protect and manage, and so forth, that's the action zone -- that's the region which appears to be most heavily utilized by juvenile organisms of various types, moving back and forth, feeding, for protection, and so forth. I'm not saying they didn't know that twenty to twenty-five years ago, it's just the evidence is a lot better now. And we can carry that one step further and start thinking that, well, the

more of this sort of edge habitat we've got, the more complicated the edge of an estuary is, then perhaps the better it is if we're interested in shrimp and fish production, and so forth.

Here is an example. This is made from an aerial photograph. If you were in an aircraft, you'd be probably 20,000 feet up looking down, and what I wanted to emphasize to you is that in this particular wetland, we've got a very complex pattern of big tidal creeks, little tidal creeks, little tiny creeks, low depressions in the marsh surface that are only flooded periodically by the tides; it's an extremely complex marsh. In fact, you can almost think of this in terms of an analogy, you can almost think of this as very similar to your own circulatory system in your body, where you've got larger arteries, smaller arteries, capillaries, and the venous return system. This type of wetland, with this type of pattern, without a doubt is going to be extremely productive in terms of fisheries, organisms, waterfowl, and fur-bearing mammals, all the sort of things that we're talking about here, because it's got so much of this intimate edge between the open water at the tidal creeks and the marshes. I don't have an example, but if you want to think of the opposite situation, think of a wetland which only has a very, very simple circulatory system, in a lot of upland, sort of high marsh. So a lot of evidence, particularly in the last five years showing that the surface of the wetland in these areas in terms of its importance to fish organisms, is much, much more heavily used, much more valuable than a similar marsh which doesn't have this nice creek drainage system coming into it.

Well, that tells you all sorts of things about areas that are particularly critical for protection. It also tells you if you're going to rebuild a marsh, or re-create a marsh, or build a brand-new one through mitigation activities; these have to be some of the things that you want to incorporate into that, you don't want to just put a simple marsh up there, you want a very complex system of this edge-type habitat.

Now, this diagram is about twenty or twenty-five years old, and it's obviously not the real world, it's just a simplification for purposes of discussion. What it suggests (I originally did this to try to show the relationship between mangrove, primary production, in other words the plant production in mangrove swamps, and the plethora of fishes and invertebrates that are found in mangrove swamps). And what I'm trying to show is that there are two sources, primarily, of plant material: there are the vascular plants, such as the mangrove, in this case (in your case, the marsh grasses and sea grasses and so forth), and then also phytoplankton and other types of algae, including large algae, microalgae and so forth. I'm trying to show that some of this material is consumed directly, particularly the algae, and some of it is consumed only after it has been decomposed to some extent, altered by microbial activity, thermal activity, and so forth. There is a group of organisms, and this is true even now, I think we recognize a group of very, very critical, important organisms in almost all estuaries, which are able to utilize the basic premise called primary production. This sort of action group, I call them detritus consumers here, that's probably not quite correct. Probably the best terminology, based on more recent research, is that we're dealing with organisms which eat everything, very ubiquitous feeders that will feed on a variety of different plant material, and even animal material, if it is made available. And

we're talking here about things like arthropods and small crustaceans, shrimp, certain marine polychaetes, and worms, and nematodes, even insect larvae at the lower salinities, a few fishes, and some of the bivalves. A very critical group, which apparently converts the primary production into a form that can be used by other fishes, wading birds and so forth.

Well, it's a nice conceptual idea, it's the details that we've been stumped on. Millions of dollars have been spent trying to understand what exactly is going on here, and the relative importance of the two different sources. For example, remember about twenty minutes ago, B.J. Copeland put up a diagram showing menhaden, which happens to be, in terms of weight, our most important commercial fish on the East Coast, trying to show what types of food were important. Menhaden, remember the two boxes: one says phytoplankton, one says zooplankton. Well, unfortunately, that diagram, we now know, is not totally correct. People who studied cut-open menhaden saw phytoplankton and zooplankton, because they were easy to see. Then mixed in with that we saw this amorphous goop which they just sort of discarded. But now we can go back and look at that goop and we find out it's made up of almost unidentifiable little fragments of plant material, bacteria, floccular material (it turns out estuaries are full of all sorts of floccular material, just floating around). And fishes like menhaden engulf this stuff, and apparently utilize it to some extent. How important is that compared to the phytoplankton, or to the zooplankton? We don't know. They're our most important commercial fish, and we don't know, and we've spent millions of dollars on it.

So, that's one of the points I'm going to leave you with here, is that we do understand that estuaries are very productive, we understand a lot about how they are used physically by other organisms, as apartment houses temporarily and permanently, but we don't know too much about the cafeteria service here. And it's a little frustrating. It turns out it's not because of a lack of trying, and not because people are not particularly good scientists, it's just a very difficult problem. So now we're going to purely esoteric sort of techniques to try to get at this problem.

You can only leave a couple of messages in fifteen minutes — you remember I talked about that edge and the critical importance of the edge, well we didn't know that 30 years ago. Bulkheading such as this activity here, which happens to be in Biscayne Bay, Florida, was relatively common. What this did was take that critical edge zone and destroy it, replace it with concrete walls and water maybe three to five feet deep. And we couldn't understand at the time why we were losing, to a great extent, a lot of the fishes and invertebrates that use this area as a nursery area. So that's why you may think the details are not that important; I would say they are. Just because we see the overall patterns is not enough. We've got to understand the critical, complete detail. We've got to understand where the nutrition for menhaden is really coming from and break it down into its various component parts.

That's the main message, and I have one more, extra message, which I'll just throw in for the heck of it: this has nothing to do with anything I said before, but everybody gets to proselytize a little bit. We have spent a lot of time on coastal wetlands, we're all reasonably well educated about their value. We don't know the details, but we have good legislation in

place in almost all coastal states. What we have ignored are the interior, non-tidal wetlands. And they are linked to the coastal wetlands in a lot of different ways: the life history of waterfowl, wading birds, as nutrient interceptors illustrated this. So the last thing I want to leave with you is a little after-thought: in states like South Carolina, North Carolina and Virginia, we have virtually no protection for our non-tidal wetlands, and that's a very important area and I think it's the next big action area for at least many of our southeastern states in terms of the impact that you might have for manipulating and so forth. Thank you.

## SESSION I: IMPORTANT ASPECTS OF ESTUARIES

### PART 3: ECONOMIC VALUES

Dr. James C. Hite

We've been making a lot today of B.J. Copeland's remark that water runs downhill — I wasn't sure, B.J., that we do teach that at Clemson; we also have been trying to teach people through the extension service for about eighty years not to put their privy uphill from the well, because water runs down hill. And then I think we heard also that all estuaries are downhill from privies. So you ought to think about that if you live in Charleston.

My assignment is to talk about the economic value of estuaries, and I'm not going to talk much about numbers. I want to talk a little bit about some concepts, and I think that perhaps fits in very well with some of the other sorts of things that have been discussed here this morning.

I think we have to start by talking about what we mean about the economic value of estuaries. We have to come to some sort of common understanding about what we mean by economic value. And I have been trying to deal with this subject for twenty years or so, and I think, to many lay people, the term "economic value" is synonymous with "money value." That is, we think about something having economic value if it can be translated into money. A thing that has economic value is something that can be bought and sold. But that's not really the meaning that at least most economists would accept for value. A thing has value to an economist because it possesses utility. And what we mean by utility is that we mean that the thing in question is capable of serving some human need. So anything that serves a human need, whether or not it can be bought and sold, has economic value.

Now, that's a pretty broad concept of value, and it's the one that I want to hang onto here today. But before I go any further, I think that it is only fair that I point out to you that this concept focuses upon human needs. In economics, we would not accept that a thing has value simply because it serves the need of a sea gull, or it serves the need of a palm tree. Now, there is, I think, a legitimate philosophical basis to contend that a human-centered value system is inadequate. And that this human-centered value system that we use in economics is too narrow. I think there is a legitimate economic/philosophical argument there. But my task today, really, is to deal with economic value, economic value of estuaries. And not other kinds of values. I think that it is important for you to understand that when we talk about economic values of estuaries, we're talking about those things that are human-centered. They're not necessarily just dollars and cents values, but they must be related to serve human needs.

Economists take a fairly democratic approach in terms of consideration of human needs. We start with a proposition that each individual is the best judge of his or her own needs. And we recognize that those needs are not just biological, or social, even; they can also be spiritual. So any-

thing that gives human beings satisfaction serves a human need. And it is up to each individual to determine for his or her self what it is that gives them satisfaction, and how much it gives them.

Now I think that there is even a more basic concept to understanding economic value. Economists make the assumption that human beings are rational. Now, admittedly, that's a simplified assumption. None of us are rational all the time. And there are some people who know me fairly well who would argue that I'm not rational any of the time. So this assumption of rationality is a simplifying assumption. But we assume. Now, if you assume a rational person, you would say that no rational person freely and knowingly is going to give up something that gives him a great deal of satisfaction in trade to get something that gives him less satisfaction. That make sense? No rational person will give up something that they find very satisfactory to them to get something that is less satisfactory to them. So if you decide to purchase a good in the market, then we conclude that you believe that that good will give you more satisfaction than whatever it is that you have to give up to get that good. Okay? Now, the price of the good might be denominated in the form of money. And, if you pay for it in money, you go buy a shirt, or a pair of socks, and pay for it in money, then what we really are doing is saying that you are rational, so you must feel like you can get more satisfaction out of that shirt, or those socks, spending that money there, than you would if you used that money for something else. Otherwise, you wouldn't do it.

That leads us to the conclusion that market prices which arise out of competitive markets are pretty good indexes of economic value. And we can use that notion, we can go quite a long way with that notion. We can use that notion if we think about the economic value of estuaries. We can use it up to a point. To the extent that the services that are provided by estuaries in some way end up being traded in the marketplace. We can do a little fancy mathematics, and we can come up with some dollars and cents figures on the value of estuaries. That means that we can estimate, providing we get reasonably good biological data, we can estimate the value of estuaries as nurseries for commercial fishes. Commercial fish stocks, since those fish stocks then move through a market. We can estimate the economic value of an estuary for port facilities, because a lot of those port services move through a market. That's a fairly straightforward task. But not everything that has economic value ends up being traded in the marketplace. That's where we begin to run into a problem.

Let's just think about the service that estuaries provide in spreading out flood waters. It's a fairly important service that they provide. Waters come down from upcountry, they spread out over these estuaries, and you don't get as much damage as you might get otherwise. This is not something that you can go out in the marketplace and purchase. You can't go out and purchase the service of having flood waters spread out. You can't go out and buy tickets at this point, to avail yourself of the recreational opportunities that an estuary provides. So when we try to measure these non-market services that are provided by estuaries, we find we're dealing with a very, very complicated business. It's like some of the food chain problems that Bill Odum was talking about. And it's one that we economists can perform, if at all, only with a fairly wide margin of error. That is, in some cases, and I think we've made a lot of progress in the last few

years in terms of being able to estimate these non-market values. But they are estimates. And the margin of error may be fairly large.

Now, in addition to these marketed goods that come out of the estuaries, commercial fish, etc., add to these non-market services, flood control and so on, that we get from the estuaries, there is another way in which estuaries serve a human need, provide satisfaction to human beings, and therefore have economic value. We sometimes call this thing "existence value." And what we mean by it is that you may obtain satisfaction out of simply knowing that Charleston Harbor is there, or Georgetown's harbor, or Winyah Bay. You may get satisfaction out of simply knowing it's there, even though you never use it. You may get satisfaction out of knowing that the Grand Canyon is there, although you've never visited, because you always have the option to visit, as long as it's there. Existence value, option value, that never ends up in any market, in any form or fashion. It's real, but we have no way of measuring it. We simply cannot give you any idea of what that existence value is worth. We can identify it, but we can't measure it at all. That doesn't mean it's not real; it's very real. But we can't measure it.

Now, from an economic perspective, the goal of what we want to do, it seems to me, is to try to manage these estuaries so that they produce the greatest total economic value over the long-term. If all the economic value that arose from estuaries was associated with things that sooner or later feed into the markets, even into real estate markets, then we might be able, well, we could manage those estuaries, I think, fairly well, in terms of trying to maximize the long-term impact that they had, on some objective measure like, say, gross national product. I don't mean to imply that that task would be easy: let's just figure....suppose Charleston Harbor, the whole Harbor, was owned by one person, or one firm. What would they do? How would they operate? Well, they'd look at what they could gain from the fisheries, they'd look at harbor activities, they'd look at all the kinds of activities that could take place in the harbor that would generate them some sort of benefit, and they'd find that mix of activities that gave them the greatest benefit over the long-term. They'd have to make some trade-offs. They might find the harbor activities, dredging activities, were damaging the fisheries, so they'd do some trading off there to decide which one gave them the greatest return. They'd have to make choices, in effect, between two or more competing uses of the same estuary. But if you had a rational single owner, and you had reasonably reliable information on the market value of particular uses, that owner could manage that estuary reasonably well.

But as we've seen, not all of the goods and services that come out of the estuaries go through the markets. And estuaries are certainly not owned by private individuals, or by firms. They're what we call "common property" resources, which means that they belong to all of us in common. Government has management responsibilities, it can exclude some uses, and it can put restraints on certain otherwise allowable uses, but government, in effect, acts as our agent in trying to manage this estuary to maximize the total value of that estuary over time to everyone.

Therein lies the problem. Some uses conflict with other uses. Some persons may place a very high value — they may get a lot of satisfaction,

for instance, from the money they earn from harbor activities -- on certain uses that conflict with uses that other people place a high value on -- say, recreational fishing. The economic value of some of these conflicting uses is measurable from market behavior, and the values of other conflicting uses are not measurable, or measurable with only very large errors, because there are no relevant markets. So how is government to make the trade-offs? Whose values count? And if everyone's values count, do they all count equally, particularly when those who must give up a use (those who must pay the price) are not the same persons as those who benefit from a conflicting use?

There are all kinds of theories floating around that can provide answers to these questions. One might take the public choice theory of the Nobel Prize-winning economist, James Buchanan, for example, and say that the public interest is simply the summation of the individual interests of all those persons living in a given society at a given time. If you buy that premise, we can solve the economic problem of estuarine management fairly quickly. But if, on the other hand, you accept the theory that society is something more than the individuals living at any given time, then the public interests involves the values of all those who have ever lived and all those who will live sometime in the future. That leads you to a public trust theory of estuarine management, but it does not solve the practical problem of trying to know what the values of future generations will be-- i.e., what will give them satisfaction, given changing technology, social mores, etc.

What I am trying to suggest to you is that a very competent, very public-minded body of experts in the employ of Plato's philosopher king would not be able to determine the optimal management of an estuary. Not, at least, until human philosophy develops far beyond where it now stands. Yet the practical problem of managing estuaries in the public interest remains. So is there anything of practical significance to be gained from trying to improve our ability to identify and measure all the various types of economic values that arise from estuaries?

We cannot know the optimal way to manage an estuary, and we still would not know, even if we had good measurements of all the relevant economic values, because those values are, at root, subjective. So we would still not know how to weigh all the values, including how to factor in values of generations yet unborn.

Yet the estuaries are there. They are being used. Some of those uses conflict with other uses, and there are significant conflicting uses over the long term. We either try to manage them, or we throw up our hands and leave estuaries to the devil. If we are pragmatic and try to do the best we can managing estuaries as common property to maximize human satisfaction, what kind of strategy makes sense?

Economists can suggest an answer. In the first place, we are dealing with things that are unknown and, in some cases, unknowable. That means we are faced with uncertainty. But we are faced with uncertainty in our ordinary economic affairs continually. We do not know whether the stock market will go up or down this afternoon, or next week, or next year. The sensible way to deal with financial uncertainty, such as that prevailing in



the stock market, is to diversify our holding -- to not put everything we own in one stock, not to put all our eggs in one basket.

That means, in the context of estuary management, not allowing all our estuaries to be used in the same way. It also means that to the greatest extent practical, keeping as many options open as we can and not closing out any option for the future of an estuary until the cost of closing it out becomes very, very high.

How high is very, very high? That will almost always be a matter of judgement and, hence, of debate. But that is why it becomes intelligent to try to improve our ability to measure the economic values -- both market and non-market -- associated with estuaries. We must be more precise in determining what the present cost is of not closing out a particular option on the future use of an estuary.

Let me give an example. We have a reasonably reliable estimate of the economic value of Charleston Harbor as a port. Professors David R. Pender and Ronald P. Wilder of the University of South Carolina have estimated that the Harbor contributes \$1.5 billion or 4% of the state's GNP each year. Of course, the decision to use the harbor for a port was made a long time ago, but to the extent that we foreclose dredging in the harbor to protect some future options on harbor use, we must be willing to give up some of that \$1.5 billion in South Carolina.

There may be some persons -- but probably not many -- who would sincerely argue that protecting those future options is worth giving up the benefits realized from the Harbor activities. That is their subjective judgement which they have every right to try to persuade their fellow citizens to accept by making the issue a political one. The voters can then decide whether keeping the options open are worth the cost. But without Professors Pender and Wilder's estimates of economic values, the debate is less focused and the resulting political decision less intelligent because it is based on less information.

Improvements in our ability to estimate the economic value of estuarine goods and services, therefore, do have practical value. They allow us to place reasonably reliable estimates on the costs of various management alternatives that must be made for pragmatic reasons. They allow us to put a price tag on maintaining options.

That is all that we economists will ever be able to do (and we cannot do it very well yet, although we are getting better at it). No one can tell you whether the shirt you are wearing, or the dress you are wearing, was worth what it was priced at in the store. You thought it was, or you would not have bought it (although you now may think you paid too much). No one will ever be able to tell you, or government officials, whether the price we have to pay as a society to get some goods and services from estuaries is too high, or too low. To expect that economists can do it is to misunderstand in the most fundamental way what economic values are. All you should expect from economists is better and better measurements of costs.

With estuaries, as with everything else, there is a profound truth to the old saying that economists are people who know the costs of everything and the value of nothing. Thank you.

MARGARET DAVIDSON: Before we rush out to refuel on doughnuts and coffee, I'd like to go ahead and tell you a little about the second session which will focus on how the folks living here along the coast and in the upstate affect or impact our estuaries. We're going to talk about what happens when 55% of our state's population will have moved to an estuary by the year 2000; what happens when we tamper with the flow of water in and out of an estuary; what happens when we pave over a watershed area — what washes off the concrete into the rivers, and what does it do to an estuary?

Bob Becker from upstream at Clemson University, is the Director of the Regional Resource Development Institute, and is here to tell us who it is that's moving to our estuaries, and what do they want and what will they do. What impact will they have? In fact, Bob is currently in the process of examining growth trends in the Southeast and the way natural resources are being allocated to different groups.

Neal Armstrong, no — not the astronaut, folks. Our Neal Armstrong is Professor of Civil Engineering at the University of Texas at Austin. Neal will talk to us about the effects that altering or manipulating the flow of freshwater into an estuary has on the system. And we're not just talking about diversion or re-diversion of a river, but also about the increase of freshwater in our estuaries from surface or stormwater runoff as the land around estuaries becomes more populated.

Finally, B.J. Copeland will return to tell us just exactly what are these pollutants — whether from a pipe or seeping through the soil or washing off the pavement — what are the pollutants we need to know about, where are they coming from, and how does the estuary react to them? We ask that you all in the audience again hold your questions until the end of the session. Thanks, and we'll see you back here in ten minutes.

## SESSION II: IMPACTS ON ESTUARIES

### PART I: GROWTH IMPACTS

Dr. Robert H. Becker

What is affecting, how is growth affecting our estuaries? I don't like the word "growth impact," and when it came in the program, I phoned down and I said, "You know, most of the time I spend talking about how to stimulate growth." After all, the Regional Resources Development Institute is a resource development institute. We look at strategies for economic development, largely in the mountain areas. So being on the coast for this is rather an anomaly also.

But it reminded me of a story, a parable, actually, which might put this into context. There was this man and he walked up to a gas station in South Carolina and there was a boy and dog in front of the gas station. And he asked the boy, he said, "Hey, does your dog bite?" And he said "No." So, the man walked up to the dog, and the dog bit him. He jumps back and says, "Hey! I thought you said your dog didn't bite!" And the boy said, "That's not my dog." Growth impacts are a lot like that — our growth program, our growth interests don't bite. That's someone else's dog. But actually, everyone's dog bites sometimes. All types of growth have associated costs and have associated benefits. Jim Hite laid it out very well when he talked about how we value, how we perceive that resource base.

There is a quote that puts this into context. It's a quote I was given when I was an undergraduate, on values. It's a quote by a man named Zimmerman in 1951, and Zimmerman said: "Resources are not, they become." What this means is that objects become resources when they are given value and importance by some people. If I value a tree, or a wildlife habitat for its recreational values, or just for its aesthetic qualities, that resource has value. That object becomes a resource, it has value to me. If Champion Lumber values that tree, for pulp, plywood, particle board, that object becomes a resource. It has value to Champion Lumber. Now, unfortunately, both of us value that resource for purposes which may be mutually exclusive. We both can't have our way. Similarly, our wetlands, our coastal areas, our estuaries, we value them for their ability to handle waste water, to handle wildlife. Dr. Copeland mentioned our upland wetlands which we value for their water filtration properties. Then they become a resource to us. If someone else values them, for the yacht basin that could go in, for the condo development that could go in, it is a value to them, and it is a valid use of that resource. The question for us will not be stopping growth—that's like holding our finger in the dike — it won't work. The questions for us around growth will be how to manage growth to get the optimum mix, that mix of economic and social benefits within the desired environmental quality.

Now, I want to underline, because I did this on my paper, desired environmental quality, because that's the standard by which we have to place all of our growth against, in order to assess if impacts are acceptable. We are going to have them. Growth will cause change, and some of those changes will be perceived by some groups as impacts. Different

claimants for that same object will perceive change due to growth as an impact. And if we don't have an established public agenda for what is desired environmental quality, then undoubtedly, the claimants who seek enhancement and value through growth will undoubtedly overwhelm those claimants who view environmental quality as an essential property for our resource base, be it estuaries, mountains, rivers, upland wetlands, whatever. Because while the intensity of impacts to estuaries are debated by legislative bodies, scientific panels, various citizens, growth is generally applauded.

Our resources are, as has been accurately told to us in the past six years, the foundation of our economic growth. Garrett Hardin put this relationship between growth, particularly population growth, and natural resources into the context with his classic essay "The Tragedy at the Commons." Briefly, in "The Tragedy at the Commons," he lays out an example, he says picture if you will, an English common -- where anyone can graze their cow and give value to their cow. As Jim Hite said, people are viewed as rational. So if you're a rational person, able to graze your cattle at no cost on public resources, what are you going to do? You're going to increase the amount of cattle in your herd to increase the return to you, because that's a rational behavior. But as a result, the commons start depreciating. The commons start to decay. Being rational people, we say, well, we can fix that -- there's a technical solution. So we fertilize the commons, we shore them up, we keep weeds out, we improve productivity of our commons. What happens? Well, being rational people, more people will start putting more animals on the commons. Technology is not a solution to resource management. The commons eventually will reach its limit. Just like your room reaches your limit. Things expand to fit the space, the more space you have, the more things you need, the more resources you have, the more you extend the life of a resource base, the more that resource base will be exploited. You've just delayed an outcome.

According to Hardin, the solution to the tragedy of the commons lies in what he calls "mutual coercion." That is, growth management based on restricted access to the resource. By keeping some claimants away, and making those value judgements that Jim Hite said are difficult, which can't be made in an economic context, and can't be made in a technical context; they have to be made in a political context. That means restricting access to those commons.

Now, in this state, what's the future of our commons? What's the growth in South Carolina? We are, by most standards, a very healthy state. Sure, there are pockets of problems, and the state as a whole is not uniformly well-off. Just from your elementary geography of the state, there are three major population nodes that run in the axis along the I-26 corridor. Greenville in the upstate, Columbia, and Charleston along the coast. The growth pattern in this state is remarkable, because it follows upstate, coastal, with just a little bit of blip around Columbia. The rest of the state isn't doing a whole lot. But, in terms of the fastest growing counties in this state, six of the ten fastest growing are on the coast. And they're all in the upper quartile, that is the upper 25%, of growth in this state. They are Dorchester, Colleton, Beaufort, Georgetown, Horry, Jasper; Charleston's already so big that it can't grow at a growth rate to make it into that top group. So you're going to have increased population, we're going to have increased population density along this coastal quarter.

It is projected by the year 2000 that we're going to have approximately 55% of all the state's population living in that coastal strip. That's a lot of folks.

In addition to growth, we have a sector of growth that is going to offer some interesting opportunities in South Carolina, and some interesting problems. South Carolina's coast is an in-migration retirement area. Now what this group means in brief, is that in-migration persons over 60 years old exceeds what should have been expected (that's in a statistical sense, about 20%). The in-migration counties are Horry, Georgetown, Charleston, Beaufort and Colleton. So we're getting a very special group of people moving in here that seek very special services.

In addition, tourism — what has been hailed as being one of the economic saviors of South Carolina — is most important of all. Once again, all our coastal counties are classified as tourism-dependent counties. That is, tourism expenditures exceed 25% of total retail sales. That's a lot of people coming through this area. What does that mean? It means economic well-being. Yes, it does. It also means that we need a supporting infrastructure, that is, roads, shopping centers, waste management systems, potable water systems, and this means a hardening of the actual coastal areas.

Now, if you tie this growth pattern, which is going to be dynamic along the coast, and if you look at the growth pattern of population in South Carolina as a whole, South Carolina is growing in an odd pattern. That is, we have amazing growth also occurring in the upstate. The I-85 corridor is actually growing at a slightly faster rate than the coast, but it's growing in more of the industrial sectors, what are known as "emerging technologies." This means that the upper watershed areas that feed our estuary system are also going to be experiencing pressures. As our traditional economic sectors fall off, that is as agriculture falls off, we're going to see different uses of our land, we're going to see different uses of the water resources in terms of light industry.

Now, we like to think in the upstate, that the problems with estuaries are really your problems down on the coast, because after all, we spent millions and millions of dollars supporting the construction of dams across all the rivers that stop our waste somewhere before they get to you. And so the protection of the resource is going to have to be an indigenous protection on the coast. Now that's not true, but that's how it's perceived. Unlike some other states, such as Florida, which you'll hear about, we have a wide base of popular support for estuary and coastal protection. We don't have that wide base of popular support in South Carolina. In fact, the Charleston Harbor area of the coast of South Carolina is perceived as somewhat better than it was 20 years ago. The Harbor doesn't smell as bad, it certainly doesn't look as bad, and the people don't understand the intricacies of wetland dynamics. The information has not been translated to a population, that is a general population, that will drive a political agenda. It was easy at one time to point to the large industries, the smokestacks, papermills, and say, that dog bites. And say, we can take care of that; that point source of pollution, we can take care of it. And we put our technology to it, and we generally have taken care of many of our point source problems. But the

kind of growth that South Carolina is experiencing today will not accept those kinds of solutions. Today's population growth will drive non-point source pollution. Those of you who live or have just purchased a new property in coastal areas: if you have a driveway, depending on how you paved your roads, depending on where you go shopping, at a big shopping mall, all the things that make the quality of life fine in South Carolina—these are some of the causes of the problems with our estuaries. This afternoon we'll hear more specifics about that. So our new problems will be much more difficult to handle, because the problems are not just the other guy's dog. They're our dog. The changes that we're going to have to do if we're serious about estuary management are changes which are going to affect our everyday lives. It may affect the way we have to design our landscapes around our properties, it may indeed affect the way we design our properties. We're no longer going to be able to look to the abusive industry that some have mentioned here and say that's the dog. We're going to have to look at all sources, and all the political infrastructures that are required to make those changes.

Now in this state, every time I've gone into a community group and I've suggested that what we need is aggressive land use management, and aggressive land use planning, I'm usually stoned, that's why I was hoping for a bigger podium — for protection. But that may be what we need — very aggressive land use management in the areas affecting sensitive environments. The plush condos are as much an impact as the papermill. They're just less obtrusive. We find them pleasant. But remember, a pack of little dogs has as much bite as one big dog. So as we think about the potential tragedy of the commons and how to avert that tragedy, we think about our growth and how to manage that growth. There will have to be, as part of our growth management plan, a public recognition that problems exist, and that the problems start with individuals, not with the other guy. There will have to be a willingness to forego benefits for growth, or be willing to pay the added cost associated with managing the environment at the desired level of quality, or we're going to have to accept a lower environmental quality. That means a public agenda. And the public agenda for estuarine quality is going to depend on a coercive force. It's not going to be a voluntary item. It's going to require each of us to be willing to vote, to take action on land use plans, it's going to require us to take part in our county, city, state government, in terms of defining what is the quality of life in SC and what components make up that quality of life. In terms of estuary quality, it's a long, uphill fight, because those of us who are elsewhere have not been sold on the problem. We don't see a decline in the water quality, we hear it; I understand it, I accept it, but I don't know if my legislator will. And I don't know if my legislator will allocate state funds to solve what is perceived as a local problem, until the tie to estuary quality comes back to rest in every South Carolinian's pocket.

How important is this estuary to the coast? While Jim Hite said he can't give a value, you must certainly be able to put a cost on something. And so we're going to have to find ways of translating the feelings and the insights that the scientists and the economists have toward the value of estuaries into the lives of every citizen of the state. If you can't do that, then the probable future and the siege, as this thing is called (I love that title -- Estuaries Under Siege?) will continue, because our coastal area is going to be our growth frontier. Thank you.

## SESSION II: IMPACTS ON ESTUARIES

### PART 2: ALTERATIONS AND MANIPULATIONS

Dr. Neal E. Armstrong

Usually, when I talk to an audience that doesn't know me, I introduce myself as "I'm Neal Armstrong, not that one." I've learned to detect that telltale sign in people's eyes as they ask themselves "is he, or isn't he"? And I am not. Also, when I had my glasses made, it was because I had to do this and when I had them ground, they weren't designed to look that far away, so I may have to hold my paper a little high.

I'm going to talk about alterations and manipulations to estuaries. To understand what we're talking about, we do have to talk about the definition of estuaries, as we've already discussed, because these alterations and manipulations do involve modifications of an estuary's morphometry; they involve altering the tidal exchange that occurs, they also involve, especially, alteration of freshwater influx. The impact of these alterations can change mixing regimes, salinity patterns, biota and a host of other things in estuaries. The question is: are these alterations always bad? Do increases or decreases in freshwater harm estuaries? What magnitude of impacts might be expected? The framework that we might use to deal with these kinds of impacts and understand them, involves both conceptual and mathematical models of estuaries.

What I want to suggest to you today is that there is a natural model, a very simple one, that might begin to give us some clues about the impacts of these freshwater alterations to estuaries. That natural model is one that I'm fairly familiar with, and that's the Texas estuaries. These estuaries have been modified over time, they are subject to reduced freshwater inflows, and thus, suffer some of the alterations and manipulations that we want to talk about and focus on here for South Carolina estuaries. There are seven major estuarine systems on the Texas coast, starting with the northern shore, we have Sabine Lake, Galveston Bay, Matagorda Bay, San Antonio Bay, Copano and Aransas Bays, Corpus Christi Bay, and the Laguna Madre in South Texas. The combined inflow of freshwater from overland runoff, return flows and diversions to these estuaries range from 16 cubic kilometers per year into the Sabine Lake estuary down to 0.8 cubic kilometers per year into Corpus Christi Bay. Now when one takes into account precipitation and evaporation (when the precipitation patterns increase, going from Southwest to Northeast, evaporation increases going the opposite direction), these net inflows change again 16 cubic kilometers per year at Sabine Lake down to 0.5 cubic kilometers in Corpus Christi Bay. Obviously, evaporation exceeds precipitation for the lower half of the Texas coast. The halving of precipitation from Sabine Lake down to the Laguna Madre, 34% increase in evaporation, the same direction, location and size of the drainage areas for these estuaries, and particularly the dramatic decrease in precipitation from East Texas to West Texas, produces a tremendous change in these freshwater inflows to the Texas estuaries. And these large differences, coupled with our very weak tidal regime, well, that's at least compared to the East and West Coasts, produce large differences in salinities in these estuaries.

The hydrographic regime of an estuary is primarily a function of freshwater inflow and tidal exchange, as B.J. Kjerfve has already discussed. And estuaries may be classified using these factors. So our first step in comparing estuaries, and beginning to assess the impacts of alterations on them, might be to compare their hydraulic characteristics. One of the very simplest of these is a hydraulic residence time. When we calculate hydraulic residence time, it is simply the volume of the estuary divided by the combined freshwater inflow to it. Doing this, one obtains an average residence time of water flowing through the estuary, as if it were a simple, well-mixed reactor, with the only mechanism of flushing being the freshwater inflow. Using that measure, residence times in Sabine Lake are on the order of 0.02 years, or 7 days. Galveston Bay has a residence time of 0.23 years. And Corpus Christi Bay 2.25 years. One accounts for the inflow of freshwater as well as precipitation and evaporation, these numbers change slightly, getting larger as we go towards the lower part of the coast. But since it's unrealistic to describe residence time in estuaries based on simple hydraulic residence time, if we had to include tidal mixing, we can use the Bowden single layer model to account for tidal mixing, and calculate residence times on that basis. In doing so, we find the Sabine Lake residence time, again 0.02 years, indicating the freshwater inflow is very important in that system. In Galveston Bay, the number drops a little bit to 0.11 years, and for Corpus Christi Bay, it's now 0.46 years, about a fourth of the hydraulic residence time.

Another hydrographic classification scheme uses a ratio of freshwater inflow during the tidal cycle to the tidal prism, and states that estuaries with a ratio of inflow to tidal prism greater than one, are a salt-wedge type, or those with slightly lower ratios are partially mixed and those with much lower ratios are completely mixed. Based on this scheme, then, Sabine Lake would be classified as a partly mixed estuary, where the others, Galveston Bay and Corpus Christi Bay, would be termed completely mixed systems.

Now, do these hydrographic descriptions have any relationship to biota in the estuaries? Well, since the hydrography drives the salinity levels, which in turn effect the biota, the answer is, of course, yes. On what kind of relationships exist. Several years ago, I related for Texas estuaries the commercial finfish and shellfish harvest for about a 30-year period, to the freshwater inflows and salinity regimes. We looked at total annual catch, as well as an areal catch, that is, catch expressed on a per-unit area of estuaries, we could compare one estuary to another. For shellfish, areal yields are highest in Texas estuaries, with average salinity between 15 and 20 parts per thousand, and these yields drop gradually in estuaries with both lower and higher salinities. This pattern was also the case for individual species, like white shrimp, brown shrimp, pink shrimp and the bay oyster. But the blue crab had the highest yields in the lowest salinity estuaries. Finfish yields were highest at salinities between 10 to 15 parts per thousand, dropping off rapidly at lower salinity estuaries, and increasing somewhat in higher salinity estuaries. The influence of fishing effort was evident in these data, but could not be deduced.

Now let's turn to Charleston Harbor, and see if this natural model might have any bearing on the impacts that freshwater inflow alterations have had to Charleston Harbor. The National Estuary Atlas described the



Charleston Harbor estuary as being 40.8 miles long, having average width of 2.4 miles, average depth of 12 feet, which would give us a volume of the estuary of  $3.28 \times 10^{10}$  cubic feet. It also describes the tidal range as being about 5 feet, which would produce a tidal prism of about  $6.8 \times 10^9$  cubic feet. Prior to 1942, total freshwater input to the harbor was about 72 cubic feet per second, with most of that from the Cooper River. Salinities, as I understand, were about 31 parts per thousand in the mouth of that river. In 1942, the Santee Cooper diversion was completed, and included construction of lakes Marion and Moultrie, and a hydroelectric dam at Pinopolis. I understand the purpose of this project was to provide the source of cheap electricity and to increase flow down the Cooper River to an average of 15,600 cubic feet per second to flush and deepen Charleston Harbor.

However, the result of the project was to lower salinities to 16 parts per thousand at the mouth of the river, and, of course, to increase considerably the sedimentation that occurred in the Harbor. So much so, that maintenance dredging had to be increased 0.9-fold. According to Jerry Schubel, the increased sedimentation results in the problem of the addition of an important new source of fluvial sediment to the estuary, and a change in circulation patterns from a well-mixed estuary to a partially mixed estuary. The Cooper River re-diversion project was to return to pre-diversion situation as far as possible. With the re-diversion, the Cooper River receives an average of 4,600 cubic feet per second from the Pinopolis Dam. While the pre-1942 flow in the Cooper River was increased 220-fold with the original diversion, the re-diversion will maintain that flow almost 65-fold above the historic flow.

What will be the consequences of the re-diversion? Will the relatively high inflow at the re-diversion continue to cause the high sedimentation problems found earlier? Will changes in biota, composition, populations, commercial shellfish and finfish yield, sport fishing catch, marsh systems, nutrient-cycling of the processes, will changes in those occur? Well first, how does the Charleston Harbor estuary relate hydrographically to the Texas estuaries? Not knowing very much about Charleston Harbor, I can do some speculation here, and go back home not having to worry about the consequences, perhaps. In terms of the ratio of freshwater inflow to tidal prism, the Charleston Harbor was a completely mixed estuary before 1942, and partially mixed between 1942 and 1985. Jerry Schubel's already discussed that. But with the re-diversion, the estuary should return to being a completely mixed estuary, and I understand that some field observations support that. In terms of residence time, the Charleston Harbor estuary had a 14.4-year hydraulic residence time with pre-1942 flows. Without tidal exchange, the actual residence time, is probably closer to about 2 years. The resultant salinities were high, perhaps 25 or 30 parts per thousand, throughout much of the estuary.

Under this hydraulic and salinity regime, Charleston Harbor would be similar to our Corpus Christi Bay, producing low yields of shellfish, lower yields than possible, at least, and higher yields of finfish. During 1942 to 1985, the period with the higher freshwater inflows, the hydraulic residence time of Charleston Harbor estuary was about 0.07 years, about 14 days on the average. That low hydraulic residence time, coupled with the high rate of tidal mixing, produces an even lower actual residence time. In

terms of residence time, then, Charleston Harbor would approach our Sabine Lake. There, phytoplankton and zooplankton populations, would contain high percentages of freshwater forms, and under very high flow conditions, even the zooplankton populations would exhibit hydraulic flushing effects, that is, they would be flushed out of the system. Finfish yields may have been lower than pre-1942 conditions, while shellfish (especially the blue crab) may have been higher.

With the re-diversion and decreased flows, the hydraulic residence time will increase to an estimated 0.3 years. Again, by tidal mixing you can assume the actual residence time should be a bit lower, but salinities should stay around 15 to 20 parts per thousand. Such conditions would be close to those we find in our Galveston Bay. And, patterns here, as in Galveston Bay, should give higher yields of shellfish, especially white shrimp, and lower yields of finfish. Whether the Charleston Harbor has followed in the past any of these patterns that I've described, whether it will follow the one I suggested at the re-diversion, I trust research will reveal. The Charleston Harbor will still be an estuary. Modified from its former hydrography, water quality and biota, in fact, if the estuary does become more like Galveston Bay, it may provide higher and more consistent yields of commercial shellfish and finfish than before. All I know is that the research being done on this estuary is really essential to document changes that have occurred, and to provide the basis for making assessments of future alterations and manipulations. Thank you.

## SESSION II: IMPACTS ON ESTUARIES

### PART 3: POLLUTION IMPACTS

Dr. B.J. Copeland

Well, let me pick up where Neal ended. And while water and its distribution and its history are extremely important to estuaries, as we pointed out earlier this morning, it's also important to understand what's in that water and what it does. And I'm afraid with the Charleston Harbor reduction in freshwater inflows, you're likely to see some differences in the pollution problems that you haven't seen before. And there's going to be some changes. So, while we're doing this research to find out the residency time for the water, let's also include some research to find out what happens to the things that are in the water.

One of the things we're going to have to worry about, in pollution impacts, is that of sediment. Now, here's a little photograph to give you kind of a shock about what happens to sediment (this is North Carolina, now the other, younger B.J. showed you this morning some stuff for down here). Our people up on the hillside are not doing a real good job of keeping the dirt, and haven't been for some time. We're still suffering from all those little....where's the Ag Extension folks? We started this soil conservation thing back in the 30's, so we've had some improvement, but we're still suffering from all those little mistakes we made back then. So some of this stuff you see may be 1935 dirt from up in the Piedmont, I don't know, but we've got problems with sediment.

Now, with the sediments, there's land use activity problems, and there's construction problems. We've heard the economists say that we want to have some things of value; many things of value turn out to start with a "c", and so while we're doing those constructions of those condos and highways and things like that, we don't confine the sediment very well. But these sediments (not only do we change the configuration of the estuary and how it may look and how it may seem) also carry things. And as we get more sophisticated in what we do and how we keep our lawn green, our house clean, and our cars operating and wearing all these stay-pressed clothes and things like that that we love to do, we release a lot of sophisticated chemicals into the environment, and many of these just love to be attached to a soil particle. So we carry them down here, and so we've got lots of problems. A Bill Odum told you this morning, we don't know a whole lot about some of the re-working of the sediments and the transport of some of those materials and how they get into the food chain and all these kinds of things, so these are worrisome problems. This is a picture of what happens around the edges of our estuaries. This fellow used to plow soybeans there, he now has moved his rows back a little bit. But, you know, we have this sloughing off all along our estuarine shores because of activities that we do and the natural problems of the rise in sea level and changes in the water distribution and how it flows. So not only are we concerned about the sediments that come downstream, but we have sediments being generated within the system itself.

Let's move into another item: pathogens. The more we learn about pathogens, the more scary it gets. We used to have typhoid fever, and we figured out a mechanism to assess that, by measuring Escherichia coli, and we said every time you see a certain number of these things, you have certain odds of getting typhoid fever. Now, we haven't had typhoid fever in a long time, and the ratio between Escherichia coli and typhoid may or may not be the same as it was in 1892 when whoever it was that invented that did so, and now we concern ourselves with other things, like hepatitis and polio viruses and rhea viruses of many sorts. We're subjecting ourselves to all these kinds of things. Now here, this is what our state agencies do when they find certain levels of bacteria in the water: they put this little beautiful-colored sign here, which says you can't take shellfish from there. And so we cut into the resource utilization. Jim Hite talked about value—we lower the value of that area, but we're doing this to protect our public health. Now, these pathogens come from many sources: municipal waste is one source, but we also get that from drainage around the watersheds and runoff, urban runoff (you've got a lot of it here in Charleston), sweeping off the watershed with water. When it rains, there's a flush of material. There are a lot of pathogens in that kind of water.

But our knowledge of what these things do and how they get there and what happens to them is not very good. We've just gotten done spending a great deal of money to try to figure out some way to measure them better. And our researchers who did that are now rewriting the FDA manual, to kind of help figure out how to get these county and state sanitarians geared up to do it. But that takes a long time, and we're in bad shape for trying to assess that. Here's part of our problem. Now, here in Charleston, you have a lot of people clustered in a very small area, but that's not characteristic of the entire coastline, and it certainly isn't ours. Most of our people are kind of scattered out a little bit. So, in addition to sewage treatment facilities and all that kind of stuff in a big town, we've got little places. And you have a few situations like this. That's a septic tank that's not working the way the engineer who designed it meant for it to. Now that's not a big problem, unless you've got light-colored carpet or something like that, but this stuff does drain off backyards. We've found in our state that 85% of the soil in the coast of 20 counties don't support conventional septic tanks. You know, the same septic tank that worked up in Raleigh, simply does not work in Dare County. You got poor soil, you got clay hardpan, where it just sweeps right out into the water, it's a real problem. So failing septic tanks are a real coastal problem. Now you couple that with its companion, that is where do you get your drainage water, you might dream up a pretty good problem here. We have one area in Dare County where there are no regional septic systems or sewage receptor systems in that county. Everybody there, this is a county that swells up to 150,000 in the summertime, 5,000 in the wintertime, all their waste is disposed of by conventional septic tanks, or unconventional septic tanks, I guess, too. And all of the drinking water comes from wells. Now the two meet, and it's not a lot of fun to realize that you're drinking what you just flushed just a minute ago. And so we're now putting in a reverse osmosis plant up there, and people are paying big dollars for water. You think water's high-priced in Texas, Neal, it costs 3,000 bucks to tap on, the tap-on fee. And they're paying ten times the value that Raleigh is for drinking water, because it costs a bunch of money to support one of those kinds of systems. So not only are we contaminating our environment,

creating problems of that sort, but we're also short-circuiting our own problems of getting enough water to drink to support our own desires to live there. Drainage ditches such as these, draining organic soil and things of that sort along the coast also put a lot of pathogens in the water.

The next problem's that of nutrients. We have quadrupled the loading of nutrients in this country in the last fifty years into our coastal systems. Quadrupled. Now, you heard Bill talk earlier about estuaries being very productive places, well we're fertilizing productive places. And sometimes the results of little situations like this, this is a blue-green algal bloom in the Neuse estuary in North Carolina. Now, this is the problem, because you now have an organism that is not ordinarily eaten in the regular food chain. In fact, the studies that we did found that these blue-green algae here, these are microsystems, these blue-green algae are grazed upon by certain amoeba and a few rodents. Weird rodents. And nothing else. So, you've short-circuited the food chain. Now, we talked earlier this morning about how these food chains are abbreviated and you've little branches off of them and things, that sort of stuff — it's very important. But if you go in there and tie up your energies in this kind of phytoplankton, you're short-circuiting the food chain, so you wind up having blooms build up here, because there's nothing grazing on them. It's beginning to exclude all those things below it, because of light exclusion, so pretty soon you got a pure culture. And then it doesn't live forever, it starts to die and you got an internal pollution problem just from tying up all the organic matter there that's not going to be eaten.

Now, nutrients is a difficult question to manage. We know how to take some of these things out of sewage, but it costs a lot of money. And you get a city like Los Angeles or New York City, and then probably by inference Charleston, the amount of dollars that it would take to achieve tertiary treatment levels to get the nutrients down to some acceptable level is going to be astronomical. I was on a committee one time with this guy up in New York who was in charge of that (we were a committee of the Federal Water Pollution Program, that goes to show you how long ago that was), and he was saying that if you don't want any schools or transportation systems or this, that and the other, they could clean up their waste in New York. But at that time (this was in 1968), the cost was \$19 billion just to upgrade their sewer treatment plants. To almost good levels. And they have that kind of money. Lindsay was the mayor then, and he just wasn't going to let them have enough money for that, he wanted to do something like build a school. So, anyway, the problem is that these nutrients are distributed in various kinds of sources.

Look at this thing — 35 and 36, or 71% of the nutrients coming into Albemarle Sound are non-point source. How do you put a diaper on all these folks? You don't. Now, what we did, we really did it right, too — we picked out one of the industries up there, which account for about 4.9% of the nutrient loading, we shut them down. Because they had the tallest smokestack in that whole county. And we found out that they could get fertilizer someplace else cheaper, so we shut them down. They made nitrogen fertilizer. So we do things like that, but that doesn't solve the problem. Chowan River still has its algal blooms every year, and they haven't operated in 10 years. Non-point source is an elusive problem. And we don't understand how all that works. Now here's a low-tide problem. A

lot of our nutrients and things of that sort come from industry, comes out of a pipe. This is low-tide. Now, at high tide, it don't look so bad. It comes out underwater. There's a change in land-use activity, so nutrients, pathogens, sediments, all those things, and then our new kid on the block, toxics, come from various kinds of land-use activities that we do around those estuaries and those streams.

Now, in our state, we've cleared a lot of land in the Pamlico-Albemarle peninsula, and turned it into this kind of activity. This is a farm. This is a farm of 28,000 acres. And each of those little blocks there, are a half mile by so many yards wide, each confined by a drainage ditch, so you can drain water. So, whatever kinds of things you may spray on that, or use on that, or fertilize on that, it's going to get into the water. Now we've been doing some research in this area up at our place to try to figure out how to minimize the load that comes from there, and we've been relatively successful, and the farmers are beginning to utilize it now, so we're making some progress. But there are so many things that we don't know. As Bill pointed out earlier today, we're babes in the woods here with a lot of these things.

I think my time is about gone, Margaret, so I'll flip through these quickly. These are phosphate mining activities, so industrial waste is also important in what we do about trying to figure out how to contain that activity -- it's real important around our estuaries. What happens upstream and what happens downstream around there is important to us. Most industrial wastes fall in a toxic frame, because we're manufacturing all kinds of good things these days.

I was going to talk about water management, but I think Neal covered that adequately, but water management is really important to our estuaries, because it can in some ways be a pollutant. Too much fresh water can be detrimental. And if it's in the wrong season, you've got a problem. This is a map showing water distribution around the United States, down in Louisiana, they've got lots of it. The message I want to leave is: we're going to have to learn more about how these things behave in our system before we can figure out better ways to manage them. Thank you.

**MARGARET DAVIDSON:** I'm sure you all appreciated hearing about food chains and pollution right before lunch. In fact, you can go pick your own food chain cycle at several different places. After completing your internal pollution, we will come back and start again at 1:30p.m. Are there any questions? Yes, sir.

**A SPECTATOR:** Can you direct us to where we can find information about sediment pollution, especially toxic waste and what effect it has on marine life?

**NEAL ARMSTRONG:** There are some very good case studies of impacts of sedimentation and heavy metals particularly organic materials, on the James River and the Hudson River. One of the problems that you probably had here in Charleston Harbor with the high sedimentation rates was that because the system was partially mixed, the sediments were carried upstream on the bottom and deposited, increasing the dredging problem. What that does, in essence, is to tie up the organic material -- toxics, organics and metals-- keeping them in the estuary, rather than helping them get flushed out. And there are good examples of how that happens in the Hudson River and James River.

**B.J. COPELAND:** You might contact the Virginia Institute of Marine Science for the James River question. They have a series of reports there.

**MARGARET DAVIDSON:** Other questions? Right here....

**A SPECTATOR:** I have a question for Dr. Copeland and another question for Dr. Becker. Dr. Copeland, you mentioned the problem about the blue-green algae, is there a specific area that has experienced a deterioration of fauna because the algae prevented light coming through, just as an example?

**B.J. COPELAND:** Everywhere that there's a blue-green algae bloom, there has been a deterioration of fauna, yes. If you're interested in some specific reports on that, you might contact Dr. Hans Pearl at the Institute of Marine Science in Morehead City, University of North Carolina. He's written several papers on that issue and has recently been on the board for the Potomac River, where they're suffering similar blue-green algae blooms, and they have written a big, published report on the Potomac for the Washington, D.C. metropolitan area, where they're trying to make some decision on what they're going to do with the Potomac. The Potomac not only has nutrient problems with blue-green algae, but it also carries waste from our Senate and Congress, you know. But Hans Pearl can give you a lot of information about the fauna going away in those areas. So you ought to contact him.

**A SPECTATOR:** Dr. Becker, could you clarify what you meant by "non-point source pollution"?

**ROBERT BECKER:** The general runoffs that have been occurring in construction and from the increased population densities, are basically what I was referring to at that point in the presentation.

B.J. COPELAND: "Non-point" is generally regarded as being the materials that will seep into a body of water, either by surface transport, but primarily by subsurface transport, percolating through soils and little holes in the soil from farms and forests and parking lots and watersheds and all that. It's called "non-point source" because there's no place that you can identify where it comes from. It comes from everywhere. So it's more of a sheet flow.

MARGARET DAVIDSON: More questions? Okay. I hope you all have a good lunch, and we'll see you here at 1:30.

— LUNCH —

MARGARET DAVIDSON: Now you know an estuary when you're standing beside it or you've fallen into it, and we've also talked about what are some of the things that go on in and around estuaries. A question that I always have, because I'm not a technical person, is after I listen to a bunch of scientists talk, I always wonder "So what?". Well, that's what this afternoon's program is about — it's the "so what" of it. We discovered that while we do know some things about estuaries, there are a lot of things that we don't know. What do we do about the issue, what do we do about impacts and values? This first panel this afternoon is precisely about how some places do and don't deal with that issue of "so what?" — management of estuaries.

We have three different speakers today, and the first is Diane Barile, who is Executive Director of the Marine Resources Council of East Florida, and I have to tell you what that means. That means that Diane's been closely involved in developing an estuarine research and management strategy for protecting the Indian River Lagoon system, which is a portion of East Florida along the Atlantic Coast, that is still a remarkably nice area, but heavily impacted. We always like to, in the environmental community of South Carolina, point to Florida, because Florida has been very innovative in dealing with their coastal and marine resources. There are two reasons why they have been innovative: almost every place that you live in Florida, you're living on the coast, so that the coast is sort of uppermost in everyone's mind; and, of course, the second reason is that with 10,000 new residents per week in Florida, they have to deal with management issues, because it's all going away right before their eyes. So we brought the folks from Florida to come talk to us about what you do when you've got to do it.

We also have Will Baker here to talk with us. He's also going to talk about what you do when you have to do it. Will has been with the Chesapeake Bay Foundation since 1976, moving up through its ranks to become the President. He's a member of the State of Maryland's environmental task force, he's involved with the Maryland Sea Grant Program, and he's a recent recipient of the Rachel Carson Environmental Award. And I was actually quite impressed by that, because Rachel Carson really sort of kicked off environmental awareness almost thirty years ago. Chesapeake Bay is a place that a lot of folks have been concerned with, mainly because it's not as healthy and vital as it used to be. And so he's going to talk about how



they've dealt with the Chesapeake Bay. In Florida, I believe, the Indian River involves something like 256 public entities around the edge of the Indian River system. Chesapeake not only involves all these public entities, but it also concerns and affects about three states. One of which is Pennsylvania, which you don't really think about being a coastal state, yet the headwaters of a lot of the Chesapeake system start out in Pennsylvania and its agricultural lands.

And the third person who's going to talk, after these folks have talked about what you've got to do when you have no other choice, is Bill Dreyfoos, who is an attorney here in town, with Dallis and Dreyfoos, but we won't hold that against him. He's an Environmental Consultant with the Berkeley-Charleston-Dorchester Council of Governments, and he's worked on a lot of environmental issues. He used to be in Florida before moving. He's also recently been involved in the 208 Water Quality Plan Update for this area, so he happens to know a little bit about water quality kinds of issues. With that, I'm going to turn it over to these folks who know something.

## SESSION III: MANAGEMENT OF ESTUARIES

### PART 1: FLORIDA PERSPECTIVE

Ms. Diane D. Barile

I was really excited about coming here, when Margaret called. I mean, I'll go anywhere to talk about the Indian River Lagoon system. And then I got to thinking about the times I'd been here before, and then I saw the title of this whole thing, "South Carolina Estuaries: Under Siege?"; it seems as if a relative of mine made some indelible impressions on Charleston. He was the Captain of the Monitor. I came myself once, when I was invited to a dance at the Citadel. My best friend, Liz Taylor, who looked like Liz Taylor, made this Southern Belle entrance down a big staircase, and I followed, and tripped on the rug, and fell at the feet of my Citadel Cadet instead of in his arms; so I made a similar impression, I believe. And then I got here, and all I've been hearing is about how S.C. is under siege from Florida. I've heard about the red tide, I've heard about the tourists that we're sending; I was supposed to be impressed that 50% of your population will be in the coastal zone by the year 2000. We already have 80%, so we're exporting those people who think the coastal zone is crowded up here. Maybe I'm part of the siege. I'm beginning to worry.

But the question is, I believe, under siege by whom? I mean, who is the enemy here? The key in planning for the use of resources and their values is how can we plan so that we all win. Not only the skirmishes and the battles, but the war itself. I contend that the key to that is diplomacy, tact and sharing. So, I prefer not to come to a siege. I prefer to come to share the Florida experience with South Carolina.

In Florida, there have been constituencies built around many of the estuaries. Biscayne Bay, Apalachicola Bay, Sarasota Bay, Tampa Bay, the Lower St. John's, and the Indian River Lagoon system. I happen to think the Indian River Lagoon is the best group, so I'm going to talk about that since that's what I know most about. But there are, and I think you'll find here in South Carolina, there are people and groups who care about each of your estuaries. You all have a stake in it. The developer, the environmentalist, the recreational fisherman, the commercial fisherman, you all have a stake in what's going to happen. And there are people here who care. And what you must begin to do, is develop that constituency and allow that caring to be reflected in action, both through the scientific community and through your management planning. And, in fact, how people live their lives. So I'm going to describe what's happened on the Indian River Lagoon, and a little bit about the system. I'll outline some of the problems that we faced, and they're similar to some of yours, and then I'll go through the process that we used for improved management on the Indian River. If I can have the first slide.....

Start with a pretty Florida picture. The Indian River Lagoon system in Florida extends about 160 miles along the Florida coast, from New Smyrna Beach to just north of Palm Beach. About a million people live on its shore, and it's basically, on the northern end, about 7 miles wide, and there's one point near Vero Beach that's only about a  $\frac{1}{2}$ -mile wide. It's a

broad, shallow estuary, mostly cut off from the Atlantic Ocean by a barrier island. This is the Mosquito Lagoon. The inter-lagoon system includes Mosquito Lagoon, Banana River, and the Indian River. This is taken from a trip down the Lagoon — you can see grass beds along the shore, you can see the causeways, on the far side you can see the ocean, barrier island (Merritt Island) and the mainland. You can see the Lagoon is fed by several coastal streams, small creeks along the west bank. And as you move South, then the Lagoon narrows. There is a dredged channel, the Intracoastal Waterway, that's dredged the length of the Lagoon. You can see there's been considerable dredge and fill both on the barrier island and on the mainland. This is the narrows, as you can see, it has been straightened a little bit there.

One of the problems we had was our inlets. We have only 2 natural inlets (we have 5 inlets all together); the big problem is that the major inlets are on the south half of the Lagoon where it is very narrow. So we have two-thirds of the volume in area of water in the north half, which receives very little flushing. And the result of influence around these inlets is only about a mile to a mile-and-a-half. So it's a very poorly flushed system. If you look at the amount of water in the Lagoon, only between 2% and 15% comes in from the ocean. About 5% comes from rainfall, and about 80% comes from the stream flow and ground water. We've had extensive modifications of the watershed in the Indian River; only about 40% of the watershed currently is the natural drainage basin. Through agricultural drainage programs, 60% of the existing watershed has been added on through inter-basin diversion projects.

Now I have to show you that things are not always sunny in Florida; we do have some problems occasionally. We have seen a decline in fisheries, both recreational and commercial, both inshore and offshore. The basic foodstuffs for estuaries are grass beds, mangrove systems, wetlands, and so forth. This is an impoundment, and 70% of the mangrove systems in the Lagoon are now not connected to the Indian River system itself, which means that these large mangrove areas are now no longer able to be used for nursery and hatchery grounds for fish. So that may be part of the fisheries decline. We've lost 30% of the grass beds in the Indian River, through increased turbidity, run-off, boat motor ruts through the grass beds, and dredge and fill projects. We've had extensive shoreline modification — we talk about edge effects — in some areas we have concrete edge. Water management programs have affected the Lagoon considerably. This is a large drainage canal that comes into Cherokee Creek, which enters the Indian River Lagoon, so we have water management decisions and dams. The one placed on this watershed had a tremendous impact downstream. We do have pollution problems, and a variety of pollution problems, including, I think, assault on aesthetics.

The Indian River Lagoon initiative, then, has basically taken three tacks: number one is public awareness — unless people understand that there is a problem, where they understand the importance and the value of the system, it is very difficult to encourage them to undertake any action. Early on in our process, Lee Koppelman, from Long Island in New York, told us that often what you need in order to solicit action is a perceived need. Whether it be real or perceived, the public must perceive that there is a problem and that there is something they can do about it. We've also tried

to coordinate the existing management agencies and the public, and we've tried to encourage research that is focused and directed toward the information needed for sound decision making.

This whole process was started on the Indian River by the scientists. A group of scientists from five research institutions on the Indian River began noticing trends that they found somewhat disturbing. And so they got together and formed a group called FIRST -- The Future of the Indian River System. And they held a scientific meeting, and they thought maybe they'd have thirty or forty people come, and 400 people showed up. They were amazed. And for the first time, the scientists got together and put together a special issue of The Florida Scientist, which was then a summary of the research that had been done on this system to that time. That was in 1979, 1980. The FIRST group was made up of scientists. Some of my best friends are scientists, but there is a limit to how far a scientist can go. He does not want to stretch his data, he does not want to go to every public hearing and pound on the table -- that's not his job. And somebody in the back of the room just said that it doesn't help tenure, either. So, the FIRST group said, you know, we need some help. We've gone as far as we can go, there is a problem, there's some research need, somebody needs to do something.

The FIRST group was then expanded to become the Marine Resources Council (MRC). And this is an organization that was founded under the FIT Corporation (Florida Institute of Technology), was housed at the Florida Institute of Technology, and funded and managed by a steering committee of the Marine Resources Council. We have between 300 and 400 members, from six counties on the Indian River Lagoon. And we intentionally have delineated thirty-three special interest groups that have a stake in what's happening in the Indian River Lagoon system. And we encourage, and in fact, seek membership, from those special interest groups. So, our membership includes developers, environmentalists, people from the port, people from the Inlet Commission, elected officials, state representatives, Sierra Club, Malacologists Union, anybody -- homeowner's organizations, political parties, banks, and so forth. So we've got a cross-section of the community that are involved in the project. And these, then, are basically the activities that MRC undertakes. We try, then, to be an information source, and a networking organization, so that if the port needs a study, and they want to know who is doing sediment studies of the Indian River, we can give them a list of people who are doing that. If there is a problem with water quality, where can you get some samples processed in a hurry? Who has the information on such and such a topic? We try to provide that, as well as providing meetings and so forth to generate some constituency and understanding. What we've tried to do is use a classic planning process to come up with a good management plan and strategy for the Indian River. So basically, what I'm going to do now is show you how we've gone through this process of where we are.

The first thing we had to do was define the issues. You know, what is really the problem? What do people perceive as the problem, and what can we do about it? So, we reviewed all the newspaper articles, we sent out a survey, a statistically valid sample by river mile and population density in the various counties to kind of delineate those issues. We then held two American Assembly sessions. Out of those thirty-three special interest

groups, we invited three people from each special interest group, carefully selected to be the leaders and those who would be able to interact well with the group. We brought them all together, those hundred people, three from the thirty-three groups, we divided them up into five heterogenous groups, so we have a heterogenous group with the developer and the environmentalist, and the clammer and the sports fisherman, and the man from the Department of Environmental Regulation, and the man from the port, and we take these people and lock them in a room. And then, we give them this list of questions, and we say when you answer the questions, you can come out and eat. And so, they answered all the questions. And we published the results of that; we'd given them one day of background information, much like this meeting today, and then started locking them up.

And so, we delineated three major problems. Number one (and you've heard this already today), freshwater flow, and all those things that the freshwater is carrying is the major forcing function in the Indian River Lagoon system, and other estuaries, too. In our case, it's too much water. In other estuaries, it's too little water. But that's the forcing function. We're losing the grass beds, and with that, you know, the food for everything else that's living in there. Between the grass beds and the mangroves, we're decreasing the amount of energy that comes in for these systems to operate. The other thing was that there was nobody in charge. We had six counties, thirty-three cities, two regional planning councils, two water management districts, four inlet commissions, and a partridge in a pear tree. Nobody knew what the other one was doing, and in fact, they weren't even sure what the jurisdictions were. So one of the things we had to do was come up with some kind of a strategy; first of all to get them to talk, and second, to plan together.

And so those were the problems that we were addressing. This is how we defined the issues, and then these are the problems that we delineated. The only thing was, we couldn't figure out who was really going to be in charge of the Indian River (we were trying to decide who should be in charge of the Indian River), so one of the groups invented an Indian River Czar. And then they described all the good things that the czar would do. But nobody in the group volunteered a czar. So that meant that we had to find somebody who was in charge, and the only person we could think of was the governor of Florida, and so we made an appeal to the governor to put somebody in charge. And we also appealed to the Legislature, and the really funny thing that happened is that they both responded. And so they both gave us a directive to write a plan for the Indian River Lagoon. Which we did. And we've had funding from the State Legislature, from the Coastal Zone Management Program, from private individuals, from memberships and from grants from the Water Management Districts, Department of Environmental Regulations, ports, and the Department of Natural Resources.

The first thing that you have to do, is find out what you don't know. The approach that we've used is three-fold. We use a tops-down approach. In other words, what information do we know? It's almost like the layers of an onion. You know, it's easy to look at the outside. So what do we know, and how do we organize that information? And then to go deeper and deeper down into the details. The second thing is we've used a watershed approach. Since freshwater flow was delineated as the major problem, then the only way to understand what's really happening in the estuary is to

understand where the water is coming from; and the water comes from the watershed. So we have to look at the watershed. The third approach we've taken, is a systems approach. You have to understand what's going in and what's coming out, and what happens to everything inside and the relationship of everything inside. So you have to understand all of those things in order to really manage the system well.

First thing we did was reconnaissance reports, and these were done with Coastal Zone Management (CZM) funds through the Water Management Districts. And in this book, we compiled all that we know about the Indian River Lagoon system. We analyzed where the rain gauges were, what the periods of record were, where the staff gauges were, where the tide gauges were, we looked at hydrodynamics (we have a hydrodynamic model underway), we looked at hydrogeology, population, sediments, and so forth. And all this has now been published and can be used by all those agencies. Level two of the reconnaissance reports begins to look at the strategic places for gauges and placing those gauges, and looking at other information needs, and delineating exactly what research is needed in order to complete our picture of the Lagoon. And then the third phase is to go ahead and start analyzing the data as it is developed.

One of the major things was that researchers spend a lot of time traveling from library to library trying to figure out where all the studies are. One of the things we've done is put together a library collection of the reports, studies, data and so forth on the Indian River Lagoon, and we have it housed as a library collection. That whole library collection of about 1,000 documents, is augmented by a bibliography of about 3,000 entries that is on this computer, so that you can now, by the end of this year, come in and query the computer about what information do you have on water quality at Sebastian Inlet from 1950 to 1980, and it will print you out a piece of paper like this that tells you. The researchers are sending us their documents and their reports and studies as they finish them, so there's one place where everybody can use them. We also have a GIS system, an ERDAS system, so that we can now generate land use and land cover maps and then generate land use maps on the computer so that we can take satellite information and data or aerial photographs and generate and continually update land use and land cover information. Because if you're going to know something about freshwater flow, you have to know something about the land it's coming from.

We've mapped the grass beds; a couple of guys spent two summers being dragged behind a boat mapping sea grass beds, so we now know exactly where the sea grass beds are. What we found was that using aerial photographs is not accurate enough for permitting and enforcement. So we now have ground-truth maps of the sea grass beds. So if a clammer is out (according to Florida law you can't rake for clams in a grass bed), an enforcement agent has these maps with him and he can tell whether the guy is in a grass bed or not.

We've done a lot of sediment studies. What we're finding is that water quality data is nice. You know, you always go out on the first Monday in the month, when it's not raining, and it tells you exactly what the water quality was that second you dropped the bottle, but probably you missed the big rainfall that occurred two weeks before, that really shocked the system.

Also, it doesn't tell you about the whole water column. So what we've found is that by going back and doing some of the sediment studies, it gives you a time history of water quality in the Lagoon. In fact, we've got one set of cores in one of the streams that had a high concentration of mercury. We couldn't figure out where it came from until Dr. Trefry at FIT explained that we had about thirty years accumulation of dyes from toilet paper accumulating in the channels, and other pollutants as well. The Department of Environmental Regulation has done water quality surveys which augment the sediment studies. We got a call from a clammer, several clammers, saying that 20% of the clams in their rakes were dead after a certain rainfall. So we had a SWAT team of people who volunteered to go out and sample. We found out where the rain fell, what the runoff characteristics were from the various streams, and then we looked at how that was reflected in salinity, and then we looked at the impact of those salinity changes on the clams. And what we found was that the first flush of freshwater was good. It caused the clams to spawn. But as the freshwater continued to come out of the stream, the salinities dropped further, the larvae were in the water, and had a lower tolerance for low salinity than did the adults, and we killed the larvae, which meant that we killed the set for the following spring. So you need to have some money somewhere for these episodic events, that the people on the ground will tell you have an impact, but monthly or weekly sampling programs often miss.

We also then looked at cultural and historic trends. We're writing an estuarine monograph for NOAA, looking at 500 years of environmental trends in the Indian River. It's really pretty interesting, because the place where the Spanish first saw the American mainland was along our coast. This is also the place that man last looked at earth as he blasted off into space. And so we have a diversity of impacts over the 500 years that we're looking at. If you're looking at research, then, this is kind of an outline of the types of things that you need to know in order to understand your system. You need a water budget, so you know where the water comes from, where it's going. You need a circulation and flushing hydrodynamic model, and all the rest. So we did write two plans. Fortunately, we cooperated and so, if we have two plans that are the same inside, and have two different covers, we have responded to the Legislature and to the Governor. Those plans were then made part of a law in Florida, called SWIM, the SWIM Act. That's the Storm Water Improvement Management Act. And under that, key priority water bodies were established in the state of Florida and funds were made available to restore and improve those water bodies. They include freshwater and estuarine systems. So we're going to be working with local government this year; Florida has a local government Comprehensive Planning Act, and every city and every county has to have a new plan this year. And so we're going to be interacting with those cities and counties to include the Indian River priorities and goals in their coastal protection elements, drainage and infrastructure plans. So we'll be working with the planners and with local watershed committees and planning commissions to implement those goals. These are my pride and joy.

Also at FIT, we have a coastal management program, and so we're training professionals who know about it; after they've been around me for a year and a half, they better know about the Indian River. These people are now staffing the various agencies and engineering companies and so forth that are involved in implementing the plan. One of the things you need to

look at is are you training professionals who'll be able to talk to one another? Often, the language is a little different between a biologist, an engineer and a manager. And you're going to have to find mechanisms and key professionals who can facilitate their communication. Everybody else ended with a sunset; this is sunrise, because this is the sunrise. We've got a new awakening to the values and the importance of the Indian River Lagoon, not only to the economy, but to our lives.

We're involved in very active education programs throughout the state and national parks. The Marine Resources Council puts out a quarterly newsletter, tries to keep everybody up-to-date on what's happening. We hold quarterly meetings where we get all these people together — we don't lock them in the room anymore, they come and stay without the locks, but we still have to feed them. But it's a very important part of the whole process that all the players know each other, so that when there is a problem, you don't sue, you call the guy up, and say, hey, we're putting up too much freshwater. Our biggest success was two weeks ago. We had a very heavy rainstorm, one of the clambers called, and said the salinity's down to 13. If it goes any lower, I lose my whole investment, I've got 5 million clams in the water (they grow up to be worth 20 cents apiece), if the salinity goes down any further, I'm wiped out. What's happening? One dam was open, the other was closed. The Water Management District said we don't think we'll have to open it, a little while later they said we have to open it, we ask isn't there anything else you can do? One man who was supposed to have been on vacation for the first time in two years of his life decided not to go on vacation, knew where there was some heavy equipment, went out in the marsh, and knocked down a levee. A week before that, one of the agricultural interests, a very large agricultural interest, broke down a levee to allow water to flow back away from the Indian River. It was done without a regulatory program, it was done without a law, it was done without a lawsuit, I'm sorry to the attorney over there, but you don't always have to have an attorney, if you've got people talking to one another. And that's the key to the whole thing. So lunch is important.

When we go to every fair, festival and meeting of more than five or six people, this is our fair exhibit; we also have one that goes to the seafood festivals and the schools, and a museum display for travel. Even private enterprise has gotten involved. This is a bank that commissioned these paintings and all this stuff and ran it for several weeks. They had a whole series of these in the newspaper. It was important to the bank that the Indian River Lagoon system be protected. You know, we publish, and distribute all of our information as widely as possible. We ran a summer institute for teachers — we got thirty of the best science teachers in the county and they were paid to go to school and we took them on field trips all over the Indian River Lagoon system and taught them everything that we want the kids to know. On this particular field trip, they rescued this manatee that had been wounded. We run meetings whenever possible; at this one, we looked at 500 years of environmental trends. We're also doing a movie, we'll be doing a one-hour TV special with the PBS station in Boston, who will be filming it this winter. You have to have people know why the place is important, so this is the type of public awareness, then, that you can undertake. And the management has been coordinated both through the state legislature, the governor, and a special task force that the governor set up. Implementation -- we're now looking at implementation through the



SWIM bill, we're working with the local government comprehensive plans, and we're working with parks and other national programs.

So, how far are we in this planning process? We've got a good start. We've defined the issues, we know what the problems are, we've achieved some consensus about what those problems are and what we should do. We're focusing. You have to make your goals simple, so people understand what you're talking about. You know, if you say "I'm going to improve water quality," it's real nice, but what is water quality? If you're going to stop freshwater and cut down on fertilizers on your yard, that's something people can understand. So you may have to take a multi-disciplinary approach. You can't attack this thing on one level. So we've taken three approaches here. The systems approach, you have to use the whole watershed, take a tops-down design. You will never know everything, but there are certain levels of knowledge and the place to start is what you know now. The second point is to define what you don't know. The third point is to find out what it is that you didn't know and then you keep refining that information until you are down to the level in which you feel comfortable making a decision. You have to use the whole watershed. You have to look at where the water's coming from in the lagoon, both in the ocean and the land, and that's rainfall, runoff, ground water, irrigation discharges, or whatever. Saltwater intrusion. What are those relationships? You have to look at the whole system. You have to know what's going in, you have to know what's coming out, and how the pieces are connected.

Where are we? We're right here. We've pretty well defined the problem, we're into the planning process, we've got a public awareness program, we've got citizens working, we've got legislative action, governor's action, we've got coastal programs active, we have a management plan, and it's being implemented now. Maybe the next time I come we can tell you about some of the evaluations, but I have to ask you, one of the reasons I come to these things is to extract a promise from all of you. The Indian River is not a river. That's part of the public education I'm doing right here. The Indian River is an estuary. It's a very strong system. It has tremendous assimilative capacity. It can take change. But everything has a limit. So what we're trying to impress upon people is that the Indian River is not a river, it's an estuary, and it has to be managed as an estuary within its sensitivities and limitations and vulnerabilities. So at this point, I want you to raise your right hand, this is important, this part is public education, you've got to do this. Right hand — I solemnly swear (your hand isn't up) that hereafter, I'll never say Indian River. I'll say Indian River Lagoon. Thank you very much.

### SESSION III: MANAGEMENT OF ESTUARIES

#### PART 2: CHESAPEAKE BAY PERSPECTIVE

Mr. William C. Baker

I've got to do one other thing first, before I get started, and that's to alert you that when I say "the Bay," be prepared, be advised, that I'm referring to the Chesapeake Bay. After all, the Chesapeake is the crown jewel of the world's hundreds and hundreds of thousands of estuaries. That's not to say that your "lower case", "B" bays are not important and worth preserving. I just want to make sure that we have all of our priorities straight at the outset. But seriously, the Chesapeake is a remarkable system. H.L. Mencken called it "a giant protein factory," and historically, a half of all the nation's blue crabs have come out of the Chesapeake. A quarter of all the oysters; more soft-shelled clams than all of New England combined. And New England you think of as the clam capital of the world, really. Striped bass until the last ten or fifteen years, nine out of every ten striped bass caught off the Atlantic Coast was born in the Chesapeake Bay or its tributaries. When we say the Bay, we mean the entire system.

Before I go on, though, let me tell you a quick story. I was walking through an Eastern Shore fisherman's village, with my two year-old son, about three or four weeks ago. And the Eastern Shore is always capitalized. They have bumper stickers that say there's no life west of the Chesapeake Bay. The western shore is never capitalized, that's just part of the rest of the country. It's a land unto itself, and there was a little church down at the end of the road, and my son and I walked back into the cemetery there, and as in any rural area, you know, you have nicely kept gravestones, some of them are fairly elaborate. Well, way over in the corner was one that looked like it had been abandoned. Weeds were growing up over it, and we went over and sort of brushed everything aside and took a look at it. The epitaph read, in its entirety, "I told you I was sick." You can imagine the old fisherman. At least he had a sense of humor.

The point of the story, the moral, is that the Chesapeake Bay has been telling us she's sick for years, and no one would listen. We nearly lost her. There were the obvious signs: the declines of such species as oysters, striped bass, shad, yellow perch, white perch, and then the nearly bay-wide die-off of submerged aquatic vegetation, what we call eel grass. Finally, the waters become extremely turbid, and we all know that's due to increased amounts of algae, increased turbidity, increased sedimentation in the water column and what-not. And, you know, to the general public, that just looks dirty — they know something's wrong. We have on the Chesapeake, as all around the world, all around the country, here, some very sophisticated monitoring equipment. I sat on a monitoring panel with the oft-quoted Jerry Schubel, who is chair of it, and we looked at some of the most sophisticated things that are being done to monitor the health of the Chesapeake Bay. But one old state senator, named Bernie Fowler, who lives down on the Patuxent River, said "I know when the Bay is going to get cleaned up, because when I can wade out into the Patuxent around mid-summer up to my waist and look down and see my toes, then I'll know the Bay is on the road to recovery."

and that's not all that bad, when you come to think about it. The water just is looking worse.

The good news is that although the Chesapeake has gotten pretty sick, she's in the Intensive Care Unit now, and getting a tremendous amount of attention. It's about time. National and even international attention has been focused on the Bay, and the federal dollars are flowing to it. I think we're sometimes looked to as a trap, a sediment trap for federal dollars, but more importantly, state funds, over 200 million dollars in state monies, new state monies, have been appropriated since 1984. They're flowing in far greater amounts than the federal dollars. But what this federal carrot of monies for cost-sharing programs and what-not has done is brought many states in the Bay watershed together, to work together. And historically, that's just not happened. The oyster wars back in the 1800's were only an example of the way Maryland and Virginia, for instance, have fought over the resources of the Bay. Now they're fighting together for it. It's an enormous change, and I can't ever emphasize how important it is.

If we could have the lights and the first slide, I did one of the smartest things I've ever done — I only brought two slides this time. I'd like to show you a little about the Chesapeake Bay. This is a recent Landsat image that we've made into a poster for fund-raising, and we haven't gotten a good slide of it, so we just took a 35mm, but you get the idea. It's 200 miles from the Virginia Capes up to the Susquehanna Flats. And the Bay is, oh, anywhere from 30 miles wide to 4 miles wide. It has 8,000 miles of tidal shoreline, and the average depth is only 21 feet. It's kind of like a broad flat pan filled with water. But that 21-foot depth belies the information a little bit, because there is a deep natural channel that skews the average. Much of the Bay is far shallower. Large, broad flats, 2 or 3 feet in depth. Willy Warner, in his Pulitzer Prize-winning book Beautiful Swimmers, quotes an old waterman as saying "a man who hasn't run ashore from time to time just doesn't know the Bay," and that's quite true. Using that criterion, my wife and I know the Bay about as well as anybody. Waiting for high tide stranded on a tidal flat is not the best thing when you're out sailing, but it happens. We've learned, fortunately though, to view the system in it's entirety.

And this new view of the Chesapeake is one that's happened since I've been working, which is only about 10 years. We're starting to look at the whole watershed. And when scientists and managers in the Chesapeake area say "The Bay," this is the system they're talking about. It runs all the way up into New York state; shad used to migrate up to Cooperstown before the three or four dams were built on the Susquehanna, much of Pennsylvania, a bit of West Virginia, a little smidgen of North Carolina, a bit of Delaware, and of course a great deal of Maryland and Virginia.

The important thing is, that any water, any storm water running off any of that land, or any point source discharges coming from any of that territory, eventually winds up in the main stem of the Bay. And there it slows down, drops out of suspension and it gets tied to the sediments, and it doesn't leave. Pollution in the Chesapeake Bay and in many estuaries is a cumulative problem. Something that's very important to remember — it doesn't just wash out to sea.

My organization, the Chesapeake Bay Foundation, was founded in the mid-60's, in response to severe pollution even then. Toxic chemical contamination and over-abundance of nutrients, loss of wetlands, habitat alteration, reduction of fisheries, etc., were all the pressing problems back in the mid-60's. And guess what -- they're the same now, just a lot worse. What's interesting, though, in these last ten years is when you hear somebody say "I know what's wrong with the Bay, and I can fix it." And they talk about things like oil spills, chlorine discharges, shipping and dredging activities, industrial wastes, sewer, agricultural runoff, even acid rain. All of those have been held up at one time or another as the primary, if not the sole reason, the Bay was dying. People love to point the finger at somebody. It's always away from them, towards somebody else. But we've got to remember old Henry Mencken, the Bard of Baltimore, he has a great quote for this, too. He said, "There's a simple answer to every human problem -- neat, plausible, and wrong." How true. Environmental problems don't have simple answers. There's one important message I can leave with you: it's whenever anybody tries to tell you "Here's the problem: it's either the developers or the industry, or the farmers," say "No, it's all of those, and probably a whole lot more." And the only way we're going to fix it is with a multi-dimensional strategy. You can't think it's simple, or even neat.

Let me give you just a moment on the make-up of the Chesapeake Bay Foundation, because it might help crystalize some of your interests in focusing similar programs here. Although we are the largest such organization in the country now, we certainly didn't start that way. We began in a one-room office, with a part-time executive director, a borrowed Boston Whaler to use for environmental education, and a law student intern. We now have offices in Richmond, Virginia; Annapolis, Maryland; and Harrisburg, Pennsylvania; the three primary state capitals. And about seventy full-time employees. But our programs are still the same as what we started back then. We call environmental defense the work of the lawyers and scientists. They're working on fairly short-term issues -- fighting brush fires, if you will, lobbying for a bill, opposing the location of an oil refinery, working on a new regulation, that sort of thing.

The second program is environmental education. We take about 27,000 students a year out onto the Bay, and we've graduated from that old Boston Whaler to the point where we now have about half a dozen research vessels, forty, forty-two-foot traditional Bay-built boats, a lot of canoes, a lot of row boats; we even have an old farm that was donated to us that we made into a model farm, of best management practices. Four thousand students a year come out and see what the problems are that farmers face in trying to do a good job in terms of what agricultural runoff can do to the system. And our third program is a land conservancy. Taking land, managing its wildlife habitat, using it in the education program. There's a little something for everyone, and that doesn't necessarily hurt when it comes to fund raising or membership promotion.

But that three-pronged approach was based on real logic. You know, you have to work on the short-term issues while you're making that investment in the future, trying to change, get a whole new generation who will be educated about the Bay. And they really do work well together. We've built upon our successes over the years, and ridden a real wave of interest in

Chesapeake Bay. We now have an organization that is supported by 50,000 members, representing every state in the Union, and ten foreign countries. The funding comes from everything from \$20 members to foundation grants to corporate grants -- we have a budget of about \$3.5 million. We get almost no federal money, and a little bit of state money when we take public school children through the education program. We've gotten, as one trustee said, a critical mass that we're able to have a certain amount of clout in the legislature and on Capitol Hill and in the state legislatures, and even in the courts. The U.S. Supreme Court decision from a lawsuit that we brought that reached the Supreme Court, was just handed down earlier this week. We won a limited victory against an unchecked industrial polluter, and set a standard as to how the Clean Water Act and citizens' suits can be interpreted. Not as liberally as it has been in the past, but not as restrictively as the company wanted it interpreted.

In my remaining few minutes, I want to give you a few of the things I have found that have been useful in our work on the Bay, as recommendations. Don't get me wrong, with my recommendations and a quarter, you can go out and make a phone call, but it's the best I can do. So see what you think of them. First and foremost, you've got to get over the economic argument. All too often, decisions have been made for short-term economic gain that sacrificed long-term environmental protection. And that's not only stupid, but it's downright bad economics. You can't, and I think we heard the speaker articulate this well this morning, you can't put a dollar and cents value on some of these environmental things, but with a little work, it's not that hard to demonstrate that clean air and clean water are of an enormous value to a community. Take it the other way -- how much would be lost, to South Carolina, for instance, if the rivers and estuaries were polluted to the point of not producing seafood, or seafood that couldn't be consumed, being too dangerous to swim in, or just looking and smelling putrid? It's not only tourism that would suffer. It's real estate values, a reduction in the number of corporations that would want to locate in this area, and a stigma not unlike that which, perhaps, New Jersey suffers under. I'll take care of the New Jerseyites afterwards. You say it can't happen here? Well, maybe you're right, but is it worth the gamble? You don't want to have to deal with that question, "We can't afford to do it." You want to turn that question around, or that comment around, and say, "We can't afford not to." And I think, in this country, we're finally starting to reach that.

My second recommendation is to lobby your elected officials. For years, we found it very difficult to get people to lobby, and I think there's a natural aversion to doing that. Maybe it's got a distasteful connotation to it. But what we've done is made it easy for them -- we've trained volunteers who can work, organizing groups on a river-by-river basis, to mobilize people on a specific issue. And next, we've encouraged people just to do something as simple as to write or call their legislator and say, "We are for saving the Bay. We hope that you will make it a priority." It's working. I've heard, over and over again, from state and local elected officials, that all the studies in the world don't hold a candle to constituent pressure. And I think that's encouraging, I think it's encouraging to see that the system, the democratic system, does work. Finally, on this score, the press can be enormously effective. Getting to know your local environmental reporters and the editors on the papers well,

they need stories, and they need to be fed stories, and nothing gets a politician's attention faster than a good story or editorial in his or her local paper.

My third point is involve the politicians in the ways they want to be involved in. What do I mean? Well, give them photo opportunities, for one. Give them credit for good decisions, popular decisions. Give them photo opportunities. Provide them with the briefing materials that they can draw from, and work with their staffs. And give them photo opportunities. You get my point. But it is important, and on the Chesapeake, when people see the governors and the senators and Bill Ruckelshaus, Lee Thomas, whomever, come out and tour the Bay, they get cynical and they say, "Oh, that's just window dressing." I think it's great, because I was working there when I saw that those elected officials didn't want to take the time to associate with the environmental protection movement. You know, you've got to get across to them that environmental issues are not only issues they can't ignore, but they're issues that will help them win votes. And once they understand that, they're going to be involved. It's a political system we live in, and they will be appropriating the money to get the job done.

Fourth: drive home the cumulative nature of pollution. I touched on this a little bit before, and scientifically, you're absolutely sound in talking about the cumulative nature of estuarine pollution, how rivers and bays are traps for pollutants. And it's far easier to begin cleaning them up when they're just in the out-patient ward than before they get into intensive care, if you will. As a practical matter, don't let the regulatory agencies look at one discharger in isolation, and you know they love to do it. They love to say, "Oh, this much coming out of the pipe isn't going to hurt anything". But how about that one over there, and that one over there, and that one over there? Look at the cumulative nature. And that's the same with non-point source pollution, and new development. One marina, ok, maybe not a problem, but look at the shoreline — it's virtually all marinas, perhaps.

Finally, the last piece of advice is one you may not agree with, and you may find a little odd, but I've witnessed its effectiveness for years— that is to be reasonable, and honest, in your advocacy. Avoid getting the reputation of always being against everything. Support those projects which are good and are innovative and creative. Realize that those on the other side of the negotiating table, if you will, are just like you and me — they have wives and husbands, and families they go home to at night. Most of them, I say most, are not monsters, but just people who are trying to do their jobs well. And if you realize that, get rid of the emotion and the rhetoric, I think you'll go a lot further. Above all, be courteous and be professional. Now, this doesn't mean to be a push-over. There always comes a time when you have to draw the line in the sand and not retreat from that, you have to establish a credible position based on good science and good law. You will lose your credibility if you don't defend that. And I can only say that with science and law on your side, environmentalists can be as tough as anyone. Should be. Remember what the great environmentalist, Al Capone, once said (he practiced population control for years). Al Capone said, "You can get more with a kind word and a gun than with a kind word alone." Thank you.

## SESSION III: MANAGEMENT OF ESTUARIES

### PART 3: SOUTH CAROLINA PERSPECTIVE

Mr. William W. Dreyfoos

I've been given fifteen minutes to talk about estuarine management in South Carolina, and I have a reputation of not being able to say anything in fifteen minutes. But today I'm very lucky, because if what we've been hearing about in Florida and the Chesapeake Bay is estuarine management, and I believe that it is, then there is no estuarine management in South Carolina. So I've now completely covered my topic, and I have fourteen minutes left. What I would like to do with the rest of my time, then, is to talk about what we do have in South Carolina, and I think it's obvious from the discussions that we've just had over the last two presentations, that we're at the beginning stages of estuarine management. We have bits and pieces of it, but we don't have it all put together.

The first thing that we do have are the resources. And perhaps unlike many of the systems in Florida, unlike the Chesapeake, our resources are in good shape in South Carolina. Many of them are stressed, many of them are starting to have problems, but there are many estuarine systems, most of them in pretty good shape. Let me go through the list, and I'll probably leave one out: Port Royal Sound, St. Helena Sound, Edisto River (North and South portions), Charleston Harbor, North Inlet, Little River, and many other smaller rivers which have estuarine portions as they empty into the ocean. We have a lot of development pressure up and down the coast. Some of our estuaries are in relatively pristine condition in the sense that there's not too much development in the areas immediately surrounding them, even in the basins. Other estuaries, like Charleston Harbor, are very heavily impacted by development. We have increased public interest in environmental concerns and resources and quality, and increased public activism, particularly in the Charleston area over the last few years. And it's not just for environmental reasons, but it's the beginnings of the recognition of the importance of our estuaries and our natural systems to our local economies and to our ways of life.

To me, this is the key, this public interest and public activism to any kind of real management, and, in fact, in Coastal Zone '87 in Seattle this past May, I made a presentation which was entitled, "Estuarine Management Through Public Participation." And the point that I made there is that the strides that we've been able to make in the Charleston region over the past three or four years, since there's been any real progress, has been primarily due to two factors: increased public activism and increased media attention, and increased public concern for these resources. Again, we have little bits and pieces of management or cooperation among jurisdictions, among governmental agencies; if they were all put together, they might be estuarine management, but they're not put together yet. Instead, what we have more than cooperation is a lack of coordination. There are a few of these instances where everybody gets together and works towards a common goal, the kinds of things we've been hearing about, and I'll talk about those in a minute. But mostly we don't have that. We do, however have a number of new initiatives among governments at the state and local level

over the past two or three years, and we also have a number of dedicated professionals, both in and out of government in South Carolina, who want to make estuarine management a reality.

Having said that, though, I think it's constructive to look at what we're actually doing, and I put together a list of things that have happened in the past six months that involve estuaries in South Carolina. Perhaps the most important one is this Conference, in part because it provides visibility, it gets people together talking about commonality of interests and the need for estuarine management. But if we only talk about it, it's not even a first step.

The second one involves activities going on in North Inlet. For years, the Baruch Institute has been conducting research, the type of research that is the basis for any real estuarine management program, part of the good science that we've been talking about. This is threatened now by a development proposal that would create waterfront property out of land that's currently not on the waterfront. And one of the state regulatory agencies has approved this. Arguably, it didn't meet the regulatory standards of that agency, arguably it doesn't meet the regulatory standards that would be or will be imposed by others. All the decisions, though, are now in the process of being considered or reconsidered after it was found out that the funding for this research that's been going on, and it's longitudinal studies that involve years and years and have years to go, that's now in jeopardy, as a result of the impacts of this decision on the North Inlet. That wasn't considered at the time the decision was made, now it's being considered, everything's all messed up. There will be some resolution out of it, but obviously, there's no management going on with respect to decisions involving development and water quality in that particular estuary.

The second one involves SAA classifications or the proposed re-classification of waters in a number of estuarine systems up to class SAA. This is a water quality classification that the legislature adopted in order to protect near pristine types of areas. One of the major points that goes along with SAA classification is that point source discharges are not allowed in SAA waters. The SAA label, the re-classification process, has become symbolic to a lot of people. And there have been lots of proposals to upgrade rivers, in the belief that this is more or less estuarine management. Or at least maybe it's not management, but it's all-inclusive protection, that once a body is classified as SAA, you don't have to do anything else, everything has already been done. Well, the Edisto Rivers, the lower Edisto Rivers, North and South, were re-classified to SAA earlier this year, and several months ago permit requests came up to DHEC for a marina located in the South Edisto in the areas that were classified SAA. Staff recommendation on the basis of looking at environmental considerations was to approve the marina. Now, you can argue about whether or not that was appropriate, and there are good arguments either way. I think the point is that SAA in and of itself is not an all-inclusive protection. It doesn't afford the type of management that we've been talking about today.

The third point involves marinas and water quality. This fall, over a two-month period, the Department of Health and Environmental Control (DHEC) Board has over-ridden staff recommendations on two marina permit applica-



tions that have occurred in this region, in the Charleston area. On the Stono, the Board determined that a marina expansion was permissible, and this was in a water body that does not meet standards all of the time. On the Edisto, the Board said that for water quality reasons you couldn't have a marina in that water body, and that is in a water body that does meet standards all the time. And that's a little bit of an over-simplification, but on the face of it, it sounds backwards, and I think that there are a number of points that come out of this particular activity.

The first one is that we don't seem to have a firm set of criteria for marinas, that's based on sound and rational principles and that is applied uniformly. At least we don't have one that everybody can understand very easily.

The second one is that this is a good situation for lawyers, because you've got situations where the staff makes a technical assessment recommending one thing, the Board turns around and does something else in two different cases on that basis -- it provides an excellent means to challenge either of those decisions or the next few that come back down the line. The question is: on what basis are these decisions being made?

The third one is that there's no management. In this case, there's no coordination between the decision makers within DHEC and the staff. At lunch today, I was privy to a conversation which says "this is coming," and, in fact, is being put in place. And I don't mean to pick on DHEC on this one, and the note that I have here is that I could have used a Coastal Council example over the past few months instead of a DHEC example. This is true with all of our regulatory agencies, a question of whether or not there is internal management as well as looking at the resources.

The next one is using the data that's available. Back five or six months ago, Sea Grant called a meeting of all of the state agencies and federal agencies in South Carolina that are involved in resource-related decisions on the coast. So everybody got together in a big room, long table, and these are the kind of questions that people were asked and began to ask each other. What kinds of projects are you working on? What kind of data do you have? What kind of computer do you have? What kind of software is your data expressed in? And can my computer interact with your computer to get your data? The point is that the agencies that are involved in resource management, each of them has its own little compartment, has its own focus and its own project. They don't know what the others are doing, and if they do know what the others are doing, they're not always able to interact with each other and take advantage of the work that the other agencies have done, and this can be on as basic a level as whether or not the computer software is compatible. If it's not, there's no interaction. And that means that you are far away from any kind of management framework.

The last one involves coordination of data; this is a good and bad DHEC one, the bad part may not be warranted, and folks sitting right up here can tell me to stop. DHEC and United States Geological Survey (USGS) are doing a program that began in the Waccamaw River a couple of years ago that's been expanded to the Ashley River here, putting in real-time continuous monitors in the river to ascertain exactly what water quality conditions are and to begin to get a handle on the impact of storm water on water quality. This

is something that's been needed for a long time, it's something that DHEC is able to do only on a limited basis, because they don't have very much money for the program. And, for example, the Council of Governments thinks this is just a wonderful idea, it should happen in all the river systems, and DHEC doesn't have that capability. What it does, is it provides, as I understand it, information on some parameters of water quality, once every ten minutes; it's telemetry read. Now, the old way of getting information was once every month. So there's a lot of difference between once every ten minutes and once a month. And this is going to produce some real data that's going to be very useful in assessments of water quality and in the beginnings of the management framework. Now that's the good side. The bad side (and this was true up until a year or so ago anyway, it may still be true) is that although DHEC and USGS are cooperating on this project, in the Cooper River, the one next door, USGS has monitors in that river and DHEC doesn't use that information in its water quality programs. Now, I don't know if that's still true, I know it was. Although we are coordinating in some ways, there are other ways in which we're not.

Well, there have been meaningful actions, though, and we are at least on the road to estuarine management if we decide that's the course that we really want to take. There are a couple of examples. The first one is an informal one. It's what's been termed a "fish kill committee," although they want to come up with a different name. And it's an informal inter-agency process in which all of the entities that are involved in the coastal area with matters that involve fish kill, which means all the environmental people, all the agriculture folks, governmental as well as some private people, as well as farmers, have gotten together and tried to assess what problems there are in response to particular situations. Those of you who have followed the course of fish kills in the Charleston area will note that in Leadenwah Creek, which is a tributary of the North Edisto, there was no fish kill this summer. And that's attributable to the actions this particular committee took, which involved getting a one-year trial, conditional approval, of a new pesticide to use on the tomato fields. That's not the typical kind of action you think of when you think of estuarine management, but change in tomato pesticides, and working with the farmer, made a big difference in that estuary this year.

The second one, I think the largest effort that's gone on in the Charleston area, with respect to estuarine management, is the development or the updating of the Regional Water Quality Management Plan that the Council of Governments has undertaken. This has been a 2½-year effort, it's been funded jointly by DHEC, Coastal Council, and the Council of Governments (C.O.G.). And it's involved a comprehensive (in one sense, what it did is to update the old 208 Plan) plan that looked at water quality generally, as well as updating conditions, that type of thing.

But the other thing that the Plan did is it took a really comprehensive evaluation, one that really had not been done before in the Charleston area. And it looked at a number of things — it looked at what the resources were, not just the water resources, but the resources associated with the estuarine systems as well as the land systems. It looked at what causes changes to these resources. And in the Charleston area what causes changes to the resources is growth, and the spin-offs of growth, such as increased discharge of waste water, increased discharges of storm water, on and on.

It looked at growth in terms of where it's occurring, how much it's occurring, and projections of where and how much it's going to occur when, what development patterns will look like in 1990 and in 1995, and in 2000, and off into the future. The plan looked at the same thing for sewage discharge: how much sewer, how much waste water is going to be generated in the region, where, from what types of developments, how can it be discharged over the same period of time? What are the demands being placed on the system? And then looking at how those demands can be met. It identified issues that relate to water quality in the region — what issues are important here? And, for example, one of those is storm water that has not been addressed in very much detail.

One of the things I was glad to see was the approach that has been taken both in the Florida and Chesapeake examples, of looking at drainage basins as opposed to just looking at the water bodies themselves, which validates what we've been doing. Most people, I would suspect, in the Charleston area, don't know where the drainage basins are for our rivers. For example, everybody hopefully knows where the Stono is. And you think of the Stono drainage basin as being John's Island and a little bit of James Island, but the major portion of the Stono drainage basin is West Ashley; almost all of West Ashley drains into the Stono. Similarly, you assume that the drainage basin for the Ashley is right around where the river is. But the greatest proportion of the drainage basin for the Ashley River is going up in Berkeley County, up towards Lake Moultrie. The basins are not necessarily where you think they are, and you have to know where the basins are, where your water is coming from before you can come up with any kind of realistic management framework for water quality. That's what this plan has done.

Now, having looked at those issues, the C.O.G. Plan has evaluated various alternatives, again focusing both on water quality and looking particularly at the questions involving growth and sewage. And it's developed strategies and policies that will help clean up the rivers that need cleaning up, where the water quality is currently below state standards. To keep water quality standards from being violated as the region continues to grow, and to accommodate growth — to make sure that when growth occurs, particularly with respect to waste water, that there are adequate sewage plans and facilities in place to accommodate it. What's been developed is a product, a framework, for decisions, so that policies are in place. Decisions will need to be made over the next five years or ten years or fifteen years, and we must have a framework there that can guide those decisions. Now, there is a problem in the C.O.G. program that bothers me, and it bothers a lot of other people, which is: Are we necessarily looking at the right parameters when we come up with this decision framework? The spectre that I see is that we end up with "clean" water, with clean in quotes, and no critters in the water. Are we looking at the right parameters, are we regulating the right things, are we regulating the right parameters? Those are questions that we don't have answers to, because we don't have enough data, and it points out that although activities like the C.O.G. Water Quality Plan are a good first and second step, and are a necessary step to meaningful estuarine management, that, in and of itself isn't estuarine management, it's not enough — there needs to be more.

The third kind of meaningful action that's going on involves local governments in this region. It involves the imposition of land use controls, and the imposition of a variety of performance-related techniques that relate to storm water runoff and drainage. There is a proliferation of these management frameworks among cities and counties all up and down South Carolina's coast to manage land development, and most of these have a natural resource orientation and environmental quality orientation, at least to some degree. Meaningful action by local governments as opposed to state or federal management agencies or regulatory agencies....action, again, by local governments is the only really effective way of controlling runoff (when we say "runoff," we're talking about storm water). The suspicion that's come out of the C.O.G. Plan that other people have talked about is that in an impacted or developed estuarine system, such as the Charleston system, storm water is what we have to worry about, because the area's going to continue to develop, storm water is getting worse, we have sewered most of the region, and the water quality has not gotten better. In the Charleston region over the last ten years, we must have spent 200 million dollars putting in sewer systems, and water quality hasn't gotten any better (it hasn't gotten worse, but it hasn't gotten better). And if it's not going to get better by putting in sewers, then what's going to happen gradually over time as we continue to develop more and more? That cites the need for estuarine management.

Well, again, specifically talking about the Charleston Harbor system, there's a ray of hope on the horizon, and that's the National Estuaries Program that came out of the Water Act this year, 1987. The Governor has nominated Charleston Harbor for inclusion in this system, the nomination has not yet been acted upon, but if Charleston Harbor is included in this system, then there would be an impetus and money and attention focused on Charleston Harbor that could make it a model for all of South Carolina's estuaries to begin to do some real estuarine management. And it's important, not just for Charleston, but for every other estuarine system in the state, because you're talking about largely the same group of people, certainly at the state and federal levels, interacting with each other for purposes of management. And if they can do that in Charleston, they can do that in every other estuarine system in the state. This is a real possibility, but it means we have to cooperate, and it means we have to coordinate -- most everybody who's been in South Carolina for a while knows that there are lots of turf battles, lots of concern about who's in charge. Frequently, that takes precedence over what we do; and if we allow those kinds of concerns to be paramount in the minds of the agencies, state and federal and local jurisdictions, instead of looking at the need for estuarine management and how we can work together, then we're not going to get it. I might add that the first meeting of all, or at least many, of the affected interests that could be involved in the beginnings of putting together this program is going to be held next week, and I hope that that will be the first in a series of meetings that will lead Charleston Harbor into inclusion in that system. But we'll have to see. The caveat is that Charleston is not the only potential nominee for inclusion, there are other systems in Georgia and North Carolina in which a lot more of the basic work needed for successful nomination has already been done, and we're lagging behind.

I think, in conclusion, let me say, that we have the components of estuarine management in South Carolina, if we choose to use them, if we choose to put them together, if we choose to cooperate with each other. We haven't done that yet, and I don't think we're going to do that, until the public lets the governmental and private decision makers know that that's something that the public wants to have happen. The public has been, I think, the key mover behind all of the water quality improvements that have been made over the past few years, the public still has an important role. So at this point, for all of you who are from South Carolina and involved or interested in estuaries in South Carolina, let me congratulate you all for coming, commend you for that, and charge you with going out into the world and working for estuarine management. Thank you.

**MARGARET DAVIDSON:** Are there any questions for the estuarine managers? Yes.

**A SPECTATOR:** It's my understanding that some states' coastal management systems provide for development which allows filling of wetlands, if new wetlands are built; and I wondered if these wetlands are being built and if there's any data as to whether they're viable or unproductive.

**DIANE BARILE:** There's some in Florida, there have been some successful ones in the Florida Keys, in Biscayne Bay, and there's a study going on right now in Tampa Bay. It hasn't been tried in the Indian River yet, that's something I'm looking at. The Indian River Lagoon plan calls for a replacement of those areas two to one, as a mitigation criteria if you impact a wetland, you have to replace it two to one, either elsewhere or on that site. But that hasn't been adopted throughout the state, but there are restoration programs that have been undertaken as a result of the enforcement program.

**WILLIAM BAKER:** The only thing I'd add, I agree with all that, is that I'm not interested in allowing you to be able to buy your way into destroying wetlands by saying, we'll re-create wetlands somewhere else. I think mitigation should only be used as a last resort, and should be required. If you want more information about the technical aspects of it, a fellow named Ed Garbish, in a company called Environmental Concern in St. Michaels, Maryland, is doing more work on the East Coast in wetlands re-creation than anybody else. Just write Environmental Concern, St. Michaels, Maryland, and they'll send you more information than you want. He's also non-profit.

**WILLIAM DREYFOOS:** Let me add that the South Carolina Coastal Council does use mitigation as one of the rules that's available in its permitting process, and you should contact Coastal Council staff for more information on a technical basis in terms of how that concept or technique is being used here.

**DIANE BARILE:** There is some question, too, as to the viability of restored wetlands, and there are studies being done to compare restored wetlands to natural wetlands to see if indeed they fulfill the function of

their alleged performance.

**WILLIAM BAKER:** If I could give just one more thought. None of us really talked about freshwater wetlands, there ought to be the thought that filling and destroying freshwater wetlands is just as bad for the estuary and coastal environments as tidal wetlands. I understand you have a bill in front of your General Assembly this year, each and every one of you ought to do everything you can to support it -- we're trying to get the same legislation passed in Maryland and Virginia.

**MARGARET DAVIDSON:** Any other questions? Yes.

**A SPECTATOR:** The increased stress in the future, with population growth, everybody wanting to have boats, and the need for new marinas, it seems to be a thorny problem, and I was wondering if we have some areas of, say, relatively degraded waters where we could still build new marinas to keep our boaters happy, without degrading the water quality further. I'm just curious if any of you knew a little bit about that?

**WILLIAM DREYFOOS:** Well, there are a number of proposals for new marinas in coastal South Carolina. Some of them are controversial when they're proposed for SA or SAA waters, others are not. For example, Patriot's Point is planning a large new marina that's in class SC water, I'm not aware that anybody has raised any major water quality type of concerns about that. One of the new trends that's going on along the coast is dry stack marinas, or dry stack storage facilities in which boats are not housed in the water on a permanent basis. Particularly in North Carolina, that approach is being promoted as a way of increasing boaters' access to the water, increasing the number of boaters that can easily get their boats into the water without having a proliferation of marinas. There have been a few in South Carolina, but not very many yet.

**MARGARET DAVIDSON:** More?

**A SPECTATOR:** I'd like to make a comment; I don't keep a boat in a marina, I use a canoe, but I think what we need to do is call marinas wet storage as opposed to dry storage of boats. When I drive by marinas, I've never seen a marina that looks like more than two or three boats are out being used; it seems like it is a wet storage area. And I would think that it would be an advantage to have your boat out of the water in a dry storage area.

**MARGARET DAVIDSON:** I think that it does reduce some maintenance costs. Other questions out there? Yes, sir.

**A SPECTATOR:** It's my understanding that the C.O.G. study has shown that the predicted nutrient levels in the sub-basins of the Stono and the Wando and the Ashley are such that at these predicted levels, these sub-basins will not meet their water standards, unless a portion of this pollution is discharged elsewhere. Points of discharge for all these basins is going to be lower Charleston Harbor, either through the existing Plum Island sewage treatment plant, or through the planned sewage treatment plant over on Mt. Pleasant. And I wonder if there's anybody down there who'd like to comment on the effect that this concentration of sewage effluent, say all

the way from Awendaw to Ravenel, would have on the waters of Charleston Harbor, and its chances as a national estuary program nominee.

**WILLIAM DREYFOOS:** The first part of the question is somewhat inaccurate, because the C.O.G. plan has not yet been adopted. The findings in the C.O.G. study going back over a couple of years, indicate that there are some problems with, potential problems with water quality discharges in some of the streams. But discharges are discouraged from some streams for reasons other than solely water quality. For example, in the Wando River, one of the reasons to discourage discharges in the Wando is that there are attempts being made to reopen shellfish areas; discharges might be acceptable purely for ambient water quality conditions, but in some areas it might jeopardize shellfish harvest. The C.O.G. plan focuses on alternatives: what alternatives are available to discharges at any location, what of these are environmentally preferable alternatives, and are they economically feasible? The framework of the C.O.G. is looking at arguments that when there are these alternatives that are environmentally preferable and economically feasible, these ought to be the ones that are selected. There is a tendency in the overall plan to concentrate discharges not necessarily in Charleston Harbor itself, but in the lower portion of the Charleston Harbor system, or the metropolitan Charleston area. And that may or may not end up having a water quality problem in terms of modeling and monitoring work that's been done by DHEC, which is extensive and the basis of all the monitoring and modeling. It was state-of-the-art when it was done in the late seventies, and the state of that art has not changed too much, so we're still talking pretty close to state-of-the-art kind of work. All of the indications are that at the levels of discharge that we're talking about, that there is more than enough assimilative capacity within that system in the areas in which the discharges are proposed, to handle all those discharges without seeing marginal decreases in water quality. It's certainly an area for concern, it's something that all of the regulatory and management agencies will be looking at, but the alternative is to put discharges into the small, upper portions of river systems which simply can't handle them. And you're looking at, really, destroying many of the rivers, the smaller river systems by using that alternative, so that's not a feasible alternative. The C.O.G. is also looking at other systems, and DHEC is requiring jurisdiction to look at other alternatives, such as land application of treated wastewater for new systems. So there are a variety of new approaches that are being attempted.

**WILLIAM BAKER:** Just a quick comment on sewage treatment plants—thank God for them, because think of the alternative. But, they're only as good as they're operated, and they're only as good as their permit, and there are a variety of levels of permitting that you can apply to a sewage treatment plant. It's very easy to check whether they're in compliance with their permit -- they're required to file monthly discharge monitoring reports, probably with your state health department, and you can go in and request copies of those of the sewage treatment plants near you, and we, for instance, compile annual reports called "The Good, the Bad, and the Ugly" on all the state sewage treatment plants, and show people which ones are out of compliance. Many of them are out of compliance over six months of the year. You get that information, you get it in the paper, and you'll find out that the local elected officials in that area will start to say, "Get your act cleaned up — I don't like the bad publicity."

MARGARET DAVIDSON: We're not going to take any more questions, because of two reasons. We're going to have a break in just a minute, and I again remind you that there will be an informal reception after this symposium, a couple of blocks down the street at the Consortium's offices. Diane, I believe, has a final comment that she would like to make before we take our 10-minute break. Diane?

DIANE BARILE: We started on this, talking about the "siege," and the question was, you know, who's directing the siege? Who is it? And I think you'd have to look back to Pogo, who said, "We have met the enemy, and he is us." And, I'm not sure that you're having a siege, but self-destruct. So what you need in managing estuaries, is that constituency of people who feel that they are responsible, and that they need to do something. I've got a quote here, that says that "we can't push somebody up the ladder who doesn't want to climb." And a person who doesn't climb is the enemy. So your job, if you're just beginning in coastal management, is to get everybody who's involved to have a stake, and get them all willing to climb, and then you'll all be able to go up the ladder. And part of that is diplomacy, tact, and manners. It's the art of making a point without making the other guy the enemy. Because in estuaries, we're all the enemy.

MARGARET DAVIDSON: We're going to have, I think, a really exciting panel in about 10 minutes, so you might want to stand up, grab a quick break, and we'll try to bring you back fairly soon.

--- BREAK ---

MARGARET DAVIDSON: I want to make a comment before we start this last session, sort of as a follow-up to Bill Dreyfoos' comments. There has been a nomination of Charleston Harbor that has gone forward to the Environmental Protection Agency, and that nomination and the responsibility for sort of shepherding that nomination and carrying out that nomination, if successful, into a management program is going to fall most squarely on the shoulders of DHEC, and we're hoping that the rest of the state agencies that have some concern with coastal and environmental issues will provide the communication and support that DHEC's going to need in order to carry out a rather responsible task. And so, I just wanted to let you all know that, and encourage you to support DHEC's effort in this regard, in terms of getting the General Assembly excited about this possibility, because, ultimately, the state, including the Governor and the Legislature has to express their commitment, not only to DHEC, but also to the concept of the nomination and provide state enthusiasm to breed state support to the effort.

I think we've saved the best for last, or at least we've certainly saved the most interesting for last. We've talked about what is an estuary, what happens to an estuary, and what some folks do with an estuary. This panel was sort of put together with an eye to what really might be possible with the estuaries here in South Carolina. South Carolina estuaries were under siege in the Revolutionary War, they were under siege in the Civil War, and we drew the title because we felt that they were under siege during the remarkable coastal development that has occurred, particularly in the last fifteen years. What these gentlemen are going to address, I hope, is



how we line up the battalions, and which way they're going to march in the future.

To do this, we're going to go to a different format. We've got a fellow here, Dr. John Mark Dean, from the University of South Carolina, he's a professor of marine science, and he's been very much involved with coastal and resource management issues in South Carolina. I'm actually going to disappear, and he's going to be the moderator, he's going to keep these people on track, and ask them some questions, and also work with you to ask them some questions. Before I disappear, let me introduce the rest of the panel.

The first panelist is Lee DeHihns, who is the Acting Regional Administrator for the Environmental Protection Agency, Region IV. He's located in Atlanta; we won't hold that against him, because he's a native of Columbia, and he's also a lawyer. He and I actually chatted not long ago about the fact that we were both rehabilitated lawyers.

The fellow sitting next to him is Harry Hallman, who represents the First District (read the coast) on the South Carolina Board of Health and Environmental Control. Mr. Hallman is a businessman who's served on the State Development Board and a variety of other state boards. He's active in civic matters, and particularly interested in water quality issues in the coastal zone.

Next to Harry is Dr. Wayne Beam, Executive Director of the Coastal Council. Wayne's been involved with coastal issues for more than a decade now. He was first with the Wildlife Department before he got involved with the Land Resources Commission, before he got involved with the Coastal Council, and I think he's even a native of South Carolina, as I recall, at least he got a degree from Clemson.

The next fellow is Don Welch, who is the Director of the State Ports Authority. And Don actually has been around here for about fifteen years or so. He used to work in a place called Ohio. Currently, he serves on the Board of Directors of the American Association of Ports Authorities, he used to be the Chairman, and he certainly knows how to get a port moving—the South Carolina Port System is now one of the major ports on the East Coast, and coming up fast.

Seated by him is a fellow named Col. Gene Foxworth, who's also known for being in the House of Representatives and attacking a host of controversial issues. He is, of course, a retired U.S. Marine officer, and he's not afraid to pick a fight with anybody.

And last is somebody who's not afraid to pick too many fights, Charlie Sweatt. Charlie lives on Sullivan's Island, he was a member of the recent Blue Ribbon Committee on Beachfront Management. Charlie's been involved with environmental planning on a variety of local, county and state levels, and he's a general environmental thorn in many peoples' sides. And with that, I'm going to turn the program over to John Mark Dean.

## PANEL DISCUSSION: TOWARDS A FUTURE POLICY

JOHN MARK DEAN: Thank you, Margaret. I would suggest that, for those of you who are still with us, that we've gone through the shrimp dip hors d'oeuvres, had the she-crab soup, and we're now ready for the oyster pie. And Margaret's going to deliver the dessert at her place at the Sea Grant Consortium afterwards. What I mean by that is that the format for this is going to be a series of questions directed to the panel, to each individual member, and they'll have five minutes to answer that question, and then we'll go to the floor. We solicited some questions from some people whom we knew were knowledgeable and involved and interested, and synthesized that so we have a starting base to go from. After this first round of questions, we'll then go to the floor for participation.

The first question is directed to Mr. Dehins of the U.S. Environmental Protection Agency (EPA): What is EPA's interest in estuaries? Is it only triggered by a significantly degraded system, i.e. the Chesapeake Bay (capitalize Bay), or does EPA have a management role in lesser degraded systems, or undisturbed systems?

LEE A. DEHINS, III: First of all, I'm happy to be here today in Charleston, and even though I'm on this panel this afternoon, I've attended most of the session throughout the day, and have been really pleased. I've learned a lot that I didn't know before I came here today. But I also spent quite a bit of time in the area yesterday, in a meeting concerning a particular estuarine area in the state called North Inlet. I'd be happy to share with you how that discussion ended another time.

But the question of what is EPA's interest in estuaries, really is both a voluntary and involuntary interest. The involuntary part comes from the fact that the Congress of the United States has passed a measure this year, twice over the veto of our President, that requires the EPA to establish a National Estuary Program. Now this is something that we've already had the beginnings of, through prior appropriations, but not through any legislative mandate that was directly oriented towards estuaries. But again, as you heard throughout the day, there are many programs that have been in effect for a long time, and continue to be in effect, that are both regulatory and non-regulatory, that can be used to protect the quality of an estuary. Non-point source programs, best management practices, NPDES permits, 404 permits, 208 plans, and other kinds of water strategies that many states and communities around the country have been using as a model for decision making for a number of years. What Diane Barile talked about in the last panel, what they were doing down on the Indian River Lagoon, those are the kinds of activities that have been underway for some time without the national impetus through the legislation. And that's the involuntary part, if you will, not involuntary that we are unwilling to do it, but involuntary in the sense that it's a program that Congress has told us it wants to see us manage.

The voluntary part comes from activities that we in the regional offices and headquarters as well, have been carrying out for some time in many estuarine areas all over the country. In our region of the country, EPA Region IV, headquartered in Atlanta, we work with eight southeastern

states, and our coastal area, in terms of the estuarine areas, starts at the Virginia/North Carolina border, and goes all the way around to the Mississippi/Louisiana border. So if you just can envision in your mind that length of coastline, you're thinking about miles and miles of the coastline in acreage and square miles of estuaries. Not to mention all the freshwater flow, freshwater wetland areas and freshwater ecosystems that are a part of those areas, all of that comes within the territory that we work with.

As to the issue of "Do we only look at degraded estuarine areas? Do we also look at any areas that are essentially undisturbed?", the answer to that question is a two-part answer. Part of it is that the old theory that the squeaky wheel gets the grease, certainly applies in areas like the Chesapeake Bay, Puget Sound, Boston Harbor, and places of that ilk, simply because of the national commitment to those estuaries. You heard all the data about the Chesapeake Bay from Mr. Baker, I don't need to repeat that to let you know that that is a significant body of water and system. That area is being studied, and that got attention nationally because of degradation and because of the need to attend to that degradation and to try to reverse it to the extent that we can do that. The nomination of many other areas in the country, and there are eleven that are mentioned specifically in the Clean Water Act Amendments, those areas certainly have the right to receive priority attention, the law requires that they receive priority attention, because those areas have a varying degree of concern and/or degradation. And those areas will have to get some priority attention by EPA because we'd best begin with what the law dictates.

Charleston Harbor is not one of the areas that was listed in the Clean Water Act Amendments, but it's an area that EPA, both in a regional level and on the national level, under the leadership of Lee Thomas, another South Carolina native, that EPA will take a look at very seriously and work closely and cooperatively not only with all of the state agencies involved, but with our other sister/fellow agencies represented here today as well-- by Roger Banks from U.S. Fish and Wildlife, Col. Bornhoft from the Corps of Engineers, the National Marine Fisheries Service, and many other fellow agencies. We'll work with them, we'll work with assistance groups, we'll work with groups like the Coastal Council and all the other state agencies. We're willing to do that, we want to work on that. The time frame we're talking about is very short, however. As a practical matter, when you look forward to a presidential election and a change of administrations and a time of decision making in EPA, whether or not Lee Thomas is from South Carolina, there's a certain limited number of decisions that an administrator of EPA can make in the amount of time that remains in his tenure. And you're talking about an administrator of EPA right now who has twelve to thirteen months of effective time remaining in the job before he is no longer going to be able to make decisions that will have to be put off until the next administration. So, not only Charleston Harbor, but all the other estuaries that have been nominated or are seeking nominations as designations as national estuaries, are going to have to move rapidly, are going to have to move in a serious way to get these areas nominated and approved for five-year management plans.

Let me make just one final answer to the question that John posed, and that is we're not only concerned about the degraded estuaries, we're con-

cerned about the entire South Carolina coast. There are many pristine areas on the South Carolina coast that are not now degraded, and perhaps should not be degraded. North Inlet, the Baruch Institute area we looked at yesterday, and the discussions we had. This area is not degraded, but is of concern to us as to what the quality of that estuary continues to be. So we're concerned about all estuaries, but like any other organization, we have limited staff, and limited time to look at all areas, and we can't look at every area to the same extent, and obviously the areas that are degraded get priority attention.

**JOHN MARK DEAN:** Thank you very much. Mr. Hallman: Who is responsible for the water quality of our South Carolina estuaries? What is the mechanism by which DHEC plans for evaluation of water quality, not only on a permit-by-permit basis, but on an estuarine systems basis?

**HARRY M. HALLMAN, JR.:** Well, the South Carolina Legislature by way of the Pollution Control Act, has given statutory authority to the Department of Health and Environmental Control and made them responsible for clean water in the state of South Carolina. We like to think that we've got an outstanding staff, they're all very talented, they work hard at monitoring all the waters of the state to make sure that we've got pure, clean water, including the estuarine systems. We recognize that there are others involved in clean water in the state. Certainly the Coastal Council along the coast is very involved in clean water. Water Resources, the Wildlife Department, the public, and most certainly the public. Everyone is responsible for clean water. It's everybody's responsibility. We just happen to be the agency that's charged with the lead role. Our agency is working very closely with the C.O.G. in developing management programs for the rivers in this area, and we're working closely with the Coastal Council now.

And let me just tell you why I think it was necessary for us to work closely with the Coastal Council; we sort of backed into this role, it's wholeheartedly supported by every board member at DHEC, and every member of our staff. Nobody is opposed to having a cooperative effort. As most of you know, here recently we made a decision not to put a marina in a body of water, the Edisto River. And we realized that we live in an area where there is tremendous growth, where boating is something that everyone enjoys who comes to this state. And we realized early on that we were going to have to cooperate and try to send positive signals out as to what areas are acceptable for marinas. We had made a motion at one of our board meetings and asked our staff to work closely with the Coastal Council to do some long-range planning to identify areas that are acceptable for marinas. And since we've started that effort, we now realize that it's very important that we work with the other agencies responsible for water quality, Water Resources, the Wildlife Department, and the C.O.G. -- we're doing that. And we think out of that we're going to get some good resolve to problems.

I'm concerned that this be a cooperative effort. It's vitally important that it be a cooperative effort. If our board could just sit down with the board of the Coastal Council and our staffs, I think we could better understand the problems that each agency has. Not intrude in the decision-making process of those other agencies that are involved, but just to understand what they're doing, and let them understand what we're doing.

We feel like that's important. We feel like it's important that we sit down with all the agencies in the state and let them know what we're doing and let us understand what they're doing. I think by doing that, we realize that there are certain loads under which a body of water is going to reach a saturation point. And out of the bodies of water that we have in the state, there are economic benefits to be derived. If we alone sit in judgement on every 401 water quality permit that comes before our agency, and we do it on a first-come, first-serve basis, then pretty soon we're going to have a cumulative effect and we'll be doing nothing more than serving as a barometer that we've reached a saturation point.

I think by working closely with the other agencies involved in the state in developing good management plans, that we can be selective in approving 401 water quality permits. and we can get quality programs, we can get quality projects that would mean something to this state economically. And we can work close enough with the other agencies to identify sites that are acceptable for marinas so that we can begin to do long-range plans and understand where we want to go collectively. We've got clean water, we really do have clean water compared to other areas, but we don't need to sit still. We've got to plan and work hard and coordinate our activity to make sure that we get the maximum out of each water quality permit that we issue. I think there's a strong commitment on the part of Governor Campbell's administration, and his staff, to coordinate the activity amongst the boards and the staff of the agencies involved in clean water, and from my agency's standpoint, without exception, our board has been very, very receptive to a cooperative effort, without exception. It's not a partisan political issue. Every man, without exception, on our board is totally committed to good water in this state, our staff's totally committed, so I think by working together, we're going to, we'll have an opportunity to impact what we're doing jointly in our cooperative efforts.

**JOHN MARK DEAN:** That really leads us directly to the next question, Dr. Beam, which is, "What is the role of Coastal Council in management of estuarine water quality on a case-by-case basis? Is it possible that DHEC certify an effluent discharge and Coastal Council deny the permit because of estuarine concerns?"

**DR. H. WAYNE BEAM:** Thank you, John. Before I answer that, I would like to go on record with Mr. Hallman in saying that if DHEC would host a barbecue or something, I think our Board would be glad to come. We have talked with the DHEC people in the past, and I think what Mr. Hallman's indicated is certainly a worthwhile goal, that is, to get our boards together, and our staffs do work, I would say, very closely together on a lot of projects in this state, especially marinas and some of the other areas that are of vital importance to the coast. But we certainly would welcome an opportunity to get together with the DHEC Board, I think our board will certainly be discussing that more in the future.

Directed to the question that Dr. Dean posed, the Coastal Council administers the Coastal Management Program in this state, which has a definite set of policies which address activities that have direct and significant impact on coastal resources. This is through our direct permitting program; those policies address things like dredging, boat ramps, marinas, the full gamut, and our policies basically are that the

Coastal Council is supposed to not only restore but enhance water quality in the coastal zone. And we have to look at it in the context that the law requires, and the Federal law requires, that we look at environmental quality as well as the overall economic benefit to the state of South Carolina and the citizens. So, therefore, there exists a lot of gray areas and people become polarized very rapidly in the process, those who are concerned by economic development and those who are concerned by environmental quality and preservation of environmental quality. For that reason, the Coastal Program in Washington, of course, is headquartered in the Commerce Department, it's not headquartered in the Department of the Interior like some people might want to believe. Therefore, it is a balancing program and, unfortunately, a lot of people don't understand that. The program is not set up to create an estuarine sanctuary throughout the State of South Carolina. It's created to assimilate growth properly, well-managed growth, supposedly, into the coast of this state. That causes a great number of people a great deal of consternation. We're trying to reconcile that difference that's right there on the surface; it's almost an impossible task, as I think most of you would probably admit.

On to some of the other things that the Coastal Council is doing thus far, namely our certification program working with other agencies as Mr. Hallman indicated. I would submit that we're the only agency working specifically with DHEC, that is, doing anything about storm water management in the state in the coastal zone. Storm water management, these permits for activities that require DHEC permits, our staff has to work with them in order to certify that project. We require a Storm Water Management Plan, and I think over the long haul in this coastal zone, that in itself is going to be significant in restoring and enhancing the water quality.

The other issue that was raised by Dr. Dean was that of could DHEC certify an effluent discharge through NPDES and the Coastal Council deny that. The answer to that is yes, we can and we have, in fact, made our intentions known to DHEC that we were not going to certify certain NPDES permits, specifically on the Stono River. Two or three years ago, there were some discharges up there, especially some domestic waste treatment effluents that were to be sanctioned by an NPDES permit. This went on NPDES public notices, and the Coastal Council worked with DHEC and we were able, I believe to move those, especially one of them was moved to the Ashley River, where they had some more assimilative capacity. And also I will submit that our early involvement in the Hilton Head waste water management scheme down there, and I worked with DHEC, did in fact result in, if there's ever a discharge in the Calibogue Sound or Port Royal, advanced treatment, tertiary treatment, rather than secondary treatment.

So that is a basic wrap-up of where we go in view of our role in estuarine water quality, Dr. Dean.

**JOHN MARK DEAN:** Thank you, Dr. Beam. Now for Mr. Welch. How are the State Ports Authority's future plans impacted by other development, specifically residential or industrial activities, which might contribute to the degradation of water quality of an estuary?

W. DON WELCH: I'm just speculating on this, possibly the last year that there was tranquility and no pollution in Charleston Harbor was the year 1669. Now I couldn't prove that for sure, because I'm not quite sure what the Indian's sanitary habits were. But three things happened immediately when the white man showed up here: Charleston became a sea port, and it's been one for 317 years. The lands in and around Charleston Harbor started the process of alteration, change, from what they were. And competition started over the use of those lands, between the people. And not a heck of a lot has changed since 1670, has it? We're still in the process of evolution in this area, looking for the best solutions from a number of different points of view.

Now what drives us? That's important. I give you just a few statistics that I think will make it clear. What drives us is economics. There're 7,000 jobs clustered around Charleston on the commercial side of the seaport. There are 116,000 jobs in the state of South Carolina that relate to the existence of the seaport. That ties together with over 5 million tons of cargo moving through the port system, valued at more than \$8 billion a year. Tie together a half a billion, \$500 million investment in port facilities, and you'll get some idea what drives us. We are dedicated to the operation of the seaport, our legislature specifies that we have to be, we develop, we construct, we operate and promote. You go right back to 1942, when the legislation was drawn that created the Ports Authority. It also gave us another little useful tool that in the event of overly significant controversy, we would have the power of eminent domain. And that still continues. We have used it rarely, we don't want to use it, but we do have it. And we're not without concern for the environment, maybe in some quarters there may be disagreement with that. But what are all of these competing elements? -- residential, recreational (that includes the marinas, there's been a lot of talk about that), industrial, military, and the commercial port.

A little profile -- we did a little survey of potentially developable navigation, for deep navigation land mass in the Charleston Harbor. Not everywhere, because it isn't potentially developable. 63% of it is owned by the Navy. 16% is owned by the Ports Authority, the balance of it is in private hands. Some of which is developed and some of which remains to be developed. That gives you an order of magnitude of what the land ownership pattern is here in this harbor. Now everytime the Ports Authority needs to do anything, we pop up against someone, and there's no doubt or no question about it. We try to be good citizens. We are aware of the environmental impacts of our operation in this area. We do several things that you may or may not be aware of to try to mitigate that. One of the things, literally, we try to do is avoid building new facilities. We develop to the most intensive, "through-put capacity" we can the existing facilities that we have. We're in the process of spending fifteen million dollars to re-develop the Columbus Creek Terminal, we've just completed a seventeen million dollar program for the North Charleston Terminal, all of it re-developed. We have built one new facility in the last fifteen years, that's the Wando Terminal. It was clearly impossible for us at any of our other locations to expand. Had we chosen to expand in the peninsula of Charleston, we would have had to condemn land all the way from the Cooper River to the Ashley River, crossing the peninsula. So the nature of port operations today are totally different -- it requires large areas of land.

We had to move away from the metropolitan, high density, populated area. We moved to the Wando not without controversy. But it works.

Now one of the things we did at the Wando, as an environmental protection measure, I'm going to ask my friend Charlie Sweatt to describe, not me. We've done a number of things to avoid further impacts on the estuary, if you want to call it that, I call it a harbor. You know what a harbor is? It's a refuge, a place of refuge. It's not a seaport. A seaport is built within a harbor. A harbor is a place of refuge for all, it came from, I guess, the Greek. One thing we try to do is to minimize the "Mad Russian," and the "Mad Russian" is known as urban runoff. We have hundreds of acres of paved areas, and that'll tell you what our problem is. Thank you.

JOHN MARK DEAN: Thank you. Col. Foxworth, do you see our state agencies adequately addressing overall water quality in our estuarine systems, or should it be a legislative concern?

EUGENE D. FOXWORTH, JR.: Let me just say real quickly, I would never have thought ten years ago that I'd ever be sitting on a panel because I was a politician, and the guy who got me started in all of this, and sometimes I use his name in vain, was our good Congressman Arthur Ravenel, who just came in a few minutes ago. I can blame my heart attack on him, I can blame the loss of my hair, I can blame the disruption of my life, but nobody enjoys it any more than he and I do. He likes to battle, and I like to battle. He gave me good advice on how to get involved in the environment. He and Dana Beach and Margaret Davidson and Johnny Ohlandt have really taught me a lot. I thought I was an environmentalist to start with, but now I know I am, and I'm learning a little bit more about it every day.

I've been involved with all of those who have spoken, I've trusted all of them on this panel, including Charlie, at one time or another, and I think we've all tried to do the right thing. Sometimes a politician has to be a little bit more outspoken and maybe a little more emotional than these administrators do. But Don can tell you that when he was trying to deepen the channel down on Columbus Street not long ago, I got caught right between his staff and the Wildlife staff and I thought they might come to fisticuffs before it was over. But then when the Highway Department wants to close the bridge, what does the politician do? He has to again get involved in it, and it's not always popular. But both times I think we've come up with the right decision, because the port's important, and the water quality is important, and I do see that as time goes on, that the state legislature, not just South Carolina, after listening to some of the panelists today, have been negligent in setting standards. Dr. Dean pointed out yesterday, when we were meeting up in Columbia about beach erosion, that the more the legislature can give him guidance in the law that we write on that, the better off he can manage whatever we want to manage, or however we want him to manage the beach erosion.

So, the legislature does have to get involved, and it has to get involved sometimes after the fact, as well. When the pressure is brought on Dr. Dean by some other group, someone's got to take up for him. I happen to be the Chairman of the Wildlife Subcommittee, and I enjoy it tremendously, and I have nothing but respect, admiration and love for that Wildlife



Department, because they are some of the hardest working people I've ever come across. And I've spent my time, as you know, in the Marine Corps, and I thought we were dedicated. One of them is sitting up in the back, now, young Jane Settle, who's I don't know how many months pregnant, but here she is still playing a part in this — probably just came out of the marsh today, looking for something left after that oil spill down in Savannah. But the legislature has to write the laws, they have to write them the best they can, but the way we do it is by the input from the public.

I've got several bills up there that'll get me beat around the head, I can guarantee you, and I enjoy it. I can even here 'em say "Here comes that S.O.B." when I walk into a room now, you know, and particularly with the lobbyists. Some of the bills I've got up there that are really critical are the Wetlands Bill, the Beach Erosion Bill that I got started up there, and the Easement Bill — we've got to try to give more benefits to people who are willing to grant easements. But the most disappointing thing I've seen in the last three years up in the legislature happened to me this week on Tuesday, when I was with a group of supposedly friends of business people who were trying to help politicians learn how to raise money, how to address the issues, and so on, and they put a little slide up on the good people and the bad people, and on the bad people's side were environmentalists. Now, I tell you, I had to turn myself into the emergency room Tuesday night when I got home, 'cause I was so damn mad I knew I was getting ready to have another heart attack. But I went to them and told them, I said, "I don't want a penny, I don't want one penny, but if you think that because I'm an environmentalist, I'm not a friend of business, you don't understand the world." And it is tough, and sometimes you have to go one way or the other, but I'd rather not be re-elected than to cave into pressures from people who think they can buy me.

**JOHN MARK DEAN:** Well, we know why he's a politician. Charlie: given that the constituency for estuaries is ambiguous, how do you think public interest groups can be involved in estuarine management? And I think you have been well set up.

**CHARLIE SWEATT:** John, I don't think we can manage estuarine systems or any natural resource without public involvement. We have some very talented agencies in this state, but they come under political pressure. They cannot always do what they would like to do. They can't always do what the right thing is. We have a new day dawning in South Carolina. But there is still enough of that "Good ol' Boy" System left that's imbedded in the cracks, and until we get the cracks cleaned out and we sweep away the good ol' boys, the public is going to have to remain aware and cognizant of what's going on. And we'll never have a clean estuarine system, we'll never have anything worthwhile in this state without public involvement. The agencies cannot do it by themselves. I think this is apparent by what John McMillan told us this morning. He said go out and adopt a river. Let's think about doing that. Now, the Coastal Council has a Creek and Beach Watch program, let's do that. DHEC needs to get a program like that. Get the public involved in water quality. Water quality is something that is nebulous. To Don, water quality is enough of it that will float a vessel. To the city of Charleston, water quality is the Edisto River, where they get their drinking water; it's crucially important. But water quality in the Harbor to the city doesn't mean anything.

Now, let's think about that for a minute. Without public involvement, we have had some rotten decisions in the management of our estuarine systems. Lee DeHihns gave the example of North Inlet — that was a classic "good ol' boy" case. We had some developers, out of Columbia, not from the coast, but out of Columbia, that wanted to dredge salt marsh to create waterfront lots. They've gotten some of their permits. Those permits have been appealed. And I feel that they will be overturned. But why did they ever get them? Because the public didn't get involved quickly enough. It is only now that we're beginning to see the economic losses if we lose the National Science Foundation grants to Baruch, that people are taking notice. The public, some of these so-called environmentalists, said it's a bad idea. You're selling off our resources to a greedy few up there, that have just got political connections -- the lobbyists, if you will. There are some law firms in this state that make a living, not ever going to court, but just lobbying politicians and committees. Gene Foxworth was one man who had the courage to say that. Without the public, these self-serving good ol' boys will take everything you have. Everything. And what they don't squander, they'll put in a Bahamian bank somewhere. It's just gone, folks, it's gone forever.

Be active — participate. The agencies can't do it without you. And I cannot reiterate that enough. The Ports Authority is a good example. The Port Authority is not popular, there's no question about it. But let's look at what public pressure has done to bring cooperation between the Ports Authority and the so-called environmental community. The Wando Terminal— they didn't want it there, they don't want it there now, the people who live over there, but it is there. And it brings a lot of health to this local economy. A vessel passing over the water is completely, environmentally sound. There's nothing wrong with that. The Ports Authority has a large parking lot out there, and with it, storm water runoff (we've heard that over and over today in estuarine systems). The Ports Authority now has a quite sophisticated and well-working interceptor system that they treat their storm water runoff with from that parking lot. Now, would they have done that without public pressure? I would hope so, but maybe not. The point is...

(Mr. Welch: "We did - that was our idea, no one else's.")

I wasn't going to mention the agitation dredging. It didn't work, so I know we won't do that again. The point is, that public interest has brought the Ports Authority to a position where they are doing things that are not absolutely required. They're addressing non-point source. And I applaud them for that. And I would like to see the city of Charleston do the same thing. And until the city of Charleston comes up and says "We must meet the same standards that we expect of private development," then we're not going to have a quality estuarine system. And you're the only folks that can do it. Help the agencies. And with Mr. DeHihns' help and if EPA will give us this designation, give us some funding, funnel it through our Governor's Office, and between DHEC and the Coastal Council, I think that we can have an estuarine system here in Charleston that is second to none, and the economic impact of this system, from the Port, from the Navy, and recreation. Recreation is the biggest business in this state, folks. I'm not sure, but I think we've come to a stage where the environmentalists and the economists are working for the same things. Because the quality of our

natural resources are the number one industry in this state. And if we shoot it, it's gone. We've not only lost our birthright, but we're going to die poor. And our children will be poor. There won't be anything left. Preserve this environment, enhance this environment, and economically and environmentally, we're all better off.

**JOHN MARK DEAN:** Thank you, Charlie. Well, I think that the floor is now open for questions of the panelists. The microphones will come around to you, and please speak closely to the microphone so that it is transmitted well. We had a question over here.

**A SPECTATOR:** Yes, sir. I don't know to which gentleman I need to address this question, but this is just a point of information that I need clarified. I'm from Surfside, and I would like to say that none of us living in Surfside and Myrtle Beach, and I teach in Myrtle Beach, was cognizant of the fact that some marshlands were to be destroyed. And I want that to go on record, because I did some nosing around. Here's my question: Marshlands and wetlands, formerly known as the Village of the Barefoot Traders, in North Myrtle Beach, were partially destroyed. The destruction was temporarily stopped, and all of a sudden articles came out in the paper that it was to be resumed, to build a shopping center. My question is this: could you please explain to me so that I, in turn, can explain to my children whom I teach, why this was approved, and why these wetlands could be destroyed, and was it mitigated so that other wetlands could be built?

**JOHN MARK DEAN:** Let's start at the local level, Wayne.

**WAYNE BEAM:** I will attempt to answer that, if I may. The Barefoot Traders situation up there was isolated wetlands, a pond, actually, off of Highway 17, I believe, right? And the developer had all their approvals from DHEC and the 401 water quality certification and all that, that they would need, if they needed one. They had their water supply and those type things, I believe. Ron Tata's organization up there at DHEC's office would have supplied that. The Corps indicated, I believe, that they did not need a permit because of the activity involved. So it befell the Coastal Council, reviewing other permits, to look at the situation. We took the matter to the committee, to the Management Committee up in October that met in Myrtle Beach, as a matter of fact, at the Landmark Hotel, and the decision was to allow them to go forward. They did modify the project, and did mitigate with some other wetlands involved in that same system. The problem we had was a legal one, of how much authority we actually had, because it was a pond, and the argument that the lawyers made at that time, was if we can regulate a pond like that, then we can regulate a pond in Dorchester County that's a farm pond. Actually, the policy we were looking at is can you build over a pond like that? They were driving pilings and building part of a shopping center and restaurant and everything. And the committee, the staff, made a presentation and the Management Committee of the Coastal Council allowed them to continue that development which was a non-contiguous wetland. It is not contiguous with an estuarine system. It's an isolated wetland, and the committee allowed them to go forward with mitigation, but with significant modification of the project, as I understand it. I'll be glad to talk to you after the meeting if I might.

JOHN MARK DEAN: That articulates the issue that this is an area that is emerging and the regulatory authority for that is just coming into play; it is right at the cutting edge of the whole thing Bill Odum spoke to us about. Another question?

A SPECTATOR: This is a follow-up to that question. If that is an isolated wetland, and if there was fill involved in that wetland, why was a 404 not needed by the Corps of Engineers and if so, why was EPA not involved in that decision also?

WAYNE BEAM: Well, that's a good point, but there was no fill involved. It was dredging, no fill, therefore a 404 permit from the Corps was not required.

JOHN MARK DEAN: Okay, another question.

A SPECTATOR: This is for Col. Foxworth: you mentioned a number of important pieces of legislation that you've introduced and others have introduced in the legislature, in this session and recently. With so many of these other issues unresolved, is it possible, or how is it possible to get the legislature more concerned with overall water quality in estuaries?

EUGENE FOXWORTH: I'm glad that I did get a chance to get the mike again, because I think in Charleston we get probably the best press environmentally, of any place in the state, and I think we really do need to take our hats off to the News and Courier, and our TV channels, too, but particularly the News and Courier.

Just to give you an idea of how slow the wheels turn, I introduced the Beach Management Plan after I was elected in November. Now, and I am fussing, because then the Governor and Wayne's Coastal Council, and I think Charlie sat on it, had another committee set up to decide what to do. Well, I bet if you took their recommendations and my bill, it wouldn't be anything of any substance that was different, but that delayed it another two or three months. In the meantime, though, the committee that chairs the environmental affairs of the House is not the most productive committee, in my mind, and they are just finishing up. It's a more major piece of legislation than my Shrimp Bill was, but they haven't spent the number of hours that we did — I worked night and day and so did my committee, and so did the Wildlife staff.

So I don't know whether I'm answering your question or given you a chance to say, but what's really happened is I've got that bill, and the Freshwater Wetlands Bill is the one that's got the wrath of the big boys and the good ol' boys that Charlie's talking about on my neck. And I love it. They really are furious, and they are fighting me tooth and nail, and I have had, yesterday, some of the most discouraging news I've heard, because I got word that the leadership of the House has said "put it on the back burner and don't let it out." Here we were worrying about the beach erosion, and then I also have the Infectious Waste Bill, which fits right in with what we're all talking about. And that really should come before the Freshwater Wetlands with that committee, because it goes so damn slow. I volunteered to resign my chairmanship of the Wildlife Subcommittee, and just serve on that other committee, because I think I can give them a little

emphasis to get some things done, and maybe it's unfortunate I have the time, but we've got so many environmental bills up there, that Bob Sheheen said he didn't want to hear my name again. And most of them are with wildlife, but we're going to get them through. Now, I think the beach erosion will go through this year, the freshwater wetlands will probably start some hearings this year, I hope, and some of the others will get out of subcommittee, but it will take another year, and I'm not asking to be re-elected because of that, but damn it all, I want to be up there 'til I get all those things that need to be done, done.

A SPECTATOR: I wanted to ask a question about the coastal management. Not so long ago, our own town planning commission removed from our land management ordinance, a thirty-year erosion set-back line. Now, as far as I'm concerned, to renourish our beach without having a set-back line, is like pouring money down a sewer. Now, if the individual municipalities or the counties or the state will not pass an erosion rate set-back line, can the EPA do anything about it, by threatening to withhold subsidies from flood insurance? That's the gun I think we should use.

LEE DEHINS: First of all, I don't know anything about the particular bill or action you're talking about, but I don't have the stick that you're talking about, because I don't administer the flood insurance program, that's done under FEMA, which is a different federal agency. The issue you're talking about is not really within our jurisdiction, but perhaps Dr. Beam from the Coastal Council can address it.

WAYNE BEAM: Ms. Angeletti, I just knew you'd be here today -- it's good to see you again. It seems to me that your problem is a local one, if the state's not going to pass one, and Col. Foxworth's already addressed the labors that we're involved in right now, trying to get a set-back, a statute passed in this state. But I believe your fight might be taken to the ballot box at Hilton Head. I think that the local government down there, you've got a town council, they're the ones who removed that stipulation from the ordinance, if I'm not mistaken.

MS. ANGELETTI: Well, you know we're fighting, you're well aware of that.

WAYNE BEAM: Yes, ma'am, I'm well aware of that. But thank you. I think that is a good point, and Bill Marsh and those down there are very committed, and he was at the meeting yesterday that Col. Foxworth addressed concerning the state statute for a set-back.

MS. ANGELETTI: Well, Bill Marsh always tells us that it's not legally contestible, and I think that's a lot of bull.

JOHN MARK DEAN: Question right up here.

A SPECTATOR: I think that everyone who's attended this conference realizes that there's a multiplicity of diverse interests that are involved in natural resources and in all estuaries in this state, and it seems to me that one of the impediments to a comprehensive management plan is that there's a lack of communication and cooperation among the diverse interests. One of the techniques that has been used elsewhere to address that problem

has been to develop an outside body, generally in the form of an advisory commission or advisory body that can at least bring together these diverse interests to discuss their various needs and interests, and at least they know what's going on among themselves. I don't really know who to address this to, but I'd like to just bring that up to the panel to see if they have any input to that type of strategy for addressing a comprehensive management plan.

**EUGENE FOXWORTH:** That's part of what my Freshwater Wetlands Bill did, was trying to put all the coordinating and the permitting in one place. So you didn't get confused as to who's on first and who's on second. And I think that's coming down the road in the near future, but you've got to remember that not just South Carolina, but very few states have what we really want — a perfect set of laws that protect our environment and so on. I think we're getting a head step on other states, particularly our sister states, but once that's done, and I think this is where you really are concerned, too, is that several times we find someone doing something in DHEC that really should be in Wildlife, and so on. And once we get through, I would like to see, and I hope someone who runs for Governor says, "I'm going to go through and I'm going to reorganize this state government, because I'm going to put it in a sensible way that an ordinary, lay citizen can go and do what he wants done to protect his property."

**LEE DEHINS:** Some additional information there would be helpful, and that is in the Albemarle-Pamlico Sound estuary designation which our office also participated in, in providing some leadership along with many other parties in North Carolina. It sets an example of what needs to be done with the Charleston estuary designation. One of the things that has to be done is to set up a committee structure, perhaps a policy committee, a management committee, citizens advisory groups, a whole network of groups that sit together, share information, both vertically and horizontally. And that's the way to do it in an area that is designated. In areas that don't get designated, such as again what Diane Barile talked about earlier, there's no designation at all in Florida, but you see the kind of activity that took place there because of local initiative. And that's what you've got to have here, anywhere, if you're going to get anything off the ground.

The other point to be made, which echos some of what Mr. Foxworth said, is that we're a fellow agency, our headquarters are in Washington, D.C., our regional office is in Atlanta, Georgia. We don't want to, not now, not ever, to come to South Carolina and manage any of the estuaries here in the state of South Carolina. First and foremost, that responsibility belongs to the Governor, the executive agencies, and the citizens of the state of South Carolina. We're there to provide technical leadership, coordination based on our experience on a national level. We have a lot of experts who work for us, we have experience in other parts of the country. But unless the agencies that are here pull together, work together, and involve the citizenry, you're not going to have success of anything, not either in developing a plan, or if you do develop a plan, in getting it implemented.

**JOHN MARK DEAN:** Okay, question right down here.

A SPECTATOR: A follow-up on the beach erosion question. Development around this state's inter-tidal wetlands threatens them for the same reason that development around beaches threatens beaches. That is, as sea level rises, these systems need room to migrate. And I would like to know if any state agency is addressing this problem, or if the beach erosion bill includes a provision for wetlands.

CHARLIE SWEAT: No, sir. The present beach erosion bill does not address wetlands. You're quite correct, though, that as sea level rises, we're going to have an increasing problem. The encroachment of water on what we deem as high land, this is another reason for this estuarine study of Charleston Harbor. By concentrating on Charleston Harbor, as an example of South Carolina and others, we could study the effects of the sea level rising, and establish, well, now, how much buffer do we need to leave between our developed high land and the water level today? And clearly we need a buffer, for storm water management, and to anticipate the future that you've pointed out, to live with sea level rise -- it's very real. And no matter what we say, and how much we want to disbelieve the sea level rise, the simple fact is that it has risen 14 inches in Charleston in this century. And it is accelerating. So, 14 inches is quite significant, folks. At the rate it's going, it could be that in 50 years, it's going to be washing on the battery on a calm day. So, it's something we need to deal with, and it's critically important that we deal with it now, and that should be an inclusive part of the Charleston Harbor estuarine study.

JOHN MARK DEAN: We have a question right here.

A SPECTATOR: I've got a question for Mr. Hallman -- many of us who are familiar with the permitting process of DHEC notice they really like their models, and I'd like to ask whether DHEC is contemplating development of a water quality model, specifically for estuaries. And I guess the catch word that I've heard here a lot today, is one that would include multiple and cumulative effects of the pollution in the estuary, not always just looking at the one permit case, but looking at the whole body of water.

HARRY HALLMAN: Being a board member, I'm certainly not an expert on water quality. We have Chester Sansbury, who is in the audience, who can answer that question better. Chester is our water quality fellow for DHEC. Chester, where are you? I'm going to refer that to him, if you don't mind; let him give you a better answer.

CHESTER SANSBURY: Thank you, sir. Responding just briefly, and directly, yes, we do have comprehensive water quality models in fact, as was mentioned earlier about our modeling effort in Charleston Harbor, we have a mathematical model that represents the entire Charleston Harbor system, including the Cooper River, the Harbor and the Ashley River. And our expert on that happens to be in the audience, Mr. John Chigges, if you'd like some details about that. But to tell you how it's been applied in the past, you heard some comments earlier about the Army Corps re-diversion project, and they didn't predict, they didn't accept the fact that the salinity would encroach the Durham canal intake to Back River reservoir. Our water quality model did predict that, and we were right, in hindsight, and the Corps was wrong. Col. Bornhoff, you weren't around at that time, you don't have to take any credit for that, but yes, we do. In fact, that particular model

was developed through the 208 planning process back in the 70's, and initially an effort involved in developing that model was in the neighborhood of \$200,000, and since then thousands of dollars have been spent on maintaining and using that model. It is probably the most comprehensive model we have on the coast. We have varying degrees of complexity, in terms of estuarine models on the coast, depending on the complexity of the questions that we have to deal with.

JOHN MARK DEAN: Thank you very much, Chester. I'd like to take advantage of this opportunity to acknowledge and recognize Congressman Ravenel, from Charleston, in the audience. I think you all should know that there is a trend occurring, that we do see our legislative members participating in an active, positive role with sessions such as this, and I think his presence here speaks for that. Do you want to take the mike for a second here? This would be considered a mike opportunity, rather than a photo opportunity.



## CLOSING REMARKS

The Honorable Arthur Ravenel, Jr.

Thank you, John.

Today, we in South Carolina are faced with a challenge and an opportunity to preserve our estuaries that may never come again. What we do within the next three years will determine whether they remain healthy and productive into the next century or, as has happened from North Carolina to New York, begin a spiral of decline that could end in biological death within our children's lifetimes.

South Carolina was blessed from the beginning with an incredible abundance of natural wealth. Today, we have some of the most untouched coastal waters in the country, but they are beginning to feel the pressures of a furious coastal population explosion that is occurring nationwide. In less than three years, 75% of this country's population will live within 50 miles of the coast. By the early part of the next century, the population in Berkeley, Charleston and Dorchester counties will have risen dramatically. Our coastal environment cannot possibly survive this growth without a concerted effort to plan for and manage it.

Within the 1st District, our estuaries show great variety and will require a specialized approach to management of each one. Port Royal Sound is a gem of staggering beauty and productivity. Consequently, people from across the country have flocked to its many resort developments over the last two decades at a rate that is almost unprecedented. Port Royal's major threat is from stormwater runoff from residential and commercial projects, including golf courses. How to deal with additional sewage from new developments will compound the problem of dealing with stresses to the estuary. Marinas create localized problems with elevated levels of petroleum hydrocarbons, metals and bacteria.

St. Helena Sound remains one of our wildest coastal estuaries and is not yet threatened by resort and marina development except on its northern edge from Edisto Island, and on the southern edge near Harbor Island. Long-term planning and management here is as critical as anywhere else on the coast, though. The Ashepoo-Combahee-Edisto river basin harbors tens of thousands of acres of land owned by the state, Ducks Unlimited, the Nature Conservancy, and private individuals that is intensively managed for wintering waterfowl. The ACE basin is the only area in the state where waterfowl populations have actually increased over the past few years.

The Charleston Harbor estuary presents the most complicated pollution problem we have to deal with. Its influences are many and varied. They include:

Increased rates of runoff from residential development on the Ashley and Wando rivers; industrial discharges and shipyard operations on the Cooper; rapidly increasing amounts of sewage from the West Ashley area; Mt. Pleasant's new sewage treatment plant; expansion of the Plum Island plant; and expansion of the North Charleston and Berkeley County plants; and increasing problems from non-point source pollution from the peninsula and surrounding area.

U.S. Fish and Wildlife studies have identified concentrations of metals and other toxic materials in fish tissue from the Harbor. Recent NOAA water quality tests have shown that while Charleston Harbor is not yet in a league with harbors in the industrialized Northeast, like Boston and New York, it is one of the most polluted estuaries in the South, surpassed only by the St. Johns River in Florida and the Mississippi. Problem pollutants included metals such as cadmium, chromium, and lead, hydrocarbons, and sewage.

Farther up the coast, the Santee Delta ranks with St. Helena Sound in its wildness and productivity, yet monitoring and management will be more complicated because of the unknown long-term effects of re-diversion. We need to protect this valuable and historic estuary now, so that development upstream will not threaten its integrity.

Winyah Bay also exhibits a variety of influences, ranging from industrial activity in Georgetown to rapid resort development along the Waccamaw Neck. The point is we can't afford to ignore even one of our estuaries. They are all vitally important, and they are all to some extent threatened.

One reason I voted for the Clean Water Act re-authorization last January was that it includes a \$400 million non-point source pollution control effort that will begin operation in 1989. As many speakers at this conference have made abundantly clear, without effective non-point source programs, we cannot hope to save our estuaries. After tremendous amounts of money and time from local communities, states, and the federal government over the last two decades, we have begun to get point source discharges under control. Now we realize these discharges are not even 50% of the problem. We will have to begin looking at the cumulative impacts of point and non-point source pollution on the estuary as a whole.

The need for individualized estuary-wide management plans is critical. I recently supported Governor Campbell's request that Charleston Harbor be designated an estuary of national significance under section 317 of the Clean Water Act. If we are selected, the resulting program will help us decide the best way to monitor, rehabilitate, and preserve the Harbor in perpetuity. We cannot wait for any of our estuaries to reach the same condition the Chesapeake has reached, or even the condition Charleston Harbor has reached. By then the costs, energy and time required for cleaning up will be many times greater than they are today.

I would like to propose the formation of a Blue Ribbon Committee for each estuary on the coast of South Carolina that will develop a management plan specific to that estuary. We have already seen how effective such a committee of informed citizens, businessmen, and technical people can be in the creation of sound, progressive recommendations. The Blue Ribbon Committee on Beachfront Management was a tremendous success and should be a model for the rest of us.

We need to form these committees by early spring and let them begin working on plans that could be completed by mid 1989. This would give them time to work with DHEC in developing the federal non-point source program for the state. We have the agencies available to provide the committee with information to make far-reaching decisions, and the federal government is

doing its share in providing a number of sources of funding for this effort. Many of the committee's recommendations, though, will have local land use implications. This has been the case with many of the problems the Chesapeake is experiencing. In order for us to succeed, we will have to have the participation and cooperation of local governments. Without the local element, our estuaries don't have a chance; with it, they can't lose. Let's get started now. We don't have a moment to spare.