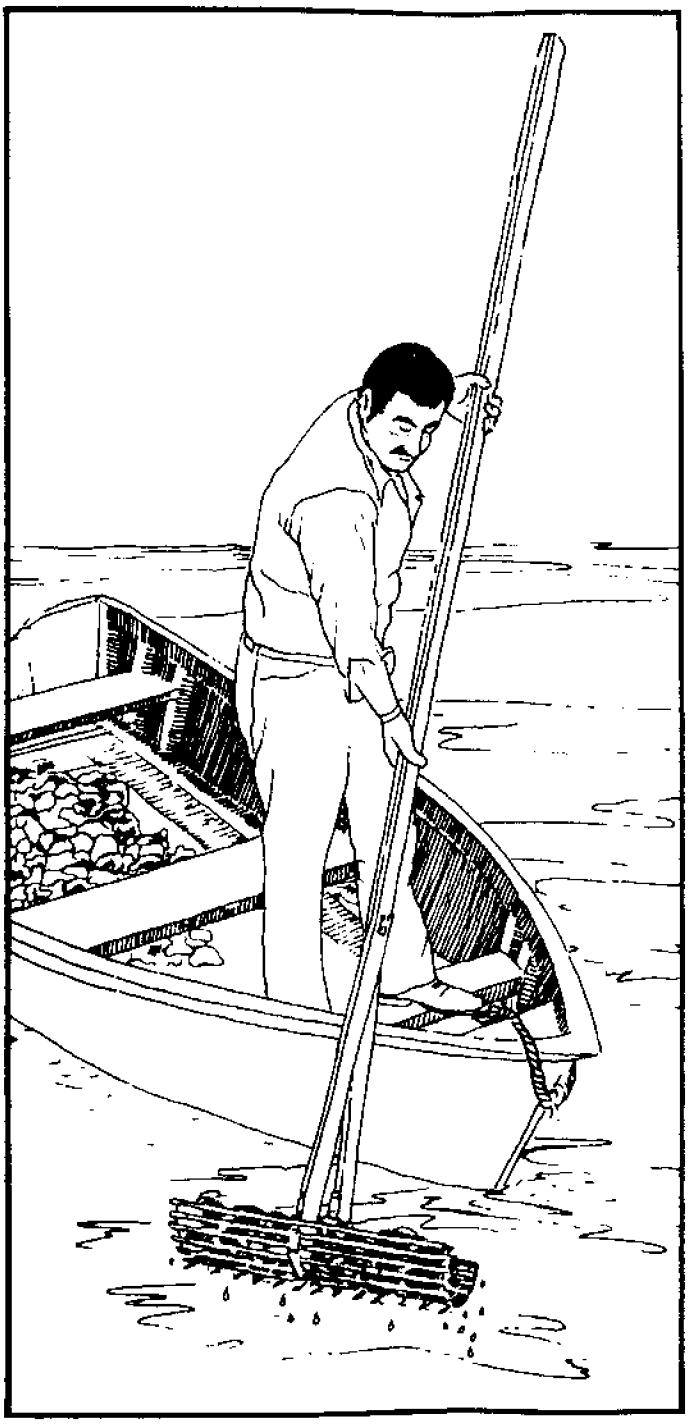

The Mississippi Oyster Industry: Past, Present, and Future

Proceedings of a Conference
Held in Biloxi, Mississippi
December 1-2, 1988

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The Mississippi Oyster Industry: Past, Present, and Future

Proceedings of a Mississippi Sea Grant Advisory Service Workshop
December 1 - 2, 1988

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Mississippi Cooperative Extension Service

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The Mississippi Oyster Industry: Past, Present, and Future

(Keynote Address)

The Honorable Ray Vecchio
Mississippi House of Representatives
District 112 – Jackson County

It truly is a pleasure being here this morning. One of my colleagues, Mr. Ryan, is sitting back there. Perhaps Ed should be the one who's up here since he has vast knowledge of the seafood industry. I do not take the task lightly because during the course of my last 5 years in the legislature, I find that a considerable amount of my time has been consumed by problems related directly to the seafood industry. And, therefore, with all your book knowledge you have to have practical knowledge. I was also caught up with just exactly defining the problem.

Dr. Cake tells his class that before you can approach any problem, you have to define it. You have to gather all the facts and make a determination of what's the best solution. You have to consider probabilities, benefits to cost, and many other things.

We in the legislature, which is the august body of this state, meet a short time each year and we're supposed to address all of these manifest problems. Yet we don't individually have the expertise as we do in this audience today.

I commend Joe Gill and Dr. Leard and the Gulf Coast Research Laboratory. Each time I have approached them for advice on a particular situation, they have been there with the information. If I had a problem with respect to oysters, I could pick up the phone, call Dr. Howse's people, call Rick Leard, call Joe Gill, and I'd have the factual information at hand.

One of the things that I have learned, and one of the things that I hope we address during the course of these 2 days, which is going to be very important, is communication. Communication is two-sided; you have to learn to speak and to listen. It's important that those people who are, as the fishermen say, "the egg-heads"–those people with degrees–have the technical knowledge. But you have to apply that technical knowledge; you have to marry it to that knowledge which these oyster people have accumulated for many, many years out there in the waters, and they have a lot to contribute.

It's during the course of these next 2 days that I hope we have open communications, that we have a discourse going on, and that we're communicating with each other on the same wavelength. Because if we don't speak to each other, we're going to find that when we leave here, we're going to go out and ride off in all different directions as has been the case in the past. And that's not what we want to do. We don't want to be like the ship without a rudder. We want to have a course, and we want to adhere to that course. We want to make sure that the ecosystem here in Mississippi is maintained for today, for the future, and for our children. We can no longer afford to lose our marshlands and wetlands.

When I first came to Mississippi as a boy from New York in 1951, I fell in love. What I fell in love with was the fact that I saw people getting out in the very early morning hours to make their living. I saw men out there with their tongs (and I didn't even know what a tong was). I consumed oysters and probably was one of the best persons for buying oysters. But I didn't know the problems which were inherent in the oyster industry.

I think we need to do something to revitalize the oyster industry. The governor goes to China and Japan, looking for new markets. But when I speak with my cohort Senator Gollott, he tells me that we import more seafood than we export. They tell me that we've got some of the best oyster reefs in the United States if not in the world. But because of a number of situations, they have deteriorated. That's what I hope we can discuss in the next 2 days. And I think that with the expertise that we have–the federal people, the state people, the local people–we can define the problem. As I've looked at the agenda for the next 2 days, I've noted that there are a number of topics that we will deal with that will enable me personally to go away with much more than I bring. That's what we're here to do.

If we were to look at the information Bill Demoran had in his report, which I read in 1986 and found very enlightening, he indicated that from the 1800s to the 1940s the harvest was something like 250,000 barrels of oysters per year. There were, of course, a

number of problems: During 1941-45, I understand the oyster industry was unregulated; and anytime it's unregulated, people feel free to do what they want to do, not thinking about tomorrow. They raped the reefs. It was from that point until 1960, when a conservation program was put in place, that the industry went down.

As I understand it, there was a movement to rehabilitate the reefs using cultch materials, etc. The legislature was brought into it. We found that if we put up a $1 million we could expect to get $4 million in return. That's a pretty good investment! And that's what it's going to take. It's going to take a hard-line-item in the budget so we don't participate in, as I say, "helter-skelter" or "in-basket" management. We have to know just exactly how much money BMR is going to have so that they can plan ahead how to use that particular money.

In addition we're going to have to look at what's going on in Alabama and Louisiana. One of the phone calls that I get when Joe Gill closes down Mississippi reefs is, "Why do we have ours closed and over in Alabama or Louisiana they're continuing to go out and gather up oysters?" My answer to them is, "I don't really care what they're doing over there if our experts tell us our waters are polluted. I don't want to risk – nor do I believe any oysterman wants to risk – the health of this community. It only takes one death to be attributed to a bad oyster, and you know the repercussions that could occur." So the legislature, in conjunction with the industry, has made some major changes that perhaps have gone unnoticed in the last few years.

We have now a testing lab at the Gulf Coast Research Laboratory where Dr. Howse's people can test water samples quite rapidly. We no longer wait a week or 10 days. We have asked the experts to do the testing on a 48-hour turn-around. And they do it! They keep the legislature knowledgeable because we're the ones who get the phone calls and we're the ones who are supposed to call and "call off the dogs."

But as I said, Mr. Ryan and the rest of us don't act just on gut feelings. We have to act on reports and we will continue to do that. I think the message has to go out very strongly to those oystermen who are making a living that no one's curtailing harvest because they just want to do it they're doing it based on fact. Those records are being kept now and they are accessible to legislators, and to the public.

We need to have a comprehensive, management program, which is at least a 5-year program. We need to establish goals and targets we can be working towards. We need to place quality products out on the market. I think we can do that. I think that the industry will profit from the efforts being made by our research scientists to find out just how water temperature, salinity, and predation change the manner in which we should replant these particular reefs. I understand now that we are trying to find out if fly ash is a good substitute to place on the reefs. These are things that we're working towards. This 2-day program is a two-way exchange. There will be opportunities for each and every one of us to provide input because no one has a monopoly on the system. If the system doesn't function, nobody will make any money and the state will be the loser in the long run. If we don't do anything else in the next 2 days, I hope we'll work together to address the problems of our industry.

Again, I don't pretend to be an expert, but I do know that we have a problem. We have seen some indications where the problem is beginning to be resolved. We haven't quite gotten there, but we're striving to get there. I feel that maybe in the next 2 days we'll look closely at some of these options and develop some sort of a strategy. I don't claim that these are the answers, but I want to mention several options, to consider and discuss.

Maybe we will have to privatize all the public reefs in order to maximize efficiency. That might be one approach.

We may have to offer the state-owned public reefs to the municipalities and local governments since they benefit most directly.

We may have to change our management strategy to maximize economic return to the state. To accomplish this, we would auction off available oysters or sublease parts of the reefs, or establish state-owned seedbeds. We would provide for limited entry into the fishery, offering a few a good living and restricting others from the fishery, or allow the oyster fishery to be used only for recreation and sustenance. I know that's quite controversial.

The state might also invest heavily in on-shore and off-shore depuration. This is a technology which is being employed and, hopefully, may be able to resolve some of the health-related problems that we've been involved with. In addition, the state might consider investing in oyster hatcheries.

These are just a few of the things that we can explore. But, again, let me say (and put this in it's proper context): we have to decide what we're going to do with this industry. That's the first thing. We have to find, using what some of the organizers call, "the systems approach," where the oyster industry fits into the scheme of things. Where does it fit with crabbing, shrimping, and the rest of the state's seafood industry? Is it compatible? Are we doing something here that is having a detrimental impact on other parts of the industry?

So, again, we're going to spend the next 2 days speaking about oysters. I hope this is only the first of many forums that will help us put the complex

together and discuss these issues with the recreational people, with the commercial people, with the Gulf Coast Research Laboratory people, with the BMR people, with the legislators, with students, and with the public. When we've finished I hope we will have found a way to get the most for our dollars, and to revitalize an industry that is already here. I hope we don't have to go and beg and borrow from somebody or offer tax incentives to come here. If we are successful, we will put people back to work, put bread on their table, put food in their mouths, and clothes on their backs.

We can develop a community of respect between the experts, the legislators and others. We can have a community where tourism will be enhanced. But best of all, we will be able to market a product that processors will probably label "caught and processed in the state of Mississippi." Maybe we can revitalize that $22 million industry we have sitting out there. As I understand it, our goal is to get to a harvest of 100,000 barrels per year in the 1990s. I would like to see us achieve a goal of 200,000 barrels per year.

Again, in closing, let me commend those who are sponsoring this conference. Let me say to you who are here this morning, please feel free to communicate. And, hopefully, together we can again make the Mississippi oyster industry number one in the United States and in the world.

Economic Profile of the U.S. Oyster Industry

Ken Roberts
Professor
Louisiana State University
Baton Rouge, Louisiana

One of the things that happens when you're involved in fisheries is you get caught up in local issues. It happens to us in Louisiana, and I'm sure it happens here in Mississippi. But you exist in a much bigger world in terms of supply/demand, consumption, prices, and other forces. I think my job today is to try to give you what is happening, or has been happening in the past with the national and, in some cases the international, aspects of the oyster market and the industry overall.

Let's talk about the oyster supply situation in the United States. Everything that I'm going to present will be in pounds of meats. In 1970, the U.S. oyster supply was about 75 million pounds of meats. This supply remained relatively constant until about 1980. Since then, a small supply increase occurred and peaked in 1985, 1986, and 1987, to a little bit above 90 million pounds. You have to dissect that a little bit to understand some of the contributing factors.

For Eastern oysters, (the one we're dealing with in the Chesapeake Bay, Louisiana, Mississippi, Appalachicola, Texas, and Alabama), the supply was constant up until about 1982. We had an average supply of about 48 million pounds of meats. Since then, the Eastern oyster industry has been in a dramatic decline for about 6 years.

If the oyster industry has been up slightly since about 1982, with a little leveling off, where did the supply come from? It obviously didn't come from the Gulf Coast or the Chesapeake Bay area. Eastern oysters have been in a decline for that period of time when the oyster market in terms of supply had been experiencing a bit of an increase. Some of it came from the Pacific Coast oysters. I know we may look down on the Pacific Coast oyster, not thinking that *Gigas* is an oyster comparable to ours and I certainly don't see it that way in the marketplace either. But it's there in terms of supply and it remained about level until 1978 in terms of production. In about 1984, they started getting in some remote setting type operations, and I think we're starting to see some results of that. They've increased to about 10 million pounds of meats as of 1987. What kind of year they're having right now I don't know. But that's been one of the contributing things, at least the West Coast Pacific oyster, which is primarily concentrated in Oregon and Washington. It has had a bit of an increase at a time when the Eastern oyster industry was in the process of declining. That's basically the way that domestic supply is going. The bigger contribution in terms of a growth rate is from the Pacific oyster. Since about 1978, Pacific oyster production has about quadrupled while that of Eastern oysters has gone down significantly.

Roughly 65 percent of the U.S. seafood supply overall, whether it's value or pounds, is composed of imports. You would think that if there's one thing that we would be relatively safe on, it would be shellfish. That's not the case, however, and the situation has worsened since about 1982. The growth in U.S. oyster consumption has been primarily from imported oysters.

The per capita consumption and the U.S consumption for domestic source oysters have been going down, but imports have been filling in. Imports have had an expanding market, contrary to domestic production. The largest increases come from canned oysters. Our canned industry has basically been on a slide and is definitely not in the growth mode; and that whole aspect of the consumer market shifted to the import sector. We're not really capable of recapturing that market and maybe we don't really want to. We want to continue to focus our production on shucked oysters or half-shell oysters.

An interesting thing about the imports is the increase in fresh and frozen oyster meat. It's up in the range now of around 6 million pounds, or about a fourfold increase since 1980. Some of that is Pacific Coast oysters, the rest are oysters from New Zealand and other places. But the striking thing about it is that in the U.S. oyster market, even though in the past we've seen a lot of canned production, the fresh and frozen market in terms of supply from imports has been expanding while the domestic industry has been contracting. We don't think we mind giving up the canned if we have to because of labor costs and what

not, but you would think the fresh and frozen markets would be relatively safe. We're under a little bit of duress there, and I think that some of my later comments may put that in better perspective.

Let's talk about the price performance nationwide in the industry. Prior to 1986, oyster prices were, in general, at the ex-vessel level, on the rise in the United States as a whole. In 1987, the trend continued upward. So the price performance has been relatively good from a national perspective, at least at first examination.

If you compare oysters for the same time period and the same base year with all edible shellfish, you see the increase on edible shellfish came a lot earlier. And it maintained itself while oysters were struggling, even though they were rising up to the 1986 base. In 1987, oyster prices went up—and edible shellfish prices went up, but not as much as oysters. Part of that is the reaction to reduced domestic supply in the United States market, not a stronger demand. That's a supply reaction, in my opinion, and not a new, heightened consumer interest and willingness to pay more for oysters.

If you compare oysters against all edible seafood, not just shellfish, you see that edible seafood was outperforming oysters through the base period (1986), and all seafood has progressed in ex-vessel price increases faster than have oysters. I think that's a reflection that there have been new consumers brought into the seafood consumption area (outside of oysters), who are probably willing to pay more and drive up even the ex-vessel prices. I think the oyster industry increase was induced by supply cutbacks and not demand shifts. If you just take inflation out of the ex-vessel prices, you see that the price increase has not been anywhere like the ex-vessel value would indicate. The point here is you can't take that to the bank in terms of public policy and have public decision makers say, "Well, the industry can't be doing too bad because the value keeps going up." It's a false indicator. You need to account for inflation.

Poundage is what we want to produce. Let the market take care of the rest. What the public investments and public policies should be focused on is producing more oysters, and the market will take care of the rest. But you need that base, that big supply, to increase the value of the industry. The market is not going to pull it up indefinitely.

Let's talk now about food consumption. Everybody says red meat consumption is down, and since 1980, it **has** been trending down. But there hasn't been a real precipitous drop in the last 3 or 4 years and maybe it's flattened out. We can't "go to lunch" in the oyster industry in terms of public investment on the basis of the fact that other people are having their woes in the food market, and therefore, whatever we do with oysters is obviously going to turn a profit. That's not the case. You can't build an industry in the long run in terms of strength nationwide on somebody else's woes. You don't want to do battle with the red meat people. They're better funded; they're better organized; they have research money; and I think they have about bottomed out in terms of declining consumption. Poultry consumption has gone from 60 pounds per capita in 1980 to 83 pounds in 1982, basically increasing every year. There is consumer interest in health, but I think the main thing that's driving the poultry market is price comparisons. You'll probably never see an industry perform better in terms of putting products on the retail shelf at stable to under-inflation type prices than the poultry industry. I think this is what clearly is driving their industry.

What's happening with seafood? Consumption has gone from around 12.8 pounds per capita in 1980 up to about 15.4 pounds in 1988. The difference here in terms of poundage is that this is **edible** weight. Seafood statistics are kept, generally, in edible weight basis. Sometimes the USDA figures report edible red meat and edible poultry on the basis of retail cuts. You have to be careful when you're playing with the numbers to make sure you have what you're really interested in.

If you take a look at oyster consumption as a portion of overall seafood consumption, you can see it's increased a little bit since 1978, but it's basically trending between 85 and 95 million pounds of meats. I think its better to look at it in terms of **per capita** consumption of oyster meats from 1980 to 1987. We had a little increase in 1982, which is what we looked at before, of 0.36 pound per capita edible. But basically we've been stagnant since that time. That difference between 0.36 and 0.38, which is where it stagnated the last 3 years, is basically insignificant to the oyster industry in terms of value. So, we've got an industry on a per capita basis that really is not keeping up with the overall trend in the seafood business.

I have words of encouragement that you've got to leave with public officials and with industry members. The particular thing that has to be addressed is that though the seafood market has been booming the last 8 years, the oyster industry has not been participating in it from the standpoint of volume. Sure, some of the sack prices have been going up. But then again, if you don't have the pounds as a basis, you lose a lot in terms of economic impact. Here's the bottom line. If you look at 1982-87, per capita seafood consumption in the United States has gone up about 4.2 percent a year (like a bond rate, 4.2 percent annualized). Each year during that time period, seafood consumption on a per capita basis went up about 4.2 percent. Oyster consumption went up around 1.1 percent. That will tell

you pretty quickly that if that kind of trend continues, oysters will be something less than a focal point in the seafood industry. We will be relegated to something that is dragging and not progressing. That is not a good position to be in.

There is **some** good news, I think, in the consumption end of the business. If we look at the 1985 figures, which are the latest we have available, for oyster consumption in the United States, around 54 percent of the consumption is at home. That's another way of saying it's either bought at a supermarket or at a retail store. Forty-seven percent of consumption occurs away from home. That's a good balance. It's a good thing to build on in the future.

Let's take a look at economic impact. In the United States in 1985, we had $70 million ex-vessel of domestic oyster landings. The value at the primary wholesale level was $155 million. The value at the secondary wholesale level was $190 million, and the retail value, whether it was sold in a restaurant or whether it was sold across a counter, was $482 million. If you kind of play around with numbers, that's a factor of about 6.9. In other words, you take dock-side value and go to retail value with a factor of about 6.5 to 7. That's why there's interest in public investment, research, and management of oyster grounds, whether it be leased property or commonly-owned property like public reefs.

The National Marine Fisheries Service keeps statistics on processing establishments. A processing establishment is basically a firm that **does** something to the product. That's the best way I can define it. In the oyster industry, people who receive sacks or bushels and ship the same, are not considered to be a processing plant. They're considered to be a dealer or a handler. So the figures, whether they are from Louisiana or Mississippi or someplace else, represent people who "change" the product. They'll grade; they'll sell box oysters; they'll shuck; they'll bread; they'll do something with the oyster. Let me give you some figures for the Gulf of Mexico, which is something we probably ought to be interested in. For the 16-year 1970-85 period, for the whole Gulf of Mexico, there were 416 oyster processing plants that came into existence. They were either companies that started up or companies that were already processing something like shrimp or whatever and added oysters to their processing line. The key point I think that you have to look at nationally, is that there were 405 closures during the same time period that 416 firms came in. In a typical year on the Gulf of Mexico, there are about 170-180 firms that are processing oyster meats.

The point is that there's a very dynamic business there in terms of processing. It's a very unstable business. Some people get in for awhile, add it to their line, then drop out. That is an indication to people who are in public policy and looking for public investment that public investment would pay for itself simply by stabilizing that a little bit. That's because anytime someone comes into the business, there are start-up costs which cut margins. Anytime someone goes out, you know it's probably under unpleasant circumstances, such as being stuck with big accounts receivable or having product kicked back. There's something wrong when there's that much "in and out." It's a very expensive way to do business and is not healthy for the industry. We can't look simply at public policy and public investment as producing more oysters. Anything that public policy or public investment would do to stabilize the market and economic environment for oyster processors would yield public benefits.

For example, if you examine Louisiana oyster processing establishments' sales per company, we haven't gone anywhere since 1970 in terms of deflated sales. We're where we were 16 years ago. I think that's pretty much the same situation you have in the oyster industry in the Chesapeake Bay and, for sure, the Gulf. If you examine ex-vessel prices per pound of meats in Louisiana, it looks like things are going pretty well since about 1984 with some big price increases. But if you take inflation out, it's generally been sideways, with a little increase in both 1987 and 1988.

One of the things that I want to caution people who are not too familiar with the industry about is when you start looking at things like this where there's public policy or public investment concerned, prices per sack or per bushel are, to me, basically a false indicator if you're looking for information. You would have to know what that sack is **yielding** in the shucking business. If the yield is up in pints, $25-28 a sack isn't too bad. If the sack price is $18-20 and it's yielding only 4½ or 5 pints, effectively your oysters may be more expensive than a $25-28 sack that's yielding better.

If you look at sales per establishment in the Gulf region, the 1981-85 average for oyster processing establishments was about $300,000 in sales a year. The typical blue crab processor had sales of about $450,000 a year. The typical shrimp processing plant had $6,700,000 in sales per year. So the oyster industry is beset by small companies or companies that only have a small role to play in terms of oysters in relationship to the other products they're handling.

How about the economic concentration in the industry? It's the least concentrated of the industries we have in the Gulf of Mexico. At least the National Marine/Fisheries Service tells us that the top 10 oyster processing plants in the Gulf of Mexico produce about 36 percent of the total oyster value. The top 10 crab processing plants in the Gulf of Mexico produce around 58 percent. The top 10 shrimp plants produce

about 53 percent of the value. So it's the least concentrated of the industries, which indicates they are small firms or oysters are a small element in relation to other aspects of the firm.

Anything your policy-maker, your management group, your legislature, etc., can do to smooth out the supply of oysters from the wild fluctuations in production we are currently experiencing, the better off your industry is going to be overall. With that many firms coming in, it's too expensive for start-up costs. With that many firms going out, you not only get hung with bad debt problems, but people lose their jobs. Anything you can do in terms of public policy that addresses operating in a narrower production range over a period of time, I think, is a good public investment.

Unfortunately, the image some consumers have of the industry is tarnished. Consumer perspective is really important in terms of the future. You are probably aware there are a couple of critical lawsuits that have just been resolved and we're waiting for judges (particularly in Louisiana) to issue a final ruling that could have very dramatic impacts in terms of things like posting warning signs at eating establishments or labels in terms of health hazards. There are other ways around this in terms of dealing with the public. Let's stick with educating consumers and the public instead of putting warning labels on things. I think the industry has to look at itself very clearly and address its image problem nationwide, not just in Mississippi, Louisiana, Alabama, Florida, and Texas. Let's look at it overall and make sure we're putting the best product out and that consumers know about it.

I would like to make a point about depuration. In my opinion, depuration is not going to put any more oysters on the market. I may have a minority opinion in that regard, but I don't believe depuration makes more oysters. Public management and private reef management make oysters. Depuration puts a few more on the market, but I would not like to see euphoria about depuration spill over to the point where we lose emphasis on public policy and management of beds, sanitation of those beds, and policing and enforcement of those beds. This is the concern I have about depuration: that it will produce no more oysters, particularly in the long run.

Let me end with a few hopefully positive things about the oyster industry for the future. There seems to be more industry interest, legislative interest, and public policy type emphasis on really **doing** something finally about the basic growing habitat, and taking a look fundamentally at what could be done. The second thing is that you have a good foundation in terms of the consumer in this regard: the product is roughly 50-50 between at-home and away-from-home consumption. You're not going to get tripped up by one market progressing faster and you being left out of it and you're not going to be tripped up by having only one product emphasis. Oysters, I think, have a good foundation in the fact that roughly half goes to each side of the market, which means there are opportunities both ways.

I think another plus in the near future is that supply increases are not going to result in dramatic price decreases. The price increases have been the result, I think, of supplies basically being cut back and not demand progressing. I'm not worried that supply increases will occur with enough stability and rapidity to affect prices dramatically in the long run. That's good because whatever investment you're going to make has the ability to participate without the price being driven down. Only four countries produce 90 percent of the world's oysters – South Korea, Japan, France, and the United States. That's not a lot of competition. Public investment that is going to be made here stands a very good chance of paying off. Most of the imports are in the canned items and that's where, I think, most of them will stay, even though there are some fresh and frozen imports that we have to be on guard for. But public investments, I think, are safe domestically.

Finally, I see increasing consumer confidence. I think there's some hope there, and I'm going to get to specifics. The National Fish and Seafood Promotion Council, during this time of the year, is conducting a nationwide poll of people in the shellfish industry, to take a look at what possible benefits, willingness to participate, etc., there may be in terms of increasing consumer awareness. This includes promotion, and having a council or board that receives funds through an industry assessment to run promotional, educational, and consumer-type programs. If you have to look for an industry that has the biggest potential for payoff for this kind of program, where the majority of the benefits will be U.S. benefits and not received by imports, it is definitely the oyster industry. That doesn't say you ought to blindly go out and create a board and assess yourselves. But what I'm saying is that it's a good thing that's happening right now. That is being addressed, debated, and will get a thorough airing. Whether it survives or not, no one knows right now. But for sure it's a good sign that people in this industry are looking at it nationally. Primarily, the domestic industry will be the beneficiary, not the imported product.

History and Status of the National Shellfish Sanitation Program and the Interstate Shellfish Sanitation Conference

Richard Thompson
Director, Division of Shellfish Sanitation
Texas Department of Health
Austin, Texas

You can see why, when I talk about the ISSC, I don't try to say Interstate Shellfish Sanitation and Division of Shellfish Sanitation. They tend to run together so you will hear me say ISSC and you may feel free to do the same. I am going to give you a sort of history and status of the ISSC. I want to talk a little bit about the structure of the program when we get to that point. I think that you will find that it ties in very nicely with what the first two speakers have talked about and that is communication; working together and both sides listening to the other side and trying to come up with a plan or program that does the two things that need to be done. That is, to provide public health protection from a product, which we do know makes people sick, and to provide that public health protection in a manner that allows the industry to make as much profit as it can without being over-regulated.

This has been a long history, which I am going to sum up in a very few minutes. I will be here for 2 days and will be happy to discuss any of the history in more detail if anyone is interested, but I will give you just a few key background elements that sort of serve as the foundation of the current program. Some of it will be repeated history to some of you, so please bear with me because it does have a bearing to those who are not familiar with it.

Health concerns go all the way back to 1925. In the first 20 years of this century, there were a lot of illnesses related to molluscan shellfish. When people first came to this country, one of the first things they found they could eat was in the estuaries where they landed their boats and they started eating molluscan shellfish. The Indians ate them, pilgrims ate them, people got sick, and nobody knew why. Well, in the first 20 years of this century, they began to get a handle on it as we got some medical and technological advancements. They began to tie together the fact that if you ate the shellfish from certain areas, you got sick. If you ate shellfish from other areas you did not get sick. Then in 1924-25, there was a major typhoid illness outbreak throughout the country and it was traced back to contaminated oysters from sewage contaminated areas. That was sort of a death blow to the industry at that time and you are looking at something like that right now with a hard word that I use that scares the hell out of me, and I think scares a lot of you out there – and that is *Vibrio vulnificus*. A lot of people are getting sick from it and we have got to do something about it and other things right now.

We go back again to 1925. What was their response? What did they do? The industry requested and the states and federal government came together and held a conference and meeting and developed a program – the National Shellfish Sanitation Program. It was a tripartite cooperative program in which each of the partners agreed to do certain things. The states agreed to take on the responsibility of surveying and classifying growing areas to determine those that were safe, and further, to develop sanitation guidelines for processing and handling shellfish. The industry agreed that it would harvest only from those areas determined safe by the states and that it would comply with these sanitation guidelines. And the federal government agreed that it would come in and evaluate the state programs to see if they were operating on a good foundation. They did, in fact, provide the necessary guidelines. The federal government would also determine if the industry was, in fact, complying with these guidelines. Sounds like a very simple program, very easy to work, and in fact it was – in 1925. As the years progressed and as the industry progressed, it expanded and we began to ship products, literally, all over the country.

As we developed and improved, we started shipping the oysters all over the country and the program began to have problems. Different states were trying

to go in different directions. They had disagreements over what those basic guidelines should be and how the products should be handled. Even some of the simple bacteriological guidelines could not be agreed on.

In the mid-1970s, there developed a situation where one state was not following the national programs and a challenge developed between that state and the Food and Drug Administration. (By that time, the program had been moved from the Public Health Service to the Food and Drug Administration.) This challenge resulted in the fact that, while it never officially went anywhere, the FDA determined that it really had no enforcement powers under this program. So we still had a program, but we had a program with no control, sort of like having a car with no driver or an airplane with no pilot. You can go somewhere and go real fast but you may not end up where you want to be.

The states got very concerned about this. Along about 1975, I believe it was, the Food and Drug Administration proposed some national regulations (called the GMP's–Good Manufacturing Practices for Shellfish). They would have, in fact, been federal regulations of this program. There was probably the most democratic response I have ever heard of when every industry person and every state person rose up in opposition to these. They did not want federal regulation of this program. If we did not have federal regulation and we did not have a driver, we began to wonder just where we were going with this thing.

Over a series of meetings, starting in 1979 through 1981, a group of state people representing 15 to 18 of the 26 producing states met about twice a year at regional meetings and we finally developed a structure and a constitution and a proposal for what is now called the Interstate Shellfish Sanitation Conference. That program, that constitution, was formally adopted at a meeting in 1982, and that was the beginning of the ISSC.

The way it works is very similar to the old NSSP. It had the same three partners–industry, state people, and federal government. The only difference is that now we have an executive board that works year-round to keep things going. We have an annual meeting every year instead of a meeting when we have a major problem that we have to try to resolve. The hope there, of course, is that you take a little problem and resolve it before it becomes a major national crisis. When we go home after these annual meetings there is a summary of actions published and changes are made in the manuals and guidelines. In the past, a lot of decisions were made and nobody was there to carry them through and now we have a mechanism for carrying those through and for keeping those manuals current.

When we first formed the ISSC, as you can well imagine, it was formed out of a need or a problem situation. One of the strongest generators of the ISSC was the Gulf Coast. We all remember 1981-1982; we were all trying to ship products to the East Coast and many thousands of pounds and truckloads were being seized, detained, and held. Some, in fact, were disposed of along the East Coast because of the bacteriological standards we did not like.

One of the first things we did in the ISSC was to buy ourselves a little time by developing some shipping protocols which got us to, while not where we wanted to be, something we could live with for a few years while we tried to catch up. The last set of national manuals was published in 1965. We formed the ISSC in 1982, nearly 20 years later. What we had in the meantime was a 1965 manual with some interpretations, and you can imagine that it was very much out of date. We could not update that instantly. We could not come overnight with a new manual so we tried to come up with some way of living with the situation until we could get those manuals updated.

The structure of the conference is such that we use you. This is where I get back to what the keynote speaker said. When say you, I mean everyone out there in the audience. We in the ISSC use you to develop the guidelines. The way the conference is structured is that there are task forces at the annual meeting composed of equal representation of the producing industry and the state regulatory people. These people sit down, these are the two front line people, and those of us like myself and the regulatory side of the situation find ourselves caught squarely in the middle just about every time we turn around. In this case, we sit down with the two people, the regulatory and industry people, on what usually is, unfortunately, the two opposite sides of the fence and try to come up with some ways to open gates in those fences; some way to come back to what I said originally. We can provide public protection and health protection without stopping you from making a living out there.

The task forces meet, consider every issue submitted to the conference, and come up with recommended solutions to those issues. They are in turn sent out to the general assembly and the general assembly votes as a group of state regulatory people. Ultimately, these will be regulations and must be decided on by the regulatory people who vote to either accept what that task force is recommending or return it to the task force for further clarification. Those recommendations that we come out with from the ISSC are then forwarded to FDA for inclusion in the national manuals.

The first thing we went to work on immediately after developing the shipping protocols to buy us some time before we literally blew the industry apart was to take up Part One, *Sanitation Shellfish Growing*

Areas, the classification of the waters. It took about 2 years to get that manual updated. The second year, we started in with Part Two, which is the *Sanitation Guidelines for Processing*. Over a period from about 1984 through 1987, we were working on both sets of manuals.

We now, I am happy to tell you, have a complete updated set after the 1988 meeting that contains all of the changes that have been discussed and recommended in the last 3 years with a couple of minor exceptions that are not excluded but simply not included at this time. They need more development in statistical design and so on to be included. Those new manuals will be off the boards about mid-December. There will be notices in the Shippers List for those of you who may not have been to our meeting and may not be on our mailing list. There will be notification coming out in both the Shippers List and *Federal Register* and I am sure that if you are related to the industry at all, you will be hearing about these manuals. They will be available for purchase through the ISSC office.

That is sort of the history, if you will. That gets us to 1988. We had a problem, jumped in to form an organization, and did what needed to be done immediately. That was, of course, to bring the basic guidelines up to date. There are a lot of changes, there are still a lot of problems out there. I think that anybody who doesn't recognize that is a fool. We have problems with our indicator organism, both from a growing area standard and from the market standard situations. One of the talks you will hear later today is about a national pollution indicator study. We all recognize that there are things that need to be done.

Where are we then? I want to give you a little bit of status, if you will, of the ISSC. Where are we in relation to these problems? The biggest thing that speaks for the ISSC is that it has been recognized. It is a relatively young organization, formed in 1982. But in just a few years this organization has already been recognized formally and officially by FDA with a memorandum of understanding acknowledging that the ISSC is the group that will set the sanitation standards.

We have been recognized by a number of other national organizations. Those organizations that set policy and guidelines in other areas: the National Environmental Health Association, National Food Protection Association, Food Protection Conference, and National Conference of Interstate Milk Shipments. Many of these similar national organizations have formally and officially recognized the ISSC as the one to listen to regarding shellfish.

In addition, probably one of the biggest things that has come up recently, the National Marine Fisheries Service, I think most of you are aware, is working on the model seafood surveillance program under the direction of Congress, to determine if we need a federal mandatory regulatory seafood program. The National Marine Fisheries Service in their Molluscan Shellfish Workshop and at the instruction of the industry that was there, came out with a statement that if they had a national seafood regulatory program it should utilize the ISSC as the route to regulate and to control the molluscan shellfish portion of that program. Through that, if in fact we end up with a National Federal Seafood Regulatory Program, the ISSC will be recognized as a part of that program. The key here and I use the term recognize, is that for the first time, there is someone to call to talk to when you have a question about molluscan shellfish.

It has been a challenging 4 years for me as chairman of the Conference. My phone has rung literally off the wall. Thank goodness I don't have to pay the long distance phone bills for the calls I have made. I have been all over the country talking to people and learning from those people and the more I look at this type of organization, the more it strikes me to be the very basic democratic process of this country. The people who are involved sit down and figure what to do with the problems and then we go from there. We have a very strong move currently under way for uniformity.

That goes back again to a question the keynote speaker raised: why does one state close their areas while another state doesn't? There are a lot of reasons for this. One of the biggest, right now, is simply a lack of uniformity in programs, a lack of uniformity in the basic guidelines and how we operate our programs. There is a very real problem, speaking as a state person, that we see within the Food and Drug Administration. That is a lack of uniformity between regions and evaluations and even between people within regions. We have been calling ever since the ISSC was formed for uniformity in both federal and state arms of the program. The FDA has already begun a move toward uniformity on their side.

Standardizing, for those of you who don't know what standardizing is, is taking one person and standardizing or making other people do things the same way. If you take one person and get that person fully trained and then that person in turn trains two or three, each of whom trains more, and we have a pyramid effect. Essentially, when you get through with this, everybody in the end, which may be hundreds of people, is supposed to be identical with the first one who started. That is what standardization is. FDA has already started a standardization move within their organization. We are discussing it with them. We are beginning to work that way through the ISSC by development of some check grading procedures. Specific inspection forms based on the

guidelines will be used by all. If this standardization is completed, and mind you it will not be done overnight, it will take some time. We will have to put up with it while we are developing it. When this standardization is completed, then Louisiana and Texas will do it the same way. Then, Maine and Texas and Mississippi will do it the same way. It is going to be a slow process because again we are dealing with 20 or 30 years of going our separate ways and trying to come back together. Don't expect it to happen overnight, but at least we are pulling together in that direction now.

One of the key things that we have to do and that I spoke about in my last speech to the conference to urge them in their future direction, is to develop a model ordinance. We now have a manual, a set of guidelines. Any of you who are familiar with that manual will know that it is full of generalities. Areas have to be interpreted and that again leads to problems when we interpret it differently from the way you do. I definitely believe that we should develop a model ordinance that is very specific on each phase of the shellfish situation that allows for the differences in clams and oysters, that allows for the differences in Maine oysters and Texas oysters but that is very specific in those areas and can be applied uniformly.

The two biggest problems that we are facing right now have to be settled as quickly as possible. First, as I have already mentioned, is developing a growing areas criteria; a growing area standard developing an indicator organism. I won't go into much detail on that because you will be getting a breakdown later today as to what is happening as far as developing a new indicator organism.

We have many areas in this country that are closed. Unfortunately, because we don't know for sure that they are safe and in the public health mode, we don't have much choice. If we are not sure that an area is safe, we must close it down. That is called prevention. I know you don't like it on the industry side when we don't know and close it down, but again, going back to the comment made earlier: if we leave an area open and we get illnesses out of that area, the effect will be much wider than any of you want to have.

We had a situation in Texas a few years ago. Probably most of you heard about the cholera epidemic we had in Houston. There was absolutely nothing to it, but you ask the people in the industry and the Texas market what happened and you find out that overnight, even though there was no "epidemic," there was a 92 percent reduction in the market and it was weeks before those people even began to recover and months before they fully recovered to where they had been before this false epidemic was created. If you have a real epidemic, you are looking at a much longer time period.

You have to have growing area standards that enable us to accurately close those areas that need to be closed but let us leave the areas open that are safe. Marilyn Kilgen's group is working toward providing that to us. We also have to develop a valid market standard. The market standard that we have right now—part of it may be valid and part of it I don't think anybody believes is valid. We have to move toward correcting that so that when you do provide, as a producing group, a safe product into the market place, you don't have somebody in Denver or Chicago or Phoenix taking it off the market because they are using an invalid market standard. So you don't have product shipped from one state to another that is perfectly safe taken off the market for the wrong reason. Those are the two things that we are working very strongly toward right now. The growing area standard and the market standard.

In summary, this is how the ISSC works. The industry sits down with the regulators and we jointly develop a method to provide public health protection while we allow you to make the best living that you can. I want to strongly encourage those of you out there in the producing industry who have knowledge and information to give us. There are many of us in the regulatory situation who are willing to listen to all sides—the technical experts, the research people, and the industry. Each of you has your place in our organization.

As a regulator, I am not an expert on shellfish. I have not made my living on a boat and there are a lot of things you know that I don't know. I can't learn if you don't come tell me. Nor am I a research expert. I don't know what happens in the laboratory, I can't name all of the bugs that are in the oysters we eat. You research people can't. You have to come tell me your side.

Through this organization and all of us sitting down together and communicating with one another, we can make this thing work. It's the only future that I see. I am opposed to federal regulation of this whole industry, both as a state person and as someone who was sitting back and looking at this thing from all different angles for the last 4 years. It can work on the state level but it can only work on the state level if we all work together, and the way to do that is through the ISSC. It is the group that exists now.

I encourage each and every one of you to participate as much as you can. If you can't physically come to the meetings, get to know the people in your area who do go so that you can get your information to us. We have got to have you to make this work. I will be here for the rest of the conference and will be happy to entertain any questions from anyone, either now or later, on what we are and where we are going and where we work.

The Buyer's Perspective of the Gulf Coast Oyster Industry

John Ray Nelson
Bon Secour Fisheries
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First, I would like to review, briefly, the history of our industry. The early and mid-1800s found growers in Alabama and other states to the west actively engaged in providing buyers with a fine, healthy product. By 1900, many canneries were operating in Alabama, Mississippi, and Louisiana–continuing to provide a good, wholesome product for distribution to a wider area. By the 1930s, we had the National Shellfish Sanitation Program under the FDA, which was and is the program that enables the Gulf States to continue to provide a safe product, even with the increased population along the coastline.

The Federal Water Pollution Control Act of 1968, which included shellfish growing waters, was an aid to the industry by helping to guarantee a continuous supply of fine, healthful oysters for the buyer and consumer. By this time, the canning business had slowed down due to the heavy demand for the raw product, since with refrigeration, shell oysters and shucked oysters could be shipped all over the East Coast to supply the demand. The buyer could continue to see a supply of Gulf Coast oysters filling in where other areas had fallen to various problems affecting production–disease, pollution, and the dredging of less productive beds for their shells. Gulf Coast producers were increasing their leases in Texas and Louisiana to take advantage of the newly opened markets through the 1960s and '70s. At this time, the buyer was facing the problem of higher and higher prices, and some of the larger processor/buyers were turning to the Korean frozen product to import, re-process, and substitute for the Gulf Coast product. This was very nearsighted as the consumer did not accept this product because of its strong, fishy taste.

As the price continued to rise, we saw less of our product in retail stores and more and more being served in restaurants. As in long years past, the oyster served on the half-shell was continuing to be seen. Most restaurants serving seafood had raw oysters on the menu, as always, and the price continued to increase. However, the public demand did not wane.

It is my view that the buyer and consumer can continue to appreciate a good supply at what we, as producers, consider a fair price. This is all the buyer wants and needs; that is, a continuous supply at prices that the consumer will pay; however, there is a limit to what the consumer will pay, and that is where the buyer can get into trouble in this economy.

It is possible to produce regulations that will restrict an industry, eliminating a good many problems, and still be a benefit to the industry so regulated. The National Shellfish Sanitation Program aided the oyster industry in this regard. It guaranteed to the buyer that the oysters would come from certified areas–tested on a continuous basis from a bacteriological standpoint. This program served its purpose for a good long time until the population growth along our Gulf Coast created pollution–both from industry and from people–that closed a good many of our growing areas.

An attempt was made in the '60s to relieve this situation with the passage of the Federal Water Pollution Control Act. In the case of oyster growing waters, there was not a complete turn-around and we're still working to get some of our old areas back into production.

In the early '70s, as prices elsewhere rose, there was a great demand for the Gulf Coast oyster. At the same time, the auto and steel plants began laying off workers, many of whom came here and got into the oyster business. Later, when forestry products and then, oil, met a downturn, even oil workers went fishing for a living. The Gulf Coast states were really not ready for this influx of people in the industry–the enforcement officers especially–and we did have a problem of fishermen producing oysters from closed areas. But even with the minimal enforcement–and Texas and Louisiana in particular have made great strides in improving both testing the waters and enforcement of regulations – there were only two major outbreaks of the disease we feared most then, hepatitis. One was in the Houston area from oysters produced in Louisiana, the other in Atlanta from Mississippi oysters. In both cases, the oysters came from non-certified waters and were caught there, it is my understanding, by so-called "new" people who didn't know any better. The states have tightened surveillance; and since then, we have seen minimal problems along this line.

As a buyer myself, the first thing I think about is where are these oysters coming from – is my supplier taking the oysters from certified beds?

By the 1980s, the continuing demand for Gulf Coast oysters brought more and more people into the industry as oyster catchers, and it was at this point that I began to see the quality of the oysters diminish. It is my view that there are two reasons for this. The public reefs in Texas and Louisiana were being worked harder and harder. In Louisiana, less emphasis was put on shell planting to help renew the wild reef resource because of the general downturn in the economy of coastal Louisiana and resultant loss of funds to the Department of Seafood and Oyster Bottoms. The wild reef is important to the oyster grower because it is from there that he gets his seed oysters for transplanting to his private bed. It is always true that when demand is up and the price holding up, too, if the traditional production areas won't supply enough, the marginal production areas will be worked. Recently, areas have been used where the oysters were sparse and of poor yield. These oysters of less commercial value were traditionally **not** produced, but now they are, and, while this is a boon to the economy, it has lessened the overall quality of the Gulf Coast oyster.

The second influence on quality has to do with a method of production which is becoming more and more frequently used. As a buyer, I'm concerned about the fact that oysters are being taken from polluted areas and planted in non-polluted areas – a process of natural depuration. Commercial quantities were first transplanted in this manner in Texas. The oysters are left for a short time, harvested, and offered for sale. My concern is that growers soon will add a new wrinkle to this natural depuration process. It is conceivable that they could take their seed oysters from the wild reef-certified waters, place them on their old growing areas which used to be certified but no longer are, then, when the oysters are of good commercial size, move them to a third location – certified water – for cleansing. Now, I know the scientific community says an oyster cleanses itself after so many hours of pumping. But as a buyer–consumer too, for that matter – I'm uneasy about this. I know they're checking the water quality, but who watches to see if the oyster is pumping?

Next in importance to me as a buyer, after I feel sure of the product quality, is supply. Can this supplier sell me commercial quantities on a continuous basis 12 months of the year? I'm not interested in continual small production, and certainly not in large supply over a short term. The only way you can handle a larger supply than normal is to freeze it, but the oyster doesn't lend itself to freezing as does shrimp. Frozen shucked oysters are not easy to sell even though this product has been on the market for about 25 years. If it were readily saleable, I could buy large production on a one-shot basis for freezing, but that is not now economically sensible. In the business today, buyers have to have a steady, constant supply of fresh, raw product. Actually, and you will find this hard to believe, for the last 5 years, my company experienced a greater demand for the product in the summer than in the winter–sales are to restaurants and supermarket chains for the fresh, retail trade.

The most recent problem in the industry is that of the *Vibrio vulnificus* scare. The fact that six people died from eating raw oysters from the Gulf Coast in the year between October 1986 and October 1987 is of concern to me as a buyer only that this is further proof of the need to educate our consumer through good information from the medical profession, and not scare tactics through the news media. As a buyer, I know what widespread hysteria due to misinformation in the press can do to sales. Yes, the fact of *Vibrio vulnificus* has hurt sales somewhat, but we have made every effort to combat the bad publicity with the help of FDA and our trade associations through an educational process warning those very few people who are at risk. I believe that further education is necessary to safeguard the consumer and not adversely affect sales. But I think the suggestion that I've heard, to put a warning on the product container, would be overreacting to the situation.

It is true that two large outlets chose to quit selling raw oysters at the retail level in order to protect themselves from possible litigation. Fortunately for the industry, at the time they quit buying their sales were low anyway; therefore, overall, it did not have an adverse affect.

As a buyer, the *Vibrio* scare has not affected the amount of oysters I purchase anymore than the risk of teeth broken on pearls would do. I don't mean to equate the two in degree of seriousness, but I believe strongly that educating the public truthfully and not through scare tactics should take care of the problem along with the continued care of the product from planting through harvesting, processing, shipping, and sale to the ultimate consumer.

Human Diseases Associated with Shellfish

Roger Olmsted
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It is a real pleasure to be here and to see so many old friends and some new friends in the shellfish industry. To your left, up here on the stage, is a copy of a document entitled "Shellfish Borne Disease Outbreaks." This publication was prepared by Dr. Scott Rippey who is with our FDA Northeast Technical Service Unit in Rhode Island. The report summarizes infectious diseases and toxic agents associated with shellfish-borne diseases or illnesses from 1894 up through 1986, or almost 100 years. Foreign outbreaks are also listed in this document. It has very good appendices that list the publications or memoranda on disease outbreaks that occurred in the United States over the years. The report also contains the medical consequences of infectious disease that have been historically associated with consumption of molluscan shellfish and I hope that you will pick up a copy of this report. I am going to concentrate on those illnesses and deaths that have been associated with the consumption of oysters in the Southeastern Region of the United States during the past year. Most of the illnesses that I will discuss occurred from May 1988 up to the present. A total of 138 cases of shellfish-borne illness and deaths have been logged into the FDA Southeastern Region files during the past year. These illnesses can be separated into three broad groups which include bacterial, viral, and marine biotoxins. This number of cases (138) and some 14 deaths, which I will speak about that are associated with consumption of raw oysters, are totally unacceptable. In addition, the epidemiological investigations and case history reporting leave a great deal to be desired. There are undoubtedly many cases of illness and even deaths that go unreported. We will be meeting with officials from the Center for Disease Control to try to improve on the reporting procedures for shellfish-borne diseases at the local, county, and state levels. Generally, we hear about these cases from County Health Departments, sanitarians, nurses, physicians, or the information could come from a hospital record, state epidemiologist, or just a consumer complaint. There are a lot of people from different backgrounds who are investigating these outbreaks and reporting to us.

I want to discuss the *Vibrio vulnificus* problem. This bacterium was only recently described in the scientific literature. A human case of *Vibrio vulnificus* follows a typical pattern. The cases which come to our attention are individual cases, which occur between May and November, primarily during the summer months and during summer harvesting. The typical patient is an adult male who has a pre-existing underlying chronic health illness such as cirrhosis of the liver, and is an alcoholic or perhaps a diabetic. *Vibrio vulnificus* is most often associated with consumption of oysters on the half shell. In our Southeastern Regional office in Atlanta, there are only two cases of *Vibrio vulnificus* that I can recall that we have been able to associate with shucked oysters. So it is very much associated with consumption of oysters on the half shell. Generally, if infection follows consumption of oysters on the half shell, within 4 days the patient may die. The mortality rate from *Vibrio vulnificus* seafood consumption cases, generally ranges from 40 to 60 percent. That is a very high mortality rate. We also are very concerned about *Vibrio vulnificus* because of the course the disease takes. It includes primary sepsis associated with fever and chills, hypertension, nausea, vomiting, diarrhea, abdominal pain, and frequent skin lesions. The patient may suffer the amputation of a limb, and generally death will occur on the fourth or fifth day after consumption of the contaminated oysters.

Another aspect of *Vibrio vulnificus*, other than the consumption cases, are the wound cases which can result from puncture wounds. We have recorded cases resulting from the handling of crab traps or other types of exposure in the marine environment. I will mention a couple of unique cases that have come to our attention. There was a nurse working in a hospital in New Orleans and a fellow came through the building peddling oysters. The nurse bought some of the oysters. She took them home and shucked them out in the back yard. The oyster shells were discarded in the grass. Later, her husband came along with the lawn mower and ran over these shells. A fragment of shell flew up and pierced the husband's eye and an infection resulted. Another case, which came to our attention, involved a father and son on a shrimp boat. The son had been handling shrimp, his hands were contaminated with *Vibrio vulnificus*, and he accidentally poked his father in the eye. The father developed a *Vibrio vulnificus* infection.

These episodes underscore the fact that *Vibrio*

vulnificus is common in the marine environment. It is in the waters and sediments in the estuaries, as well as in oyster meats. *Vibrio vulnificus* also has an affinity for chitin. There is no known control for *Vibrio vulnificus* in the marine environment. However, there are time/temperature controls that can be followed in the harvesting, transporting, and storage of shellstock that will help. Dr. David Cook from the Gulf Coast Research Lab has completed a study and published the effects of storage of oysters at different refrigeration temperatures. He has concluded that the best method of control that we presently have for *Vibrio vulnificus* is to keep the oysters at or below 10° C to retard the growth of bacteria. I would quickly add to that from my experience in observing harvesting, distribution, and processing activities that oyster shellstock should be stored in the plants in walk-in coolers at temperatures of 34° to 37° F to minimize multiplication and growth of *Vibrio vulnificus*. Supporting evidence also comes from a study that Dr. Frank Bryan did. He is formerly with the Center for Disease Control and summarized nearly 800 foodborne disease outbreaks over a period of several years. The most common factor he found that leads to foodborne disease is improper refrigeration of the product. Good common sense will tell you how this also can be applied to the handling of oyster shellstock. Since this problem with *Vibrio vulnificus* has arisen, there are five states that now have mandatory reporting for *Vibrio vulnificus* cases. Those states are Florida, Alabama, Louisiana, Texas, and California. Since May 1988, a total of 17 cases of *Vibrio vulnificus* associated with consumption of seafood have been reported to our Southeast Regional Office in Atlanta. There were another four cases reported, but no food history was obtained from the patients. Of these 21 cases, we have recorded a total of 11 deaths. The majority of these patients (practically all of them) had recently consumed raw oysters which were traced back to oyster beds in one or more of our Gulf states. In addition, during the same time period, we noted four cases of *Vibrio cholera* and we had one *Vibrio parahaemolyticus* death. I can recall back a few years when the scientific community considered *Vibrio parahaemolyticus* as being a problem of the coastal waters of Japan. Now that organism is commonly found all over our U.S. coastal waters. We also had one case of *Vibrio hollisae* and three other separate cases which were due to unknown pathogens.

I want to discuss the hepatitis outbreak which you heard mentioned earlier this morning. This outbreak was centered in Bay County, Florida. There have been 61 cases of hepatitis confirmed in association with consumption of oysters on the half shell, which were illegally harvested at night from closed areas. One area, Watson's Bayou, which is grossly polluted, was felt to be the main source of suspect oysters. The Florida Marine Patrol, prior to this outbreak, had been well aware of the extent of illegal harvesting in the county and had made 34 arrests of bootleggers, mostly at night in the closed areas. The window for the period of infection for this hepatitis outbreak was in June and July of this year. The patients which were involved in the illness came from Alabama, Georgia, Mississippi, Florida, and as far off as Hawaii. There was a lot of publicity that resulted from this outbreak.

In my experience, it seems like the Hepatitis A cases appear to come in 10-year cycles for some reason. A Hepatitis A outbreak, as we know it in the shellfish industry, is associated generally with gross sewage contamination flowing over the oyster beds. Hepatitis A cases may be subclinical infections or can result in severe jaundice, liver degeneration, or death. The incubation period from time of consumption of the oysters is anywhere from 15 to 50 days. This does make it difficult in trying to trace the source of suspect oysters, which again reflects on the importance of keeping adequate records on purchases and sales. With Hepatitis A, the convalescence period may be prolonged. It can last from several weeks to months.

I want to mention the third group, which is the neurotoxic shellfish poison cases. We saw a total of 48 cases of neurotoxic shellfish poisoning, primarily from North Carolina, and a case or two from South Carolina last year. This episode really took everybody by great surprise. It was unprecedented in the literature. There are rather frequent dinoflagellate blooms that occur off the west coast of Florida out in the Gulf. Occasionally, these blooms will move down around the Florida Keys and, in this particular instance, apparently got into the Gulf Stream and the toxic organisms were carried up to North Carolina. Then a portion of that bloom came down the North Carolina coast and into the South Carolina oyster beds and resulted in the closure of the shellfish industry for several months in that area. We all have a common goal in the shellfish industry and that is to ensure that the consumer receives a safe and wholesome product in interstate commerce.

I would like to focus on the *Vibrio vulnificus* problem. As I mentioned, *Vibrio vulnificus* is commonly found in the marine environment. It can be recovered from sea water, from the muds in the estuaries, and from the raw oysters themselves. The *Vibrio vulnificus* cases that we see occur during the summer months, primarily, from May into November. They can result in blood poisoning and have a very high mortality rate. After the *Vibrio vulnificus* problem reached national attention, we had a workshop in Washington, DC. Sixty scientists, administrators, and several people in the audience here today participated in that

conference. The National Marine Fishery Service, the Interstate Shellfish Sanitation Conference, and the Shellfish Institute of North America were all actively participating. The group was divided into four categories or study groups: the environmental group, time and temperature controls and relationships, epidemiological and analytical. The four groups came up with some conclusions and recommendations.

First of all, you have to accept the fact that *Vibrio vulnificus* is commonly found in the marine environment. There are no known correlations with environmental or water quality factors. It is not associated with pollution and we don't know of any control method in the marine environment. We are quite disturbed to find that if you sample two oysters from the same lot, one oyster may have a very large number of *Vibrio vulnificus* organisms whereas the other oyster may not be contaminated at all.

Time/temperature controls are what really need to be emphasized. There are going to have to be a lot more studies made on harvesting practices, optimum transport times (both at sea and on land), how oysters are handled in the plant and stored, and how they are distributed in interstate commerce. At the present time we don't know what the infectious dose is and we don't know really where these organisms grow and multiply in the distribution chain. We don't see the *Vibrio vulnificus* problem with shucked oysters and this is probably associated with temperature controls. My experience in the shellfish plants, shows me that most all of them have a chilled water skimmer. Oysters are often held in an ice slurry in the blowers. I have also noted in the last 2 or 3 years, that plant managers are beginning to store shellstock at lower temperatures. In inspecting plants in South Carolina, I found this past year that 75 percent of the plants were storing oysters and clams at temperatures between 34° and 37° F.

From the epidemiological standpoint, there is a lot of research going on at present to develop better and more rapid methods for identification of the organism. The virulence factor is not well understood. We do know, because most cases we see in the United States occur in the Gulf region, that apparently the organism is much more virulent in this section of the country than other parts of the nation. However, part of this could be due to better reporting procedures and greater awareness of the problem. We occasionally see cases from the Pacific Coast states. This is a problem with individuals that have some underlying, preexisting chronic illness such as cirrhosis of the liver or diabetes. My recommendation to anybody in that high risk group is that under no conditions should they eat a raw oyster. Risks and consequences are too great.

There are some studies that are going on at present at our FDA Technical Service Unit at Dauphin Island, Alabama. They are studying the freezing of oysters to see how this affects the organism. They are also doing some harvesting from Alabama waters, bringing these oysters into the laboratory, and storing them at different temperatures. They are also holding them for different lengths of time and then checking the numbers of *Vibrio vulnificus* that they find in these oysters.

There is an FDA publication that goes out to all of the nation's physicians, pharmacists, and a lot of nurses. One issue of this publication focused on *Vibrio vulnificus*. FDA also has a consumer reports magazine that comes out monthly and there have been two articles devoted to the *Vibrio vulnificus* problem. In addition, the Interstate Shellfish Sanitation Conference and the Food and Drug Administration have been making presentations at the American Medical Association and to various high risk groups that are so vulnerable to infection by these organisms. The Interstate Shellfish Sanitation Conference also recently has published a packet of helpful information on *Vibrio vulnificus*.

Classification and Trends of Shellfish Growing Waters in Mississippi

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Before I give you the trends and classifications, I think we need to discuss the National Shellfish Sanitation Program. It is a cooperative state/FDA/industry program for the certification of interstate shellfish shippers as described in Public Health Service Publication Number 33: *The National Shellfish Sanitation Program Manual of Operations, Parts I and II.* Part I deals with the classification of growing waters. Part II deals with processing plants. The manual is simply agreed-upon guidelines between FDA, state, and industry personnel.

The states have responsibilities for adopting laws and regulations for sanitary control and for sanitary surveys of the growing areas and subsequent classification of all actual and potential shellfish growing areas. They also have the requirement of controlling closed areas. They inspect the shellfish plants and they issue certifications as appropriate. The states do the certification and perform additional control measures as needed.

The FDA then gives an annual evaluation of the state shellfish control programs. Roger and I cover North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, and Louisiana. Then we report to the ISSC the status of the state programs. We also publish the Interstate Certified Shellfish Shippers list from the list that is given to us by the member states.

The industry responsibility within the program is to ensure that processing plants meet the standards. Shellfish are labeled with the proper certificate number and processors maintain records of the origin and disposition of shellfish. This is extremely important.

Surveys of the growing area must be made. They must be made for each approved, conditionally approved, and restricted growing area. Each survey must then be reviewed each year, and there is a complete re-evaluation of the data every 3 years.

For an approved area, there can be no contamination with fresh fecal material, pathogenic organisms, poisonous substances, or marine biotoxins. As far as bacteriological water quality is concerned, many people think that you classify a growing area based simply on general data. That is not true at all. There are a lot of other things that go into the proper classification but the bacteriological water quality at every sampling station must be included. In other words, each sampling station stands by itself as, if you will, an individual growing area. It is difficult to understand sometimes, but the sampling stations have to be properly placed and be indicative of that growing area. The bacteria count (median) cannot exceed a total coliform MPN (most probable number) of 70 per 100 milliliters with not more than 10 percent of the samples exceeding the MPN of 230. In all of our states in our region, they use a fecal coliform standard, the median which cannot exceed 14 per 100 ml with less than 10 percent exceeding 43 per 100 ml. That is for approved areas.

Let me describe to you briefly what "14 fecal coliforms" break down to. If you take one person's waste that is excreted in one day and mix it up and spread it in some water and try to dilute that waste down to meet this 14 per 100 ml standard, it would take 8 million cubic feet of coliform-free dilution water to dilute one person's waste. That is a strict guideline. That breaks down to approximately 61 million gallons for one person or roughly five football fields 3 feet deep. It is a very strict standard to meet approved area criteria.

We also have other classifications of growing waters. A restricted area must also have a sanitary survey and a limited degree of pollution. It may be a source of shellfish for relaying or controlled purification and depuration. No poisonous or deleterious substances may remain in shellfish after the relaying or controlled purification process. We also have another bacteriological standard, which is 88 fecal MPN (88 per 100 milliliters) median and not more than 10 percent of the samples can exceed 260 MPN per 100 milliliters. We also have a prohibited area classification. Obviously when you have a prohibited area, you don't have to do a sanitary survey. You are required to classify the area as prohibited if the shellfish are

adulterated with poisonous substances and can't be cleaned. These areas are subject to unpredictable sources of actual or potential pollution. There is no shellfish harvest from prohibited areas for human food use.

We have conditionally approved areas and we also have conditionally restricted areas. The conditionally approved area has to meet approved area criteria at all times when it is open. This includes the correlation of water quality with predictable environmental conditions, performance standards for other sources of pollution such as sewage treatment plants, alert systems to notify authorities when adverse changes occur, criteria and procedures for opening and closing these areas, specifications for re-evaluation of the management plan, and an agreement by all parties involved, including the industries, showing that the purpose and conditions are understood. You take enough bacterial data and do a correlation study with whatever existing environmental condition that causes the degradation of the water quality to where it no longer meets approved area criteria.

For example, if you take bacterial data and find that with a 2-inch rainfall you will no longer meet approved area criteria in your management plan for that conditional area, for your closure criteria on this area you should state: ". . . will close the area upon the occurrence of 2 inches of rainfall."

Another example would be a river stage. Appalachicola Bay in Florida has two conditions or two variables that cause the degradation of water quality: the height of the river (or amount of fresh water coming down the Appalachicola River) and rainfall. Another example would be the closure of a conditionally approved area based on the performance of the sewage treatment plant. They may have an overload for some reason, such as high rainfall, and resulting additional fecal material the sewage treatment plant is unable to treat is released into the area. You always want to close an area prior to the actual degradation of water quality and the reason is that the initial pollution is probably laden with more of the pathogens that we are concerned with than any other part of the storm effect. You want to be able to close the area as soon as your environmental condition indicates. If you wait for the sample to come back from the laboratory, you miss the critical time you want to close.

Oysters have the ability of bio-accumulating in the environment during normal feeding activity. They will concentrate organisms. It has been stated by reliable microbiologists that an oyster will reflect the water quality within one hour. In other words, if you had good water quality and all of a sudden you had a lot of rain and washed the waste into the area the oyster would reflect that within one to 6 hours. They also concentrate the organism up to 10 times what the overlying water would indicate. So if you had 10 parts per million in the overlying water or 10 fecal, then you would have 100 in the oyster meats.

Let's go to the trends and the qualities of shellfish growing waters in the Gulf currently. Approximately one-third of the growing areas in the Gulf are currently classified conditionally approved. I certainly foresee an increase in this classification category based on the experience on the East Coast where North Carolina increased in population along the coastal areas 100 percent in 6 years. In the summertime, it is 500 percent. The majority of the shellfish growing waters in the Gulf of Mexico do not meet the fecal coliform standards for approved harvest. Twenty-nine percent of the waters are classified as prohibited. These are waters adjacent to urban areas and smaller shoreline developments. An additional 27 percent of waters are managed as conditionally approved. These areas are further from developed shorelines, have harvestable resources, and are heavily affected by freshwater inflows from heavy rainfall or high river stages.

The Gulf area is the fastest-growing coastal region in the United States. Concurrent with this growth has been a decline in the availability of molluscan shellfish resources throughout the region. During 1987, production was severely curtailed in Florida, Alabama, Mississippi, and Texas. Only Louisiana continued level production, due to a very successful shell planting and relay program.

In the Gulf of Mexico, the predominant sources of fecal coliforms are sewage treatment and collection systems, which are a contributing factor in the closure of 34 percent of harvest-limited waters. These are both from primary sources and 22 percent from upstream sources. Septic systems that do not function properly in coastal areas because of poor soils and high ground water tables also affect classifications. Approximately 39 percent directly affect and about 10 percent upstream affect the growing waters. The only region that has an appreciable amount of approved growing areas currently in the southeast is the Chandeleur/Breton Sound region.

Appalachicola Bay is an entire bay system where the oyster area is classified as conditionally approved, with the exception of about a half-mile radius around Appalachicola Bay itself, which is a prohibited area. Mobile Bay shows a similar condition and the largest part of that area is prohibited. In the Mississippi Sound, which we are concerned with here, the area that is approved doesn't have any oysters in it. The area that is conditionally managed is where the majority of the oysters are located. This past year we did a Biloxi Bay study and it was very difficult to find oysters anywhere for samples. You can see the

trends indicate the movement to a conditionally approved status. As you can see from the landings and oyster reef locations, nearly all of the oysters that were landed in the Gulf region were from conditionally classified waters.

Of course, one of the primary problems is sewage treatment: straight pipes, sewage treatment plants which continually malfunction, and septic tanks with inadequate drain fields or in ground water. Other pollution sources would include industry, boating and shipping activities, urban runoff, agricultural runoff, feedlots, wildlife, and other upstream unidentified sources where there are so many that we would simply identify the river itself as the source of fecal material. In the Mississippi Sound area, you can see the sources of pollution vary from the sewage treatment plants, industries, septic systems, shipping, boating, and urban runoff. These are upstream sources that generally feed into a river. The river then is considered as a source of pollution.

Changes in the Gulf of Mexico shellfish growing waters have been noted in more than 800,000 acres in 45 areas. More than 90 percent of these changes are from approved to conditionally approved or similar classification. In Mississippi, the major changes to occur from 1971 to 1985 are the designation of ship channels as prohibited and the addition of conditional areas. The inner bays have been closed to harvest for many years. The first closure line in Biloxi Bay was established in 1945. The line gradually advanced outward toward the Sound until the entire bay was closed in 1967. Pascagoula Bay was closed in 1936, after oysters harvested at the mouth of the Pascagoula River caused an outbreak of hepatitis. Development in the unsewered community of Mallini Bayou, at the western end of the sound, is currently threatening to close additional harvest areas due to increasing levels of pollution.

Although studies of fecal coliform levels along the Mississippi Coast show great reductions as a result of improvements in sewage treatment plants, collection systems, and storm drainage, levels are still above shellfish growing water standards. Data collected at bathing beaches during summer months from 1976 to 1986 showed improved water quality at 8 of the 10 stations. Fecal coliform levels in Biloxi Bay declined by as much as 95 percent after a new regional sewage treatment plant in Ocean Springs replaced an older overloaded facility.

A study was conducted in the summer of 1987 to determine if prohibited shellfish waters in Biloxi Bay could be opened to harvest on a conditional basis as a result of the Ocean Springs upgrade. Preliminary results suggest that the waters are still not suitable for conditional harvest but may be used for relaying or depuration.

National Shellfish Pollution Indicator Study

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I am really glad to get to come to Mississippi and talk to you about this project. I know that some of you were at the Louisiana Oyster Growers' Convention last summer, and some of you have been to some of the other meetings that I have been to. But, I would like to talk with those of you who have not heard about this project and why we feel that it is important.

Of the 15 million acres of national estuarine waters classified for shellfishing by the National Shellfish Sanitation Program, the most productive areas are often classified as conditionally approved. These areas may be closed during a great part of the year due to rainfall runoff or high river stages. Actually, one of the 15 million acres is in Cocodrie, Louisiana behind our marine laboratory. I think that that area has been closed since 1973. It is at the lower end of a residential coastal area. That area hasn't been open for a very long time. But many state regulatory and industry members I have talked with in visiting throughout the country have estimated that at least one-half of their most productive shellfish growing areas may be closed for harvesting for as much as 50 percent of the year. NOAA has statistics that show that at least one-third of all the acreage is not approved, and these closures are based on unacceptably high levels of the current fecal coliform indicator, sewage, pollution, and growing waters. The following is a consensus of the most serious sewage and runoff problems that cause the main impact on water quality conditions, health risks, and resource management of the shellfish estuaries.

First of all is a lack of effective sewage treatment and disposal systems in unsewered coastal communities; or noncompliance of sewage treatment plants in coastal areas. It is a little bit different in Mississippi, but in Louisiana I can tell you that the type of ground we have down in our coastal communities is highly unsuitable for septic tanks to say the least.

Second, and we have certainly discussed this many times, is the lack of resources in many states for rigid enforcement to prevent shellfish harvest in non-approved growing waters.

And third, and this is what we are concerned with, is the lack of a valid indicator system of actual human health risk from shellfish consumption, especially from animal non-point sources. And that brings us to the main question that has been addressed so many times. The question of the health significance and validity of the current indicator guidelines and standards in shellfish growing waters and in meats has been asked in many workshops and discussed in meetings many, many times over. And, in answer to this in the summer of 1987, the shellfish industry in Louisiana requested us to put on a workshop to evaluate this problem with the indicator once and for all and outline a rough draft of a proposal for a national study to address this question at the national level. We invited members from universities from throughout the country who work in shellfish sanitation and also members from ISSC, state regulatory agencies, the federal regulatory agencies, and some industry people to attend this workshop and work with us in putting together this rough draft.

We outlined a plan for a collaborative study that would involve input and expertise from members of state and federal regulatory agencies, from industry, and from the universities. We had several objectives that we felt we would like to accomplish. These objectives include evaluating both the existing standards and new technology, methodologies for the enumeration of fecal indicators and enteric pathogens in shellfish growing waters.

As stated earlier in the history of the ISSC and the NSSP program, the current indicator standard was extrapolated from standards set in the 1920s to protect the public from typhoid fever, which is caused by a salmonella enteric bacterium that can be transmitted to man from raw sewage. This indicator certainly proved to be very effective, since we have not had a case of typhoid fever, from raw shellfish in the United States since the 1950s. However, there is now a need for high technology rapid-method indicators that can differentiate animal from human contamination. The public health risk of fecal material from animal sources versus human sources has not been evaluated.

Gary Stelma at EPA is putting together an extensive literature review on the subject of animal

contamination and health risk. His basic conclusion is that there is very little material on this subject and this is something that obviously is going to be very important. The problem of extensive closures due to high fecal coliform indicator counts from non-point animal sources has been identified as one of the major concerns of state regulatory and industry members throughout the country. Although animals can carry bacterial pathogens, these have generally not been associated with shellfish-borne human illnesses.

Sewage-associated human illnesses from shellfish consumption are mainly of a viral ideology, which is very species specific—in other words, specific for humans and carried by humans—not by animals. These are mainly, of course hepatitis type A and a non-specific of gastroenteritis of which the Norwalk virus is the main type. The cases of hepatitis today, seem to go in cycles and in the last 10 years, the cases have decreased in the United States. But the incidences of the Norwalk virus and other non-specific viral gastroenteritis diseases have increased.

However, current microbiological data indicate that a constant and predictable relationship does not exist between the current fecal coliform indicator and human enteric viruses in estuarine waters and shellfish.

The second objective that we felt we would like to accomplish in this study would be to design and conduct epidemiological studies to relate microbiological and sanitary survey data and shellfish consumption with actual consumer disease risk. Some of you may be aware that NOAA and EPA are currently carrying on a pilot epidemiological study on the East Coast. The results of this study are just beginning to come in. Essentially what they are doing is evaluating potential health risks from sites where there is a known human point source of contamination. What we would be looking at in our study would be to evaluate all possible areas that have different types of contamination, especially sites which are impacted by animal non-point sources of contamination and by rainfall runoff to see how this impacts human health—not just how human point sources impact human health. We know that human point sources can certainly impact human health, because this is where the human viruses come from. The results and the design of this pilot study can certainly be used as important background information that can be used to help develop the national study.

The third objective would be the overall objective of this proposed study, and that would be to determine the best regulatory indicator (or indicators as the case may be) of sewage associated disease risk from the consumption of raw shellfish.

At the LUMCON meeting we put together a work plan to accomplish these objectives and the main components of this work plan. First of all, we had to obtain some funding to develop this project. This has been ongoing since February 1988. We were awarded funding from a Saltonstall-Kennedy research grant through the Gulf and South Atlantic Fisheries Development Foundation in Tampa, Florida to develop this proposal for this year. This has been ongoing since February and will run through the end of January.

The second thing that we felt we had to do was establish a steering committee. This steering committee was made up of ISSC, federal regulatory, industry, and university people from the four main shellfish producing areas of the country. We divided the country into the North Atlantic, the South Atlantic, the Gulf Coast and the West Coast, and we have one university representative and one industry representative from each of these areas. We have an ISSC representative representing the state regulatory agencies and one member from each of the federal agencies—the FDA, the National Marine Fisheries Service, the National Ocean Service, and the Centers for Disease Control. Each of the federal agencies is also represented so that we can have input from all of the people who are concerned with shellfish sanitation.

We also felt that we had to establish some working groups to develop this project and we set certain groups together. We have chairmen for each group, and people who have been working with these groups, and we certainly invite anyone to give any input or comment into some of these areas. You can contact the person who is the chairman of any particular area in which you would be interested in giving any input. Their names and addresses are listed in the packets of information, which I have provided. Obviously, the literature review is a very important and a very difficult job. The National Marine Fisheries Service Laboratory in Charleston, SC will coordinate that effort. Estuarine site selection is being coordinated by Dot Leonard of the National Ocean Service; virus methods by Dr. Mark Sobsey at the University of North Carolina in Chapel Hill; rapid methods by Dr. Rita Colwell at the University of Maryland; microbiological methods by Dr. Cameron Hackney, who is at Virginia Polytechnic Institute; the shoreline survey methods by Dr. Stewart Stevenson, who is with the Georgia Department of Natural Resources and also chairs that particular committee for the ISSC; epidemiological methods by Dr. Al Dufour of EPA, the coordinator for the EPA-NOAA epidemiological study that is ongoing; statistical records by Dr. Al Ranasek at the University of South Alabama; and the budget committee is chaired by Mr. Tom Murray, executive director of the Gulf and South Atlantic Fisheries Development Foundation.

We also certainly felt that we would have to obtain support for this project from federal, state, university, and industry communities and we have been presenting this particular information at many different meetings. There have been many individuals who have given of their time and effort to support this project directly at meetings and workshops and also indirectly. This includes everyone from the federal agency members, state regulators, and especially the industry members who have helped with the Congressional support effort and the university researchers who have given of their time and expertise.

We also have some resolutions of support from some of the states–Virginia, Louisiana, and North Carolina–that are very nice and I would certainly like to get one from Mississippi and from more of the states. Again, these came through the efforts of state regulatory and industry members; and essentially it is just a resolution by your state legislature saying that your state would benefit from this type of study, and that they support it. They send this resolution to the Congressional delegation in Washington. These are pretty easy to get because it doesn't cost the state anything and it makes the industry people happy. So we haven't had any trouble getting these. I have asked some of the industry members in some of the states to work with us on them. But it certainly helps out in Washington when you have a resolution from the entire state legislature saying that they would support the study.

We have also obtained some important resolutions of support from very important industry and regulatory groups, and ISSC gave us our first resolution of support when this project was first put together. We have one from the Interstate Seafood Seminar, the Gulf and South Atlantic Shellfish Sanitation Conference, the Pacific Regulatory Industry Meeting, the Shellfish Institute of North America, the Virginia Seafood Council, the Louisiana Oyster Industry Convention, and actually I also have one from the Pacific Oyster Growers and Dealers. I would certainly like to have some support from the Mississippi oyster growers on this particular study.

Some of the university meetings we have attended and discussed this project include the American Society for Microbiology, the National Shellfish Association, and the Tropical and Subtropical Fisheries Society Meeting. We had a microbiological methods workshop at the University of North Carolina in Chapel Hill where some of the scientists got together and we tossed around some ideas on research methodology and priorities, and of scientific alternatives.

We also felt that we had to obtain Congressional funding for a 4-year national study. We put together a rough budget of what we thought it would take to accomplish the study. We originally felt that we would like to target at least 16 estuarine sites for a national study and that would be four in each of the four geographic areas of the country. We felt that it would take a minimum of about $300,000 per site and that is a very conservative estimate, especially if several laboratories would be collaborating at each site, which we feel would be the case. So when you multiply $300,000 times 16 sites, plus administrative cost, it would be approximately $5.5 million dollars a year or $22 million for the 4-year project.

The support for the funding in Congress has come through the efforts of state agencies and industry members throughout the country who have contacted their legislators and asked them to support this effort. We have been invited to present testimony to some of the subcommittees in Congress. Some testimony has been presented to the House Appropriation Subcommittee on Commerce, Justice, State, and Judiciary. Mr. Neil Smith of Iowa is the chairman of this subcommittee and, unfortunately, this has been our toughest subcommittee. Iowa does not produce a lot of oysters as you could well imagine and Mr. Smith is not too favorably inclined toward this, so we are trying our best to work with that committee.

We were also asked to present testimony to the House Subcommittee on Fisheries and Wildlife Conservation and the Environment. Mr. Gerry Studds of Massachusetts is the chairman and he held a lot of hearings on coastal pollution during the summertime and into the fall. One of these hearings was on coastal pollution and shellfish bed closures. We felt that that was a very beneficial hearing. The industry in Massachusetts has certainly been urging Mr. Studds to do something about the closures, because Massachusetts, as a shellfish producing state, has the same problems that we have on the Gulf Coast and all of the coastal states.

Those of you who were at the Louisiana industry meeting at the end of August heard Representative Billy Tauzin from Louisiana speak and he has authored a resolution in the House called the Shellfish Indicator Act. This particular House Resolution has been referred to Mr. Studds' House Subcommittee on Fisheries and Wildlife Conservation and the Environment. Essentially, this is an authorization bill, which would authorize the Congress to appropriate the funds for the 4-year study. Mr. Studds' staff people tell me that this bill will be reviewed by the end of January by the subcommittee and we certainly hope that it will pass. In the meantime, because we didn't have any funding to get this program started, Senator Bennett Johnston from Louisiana put in a Senate appropriation committee amendment which was supported by Senator Hollings from South Carolina, Senator Mikulski from Maryland, and

Senator Breaux from Louisiana. An appropriation of $500,000 was granted by the House and Senate Conference Committee for start-up money, and certainly this was important because now this is no longer a new project. New projects were not to be funded at all. So we felt that this was very good. These funds will be used to begin some preliminary work of developing a human-specific indicator.

What are the potential benefits of a study of this type? Well, first of all, and obviously I think that everyone realizes that consumer confidence in shellfish is not very high right now. We feel that a study of this type would certainly build consumer confidence and protection from sewage contamination in shellfish products by developing a new system for classification of shellfish growing waters using the latest technological advancements in microbiological and epidemiological methods. When I was at the coastal pollution hearings in Washington, one of the people on the panel with me was from NOAA, and was handing out charts that had appeared in *Time Magazine*. I think you can see why consumer confidence is probably at an all-time low currently due to many alarming publicity reports concerning the questionable safety of seafood. This is just one example.

A map was drawn up by NOAA to show areas where more than one-third of shellfish growing areas were closed for commercial harvest. *Time Magazine* artists added little skulls and crossbones for effect and if you don't read the article very carefully, you would not see that those are to indicate areas where they found some toxic chemicals in fish livers, which has nothing to do with the shellfish. Yet, the skulls and crossbones are right next to the shellfish. This type of publicity has certainly been rampant in the seafood industry and this is unfortunate especially in the light of the recently published GAO Report which concluded that "The available seafood-borne illness data from the Center for Disease Control, while certainly not complete, still did not indicate widespread problems with the Nation's seafood. In fact only 5 percent of all the food-borne illnesses recorded from the period 1978 to 1984 were due to seafood and only about half of the seafood illnesses were due to shellfish. Most of the shellfish illnesses were due to toxins." However, it was acknowledged in the GAO report that more research was needed in some areas, and this included development and research on tests for certifying shellfish growing waters.

A second benefit, is possible alleviation of the economic burden on the shellfish producing states that have very large areas of productive growing waters closed due to (non-point) animal and rainfall runoff sources. Some of the most productive growing waters often are most impacted by non-point source pollution runoff. The persisting problem of extensive closures due to high fecal coliform indicator counts from (non-point) animal runoff has been identified as one of the major concerns of state and federal regulatory agencies and industry members throughout the country. This is something that everyone has cited as a number one problem and a number one concern. There is a priority need for research in this area to provide indicators which distinguish animal from human fecal contamination and assess the health risks of each in estuaries throughout the country.

The last benefit of the study would be to improve shellfish resource management and regulatory capabilities for state and federal shellfish sanitation and regulatory agencies. All results of this national study will be referred to the ISSC, which is of course, the regulating body in the shellfish industry. The ISSC can then evaluate and consider these results for possible use in the National Shellfish Sanitation Program.

State and federal regulatory officials have continually expressed the need for high technology, simple, rapid methods to enumerate or quantify reliable indicators of human health risks associated with shellfish consumption for management or classification of shellfish resources. And surely this is not too much to ask scientifically as we approach the 21st century for such a valuable renewable resource as our shellfish estuaries.

Pollution Abatement and the Associated Effects on Shellfish Waters

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I appreciate the opportunity to speak this afternoon. As Dave mentioned, I was asked to speak about pollution abatement and associated effects on shellfish waters. I think you realize from the last several speakers, it is almost impossible to discuss shellfish without bringing up the issue of pollution.

The very nature of shellfish beds, being located in shallow waters near the shore, puts them in jeopardy due to pollution from developed areas. There is a direct relationship between U.S. population levels in coastal waters and pollution. It has been determined that one-sixth of the population now lives in the Gulf coastal states, and this figure is expected to grow larger in the future. With increased population, the potential for pollution increases due to discharges from industrial and municipal sources and general runoff from urban areas. As in other states, emphasis has been placed in Mississippi on regulating point source discharges. Point sources are simply discharges that come out of a pipe from sources such as municipalities, industries, or commercial developments. The Federal Clean Water Act requires that all wastewater discharges into the waters of the United States meet certain criteria in order to protect the existing or potential use of those waters.

Along the Mississippi Gulf Coast, wastewater treatment has been a particularly important issue when considering the environmentally sensitive uses for recreation and shellfish harvesting. Much progress has been made in eliminating sources of pollution along the Gulf Coast. In particular, Gulf Coast public officials and citizens have taken the initiative to solve water quality problems associated with municipalities. Extensive planning was conducted which indicated the need for new or upgraded regional wastewater treatment facilities, which would eliminate numerous small private facilities. The municipalities and wastewater authorities have received millions of dollars in grants through the Federal Construction Grants Program, which is managed by the Bureau of Pollution Control, to rehabilitate and expand sewer systems and update or build new wastewater treatment plants. These grants typically require a local match of 25 percent and the municipalities or districts then turn around and have been able to get 12½ percent sometimes through state loans and then usually the other 12½ percent has to come from the local citizens.

To give you an idea of the commitment made by the Gulf Coast citizens to improve and protect water quality, I will show you some listings of major projects which have been completed or are currently under construction or planned for the future. Significant projects already completed along the Gulf Coast are shown in Table 1. Here again, I remind you that the numbers up here represent the grant amounts that I was able to get from my office, and so you have to assume that generally these represent 75 percent of the total project cost.

Table 2 shows projects currently under construction, and Table 3 shows projects planned for the future. Notice that the first column on Tables 1 and 2 says

Table 1. Completed Projects.

	Project	Grant amount millions of $	Completion
Biloxi	Rehab	1.3	8/87
	W. Biloxi Outfall	0.122	6/80
	Keegan Bayou STP	6.5	9/87
D'Iberville	Treatment	3.9	10/88
	Collection	3.7	6/88
Gulfport	Rehab	0.8	5/82
Ocean Springs	Rehab	0.5	2/84
	Treatment	14.1	10/87
Gautier	Collection	6.2	5/88
	Treatment	5.0	4/88
Pascagoula/ Moss Point	Moss Point Rehab	0.5	5/83
	Pascagoula Rehab	0.75	10/83
	Pascagoula Treatment	0.9 12.9	3/81 10/87

Table 2. Projects under construction.

	Project	Grant amount millions of $	Start-Completion date
Gulfport	Treatment	17.4	10/84 - 4/89
W. Biloxi	Treatment	4.0	10/88 - 4/91
Waveland/	Treatment	5.9	4/85 - 4/89
Bay St. Louis	Collection-Breath/Edwards Bayou	3.0	6/87 - 6/89
Long Beach/Pass Christian	Treatment	7.5	6/87 - 6/89

Table 3. Projects planned for future.

	Project	Loan amount millions of $	Start-Completion date
Escatawpa	Treatment	23.5	3/9 - 3/92
N. Back Bay	Collection/Interceptor	10.0	3/90 - 3/92
Pascagoula	Rehab	1.5	3/90 - 3/91
Waveland/Bay St. Louis	Breath/Edwards Bayou	0.9	4/90 - 4/91
Pass Christian/Long Beach	Henderson Point/Pass Christian Isles	2.2	2/90 - 8/91

"Grant Amount"; Table 3 says "Loan Amount." The Federal Construction Grants Program is being phased out now and is going to be replaced by the State Revolving Loan Program. In this program, 20-year loans will be available to public entities at a very low rate of interest to construct these types of wastewater projects.

It also should be noted that during the same time that municipalities have been addressing their wastewater treatment issues, the industrial and private facilities were also required to comply with the Clean Water Act. However, in their case, monies in the form of grants or loans are not available as for municipalities. Therefore, you can see that a considerable investment has been made along the Gulf Coast to protect water quality. As projects have been completed, we have noted improvements in water quality through our various monitoring programs. However, we feel that we will not be able to further improve water quality along the Gulf Coast unless we now concentrate on non-point sources of pollution. Non-point source pollution basically comes from runoff from activities such as agriculture, forestry, construction, and mining, as well as general runoff from urban areas. When you consider that two-thirds of the contiguous United States drains into the Gulf of Mexico, it is obvious that some of these sources must be controlled far away from the coast. The state is currently developing a new Non-Point Source Control Program to start addressing these issues. Specific "Best Management Practices" have been identified which will reduce the transport of pollutants from the various activities. The Non-Point Source Program will focus on statewide educational programs to inform the public about best management practices. Also, specific watersheds will be identified for demonstration projects. However, this program currently has very limited funding since Congress did not fund Section 319 of the Clean Water Act, which was to provide funding for projects under a non-point source program. Collection and treatment of storm water has been investigated in coastal areas to control non-point sources of pollution. We may need to look at this in the future at some point on the Mississippi Gulf Coast, but I expect this may not be found to be feasible and certainly would be very costly.

The problem of runoff from unsewered areas is a major concern along the Gulf Coast that **may** be feasible to address. As I noted in Table 1, two major unsewered areas have been provided wastewater collection and treatment systems through projects in D'Iberville and Gautier. Also, proposed sewer projects in the Bay St. Louis and Pass Christian areas should cause a noticeable improvement in water quality at Handkerchief Reef and other smaller reefs near St. Louis Bay. I think an earlier speaker mentioned the Mallini Bayou problem near Pass Christian. We feel that every effort should be made to provide collection and treatment for the other remaining unsewered areas. Some of the areas will be relatively easy to address because existing sewers may already run nearby. For example, we funded a study conducted by the University of Southern Mississippi on one small watershed in Gulfport to look at impacts of coliform

and we were very surprised to learn that even though sewer lines were available, there were some 60 homes that had never been connected. I suspect that we will run into that situation in other areas.

Other areas will present a problem because of remote locations and high ground water. In these areas, innovative measures will have to be designed to correct the problems. These measures may be quite expensive to implement, but the costs must be weighed against the benefits to the shellfish industry and public health.

A key point I would like to make here is that the Gulf Coast officials and citizens simply should not tolerate any new housing developments that allow individual home septic tanks instead of a sewage collection system and treatment. History has shown us that while septic tanks may reduce the cost of lots when initially sold, sooner or later these systems will begin to fail and collection and treatment will be required to correct the resulting pollution and public health problems. In most cases, the taxpayer will end up paying the bill. These projects can be quite expensive in the areas that previously did not have any sewage collection or treatment.

I want to mention quickly something about EPA's new program called The Gulf Initiative. Some of you are probably already aware of it, but all of the Gulf coastal states are cooperating in this program to help develop a comprehensive strategy for managing and protecting resources in the Gulf of Mexico. It will deal with such problems as nutrient over-enrichment, toxics and pesticides, habitat degradation, fresh water diversion, and public health. We feel that this effort should be of great assistance in coordinating the efforts to protect the shellfish waters in Mississippi. You may have already seen the brochure that they have on the Gulf Initiative and I am sure if you have any questions regarding this program you will want to contact the EPA office. I think we are very fortunate that the program office is located at the Stennis Space Center. All of the states in the southeast that border the Gulf of Mexico are participating in this and I feel we are fortunate to have the headquarters located here in Mississippi.

In closing, I feel that the efforts made along the Gulf Coast in pollution abatement are commendable and should go a long way to protect our shellfish resources. While I feel it should still be our goal to try to upgrade shellfish classifications in some areas, our real challenge for the future will be to keep waters currently classified as conditionally approved or restricted from being further degraded. When you consider still being able to harvest at times when water quality standards are met and being able to use these waters for relaying purposes or depuration, it is important that we not let them slide any further and be permanently closed.

I feel that we can keep waters from being further degraded by controlling known sources of pollution and properly operating and maintaining the wastewater collection and treatment systems that we are building. These efforts have shown to be costly, but here again they must be weighed against the resource values of the Gulf coastal waters.

The Bonnet Carre' Spillway Diversion Project and Projected Impacts on Mississippi Waters

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Good afternoon. I believe everybody realizes now that I am going to talk about a controlled freshwater diversion for environmental purposes and not the massive operation that involves use of the Bonnet Carre' Spillway for flood control purposes, which does wreak havoc on the Mississippi oyster industry during the year of operation.

I think you are mostly interested in the Bonnet Carre' project, but I believe it's important to present a little background information on all of the Corps' diversion projects and how they came about. As you are aware, coastal estuaries are facing some major problems, the most notable being loss of wetlands and saltwater intrusion. There are many reasons for these problems. They include natural processes such as subsidence, compaction, erosion, and sea level rise as well as man's activities, which include leveeing, channelization, and mineral exploration.

Channelization causes saltwater intrusion and increases hydrological regimes, which leads to loss of habitat and alteration of habitat types. Many of our marshes are being converted to more saline marsh types and many estuarine water bodies are also being converted to more salty environments.

An example of a major navigation channel that you have probably all heard about is the Mississippi River Gulf Outlet. It has caused a lot of saltwater intrusion and a lot of damages in St. Bernard Parish. Oilfield canals have also taken their toll. There are thousands of miles of oilfield canals throughout the marshes.

Levees, particularly those along the Mississippi River, have disrupted overbank flooding and distributary flow, which historically provided fresh water, sediment, and nutrients into the estuaries. This has led to saltwater intrusion and reduced quality and quantity of the habitat. Historically, the Mississippi River meandered back and forth across the coast, creating a series of deltaic splays and millions of acres of marsh and wetlands. Generally, a delta builds and decays over a fairly long period of time. However, man has accelerated that time course. The St. Bernard Delta at one time extended out to the Chandeleur Islands and actually covered the areas where Mississippi oysters are now.

Now the river is entrained in place. The levees have cut off the river flow. The land is sinking, sea level is rising, and saltwater is moving in. In many areas, the only significant source of fresh water is local rainfall. Land loss and saltwater intrusion are causing the loss of thousands of acres of swamp and also jeopardizing marshes ranging from fresh water marshes in the upper parts of the basins to saline marshes near the coast.

What are the implications of this? Many people have believed for some time that there is a strong correlation between wetland area and fishery productivity and recent studies are confirming that more and more all the time. As you impact wetlands, you also impact fisheries, including the fishery you are mostly interested in here today, the oyster fishery. It is severely impacted, particularly by saltwater intrusion. Wetland impacts also affect things like waterfowl hunting. Louisiana and Mississippi overwinter about two-thirds of the ducks and geese in the Mississippi flyway. A thriving fur and alligator industry is also impacted. The coastal areas also support populations of other ecologically important wildlife. What can be done to lessen some of these problems? The Corps of Engineers and other agencies have undertaken some studies with the following objectives: to create and restore wetlands; enhance vegetative growth; establish desirable salinities; and enhance overall fish and wildlife productivity.

We have worked over the years with a number of other agencies, including federal agencies and agencies from Louisiana and Mississippi. A variety of management measures were investigated. Some of them are still under investigation but what we will be concentrating on today is fresh water diversion. As you all know, when the Bonnet Carre' Spillway is

operated for flood control purposes, it causes a lot of problems in that particular year. However, the second or third year following the spillway openings generally has very good oyster production.

Through a series of studies, the Corps has developed a comprehensive fresh water diversion plan that includes the controlled diversion near the Bonnet Carre' Spillway, which affects the Mississippi area. There are two other diversions; one in the top of the Barataria Basin and one in the Breton Sound Basin. Through a series of studies, diversion sites have been recommended at Davis Pond and Big Mar, which is also called Caernarvon. Caernarvon, which I will show you a little about at the end of the presentation, is currently under construction. The area you are primarily interested in today would be affected by the Mississippi and Louisiana Estuarine Areas Study. That study was authorized in 1976. The resolution was sponsored by Mississippi Congressman Trent Lott. The study area includes the oyster areas in Mississippi.

In addition to problems with the oysters, there are a number of habitat changes that have occurred in that area as salinities have moved inland. Some fresh marshes have been converted to non-fresh marshes and large areas of swamp have been either killed or are stressed due to elevated salinities. The oyster areas that are experiencing problems are located throughout a band running basically from Pass Christian all the way down through the bottom of the Barataria Basin. There are some very old oyster reefs in this area that date back thousands of years and in some places are 20 feet thick. These reefs were created at the time when the Mississippi River regularly overflowed on a seasonal basis and there was a spring freshet.

Extensive oyster seed grounds historically occurred off of Louisiana and Mississippi seaward of the Biloxi marsh area. These areas now lie largely dormant because of excessive salinities, although the reefs and suitable bottoms are still there. During the last 15 years or so, there have been a lot of leases granted in Lake Borgne as the salinities have moved inland. Optimal salinities for oyster production have shifted inland over the Lake Borgne area, although in a lot of areas the substrates aren't actually suitable and there are also pollution problems from time to time. In an effort to do something about the problem and manage salinities in this area, we looked at a number of alternative diversion sites under the Mississippi and Louisiana Estuarine Areas Study. Through an analysis that involved economic, engineering, and environmental considerations, we screened the sites and determined the best place to divert would be at a location near the Bonnet Carre' Floodway.

The structure would actually be built upriver from the existing spillway. The channel would go back into the spillway and out into Lake Pontchartrain.

Over the years, a lot of people have asked, "Why don't you use the Bonnet Carre' Spillway in dry years to give us some fresh water?" The problem is that the spillway is a fixed structure. It has very high sills and water can only pass over them during very high river stages. You cannot get water over the structure whenever you want it. Normally, when you need some fresh water, the river is too low to get water over the sills. So we had to either look at modifying a portion of the spillway or go upriver of it. One of the problems we faced was a small community where our structure is going to be located and that was a very serious social consideration we had to deal with.

Some of the ultimate benefits of this project would be retarded salt water intrusion, enhanced vegetative growth, reduced land loss and enhanced fish and wildlife productivity. There are also some benefits we call intangible that are hard to put monetary benefits on. They are nonetheless valuable. Oysters will benefit from this project and actually constitute the primary monetary benefit. As we have said, most of the productive bottoms are located further offshore than where the optimal salinities are currently located. We hope with this project to be able to shift the salinity regime back out in areas where the suitable bottoms are. The two key parameters for oyster production are proper salinities and suitable substrates. We know where the suitable substrates are located. They are in the areas where the reefs used to be and where there are still reefs with hard bottoms, but which are not producing because of high salinities.

Our next problem was to decide what sort of salinity regime was optimal and what sort of salinity regime we wanted to create over the suitable bottoms. That regime came out of a study done by Mark Chatry and Ron Dugas from the Louisiana Department of Wildlife and Fisheries. They collected salinity and spatfall information from 1971 to 1981 at three stations. The interesting thing about what they found is that the optimal salinity regime basically mimics what happened naturally before the rivers were leveed and natural spring flooding and spring freshets occurred. Lowered salinities in the spring months are very important. One of the primary reasons it is so helpful to oyster production is because it controls predators. Yet, salinities increase following the spring freshet, allowing good spawning and seed oyster production. In order to create that optimal regime out over the productive bottoms, our hydrologists calculated a diversion scheme. The large diversions are needed in the spring to lower salinities in the spring, as occurred naturally before levees were constructed.

In order to calculate benefits in oyster production for the project, we overlayed the optimal salinity regime over maps of these productive bottoms. Using a regression equation from the Chatry and Dugas study, which correlated salinity and seed oyster production, we were able to identify optimal and secondary zones of productivity over those reefs. The optimal zone was an area where you could create 20 or more seed oysters per square meter of good reef bottom. In the secondary zone, you could create 10 or more seed oysters per square meter of good reef bottom. Through a series of calculations that we feel were fairly conservative, we came up with economic values for the oysters from this project. Benefits were calculated for the entire area, which includes all of those areas in Louisiana that will be benefited by this project as well. As Bill Demoran stated this morning, a lot of people believe that The Biloxi Marsh area in Louisiana is often very important for contributing spat for recruitment to the Mississippi fishery. The figure for the Louisiana and the Mississippi areas is $8.1 million. It is an annualized figure representing the benefits attributable to this project. If you break that down, it will be $6.3 million in Louisiana (because the reef area there is much more extensive) and $1.8 million in Mississippi. Of course, as with every project, along with the good there is some bad. We don't really expect many adverse impacts in Mississippi from this project because of the distance away from the diversion. But you do have some potential adverse impacts because of pollutants in the river such as heavy metals, pesticides, PCB's, and fecal bacteria, which we have talked about so much here.

One other potential adverse impact is that Mississippi River water temperatures are considerably cooler than the water in adjacent estuaries in the spring. This could cause some adverse impacts to fisheries, but those impacts would occur closer to the diversion and would not affect Mississippi. However, because of these potential impacts, all of our diversion projects, including this one, include an extensive monitoring program. We have already designed one for the Caernarvon diversion and will, in the near future, be coordinating with the states of Louisiana and Mississippi to develop a monitoring program for the Bonnet Carre' project.

There would be a 3-year pre-construction program that would be implemented 3 years prior to constructing the project. This program would supplement existing information and establish baseline conditions for biological factors, hydrological factors, and water quality. Then for 4 years after we actually operate the diversion, we will collect the same kind of information as we did beforehand so we can determine the effects of the diversion. Through time, we will be able to adjust operation of the structure to maximize benefits, while reducing potential adverse impacts.

We would also have a long-term monitoring program. This project is considered to be a 50-year project for planning purposes. This long-term program would be scaled down from the intensive pre-and post-construction programs. The environmental impact statement and feasibility report have been completed since 1984. The project is currently in preconstruction engineering and design. If everything went perfectly, which it normally does not, construction could begin in 1991.

The cost of the project would be about $60 million. The project would preserve about 11,000 acres of marsh and swamp. The structure would have a maximum design discharge of 30,000 cubic feet per second. To put that in perspective a full-blown spillway opening diverts up to 250,000 cubic feet per second for a month or more at a time. That is over half the average flow of the Mississippi River. This is a much smaller diversion, so you reap some benefits without suffering severe adverse impacts. The current benefit/cost ratio for the project is about 1.2 to 1. These diversions have been in the planning stages for years. Most people did not believe that one would actually be built, but the Caernarvon site in the Breton Sound Basin is actually being constructed.

Impacts Caused by Coastal Engineering Activities

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My background is mainly with dredging and dredge material management. I think you've already had other types of activities addressed sufficiently, especially by Dennis in the previous talk about habitat modification involving salinity intrusion and fresh water diversion-type projects. Suffice it to say that those are extremely complex and the solutions as well as the problems are very long-term type activities to get sufficient technical handles on. My talk will be a little bit broader in scope and I would like to make an addendum to the title here on oyster habitat and add potential risks and benefits. What I would like to address today is when you talk about impacts, most people have a negative perception of that one word. They perceive that something detrimental is going to go on with any activity. That's not necessarily so. I would like to try to point out today that there's a potential out there to accrue resource benefits with routine dredging projects.

What are the types of impacts associated with coastal engineering activities? I've broken these down into risks and potential benefits and if I can go through this talk and address one topic at a time they will fall into the categories of potential risks: sedimentation, turbidity, salinity alteration, and larval entrainment. The first, second, and fourth of these are mainly associated with dredging activities so I'm going to focus in on them and then end up the talk with a little bit of information on a demonstration project that we're working on right now that involves oyster reef creation.

To start us all off on the same time line, most people don't really have an accurate feeling for what is involved in dredging activity from the logistics to contracting and so forth. I think most of the people here have spent quite a bit of time out on the water, in all probability have been in the vicinity of a dredge, and would be willing to admit that these are pretty impressive pieces of equipment. Their function is pretty simple–to move mud from one point in the estuary to another; offshore, or upland, or whatever. The engineering aspects are pretty darned impressive and so are the amounts of material that they move and the attendant problems that go along with that.

There are a number of names that we can use to describe different types of dredges but basically, on the Gulf Coast, there are two main types that are involved in inland projects. One would be the mechanical dredge that you've probably heard of called clam shells, bucket dredges, etc. In mechanical dredging, you have essentially this grab (they come in all shapes and sizes) that is lowered to the bottom and scoops up a plug of sediment, which is taken and placed on barges for transport offshore or to a suitable disposal site.

Attendant with that activity is the creation of a lot of suspended sediments. There is suspension of sediments that were in the pre-existing bottom. We have to consider what the fate of those re-suspended sediments is when they eventually settle out somewhere else into the system. Obviously, a bucket dredging operation is not all that aesthetically pleasing. It is the one that is most visible to people and the one we probably get the most complaints about simply because the amount of turbidity or visible sediment in the water column that results from a bucket dredging operation.

The other main type of dredging activity in the Gulf Coast area is hydraulic dredging. Hydraulic dredging is a little bit better from an aesthetics point of view in that all of the activity is essentially happening on the sea bed itself. For those of you who are not familiar with suction or hydraulic dredging, you can visualize the analogy that the equipment is acting as a vacuum cleaner. It has a pipe on the bottom, usually with a cutter head that spins stirring the material it contacts and this is sucked up hydraulically through pump systems on the dredge and into the pipeline for some type of disposal. There are a number of different disposal options.

The other side of the dredging/disposal equation is disposal. Again, there are a number of options.

Basically they are upland disposal in dike containment areas, in-bay disposal that has been used in places like Mobile Bay and along the Intercoastal Waterway, and offshore disposal. Logistically, there are a lot of considerations, such as equipment costs, how you get rid of material, and where you take it. A number of factors come into play, such as the distance of transport, the size of the equipment that is used, etc. Typical values range from less than a dollar per cubic yard on up to $5.00 or more. When you're looking at a dredging program in a number of districts with many small to large-scale projects a few dollars difference in the cost per cubic yard to move it from one spot to another can be quite considerable. It is something that will always be an important consideration in just how a project proceeds.

I would say now that as far as the relationship between dredging activities and oyster reef habitat is concerned, the disposal question is much more straightforward than the dredging question. I would, as a biologist and technical person, stand up here and say that it would be pretty unreasonable for most dredging and disposal operations to consider having a disposal on or in the immediate vicinity of an oyster reef. I'm not familiar with any examples recently where anything like that has happened and I think we can essentially say that the disposal end of the question is resolvable. Oyster reefs are recognized as important habitats that have value and are to be avoided in the disposal side of the operation. The more speculative half of the equation is the dredging side where it is still controversial as to what the magnitude of impacts can be. When looking at potential risks, sedimentation is at the top of the list. There can be several types of sedimentation-related impacts. Burial and suffocation are the most obvious. If you put enough sediment in the water column, and if it's thick enough, it can suffocate the organisms living there, including oysters. Oxygen reduction is a little bit more complex. If sediment placed on the bottom is high in organic material and has an oxygen demand or an oxygen load to it, you can change the chemical characteristics of bottom sediment such that it's no longer suitable for supporting living organisms.

Exposure to sediment compounds is another very complex question if the sediments that are being disposed of contain contaminants of any sort. If they do, there is a whole realm of regulations that confront the people who handle these projects. Interference with spat settling is hypothetical in that we really don't have the technical evidence out there, even though there has been a lot of laboratory study. We're looking at organisms, for example, spawning products of oysters, being in the water column looking for places to settle. The setting stage of the larval oysters occurs when they are about three-tenths of a millimeter in diameter. Conceivably, a sedimentary layer that has been the result of a dredging activity that would be a millimeter or two in depth would quite probably have some effect on the ability for that settling larvae to find a suitable site for attachment. It is a little bit ironic though that oyster reefs are turbid environments. There is sedimentation going on all the time due to natural effects. But again, the challenge is to take what we know about dredging and relate that to what we see in biological responses. Then we have some sense of what the actual risk can be, what are acceptable risks, and what are non-acceptable risks.

Turbidity is related to that portion of the re-suspended sediments while they are in the water column before they settle out. Here the concern is that while the particles of suspended sediments are in the water column they can have detrimental effects on the larval stages in the water. I'm going to try to characterize what we know about the physical alterations occurring around an operating dredge. They are going to vary according to the type of dredge plant that you have out there. By accumulating a number of different data sets and through monitoring activities, we can get a picture of the magnitude of sediment re-suspension and how long it's in the water column. The data relate the quantities of suspended solids in milligrams per liter with distance from the operating dredge in feet. Samples are taken along the bottom of the water column, in the middle of the water column, and in the upper water column. With a hydraulic dredge, most of the sediments that have re-suspended are going to be at the bottom. This is where the actual agitation is going on; the rest of the sediment is up the pipeline. What we have here are turbidity levels in the upper end of the water column that are not significantly above what would be ambient. If there is a concern, it's going to be at the bottom of the water column and fairly close to the dredge. There's a fairly rapid dropoff out to a distance of about 1,600 feet from the dredge.

We get a number of those types of data sets for different types of dredges. Then we can try to get a feel for what is actually going on with the physical alteration that a dredge in operation entails. In terms of the bucket dredge, we're looking at nearly 700 milligrams per liter at the surface and higher at the bottom. Obviously the impact of the bucket on the bottom causes quite a stir; much higher than the amount typically raised by either a hopper dredge or a cutter head dredge. I haven't mentioned hopper dredges at this point. That's just another modification of a different type of dredge. A hopper is usually a self-contained sea going vessel where the material is moved from the bottom, usually hydraulically, into a containment area on the vessel itself until it can be transported

to a site elsewhere. The newer ones are split hull hopper dredges; when they get to the disposal site the hull splits and drops the sediment there. Bucket dredging is a lot less clean than hydraulic dredging. In terms of spatial extent, the turbidity levels drop off with distance from the dredging site.

We have three different types of dredging operations: cutter head, clam shell, and hopper. We also use a hopper dredge with overflow, where overflow is used to increase the density of the material in the hopper so that fewer trips must be made to the disposal site. It's used on large-scale projects, but seldom for an inshore dredging operation. The cutter head is really quite a clean operation. We're talking about an average in the neighborhood of 200 milligrams per liter suspended sediments. The clam shell operation is quite a different thing. There's a lot more sediment involved in the movement of the clam shell itself through the water column, what is spilled over the surface, and what is agitated on the bottom.

How does this relate to what we know about the biology of the organisms? In terms of the oysters themselves, the critical life history stages are generally considered to be the larval stages. There is a period of 2 to 3 weeks that the larvae spend in the water column when they would be most likely to be exposed to these types of suspended sediments. In Gulf Coast estuaries, which are pretty turbid, you can get levels of 50 to 150 milligrams normally just due to fresh water input from river systems with high sediment loads. During storms, in soft bottom estuaries we have documentation that natural levels of suspended sediments can run up into the hundreds quite normally. Again, a dredging operation and a storm have some similarities and some differences in the terms of the time that the sediment is in the water column, how long the dredging project is going on and so forth. On a spatial scale, storms effect the entire system; the dredge is essentially only a pulse in that system. We do know, in terms of the larval stages of the oysters, that early larvae tend to benefit from some concentration of sediment in the water column. Laboratory studies have shown that for the early stages, a turbidity reading of up to about 180 milligrams per liter is beneficial to the larvae. That pretty well fits in with the concentrations resulting from the cutter head. The later stages of oyster development are a little bit more tolerant to suspended sediments and up to about 500 milligrams per liter are beneficial to late stage oyster larvae. That pretty well takes in the entire realm of suspended sediments created by the cutter heads, but not by the clam shell dredge. We know for sure that there is a plateau created where most of the oyster larvae remain pretty well tolerant. But there is a level (about 750 milligrams per liter) beyond which there are definite observed effects, such as slower birth rates, metamorphic stages, etc. If we can generate enough data to actually characterize what is going on around a dredge and compare that with what we know about the life stages we're concerned about, we can make some intelligent decisions about just how to conduct an operation with minimal risk to the oyster resources.

Larval entrainment is a type of impact concern that you're probably not familiar with on the Gulf Coast. It's mainly been raised on the East Coast in connection with hydraulic cutter heads. Once again, visualize a vacuum cleaner type operation going on the bottom. The oyster folks up in Chesapeake Bay were concerned that this was creating a significant additional mortality to early life history stages of oysters. To address this, we held a workshop seveal years ago on the East Coast. We asked them to examine all the technical information we had on the life history of the oyster stages and what was going on around an operating dredge and charged them with trying to come up with a model that would predict just what those impacts would be. Two basic models came out of that workshop. One voided the problem of attaching absolute numbers to mortalities. If we got into a technical discussion of how reliable model predictions could be we could go on for days, but this one was put together by a number of people who are well known in the field. They came up with the worst case scenario; an additional three-tenths of one percent of late stage larvae in any water body around an operating cutter head dredge would be taken out of the system. That would be the worse case scenario of mortality.

An alternate model proposed by the Department of Marine Fisheries in Maryland, which did involve an increased number of assumptions, used a lot more absolute figures around which we didn't have any confidence levels. It came up with the scenario that you could potentially impact 25 to 55 percent of the late stage larvae in the system at that point in time. We feel that these models have now been through technical review. The weight of the best available information indicates that the lower estimate is the one that is probably more accurate.

We move onto the other side of the coin in terms of potential benefits of dredging; habitat creation, rehabilitation, restoration, etc. These would indicate that routine dredging operations can make a positive contribution to what we're trying to do in reestablishing biological resources in our estuaries. The Corps has a major emphasis going on looking at just what we can do in that light. It involves a lot more than oyster bed creation. Basically, there is a breakdown between what we're trying to accomplish in the estuarine zone and what's going on in the offshore zone.

Oyster reefs are just one example of the studies that we have going on. We are looking at past attempts at creating different types of habitats with dredge material and we also have a number of current demonstration projects underway in the coastal zone. There is one going on right now just offshore of Dauphin Island, where the Mobile District is creating a sizeable disposal mound with the material from the deepening of Mobile Harbor. We are looking at habitat benefits and increased recreational fisheries catch, etc., and we have some preliminary indication that there is an increased recreational fisheries catch. Obviously, the Corps is not involved in this from an altruistic basis alone. We have motives for serving the sponsors for many of the dredging projects going on out there. I'll go into cost effectiveness when we get to the example of a current demonstration project. Fishery habitat enhancement, if we accomplish that, is a bonus. Long-term placement sites are going to be a crucial question in the future.

As long as rivers are running to the sea and carrying sediments with them there will be a need for dredging to maintain the harbors and navigable waterways. Something has to be done with that material. Right now there is a lot of pressure to take it offshore for disposal, and as I said before, that involves several orders of magnitude of higher cost in many cases. If we can accomplish beneficial use scenarios, we might end up with full maintenance and project programming. That in turn relates to dollars and finally, to public appeal. There is a lot of support for these types of projects and that will facilitate the coordination and planning processes for these projects in the future.

Here is one example. The Smith Island site, which is in the lower and middle portion of Mobile Bay, it is an island used by commercial fishermen and a large summer community. Historically, the material from that channel has been placed in an upland site. This entailed building a dike and establishing the pipelines to get the material to that site. As an alternative, a site just south of the channel itself was used to demonstrate whether dredge material could be placed there, stabilized, consolidated, and used for the creation of a sea grass habitat. One of the main considerations in placing dredge material, which is a "fluffy," very watery material when it first gets there, is whether it will stay in place through storms. How do you stabilize it to keep it in the desired area? Screen tubes are essentially fabric tubes that you can fill with material. They form a physical barrier around the site to help keep the material there. It also acts as a wave barrier to break down turbulence so there is not as much tendency for re-suspension after it's been established.

This is an example of how you could engineer into a dredging project things such as this to keep material in a site and alleviate the fears of it moving offsite into surrounding areas.

The project that involves an actual oyster reef creation is at Slaughter Creek, which is on the western shore of Maryland in Chesapeake Bay. In this scenario, in a very short channel, about 16,000 cubic yards are dredged on a maintenance basis. Historically, it was pumped to an upland disposal site, which required a diked-in area and involved considerable expense to hydraulically pump material up to the site. The agencies got together (the Corps is currently involving the National Marine Fisheries Service in a what they call a memorandum of understanding to look at joint efforts at creating habitat). We got together with the state people, a number of agencies, local interests, the watermen, and others and identified a site. It was an area known to be currently nonproductive in oysters. Thus, the demonstration project had the goals of placing dredge material at the site, topping it with oyster cultch, and hopefully returning it to production. The same types of consideration went into locating the site to enhance the probability that it would be productive for the long term and not just a "flash in the pan."

The project involved moving material hydraulically to the site and, with a modified diffuser, placing the dredge material in a layer about 3 feet thick over the 2-square-acre area on the bottom, and then placing on top of that a 3-inch layer of oyster cultch. As the pipe was moved over the area the material was spread out at as slow a velocity as possible to increase sediment at the site itself. After the material was on the site, we went through the operation of creating the oyster shell cap. This involved barging material in and blowing it off the barges with high pressure blowers. I'm not sure exactly what the routine scenario for creating sites is here, but this is the variation they used in Maryland.

One of the concerns after the oyster caplet was placed was that it achieved the design criteria. They originally were after a uniform 3-inch thick cap layer. It was noted that the central portion of the site turned out to be somewhat thinner than the outer portions. This turned out to be an opportunity in itself. We entered into a monitoring arrangement with the National Marine Fisheries Service, Beaufort Lab. They are now mapping the thickness of the oyster shell cultch and taking samples of spat survival on the cultch itself. What we will eventually end up with is a map of survival of oyster spat in relation to the cultch thickness. In the long run, we hope to be able to relate that to design criteria for oyster reef creation projects. The demonstration project was a simplistic one where a uniform layer of dredge materials was capped by a uniform layer of oyster

cultch. We would like to be able to mimic "Mother Nature" a little bit more. I think you're probably familiar with the fact that oyster reefs evolve in a number of different ways. Some of them are evolved perpendicular to a prevailing water current. Some of them down in Texas have become oriented parallel to existing currents. Basically, we're after information that will enable us to go in and design oyster bars with ridges that mimic "Mother Nature" a little bit better than we have so far. Finally, the bottom line is that we hope to do this on a routine basis with small to moderate size dredging projects. If these particular projects work out and prove to be successful over the long-term, it would help with our dredge material management requirements and at the same time achieve some cost savings for the sponsors.

The Enforcement Issue

Hank Boudreaux
District Manager, Law Enforcement
Mississippi Bureau of Marine Resources
Mississippi Department of Wildlife Conservation
Biloxi, Mississippi

For the benefit of the very few of you here who don't know me, my name is Hank Boudreaux. I'm the Supervisor for the Bureau of Marine Resources Law Enforcement Division. I could stand up here and talk for hours just like each and every one of you fisherman can about the problems we are having in the oyster industry and all industries in the seafood business.

The biggest problem in seafood enforcement, just like any other form of enforcement, is manpower. There are just not enough of us. It's not an excuse, it's a fact. It would be ideal if your state or federal narcotics agents could catch all of the dope traffickers in this world, but they can't. A lot of them get away. Unfortunately, a lot of unlawful activities, such as illegal oystering and other things, happen in our area of responsibility too.

Another big thing that is really frustrating, especially to young officers actually making arrests, is our court systems. There are some good judges and some bad judges, just like there are good and bad enforcement officers. They are all human and so are we. It seems like some judges do not take these oyster violations as seriously as they should be taken and, as we all know, it is real serious business when it comes to a life threatening situation. So we have problems in the court system and I am sure it is not just us.

Another problem I have in my area, which stretches from Gulfport city limits to the Louisiana line, is the Mississippi/Louisiana state line. Before the Bureau of Marine Resources took over the sampling, the Health Department would sample. One year they closed St. Joe Reef because the fecal-coliform count was very high. But the Louisiana side was still open. We had to "babysit" that line—we had to just sit there. People would come over to the Mississippi side and oyster and then go back to Louisiana, put on tags, and bring them in. If we just did not sit there hour after hour, they got away with it.

That was a big problem, but I think we are working on solving that right now with an agreement with Louisiana. This year, we established check-in and check-out stations. We used to have them in the past and they worked well. For some reason or another we did away with them. This year we have re-established check-in and check-out stations. An oysterman has to check in in the morning, get a clearance slip, then come back that evening to check back out and get this year's tags. It has helped a lot and I believe it is going to continue to help control the oyster problem we are having in Mississippi.

One big problem (I guess every dealer here will agree with this) is the refrigerated vehicle law. It is real vague, but the law requires you to have your oysters refrigerated down to 50 degrees or less within 2 hours after loading. In 2 hours, you can get a lot of places. We are working on that right now. The law needs to be changed or worded a little differently. We can definitely enforce it, but it is weak, in my opinion. It was something that was handed down to us from the Health Department when this merger took effect. Another problem, which has surfaced in the last couple of years (and I like to refer to this as a terrorism or threat problem) is if a fisherman or a group of fishermen feels that an area should be open they won't take the state's opinion that it shouldn't be open. They just go in and open it up. This is conspiracy. Conspiracy to commit a misdemeanor is a felony. We have had a lot of this conspiracy going on and that is another problem we are working on. That is not the way to get it done. This conference is the way.

Q. *Louisiana does not issue weekly or monthly or daily trip tickets out of Grants Pass like they used to. Can I still legally bring oysters from Louisiana into Mississippi by boat without a ticket?*

A. As long as you have proper paperwork from your lease and your oysters are properly tagged, dated, and filled out by Louisiana, the answer is yes you can. You do not have a check-in and check-out station through Grants Pass for oystering, shrimping, or anything else like there used to be. We had a meeting on that prior to the season with Louisiana and eight or ten of their officers and discussed this problem. Your answer is, you do not have to have a check-out slip through Grant's Pass as long as your oysters are properly tagged and dated.

The Enforcement Issue

Jimmy Cannette
Mississippi Oysterman
Ocean Springs, Mississippi

I am going to speak about the conservation and enforcement of Mississippi oyster leases. The Bureau of Marine Resources has worked with us for the last 7 or 8 years. I have been in the program for 6 years and they have done a real good job with it. But if everyone gets a lease, if we have 50 leases in Mississippi, we are not going to have enough conservation officers to enforce the polluted grounds.

I called the Louisiana Conservation Department and they told me what they were doing as far as enforcement of the polluted grounds. They said that whenever they open the polluted grounds, they give the lease-holder 60 days to move the polluted oysters without allowing them to work their lease at all. Everything as far as sacking is closed for 60 days.

That would go good for us here, because they could give us 4 weeks in the spring and 4 weeks in the fall to move our oysters from the polluted grounds. I talked to Terry Ladner and a couple of other men who moved polluted oysters and they agreed that would be a good idea. They have a bunch of dead reefs in Mississippi on the wild reefs. One is by Cat Island Buoys D, E, and F. These reefs have not had oysters on them in 20 years. During the time we have in the middle of the winter, we could move these dead rotten shells and put them on our leases. That would give us a base for our reefs and would also refresh these reefs, if by chance they would ever come back into production. That would be just like cultivating a reef. It would also help people get into having their own leases because you would not have to put up a $10,000 bond.

The Bureau officers monitored us every day and they did a good job, because we moved trays and did on-bottom relaying. But, if we get too many people, they can't watch us because they don't have the manpower. That would limit our time for moving the polluted oysters and for working our leases. If we take them (BMR) away from watching our leases with our oysters on them and watching those on the polluted grounds, that gives those who want to steal our oysters a chance to do it.

The Health Department activities have been moved to the Bureau and going to the 4 weeks in the spring and 4 weeks in the fall moving polluted oysters would give them a chance to check our leases so we could work our leases. If it is open all the time and you have 20 or 30 oystermen working leases, the enforcement people can't handle the amount of work involved in checking our oysters. Every time we move polluted oysters, we have to have a meat sample and a meat sample takes 3 days to test. A day to get up there and a day to get back adds up to 5 days. We are spending all of our time waiting for a sample. It would help enforcement, too, if they could watch for 4 weeks at a time while oysters are moved out of the polluted grounds. They could alternate between the polluted grounds and that would help us on our leases.

The Enforcement Issue

Earl Fayard
President, Mississippi Shellfish Association
Ocean Springs, Mississippi

Hank and I seem to agree on a lot of points about Mississippi enforcement. I think we have a very good professional enforcement group, and in general they have done excellent work. But what we see that is lacking is conservation. We have a good police force, but we don't have a conservation commission anymore, or any form of force that replants or takes care of revitalizing our seafood industry, particularly our oysters. What we would like to see is some change made where the reefs are taken care of and some provision is made for continuous revitalization of the oyster reefs. I know that may be slightly off the subject, but it is very important.

On the enforcement issue, the biggest problem we see is the failure to enforce all the regulations due to improperly written regulations. I think Hank touched on that and we agree with him. Some of the wording and some of the laws are so ambiguous that the enforcement officer on the spot does not feel he can enforce them. A good example of this is happening this season. A lot of the fishermen seem to want to put a sack and a half in a sack to get away from the 10-sack limit. The enforcement officers do not seem to be able to enforce that. Also, on the refrigerated trucks, the law plainly says that you should have refrigeration, or at least that is the understanding that it gives you. But it does not come out and say you must have mechanical refrigeration. If it is cold outside, perhaps a man could travel 2 hours and oysters could be still 50 degrees. Yet we don't get treated the same in other states.

If we go to Louisiana or Alabama, we have to have a refrigerated truck. We need these regulations rewritten where they are enforceable. I think our FDA people and any health official would tell you that you need to get these oysters in refrigeration as soon as possible. We are going to be meeting with our legislative people on December 13 to ask them to help us get these regulations straightened out. Another problem along the same line is the problem fishermen have in understanding why Mississippi will close for bad counts when Louisiana and Alabama on each side of us do not. This has happened several times and creates a problem that puts enforcement officers on the spot. It is sort of hard to explain to everybody why he is out there keeping everybody from working when other states are able to work right across an imaginary boundary line. That brings up the situation that Hank was talking about where the fisherman feel like they want to go out there and work in what he called a conspiracy to go out there and break the law. What they are trying to do is make a point that there is an inequity. There is unfairness in a system that keeps those in one state not working while those in other states are working in what are basically the same waters. Personally, I don't see anything wrong with the fisherman bringing something like that to a court case, or bringing it to a point where there is a decision made on it.

As for enforcement, in general, I think we have a good force. The problem with enforcement is the level above that, where the decisions are being made and where the law is written.

Q. *What can be done about fishermen who go out and catch 20 sacks in Mississippi and tag them properly and go back out and catch about 15 or 20 more sacks and tag them as if they came out of Louisiana?*

A. We saw a lot of this last season. For some reason, the enforcement people, which is unusual in my opinion, were lax in watching the reefs this last season. A lot of this occurred. The sacks were filled with an improper limit, which gave them 15 sacks instead of 10. It happened regularly. Boats went and fished and caught them again. This is a problem and I don't know how to answer your question.

The Enforcement Issue

Phillip M. Bohr
Assistant Special Agent-in-Charge
National Marine Fisheries Service
Law Enforcement Division
St. Petersburg, Florida

There is no doubt the minds of anybody in enforcement that personnel are the key. We constantly, at the federal level, get complaints that the state enforcement people aren't doing their job. I am here to say that we handle 10 states in our region and I don't feel there is any state conservation and enforcement agency that is not doing their job. But they deal with serious manpower problems and budget problems, just like in your business. You have a budget and problems in finance – they have the same thing.

For the benefit of those who don't know too much about National Marine Fisheries, Southeast Office, we handle the 10 southern states, Puerto Rico, and Virgin Islands. We have a total of 18 enforcement agents for that total area and four are supervisors. You can see we are spread thin. I think if you want enforcement, you are going to have to begin by going to your legislature and getting your state to get more people and more money into your enforcement agencies.

One of the areas of enforcement itself, and it has been touched on, is that various laws are so diverse among the states that we deal with, it is just unbelievable. In Mississippi, Louisiana, and Texas, the shellfish laws are sometimes totally different from state to state. So I can sympathize with you and understand what some of the people were saying here. With oysters, you are dealing with a situation where I think it is to the benefit of your industry to try to get the different states to unify some of their laws. Here's a good example. I recently came back from the ISSC meeting and a big subject your enforcement people in this state and other states are very supportive over is to try to get uniform tags. It is very hard for me to do enforcement when I have to learn eight or nine different tags. Tags are a major problem.

Another item would be the monitoring stations. That program seems to work successfully and it was touched on just a moment ago. The laws again are diverse between states. One state might read that if you sell an untagged sack of oysters, it is automatically considered to be from a polluted area. Another state might not have that little phrase in there and that makes enforcement very difficult.

Reporting violations. I know you hear a lot on television and you think we have a lot of loyalties to our friends and so forth. But one of the ways for **you** to improve **your** industry is to report violations. It's not squealing or anything of that nature. You are in the business and you know those who are and those who are not doing what is proper as far as harvesting is concerned – like harvesting from a polluted area and not tagging. In my opinion if you are a legitimate oyster fisherman, by getting this information to your state enforcement people, (and they usually do pass on information of that nature to us when we are working together), you are helping your industry. Tightening the industry up should result in more profits for you if we can get some of the bootleggers out of the business. You may not all agree with me, but it is something for you to consider.

One of the things I was asked to touch on was the undercover operations that we do rather extensively – not just with the shellfish industry, but with several of the other fisheries as well. I would like to have some tapes, but unfortunately I can't bring them in at this point because we have a number of on-going investigations. Let me give you just a little feeling for what it is all about. First of all, as a general rule, when we go into a state to do an undercover operation, there is dialogue between the state people, conservation people, and ourselves. It's one of the first things and you may be surprised to know that we get calls constantly from the states asking for assistance. Again, this is because of shortages in manpower, money, and things of that nature. So your state law enforcement people are consciously trying to do what they can with their limited resources and they try to get us involved.

Most of the investigations are joint. Combinations of undercover people from both the state and federal level are used. Keep in mind that if we do an undercover operation, violators can be charged with both state and federal law violations. It's not double jeopardy or anything of that nature. With our investigations, the fines can range anywhere from $10,000 up and there is jail time if you are charged and convicted of conspiracy.

We have conducted several recent undercover operations, in South Carolina, one in Louisiana, and one in north Florida. I'm sure that some of you, if you are in the business, have read or been apprised of some of the activities. Right now, all of the cases I just mentioned are in various stages of either investigation or going to the grand jury so I can't tell you too much of the specifics. Of course, I can't give all of our trade secrets away or we will be out of the business.

To sum up, the key, to me, for you and your shellfish industry, is the pressure you put on your legislature to get better laws, to get your enforcement agency more people, and more dollars. That is where it has to start. If you put the pressure on, you will ultimately benefit.

We can all come to these meetings every year and go over the same thing. I think you will see that at most meetings, when you bring in an enforcement person, you are going to hear the same thing. Some people might say, "Well, they have too many people. I see 2 or 3 of the conservation people down here having coffee for two or three hours." I get that all the time from some of the people who work for us. You really don't know about the nights they are laying out in the swamp doing a surveillance or something else. I can assure you, your people in conservation in the states that we deal with are like our people, probably working minimum of 50 to 60 hours a week without a blink of an eye. That is just a starter.

So the key is you, your associations, and the pressure you can bring to bear on the legislatures in the different states to get some of the things done we have talked about.

The other and final thing that I have in mind is self policing. I think if we can get out of the mentality that, "I'm squealing on my friend," and so forth, self policing is one way to get the bootleggers out of the business and make it a little cleaner operation.

I recently had somebody from Mississippi giving me some information on a regular basis, and after about 3 or 4 months the person got mad. He called me up, gave me some real nasty words, and said "you are not doing anything," more or less, and "I am not going to tell you anything else. I am not going to try to help you provide information." You keep in mind that on the undercover operations side, an average time to complete a case is anywhere up to a year. That is just a ballpark figure, for both state and federal operations. If you do pass on information, I like to think that people you pass it to are working on it. Don't get discouraged and just say "well you didn't do anything" because 3 or 4 months went by. Keep in mind, we are sitting here today talking only about shellfish problems; oyster problems. If you multiply that by all the other fisheries that we and state agencies have to look after and enforce, it is a big problem.

Q. *How many indictments have been brought as a result of the sting operation you spoke of?*

A. The indictments that we anticipate at this point are 9 in South Carolina, 3 in North Florida, and 7 or 8 in Louisiana. Again, they are in different stages, in grand jury, etc. The paperwork is horrendous in these cases.

Oyster Resource Enhancement

Scott Gordon
Mississippi Department of Wildlife Conservation
Bureau of Marine Resources
Biloxi, Mississippi

The preliminary goal for oyster management developed by the department's comprehensive planning team is to provide the optimum harvest potential given the environmental conditions. Wetlands are vital to Mississippi. The department considers the oyster resource to be an important component of Mississippi's wetlands.

The coastal area of Mississippi is relatively small when compared with the rest of the state. However, the economic impact of this tri-county region is with the seafood industry providing a major boost to the region and state's economy.

Growth along the coast continues to increase, and with it, so do demands on the environment and the oyster resources. Unfortunately, many of these demands result in negative impacts on the oyster resource. Inefficient sewage treatment and habitat loss are among the most damaging. All of the negative impacts are not attributable to man, however. Among the natural negative impacts are flooding, saltwater intrusion, disease, and predation, all of which may cause serious depletion or destruction of the resource. In order to consistently harvest certified Mississippi oysters, we have to overcome as many of these obstacles as possible.

The Bureau's Wetlands Division acts as the sentinel for wetland resources. Since the wetlands are spread over the tri-county area, the Division must rely heavily on concerned citizens' reports of potentially harmful activities. Assistance from the Bureau's Wetlands Division is available and would prevent such activities. It is essential to prevent the unnecessary destruction of wetlands.

In order to increase the oyster resource potential, we must first study and monitor the existing resource. This is done by field work coordinated with the Gulf Coast Research Laboratory. Water samples are taken. Areas to be planted are mapped, then marked and a suitable substrate, such as clam shells, is brought in for planting. Substantial funding for the purchase and planting of the shells is provided by the Coastal Zone Management Program through the Bureau's Coastal Programs Division. The shells are sprayed evenly over the suitable water bottoms. Then, with a lot of cooperation from "Mother Nature," oyster spat will set on the clean clam shells. The growth is carefully monitored and in about 18 months, you have harvestable size oysters. Clam shells generally produce large single oysters. Oyster shells are also planted by the Bureau. The oyster shells are planted in a similar manner to the clam shells. This method is often used to construct the popular low-profile fishing reefs. Oyster shells generally produce clusters of smaller oysters.

In recent years, "Mother Nature" hasn't been very kind, alternating from disastrous floods to near record droughts that resulted in increased salinities, which in turn allowed the increase in predator attacks on existing or developing reefs. Oysters are sometimes dredged from polluted waters and relayed to public reefs for cleansing, then the area may be opened for public harvest. The public has participated in these relaying operations. Oyster harvest is what it's all about, whether it's tonging, dredging, commercial harvest, or recreational harvest, certified Mississippi oysters are what we want.

Relaying and Depuration

Gary Richards
Research Microbiologist
National Marine Fisheries Service, Charleston Laboratory
Charleston, South Carolina

Dave asked me to come and summarize a review that I published last March on depuration. The review covers the relay and depuration of 11 different species, not only from this country, but from throughout the world. I'm going to concentrate today on the Eastern oyster, since that's our primary interest in this Gulf area.

I plan to give you an overview on depuration. A very general overview. I'll then discuss what we know about the science of bacterial depuration including vibrio depuration, and virus, such as hepatitis, depuration.

There are some oyster grounds that are closed to harvesting in the South Carolina area. We've got thousands of bushels of oysters, which are unavailable because of pollution. There are numerous measures that we can use to reduce illnesses and one, of course, is cooking. Many people who are accustomed to eating raw shellfish, particularly raw oysters, frown upon that idea and continue to eat raw shellfish. We can also ask for better enforcement, but as we've heard earlier today and as we've known from the past, enforcement is difficult. The areas are so expansive, the state budgets are so strained, that they just don't have adequate enforcement of the areas. We can improve the monitoring of the shellfish at the market level or at other levels, but that again is an expensive proposition.

A more acceptable alternative may be by processes known as relaying and controlled purification or depuration. Relaying in general has some drawbacks. Recontamination is a major drawback and if you'll look at the research that has been done on relaying, in 90 percent of the cases they have some type of recontamination because of heavy rainfall or things that are out of their control during that 14-day relay period. We have conditions where treatment plants may fail or may suddenly discharge pollution into areas where you wouldn't normally expect it. We have shell breakage problems associated with certain types of relaying and we have smothering and mortalities of shellfish. One additional problem is that there are certain economic disadvantages to relaying.

I want to talk primarily about controlled purification which I will call depuration. Depuration is the purification of shellfish in tanks of clean seawater. Seawater can either be recirculated through the system as it's passed through ultraviolet lights or some type of ozone system, or it can be simply pumped into the plant and discharged as in a flow-through system. Factors that are crucial to successful depuration include water quality, hydraulic conditions, disinfection, shellfish status, the depuration time, and monitoring activities. Under water quality: temperatures, salinity, dissolved oxygen, turbidity and pH can all be important factors to ensuring successful depuration. Looking at Eastern oysters and the optimal depuration parameters from the standpoint of temperature and salinity, we see that *E. coli* depurated optimally at 27° C and at 25 parts per thousand salinity. We find polioviruses depurated at the same optimal temperature. Eight to twenty-eight parts per thousand salinity seemed to work equally well for poliovirus depuration. Some work that's recently been conducted under contract for the National Marine Fisheries Service shows that the higher salinities and the higher temperatures seem to be preferable for both polio and *E. coli* depuration.

Some work is being done on hepatitis A depuration and they're using a special cell-culture-adapted strain of hepatitis, which can be assayed in the laboratory. At 28 parts per thousand, hepatitis was reduced somewhat. I'll discuss hepatitis and the ability to depurate it a little bit later on.

Under hydraulic considerations we have such things as the tank design, the basket design, the water movement through the system, (both through the tanks and through the baskets of shellfish), the flow rates, and the shellfish loading rates. These are all important factors crucial to successful depuration. Newburyport, Massachusetts has a large depuration facility, which is maintained by the Commonwealth of Massachusetts and has been in existence for some 50 years. They've developed quite a track record over the years for the successful depuration of soft shell clams. South Carolina had until recently five hard clam depuration plants.

One of the problems we frequently encounter is the processor trying to overload the baskets. They are filled nearly to capacity and that will affect the hydraulic flow of water through that basket. Obviously, if we do not allow the shellfish to come in

contact with the water to properly pump, they are not going to properly depurate. Overfilling the basket may prevent the shellfish in the center from properly depurating. Water movement through the system, therefore, is very important; the flow rates are very important; and the shellfish loading rates are important. For Eastern oysters, a flow rate of one gallon per minute per bushel is recommended; however many bushels you have in that system is how many gallons of water you should be pumping through that system every minute. The loading criterion for oysters is one bushel for every 8 cubic feet of seawater. Temperatures and salinities that have in the past been recommended for oysters are a 10°C minimum temperature and a 25°C maximum temperature. Salinities should be within 20 percent of harvest area salinities and dissolved oxygen should be a minimum of five milligrams per liter. The pH should be somewhere between 7.0 and 8.4. You shouldn't have a problem with pH in a flow-through system, but in a recirculating system the water will pick up byproducts from the oysters and become more and more acidic so you need to monitor pH closely. You want to make sure that there is not too much turbulence, otherwise it may impair shellfish pumping when you want to enhance their pumping as much as possible.

Water purification can be accomplished using chlorine, ozone, ultraviolet light, or other methods. Chlorine is not used to any appreciable extent throughout the world. There are still some countries that will use it on occasion. The chlorine inhibits the shellfish pumping even at fairly low levels and it's difficult to ensure that you've got a low enough level to allow shellfish to pump. So we try not to use chlorine.

European countries and Australia like to use ozone. It's been used frequently. If you use ozone, you have to vigorously aerate the water before it's pumped into the system so that the residual ozone will be dissipated.

Ultraviolet light is frequently used in the United States. In fact, up until recently, it was the only water disinfection procedure used here. Ultraviolet light works very well as long as the water is clear. If you have warm temperatures and the shellfish start spawning (making the water turn a milky white) you're going to have a problem with the ultraviolet light penetrating that water and it will not adequately disinfect. Other systems include something called activated oxygen. There's some hope that activated oxygen may offer advantages over the use of traditional disinfection methods. I also want to mention waste partitioning and system sanitation. A tank containing baskets of shellfish should have a place for the shellfish waste to drop. If the shellfish are active they will produce a lot of feces and pseudofeces during the depuration process. Wastes should be allowed to fall clear of the shellfish baskets to collect in the bottom of the tank.

The design of the tank is crucial to facilitate cleansing of the tank. It should have a sloped bottom so that the waste will migrate to one end where it can then be rinsed and flushed and dried out between uses. There are certain guidelines that have been produced by the Food and Drug Administration and others that give guidance on proper tank design. Tanks should be flushed with chlorinated water after the end of each cycle in order to disinfect them properly and to prevent the buildup of algae, scum, and other materials.

What is the shellfish status? We've got to make sure that the shellfish come from waters classified as no worse than restricted. They can come from approved waters if you choose and there may be economic reasons that you'd want to take shellfish from approved waters and depurate them, for instance, to remove sand and grit and perhaps give you a higher price. Then again, there are the costs of depurating to consider and I'm not sure one would balance out the other. If in fact you take shellfish that are heavily contaminated and subject them to depuration, I would speculate that after 48 hours they will not be below the levels of fecal coliforms required in order to have them approved for commercial sale.

The physiological activity of shellfish is crucial. If shellfish are put into a depuration tank and they fail to pump they will probably fail to depurate to any significant level. You must ensure that they're handled in a proper way. They are live creatures and are being subjected to stresses that they're not accustomed to, such as variable temperatures and salinities. If you take shellfish out of waters that are warm and put them into an air-conditioned depuration plant where the waters are cold, you can expect those shellfish to undergo some signs of stress. So we have to make sure that the shellfish are gradually adjusted to a certain temperature or a different salinity and depuration timing should not start until we feel sure that the shellfish are effectively pumping.

The length of time that we depurate will be variable. It's normally 48 hours, but under certain conditions where you have to acclimate the shellfish, you will have to give them a little longer. Your particular plant may be a little different from your neighbor's plant and yours may just routinely take a little bit longer to depurate for reasons that are either known or unknown. Adequate time must be allowed for the shellfish to pump and to purge. You should not try to rush the process. I know economics sometimes get to all of us and we try to cut corners a little bit to save a buck, but in the long run, if you have to subject the shellfish to another whole depuration process you're wasting money and wasting time needlessly. So don't

try to rush the depuration process. Give it the full time and make sure the conditions are proper.

We should monitor the raw materials, the depuration system, the finished product, and the overall plant performance. Raw materials and depurated products are frequently analyzed by state health departments as they try to verify that a depuration plant is processing effectively. Plants can also monitor raw materials and ensure that the dead shellfish are culled out and that they're properly washed and free from mud and debris that may otherwise foul up a depuration system.

The system should be monitored regularly for salinities, temperatures, and flow rates. If you're using a UV system you should check regularly to insure that the UV bulb is still operating efficiently. The product should be monitored microbiologically. Total and/or fecal coliforms are frequently measured in the finished product and this is your assurance that the depuration system is working.

Overall plant performance is very important. Many people fail to realize this. If you have a depuration plant that's been effectively processing for some period of time and you suddenly have problems getting the coliform levels down, then you might question what has changed. Why suddenly are you having problems? You should try to diagnose what those problems are. Many times it is something very minor like a UV bulb that you didn't realize needed to be replaced, or maybe you've started to collect shellfish from a different and more contaminated area. You can resolve many of your own problems by just monitoring the system closely.

Now I want to get off of the general aspect of depuration and go into more specifics on bacterial and viral pathogens. Bacteria in general, at least those that are associated with human sewage, depurate quite effectively from shellfish, within 48 hours. Many papers show that total and fecal coliforms, salmonella, and numerous other organisms associated with sewage are fairly readily depurated in shellfish placed in the proper depuration system. However, we have some native organisms, such as the vibrios, which do not depurate well in shellfish. We're not sure why yet. It appears that many of the vibrios have adapted to life within the shellfish, within the gut and perhaps within the tissues. Vibrios that are loosely associated with feces will pass through the gut and will be purged, but in many cases the vibrios set up some type of relationship with the gut tissues and perhaps with some of the internal tissues and will not depurate after even fairly lengthy periods. *Vibrio vulnificus* is a rather serious problem.

This year (1988), about 25 cases of *V. vulnificus* were associated with raw oyster consumption, including 17 deaths. It affects primarily the immunocompromised host. There is research currently underway on the state, federal, and university levels to look at mechanisms to enhance the reduction of vibrios in shellfish either through processing methods, depuration, or by other means.

Enteric viruses have been associated with shellfish and include enteroviruses, Norwalk virus, rotavirus, enteric adenovirus, colicivirus, astrovirus, and enteric coronovirus. Many of those you probably never heard of and many of them I hope you'll never hear of again, but they have been associated with seafoods, and are known to cause various types of human illness. The incidence of illness from consumption of shellfish containing these pathogens is not known. The enteroviruses include poliovirus, Coxsackie A and B viruses, and hepatitis A. Polio we know quite a bit about because we've had laboratory assay procedures for poliovirus for many years. Only recently have we developed special cell-culture-adapted strains where we can now perform assays of hepatitis in the laboratory.

I would like to mention the bioaccumulation or bioconcentration of microorganisms in various shellfish species. We see that hard and soft shell clams and Eastern oysters can accumulate relatively high concentrations of viruses and bacteria. Let's take the Eastern oyster for example: We can have a 40-fold increase in *E. coli* levels over the ambient water levels of *E. coli*. In a laboratory setting, where researchers maintained a constant level of bacteria in the water, they found that they got a 40-fold concentration effect in the oyster. Concentration occurs primarily within the hepatopancreas and digestive system. Poliovirus studies done in a similar way show 60-fold increases. We also see poliovirus increases as high as a hundred-fold in hard clams. Bivalve mollusks are really efficient filter feeders and concentrators of pollutants from the water.

Hepatitis A virus, as we've all heard, can cause serious clinical illness. Enumerative assays are unavailable for the viruses in shellfish because we can't currently test for the wild type viruses within the shellfish tissues. All we can do at this point is inoculate our shellfish or let them naturally take up the special laboratory strains that we can assay and use those as models for how the hepatitis virus might depurate in a system. In this country, we've had three major outbreaks of hepatitis over the years. In 1961, we had 589 cases, (these were all shellfish associated); in 1964, we had 431 and in 1973, we had 293. Since then we've had relatively few numbers of virus outbreaks. The first oyster-related outbreak occurred in Sweden in 1956, where 691 people became ill with hepatitis A. In 1961, we had 80 people in the United States become ill from oysters, and oysters contributed to another 285 cases in the United States in 1973. In

the Philippines, oysters (different species) were responsible for 7 cases in 1980. I don't have the most current information that Roger Olmstead discussed yesterday about the recent outbreak that has occurred in Florida, but I understand there are some 60 cases that have been designated as shellfish associated in Florida. I'm not an alarmist and I'm not trying to alarm you with these numbers. In fact I'd like to show you that if you tabulate for the period 1975 to 1984, a 10-year period, all the cases of hepatitis that the Centers for Disease Control have registered in their documentation totaled 282,067 cases. This is from all sources; water, secondary transmission, whatever. And of those in the literature we can only attribute 46 of those to shellfish consumption. That's a very small fraction. I'm sure there are more cases that go unreported, some of which are shellfish-associated cases, but still the proportion of shellfish associated cases to total number of cases seems quite low.

The Norwalk virus causes short-term gastroenteritis. Enumerative assays are unavailable for the viruses in shellfish because we're unable to propagate those viruses in cell cultures. I've spent considerable time over the last few years attempting to propagate these viruses in various types of cell cultures. It's difficult, but we finally developed the expertise to be able to analyze for the virus and for virus antibodies. I hope that perhaps the next time I'm down in the Gulf area and have the opportunity to speak I'll be able to give you some good news about our abilities to monitor shellfish for Norwalk virus. Norwalk is a very, very small virus. It's the same size as poliovirus or about 27 billionths of a meter in diameter. These viruses are among the smallest known viruses to infect humans and are very difficult to analyze and evaluate even by electron microscopy.

We can look at the cases of shellfish-associated gastroenteritis that are Norwalk-like in character – that is, diarrhea and vomiting with rapid onset and short duration. We see that we have quite a number of cases and some of these may not be virus associated, but many of them likely are. We see the reported incidence of gastroenteritis between 1940 and 1949 was only 738 cases and it decreased after that. In 1970 to 1979, there were 312 reported cases. Between 1980 and 1984, in that relatively short period, we had 4,601 reported cases of gastroenteritis. Many of the latter cases occurred up in the New York/New Jersey area. These were due to improperly depurated clams from England. They were sent to the United States without being properly depurated. People consumed them and became ill. Norwalk virus was found among some of those individuals who became ill. That was a very serious episode, which jeopardized the sale of raw shellfish in the New York and New Jersey area for some time. It had serious economic impact on the industry. We see hepatitis has been decreasing since 1960 to 1969, when there were 1,046 cases reported. It went down to 338 from 1970 to 1979, and between 1980 and 1984, when we were getting all these gastroenteritis illnesses, we had only 11 cases of shellfish-associated hepatitis A reported.

The effects of the outbreaks are no surprise to the industry. The negative publicity causes consumer apprehension and that causes an economic loss to the industry. That economic loss can be disastrous as we've seen in the past.

We've got a few other viruses that are occasionally heard of. One is rotavirus. Rotavirus causes acute infantile diarrhea. I guess its fortunate that there are not too many babies around who like raw oysters. We also see occasional rotavirus diseases in geriatric patients who are immunocompromised. Rotavirus is found frequently in sewage and in waters, but we haven't yet been able to detect it in the shellfish tissues although it's likely present. It is very difficult to assay in the laboratory. We also have adenoviruses which cause sore throats. They cause rather inapparent intestinal infections that we don't need to get too concerned about. Assays are available and they have been found in shellfish tissues. There's an astrovirus which has also been associated with shellfish. We don't know what consequences it has as far as potential human illness. Some researchers feel people would not contract Norwalk virus if parvovirus was not present within their system at the same time. They feel that there might be some relationship for the infection with Norwalk virus that required parvovirus to be present. There's still some work looking at the levels of parvovirus in feces and trying to correlate parvovirus and Norwalk virus presence.

We need to develop improved virus analytical procedures for hepatitis and Norwalk virus and for many other agents that may someday become a problem to industry and public health. We need to determine the effectiveness of depuration for viruses as well as for vibrios. We need to evaluate and select new indicators of viral pathogens. For many years, we thought poliovirus was probably a good indicator of other viruses, such as hepatitis A, and only recently we've found that poliovirus does not work as an indicator of hepatitis. Recent work was conducted for us under contract and it showed that poliovirus depurated more quickly than even *E. coli*. Hepatitis A virus hardly depurated at all. This is quite astonishing to me since the viruses are so closely related. They are the same size and look identical by electron microscopy. Something is preventing hepatitis from depurating that is not preventing polio from depurating. Perhaps someday we can find out what the tricks are to enhance the depuration rates for hepatitis.

Oyster Seed Sources, Hatcheries, and their Role in the Management of Oyster Grounds

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Abstract

The management of oyster resources in Mississippi Sound must diversify to reverse declining oyster harvests. Management efforts to increase oyster yields ultimately depend on dependable supplies of low cost, high quality oyster seed. These can be from natural sets of oysters or from oyster hatcheries. Cultch shell planting, reef rehabilitation, and seed transplant programs all rely on natural set. In poor spat set years, however, only hatcheries can effectively supply seed.

Because hatcheries alone are not the answer, a series of management actions to insure the supply of seed to the oyster fishery and to private lease holders is recommended. (1) Seed areas must be identified, preserved, and managed. (2) Cultch plantings need to be improved: correct times, places, and quantities for cultch plantings must be determined and adhered to. (3) Alternative cultch sources to scarce and expensive shell need to be developed. (4) Spat collection methods should be developed to augment natural and hatchery seed production. (5) Economically viable public and private hatcheries should be developed. (6) Private control of seed oyster areas, especially in conjunction with private hatchery operations, should be encouraged. (7) Remote setting techniques should be developed in conjunction with hatcheries.

Low cost, alternative technology hatcheries may be technically and economically feasible for public and private sector development. To succeed, hatcheries must either be operated profitably or receive public support in good spat set years. Profitable hatchery operations depend on diversified supplies of seed. Both production and collection of oyster seed from a combination of hatchery, leased seed ground, and spat collection systems would allow profitable seed production regardless of spat set. Because of the potential for profit, private sector investment for the development of oyster seed sources should be encouraged.

This presentation is not about how to operate an oyster hatchery. There are numerous books to refer to for information on the subject (e.g. Breese and Malouf, 1975; Dupuy et al., 1977; Krantz, 1982; Wilson et al., 1984).

There is no oyster producing region in the world that does not require rehabilitation and cultivation to maintain productivity (e.g. Korringa 1976a, and1976b; National Oceanic and Atmospheric Administration, 1977; Angell, 1986). Oyster fisheries world-wide involve many species and all face essentially the same problems in maintaining the productivity of the fishery (Kennedy and Breisch, 1981). Traditional oyster fishery management practices (Agnello and Donnelly, 1974; Whitfield and Beaumariage, 1977; Hargis and Haven, 1988) are aimed primarily at protecting existing oyster producing areas and maintaining the quality of the harvested oysters. Actions to protect existing areas include fishery licenses, permits, gear regulations, imposing of seasons, enforcing cull laws and size limits, and environmental management. Maintaining oyster quality usually involves actions to prevent the closure of oyster reefs or oyster producing areas due to pollution. With recent declines in oyster landings in the Chesapeake and Delaware Bays, Mississippi Sound, Florida Gulf Coast, and other areas, cultivation is now expected to do more than just protect the existing resources. Cultivation must also be used to improve yields from current reefs through rehabilitation, to expand and reclaim lost producing areas, and to maintain current reefs in the face of increasing harvest pressures and environmental change. In addition to traditional protective activities and sanitary surveillance, cultivation includes such activities as shell plantings, seed transplants, and making unsuitable bottom areas available for spat settlement (National Oceanic and Atmospheric Administration, 1977; Hargis and Haven, 1988).

All oyster cultivation methods depend upon a reliable supply of low cost, high quality seed (Korringa, 1976a and 1976b; National Oceanic and Atmospheric Administration, 1977; Haven, 1980; Ken

nedy and Breisch, 1981; Krantz, 1982; Chatry, 1987). The quantity of marketable oysters harvested in any given year depends upon a successful set of spat at some previous time. Numerous studies have established that there is a direct relationship between the success of a spat set and quantity of harvested oysters (Ulanowicz et al., 1980; Krantz, 1982; Abbe, 1988). In the Chesapeake (Figure 1), Krantz (1982) showed a direct relationship between reduced recruitment and reduced harvest of oysters with a 5-year time lag.

In general, if environmental conditions are not limiting and spat set, growth, and survival are consistently good, then no cultivation is required to maintain successful harvests. However, this is not the case with the oyster fishery. Environmental factors are frequently limiting. Set, growth and survival of oysters vary greatly from year to year (Kennedy and Breisch, 1981; Krantz, 1982; Chatry, 1987; Perret and Chatry, 1988). Such variability is to be expected from the highly variable estuarine and coastal environment inhabited by oysters (Hargis and Haven, 1988). In order to maintain a commercial oyster industry in the face of these variable conditions, someone must take the responsibility for oyster seed production and recruitment success. This responsibility consists of identifying the factors limiting seed production and taking the appropriate measure to overcome these limitations (Chatry, 1987).

Management Models

Both the state and commercial interests or individuals have realized the value of cultivating oysters (Alford, 1973; Agnello and Donnelley, 1975; Hargis and Haven, 1988; Keithly and Roberts, 1988; Siddall, 1988). The state has recognized that large social values are to be realized from the industry in terms of employment, commerce, tax revenues, and other income generated by the harvesting, processing, and distribution industries. Individuals have recognized

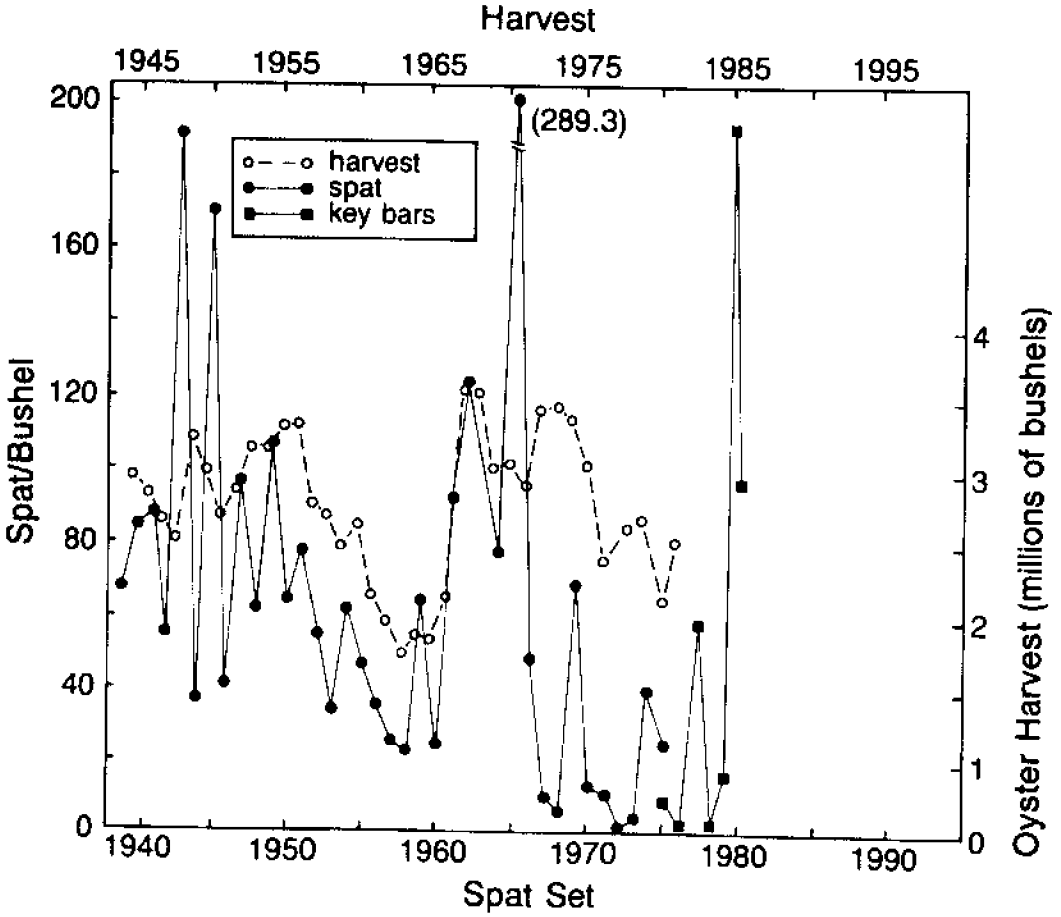

Figure 1. Comparison of oyster spat set on natural cultch with commerical harvest statistics adjusted for a 5-year lag. Harvests actually occurred 5 years later than shown here after oyster spat grew to market size. Squares indicate data from "Key bars," 1975-1981. (From Krantz 1982.)

the potential for profit and livelihood. Both public and private sectors have taken on the responsibilities for cultivating oysters and providing seed to the oyster grounds.

Three models or approaches to the cultivation of oysters have developed in North America. In the Pacific Northwest and in British Columbia (Magoon and Vining, 1980; Chew, 1984; Leffler, 1986; Halliday, 1988), the state plays a very minor role in the management of oyster resources. Most management and cultivation efforts are in the hands of the private sector. Native oyster stocks *(Ostrea lurida)* have been reduced to insignificance and almost the entire production of oysters from this area is from exotic species *(Crassostrea gigas)* raised on private grounds. The private sector controls productive bay bottom either through liberal leases or outright ownership. Because the industry depends on exotic oyster species, private hatcheries for seedstock are common. Because the private sector is responsive to markets and profits, support for hatcheries is strong. The industry has provided the funds for developing "gourmet" strains and species of oysters, has funded the efforts to restore and manage native Olympia oyster stocks, and has supported university research leading to the development of triploid and tetraploid off-season oysters.

The opposite extreme occurs in Maryland (Alford, 1973; Leffler, 1986; Greer, 1987). Few leases (less than 1,000 acres) are in production. There is little private effort toward oyster cultivation. The state has full responsibility for maintaining and cultivating oyster reefs for the public fishery. The state in essence subsidizes the public fishery from general funds (Alford 1973).

A combination of state and private sector effort is evident in other areas. Virginia (Alford, 1973; Hargis and Haven, 1988) and Louisiana (Chatry, 1987; Melancon et al., 1987, Perret and Chatry, 1988) are examples of states where both public and private sectors cooperate to maintain oyster production. Seed production is primarily the responsibility of the state. The state establishes seed preserves and regulates the maintenance and harvesting of seed from these locations. Seed collection, transplanting, growth, and harvesting are the responsibilities of the private sector. The private sector works under the regulation and guidance of the state in utilizing the seed areas for planting in private grounds.

All three of these examples work only because of the availability of low cost seed. In the West Coast system, the reliance is almost entirely on hatchery produced seed. Hatcheries do what they do best, which is to spawn oysters and produce larvae for setting at a profit. Growers provide the space, effort, and labor to do what they are best equipped for, which is handling bulky cultch, setting out and nursing seed, transplanting cultch, harvesting, and marketing. This division of labor and responsibility has resulted in profits for both sectors.

The other two models essentially rely on good natural sets of seed to make their programs work. Management efforts in Maryland, Louisiana, and Mississippi, for example, consist largely of shell plantings. Shell plantings provide substrates for oysters to set on in proven seed grounds. Where substrates are not limiting, but growth and survival are poor, state management programs may also include the moving of spat and seed from setting ground to good growing areas.

Shell plantings and seed preserves have been known to be effective in sustaining good oyster harvests in good spat set years (Abbe, 1988). Unfortunately, they are ineffective in maintaining oyster harvest during poor spat set years (Krantz, 1982; Chatry, 1987; Abbe, 1988). Shell plants in poor spat set years have failed to sustain economically acceptable levels of oyster recruitment. Despite extensive shell planting programs in Louisiana, there were total spat set failures in 8 of 10 years (1973 to 1983) with resulting lower oyster harvests in subsequent years (Chatry, 1987). Krantz (1982) reported similar failures of shell planting programs to support the Chesapeake Bay oyster industry during poor spat set years. Limiting oyster management programs to shell plants and establishment of seed preserves alone is an ineffective approach to managing an oyster fishery.

Unpredictable sets of oysters threaten the oyster industry in a variety of ways (Hargis and Haven, 1988). Private growers are unwilling to invest time, money, or labor on cultivating oyster leases if they must depend on the vagaries of chance alone to provide the seed. In order for a sustainable private sector oyster industry to exist, a seed source of some reliability must be available in order to reduce the risk to the private grower. Similarly, the public fishery will remain weak and unstable without a predictable supply of seed. Individual fishermen will limit investment in gear and effort if the returns from such a fishery are unpredictable. The number of fishermen within the industry will also decline. The processing industry will not invest in modernizing equipment and facilities if oyster supplies remain unreliable. Narrow profit margins due to shortages of product to process and distribute will affect labor costs in the post-harvest industry and act to limit marketing efforts and outlets.

Management Recommendations

Problems similar to those we are experiencing along the Gulf Coast have bedeviled the Chesapeake oyster industry for years (e.g. Hargis and Haven, 1988).

Numerous efforts in the forms of workshops, studies, plans, and so on have been made by the industry and management agencies in that area to try to resolve these problems. Some of their approaches have been insightful and solutions promising. I have adapted a series of recommendations from Hargis and Haven (1988), Kennedy and Breisch (1981), and Krantz (1982) that appear to address our problems succinctly. In essence, they recommend that the following activities must be undertaken to support a successful oyster fishery.

1. Establish seed areas of adequate size that are closed to all oyster harvesting except for seasonal collection of seed. Identify these areas through historical records and research.

2. Improve seed yields from public bottoms by more effective cultch plantings. The correct time, place, and amount of cultch to be planted must be determined through research.

3. Develop alternative cultch materials for setting oysters and alternative seed sources.

4. Make some seed production areas available to private seed growers. These growers would grow and market seed to leaseholders and/or the state.

5. Develop public and private hatchery operations to enhance natural seed production and provide some degree of support to oyster growers in case of natural set failures. In good spat set years, provide public support to the hatcheries to allow them to concentrate on producing seed for establishing new areas and developing oysters with desirable characteristics such as growth, disease resistance, and others.

Hatcheries

These recommendations plainly identify that hatcheries are an integral part of a balanced management scheme for the oyster fishery. Hatcheries are not a panacea nor the sole answer to reversing declining oyster yields in Mississippi Sound. They are a part of an integrated management program. Public support for hatcheries is essential to prevent oyster hatcheries from falling into the trap that the shrimp hatcheries, say in Ecuador, have fallen into (see Rosenberry, 1988a and 1988b). During the years when wild shrimp seed stock is cheap and plentiful, private shrimp hatcheries in Ecuador have not been able to sell their product. Consequently, many of them have experienced financial and technical difficulties and have ceased operations. However, during the years when natural supplies of seed are poor, such hatcheries are either unavailable or are incapable of producing sufficient seed stock. Public support for oyster hatcheries during periods when natural sets are good is essential for hatcheries to succeed.

While hatcheries have their technical and economic difficulties (National Oceanic and Atmospheric Administration, 1977; Krantz, 1982), and I will explore these in a later section, some of the work being done by hatcheries will illustrate their benefits (Leffler, 1986; Greer, 1987). In the Pacific Northwest and British Columbia, 90 percent of the seed supply supporting the oyster industry comes from hatcheries. In Maryland, state-owned hatcheries have identified broodstock sanctuaries and are planting these with hatchery oysters. Eight barren areas which once held significant quantities of broodstock oysters have been replanted in this way. Private hatcheries on the Chesapeake are also working on a faster growing oyster and on improving the setting success of hatchery produced larvae. State facilities in New Jersey and Virginia are working to develop a strain of oysters resistant to MSX. In Washington, cooperative efforts between private growers and the university system have succeeded in developing triploid and tetraploid oysters that can be harvested year-round.

The benefits of a hatchery system may appear obvious, but the question of how to develop a hatchery program to effectively assist the oyster industry still remains. This has been a vexing question. Large, high technology hatcheries are apparently not the answer (Lipschultz and Krantz, 1980; Krantz, 1982). Small, seasonal facilities, public or private, to produce low cost seed may be possible. This answer was not arrived at easily or cheaply.

High technology hatcheries, both public and private, tend to suffer the same difficulties (Lipovsky, 1980; in Krantz, 1982). High capital investment hatcheries failed to provide consistent supplies of low cost seed. All had serious cash flow problems and failed for similar reasons: optimistic production and efficiency projections were never met, the causes and variance of mortality of algae, oyster larvae and spat were never brought under control, and variable growth rates among the resulting seed oysters resulted in poor market acceptance of their product.

Krantz (1982) described the capital intensive hatchery system (University of Maryland and a Maryland private hatchery in Table 1) as typical of a light industry approach to production. A light industry should produce products 300 to 1,000 percent above manufacturing costs. An oyster hatchery, however, produces an agricultural food product. Gross averages for agricultural products are 10 to 25 percent above production costs. Investment of expensive manufacturing technology in food products with poor profit margins has been demonstrated to be a poor business decision (Lipschvitz and Krantz, 1980; Krantz, 1982). The very low return and very high risk profile does not justify the high capital investment. Operating expenses are unacceptably high, requiring a full-time, highly trained staff that is very costly to maintain.

High energy costs, natural variability in oyster mortality, and unresolved production technology problems all contribute to extremely high operating expenses in high technology hatcheries.

The alternative oyster seed production technology may be termed a low cost, appropriate technology design (see Krantz 1982). Minimum cost buildings, equipment, and supplies are employed to construct and operate a hatchery. Skilled labor is kept to a minimum, generally for training of employees who are drawn from the local labor pool. Seed production is intentionally seasonal and geared to take advantage of naturally good oyster spawning conditions and availability of algal food supplies. Such appropriate technology hatcheries are geared to produce larvae only in relatively small volumes, at least in comparison to high technology hatcheries.

Appropriate technology hatcheries are suitable for development at multiple locations. Multiple locations spread the risk of failure due to chance unfavorable environmental conditions. Limited output keeps the volume of oyster larvae at manageable levels. The site locations selected for such low tech hatcheries are critical. Important yet subtle differences in water conditions by location and time of year can spell success or failure for such a venture. If well sited, such a hatchery could produce well even in poor spat set years. If well located, such an effort could succeed as a commercial venture on a seasonal basis.

A comparison by Krantz (1982) of the costs involved in producing oysters by pilot high technology and low or appropriate technology systems is given in Table 1. The Deal Island facility, an appropriate technology hatchery, had a maximum larval production cost of $.75 to $3.10 per bushel of marketable oysters. This compared favorably with seed transplants made at the James River in 1977, at a cost of $2.36 per bushel of marketable oysters. These transplants had 300 to 1,200 spat per bushel of cultch material. Deal Island production costs also compared favorably with Maryland shell plant costs made in 1976. The costs here ranged between $1.00 and $3.25 per bushel of marketable oysters. The lower cost was for cultch material containing 1,000 to 1,500 spat per bushel. The high end cost was for 300 to 400 spat per bushel. Shell planting programs in Virginia (Outten 1979) ran $550 to $650 per acre for fresh shell and about $700 per acre for fossil shell. The planting rate was 1,500 bushels per acre. Using average spat set figures and calculating in the cost of transportation and replanting the seed, the cost per bushel of marketable oysters was roughly the same as that for the James River seed transplants. The Deal Island facility regularly produced spat at or below the cost of high technology hatcheries, both public and private. Only infrequently were high technology production costs for spat below the costs experienced at the Deal Island facility.

Low technology alternative system hatcheries have been tried and proven along the Gulf Coast. High technology hatcheries were apparently not successful (McGraw, 1980), so an alternative simple "brown water" method of culture was developed (Ogle, 1982; Ogle and Beaugez, 1988). This system provides no feed, just water filtered to allow the properly sized food particles to pass through. Variations of this system are apparently in operation in Louisiana and Texas. Some private operators use this system in Louisiana to produce larvae for direct stocking on to reefs.

Remote Setting

The production of larvae for direct stocking onto reefs may not be a very useful approach. Research and field trials (Krantz 1982) suggest that spat, especially larger spat, are the least costly in terms of producing marketable oysters (Table 2). While eyed larvae cost about $.07 per thousand to produce at the time of the trials, low survival made the unit cost per bushel of marketable oysters over $32.00. Spat held

Table 1. Comparison of oyster seed costs for spat produced by oyster hatcheries and by exploitation of natural spatfall (adapted from Krantz 1982).

Source	Year	Spat cost $/1,000	Seed cost per harvested Maryland bushel ($)
Hatchery:			
University of Maryland	1977-78	1.60 - 8.80	1.50 - 8.75
Maryland	1976	7.50	6.75
California	1978	14.00	12.60
Deal Island	1979-80	2.27 - 3.30	0.75* - 3.10
Natural:			
James River, Virginia	1977	3.00	2.36
Maryland Shell-Plants	1976	0.98 - 3.24	0.98 - 3.24

*Calculation is based on survival at one year.

Table 2. Cost of hatchery oysters if planted at various production stages (from Krantz 1982).

Oyster stage	Eyed larvae	Spat at set	Spat 4 weeks	Spat at 13 weeks	Spat at 20 weeks	Spat at 26 weeks
Size (mm)	0.2	0.3	5	20	30	40
Unit cost/1,000	$ 0.07	$ 0.54	$ 0.97	$ 1.39	$ 1.61	$ 1.83
Percent of desirable size cost	35.7%	59.6%	63.5%	68.2%	97.9%	100.0%
Survival at 1 year	– 0.2%	2.0%	5.0%	10.0%	25%	50%
Unit cost at 1 year/1,000	$ 32.58	$27.24	$19.35	$13.86	$ 6.43	$ 3.66

for 26 weeks (the most desirable age because of its high survival rate) were the most costly at $1.83 per thousand. This is about 25 times the cost of producing eyed larvae. But such spat only cost about $3.70 per thousand for a bushel of marketable oysters. Hatcheries and oyster growers in the Pacific Northwest and in British Columbia have recognized the value of producing large yet relatively costly spat for setting out on the oyster grounds. A division of labor and effort has evolved. Hatcheries produce eyed larvae, which they can do inexpensively and in large numbers with relatively consistent success. Rather than attempt to set and maintain these larvae, they pass them on to private growers for that labor-intensive task. The technique is called remote setting (Jones and Jones, 1983, 1988). Larvae are transported to areas near the private lease planting sites and set on shell held in tanks. The shell is then planted in a nursery near the shore to allow the spat to grow.

Various growout approaches are used. The seed can be planted intertidally on the bottom, in floating trays or on hanging racks. Growers handle the labor-intensive and space-demanding setting and spat growth phases of production. This reduces the cost to the hatchery to producing eyed larvae alone. This also spreads the risk in various ways. The risk of failure for all seed to survive and grow is reduced by dispersing it among many growing sites. Even in bad years, some sites will do well. Spreading seed production among hatcheries also eliminates the risk of any one hatchery failure drastically affecting the industry. Finally, growers may accept seed from a number of hatcheries, reducing the risk that the seed from any given hatchery may perform poorly. Because of the successful application of this technique in the Pacific Northwest, Sea Grant/Extension Service trials in conjunction with private growers are now underway in Maryland, Delaware (Greer, 1987), and in Louisiana (John Supan, Louisiana Sea Grant Advisory Program, personal communication).

Conclusions and Recommendations

The future success of the Mississippi Sound oyster industry may depend to a large extent on the combined collection and production of seed oysters. Hatcheries alone are not a solution. They are part of an integrated fishery management scheme. Because provision of seed is a critical element for successful oyster industry management, it is important that hatcheries and remote setting should be used in conjunction with other management practices.

Seed areas must be identified through research. They must then be of adequate size and be managed by closing such areas to all harvesting except for seed. During good spat set years, such seed reserves would provide the main source of seed for transplant to private leases and to enhance public reefs. Cultch plantings should be researched more thoroughly to be used more effectively. There is a need to identify the best times, places and quantities to plant to provide the greatest return for the planting effort.

Alternative seed and cultch sources also need to be developed, tested, and demonstrated. It is apparent that returns of green shell from shucking houses are not sufficient in quantity to maintain and expand existing public reefs and to support increased cultivation efforts on private leases. The costs of fossil shell cultch are increasing as shell beds are depleted and environmental concerns close areas to mining. Seed collected from spat catching devices have been successfully used in other areas for seeding public and private grounds (e.g. Krantz and Davis, 1980; Jones and Jones, 1983 and 1988). These approaches should be explored for use as alternative sources of seed.

Private ownership of seed production areas should also be allowed. Either the ownership or lease of seed producing or seed collection areas should be encouraged. It has been repeatedly proven that private, for-profit production of seed for distribution to state and private leases is an effective method of managing the

oyster resource (Krantz, 1982; Hargis and Haven, 1988).

There is a place for public and private seasonal, appropriate technology hatcheries to supply seed (McGraw, 1980; Hargis and Haven, 1988). Such hatcheries would produce seed for sale to public seed planting programs or to private leases for growout. The public fishery and the oyster lease holders would benefit from this development. A predictable low-cost supply of seed could be assured should a hatchery program be developed in conjunction with publicly and privately owned seed reserves.

Private ventures with both appropriate technology hatcheries (in combination with remote setting capabilities), seed preserves, and spat collection systems could operate profitably regardless of the success of spat set any given year. The combination of production and collection of oyster seed would allow cost effective operations.

The role of the Mississippi Cooperative Extension Service and the Sea Grant Program is to evaluate these approaches, demonstrate the relatively simple hatchery-remote setting technology, and bring the technology to the local oyster industry. The effort should then be to bring this technology to the public and private interests on the Mississippi Gulf Coast as part of an integrated oyster resource management program.

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Case Study of Off-Bottom Relaying in Mississippi

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I feel like I have come home. I spent 7 years here on the Point – 7 glorious years, I might add. It is good to be home.

An old man once said (he was president of the Louisiana Oyster Dealers and Growers Association about a dozen years ago), "Fifty years ago we had a whole lot of oysters and just a few experts, and now we have a whole lot of experts and just a few oysters." I think that just kind of shows an old man's frustration. It is true; I can see his point. At this year's oyster convention in Louisiana, I figured the only way to remedy that would be to kill off all the experts, dry their bones, and use them for cultch to catch spat. So I want to clarify right now that the only thing I claim to be an expert at is aggravating my wife and that will keep me out of that trouble.

One thing that I do want to share with you is my experience on the development of containerized relaying, and I am going to digress here. I don't like using the word basket. A basket will not work. If you fill up a basket half full of oysters, let alone full of oysters, the internal mass of the oysters won't cleanse. Oysters are different than clams. You can stack clams a little bit deeper than oysters because they can shove those two muscular siphons up through the shells and force them apart. When you shuck an oyster, look at the hinge. There is a little black or brownish ligament there. An oyster doesn't have a muscle to force the shell open, only a muscle to close it, so if you have too much weight on that shell by loading in the container, that ligament won't be able to lift that shell up. You have a basic weight problem. This was discovered by Dr. Becker in the early 1970s in the Dauphin Island area where he did some container work and found that a single layer worked fine and a double layer worked fine, but in multi-layers the internal mass didn't cleanse. I felt that the problem was basically the shape of the container. When you are thinking about going into basket relaying or container relaying, think broad and flat, not cubed. This study was your tax dollars at work. Believe it or not, industry people here in the audience, some money that you give to the state does go to your benefit. The Gulf Coast Research Laboratory, as well as the University of Southern Mississippi funded this project at the time when I was a graduate student. The Sea Grant Marine Advisory Service that is putting on today's program, coordinated with industry, with research at the laboratory, and with the Board of Health and FDA officials. It was an overall program approach and a good example of how things can come to reality.

In the dollars-and-cents aspect of it, a lot of common sense is what I am going to add. I don't have a lot of economic figures and ratios to show you, but a lot of common sense in experiences that we saw in containerized relaying.

In Louisiana, our fishermen get heartburn. Four times a year the Board of Health posts the closure map. Whether you believe or do not believe that oysters in those areas are polluted, you have to be concerned about public health, because if you get a person sick, as you know, your industry suffers until you get that market back. So this was the drive for developing this project for those areas.

In container relaying, you obviously have to be concerned about how strong that oyster is. It was difficult to get the oysters in different physiological states or different seasons of the year so that we could try relaying work before and after spawning, like when they are blistered. Obviously, you would assume that in February when they have plenty of fat and they are strong and growing well, they would relay well. So the condition of the oyster is very, very important. We have had oysters that – I even tried some oysters out of Pascagoula Reef off the mouth of the West River at the time we relayed them, you could almost tear the shells apart by hand. It was obvious that those oysters did not do well in that trial. You have to be very conscious of how you are taking care of your animal, as Dr. Richards mentioned.

Container design, as I eluded to in the very begin-

ning, should be big, broad, and flat, not cubed and not a basket. You are using a container basically so that you reduce your losses and ease of handling. But if you use a container in a method in which someone can come by the site and take it after you have just left, this just adds costs. So how you use it has a lot of bearing on containerized relaying. There are a lot of problems with relaying including container relaying. I think the first one is the stress on the animal itself and the damages caused by throwing it overboard. Frankly, "dollars and cents wise" I think it is foolish to throw a market size oyster overboard on the bottom. You ought to use it within a container where you get it all back. Mortalities can range as high as 90 percent in on-bottom, mud, or reef relaying. Of course, on the reef you are going to do better. If you are in a marginal area of sticky mud or "gumbo" mud, you are throwing your money away because you are going to have high mortalities. You are not going to get all the animals back. During this case study we had "the pros" come over from Louisiana and they "lost their butts." So I think you should really consider the cost of throwing that oyster back overboard on the bottom.

Smothering and clogging by sediments are another cause of mortalities. If you throw oysters in the areas where the oyster drills are, drills are going to get them. You are not ever going to get them all back up. Those are the "dollars and cents" reasons why container relaying can be valuable to you. Obviously, if you are going to put oysters in an area where they are going to cleanse, you have to have good water quality and the number there is 14, the most probable number or MPN value of bacteria (fecal coliforms) per 100 milliliters of water. Unfortunately, as Tom Herrington pointed out, the whole Mississippi Sound area is conditionally approved. How much rainfall you have influences what kind of water quality you have. This study was done south of Deer Island, and off of the White House Reef area when that first shell plant was put down offshore of the Methodist Home there off U.S. Highway 90. It was also done in Point aux Chenes Bay over in Alabama, and I can tell you that about 100 drills will crawl up inside a basket in about 2 weeks over there. Predominantly, it was done off Bellefontaine Point where increased rainfall in the watersheds would affect water quality.

When you are looking at any kind of utilization of the wild waters, look at your watersheds. For example, the Pascagoula River and Biloxi River have a lot more drainage area than streams affecting the area offshore Gulfport. Your watersheds and the usages of those watersheds are real important whether you are trying to raise oyster larvae or relay oysters. Obviously, if it is going to take you 30 hours to run to an area to put these oysters overboard, you've got some cost problems, so you want to be close to your reefs. If you are too close to them though, that closure line will get you and you have to start the 14-day count all over again so you have a "catch 22" there. If you are going to use a method of containerization that is off the bottom, you've got to keep in mind your liabilities to navigation. Obviously, you want to keep your water depth in mind.

We learned a lesson on dredge spoils south of Deer Island putting some containers overboard. They came in and did a little dredging to keep the channel open and the liquid mud rolled a considerable distance with the prevailing tide toward relayed oysters and caused problems with fouling by mud and siltation.

I basically approached this problem of container relaying at the time when Dr. Cake and Dr. Cook at the Gulf Coast Research Laboratory had just gotten some funding from Sea Grant to look at depuration. A portion of the proposal that was not funded was containerized relaying, so it gave me a good opportunity to try something out in comparison with the depuration activities at the time. My concept of depuration or containerized relaying was to use a container that held a commercial quantity. That was my basis for looking at containers and ease of handling, so I became interested in the milk crate style of construction. A gentleman up at Piper Industries in Jackson sent down a few chicken coops to try out. These were hung off the tide gauge platform near the north shore of Horn Island, which has since blown away in one of the hurricanes. I used three types of containers; an experimental Nestrer® shellfish growout tray, which does not hold a commercial quality, a Vexar® mesh bag, and a chicken coop.

The plastic chicken coop is a polyethylene structural foam just like milk crates are made of. They will hold commercial quantities and I stacked oysters with about 3 inches to spare on top, which is the depuration manual recommendation on filling containers; a 3-inch gap between the surface of your oysters and the bottom of the upper container stacked on top of it. That is why I like the coop. It is modular. It turns out that a chicken coop full of chickens weighs the same as a sack of oysters in there – about 80 pounds. So Piper conducted a test at their plant and found that with 80 pounds in each coop, you could stack them 11 high before you start crushing those at the bottom. So we know that we could stack them 11' high out of the water, which was nice for forklift handling.

Solid bottom containers versus open bottom depends on how you are using them. If you are stacking them, solid bottoms may be to your advantage so that you don't have all the mud and bacteria that you are trying to purge out of the oysters just drop down on the ones below. It's a toss-up, depending on what kind of water flow is going to get around the animals.

I also used a mesh bag as control because I felt that, though not really commercially feasible, it would guarantee that I had some kind of containerized oysters that would pretty much purge all the time. All of these were hung off the tide gauge platform. I threw some oysters on the bottom as a control, to be able to compare what was hanging in the containers as to what was laying in the bottom. Obviously, off of Horn Island on the north shore you have a sand substrate and no one in their right mind would put a commercial quantity of oysters on that sand and watch them roll away and bury. But for my purposes I had to do it there. It was a lot of fun, but we had to use a 16-foot Boston Whaler and slip it underneath the platform and raise the oysters up out of the water and drop them down. It was a lot of work and obviously this would not be a commercial method of doing it – too much labor involved. But it gave me a scientific basis to move on.

We tried a commercial-scale system, six stacked coops strapped to a pallet. This worked in a way, but it was too top heavy. Maybe we should have only stacked them about three high. Over a 14-day period this tilted and settled in the mud, so we had buried oysters. One was kept off the bottom and it worked great, so keep in mind again, it is how you use the container in the engineering design.

In the rack study, I did find you can adequately cleanse oysters from closed harvesting areas in these coops with holes in the bottom. With Dr. Veal of the Sea Grant Program and Dr. Cake, Dr. Cook, and Richard Gollott (who was also involved a little stronger on the industry side), we tried a larger system. Dr. Joe McGilberry, an engineer at Mississippi State University designed a rack; he came up with the blueprint. My job was to prove that it worked. At the time, Richard was looking at a heavy cage, for security reasons, that would hold about five sacks of oysters, made from welded angle iron and expansion metal. I was looking at the ease of handling. So the concept of a rack where you use something that you could individually handle and put it into something heavy – that made the whole thing virtually theft proof. It held 48 containers and if you put a little crown on each one of them you can put 50 sacks in each rack. It was six containers wide, four high, and two deep. The depuration guidelines of 2 to 4 inches between the trays were followed in the design. These had holes in the bottom. They were chicken coop bottoms that were built by Phillips Petroleum Company. There were 4x4 timbers running the length under the rack and then a solid sheet of steel or wood between the timbers and the oysters. The 4x4's would settle down in the mud and the plywood or the sheet metal would be high enough to float on the surface of the mud. We never put it in gumbo mud. We used it south of Deer Island and off Bellefontaine Point. It was sticky to firm mud, which we located by prodding with a cane pole.

A rod slipped down in front of each column of the containers with a tang to keep it from falling through. Hinged angle iron would drop on top of the rods and you could padlock the rods in place. Theoretically, if you wanted them bad enough you could jump overboard, reach in and grab a few, but you weren't going to pull the trays out of place unless you used bolt cutters.

We compared this method with on-bottom oysters, relayed by Louisiana boats. They were losing 75 - 80 percent of their oysters during relaying. We lost 2 percent. That makes a dramatic difference in profitability.

The 1978 cost of each rack at the time was $3,000. That included the cost of welding, materials, and the baskets or containers. Most fishermen have their own equipment to construct things, so you may be able to beat that. That was a commercially built price. During this time, Richard Gollott had someone at Ingall's Shipyard design a barge that could be built out of plywood and nails to dredge the oysters, fill the racks, and put them overboard. I feel that the rack system is the answer to container relaying. This system will pick the racks up off the bow. This was the two-stage process where the rack was brought up to the surface and then "cheater" chains were attached to the racks so the main hooks could be disconnected from the floats that were on the surface of the water. Then the hooks were attached to the racks so you bring them up to the deck level. All of the cabling had to be customized for the water depth that we were working. A lot of diving was conducted to develop this technique.

We tried containerized relaying that a small oyster farmer could use. Obviously, a man who doesn't have a whole lot of capital to invest won't be able to build too many racks, so I looked at taking the plastic chicken coop and laying it on the bottom. The first time I laid it on what I thought was the best mud that I ever felt with a cane pole. After 14 days, the prevailing tide eroded the bottom of the mud in front of the tray and deposited it on the leeward side and smothered the oysters. I was ending up with higher fecal-coliform values in these oysters after 14 days than I had when I started out with them. I think what happened was that the oysters were dying in the smothering muds, the meat would start to rot inside the shells and the bacteria grew in them. That is what was happening there in theory anyway. I tried the coops on the shell bottom of the White House Reef and it worked great. You have to have hard reefs, in my opinion, to keep the cost factor realistic using containers right on the bottom.

I also tried a long-line method. With a Boston Whaler, I used a pipe across the stern and had a floor flange on the end. This was connected to a steel ring that slid up and down a piling that was in the area. I would go by with a boat hook and pull up the steel ring, put the line over the edge of the pipe and drive away from the piling. The trays would just come up and I could snap off my clean ones and snap on the polluted ones and they just slid off the back of the boat. Unfortunately, I only had one long-line and the boat always wanted to yaw to the side that I was pulling on. If you are going to do this you need a long-line off each side of the boat so the boat would go forward. I figured that this long-line method, rather than an individual float method, was more feasible because you were keeping honest people honest. What they didn't see, they are not as likely to fool with. Any crabber here knows that when you have a float there, it's a big invitation for anyone to grab it to see what's underneath. With this long-line method, basically all people saw was a piling. It works as long as you use a good hard-bottomed area. One other method was tried by Ed Pullis here in Gulfport. His system used two steel pontoons with 4x4's that held them apart. Inside were baskets made of hurricane fencing that stood about as tall as your shoulders. It held commercial quantities of oysters, but was hard to handle. I don't have any exact figures on how many oysters each container held, but I would be willing to bet it was a good three to five sacks. It was really heavy and hard to lift.

The concept of a raft is very valid. Unfortunately, I think you will have to have 24-hour security out there so somebody doesn't come and tow it away. Secondly, oysters used in the surface water systems near the effects of sewage treatment plant outfalls and land runoff are more easily contaminated than an on-bottom container system, because the fresh water is laying on the surface, possibly recontaminating the oysters. Those are the drawbacks to the raft system. I think the proper vessel to use is a spud barge with a crane so that you can hold yourself in place and work. We are using one in Louisiana right now for oyster culture. When the oil crash happened in Louisiana you could get these for a song. Now the oil business is starting to come back a little bit and you have to pay a little bit higher price. But I think this is the proper vessel to use in containerized relaying.

Thank you very much. If you have any questions, I will be glad to answer them.

On-Bottom Relaying in Mississippi

Jimmy Cannette
Mississippi Oysterman
Ocean Springs, Mississippi

Mine is a small operation, nothing like Richard and John had, but it doesn't cost $100,000 either. I will tell you a little bit about it.

This is the tray that we use to depurate our oysters. It is a chicken coop. You can look at it. It holds about a sack and a quarter. We put them over four trays at a time by using an iron to rope four trays together. Four corners have ropes on them and each corner holds a tray. The ropes go to a half-inch line. It was "polypro" so it would float and you could find your line in case somebody would cut the buoys off. The four trays hold a total of five sacks of oysters. You don't have to have a big device like Richard used to pick the trays up and this is a lot lower cost, too. The chicken coop trays cost $5 each and to rope them up with the buoys, line, and iron, runs the cost to $6 per tray.

In 1984 and 1985, we moved oysters off of the Biloxi and Ocean Springs Bridge and did real well. The first month of oysters paid for our trays and our equipment – and we still have the trays, about 1,100 of them. We worked the trays in 1985, 1986, and 1987. The system worked out real well. The only problem we had was that we had a few trays that somebody either stole or something happened to them. We later found the trays with the oysters. I know of 20 of them that somebody turned over. But picking up the trays is something hard to do. It's five sacks of oysters, and it would be real hard for a guy with a skiff to lift up even one tray at a time. You need to put the trays on a hard bottom or on firm mud. We put them on a soupy mud and mud got into the bottom of the trays.

As far as small-time oyster man is concerned, this seems about the best way to go. If you go buy a barge with a crane on it, buy these big racks, and all the equipment to do it with – the trucks, the forklift, etc. – it would cost you a good bit. I believe it would be tough on even the factorymen. We tried this method and it worked.

We had the Health Department inspect the meat, and every one of our samples except for two in 3 years showed a fecal count less than 20. That is as low as they can measure, so they put 20 or less. I think the maximum allowed under state law is 100. So the depuration was great. Last year was the only year we didn't use the crates because the oysters were so few we didn't have enough to depurate. That would really be a big problem for a depurating plant because they wouldn't have had enough either.

With this system there is low maintenance, it is low cost, and it lasts a long time. It worked out great for us. We tried other stuff. Morris Sekul tried bags, and I think he is going to try them a little bit more. But the only way we depurated was with the trays.

As far as on-bottom oyster culture, we have leases that we plant and at times when there are no oysters to move, it gives us something else to do. Hopefully, next year it will give me something else to do as far as on-bottom leasing. The trays are great. I didn't have any complaints as far as the amount of oysters we caught compared to the amount that Richard produced with the barges. In a day's time, we could plant just as many oysters as they could with the barge, and it was not nearly as dangerous. We mark our leases with PVC pipe to stop anyone from hitting the pilings with their boat and sinking. The trays are very low in the water. If you run aground on them, you couldn't hurt your boat. If you hit one of the racks at 4 feet above the bottom, you could sink your boat. We know there is still a rack missing off of St. Andrews. I have the hang numbers on it and I am sure a lot of you have the hang numbers on that rack that's missing. We have a few trays that are missing – people trawled for shrimp and they got in the net, but they haven't torn up or sunk a boat. Compared to the damage a big rig would cause, something like this that is easy to keep up and economical is a good way to depurate.

As far as conservation is concerned, the Bureau of Marine Resources would monitor us all day. We had to be in an hour before dark. Our boat had to be clean. It was inspected every day. We worked 5 days a week, Monday through Friday. We had water samples taken every Monday or Tuesday, whenever we had trays ready for harvest. If we had a 20-acre lease, we zoned our lease off into three areas. We would stake it off with color PVCs and the zones had to be 300 feet apart so we wouldn't be picking up bad oysters that weren't ready. We had the agent from the FDA who rode out there on the boat to check our leases. He rode out there three times in 1984 and 1985. In the 1985 and 1986 season, he only came once. When we rode out there he wanted us to draw a diagram of everything that was going on. He got one from the Health Depart-

ment that was filed with the Health Department at the time. When he rode out there he saw what was going on, everything was smooth, and he was pleased with it. He checked the meat samples we had, and the water samples. Everything went fine. We even had a guy who bought a sack of oysters and took the sack right to the Research Lab, and had the meat sample done on it. He thought we had polluted oysters and he found out the meat sample was real good.

I even talked to one of the senators who asked if we brought in bad oysters before. He said he had a man come to him and told him that we were bringing in bad oysters. You can believe whatever you want and a lot of times people talk, too, but the only firm I have ever sold ours to was Gulf Pride. In the season of 1984-85, we kept his shop completely busy – three boats kept his shop completely busy and he handled a lot of oysters with the trays, so we really did good that one year. The other years, we did better with the trays. Even with overcoming the cost and time required by the trays, we did better than we could have on a public reef.

It is a little bit of double work and it is aggravating at times, because you go through extra work and a bunch of red tape and everything else, and it's hard to tell a fisherman that because he doesn't want to listen to all that. We had to dredge the oysters, put them in the trays, set them down, and leave them for 14 days. We had to have water samples taken and whenever the 10 or 11 days was up we had to pull one tray for about every 10 trays we had and take two or three oysters out of these trays to make sure they were all depurated. We would send off the meat samples. I have been informed that we don't have to do that now. The meat sample is taken right here by the Gulf Coast Research Laboratory and is written up for us much faster.

It worked out great. Now what I am going to do is get with some researchers for information on the best lease sites. We planted on bottom, on the outside of Deer Island in the sand, in the mud–we tried it all. Outside of Deer Island was a waste of time. We had about a 30 percent return on that bottom. You have to have the bottom right, the salinity has to be right. It's a long-term deal.

I did really well off my lease in Waveland. It was an on-bottom lease I planted with two barge loads of key shells. The shells on top died. We have cultivated it and we might have oysters on it next year. We had good spat on it this year. We are going to move oysters again if we get a little bit of ground open in the polluted areas. We may move oysters again this year, but definitely we will move shells. We have our trays. I think Richard still has all of his. They are easy to get hold of, or at least they were. I think it's getting kind of tough right now to find them.

You have to put up a bond for your lease and you have to stay within the law whenever you are working with them. That is all the conservationist asks you to do – just stay within the law. As far as we're concerned our trays paid for themselves. They are sitting in the yard right now, probably growing weeds.

APPENDIX A

Perceived Problems in the Mississippi Oyster Industry Identified by Workshop Participants

- Lack of sufficient resource management and a coherent management plan. (mentioned by five participants)
- Continual loss of shell or other cultch material (mentioned by seven participants)
- Increased salinity caused by loss of freshwater inflow (mentioned by two participants)
- Control (or lack thereof) of the Bonnet Carre' Spillway (mentioned by two participants)
- Pollution (mentioned by six participants)
- Overharvesting
- Loss of wetlands
- Lack of adequate state funding (mentioned by two participants)
- Inadequate enforcement and a need for stronger penalties (mentioned by five participants)
- Power dredging in tonging areas by out-of-state harvesters
- Construction of new reefs instead of renovating old ones (mentioned by two participants)
- Lack of hatchery development
- Lack of communication between governing agencies, legislators, and fishermen
- Lack of understanding of regulations by fishermen
- Lease size limitations
- Lack of concern for protection of public health (mentioned by three participants)
- Lack of industry promotion and advertising
- Unequal treatment by management agencies from county to county (mentioned by eight participants)

APPENDIX B

Possible Solutions to Mississippi Oyster Industry Problems Identified by Workshop Participants

- Domestic sewerage control and abatement (mentioned by three participants)
- Return shells to reefs (mentioned by three participants)
- Stronger penalties for regulation violations; better enforcement (mentioned by three participants)
- More state and federal funding for industry promotion and development
- Formulation of a comprehensive management plan (mentioned by two participants)
- Creation of new reefs (mentioned by two participants)
- Use of dredge spoils to rebuild areas for better freshwater retention
- Better monitoring of industrial pollutants (point source discharges)
- Tank and/or pond culture of oysters
- Freshwater diversion projects
- Development of hatcheries

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