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EXXON VALDEZ OIL SPILL SETTLEMENT TRUSTEE COUNCIL

TRANSCRIPT (EXCERPTED) OF THE PUBLIC FORUM

FIVE YEARS LATER: WHAT HAVE WE LEARNED?

Sponsored by the
Exxon Valdez Oil Spill Trustee Council

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PROCEEDINGS

MR. JIM AYERS: Welcome to the Exxon Valdez Oil Spill Trustee Council Forum. My name is Jim Ayers, and some 110 days ago I was hired as executive director of the Exxon Valdez Oil Spill Trustee Council. Perhaps, before we get started, in order to put us into a proper perspective, we will take a look at the slide show that kind of reminds of how it is we got to where we are today, at least with regard to the oil spill. So, if the slide show is ready, why don't we go ahead and start the slide show, and then I'll do introductions after that.

I'd like to recognize and thank Pat Enders (ph) for putting together the slide show on a moment's notice, so to speak, and I think it is well done and really appreciate his hard work. (Applause)

There are a number of people here -- perhaps, I should say -- everyone here in one way or another deserves to be recognized. I would like to recognize the Trustees that are here. Craig Tillery is here from the state Trustees side. Craig is with the Department of Law and is the Trustee representing Bruce Botelho, the Attorney General. Steve Pennoyer from NOAA is a federal Trustee, and with him today is Mike Barton, federal Trustee from the Department of Agriculture-Forest Service, and Chuck Meacham is representing Carl Rosier today who is not able to be here, a state Trustee. Carl Rosier and John Sandor are unable to be here because of previous commitments, and in many ways we were struggling with a date that was certainly within the week of the spill and yet try to find a time when we could have the most people available. Carl and John were not able to be here, neither was George Frampton from the Department of the Interior, although I understand Deborah Williams is here representing the Department of the Interior today. I would like to also recognize the Public Advisory Group. There are a number of people here from the Public Advisory Group. There is a public advisory group, and -- I saw John French. John French is a member of the Public Advisory Group, as is Jim King over here, Donna Fischer, and I saw Cliff Davidson. Cliff Davidson is an ex officio member of the Public Advisory Group. Pam Brodie back in the back is a member of the Public Advisory Group as well. Was Sharon Gagnon here representing Lew Williams? Is there anyone else that's on the Public Advisory Group that I failed to recognized? -- Rupe Andrews. Hi, Rupe, you're such a small guy, it's hard to see you. Senator Arlys Sturgelewski -- we all know Senator Sturgelewski -- thank you for coming today. And I saw Margy Johnson, mayor of Cordova here, and I wanted to also recognize Margy. So let's give them (applause).

We've asked our speakers today to address the issue of five years later, what have we learned from their perspective. Governor Hickel was in town yesterday but was not able to stay. He got called back to Juneau. It's my understanding there, Friday, there are things happening in Juneau this time of year. But I'm pleased to introduce Craig Tillery from the Department of Law, a state Trustee, who is representing the Governor today, and has a statement from Governor Hickel. Craig Tillery.

MR. CRAIG TILLERY: Thank you, Jim. As many of you are aware, Governor Hickel played a central role in bringing about the settlement of the *Exxon Valdez* litigation for the governments. Since that time, he has maintained a keen interest in the ongoing restoration efforts. The Governor very much regrets not being able to be here today, but he has prepared a statement which I have been asked to read to you:

"My fellow Alaskans, five years ago the *Exxon Valdez* oil spill resulted in a tragic environmental disaster right in the heart of one of the world's richest marine ecosystems. Alaskans pitched in to mitigate the damages. In the months following the spill, literally thousands of people washed beaches, rescued and cleaned birds and otters, and conducted scientific research so we could better understand what was happening. I am proud to have been the catalyst behind the record court settlement in 1991, which resulted in the formation of the Exxon Valdez Oil Spill Trust Fund and which provides the basis for our efforts at restoring and enhancing the environment of the spill-affected area. I am also proud of the progress we have made towards restoration. The state Trustees have joined hands with their federal counterparts to move forward with a comprehensive approach to restoration and enhancement. This balanced approach includes direct restoration activities, monitoring and research, and habitat protection. The Trustees have also taken steps to ensure that a long-term monitoring and research program is established. This program includes developing a first-rate research institute in Seward, a woods hole of the North Pacific. It also includes establishing a restoration reserve account so that important research programs can be maintained well into the future. I support the recent purchases of in-holdings in Kachemak Bay State Park and the land at Seal Bay on Afognak Island to protect habitat critical to the recovery of many of the species injured by the spill. We have made great strides in cleaning up the spill and in restoring the ecosystem. However, we must develop a comprehensive understanding of the complex effects this disaster has had and may continue to have on the resources and services that depend upon the health of our resources and the ecosystem that supports them. Many questions still remain unanswered. The scientific endeavors initiated by the Trustee Council to restore the damaged elements of the ecosystem will answer many of these questions and help people in the spill region return to the lifestyles and security they enjoyed before the spill. The increased understanding of the marine ecosystem in the Northern Gulf of Alaska that we will gain through our scientific research will be one of the most important and lasting, positive legacies of this environment tragedy. Providing opportunities for members of the public to hear reports from leading scientists about effects of the oil spill, such as today's public forum, is a very important part of the Trustee Council's mission. I welcome forum attendees and participants and urge you to use what we have learned to better the lives of all Alaskans and all Americans. Sincerely, Walter J. Hickel, Governor."

(Applause)

MR. AYERS: Deborah Williams is here today, representing Secretary Babbitt and the Clinton Administration, and Deborah has a statement from Secretary Bruce Babbitt. Deborah.

MS. DEBORAH WILLIAMS: It is my honor to present the following statement from Secretary Bruce Babbitt.

"This week marks the fifth anniversary of the *Exxon Valdez* oil spill, one of the most devastating environmental disasters in our nation's history. Five years ago, the tanker vessel *Exxon Valdez* ran aground and spilled over 11,000,000 of crude oil into the pristine waters of Prince William Sound of the Northern Gulf of Alaska. Without question, the spill was a major ecological disaster for the natural resources of Prince William Sound and the other areas impacted by the spill, for seabird populations, fisheries stocks, marine mammals and other species. Five years later, many populations of injured species have yet to fully recover. The people also suffered. The spill was also a social and economic disaster for the people of the fishing communities and Native villages which depend upon a clean and healthy ecosystem for their livelihoods and spiritual sustenance. For the people who live in the spill area, the social and economic impact of the spill continue to be felt to this day. But as we have seen so often in our nation's history in times of adversity, the people of Alaska rallied together to combat the advancing tide of oil and continue to work to help clean up and restore Prince William Sound to the condition God meant it to be. The Clinton

Administration recognizes that Prince William Sound, the Northern Gulf of Alaska, and the Kodiak Archipelago are truly special places for Alaskans and all Americans. And just as we have found in other parts of our country, a clean and healthy environment in coastal Alaska is a pre-condition for strong and local economies. In Cordova, Kodiak, and villages throughout the region, hard-working men and women, their families and small businesses depend on a healthy, productive environment for recreation and tourism and for sport, commercial and subsistence fishing. That is why the Clinton administration has made the restoration of Prince William Sound and the entire spill area a top national and natural resource priority. As stewards of our nation's natural resources, Secretary Espy, Secretary Ron Brown and I have worked closely with Governor Hickel and the Trustees for the State of Alaska to develop a balanced, comprehensive approach to guide the restoration of natural resources that were damaged by the oil spill. Through our common efforts and cooperative relationship with the State of Alaska, we hope to seize the opportunity this year to improve our understanding of the biological workings of the spill area through research and monitoring while we protect critical habitat for fish and wildlife as part of a balanced effort to restore this unique and productive ecosystem." Thank you very much. (Applause)

MR. AYERS: Thank you, Deborah. Our next speaker is someone who I've only recently met and begun to get to know. Dr. George Rose to many of you is a familiar face and a friend. Dr. Rose is a fisheries scientist from Newfoundland, and Dr. Rose has brought not only his remarkable insight into the science questions that we all face, but also a positive, inter-personal ability and a sense of humor that somehow we frequently lack as we face overcoming the tragedy of March 24, 1989. Dr. Rose is our keynote speaker today, and, George, it's all yours.

DR. GEORGE ROSE: I don't know about the sense of humor part. I guess Newfoundlanders are famous for their sense of humor. We usually direct it at ourselves, and other people do it as well, but I'll spare you some of that today. It's really my task this afternoon to try to put this *Exxon Valdez* oil spill and its impact on coastal Alaska into some sort of a broader perspective. I claim no great expertise about oil spills or about the particulars of the affected area, so if you're looking for your $200 expert from away, don't look at me. I prefer to leave the details of this to the real experts who live and work in Alaska. Where I'll try to make my contribution is in addressing the spill in a much more general way, as a gross environmental perturbation, which it's very severe as has been pointed out already by previous speakers, it's certainly not unique in the world. It shares common properties and perhaps common solutions with many other perturbed ecosystems. To me on a more personal level, and it's amazing, you know, the *Exxon Valdez* oil spill, of course, I live thousands of miles away from here, but it was front page news, and to everyone interested in the environment, especially in the marine environment as Newfoundlanders are, this was a major thing. It was felt literally around the world. But to me the whole thing symbolizes the difficulties that we have in sustaining the quality not only of ecosystems but also of people's lives, especially people who live closest to the land and to the sea, and as a Newfoundlander this strikes very close to my heart. The image still of this broken tanker, leaking oil into such a beautiful, pristine wilderness, not only lingers in the mind but it sorts of crystallizes this contrast we have between economic development and trying to preserve not only ecosystems, but people whose very lives depend on them. But there is a lot more to this, of course, than symbolism; there's reality. When a spill like this occurs, it forces all of us, especially the people most closely involved, to ask some very difficult questions, and there are no simple or universally accepted answers. Some of the questions are difficult because we simply don't know very much about these ecosystems. Ecosystem degradation occurs worldwide. Some people seem quite content to let it happen. But one number one question which we have to ask ourselves is what level of restoration action is warranted or what type is really wanted -- that's a fundamental question we have to ask -- and how to assess when restoration has taken place. In many cases, this will turn out to be some sort of a value judgment because we have no actual baseline data to say, okay, now it's restored or we need to do more. And in reality there are certain species that are going to get preferential status. This may be for a lot of different reasons. It may be for cultural reasons, it may be for economic reasons, it may be for social reasons, or whatever, and those things then may take priority in restoration. But some things are general that we should keep in mind here. One is that whether it's species or habitats or whatever, if we lack historic information to judge recovery, then it's going to be very difficult to assess when restoration or recovery has taken place. Another thing is, species may have to be selected as the prime targets for restoration for the reasons I mentioned earlier, or because they may be indicator species of a healthy environment. We all search for these, they are difficult to find, but nevertheless the search must go on. There is a lot of muddy water here, but one thing I think is clear. It's right at this point that science should earn its keep, and there seems to be some opinion that in this particular case it hasn't. This wouldn't be unique, certainly, and it's not an over-criticism of this particular situation. There are many situations in my own part of the world where the same thing is happening, and I'll refer to those a little bit later on. But it is the job of science not only to determine how to monitor these systems, but also to figure out how they work, and with that knowledge, if we had it, it would be much easier to judge just what had happened in this particular case of this oil spill or in many other environmental areas. Now, I don't want to make this sound too simple, because it's not. Making any prognoses or predictions about ecosystems is difficult, some would argue impossible. We must go well beyond this correlative approach, where we know one thing has gone up and the other thing has gone up, and so on and so forth. We must get well beyond that and develop some kind of a functional understanding of what really is making these ecosystems work. Science learns a couple of ways, through observation, through experience and experimentation, and in most cases with ecosystems we just haven't learned enough to say much in terms of predicting outcomes of actions. I was at a meeting a couple of weeks ago in my own country, and we were talking about this, and some obvious point came up, and I said something flippant, well, like, you don't have to be a rocket scientist to figure that out, and afterwards someone came up and challenged me and said, you know, rocket science is real easy compared to marine biology. The idea was maybe we should turn that around -- and then there's a strong point to be made there, this is very difficult scientific work. So, what should we do? We can't throw our hands up in despair. I would suggest that we have to do two things. We first of all have to learn to the best of our abilities how these ecosystems function, and then we have to learn how to monitor in a very cost-effective and hopefully simple way the status of those ecosystems through time. So, how do we do that? (Begins slide show) The first question -- I'm going to ask you a lot of questions today. I'm going to probably ask a lot more questions than give you answers. The first question I have is -- so what is an ecosystem? This is mine right here. People talk all the time about compartmentalizing ecosystems, very neatly some would have it. But when you consider that meteorological and oceanographic forcing occurs at world scales, then the effects may cascade down to smaller scales with often chaotic effects. For example, if we take a small plant like this, it's whole world may be small indeed, but it is influenced by weather conditions that may occur half a world away. On the other hand, if we look at a large migrator, they play in a much larger sandbox. This is from my part of the world. This is the famous island of Newfoundland, and this is a track of a migrating seal. They breed in this area, and travel all the way up to Greenland. This is done through radio telemetry and satellite linking. So, you can see that this animal and the population that it represents, plays in a very large world; indeed, over half of the northwest Atlantic. Some birds and fishes, of course, migrate much, much further. So how do we define that ecosystem? It's even more complicated than that because cascading effects may not be linear but chaotic. If we take all of our species together and just try to block this out in a very simple way, our large-scale migrators here, this is supposed to represent local scale up to world scale, large-scale migrators may use the whole world or half of it, therefore the system that they impact and are impacted by may operate at very large scales. Immobile animals and plants are the exact opposite, and between all of this, we have a very, very complex and possibly chaotic system. Here, again, from the northwest Atlantic, we have a color imagery by satellite of water temperature, and what happens in the northwest Atlantic is in all of the areas, all of the areas of the world, is that we have large-scale, oceanographic forcing, which controls cold water currents that run down here. This affects the plankton populations, the forage fish populations, the distributions of predators -- it affects them through them -- the parasite loads that occur in fish and seals and so on down the line. So these things can get very complicated, and what occurs at large scale, may not translate simply into an effect at the smaller scale of an area, for example, like Prince William Sound, which would be comparable to one of the bays on the island of Newfoundland. These areas here would function at scales approximately equal to that of Prince William Sound. Now, in your part of the world, the northern Pacific, the same thing is true. The ecosystem that we're talking about today at Prince William Sound does not operate in isolation from the large-scale processes. We have, as you know, and I won't go into any detail about them, most of you are familiar with these, but we have effects in the southern Pacific and northern Pacific which highly impact what happens at local scales. We have animals which migrate in and out of Prince William Sound large distances and are part, and an important part, of the local system, yet they operate on a much larger scale. Now, what do we do with this? What does it mean? Well, if we look at the life histories of most species, and in particular marine species, there are usual sensitive times in places in the life cycles. Simply put, not all times and places are of equal importance to survival. There exists bottlenecks. So, for restoration and for monitoring, we should concentrate on efforts on those sensitive components of the system. This approach may have many offshoots, including how we conserve these systems. We may learn, for example, that there are areas, if we can map out this here in a very schematic way the spacial lifestyle of a population, we may have areas in here which are very sensitive to the survival which should be totally protected. We may have other areas that really don't matter all that much, and impacts, environmental impacts, and so on in these areas may not hurt that species all that much, whereas even a small perturbation in this areas may have a great impact on what happens to that species. These are the things, I believe, that we have to learn. At this level then down the line habitat protection becomes important, but at the present time we don't really know enough to do that. In some cases, we do. In some cases we know about fixed breeding areas, migration routes, and so on. One interesting thing that has come out of the major research program that I'm involved in the northwest Atlantic is the actual closure in certain areas to most human activity because they are sensitive nursery grounds. These are open ocean areas, by the way. This is common practice on land, and so on, but actually to do this in the ocean is something new. So, I set up this kind of simple conservation paradigm, but it is one that has seldom been followed, and particularly not with marine ecosystems. Now, I said before that science learns in one sense primarily from experience. So, I'm going to go through a couple of examples here that I am very familiar with which will illustrate maybe what we should do and what we shouldn't do. Now, I put this up here just to sort of show you where I'm from, so I don't have to ask the question where is Newfoundland over and over again. There is Newfoundland, right there. As you can see, we are a long ways south, but we enjoy a very terrible cold climate because of the influence of oceanographic conditions. You don't have to convince Newfoundlanders that oceanographic conditions are important to the overall ecology. I want to give you an example though from Newfoundland that should give heart, even to the most pessimistic among us, and this is an example, a terrestrial example actually of the Abalon (ph) caribou herd. Now, this is the most southerly herd of woodland caribou in the world, a herd that was decimated by habitat degradation and thoughtless slaughter until the early '50s. And it was nearly extinct. It was down to nearly 50 animals. But something happened in the early '50s to turn this whole situation around, and really it came to a human level. I think it really started with one person, then others, but these people just decided that their ecosystem had to include a large and well managed herd of woodland caribou, and restoration began. It took the form of restoring the habitat, which had been degraded by water and power developed, and it took the form later on of actual land protection. Now, at first, no one knew what the target restoration was. It was really guided by common sense and bit of intuition. Research started, however, to try to determine what were the most sensitive areas, how do you actually conserve this, how do you restore this. The calving grounds in the sensitive areas were identified, they were then gazetted and protected from further degradation, and so it went, and as you can see from this graph, this is a tremendous success story. Going from less than 50 animals, the herd has continued to grow to the present time. Now, how did this happen. How come you can do this, and in other cases you can't. I maintain that it comes down to a couple of simple things. Now, I'm going to oversimplify this because I have to for this presentation, but I'd like to point out at least three main things that were essential here. One was user involvement. I mentioned that this started with the people. It didn't start with science and it didn't start with politicians. It started with people who cared and who wanted to live in an ecosystem that they wanted to define. So, user involvement was important. Around about here, actual harvest was started, local hunters became involved in the actual management process in terms of censusing animals and also in providing the biological information, and you can see that that had no effect on the growth of the herd at all. In fact, it may, if anything, increased it. But another thing that was done was to have control of technology. It was realized that you can't go in there with machine guns and so on, you can't destroy this. Now, I'm using this in an analogous sense to all degradation, but some forms of control of technology were used. And the other principle here is to protect the sensitive areas for that species. So with those sort of simple concepts in mind, we see a good success story here. There are other examples that I could use of success, but there are probably more of non-success, and for that I'm going to turn to our major stock, the northern cod. Now, the northern cod we have been trying to restore for 30 years. Now, this wasn't so much habitat degradation; this was just blatant lack of control of harvest which was started basically back in the '60s when the European fishing fleet discovered the offshore spawning grounds of this stock, and there was no protection at that time and the stock was decimated. As you can see, it dropped down and we have never really recovered. Now, in this area here, we started to make some recovery, but then our own fishing fleets -- we couldn't control those either -- and now we're at the lowest point ever in our history, and in fact we have complete closure of our fishery. So, how come? I ask just a simple question: Why is it that here we have the same place, we have desirable species, both the codfish and the caribou are species that people want to be there, and so on, how come we get two very different outcomes? I go back to these characteristics, and what we see if we examine the northern cod fishery is that we had almost no user involvement at all in any way. In fact, there was only user hostility and user -- well, total lack of any involvement in the conservation of it. We had no or little technology control; that is, we didn't understand what the technology could do to us. Technology is a double-edged sword; it can help you or it can cut you, and in this case we got very badly by it. The other thing is no spatial or seasonal protected areas could be implemented until very recently when it was too late to stop that kind of decline. I maintain that these things are symptomatic of our ability not to be able to restore damaged resources. So, some of you may be wondering what has this got to do with an oil spill. I wondered at times myself when I was trying to put this presentation together. Some may think that an oil spill is fundamentally different than these other human-caused perturbations, and, of course, in its details it is, but in our responses and abilities to restore damaged resources, I'm not sure that it differs all that much. Now, of course, we've got the immediate responses, which are very different, and we have technologies that can be brought to bear to clean up oil and things like that. We saw that earlier on in the introductory slide talk. But I think the longer term effects of this are probably far more important than that. I'll just show you a couple of pictures here. We had this happen on our coast as well. We have a growing oil industry at the present time, and, touch wood, we have not had a bad disaster such as you have experienced, but we have had some small ones. This is a burning tanker that occurred several years ago, but, fortunately, it was well offshore and did not cause us much damage. Now, if we were really on top of things, we would be able to know ahead of time what the sensitive areas were and probably protect these from traffic or whatever. But as often as not, we don't know. We don't have that kind of information, and all we can really do is follow some sort of common sense. For example, if we look at the critical elements of a spill zone -- I'm just going to come back to these same old things -- the sensitive areas for a species and productivity cycles, which is really just a temporal aspect of the same, this is what we really must know. We are not in this world going to turn the clock back completely to the point where we don't have industrial development. Few people would vote for that one anyway. What we want to do is use our intelligence to try to conserve ecosystems and restore them and still allow some level at least, some sustainable level of economic development. Now, if you take these things just in a very simplistic way, we know that a spill like this, which occurred on the Grand Banks (ph) a couple of years ago, didn't really do any damage. It wasn't in a sensitive area. The oil dissipated and burned, and so on, and so the overall net result in terms of restoration is probably minimal. But if you take this -- now this is a capeline spawning beach on the north shore of the Gulf of St. Lawrence, one can imagine in an area like this -- now, all these fish spawn on these beaches and in the intertidal zone -- but a spill in this area would be devastating to this species, which is the most important forage species for almost everything that eats fish in the northwest Atlantic. So, this is the sort of thing that I'm talking about in a very general and common-sensical way, without having a lot of hard data and knowing exactly what the effects would be. So, basically, what I'm getting at is that our longer term approach to this has to be at the ecosystem level. Now, there may be some particular effects associated with an oil spill, things like I'm not an expert at and I don't want to go into in detail, I'll just mention some generalities here. We talked a little bit about the difference between populations and habitat, but maybe I can just spend a minute just talking about acute and chronic, cumulative effects. Now, the immediate impacts of oil are obvious: things die and they are covered in oil and get slimed up and all the rest of that. We all know that. That's not a pretty sight, but it may not be the most serious result. We simply don't know. This is where a lot of research into the -- not the acute effects but the chronic effects of this type of spill may need a lot more research than has been currently brought to bear on the problem. This could result, for example, in mortality down the line. We have the problem right now, the outstanding problem, of the salmon and herring in Prince William Sound. They aren't there. People want to know why. There are so many natural fluctuations in these populations, it's difficult just off the top of your head to point the finger and say, yes, it's oil. We need more information, but certainly mortality does not have to occur in an acute sense right now. Mortality can be down the line, cumulative. Genetic damage is even worse. It's much worse to a population to destroy a number of its individuals than to harm its genetic structure, and this is something that we don't know very much about. So, I would suggest that these are areas that we have to find out more about.

So, how do we go about actually studying ecosystems. I haven't got much time -- I have a fair amount of experience with this, but I don't have much time to talk about it now. I'll just mention some key points that I believe in. One is the team approach. People, individual scientists, have been funded in trying to understand marine ecosystems since the turn of the century. I think it basically started in Norway, with Hijort (ph) who basically came with a number hypotheses on how marine ecosystems, particularly fisheries, fluctuate. None of this has done any good. If there is one thing we should have learned from all of this is that the only way that we are ever going to make progress is to use a team approach to problem solving. This team should include scientists, but it also should include people who are not scientists, and it should include users and industry and so on. Anyone who has played any team sports knows that a good team will be a group of dysfunctional superstars every time. You need a solid research plan based on hypotheses that works together as a unit to address the particular problem. I won't go into any details here. You can use your imaginations. The problem could be anything, but we need to develop that approach. Another thing that we found out is very helpful is the use of simulation models to actually pre-test hypotheses and point directions. Here's one from some of my own work. This is a cod simulation model for the northeast shelf where, underlying this -- the graphic behind this is very simple -- but underlying this there is a lot of physical, oceanographic, in-depth information, and so on, which you can modify and say, okay, cod, do this, and let the model run and see what happens, and basically, based on some fairly simple assumptions -- I'll just run this through -- we can get this cod to follow a migration track which simulates reality very, very closely, and based on cooperative work with our commercial fishing people, we have been able to validate this. So, I am highly supportive of the use of this modeling before data is actually collected and also during, and there should be some kind of a feed-back loop in there. Another thing that I support a great deal is to try to make technology work for conservation and restoration and not against it. For so long, technology developments, especially in the ocean, have been used just to kill things. It's about time that we started to use the technology, which isn't bad in itself, use that technology to try to improve the quality of life and not just to destroy it. We have been using a lot of remote sensing in our area and acoustic work, and what we have been able to do is map out -- this is actually an acoustic image of a cod school which we have been able to track for months over the range, and we have developed a very high resolution spatial map of its distributions. I don't know how well you can see that. I'll just skip over these things. We also tried to put this data together with physical information so that we can get a better understanding of what it is that's actually driving this ecosystem, whether it's physical forcing or biological forcing or other problems. So, putting the data together is a very difficult thing. It has to be done in a systematic way, but I believe that the results that will do this will more than justify the effort involved. Another thing is, in looking at predator-prey interactions, which seems to be an important thing in Prince William Sound -- you can actually use these things -- these are single codfish here and this is capeline, and you can see at very high resolution -- and this is in 400 meters of water in deep, open ocean -- the kind of high resolution data that can be gained about the interaction between predators and prey and the very important effects that will have on the whole population dynamics of the species. So, that's about all I wanted to say. I'll just leave you with a final thought about science. I'll just put that up there -- I've talked about most of these things, but the final thought that I have is just on science and how it can help solve these problems. Science can certainly help solve these problems, but science cannot solve them alone. In the long term, I believe it is the involvement of the people, particularly of the users, that will solve this problem, and without that all the science in the world is not going to get you very far. I would go so far as to say that the thing of the future will become more experimental management involving people that are users of the system. These are lessons that we have learned hard in some of the older fisheries of the world -- and I'll just show you a Newfoundland seiner here. These are people who live on the water and who we are trying to work very closely with. And our older fisheries in the Atlantic have learned the lesson that failing to do this will usually lead to disaster. We've learned it the hard way. You, here, have -- the way I see it anyway -- have everything going for you. Let's not repeat those mistakes again. Thank you. (Applause)

(Break in recording)

MR. AYERS: . . . Alaska decided that through the recommendation of a variety of scientists in the State of Alaska, and there are a variety of scientists working with the agencies, there was a recommendation that they hire an independent scientist. That independent scientist was hired and later became the Chief Scientist for the six Trustees. Dr. Spies has more than 20 years of experience in marine science, he is the President of Applied Marine Science, he has served the Trustees since its inception, Dr. Spies is also an editor of the *Marine Environmental Research Publication*, and Dr. Spies continues to be a renowned resource for all of us, in both his personal advice, professional attention, and his seeking the advice and capabilities of other scientists like Dr. Rose. Dr. Spies, please. (Applause)

DR. ROBERT SPIES: Thank you, Jim, for whatever you said. I, in my further attempts to not draw attention to myself in public forums like this, I would like to talk about something that's kind of boring in a way. None of my slides have any animals on them. But the thing I have to say is important to the public to understand where the scientific program is going, where it's gone, and the reasons why we're doing what we're doing. (Using slide illustrations) I think one of the single most important points about the scientific program of the Trustee Council is that it has been an applied science program, and that has implications in that we're really dealing with, in a way, the intersection of a couple of different cultures: the scientific culture -- which before I got involved in this I was pretty happily living as a laboratory scientist in California working on the effects of oil and contamination -- and the intersection of that with the political and social dimensions of the pollution problems, especially in a disaster like the *Exxon Valdez*, and although I understood, I think, the fact that the intersection of these cultures, where the applied science was brought to bear on social questions was very important, it has been, I think, driven home, at least in my personal experience, in a way that's quite real. So, the excitement and discovery that we are trained for, the reason we went into science as scientists, really is not the sole reason for our existence and not the sole reason for what we're doing under these applied science programs. With that sort of introduction, I'd like to just talk briefly about the several different phases that you can look at the scientific program since the spill: the response phase, the damage assessment phase, and finally the restoration phase. And we're really right now, I think my comments are somewhat timely in that we are really starting to shift paradigms from a paradigm of the damage assessment and following resources and counting them and seeing how they recover in a kind of a, some people say, simplistic way, to shifting over to try and understand what we can do for damaged resources and the resources we wish to enhance in the spill area. Those questions have to be asked within the ecosystem context -- I hope to elaborate a little bit on this -- and the science is really driven by the management objectives. As I said, the three phases that we are dealing with are essentially response, damage assessment, recovery and restoration phase, which we're in right now. Under the response phase, certainly the management objectives are quite different than we see under the other phases where first you find and track oil -- very obvious -- rehabilitate stressed animals, recover carcasses, and identify and protect sensitive areas. The kinds of characteristics of the science that is applied during these periods is a short time to plan, there may not be a lot of rigor necessarily, you may apply existing technologies to kind of a new situation or a new problem, and it can be fairly qualitative. At the same time that the response is going on, and in this case it went on for several years, it almost immediately went into a damage assessment phase -- what was the effect of the spill, what was the bottom line we can determine that this spill had on this environment? The management objectives are quite different under this phase. We really need to develop the legal evidence to establish the degree of liability and finally to establish what are the bases for restoration, what can we learn about the degree of injury and/or that we can restore the resource or at least track its recovery. The characteristics of the science under this part of the program are quite different. You want to enumerate the damaged resources, deal with cause and effect, because sorting out cause and effect in the environment, as any of you who have participated in what has gone on in the scientific programs since all this information became public, understand that this is not a simple matter. Nature is extremely complex, and assigning cause and effect in nature, with pollution separating natural from anthropogenic changes is a very, very challenging undertaking. As George Rose says, it's not rocket science. We had in this case to deal with a tremendous lack of baseline data that we could have used to get a better understanding of the state of the resources before the spill compared to what happened just after the spill. There was intense peer review because of the rigorous nature of the scientific inquiries, and the scientific effort was fairly quantitative. If we move on to the recovery and restoration phase, the management objectives switch again, and this is where we're kind of at right now. We want to determine the rates of recovery for injured species;, we want to develop a restoration strategy. Those things have been laid out in the Restoration Plan that the Trustees have recently adopted. The characteristics of the science during this period is that we continue to have population monitoring. That's a necessary baseline ingredient to the program. At the same time, we start to switch paradigms with these injured species. It's no longer enough to understand how badly they were hurt or whether they are recovering. If we want to do something in restoration, we have to understand what the bottlenecks are, what limits production of this species, what the sensitive areas are, is it dependent on food, how does it interact with natural factors, competition, predation, all these processes suddenly become extremely important. It requires a new paradigms, and we are in the process right now of shifting paradigms. Not only that, we must have a long time frame to understand those resources that are slow to recover and also a long time frame in which to test ideas about how natural variability interacts with anthropogenic effects. I mentioned already the ecosystem context. There is a strong, strong need to prioritize. There isn't enough money in ten settlements to answer all the questions that people could -- and good questions that people could compose about the marine environment and how it works. So we have to really think very carefully and rigorously about what we do and why we do it and how it relates to restoration. That's the extent of my short comments today. We do have a very excellent group of speakers here that are going to take on the task of summarizing injury and recovery and what the state of the resources are, so I didn't even pretend to make an attempt at that in the few minutes that I had. The forum today is extremely compressed. There's been a lot of information presented, and I ask you to hold your questions. You'll have a chance during the break to talk to investigators. I ask you to hold your questions until the social hour at the end of the program. If you're unable to stay until then, you can write your questions and leave it at the desk there with those that are helping distribute the literature at the front of the room there. We will get back to you as soon as possible, as I said. Our first speaker this afternoon is a professor of marine science, of biology and ecology, University of North Carolina at Chapel Hill, Dr. Charles Peterson, or Pete Peterson, as we know him. We're really lucky to have Pete. He has a tremendous expertise in marine ecology, he has a very broad ranging understanding of marine ecosystem; Dr. Peterson is an editor-in-chief of the scientific journal *Oceologica* and is on the editorial board for the scientific journal *Marine Ecology Progress* series. Since '89, we have been lucky to have Pete with us as a valuable peer review, assisting the Trustee Council review of subtidal, intertidal, damage assessment studies, and really his role has been much broader than that. Pete will present an overview of the nearshore ecosystem.

DR. CHARLES "PETE" PETERSON: Thanks, Bob. As those of you who know me may suspect, I've got too much to say. I'll try to restrain myself. I've got a lot of detail that I'll get into quickly. (Using slides illustrations) The bottom line on what I have to tell you is as follows. Because the oil initially floats and therefore gets transported in and deposited on the intertidal and nearshore ecosystem, it is this environment where the spill is most evident to the public and, as it turns out, where the damages are most intense, and what I will show you with the detail as I go along is that the damages to the nearshore ecosystem were widespread, that they were pervasive deep into the ecosystem, that recovery is incomplete, and that damages still continue to occur from the spill in those ecosystems. I will show you with three parts to my talk. First, I will talk about the oil of the habitat itself, then I'll talk about the intertidal ecosystem and biota, then I'll talk about the subtidal ecosystem and biota, in each case telling you what we know in summary form about the damages occurred initially, early on, what we know about the processes that have occurred since the spill, and give you some of the problems that remain to be addressed by the restoration and recovery and trustee groups.

First, I point out that the mileage that was covered, the pure and simple mileage that was oiled in the three geographic areas was extensive and unprecedented. The most intense oiling, the heaviest oiling, was felt in Prince William Sound, but the greatest extent of oiled mileage was in the Kodiak-Alaska Peninsula region. The surface contamination after that initial oiling has been greatly reduced below the 1989 levels in all three regions. On the other hand, there is persistent, widespread, asphalt staining present in the high intertidal, there are oil paddies still present and obvious on sediment surface among boulders in some heavily oiled shores, such as Sleepy Bay, and the subsurface oil has degraded more slowly than the surface oil. In fact, there are reservoirs of subsurface oil persisting in many sorts of locations: in fine sediment marshes such as the Bay of Isles, under oiled mussel beds where they are protected by the dynamic action of waves, by the mussels and their byssus, and in other protected sites, such as around boulders and in sheltered localities. There are restoration challenges that remain, vis-a-vis, these contaminations of intertidal habitats. One, and it's a serious one, is how and if to clean oiled mussel beds to prevent injury of important mussel consumers, and I'll mention that later when I speak of the ecosystem. There's a question of whether asphalt should be targeted for clean up, especially on national parks and in wilderness areas or in culturally sacred shorelines. There's a question of whether any clean-up should be targeted on oiled estuarine sites, fine sediments, where spill histories elsewhere show extremely long persistence, and further there is a question of whether additional technologies should be explored, such as Tesoro citrus oil technique to try to clean surface and subsurface oil in particularly nasty places, like Sleepy Bay. Here, in fact, is an oiled mussel bed of the sort that is causing one of the major concerns to the nearshore ecosystem. This one in Herring Bay. There was, as well, oil contamination of the subtidal habitat. Oil reached the shallow subtidal sea floor by transport on particles, rather than by the direct oiling that occurred in the intertidal. Various techniques, such as core sampling, sediment trap collections and assays of oil-degrading bacteria, revealed a time lag in contamination levels, with peak contamination occurring later than that in the intertidal zone, as clean-up in the intertidal helped move the oil down the slope and out of sight into the subtidal. Levels of PAHs and petroleum hydrocarbons in the shallow subtidal sediments have since declined, but there are relatively refractory petroleum hydrocarbons widespread, and there is likely to be long life of those materials and their influence in these sediments.

Now, as I promised, I'll talk about the intertidal biological damages. First, about the initial damages. These were substantial, large, and widespread alterations of abundances of both plants and animals. The injuries were great in all three geographic regions. Furthermore, the before-after tests by NOAA demonstrated that the pressurized hot water clean-up itself was a major contributor to mortality of intertidal organisms. The specific impacts of the *Exxon Valdez* oil spill on the intertidal ecosystem varied with geographic region, elevation on the shore, and habitat type. However, in general, one can generalize to say that rockweed, fucus, blue mussels, a limpet -- Tectura -- a periwinkle, some barnacles, littleneck clams and butter clams declined greatly in abundance, while oil-degrading bacteria, Oligochaete worms, and an opportunistic barnacle increased. The abundance of intertidal fishes was greatly reduced by 50-70 percent, even assessed in 1990.

Now, what has subsequently happened in this environment?

There was greening of the shore, as opportunistic algae colonized the space that was freed by the death and removal of fucus. There has been subsequent slow fucus, upwards on shore, to a degree that only the high intertidal zone finds fucus still depressed in abundance today, and in fact the high intertidal zone and its ecosystem -- its community, if you will -- is the slowest to recovery. Mid and upper elevations were colonized by an overabundance of an opportunistic barnacle, Chthamalus, and that, by preemption of space, helps retard recovery of the longer life barnacles and limpets that are normally abundant at that level on the shore. There is an analogous pattern in this system which is characterized by scientists as one dominated by strong interactions among the species. There is analogous preemption of space low on shore by fucus, where it is spread over areas and prevents the natural assemblage of red algae from returning. There are several species with non-dispersant, non-planktonic larvae that are documented to be slow to recover, notably one periwinkle and predatory drills. The slow recovery of these drills means that the opportunistic barnacles that have come to colonize the high level of the shore are not being removed by their predator at rapid rates and continue to preempt space. Recruitment of clams remains depressed on oiled shores, postponing their recovery as a population. The community composition is slowest to recover and still grossly altered in estuarine habitat and in coarse, textured shore. Intertidal fishes are substantially recovered in abundance by 1991, but I have a comment on that in a moment. Reliable reports from subsistence users reveal continuing depression in abundance of octopus and chitons (ph), important species and long-lived invertebrates in this system. There are restoration challenges that face us vis-a-vis the intertidal community. Given the importance of fucus rockweed as a habitat provider for invertebrate animals and its inability to spread rapidly upward on the shore, should restoration action be attempted to speed that return in the high intertidal? Should transplants of predatory drills be conducted to speed their recovery and overcome their slow recoupment because of their reliance upon a non-planktonic form of reproduction and colonization? Furthermore, it's quite clear that in this system, where damages are so pervasive and have not yet recovered, that monitoring is important to inform the public about the continuing damages and continuing changes in the system, but how often should that monitoring occur, where, and of what sort? There's a question of whether sediment restoration should be attempted to return the sediments to the shores that clams normally occupy so their habitat is there to be able to promote clam recovery. Legitimate questions arise about whether a shellfish hatchery should be constructed to provide the seed clams and other shellfish to promote recovery. Furthermore, and this is one of the most serious of problems, is concern over the continuing ecosystem effects of oiled mussels and other prey in inducing reproductive impairments of important vertebrate consumers in the nearshore ecosystem, notably black oystercatchers, harlequin ducks, perhaps golden eyes, turn stones, surf birds, river otters, and sea otters.

The subtidal communities also suffered initial ecological damages from the spill. There were major changes in the size frequency of habitat-providing large algae, the small kelps, Laminaria Agarum, and the larger kelp, Nereocystis, where the oil apparently killed large number of old plants but there was colonization by large number of new by 1990. The oiling reduced the number of flowering stocks and blade densities of eel grass, an important habitat-providing plant in the shallow subtidal. Amphipods, a very oil-sensitive taxon shown elsewhere, decreased greatly in abundance. Certain large invertebrates, notably the helmet crab and the leather star, were reduced in abundance, and the benthic infaunal community composition -- this means the abundance of invertebrates that live in the sediments -- was greatly altered by oiling at areas at shallow depths below the sea grass beds. The subsequent changes in this shallow subtidal ecosystem are as follows: Eel grass parameters reveal essentially complete recovery; amphipods too appear to have recovered rapidly, even perhaps by 1991. However, the community composition of the benthic infaunal invertebrates remains altered and will probably recover only slowly, as judging from the history of other oil spills such as the Amoco Cadiz. During last year, the work of the scientists in the shallow subtidal has demonstrated an explosion of green sea urchins in the albae beds of Prince William Sound. This is exactly what one would have predicted from a large reduction in sea otters, which are their major predator. Shallow water fishes collected last year from oiled sites in Prince William Sound showed hemosiderosis, a liver malfunction indicative of ongoing exposure to some sort of pollutant or stress, with oil the most likely because this exposure occurred in oiled areas but not in un-oiled areas. Now, there are restoration challenges, needless to say, that face us in the shallow subtidal systems. The first, and this follows from my comments moments ago, is to what degree the explosion in sea urchins will lead to a subsequent cascading of impacts on the shallow subtidal ecosystem. Urchins, when free from their predators, are known to create urchin barrens, where they overgraze the small algae and kelps, thereby destroying an important habitat for recruitment of invertebrates and fisheries, changing the abundance of those fish and grossly altering the coastal ecosystem. It seems appropriate that we document what effects occur here and how that cascading occurs and to what degree. There are questions about what the time frame and trajectory of ultimate recovery will be for those benthic infaunal invertebrates in the soft sediments that have not yet recovered, and there are important questions about how long fishes will continue to be exposed and injured by oil in this environment. I leave you merely with the question: At what point will this coastal nearshore ecosystem resemble what it would have looked like in the absence of the spill? And I can only tell you that we are not yet there. Thank you. (Applause)

DR. SPIES: Thank you, Pete. Our next speaker is the Regional Program Manager for the Division of Subsistence for the Alaska Department of Fish and Game, Dr. James Fall. He was a member of the Oil Spill Health Task Force and assisted in the design of the oil spill subsistence studies. Dr. Fall will now present an overview of the subsistence studies and activities. (Comment from the audience) I'm sorry, our next speaker is Stan Rice -- excuse my faux pas. Stan leads the damage assessment program at NOAA (indecipherable) fisheries laboratory in Juneau, and he has 20 years of oil effects research experience prior to the spill. He led the effort of putting out the fisheries lab crews into Prince William Sound in late March of 1989, many times ahead of the spill, a remarkable effort, and we are thankful to some of the good baseline data we have to Jeep's (ph) efforts. Dr. Rice will present a summary of the toxicology and distribution of oil.

DR. STANLEY RICE: Chuck Meacham there earlier said that if you're casual observer, you'll probably be a little bit hard pressed to find oil in Prince William Sound now. Well, I haven't been a casual observer and neither have several state and federal colleagues of mine that have been looked at the oil since it was spilled and then tracking it with time. So, we know quite a bit about the distribution; we still know quite a bit about it, I think. It is still persisting in some environments, and because it is still persisting it is suspected in some cases that it may be still doing some damage to some of the injured species and causing new injuries, if you will. So, we will be looking at that as we go through this talk.

Well, beginning in '89, of course, a lot of that oil ended up on the beach, and there was a very visible cleaning effort --

nothing new there. The real question is how much really got down to where the animals live in the water column and below the surface in the sediments. We sent a crew up there -- this is really a summary of Jeff Short's work. Basically, not a lot of oil got into the water. A lot of it was floating on the top and ended up on the beaches because oil is lighter than water and it does float, of course, but, nevertheless, some does get below the surface. Here we have the highest concentration that Jeff measured. It was about 6.2 parts per billion -- that's a part per billion there, not part per million, so that's not a really highly toxic dose at all. That is polynuclear aromatics there, and they are toxic, but not acutely toxic, at least at that level. We thought that there should have been a little bit higher concentrations. These highest concentrations were measured, starting at about Day 7 after the spill, and by two months later it was very difficult to detect any of the *Exxon Valdez* oil in the water column, and so we did not have toxic conditions, and they certainly did not persist. We also looked at the benthic sediments from literally the intertidal zone, which isn't benthic, but on down through the shallow subtidal and into the deeper zones -- we had a diver who was collecting samples -- and I'm going to summarize about a thousand analyses, or maybe even a little more, in a second here, but first the processes that get that oil down into the sediments. You have the natural wave action or you can have the mechanical action that occurred in year one and then to a lesser extent in year two, but when the sand grains were contaminated with oil and then sink, the oil particles go down with depth. When we did a bunch of measurements, literally maybe a thousand or more, we come up with these gross generalizations, which is really all we have time for today. In the intertidal zone we, of course, can find pooled oil below the surface of the sediments. We can get huge concentrations, concentrations much greater than a thousand. We've got some concentrations that are actually in the 40,000, 50,000, and 60,000 parts per million, so we can get those concentrations up there in that intertidal zone even now. Once you get into the lower intertidal or the shallow subtidal, the concentrations go down substantially. It's only in that bathtub ring where you really get the gross amounts, of course. The amounts below that bathtub ring though are quite detectable. They can have some level of significance, although I won't say we know everything about that, but once you down slope and down into the deeper depths, say, below 20 meters for sure, we seldom find *Exxon Valdez*, the majority of samples do not have *Exxon Valdez* oil below those depths, and it's very difficult to detect. We can detect polynuclear aromatic hydrocarbons at those depths but they have natural origins, such as (indecipherable) oil seeping or brought in and sedimented out over geologic time. So, there is a background matrix there, but it isn't *Exxon Valdez* oil. This here is a summary slide, a mass balance slide as some people would call it, of basically where the oil went, and there's good news here and there's bad news. The good news is that a whole bunch of the oil has left the scene for one reason or another. We certainly had some biodegradation and some photolysis or evaporations, for example. Products are broken down. A lot of animals have the capability to break down oil through biodegradation processes. The vertebrates certainly have it, and a whole bunch of microbes do too, and there's a lot of microbes. If anybody did well with the oil spill, it would have been the microbes that benefitted pretty heavily from this free energy that was input into the system, free energy from their point of view at least. Atmospheric photolysis also counted for some losses of the oil from the system, certainly some dispersed oil that really took a long -- got flooded out, you might say, was dispersed and removed. Certainly, the two billion dollars here of clean-up effort helped to recover and dispose of a pretty chunk of this oil pie here. So some of that was removed. And really we are left with two pieces of the oil pie that we have to be concerned with after, say, 1991 or so, that which was beached and that which was put down into those subtidal sediments, and let's have a look at the comparisons, and they are kind of striking in a way. The majority of the oil really is down there in the subtidal sediments, but when we look at that, the concentrations are really low. Even though the majority of the oil went to the subtidal sediments, it has a huge geographic area that we're talking about the contamination in a three-dimensional sense as we look at the topography of the bottom. There is a heck of a lot of subsurface subtidal sediments there, and both inside Prince William Sound and outside, as a lot of the oil left of course, and so this is where the majority of the oil is, but it's in low concentrations. In contrast, we have, in a way, a much lower amount of oil that was beached and some that still remains there, and yet it was the most visible, of course, and so we have a lot of pictures of it, if you will. In contrast though, the concentrations here are very high, and, of course, the majority of that beached oil really was in Prince William Sound (indecipherable) any way -- in that bathtub ring, the part that was really gucky (ph).

Well, what about the persistence, how much is still there, what's the big deal about it? Well, when we look at the subtidal sediments, the concentrations are low. It does have a long persistence, but it contrasts significantly there -- in contrast to the intertidal sediments which are much higher, and the oil now exists in two parts in that beached environment. We find oil, of course, free below the surface but in the intertidal sediments, but also in the mussels, and this is a significant event, you might say, because these mussels can be prey for a long of higher consumers, and so that's something that we need to track into the future. When we looked at the amount of oil in the sediments -- you might look here, this doesn't look like it's too oiled over here and whatnot, but you dig a hole and you can get a certain amount of oil in those subtidal sediments. In 1993, the Alaska Department of Environmental Conservation did their standard shoreline survey, and they had quite a few sites where significant quantities of oil are in the intertidal zone, and you just saw a picture of an example of that preceding it. Quite a few locations -- when we look at the mussel beds, we also find a lot of oil there. These are from our own surveys, and we are able to find some 59 sites -- 52 it is -- where we find concentrations greater than 1000. There's some overlap here, but there are no intertidal sites. For example, these are mussel beds, whereas ADEC didn't find comparable spots there, and in other places there's a lot of overlap. Nevertheless, this is where the problems appear to be continuing that we need to maybe have a greater, in-depth look at. Quickly, just to give you a little science along with this overview, we'll look at the levels of oil that we find. This happens to be in the very northern tip of Chenega Islet, and the concentrations here in total of petroleum hydrocarbons in the sediments is around 26,000 or so, and we have sites, such as Foul (ph) Bay where they go up to about 62,000. So this isn't the highest or most contaminated site, but we have some nice comparable data. The amount of polynuclear aromatics, and we concentrate on these because this is real toxic fraction, is a little over 4 parts per million in the mussels that were above those sediments. If we were to look at polynuclear aromatic hydrocarbons, this would be about three or four hundred over here. There's about one percent polynuclear aromatic hydrocarbons in those petroleum hydrocarbon measurements. This is significant because this is the tissue in Prince William Sound, the biological tissue where you'll find the most hydrocarbons, and this is a significant prey item, so we want to track this. We have tracked it a little bit. With time, we can look at what happens in nature. When we add the '93 data, we don't see much change in these mussels here. It looks like there might be some decrease, but our error bars here show us a certain amount of variability. The point is, that that's rather a stable environment, and if we're going to wait for nature to clean up these particular soft sediments, it's going to take quite a while to -- like more than my lifetime, maybe, who knows. For that reason, there's probably some action that's being contemplated for the upcoming year. Let's move on to whether this is *Exxon Valdez* oil.

This is a fingerprint, if you will, of the different types of aromatic compounds and their patterns. These phenanthrene rings right here show where the lead phenanthrene ring and then the substituted phenanthrene rings are more concentrated than the unsubstituted phenanthrene ring. That's a very common pattern. We see it in a bunch of the other types of aromatic hydrocarbons too. This is a sediment composition. When we look at the mussels overlying those sediments, we find that they have a very similar pattern basically, and we then can match that to *Exxon Valdez* crude oil. It is getting a little bit weathered with time, so it's not exactly a perfect match, but it's good enough -- certainly good enough to say that in 1993 we had both mussels and sediments that are still contaminated with *Exxon Valdez* crude oil, and we're very confident with that statement. Okay. The oil is still there. It's in isolated pockets maybe, but some of those concentrations are quite high. So what? What should we do about that? Well, one question is, is it still toxic, and is it a problem? Well, it kind of depends on the species. When we look at some of the injured species, such as pink salmon, herring, harlequin ducks, juvenile otters, and there are others but these are just some examples, these are guys that live or live and feed, one of the two, in the intertidal zone. Pink salmon, for example, spawn in the intertidal zone, so the eggs and alboms develop in the intertidal zone. Herring spawn in the intertidal zone, pink salmon larvae feed in the intertidal zone, harlequin ducks feed in the intertidal zone, juvenile otters will feed there, so these are animals that have some level of injury and are going to continue to have some level of risk as they continue to live in the intertidal zone. However, if they are still injured, when were they injured? Were they injured in 1989, when there was orders of magnitude more oil in that intertidal zone, literally ten, a hundred thousand times more oil, and consequently they are having a slow recovery period, or, are they continuing to be injured by the amount of oil that's still there -- I mean, we have evidence on a couple of species that that's certainly the case. Harlequin ducks are still feeding on oiled mussel beds, for example. There is some evidence that pink salmon in oiled streams are still having problems having survivals equivalent to a non-oiled streams -- by Sam Sharr and others in ADF&G -- and lastly, you'd have to ask the question on some of these species, is the injury that we're observing now still from the oil? The herring, in a way, might be a category here or an example, rather. The crash in '93 -- a lot of diseases in those fish, or they appeared to be diseased. Was that disease natural? Was it caused indirectly through an oil exposure? That's really tough to do cause and effect -- Bob mentioned that earlier -- and it's really tough to prove. Just taking a harlequin duck, for example, who is a vertebrate and a very good metabolizer of oil, if the bird feeds in an oiled mussel bed, we have probably about 12 hours to sample that bird and detect oiled mussels or oiled food in its crop and stomach. After that time period, it's going to be digested well enough and the oil metabolized that you're not going to be able to track it in the animal, and that doesn't give us a very good window over a 365-day year to pin it down and to really confirm and get that linkage there. And that's just one example of where it's a real problem, really tough to prove that injury, and yet, because we still are able to measure a significant amount of oil in 1993, actually in 1994 I'm sure we're going to go out there and find more oil or the same oil, it's a concern and a worry. Well, going back to the two pieces of pie we were looking at earlier, the subtidal oil then is a concern, I think. It's not acutely toxic, certainly, and yet we still have some examples there where things are happening. There are lots of unknowns. The subtidal areas is a lot more difficult to study than the intertidal zones, so we have a lot less information, and yet things are not quite normal there, and is that a cause of the oil or not? It's really tough to say. As far as what should we be doing about that environment, we still probably need to monitor it, although we can reduce the effort that we have been using to monitor it. We still have a need to understand and track that oil, particularly as it relates to the other animals that still live there and that are still showing some level of injury or recovery. I don't think we need to do it with the intensity that we have for the last couple of years. It's a place where we probably should reduce our effort a little bit. In contrast, the intertidal oil is not concern, it's more of a worry, okay. We see a fair amount of oil there, and if you live there or harvest there, whether you're an animal or a human, you've got not a concern but a worry about some of those spots out there in Prince William Sound. The concentrations of the oil that we can find there is still too high, too high in both mussels and the intertidal sediments. The species are still showing signs of injury even though we are really hard pressed to show the direct linkage, the real proof. Nevertheless, we need to be following that.

As far as that intertidal oil, though, what can we do? There are some restoration plans this year. We are planning on going out there, along with ADEC, and digging up some of the oiled mussel beds, removing the oiled mussels temporarily, and replacing the underlying oiled sediments with clean sediments, and then putting the mussels back. Basically, we want to reduce that risk to some of the animals and remove some more of that oil. This wouldn't be practical in many cases, but for those heavy duty sites that are in the upper intertidal zone, we're going to give it a shot. We need to continue to monitor and track this risk because it's still significant. We still have evidence that it's linked with some of the species, even if it isn't conclusive, and we need to conduct some research, particularly in the eco-toxicity realm of studies, for example, the pink salmon, herring, possibly the sea ducks and possibly with other species that haven't been fooled around with yet, but, basically, we need to understand better whether these chronic exposures of oil are still . . . (break in recording).

Quickly in conclusion then, looking at those two pie wedges that are of concern, the intertidal zone has the high concentration, the subtidal has relatively low. Is it a problem? I think it is. It is definitely a problem in the intertidal zone even if the geography is not tremendous in terms of massive coverage of the Sound, but it has a geographic spread to it so it is a problem. I'm not willing to say it's not a problem in the subtidal, to give it a flat no, because it really grades to be a non-problem, and it probably is a problem to some animals although we've never studied them, maybe not even know their species identification, but nevertheless there's not that much oil there, so it's going to be less of a problem even if it is a problem. We need to continue -- actually not continue -- we've done very little restoration in the intertidal zone after Year 2. We are going to renew that effort. It's not practical, at least right now, to consider the concept of restoring subtidal, but those heavily impacted intertidal zones that still have oil, we will have an effort there. We need to continue to monitor both, although I should have an arrow over here on the subtidal column, saying that we can reduce that effort significantly, but we need to monitor the actions, the restoration actions and the effects on the oil levels that we are able to find in the future. We need to track that risk. And lastly, we need to do some eco-toxicity research on the intertidal areas. And that sums it all up. (Applause)

DR. JAMES A. FALL: (Beginning portion not recorded) . . . by Alaskans for subsistence with thousands of years. In this slide, the lightly shaded area is where concerns about oil spill contamination had been expressed by the late summer of 1989. The darker areas are the subsistence harvest areas of 15 predominantly Alaska Native communities of the spill area. Subsistence harvests play a vital role in the economy and way of life of these communities. Before the spill, a wide variety of resources was used for subsistence, such as salmon and other fish like halibut, shown here drying in Nanwalek in Lower Cook Inlet. Marine invertebrates, such as chitons, shown here, clams, octopus, snails, mussels and crab were taken in large quantities, as were land mammals, birds and eggs, and wild plants. Before the spill, marine mammals, especially harbor seals and sea lions played an important role in the diets of many residents of these communities. Here are two women from Port Graham processing seal for its meat and fat. Subsistence harvest in these villages in the 1980s were very large, averaging 200-400 lbs. or more per person edible weight annually. These harvests were shared widely with relatives, elders and other in need. Harvesting and processing tied families together through cooperative activities and provided a context for young people to learn the skills and values needed to live in their communities. As shown in this slide, in the year after the spill, subsistence harvests declined substantially in the ten villages of Prince

William Sound, Lower Cook Inlet, and the Kodiak Island Borough. Subsistence harvests were down from 55-60% in Prince William Sound, 45-50% in Lower Cook Inlet, and from 10-70% or more in the Kodiak Island Borough. In contrast, although the spill did disrupt subsistence harvesting in the Alaska Peninsula communities, over the long haul for the first year we could not detect any meaningful changes in subsistence uses there. The range of resources used for subsistence also declined markedly in 1989, down about 50% or more compared to pre-spill in the communities of Prince William Sound, Lower Cook Inlet, and Kodiak Island. When asked about these declines, most households cited concerns about possible contamination of subsistence foods as the reason they had reduced or eliminated their uses of subsistence foods in 1989. This included 92% of all the households we interviewed in Prince William Sound and 78% in Lower Cook Inlet and lower percentages in the other two regions. It was clear that the spill had created conditions very unfamiliar to subsistence users and raised issues which could not be addressed by their own knowledge and skills. Further, there was little specific information available to help the resource agencies to respond to these concerns. In response, the Indian Health Service organized the Oil Spill Health Task Force, which included the member organizations listed in this slide. The task force coordinated studies in 1989, 1990 and 1991 to collect and test subsistence foods. It communicated interpretations of test results, which were developed by an expert toxicological committee to the communities in newsletters, by videotape and in public meetings. Altogether, in the three years of task force coordinated studies, tests were run on about 300 samples of fish, over a thousand samples of marine invertebrates, samples from 16 deer, 19 sea ducks and 43 marine mammals. The health advice communicated to the communities was that all of the samples of fish, birds and mammals were safe to eat, even in the very large quantities consumed in these communities. Most marine invertebrates were also safe, but the task force advised against using shellfish from oiled beaches.

Moving to post-spill subsistence harvest levels, as shown in this slide, with the spill year being the dark bar and the bars to the left being pre-spill averages, the bars to the right being post-spill annual harvest levels as measured in pounds per person, subsistence harvests have rebounded throughout the spill area since the first year. Increases were slowest to occur in the Prince William Sound communities of Chenega Bay and Tatitlek, with no recovery seen until the third year after the spill. Recovery was evidenced in Nanwalek, English Bay, and Port Graham in the second year and continued to rebound in subsequent years, and in the Kodiak area communities we also saw an increase in subsistence harvest in the second and third year, and in some cases matching pre-spill averages in the second and third years after the spill. Looking at the range of resources used for subsistence, the same story. We see a recovery over time but slowest in Prince William Sound. Here's Chenega Bay seeing a nice progression in the average number of resources used per household in each post-spill year.

Tatitlek, the other Prince William Sound community, pretty much the same pattern, and a more rapid increase in the average number of resources used in Nanwalek and Port Graham, matching pre-spill averages by the third year. Same thing in Kodiak. Despite these indications of rebounding subsistence uses, other information continues to show that the subsistence way of life in a number of communities has not yet fully recovered from the effects of the spill. For example, there are lingering concerns about the long-term health effects on human health of using subsistence foods. Subsistence users report that in some cases they have resumed uses of resources despite their concerns for cultural or economic reasons. Signs of disease and depressed wildlife populations contribute to their concerns. Examples include depressed populations of birds, marine mammals and marine invertebrates, and an outbreak of a virus in Prince William Sound herring stocks in 1993. Clearly, people have not yet regained confidence in their own abilities to judge if resources are safe to use. Further evidence of this change is a shift in the composition of resource harvests, and this slide shows the composition of the harvest in Chenega Bay in 1985 before the spill to 1991 several years after the spill, and the major change that has occurred is in marine mammal harvest. The pounds per capita harvest was about the same in these two years. However, you can see the marine mammal declined from better than a third of the total production to only 6 percent after the spill. In contrast, people are relying a lot more on salmon and other fish, such as halibut, in the post-spill years, the resources that they have more confidence in and that are in a larger supply. Another shift that we've seen is a change in people's assessments of subsistence harvests and causes of reduced uses. In this slide, using Chenega Bay as an example, this is 1989 and this is 1991, in both years when we interviewed households most households, by their own assessment, said that resource harvest had still not rebounded to pre-spill levels in their own estimation. In 1989, the vast majority of the households said that this was because they were concerned about resource contamination. That reason is a citation for overall declines went down to only 14 percent in 1991 in Chenega Bay. However, most households still said the resource harvests were down, not because they were letting concerns about contamination stop them but because resources were in short supply, and almost the exact same pattern was documented in Tatitlek with a very striking reduction in contamination concerns causing lowered harvests and a very stark increase in people's perceptions of resource scarcities leading to lower harvests. And we see the same thing in Nanwalek and Port Graham, although not as many households point to resource scarcity as a cause of decline. And I must add, that simply because households did not say that resource contamination led to a reduction, that does not mean that they still weren't concerned about contamination, just that it wasn't cited a reason for lowered harvest.

I'd like to read now an example of a couple of observations that we are getting from people in the subsistence communities, and the first is a letter sent to the Division of Subsistence from John M. Totemoff of Chenega Bay, a subsistence seal hunter, and he helped a division researcher, named Vicki Vanek, collect samples of seals around Chenega Bay in September of 1993. His letter dated to us is January 1994, about three months after he helped Vicki. I am now quoting: "I went deer hunting along the shore with my bow picker, saw two deer on the beach between four trips. Two days ago I went seal hunting to Prince of Wales Pass and then another trip to LaTouche Island. On these trips I did not see a seal, so we haven't eaten any fresh seal meat since we went out hunting with Vicki." The second example is another letter, this one addressed to the Subsistence Division's staff from Jerry O'Brien of Cordova, who we hired to conduct marine mammal interviews in Tatitlek late last year. Mr. O'Brien wrote to us, again in January of 1994, and I am quoting now: "I am no biologist, but Tatitlek is very depressed for no seals or sea lions, no wild ducks or signs of animal life around the Narrows. Very quiet. I brought two seal over for the people. I only wish I could have had more to bring them. They really appreciated that. I only wish that this was all a bad dream and we could all go back to our regular Aleut life and be what we used to be, a proud and good hunter."

In order to aid in the restoration of subsistence uses, the Oil Spill Trustee Council has funded a subsistence foods collection and testing program in 1993, which also included a large, public communications component. The overall goal of the project is to provide updated information to increase people's knowledge about the spill's effects on resources and to increase their confidence in using subsistence foods. This project was coordinated by the Department of Fish and Game, Subsistence Division, with the testing of samples occurring at the National Marine Fisheries Service's Northwest Fisheries Center in Seattle. The collection of samples was contracted to the Pacific Rim Villages Coalition. About 20 assistants from eight villages helped collect samples in 1993. This included over 100 samples of shellfish and fin fish from 15 sites, and as part of this project samples from five harbor seals taken for subsistence by hunters from Chenega Bay were also tested at the NMFS lab, and this slide depicts the taking of one of those seals. The results of the tests for hydrocarbon contamination have been consistent with those from the earlier rounds of collection and testing. Concentrations of PAHs in shellfish samples were very low and did not differ from those from reference areas at Angoon and Yakutat outside the spill area. Findings from the tests on the blubber of harbor seals were also very encouraging. As shown in this slide, blubber from samples of seals from oiled areas of Prince William Sound were taken in 1989 -- the darkened-in bars are levels of total PAHs from oiled seal, seals showing visible signs of oiling. In 1990, blubber samples from seals taken in some of these same areas had reduced but still elevated levels of PAHs. The five blubber samples from western Prince William Sound in 1993 had extremely low levels of PAHs, essentially background levels. Restoration study findings have been reported to subsistence users and others in several ways. Newsletters, such as the one pictured here, have been mailed to literally thousands of people and organizations in the spill area. We have held several series of public meetings. A first round of meetings and consultations in 1993 helped select resources and sites for hydrocarbon testing. A second round of meetings took place in February and March 1994 to present study findings and elicit ideas for this year's projects. In order to increase community knowledge about the hydrocarbon testing process, a group of community representatives travelled to Seattle in August 1993 to tour the NMFS facility. They also attended a meeting of the Oil Spill Health Task Force to review a number of oil spill resource issues. In 1994, the Trustee Council has so far funded two subsistence restoration projects. The first continues the foods collection and testing program, as well as the public communications efforts. This will likely be the last year for collection and testing, and the emphasis this year is on sites that have not previously been part of the program. Again, involvement of local assistance in the project will be emphasized. The second project is a cooperative effort to interpret data about the status of harbor seal and sea otter populations in Prince William Sound and Lower Cook Inlet. A goal of this project is to build a consensus among biologists and subsistence hunters about steps to be taken to speed the recovery of these resource populations, and we hope to continue this project beyond 1994. Finally, another opportunity to restore subsistence uses is a five million dollar appropriation by the Alaska Legislature from the criminal settlement funds to support subsistence restoration projects by the communities of the spill area. The Department of Community and Regional Affairs and the Department of Fish and Game are presently working with the Trustee Council's staff to develop procedures to implement this grants program.

I'd now like to conclude with the following points. First, the *Exxon Valdez* oil spill severely disrupted subsistence uses which are vital to the health and survival of the communities of the spill area. Second, in response to concerns about contamination of subsistence foods, an Oil Spill Health Task Force formed to coordinate studies to provide specific information to subsistence users. More recently, the Trustee Council has supported these studies. Third, subsistence uses have rebounded since 1989. Few households continue to cite contamination concern as a cause of lowered uses, although questions about the long-term effects of the spill on human health remain. Some households have returned to using subsistence foods despite their questions, simply because to do otherwise would cost them their way of life. Fourth, a common theme that we have heard from subsistence users is the suspicion that, overall, resource populations have continued to suffer since 1989 and that this is evidence that something is fundamentally wrong with the natural environment of the spill area. Given these points, it is clear that five years after the spill, the restoration of subsistence uses is not complete. Important resources are scarce, confidence is lacking, information is in demand. Future restoration efforts must build upon the start that has been made to involve all the communities of the spill area in collaborative efforts to heal the resource base. These efforts also need to address the full scope of the subsistence way of life, including restoration and enhancement of the knowledge and skills upon which subsistence depends. Strengthening the subsistence way of life in the wake of the spill is one way we can prepare to face threats of future environmental disasters to the natural resources and the people of our state. Thank you. (Applause)

DR. SPIES: Thank you, Jim, for that very informative presentation. Our next speaker is the Chief of Cultural Resources for the National Park Service, Alaska Region, Dr. Ted Birkedal. Dr. Birkedal has been involved in archeological surveys and research ever since the spill on behalf of the National Park Service, and he'll be talking about, of course, archaeology.

DR. TED BIRKEDAL: Thank you. On the eve of European contact, Southcentral Alaska was one of the great population centers of the Pacific Rim, armed with sophisticated maritime hunting and fishing technologies and aided by the redistributive powers of complex yet highly functional social and political structures, the Native people of the coastal provinces of this region were able to take full advantage of the numerous fish and marine mammals that are found in its waters. Village after village dotted the coastlines, some boasting hundreds of inhabitants, although most were considerably smaller. In fact, the population densities of the Gulf of Alaska may have rivaled those found among the agricultural tribes of the American Southeast and the American Southwest. For the Kodiak and the opposite shore of the Shelikof

Strait alone, the Russian censuses of the late 18th century record nearly 7,000 people, yet recent scholarship suggests that even this already ample figure represents a reduction from earlier numbers that may easily have been as high as 14,000 and possibly as many as 20,000 at the time of initial contact and before the first Native Alaskan encounters with European disease, warfare, and socio-economic disruption. The abandoned villages and encampments from Alaska's contact and historic era produced an impressive archaeological record in the Gulf of Alaska. Here's an example (using slide illustrations) of the Katmai coast, and you can see some of the sites we know of there, and the shaded areas show density of sites. So it's quite high here.

The archaeological record, however, isn't limited to the more recent past. The archaeological record of the Gulf of Alaska has been enriched and multiplied by at least 6,000 and possibly 8,000 years of prior occupation by the forerunners and ancestors of the present-day Koniag, Chugach, and other eluthic (ph) groups in the area, including their Athabascan neighbors and cultural relatives, the Nenaina (ph) Indians. Countless earlier generations have made their own contribution to the region's archaeological legacy. Unfortunately, on the eve of the *Exxon Valdez* oil spill, this archaeological legacy remains largely undocumented and uninventoried. Most site locations were unknown and few sites had been evaluated to ascertain their relative significance, that's either their heritage or scientific value. Thus, federal and state agencies were caught quite unprepared as far as archaeological resources were concerned. But, luckily, in 1988 a mock oil spill exercise with Russia had identified coastal archaeological sites as a potentially vulnerable resource type in the event of an oil spill in the Bering Strait. The lesson of this exercise was quickly translated to the *Exxon Valdez* oil spill event, and protective measures were rapidly built into the interagency planning process for oil spill response. Exxon Company, for its part, did not hesitate to assume a share of the responsibility for the protection of cultural resources in the oil spill area and had formed the *Exxon Valdez* cultural resource program, well staffed by some of the most expert archaeologists in the area.

Three major types of impact to archaeological resources were anticipated. One was direct oiling, which could result in the contamination of archaeological soils and specimens, particularly C14 dating samples and also mask archaeological artifacts, making them invisible and more vulnerable to disturbance because you couldn't see them. Here, you can see an oiled artifact right here. That's an axe. That's lightly oiled. Another form of injury is from clean-up activities, especially high impact methods that involved high amounts of beach disturbance and high crew numbers. Another form of injury that we identified at that time was vandalism and looting, purposeful theft or disturbance of archaeological remains by oil spill workers or fellow travellers. Of the above, direct oiling was the least controllable, except in the limited zones where booming was possible. The real threat was from the clean-up activities and attendant vandalism, so attention was placed to these two potential impacts. The best tool for the prevention of injury from clean-up activities and clean-up related vandalism was a fast track review process that was developed by the State Historic Preservation Officer and the participating federal agencies to ensure compliance with the Section 106 of the National Historic Preservation Act. In its more refined and streamlined form which had already been developed by 1990, its two essential components consisted of a cultural, technical advisory committee, called CTAC (ph), and the State Historic Preservation Officer, and CTAC's membership consisted of representatives of all the participating state and federal agencies, including the Coast Guard, Exxon Corporation, and relevant Native Corporations. This group reviewed the oil spill clean-up plans and recommended appropriate constraints or protective measures to prevent injury to archaeological resources. The State Historic Preservation Officer then reviewed the recommendations of CTAC and, if approved, these were sent on to the Coast Guard for final approval and implementation. This process rarely took more than a few days, and sometimes it took only a few hours. Protective measures or constraints were generally simple and included such actions as restrictions on clean-up techniques and methods -- there was an archaeologist working a particular beach. Another measure was avoidance of archaeologically sensitive beach segments -- they would just be excluded from clean-up -- restricting clean-up crew traffic to certain sections of beach was another. Here's a crew at MacArthur Pass. Archaeologists are present in this particular picture monitoring the action. Posting professional archaeologists, as I've just said, as clean-up monitors was another constraint action, and educating and briefing clean-up crews off site and on site about the need to avoid disturbing archaeological sites. There -- an archaeologist with an oiled artifact there. And on rare occasions, actions might even include the collection and mapping of artifacts in advance of clean-up crews if there was no other way around it. This is MacArthur Pass and it was the scene of the -- there was a site in there, it's just above the intertidal zone, and it extends into the intertidal zone, and this area was the most intensely, I believe, worked by archaeologists, and the mitigation levels were the highest. We worked with Native corporation people as well as Exxon crews there. This is the kind of work they were doing, they were testing here to determine significance of the (indecipherable) deposits so we could determine the lag deposits on the beach. These sites did contain in their soil column seeds -- they were still recoverable, 1200 years olds -- bed straw and tiny snails specimens -- just to indicate what's in those archaeological stores, there's an environmental record there too that can be disturbed. The burden of surveying beach segments in advance of clean-up and educating the crews in clean-up and monitoring usually fell to the *Exxon Valdez* cultural resource program archaeologists. They did most of the work in doing the response effort.

But after all of this, what happened? Injury assessment to determine what actually occurred to archaeological resources was difficult compared to actually implementing this compliance process because the various oil spill legislation is very vague on where archaeological resources sit as natural resources. And although an archaeological interagency cultural resources working group was formed in 1989 to begin planning injury assessment and restoration, cultural resources remain the stepchild of oil spill legislation injury assessment process for many years.

The question of whether the laws covered archaeological resource injury and restoration remains controversial to this day. The Oil Spill Trustees finally authorized injury studies to begin in 1991 under the guidance of the Cultural Resources Working Group. This is Al Deacon of the State University of New York who headed up one of the largest of these studies. This study, which was a look at 60 shoreline segments, the testing of 10 selected archaeological sites, and examination of 26 other properties, and it looked at physical and chemical and soil properties of the soil column of archeological sites, and also used geographical information systems to analyze the sediment data from the archaeological work. We also did a supplemental study, this was primarily a library study that sorted through all the records that were available from response to see if there clues as to injury at that time from the response records, and that was done by Jesperson (ph) and Griffin of the National Park Service and also the State Historic Preservation Officer's Office. One of the major difficulties that we found hampering the study was the lack of any pre-spill comparative data, the same thing you hear again and again that you can't compare to nothing, and that's the problem even with our archaeological resources. There was virtually nothing here to look at as far as we're concerned, maybe a few dozen sites we knew anything much about. What are the results of the injury studies? First, what's the universe that was injured? That's been estimated to be about 3,149 sites, based on projections from known data on 1,287 sites in the oil spill area, and I believe this is probably a conservative figure. It may be a little bit higher than that. Of that 3,000-some sites, approximately 113, give or take a few, sustained probably more than a slight amount of injury from oil clean-up activities or vandalism. That's about 3.6 percent of the projected archaeological sites in the oil spill sector. Approximately 276 sites were subjected to either light or heavy oiling. However, it appears that only 59 of these were subject to moderate or heavy oiling -- this was less than 2 percent, so that's sort of good news. The number of sites impacted by archaeological vandalism appear to number about 100. There was a close correlation between archaeological vandalism and sites with clean-up injuries. Most of the injuries observed came from 1989, near the beginning of the oil spill response effort, before things were really in place in terms of systems of prevention and protection. While the results are still not certain, it appears that hydrocarbon contamination of upland archeological materials was slight. Hydrocarbon contamination of archaeological dating specimens from sites in subsidence zones, however, are more of a problem because in future excavations if we go into the intertidal zone, we may open up lower sediments to oil from above and we will have to treat these specimens that we take from there as well and we can open up more areas to having to do that special treatment. A projected 155 sites in subsidence zones should contain some of this oil contamination. Restorative efforts have gone forward on 24 known sites, and what we're finding now in our second year this year is that a lot of vandalism apparently stopped after 1989 relative to some of the sites that were treated. We have 2 cases now out of 14 we looked at this year that do show continuing signs of vandalism, however, overall it looks pretty good.

So, what did we learn? One, we needed good pre-spill baseline data for archaeological resources. This is probably the lesson for other areas as well as the lesson for the future of this area. And then secondly, I think the most important thing here, the reason that there wasn't any major injury beyond what I've documented here is because of that constraint mechanism I was talking about. The bureaucratic process actually worked to preserve these sites more than anything else. We estimate that perhaps if that had not been in place the injury levels would have been a hundred times more than we see today. This just exemplifies that -- that little red tag there marks an axe that's in MacArthur Pass that hasn't moved in the last three years. Thank you very much.

(Applause)

DR. SPIES: Thank you very much Ted. Our next speaker is Dr. Phillip Mundy. He will be speaking on the topic of fisheries. Dr. Mundy is a specialist in salmon population biology and management. He works for the federal, state, and private interests on salmon problems in the Columbia River basin and Alaska as an independent fisheries consultant.

DR. PHILLIP MUNDY: Thank you, Bob. It's a pleasure to be here. The topic that I have to talk about today -- it really was a great honor for me to be selected to come here and talk to you about this today, first of all because I get to talk to you about work that was done by so many fine scientists over the last five years with respect to the impact of the oil spill on the fisheries resources, and second of all because I know from experience how important the fisheries resources of this state are to its people and also how important the fisheries resources of Alaska are to the people of the nation.

Now, in looking back over the last five years and asking the question, what have we learned, well, I believe we've learned a great deal, and I don't think that what we've learned is necessarily consistent with what we knew about the impacts of oil spills on fisheries resources in the past. We've certainly learned that the fisheries resources of Alaska were exposed to oil. We've seen this in everywhere that we've been able to look, where we had the money to look, we had the time to look, and where we had the experimental design that allowed us to look. There was widespread exposure of the salmon, the herring, the ground fish, the shellfish, and every conceivable intertidal resource was oiled. Now, the damages of the oil spill are currently being tallied and currently being quantified; however, we saw that the fisheries resources of Alaska were damaged both by exposure to oil and by the disruption of harvest management activities that precluded harvest managers from taking appropriate steps to limit escapements in some of our sockeye salmon systems. Now, we've got exposure -- we've learned that; we've got damages -- we've learned that; but the other lesson that we learned that's come through loud and clear has been the one of persistence. Now, oftentimes you hear in oil spills -- particularly the one that I recall is the Amoco Cadiz because this was a big nearshore oil spill that was much talked about in the biological community -- you hear that the effects are over quickly with the soluble fractions gone and everything is fine, and, indeed, we have a problem in most fisheries situations because the fish that maybe impacted by the oil die, they sink, they go away, larval fish are just like pieces of thread in the water -- when they are impacted, if you want to measure that or look at it, it's very, very difficult. However, in Prince William Sound we were most fortunate to be in a situation to have resources where we had baseline, where we have quite a bit of experience with managing these resources, and we have come to understand that, yes, the damages were done and the damages are persisting in the environment to this day, and we expect them to persist for some time.

Now, in the amount of time that's available, I would barely have time to read you the titles of all of the work that's been done under the natural resources damage assessment and under the restoration program, so I'm going to be able just to move through some results fairly quickly for you and show you a few snapshots of work that's been done along the more prominent of the fisheries resources, and offer all the researchers whose work I may not be able to do justice to apologies in advance.

Now, with respect to damages, we know that we had loss of reproductive capacity, loss of reproductive potential in the natural environment in salmon, we've also been able to measure reproductive impairment in the laboratory in herring, there's been a loss of immunocompetence, that is, a lower disease resistance, also in laboratory experiments in herring, and in sum total it seems that the damages that we're measuring throughout the environment seem to have a common theme, and that is in mortality coming from various sources and also in the reduction in growth which leads to morality. Now, if I can get the first slide -- this is data which shows both exposure and persistence. This is a measure of exposure to oil over here, and this is benthic fish at some oiled sites showing persistent exposure to aromatic compounds. This slide was provided by the National Marine Fisheries Service; it comes courtesy of Tracy Collier (ph). And basically, you can see the time period here is 1989 to 1993. We have an oiled site, and we have an un-oiled site down here. In the enzyme induction activity, we see exposure down here, lower levels. So, what I get from this -- this is rock sole data -- these are bottom fish. This will have to do for the bottom fish and the crabs -- very large resources, very important resources -- but we just didn't have a lot of opportunity to study these in relation to the oil spill.

So, we have long-term exposure; we have persistence in the environment. In the case of herring, we had exposure on the herring, and we had oiling of the spawning grounds, we had laboratory studies showing reproductive impairment and reduced immunocompetency, that is, reduced ability to resist disease, and one way to look at these things is to simply simulate the effect. Now, here in these areas, we can take a look at mortality, oil-induced mortality, and survival rate in relation to a simulated effect based on the reduction in growth, reduction in survival that may have occurred from the 1989 year class. Here is another example of the measurements that were taken. This was done in the study that was jointly conducted by National Marine Fisheries Service and Alaska Department of Fish & Game on pink salmon growth in the nearshore environment. This is daily growth rate up here since 1989, oiled areas, non-oiled areas. We saw certainly a reduction in the daily growth rate in nearshore areas in pink salmon, and in 1990 apparently they rebounded. Now, the conclusions of this study that Alex Rutheimer (ph) and Mark Willette (ph) did was to demonstrate something that's extremely important in terms of fisheries effects, and that is reduction in growth and changes in the migration pattern. The migrations of juvenile pink salmon released from the AFK hatchery in Prince William Sound in 1989 appear to be affected by oil contamination, the growth of juvenile pink salmon appear to be reduced 17 to 30 percent by oil contamination in nearshore nursery habitats, and lower juvenile growth in oiled areas appear to cause 31-53 percent reduction in survival to the adult stage. So, reductions in growth in the fisheries are usually coupled with increased mortality and consequently a loss in adult production. Now, here is the results from the Prince William Sound embryo mortality study, and here we see embryo mortality over here, and this is right about mean low water in meters -- so, moving up the screen from low to high -- and we see that we've got increased embryo mortality in the case of the oiled as compared to the control streams, which were not oiled. Now, the conclusions from this work were elevated embryo mortalities in oil-contaminated streams and now possible genetic transmission of damages of these effects. Now, we're moving out of the realm of damages that might have been due to direct exposure to the oil and into the area of disruption of harvest management activities.

In 1989 in Cook Inlet, Kodiak, and also on the Alaska Peninsula at Chignik, harvest management operations for salmon were disrupted substantially. And these are examples of what happens when you disrupt the harvest management operation -- escapement goals are set based on what we believe a nursery lake for sockeye can bear, and when you put too many fish into the area, you get a reduction in the amount of food due to heavy grazing by prior year classes, and you get lower growth which translates to mortality. So, these are various sockeye salmon smolts juveniles that are ready to go to sea from the Kenai River drainage, and I'll leave you to figure out which one was the result of the 1989 escapement down here. The lower growth is certainly going to be translated into fisheries losses, and as Chuck Meacham mentioned earlier, we're going to have to wait until this year and perhaps next year and the year after to really understand the extent of the damages that were done to the sockeye systems. This is also my obligatory slide of fish here -- so this is the only fish slide you'll see.

Now, what can I offer you, other than a recitation of what we've learned in the course of five years of oil spill studies? Well, I think I can offer you perspective that comes from a couple of different areas. First of all, having worked as a salmon manager for many years, I've been focused on one specie. However, on leaving Alaska, I started to work in badly damaged ecosystem, and I realized that perhaps there's more to salmon management than putting the right number of salmon in the river, although that's certainly important. So, I've been working with a group of scientists for the last three years trying to understand what ecosystem management means in terms of protecting salmon resources in a badly damaged ecosystem, in this case it's the Columbia River basin. Now, I think we definitely need to try to understand the fisheries damages in an ecosystem context, and in an ecosystem context we focus on how the parts work together. Again, for interpretation of damages and what they mean, you've got to avoid, I think, in an ecosystem context being reductionist, that is, pulling all the parts apart and trying to understand how they work. In an ecosystem context, you're supposed to take one step back and look at the effect on the whole ecosystem and look at what's happened. Now, I think you can look at the oil spill as a treatment. I think the ecosystem got a good treatment of oil in 1989, and I think that we've documented responses of fisheries resources to the oiling. Now, as far as actually getting down to the mechanisms, we're working on that. That's going to take a lot of hard study, a lot of laboratory work, but actually having measured in the field, in situ, embryo mortalities resulting from the oiling, I think was a major scientific achievement -- not to certainly belittle other achievements -- the demonstration of reduction in growth in the field as a result of oiling was quite an achievement, a very high scientific achievement. But, now, trying to understand what's happened, we need to sit back and try to see how the parts fit together.

The second perspective that I would offer you is what I would call the bio-assay (ph) approach. Now, in years past, about 60 years ago, one of the ancestors of the Stanley Rice was probably out there trying to figure out what happened to people who ate hot shellfish, that is, what happened to people who ate shellfish that had paralytic shellfish poison in them. Now, 60 years ago the shellfish industry that marketed clams and mussels was almost destroyed because we really didn't understand what paralytic shellfish poison was. And so, we went to the biochemist and said, please, tell us what's in these clams that's killing people, and they looked at them, and 60 years ago analytic techniques were not very good, and they told us that, well, we don't see anything -- there's nothing there -- there's nothing we can measure. So, what biologists do while they're waiting for chemists and physicists to catch up with them is they go out and conduct a bio-assay. We knew that these shellfish weren't bad, we knew that they hadn't been improperly handled, we knew they were good, wholesome shellfish, but they were making people sick and sometimes killing them. So, we took these shellfish, we ground them up, we dried them, and we fed them to rats and watched the rats die, and we counted how many rats died. Now, this is a fairly crude test, and it's certainly not something that's going to impress a biochemist, but I can tell you it was a very effective way to figure out whether a shellfish was safe to eat or not. Okay, that's a bioassay. It was some 45 years later that the biochemists finally came in; they said, oh, yeah, we know what this is, at least we know what some of it is, it's demoic (ph) acid or whatever, and so now we can measure that analytically. Well, in the intervening 45 years, we were able to function quite well without knowing exactly what it was in the shellfish that was making people sick and killing them. So, on the one hand, you need to work very hard to understand the mechanisms, certainly, but on the other hand, you have to take a view of the ecosystem as a whole functioning entity. You can't demand reduction in all aspects in order to be able to measure an effect, and certainly the effects observed in the field are now being confirmed in the laboratory, and I believe that the explanations will come if the research is supported. Now, one other perspective beyond the bioassay perspective, and that's the perspective I bring from working in a damaged ecosystem. In fact, I like to think of the Columbia River basin as sort of the Sarajevo of fisheries management. We've got a small problem down there. We have a salmon stock that's an endangered species, we've have a salmon stock that's a threatened species, we have a lot of salmon populations -- I think well over a quarter of the chinook populations in the basin last time I looked were heading for the X axis, okay. We're going to lose a lot of populations here in the next ten years. Now, in 1920, the runs in the Columbia basin, as near as I can tell, were probably in pretty good shape, and, indeed, even when the first dam was built on the Columbia River in 1932, they still weren't in bad shape at that time. But, over the period about 1932 to 1970 we lost these fish, they went down the drain. They went down the drain 2000 fish at a time; they went down the drain 100,000 fish at a time -- when we closed off spawning habitat and when we just simply abused the environment. So, we are spending probably now, if you count lost hydroelectric revenue, roughly $200 million a year to work on salmon and try to restore it. So, if you think a billion dollars in settlement is a lot of money, try the estimate of $325 million that the administrator of the Bonneville Power Administration estimated was spent last year on research, restoration, and lost electric generating revenues as a result of managing the hydroelectric system. You're talking about a very, very big problem. My estimate of what we're spending per sockeye in the Idaho Snake River basin is about $1 million a fish. So, I think that you need to take a message from the Ghost of Christmas Future here, a message from Sarajevo, work hard to understand the effects of the

Exxon Valdez oil spill on the fisheries resources and on the ecosystem as a whole. It's very important. Thank you for your attention.

(Applause)

MS. KATHY FROST: (Beginning not recorded) . . . and will spend only a short period of its time in Prince William Sound, and it was difficult, if not impossible, to document effects had they occurred. Three of these species were found to be injured by the spill and continue to be studied over the last three or four years as part of restoration and monitoring projects to determine whether recovery is occurring. Those three species are killer whales, sea otters, and harbor seals. Historical studies of killer whales before the spill indicated that about 300 whales sometimes used Prince William Sound. Only some of those are regular residents. Following the EVOS, killer whales were studied by counting and identifying individuals in the Sound and comparing those individual identifications and those counts to pre-spill data. Each killer whale has a unique color pattern on its dorsal fin and there below in the saddle which allows individual identification, and this means that when scientists count whales in the Sound, they know not only that they saw 22 killer whales on a particular day, but which particular individuals they were and whether they were the same animals that they saw last year or the year before or the year before. In one group of animals in the Sound, AB pod, a significant number of animals were found to be missing after the spill and have been re-sighted since. However, as has been so often common in our oil spill studies, there was no positively demonstrated cause-and-effect relationship between the absence of those whales and the *Exxon Valdez* spill, and we will never be able to say definitively why, in fact, those killer whales disappeared. This is complicated by the fact, as I said, we had an ongoing interaction between commercial fisheries and killer whales. Killer whales like black cod and they like halibut, and fishermen don't like it when they interfere. However, I think when all was said and done, the fishery interaction had been going on for numerous years, the oil spill was very time specific, it occurred in 1989, and the losses we saw to AB pod also occurred in that year. In 1989, seven animals were found to be missing from AB pod; in 1990 an additional six animals were missing. To put this in perspective, the total pod consisted of 36 animals, so the mortality in each of those years was approximately 20 percent. Normal mortality in a killer whale pod is about 3 percent to possibly 8 or 9 percent per year. So this is an extremely high and abnormal mortality. No calves were born into AB pod in either 1989 or 1990; however, in 1991, 1992, and '93 we had one or two calves being born each year. This graph shows the numbers. You see there 1984 to 1988 numbers of killer whales in AB pod approximately stable, ranging from 31 to about 36 sighted in a particular year. Following the spill, we see the loss of that 6 animals, additional loss in 1990, the numbers are relatively stable, slightly increased since then. As of the end of the 1993 field season, there were 26 animals documented in the pod.

In the future, what should we do? Continue to monitor AB paid at least to see if this recover and the birth of calves continue. In addition, studies of killer whales should be expanded to address their interaction with other components of the Prince William Sound ecosystem, particularly harbor seals and fisheries and not treat them simply in a world of their own. Sea otters are an extremely high profile species in Prince William Sound, as they are wherever they occur. They are abundant year round in the Sound. Even before the *Exxon Valdez*, scientists knew that sea otters would be a problem if a spill were ever to occur. The major reason for this is that, unlike harbor seals which rely on a thick layer of blubber for insulation, sea otters rely on their fur, much like you and I in a down jacket -- if it gets dirty, it doesn't work. So any kind of contamination with oil meant that sea otters were very subject to hypothermia. Not surprisingly, sea otters was one of the first species to be obviously impacted by the spill, and a great variety of studies grew up as a result of this obvious impact. This just gives you a list of some of the studies that occurred. They were estimates of total loss, there were studies of distribution and abundance made during boat and aerial surveys, people looked at survival, reproduction, mortality patterns after the spill in oiled and un-oiled areas -- this whole suite of studies. To kind of give you some perspective of this effort, between 1989 and 1993 20 scientists and over $3 million were dedicated to sea otters studies. Carcasses were recovered from approximately 900 sea otters following the spill, and at a later date after the data were interpreted and the subject of carcass recovery addressed, it was estimated that approximately 2800 otters died as a result of the spill. Sea otter investigators were luckier than some, there actually had been surveys in the Sound prior to the spill in 1984 and 1985. Surveys were again conducted in 1989, '90, '91, and '93, and based on those surveys the conclusion was that there were no significant decreases documented on the Kenai, Kodiak, and the Alaska Peninsula. And by no significant declines that does not mean that no animals died, it means that the results did not show numerically, statistically, robust evidence of declines. However, in Prince William Sound the Fish & Wildlife Service analysis did indicate a 35 percent decline in oiled areas of Prince William Sound in 1989, and that compared to an increase of 13 percent in the un-oiled areas. Since 1989, surveys have been conducted every year except 1992. In 1989 through 1991 the numbers were approximately similar. In 1993 the surveys indicate a slight increase. That increase is not statistically significant, and so we'll have to monitor those numbers in the future and see if that trend holds up. The studies by Fish & Wildlife Service and Rodderman (ph) and Monette (ph) between 1989 and 1993 indicated that more prime age, that is adult animals between ages 2 and 8, died during 1989 and the two post-spill years than before the spill and more recently in 1992 and 1993. In a normal sea otter's life, most mortality occurs while it's a very young animal, just weaned as a pup, or as it's a very much older animal, and it's not very normal for a prime age animal to die. Normal mortality at that prime age component is around 20 percent. During the years 1989 through 1991 that increased to 43 or 40 percent -- of the carcasses found on the beach were that prime age component. In the last couple of years that mortality appears to have returned to a more normal trend, about 19 percent again of the carcasses found along the beach are that prime age category. And here we see the pie diagrams show that pre-spill was by far the largest component is the juvenile, and the smallest component of prime age animals 1989 -- and again 1990, '91, a large component of the animals found dead along the beaches were prime age adults, and now 1992, post-spill, we see that prime age adult mortality has decreased. Concurrent with this, we saw studies indicated lower survival of pups in western Prince William Sound, and now, this is one of the things that I'm sure confounds non-scientists more than almost anything you hear, is every time you think you have a result from a biologist, there is always a caveat, and it's just the way life is. There aren't very many easy answers in science. Lower mortality certainly has been documented in western Prince William Sound. We don't know what the cause is. It may be oil spill related; it may not be oil spill related. This particular graph here is for the year 1990 and '91, and you see only 13 percent survival in the western Prince William Sound, which encompasses the oiled area, versus 36 percent in the eastern. The following year, you saw 46 percent survival in the western or oiled area, but 73 percent in the eastern Sound. Still a differential between the east and the west -- is that oil related, is that habitat related? Only additional studies will ever give us the answer. In the future, sea otter investigators hope to continue to monitor recovery and continue studies of juvenile survival and reproduction, and I think in addition add studies of this whole nearshore ecosystem must include sea otters and their role as a keystone species. We will have to look at how sea otters are affected by some of the things that Pete Peterson told you about in terms of survival of intertidal and subtidal species. The final species in this sort of three species sweep are harbor seals. Harbor seals are year-round residents of Prince William Sound. Current estimates of a population size are around 3,000-5,000. Probably most significant before the spill, no one predicted that harbor seals would be a problem, and I think this is a warning to all of us not to too narrowly define our expectations so that we exclude species from our investigations early on in the game. Almost everybody stated fairly emphatically that seals would avoid oil, they wouldn't swim into these oiled areas, and that it just wouldn't cause problems. That didn't turn out to be the case. Harbor seals did not avoid oil, they hauled out on oiled rocks, on oiled algae, they swam through oil, they breathed the oiled water-air interface. In oiled areas during 1989, 50-100 percent of the harbor seals in those areas were externally oiled, behavior was abnormal, animals were observed to be lethargic and unresponsive. A fairly broad suite of studies developed early on. Those included necropsies to include pathological investigations, looking at tissues microscopically to determine if there was damage to the liver or other organs;

chemical examination to determine it there were elevated levels of hydrocarbons in the tissues. In addition, there were surveys to look at distribution of these animals and see if any detectable pattern was available in their numerical abundance. To summarize briefly, lesions were found in the brains of some of these heavily oiled seals. The pathologist indicated that these lesions were serious enough to have caused animals to drown. We don't know the actual causative mechanism for those lesions, it's speculated that inhalation of the aromatic fraction may have caused the problem. Hydrocarbons were found to be elevated in bile of externally oiled seals. Hydrocarbons were slightly elevated in the blubber of some of these seals, but as Jim Fall showed you in his slides earlier, those levels have returned to normal in the last couple of years. Surveys -- we were lucky with harbor seals also -- ADF&G had conducted surveys in Prince William Sound of the Trin (ph) count area in 1984 and again in 1988. Based on those data, we knew we had an ongoing decline of harbor seals which complicated our interpretation, but our surveys sites existed in both the oiled and in the un-oiled area, and you can see if you look, 1984 and 1988 the rate of decline in the oiled and un-oiled area was quite similar, 11 percent for one area and 14 in the other. However, following the spill, we saw a 45 percent decline between '88 and '89 in the oiled area, compared to an 8 percent decline in the adjacent un-oiled sites. Studies have been ongoing since then, and it's pretty hard -- this slide presents annual changes instead of an overall picture -- but it looks like, based on surveys conducted during the fall molt, that is August and September, that numbers may have stabilized after the initial problem in 1989. In total, our best estimate was that approximately 300 seals died following the spill. (Interruption from the audience) I'll be glad to answer questions later. The status now in terms of our harbor seal studies, recent chemical analysis of subsistence-taken seals suggests that hydrocarbons are no longer alimented in their tissues; pupping, which appeared to be significantly lower in the oiled area in 1989, has apparently returned to normal. The surveys are a little more complicated to interpret. Our fall surveys suggest that numbers have stabilized on these oiled haul-out sites; however, surveys conducted during the pupping period when the reproductive animals are present, indicate an ongoing decline, and that is something that future studies will have to address. We need to continue to monitor the population status of these seals and track whether recovery does, in fact, occur. As I said, we need to pursue which is the most accurate indicator of the status of the population, whether it's these pupping surveys in June or whether it's in fact molting surveys in the fall. In addition, we need to better understand how harbor seals use their habitat, what habitat is critical to them, and to appreciate how harbor seals interact with the rest of the ecosystem. As I said, we have this ongoing decline of harbor seals in Prince William Sound, as well as in the northern Gulf of Alaska. That has been exacerbated by damage caused by the spill, and right now a lot of people's lives stand to be affected in a very real way in the future if we don't figure out what's happening with these species and hopefully figure out a way to turn it around. Where does all of this information leave us and where do we go from here? We need to continue to monitor the status of these affected species, and more than just counting and documenting injury, we need to understand why they are or are not recovering and what makes a healthy Prince William Sound. We need to take these studies of individual marine mammal species and link them with other studies of Prince William Sound to better understand how the Sound ecosystem works and how the many components inter-connect. This is neither a simple nor an easy task. No one in this room today can change the fact that that spill occurred, but every one of us can work hard to ensure that we learn as much as we possibly can from it. What we learn should be the basis for better policy decisions and better response in the future. We must ensure that our policymakers have the information they need to safeguard special places like Prince William Sound in the future. The American taxpayer pays millions of dollars each year for scientists like me to predict the potential effects of oil spills or other environmental perturbations. People like me hypothesize about what might or might not happen based on very little real life information. The *Exxon Valdez* oil spill provides that real experience. Everyone in this room is remiss if we don't insist that we learn everything possible from that spill. Scientists, fishermen, subsistence hunters, and other members of the public have to work together to collectively design and implement programs that will not only restore the injured resources in Prince William Sound, but will lead us into the future better prepared to deal with and minimize the impacts of any such event in the future.

(Applause)

DR. SPIES: Thank you, Kathy. If members of the audience would hold their anecdotal information until the break, it would be appreciated. The next speaker is Dr. David Irons. Dave has done some really excellent work during the damage assessment phase on kittiwakes, and he will be talking about the birds. He's from the Fish and Wildlife Service in Anchorage, now the Biological Survey, and he will address both injury and the state of the resources currently.

DR. DAVID IRONS: Thanks, Bob. Today, I'll tell you about the injury and recovery of birds affected by the oil spill. First, I'll give you a little background on what bird studies were done and why, and I'll give you an overview of the known injury, the status of the recovery, some gaps in our knowledge, and recommendations for future work. Much of the work presented here today was done by a suite of biologists that, again, are too numerous to name, but I thank all of them. (Using slides) First, I'll give you a brief introduction with marine birds in the spill area. In summer there's over half a million birds, marine birds, in the spill area in Prince William Sound and at least a million outside Prince William Sound. Some of those numerous species are murres -- there's a murre colony -- kittiwakes -- there's kittiwakes in flight -- forked-tailed storm petrels, marbled murrelets, and puffins. In winter there are about 300,000 birds in Prince William Sound, and at least that many in the rest of the spill area. In the winter it's primarily sea ducks and grebes -- there's a shot of golden eyes -- in all there's over a hundred different species of marine birds that occur in the spill area. In addition to marine birds, which here I'm including sea ducks and seabirds, there are also shorebirds, bald eagles, and northwest crows, which are important in the spill zone and they are susceptible to oiling. That's an oyster catcher. After the spill, everyone wants to know how many animals were killed, but there was damage from the oil spill in two general ways, as we've heard: direct mortality and long-term sublethal effects, such as affecting their ability to reproduce. To determine how many birds died after an oil spill, one can go out and count the dead, oiled birds. The problem is when you count them, you don't know what percent of them were recovered. In some cases, it may only be 10 percent of the birds are found. After the majority of oil spills that have occurred, the only major measure of bird mortality has been the number of birds that were found dead. However, besides the question of the number of dead birds, we also want to know did the oil spill affect bird populations in the oiled area. However, to determine if populations have been affected in a statistical, rigorous way, there must be data on population levels before the spill, and you also need control populations that were not affected by the spill. Another question people ask after an oil spill is where are the long-term, sublethal effects. Again, to answer this question, there should be pre-spill data and a control population. The reason I'm telling you this is to give you an appreciation for the importance of knowing the population levels and productivity of birds that may someday be oiled. Without good data before the spill occurs to determine the effects of the spill, you're limited to counting the bodies and you will not be able to determine population effects and you may not be able to determine long-term, sublethal effects. Basically, the species that were chosen to be studied after the spill were those that we had pre-spill data on. Since the spill, for one or more years, there have been studies on murres, marbled murrelets, pigeon guillemots, black wake kittiwakes, forked tailed swim petrels, bald eagles, and shorebirds, which include black oyster catchers, surf birds, and black turnstones. Several of these species were only studied one or two years. In 1994 we are studying marbled murrelets and pigeon guillemots. In addition to the single species studies, we also studied all species by conducting marine bird surveys in Prince William Sound in summer and winter. Now, I'll give you an overview of the known injury to birds, based on the carcasses and on damage assessment studies. About 30,000 carcasses which were attributed to the oil spill were picked up after the *Exxon Valdez*, which, according to one study, extrapolates out to 375,000 birds. More carcasses were found after the *Exxon Valdez* oil spill than any other oil spill in the world. Some of the other major ones have included the Torrie Canyon, the Hamilton Trader, and the Amoco Cadiz. Murres are an abundant, diving seabird. They counted for over half of all the carcasses. Generally, diving birds are affected by oil more than non-diving birds. As I mentioned, besides the number of birds killed, another important question after an oil spill is did it affect bird populations? We were able to investigate this question in Prince William Sound and some colonies outside the Sound because we had some pre-spill data to make comparisons. Surveys were conducted in Prince William Sound to determine population estimates in summer and winter. By comparing the pre-spill and post-spill numbers for Prince William Sound in the oil spill area and in the non-spill area, we found that several species of marine birds had lower population levels than expected in the spill zone after the spill. Because there were two somewhat different surveys conducted before the oil spill, these results were calculated separately. There was one survey conducted in '72, '73, when you look at that data, in the wintertime both the black oyster catchers and pigeon guillemots showed declines, and in the summertime, cormorants, harlequin duck, black oyster catcher, and northwest crow showed declines. There was a more recent 1984 survey in the Sound, in summer only, using those data, loons, scoters, harlequin ducks, oyster catchers, mewgulls, and arctic terns all showed population level declines in the oiled area. Outside Prince William Sound, the only population data was that of colonial nesting seabirds. Data from the Barren Islands showed that post-spill counts of murres were lower than the pre-spill counts. Now, we'll look at the effects on reproduction. Bald eagles had lower reproductive sets in the oiled area than in the un-oiled area in 1989. Black oyster catchers had lower production in the oiled area in 1989 and in areas of oil spill clean-up in 1990. Harlequin ducks had lower reproductive success in the oiled area than in the un-oiled area since the oil spill. Kittiwakes had lower reproductive success in the oiled area than in the un-oiled area compared to pre-spill data, and murres had lower reproductive success after the oil spill. Before I get into the status of recovery, I want to present some data that may or may not be related to the spill but certainly may affect recovery of several hundred species. Because we had this pre-spill data in 1972, we have population estimates for birds in Prince William Sound in 1972. Those population estimates were about 600,000. Now, the population estimates for the Sound are about 300,000. That's a 50 percent decline. However, not all species declined. Most species that did decline were those that feed on forage fish, including marbled murrelets, puffins, pigeon guillemots, kittiwakes, glaucous-winged gulls and arctic terns, and also, as you've heard, harbor seals, which also feed on forage fish, have declined in the Sound before and after the spill. Conversely, birds and mammals species that rely on intertidal or subtidal benthic invertebrates for food did not decline from 1972 to after the spill. These species include harlequin ducks, golden eyes, black oyster catchers, old squaw (ph), scott (ph), bufflehead duck, northwest crow and sea otters. So, of course, the question is why have these species declined and was it the oil spill? Probably not, because we've data from 1984 that indicated that several of these declines have already occurred. The most obvious connection between these declining species is that they are fish eaters, and it makes one wonder, of course, if lack of food was a cause for the decline. We'll probably never know what caused these declines, but if injured species are limited by food, then they may have little or no chance of recovery. Data on kittiwakes productivity collected by the U.S. Fish & Wildlife Service and the damaged assessment study also suggest that food resources may be declining in Prince William Sound. Prior to the oil spill, kittiwakes in the Sound had consistent productivity of a .3 chicks fledged per nest, but in 1989 -- this is just total Prince William Sound -- in 1989 the oiled colonies had their worst year and the unoiled had their best year, so the total remained high. After 1989, the productivity declined. 1993 was similar to 1992, very low productivity. For kittiwakes, you can use brood size at fledging as an index of food availability. Looking at brood size at fledging, again from 1984 to '89, it was consistently high. In 1990, '91, 92, it dropped down, and again in '93 it was low again. So, we have 10 years of data from kittiwakes that suggests that food has declined in Prince William Sound, and also the data on species decline from '72 are suggestive that food may have had a role in those declines. So, let's look at a recovery of our species now. None of the species that showed population declines have recovered. For the species that have showed declines in productivity, bald eagles and black oyster catchers appear to be back to normal. Kittiwakes and harlequins have not recovered. While looking for the recovery of an injured species in conducting the marine bird surveys, we found that golden eyes and a sea duck species that was not previously listed as injured as showing signs of oil spill effects four years later. Some of our gaps in knowledge, we do not know why kittiwakes reproduction success declined after the spill or the reasons that other species are not recovering. They may or may not be spill related. We don't know, but there is information on this large-scale food limitation. Other gaps in our knowledge are on potential oil spill effects that were not found, either because we did not have enough pre-spill data to show the effects, or because we chose not to study them. An example of the first case is the marine bird surveys. We have only one survey in 1972 and one in 1984. Had there been surveys done, say, every other year since 1972, we would have had a much better data set to demonstrate changes or effects by the oil spill. An example of not studying a species could be arctic terns or puffins, because we had no pre-spill data on their productivity in the Sound, we chose not to study them. Direction of future work -- I think the injured species should be re-evaluated at this time to determine that important injured and potentially injured species are studied to determine when and if recovery occurs. In light of the information that suggests food may be limiting the recovery of several injured species, the food limitation hypothesis should be investigated. To the extent that oil seems to still be in the intertidal and subtidal sediments, invertebrates that are prey for birds should continue to be monitored for hydrocarbons. In summary, we are limited to showing oil spill effects by lack of pre-spill data. Several bird species were impacted and most have not recovered, and recovery may be limited by lack of food. Thank you.

(Applause)

DR. SPIES: I want to thank all the speakers for their very nice summaries of the current status of the resources, and I'll not attempt to summarize in any general way or make any general comments except just to thank them and to reiterate the direction of the scientific program now that I think you've seen that we're really headed into a rubric of restoration science in which we're trying to place these injured species and to understand the ecosystem, and I think to the extent that the Trustees are committed to a scientific program to benefit the resources, that this probably the most productive way that we can proceed at this point. I'd like to turn the program back over to Jim Ayers, the executive director.

MR. AYERS: Thank you, Dr. Spies. In wrapping up today's forum, I'd like to introduce a person who I've known for probably 12-13 years, who has traipsed around the various streams . . . (break in tape recording)

(Applause)

MR. STEVEN PENNOYER: Thank you. I thank Jim. Thirty-five years sounds like a long time, but we'll go on from here. Actually, I had a couple of observations before I started. First is, this last time I get trapped into a presentation without view graphs and slides. I was very impressed with the quality of the presentations from our scientists, and I feel somewhat embarrassed to be talking about generalities and concepts after all that rather specific data that you've received. Second is that one of the advantages to going last is you get the final word. One of the disadvantages is you can't select ahead time entirely what's going to be presented before you get there. So, I'm going to have to ask for your forbearance in shuffling through some of the papers here and avoiding any egregious redundancies that I can do. I'd begin to set the stage for the topic of where we go from here with a fairly detailed review of where we have been, but I think you've had that. I don't intend to go back in history, except maybe to make a couple of points for emphasis. I think also the presenters have talked to you about where we go from here in each one of their specialties, and I will try to build in some of the things they've said.

The observations of Kathy Frost in a general way, for example, told some of the things we haven't done and need to do, and some of the obligations I think we have to the future. I would like to re-emphasize a couple of points on history, and Kathy and others brought these out, and that's our preparedness to deal with an ecological disaster of this magnitude in terms of damage assessment and restoration. Frankly, we weren't. We knew that the physical and biological resources likely to be exposed to the spill fell into the jurisdiction of several different state and federal agencies. We knew that some of them would have differing responsibilities in regard to that spill, but we had no game plan. There was no pre-agreement on how this should be accomplished, damage assessment, or which agencies would be responsible for what. At the time of the spill there was not an adequate, shared inventory of existing pre-spill background information. In fact, there wasn't pre-spill background information on any of the resources, as you've heard today. We had no idea at that time how far the oil would ultimately spread and which portions of the ecosystem would be affected. We didn't have initially the adequate, predictive models to assess what should have been studied. I think many agencies diverted resources from ongoing programs and projects and immediately sent personnel to start evaluating what needed to be done. There was no Trustee Council, there wasn't a plan for one at that time or a formula, there were no interagency coordinating groups for damage assessment, and there was shared database. I think it's a credit to the scientists involved the program that it came together in the way it did. I think from the presentations you've seen today, that despite all the obstacles a credible effort was mounted. NOAA and other state and federal agencies did respond, were told to proceed to get the job done, were given the authority to go out and do battle with the spill. The first step, of course, was damage assessment. Over the next three years, 50-65 projects a year, involving a very large number of scientists that you've heard something about here today went out and did the work on the spill, often without special dispensation in terms of budgets, often dropping their existing work and having to work around what they would normally do. The damage assessment would lead to litigation and get at potentially responsible parties to reimburse, first, the citizens of our country for the damages. I won't go into any detail on the settlement and the financial arrangements, I think they are outlined in some of the brochures that have been handed out today. I think the excellent status report and the newsletter covered a great deal of that, so I will skip over that part of it.

As you've heard from the studies, some of them were strictly damage assessment in regards to looking at numbers of animals and rates of declines, some provided more insightful information that I think has led us to the point that we're at now. I know that in this process many members of the public and even the scientific community were not always pleased with the speed at which the Trustee Council seemed to be proceeding since the settlement. I think I'd like to just say briefly that we all take this obligation seriously, and I think we have to keep our decisions in the context of what we can do in the longer term. Many restoration options were available for future funding. They range from direct commitment of the funds for short term or immediate restoration activities or research activities to longer term plans whereby endowments would be set aside to study these resources into the next century, and there were many, many options in between those extremes. We've had choices presented to us, including monitoring the natural recovery of injured resources, many direct restoration options including management support, various enhancement projects for (indiscernible) construction, habitat protection and acquisition, and other choices. We did not want to make these decisions in a vacuum but beginning significant restoration projects into a plan for expenditure of the settlement funds had been achieved. I think you have already been presented in the document and other public documents with the draft restoration plan that was prepared last fall and sent out for public review. That plan currently is under the environmental impact statement study which will be finalized by this fall. The plan, even in draft form, was used to select the '94 work plan, and hopefully the final plan will be used for the '95 work plan and beyond and we will be in the planned mode rather than trying to react to emergencies and specific opportunities we were afraid would be lost. The settlement was finalized in October 1991, late in the third year of the damage assessment effort. We had to end the damage assessment projects and make the transition to restoration, and we had only three months to plan for this eventuality. It was logical for the '92 effort to give priority to the close-out of damage assessment projects, but the Trustees also used that opportunity to initiate restoration in a number of areas, some of those you've heard about already today. The Trustees' activities have entered a new phase. With litigation behind us, the major focus is now on restoration, and I think as also as presented in the brochure and other people's comments, by Jim Ayers, restoration is a menu of activities and strategies. The Trustees have settled on a comprehensive approach, which includes direct restoration, research and monitoring, and habitat acquisition and protection. All three are essential elements of the program that is embodied in that draft Restoration Plan that I commented on earlier. That plan purposely does not prescribe a fixed allocation for each element. We, as Trustees, must exercise our best judgment, taking into account the advice of our scientists, the public, and others to develop proper proportions to ensure recovery. Yes, Bob, we are married to better science, and we will continue to use that science. Direct restoration projects are probably the most difficult to design, however the Trustees will certainly continue to support direct restoration when projects are found to be cost effective and aiding the recovery of injured resources. One area of direct restoration that is especially appealing to me is to provide the research funding necessary to support improved systems of management of natural resources by state and federal agencies. I think perhaps in the long term, this may have some of the longest lasting benefits for the citizens of the spill area and the United States, and the fact is, you heard particularly Phil Mundy's presentation, such studies providing the background for better management of sockeye in Cook Inlet -- pink salmon enhanced natural runs in Prince William Sound are occurring and they will continue. Much of the early research and monitoring focused on individual species, and I think you've heard several of those discussions today. We are now in the next stage to review and synthesize previous data and obtain new information with the goal of understanding the underlying environmental factors which influence survival and reproduction of these injured resources. The 1994 ecosystem based investigation will begin for the first time in Prince William Sound -- I probably shouldn't put it that way because I think some of our studies have been ecosystem based if we were to step back and define that term, and I perhaps would like to have spent more a longer time talking to George Rose and Phil and others about what we mean by the word "ecosystem." We have studied species as they relate to each other. We haven't, perhaps, taken all of the environmental, potential impacts into account, and we haven't looked at a broad complex of resources as much as we might. The development of ecosystem studies and a broader base than we have done to date is an exciting development from my perspective because rather than simply measuring rate of decline, I think we're going to try and get more at why resources may continue to decline or remain depressed.

I want to pay a special tribute to the folks in Cordova, both the agencies and the people of Cordova put in a lot of extra time on the current ecosystem-related project the Trustee Council, I think, will approve today -- sign into a court order today. We did approve it; we haven't sent the request to the court. I think we're going to sign that today. I think this type of ecosystem approach holds dramatic promise for influencing agencies' regulation of controllable factors, such as harvest or fish stock relative to recovery or enhancement of these injured species. This will be accomplished by putting into perspective the causes for fluctuations in those species. It is the Trustee Council's intent to move more toward an ecosystem approach with all the resources of Trustee agency concern both inside and outside the Sound, and, again, in general, I just mean a broadening of the approach taken in the research, looking more at interactions. I don't prescribe at this time to say how deeply an ecosystem study would go or, in total, what would be involved in different areas. The Trustee Council is also moving ahead with habitat protection. Last year the Trustee Council purchased in-holdings in Kachemak Bay State Park and also purchased lands in the Seal Bay in Kodiak in order to protect critical habitat. In these cases, they were judged to be imminently threatened habitat through various activities and habitat that was important to the protection and the restoration of injured resources. We are, however, continuing to pursue habitat acquisition strategy, and we are looking at other high value land parcels in Prince William Sound, the Kenai Peninsula, and the Kodiak-Afognak Archipelago. The Executive Director has been instructed to go forward with a general appraisal of these lands and the priorities for their acquisition so that we can look on it as a package for the Trustee Council. Another area of concern has been the development and coordination of a repository for Trustee Council data sets which will be used by other scientists and the public. The key areas of the discussion relative to the improved University of Alaska Institute of Marine Science's facility in Seward has to do with this level coordination for all *Exxon Valdez* oil spill resource and monitoring results. We are also interested in our obtaining, I think, meaningful increases in public involvement. I think as George Rose said today, that is a key element in planning any long-range strategy to deal with the restoration of resources in the spill area. As I understand it, the Executive Director has under consideration the formation of a newsletter and a proposed annual report of which this forum is really a key element. Additionally, further on, agency participation in research and monitoring is being emphasized by the Executive Director and has been increased in the 1994 work plan. In addition, as I think you've heard elsewhere, the Trustees have set aside $12 million into a form of reserve account for future research and monitoring activities. I think there's a growing understanding that injured resources and need to deal with them and restore them is going to continue into the next century, whether some of us are here to witness it not, that -- well, I hope we're here to witness it, I'm not sure we'll be doing this exact same thing. The Council will consider as part of their final Restoration Plan at what level such an account should be capitalized. We haven't done that yet, and I think we need to plan to do that type of plan. We need to know what we want to accomplish with it. The Trustee Council has appointed an executive director, Jim Ayers, who you've met today, with a permanent staff, and I think this is a major step in moving this process forward. The Executive Director is establishing an organizational structure to guide development of the annual work plans consistent with the Trustee Council directive that we start to take an ecosystem approach -- or expand on an ecosystem approach, I should say. The organizational plan will also include a proposal to establish an independent and highly credible science review board. This will make science-based recommendations to the Executive Director and the Trustee Council. This is not taking away in any way what Bob Spies has done with peer reviewers, but I think we're going to formalize the process perhaps even more than it has been. The Executive Director is also moving forward with fleshing out the draft Restoration Plan. The draft is a draft; it is not in detail relative to specific resources or specific strategies, and the Executive Director, working with our scientific staff and the public, will be fleshing that out. That will provide better guidance for decision-making for the Trustee Council on the 1995 and future work plans. I hope by the time we do the '95 work plan, we're dealing with a fleshed-out Restoration Plan and aren't trying to play catch-up at all. The development of a long-term science plan, I think, is also required, to include monitoring and direct restoration research, as well as ecosystem research, and I think, in combination with the Chief Scientist, peer reviewers, and our agency scientists, and the public, that can be accomplished.

I think this has been somewhat of a simplified overview of what has been a complex, arduous, and often argumentative process. We've got a very short time here today to do all the aspects of it, and I've been charged with, I think, to try to summarize it. As we've worked within this complex environment, there have been a number of issues that have surfaced and raised questions that I hope we have or are in the process of answering. I don't believe the state and federal natural resource management agencies were prepared to undertake damage assessment and restoration activities of an environmental disaster of this magnitude in Alaska. I think we have to put that at the forefront of our study and use of the information we're collecting. As I said before, I think the response was confused at the start -- I mean in damage assessment -- but ended up remarkably well coordinated, largely due to the quality and caliber of a number of our scientists that were involved in this process and the assistance we received from the public. I believe the critical job of damage assessment was done, and I hope we are well on the way to our finalizing the restoration program. But I believe a significant legacy of this effort should be a manual -- for want of a better word -- on how to respond from a damage assessment and restoration perspective to events of this nature in Alaska, so that none of us will ever be caught unprepared again. Clearly, the formation of the organizational structure and process needed to move the work of restoration forward and marry together the input from the Trustee agencies for the various resources, the public, and scientific advice has been easy. I think all of that needs to go into this "manual" or summary of what we need to do in the future. In essence, I think a book on the spill needs to be created. It would deal not just with specific data reporting, but more with the process and priorities for research and restoration that we will face again if we have to face this again. There are number of parts of this being worked on. Kathy mentioned some of them, others have, and I think it needs to be finalized. I don't think it's complete yet. When I reflect on all that has happened since the spill, I hope the long-term benefits will be gained from the massive effort. We want the northern Gulf of Alaska ecosystem to be healthy and productive so the region's people and wildlife can thrive in a pristine environment. To help realize this goal, the Trustee Council will continue to take positive actions to restore, protect, and monitor the natural resources injured by the spill. There is little doubt that the oil spill in Prince William Sound created a major ecological disaster. Many species of fish, seabirds, marine mammals, and invertebrates, as you heard, were affected by the spill. I learned today, and I think I do every time I come to one of these forums, more information about what those injuries may have been and may continue to be. The spill injured not only fish and wildlife populations and their habitats, but also human use of the affected areas. There was a special social and economic disaster for people in fishing communities and Native villages throughout the spill area because, as has been pointed out, those communities depend on a healthy ecosystem to derive their livelihoods from. The people in the spill area feel the effects of the spill to this day. As I reported in the newsletter, five years later many of the resources in Prince William Sound and other areas of the Gulf of Alaska are recovering. However, others are not, and the effects of the spill persist. An additional effect, of course, is the feeling that a special, unspoiled place was damaged and it could potentially be damaged again. Hopefully, the program we are putting together will help to strengthen our ability to respond to those concerns.

Perhaps I'll leave you with a quote from the brochure that was passed out to, and I suggest if you have it -- (aside comment) and that particularly is the mission statement. The mission of the Trustee Council and all participation in Council efforts is to efficiently restore the environment injured by the *Exxon Valdez* oil spill to healthy, productive, world renowned ecosystem, by taking into account the importance of quality of life and the need for viable opportunities to establish and sustain a reasonable standard of living. I hope this forum will help you to evaluate our progress toward accomplishing this goal, but I suspect it will be at a similar forum sometime in the future before the judgment can realistically be made, and I think I'll leave you with a quote, again from the document, at some future anniversary of this spill, people can walk the beaches and find no fresh oil, and the health of the ecosystem has been fully restored, and all Americans can truly celebrate the close of this unfortunate chapter of Alaskan history. Thank you.

(Applause)

MR. AYERS: Thank you very much. This has been our effort to continue to expand public participation in the Exxon Valdez Oil Spill Trustee Council efforts. We are continuing to do the newsletter. There will be an annual forum and status report, and the public participation, not just with public advisory group, but also in the planning efforts, is something that we intend to also expand. If you have ideas of how you'd like to become more involved, or a particular aspect of the presentation that you would like to have more detailed information on, if you will let us know, we will be happy to get that to you, at least to the best of our ability. I want to thank Molly McCammon and L.J. and Bruce and Sandy Rabinowitch and a number of staff people who really helped pull this together on such a short notice, and I really appreciate their efforts in making this come off so quickly and so efficiently. Thank you very much. (Applause) And, once again, I want to thank the scientists who have all traveled kind of shorter notice, rearranged schedules to make sure that they were here to interact with you, and for the next two hours we're available any and all aspects of the spill or baseball that you'd like to discuss out in the lobby. Thank you again.

END OF PROCEEDINGS

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CERTIFICATE

STATE OF ALASKA)
) ss.
THIRD JUDICIAL DISTRICT)

I, Linda J. Durr, a notary public in and for the State of Alaska and a Certified Professional Legal Secretary, do hereby certify:

That the foregoing pages numbered 04 through 104 contain a full, true, and correct excerpted transcript of the Exxon Valdez Oil Spill Public Forum -- Five Years Later: What Have We Learned? -- that the transcript is a true and correct transcript requested to be transcribed and thereafter transcribed by me to the best of my knowledge and ability from the electronic recording provided to me by the Exxon Valdez Oil Spill Information Office.

That I am not an employee, attorney or party interested in any way in the proceedings.

DATED at Anchorage, Alaska, this 25th day of April, 1994.

Linda J. Durr, Certified PLS
Notary Public for Alaska
My commission expires: 10/19/97