S. HRG. 104–291

SALMON SPILL POLICY ON THE COLUMBIA AND SNAKE RIVERS

HEARING

BEFORE THE

SUBCOMMITTEE ON
DRINKING WATER, FISHERIES, AND WILDLIFE

OF THE

COMMITTEE ON
ENVIRONMENT AND PUBLIC WORKS
UNITED STATES SENATE

ONE HUNDRED FOURTH CONGRESS

FIRST SESSION

JUNE 22, 1995

Printed for the use of the Committee on Environment and Public Works

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SALMON SPILL POLICY ON THE COLUMBIA AND SNAKE RIVERS

THURSDAY, JUNE 22, 1995

U.S. SENATE,
COMMITTEE ON ENVIRONMENT AND PUBLIC WORKS,
SUBCOMMITTEE ON DRINKING WATER,
FISHERIES AND WILDLIFE,
Washington, DC.

The subcommittee met, pursuant to recess, at 10:02 a.m. in room 406, Senate Dirksen Building, Hon. Dirk Kempthorne [chairman of the subcommittee] presiding.

Present: Senator Kempthorne.

OPENING STATEMENT OF HON. DIRK KEMPTHORNE, U.S. SENATOR FROM THE STATE OF IDAHO

Senator KEMPTHORNE. Ladies and gentlemen, I'll call this meeting to order.

A little more than 2 weeks ago, this subcommittee held our first field hearings in Roseburg, OR and Lewiston, ID. At those hearings, we had a combined attendance of about 2,000 people; in fact, it exceeded 2,000 people. We wanted to hear from people whose lives had actually been affected by the Endangered Species Act, both positive and negative. We had a good, balanced hearing which centered on the efforts of the National Marine Fisheries Service and the Corps of Engineers to restore chinook and sockeye salmon runs in the Columbia Basin.

One method used by NMFS to pass young salmon, called smolts, over the dams is to spill the smolts over the dams rather than either pass them through the turbines for generating electricity, or physically to collect the smolts and transfer them through a bypass system. When water is spilled over a dam, gases in the air become dissolved in the water. Depending on the percentage of the saturation of those gases in the water, fish can get a diseases called the Gas Bubble Trauma, or GBT, which is similar to the bends which scuba divers can get if they surface too quickly after a dive.

This morning's hearing will focus on how the National Marine Fisheries Service and the Corps of Engineers chose this particular scientific policy under the Endangered Species Act. NMFS chose this scientific policy in order to increase survival of young, endangered chinook and sockeye salmon, but I believe that this policy was hastily conceived without sufficient safeguards provided in the scientific method; and that as a result, we may be continuing to endanger the very species that we want to protect.

Last year, in a subcommittee hearing on the Endangered Species Act, Dr. Nancy Foster, who is the Deputy Assistant Administrator for Fisheries at NMFS, said, if we weren't experimenting with spilling water over the dams causing damage to the species we were trying to protect as well as other species, and that, "If it were a perfect world. . . ," NMFS would have studied effects of spill ahead of time. I think it is a reasonable question how, in the absence of science, this type of experimentation with endangered species could take place.

There are many, very complex issues involved in restoring the Columbia and Snake River salmon to healthy populations. Let me state here for the record that I am committed to the full restoration of salmon in Idaho and the Columbia River Basin, but it seems to me that we have to get on with practical solutions to enhance and restore these salmon runs. Without practical solutions, the only thing we will end up enhancing is the salmon recovery industry.

The effort to recover the salmon in the Columbia Basin can act as a guide as we move forward to reform the Endangered Species Act. This subcommittee today is interested many aspects of this hearing:

1. How can we get the best scientific information;
2. How can we be sure that scientific information is put through meaningful peer review;
3. Will good science be communicated to the policymakers in the proper agencies;
4. As new information is made available, can we be sure that those policies can be modified; and
5. How can we judge the results of recovery plans based on that scientific information?

In the interest of finding out how the policy is influenced by the science, I'm going to reverse the usual process today. I'm going to ask the panel of scientists to describe the current state of knowledge on the issue of spills and its effects. Then I'll turn to the Federal and State agency panel to hear how they have formulated and/or revised public policy. I'll ask each of our members of the panel to keep your comments to 5 minutes in your opening comments. Your entire statement will be entered into the record. After each panel has finished its opening comments, I will allow time for questions and answers before moving to the next panel.

With that, if our scientific panel would please come forward. Let me identify the members of that first panel: Larry Fidler with the Aspen Sciences Limited, Cranbuck, British Columbia; Wesley Ebel, biologist, Seattle, WA; Gerald Bouck, biologist, Portland, OR; Margaret Filardo, with the Fish Passage Center, Portland, OR; Phillip Mundy, with the Fisheries and Aquatic Services, Lake Oswego, OR; and James Jay Anderson, University of Washington, Seattle, WA.

With that, if we are ready, Mr. Fidler, if you would like to begin. I might mention, we will use these lights just as an indicator to help us stay on course. The green light is proceed and you'll see the yellow light come on saying you are down to about 30 or 45 seconds and then the red light. At that point, I would ask that you conclude, but again, we're going to have an opportunity for the questions and answers to really go into greater detail than what

you may feel you're covering in your opening comments and your formal opening statements will be made a part of the record.

With that, let me call on Mr. Fidler.

STATEMENT OF LARRY FIDLER, ASPEN SCIENCES LIMITED, CRANBUCK, BRITISH COLUMBIA

Mr. FIDLER. Thank you, Senator.

This morning, I would like to review two of the main topics I discussed in my written testimony. The first item is the question of are benefits of spill as a fish passage mechanism established, especially in relationship to other fish passage mechanisms? My response to that is I do not believe that is the case for the following reasons.

In the NMFS' biological opinion, NMFS failed to present a quantitative, comparative analysis of the various fish passage mechanisms. This is especially true in the case of spill and the effects of dissolved gas supersaturation and gas bubble trauma in fish. Without such a comparative analysis, it is impossible to establish which is the best mechanism or combination of mechanisms for survival.

Second, in the spill in 1995 risk assessment document, the State and tribal agencies present data to demonstrate that spill is the best fish passage mechanism. However, as I pointed out in my written testimony, much of that data is highly inconsistent and fails to support that hypothesis. Furthermore, the so-called risk assessment analysis performed in that spill in the 1995 risk management document, the analyses were severely criticized by NMFS scientists, by scientists with the Oregon Department of Environmental Quality and by independent scientists. The methods used in the analysis of gas bubble trauma were flawed to the extent that the results were invalid.

I would suggest that if the National Marine Fisheries Service had used their 1994 expert panel on dissolved gas supersaturation to review both the biological opinion and the spill and 1995 risk management document, a more scientifically defensible spill program could have been developed.

The second area I would like to discuss is the 1995 Biological Monitoring Program. You have no doubt read and you will probably hear today that this is a fine program. I would suggest this is not the case. Before describing my reasons for this, I am reminded of something I heard earlier this year.

On April 14, 1995, the Oregon Department of Environmental Quality held hearings to review the application by NMFS for a variance to the Oregon State standard for dissolved gas supersaturation. At that hearing, one of the commissioners made the observation that in his view, the 1995 Biological Monitoring Program had been designed specifically to avoid find signs of gas bubble trauma in fish.

Senator KEMPTHORNE. Would you repeat that?

Mr. FIDLER. Yes. One of the commissioners—I'm paraphrasing here—indicated that it appeared to him that the 1995 Biological Monitoring Program was specifically designed to avoid finding signs of gas bubble trauma in fish. After the program proceeded, I believe that observation is verified for these reasons.

In 1994, fish were examined for the presence of bubbles in gill lamella and lateral lines. In June 1994, on certain days, up to 80 percent of the fish sampled had bubbles in gill lamella and up to 50 percent of the fish sampled had bubbles in the lateral line. Yet, in 1995, no signs of gas bubble trauma are being reported. Yet, the dissolved gas levels in 1995 are substantially higher than they were in 1994. In the NMFS net pen studies below Ice Harbor, in 1995 the levels of mortality are much higher than they were in 1994. So the question is, why do we see this discrepancy in data.

I believe there are a number of reasons. One is that in 1994 in examining the fish for signs of gas bubble trauma, they used 90- to 100-power microscopes; in 1995, they are using 10-power magnification to look for these signs. Until only recently, no examination for bubbles in gill lamella were being conducted.

As early as July 1994, the problem of high hydrostatic pressures in the bypass system causing the collapse of bubbles before fish are collected for examination was identified. This problem was later validated through experiments at Battelle Pacific Northwest Laboratories. Yet, even to this day, the smolt bypass systems continue to be used as the primary source of fish for assessing the impact of gas bubble trauma.

I think there is a serious credibility problem with the Smolt Monitoring Program, but I also think there is a more fundamental problem and that is in 1995, the program has been designed without an understanding of how fish are distributed in the Columbia and Snake Rivers in relation to dissolved gas levels, the periods of exposure and potential for mortality. As a result, the present program is an unfocused collection of attempts by various agencies to sample fish without an understanding of the appropriate locations and conditions under which to assess the impacts of dissolved gas supersaturation on Columbia and Snake River salmon runs.

Finally, I believe if the NMFS expert panel on Dissolved Gas Supersaturation had been directly involved in the design of the monitoring program, we would have had a much more viable program than we presently have.

Thank you.

Senator KEMPTHORNE. Thank you very much. I appreciate your testimony.

I'd like to now call on Mr. Wesley Ebel. Welcome.

STATEMENT OF WESLEY EBEL, BIOLOGIST, SEATTLE, WA

Mr. EBEL. Thank you.

I'd like to address my comments again to question No. 1 and a little bit on question No. 5.

The benefits of using controlled levels of spill as a fish passage mechanism are established if there is no other alternative than passage through turbines. Available research indicates that juvenile salmon will survive at a significantly higher rate passing over a spillway than through turbines at the Columbia River Dam. Thus, spilling water at dams where fish are not collected and transported or where juvenile bypasses are inadequate does have some scientific validity as long as spill volumes are held at levels that do not cause excessive mortality from gas bubble trauma.

The benefits of spill are not established in relation to smolt transportation. To the contrary, the best available data indicates that survival of fish collected and transported is greater than in-river survival of migrants even during periods of high flow and spill. Since 1968, over 29 tests were conducted to evaluate the effects of transporting juvenile spring, summer, fall chinook and steelhead. In these tests, marked groups of fish released in the river as controls and transported by barge or truck were enumerated when they returned as adults to the fishery and to the dam and sometimes to the spawning grounds when sufficient numbers were marked.

All but two of these tests showed a benefit from transportation. In other words, transported fish returned at a significantly higher rate than fish released in the river. Two tests that didn't show a benefit indicated no significant difference. In other words, it didn't matter whether you transported them or left them in the river; the survival was the same.

Unfortunately, since 1983, there have been only 2 years, 1986 and 1989 when both transport and control leases were marked for proper evaluation of the transport operation. During the remainder of the years, no fish were marked or only transport groups were marked, making comparisons with in-river migrants impossible most years.

However, the research results available today nevertheless demonstrates unequivocally that transport of chinook and steelhead from the Snake River Dams benefits salmon and steelhead more than it does river migration. I have seen no convincing scientific studies that indicate spilling at Lower Granite and Little Goose Dams or McNary Dam is better than collecting and transporting fish from these up-river dams. State and tribal fishery agencies have attacked transportation research but I believe their criticisms lack merit.

In regard to how we can improve the decisionmaking process, I believe the decisionmaking process can be improved by continuing to properly evaluate actions taken to increase adult returns of salmon and steelhead on the Columbia River. Key studies are those designed to evaluate transportation and in-river survival of juvenile migrants under various flow and spill scenarios. If the proper studies had been continued through the 1980's and 1990's, as the National Marine Fisheries Service proposed, we wouldn't be here today testifying before this committee. I think we'd have enough information to make decisions that people couldn't argue with.

NMFS proposed continued evaluation of transportation and in-river survival of juvenile migrants during the 1980's and 1990's but these proposals were rejected by the various committees that must approve research proposals on the Columbia River. Those committees are dominated by State fishery agencies and tribes, and some of the same people who are severely criticizing the transportation operation now are the same ones that rejected the research proposals in the 1980's and 1990's to evaluate transportation and to conduct in-river survival estimates.

I believe if we're going to spend millions on various activities to increase survival of the fish in the river, we ought to spend a few bucks on properly evaluating what we're doing.

Senator KEMPTHORNE. Thank you very much. I appreciate your testimony.

I'd like to now call on Mr. Gerald Bouck. Welcome.

STATEMENT OF GERALD BOUCK, BIOLOGIST, PORTLAND, OR

Mr. BOUCK. Thank you, sir.

First, I'd like to mention that my comments are critical of some processes, but I don't direct those at any of the people.

Senator KEMPTHORNE. I understand that and I appreciate that. We're just trying to figure out the best process and the science that is there.

Mr. BOUCK. I guess the bottom line question here is: is spill helping the salmon? For me, this is deja vu all over again. We went through this in the 1960's and 1970's and I thought the gas supersaturation problem was over; now we're back at it again with the spill and the gas supersaturation problems still on the Columbia River.

Is the spill helping the salmon? I don't think so. I agree with the Snake River Salmon Recovery Team that the spill is probably hurting more than it helps. It's critical to appreciate that the basic benefit of spill is really quite small, so it's very easy to negate it. This benefit critically assumes that there is really no problem from gas bubble disease. A lot of that assumption is based on the idea that fish will dive and thus avoid the supersaturation problem. In fact, it has been shown that avoidance by fish does occur sometimes in the laboratory but there's no evidence that it actually works in the wild. Conversely, there are numerous reports in the literature that show supersaturation fish after fish kill in lakes, rivers, streams and estuaries where the fish had plenty of depth that they could dive to safety but for one reason or another, did not. So I have to say at the least, avoidance behavior is very unreliable and probably unsafe.

You might ask why don't we see dying fish in the river if we really have a gas problem? Well, we have a lot of predators there. If you're going to see dying fish in the river, first you have to fill up all those predators and they have a lot of consumptive capacity. If you want to see dead fish, you've got to keep the predators out of the picture by putting the test fish in a cage, and when you do that, you find dead fish in supersaturated river water.

At any rate, the next thing I would address is how are NMFS and the National Biological Service performing in this issue? Larry has already pointed out that the reported incidence of gas bubble disease is down this year but I'm very concerned that this reflects a change in investigative procedures. Besides, they are only looking at the survivors and once a fish is eaten and digested, it is no longer in the population anymore.

I think that a problem exists with the way NMFS and NBS are doing things. I gave NMFS some constructive recommendations and not long thereafter was told I wasn't welcome on the National Marine Fisheries Service boats. The National Biological Service basically followed suit and thereafter declined to collaborate or cooperate with us. At present, NMFS and NBS have kind of an iron curtain around them. Their refusal to cooperate or collaborate with the private sector, I think, is extremely unfortunate because it is

depriving the public of additional data that could be obtained at no cost to the Government just by working together.

So what will help the salmon? I think good science has nothing to fear from peer review. It prevents mistakes before they happen in most cases. I'm sure you're aware that the Northwest is spending something in the neighborhood of $400 million a year on salmon, depending on how you calculate it and that we spent in the neighborhood of over a billion dollars in the last 10 years. And yet, we have almost no progress to show for that expenditure. I was associated with the Columbia River Basin Fish and Wildlife Program, I funded an awful lot of those projects, and as I said, it's just awful hard to see any progress out there.

Something needs to change and it needs to change drastically. I think the most important thing is to open up this currently "closed shop" and let some sunshine in. I'd let the universities and the private sector participate, particularly by providing peer review which can help make lemonade out of the fishery agencies' lemons.

Finally, we need a new spirit of cooperation and collaboration without which we'll just simply have more polarization and less progress.

Thank you.

Senator KEMPTHORNE. Thank you very much.

Now we have Ms. Margaret Filardo. Welcome.

STATEMENT OF MARGARET FILARDO, FISH PASSAGE CENTER, PORTLAND, OR

Ms. FILARDO. Thank you, Senator, for inviting me today to speak to this committee.

I have worked for the past 8 years as a biologist for the Fish Passage Center in Portland, Oregon. The Fish Passage Center was established in 1984 by the Northwest Power Planning Council. The Fish Passage Center staff consists of individuals with expertise in biology, biostatistics, hydrology and data management. We are responsible, in part, for the annual implementation of the Smolt Monitoring Program as well as collecting and distributing data to all interested individuals. The Smolt Monitoring Program monitors juvenile salmon in the Snake and Columbia River systems of seven dams and five tributary traps. Information is collected relative to the overall species abundance and health and timing of the migration for in-season management of flow, spill and hydrosystem operations. Since 1994, the Smolt Monitoring Program has been an integral part of the overall biological monitoring program developed by the National Marine Fisheries Service for spill implementation under the biological opinion.

Our responses to the questions posed to me by the subcommittee are contained in my written testimony. In the next few minutes, I would like to take this opportunity to make three specific points.

First, spill as a mitigation measure is not a new concept. Second, the risk associated with the spill program have been analyzed and incorporated into the development of the present controlled spill program. I'd like to make that distinction between the controlled fish spill program and other spill that is occurring in the system.

I am confident that the present monitoring program is accurately assessing the occurrence of total dissolved gas and will provide

early indication of developing signs of gas bubble trauma. I'd like to elaborate on these points.

Spill for fish passage is not a new concept; it has been the long-standing goal of the natural resource agencies and Indian tribes to provide a safe passage route for fish passing a hydroelectric project. The goal of the agencies and tribes has been to achieve nonturbine passage routes for 80 percent of the fish passing a dam. Spill has long been considered a viable method of project passage; numerous studies have consistently shown that it is the safest route of passage past a dam.

In the early to mid-1980's, the provision of spill was compatible with the operation of the hydro systems since there was an energy surplus and power operators had excess water. As the region shifted from the energy surplus, the issue of spill became more problematic. Spill is presently being implemented according to the National Marine Fisheries Service Biological Opinion for 1995 with specific restrictions on spill levels imposed by the State limits for total dissolved gas. I'd like to point out that the volume of spill called for through the biological opinion is actually substantially less and has occurred in some past years.

The National Marine Fisheries Service has made every effort to obtain and consider input from diverse organizations in development of the 1995 biological opinion. The steps taken in the development of the spill program represent technical and scientific processes that occurred over several years. The risks associated with spill were analyzed and incorporated into the development of the present spill program.

In the fall of 1994, the agency and tribal resource management team reviewed all of the available literature and studies to develop an assessment of the risks associated with spill. The risk was measured in terms of trading off the benefits to fish by avoiding turbine passage versus the detriments associated with mortality due to increased levels of total dissolved gases. The agencies and tribes concluded that spill is beneficial at levels of total dissolved gas greater than the levels adopted by the National Marine Fisheries Service in the Biological Opinion. The National Marine Fisheries Service chose a more conservative level of total dissolved gas based on their concerns regarding the sublethal effects of gas exposure. I conclude therefore that the NMFS spill policy is both scientifically valid and conservative.

The 1995 Spill Implementation Program includes both physical and biological monitoring programs. The monitoring program currently being implemented is based on the recommendations of the Expert Panel on Dissolved Gas convened by the National Marine Fisheries Services and on recent research results on signs of gas bubble trauma.

Research and monitoring recommended by the State, tribal, Federal and private special interest groups and consultants has been incorporated into the monitoring and research programs for 1995. Individual aspects of the present program are being conducted by State, tribal, Federal scientists and independent consultants. Additional research is being conducted in 1995 which will be reviewed and incorporated into future monitoring programs.

In conclusion, I'd like to leave you with the following points. Spill has been shown to be consistently the safest route of passage past a dam. The controlled spill for fish passage program was developed on the basis of past research and monitoring. It was developed with broad regional input by public and private entities. The spill for fish program was developed using a conservative analysis of the risk and benefits associated with spill and dissolved gas. An extensive research and monitoring program has been implemented to verify the program; a broad range of research and monitoring data is being collected to evaluate the impacts and benefits of the spill program; and all of the information collected will be incorporated into analyses to evaluate the effects of recovery measures on Snake River salmon.

Thank you for this opportunity.

Senator KEMPTHORNE. Thank you very much, Ms. Filardo.

Now we have Mr. Phillip Mundy.

STATEMENT OF PHILLIP MUNDY, FISHERIES AND AQUATIC SERVICES, LAKE OSWEGO, OR

Mr. MUNDY. Good morning, Senator Kempthorne. I appreciate the opportunity to be here today.

To put the spill issue currently before you into perspective, I'd like to point out that nitrogen supersaturation is a phenomenon that occurs extensively in the kinds of waters that salmon occupy. In over 20 years of experience as a salmon biologist working with healthy salmon populations in Alaska, I have never seen or even heard of a fish kill of juvenile salmon that was caused by nitrogen supersaturation. In Alaska, we have monitoring programs that attempt to estimate the number of smolts leaving the major rivers, so I believe if there had been such, we would have seen it. The natural falls and cataracts of the Columbia River system prior to impoundment produced nitrogen supersaturated environments that must have been quite extensive.

In moving into my commentary here, I would like you to bear in mind that you're dealing here and talking about the recovery of a species that has evolved over a period of at least 10 million years to deal with situations in the natural environment and to overcome those. So nitrogen supersaturation is definitely a phenomenon in natural waters.

Mr. Chairman, I believe that the National Marine Fisheries Service has acted prudently in selecting spill as a recovery tool for endangered salmon in the Snake River. As a matter of best professional judgment, spill is the safest way to move juvenile salmon past a hydroelectric project. Spill has been tested in a wide variety of situations and has been found to kill smaller numbers than the turbines and the mechanical bypass systems.

Then why is there so much controversy over the use of spill as a recovery measure for Snake River salmon? It appears that the cost of spill combines with lack of knowledge about what happens to the fish in the reservoirs to create the opportunity for yet another distraction from the central issue of salmon recovery. The central issue of salmon recovery is how to measure survival of juvenile and adult salmon through the hydroelectric system. If spill were not so expensive, I do not believe we'd be here today.

On the other hand, I see no alternative to spill in the near term. In the long term, the most promising alternatives to spill involve an end to electric power generation and transportation of commodities on the lower Snake River, so I think it behooves us to see whether or not we can make spill work.

The benefits of using spill as a juvenile fish passage mechanism are established for a broad variety of localities. However, each hydroelectric dam is different, so the actual benefits achieved will depend on the design of the hydroelectric facility, the species, the life history type, and ambient physical conditions, among other factors.

The benefits of spill are established in relation to the passage mechanisms of turbines and bypass in some localities for some species and life history types. However, the same limitations of time and place apply to these comparisons as described above for the overall benefits of spill as a passage mechanism.

Nitrogen supersaturation definitely poses a risk to migrating salmon and the resident species since prolonged exposure to nitrogen saturation levels above approximately 115 percent at the surface has been demonstrated in the laboratory and in net pens to be lethal to fish. The risk may be negligible or serious depending on the degree to which the distribution of the fish coincides with the distribution of the nitrogen supersaturated waters.

To put nitrogen supersaturation into perspective, I do not regard the risk of mortality for salmon, which are actively migrating through nitrogen supersaturated waters to be as serious as the risk posed by migrating through turbines or bypasses for a number of reasons. First, supersaturation drops off sharply with depth. For example, the potential lethal total dissolved gas level of 140 percent at the surface is reduced to the still potentially lethal but lower level of about 126 percent just below the surface.

Second, migrating adult chinook are known to travel closer to the bottom than to the surface of the reservoirs when they have the opportunity. Third, although juveniles have been observed at all depths in the water column, the majority of juvenile salmon are likely to travel in an average depth of about 10 feet according to one study.

Fourth, if gas bubble trauma is affecting large numbers of juveniles, I would expect to see much higher rates of symptomatic juveniles than the negligible rates observed in 1995. Fifth, although the depths occupied by resident fish depend on factors such as feeding and reproductive behavior, monitoring studies have found few resident fish with gas bubble trauma symptoms.

Sixth, the effects of nitrogen supersaturation on juvenile salmon appear to be reversible since juvenile salmon are frequently reported to recover from the effects of exposure to nitrogen supersaturated water.

In closing, I would like to point out that it is really a stunning indictment of the research system that we've spent so much money and we don't have estimates of survival of juveniles in the hydroelectric system. I would echo the comments of other people who have called for an independent peer review process to guide research. I think we do this in all other areas where we spend very large quantities of public money on research.

Thank you.

Senator KEMPTHORNE. Mr. Mundy, thank you for your comments. Now we have Mr. James J. Anderson.

STATEMENT OF JAMES JAY ANDERSON, UNIVERSITY OF WASHINGTON, SEATTLE, WA

Mr. ANDERSON. Thank you, Senator Kempthorne, for inviting me to offer this testimony.

I'd like to describe to you some of the results from a project that I have been working on for 7 years, the Columbia River Salmon Passage Project. We have developed some models to describe the movements and survival of fish through the hydro system and through their life cycle. This project has been rather extensive. About 20 people are working on it, including undergraduates and graduates. Several Ph.D. theses have come out of this work. We are actively engaged in trying to understand in terms of the mathematics and the underlying data how fish move through the river, and the consequences of the actions we take on the fish.

I want to emphasize today that these are a synthesis of the types of information we have developed over quite a long time. A number of people have been working on this.

One of the things we found is that spill at low levels produces low levels of gas. When you reach a certain level, the system changes and the gas becomes lethal. I believe that fish have adapted to situations in nature where they can handle the levels of gas below this critical level. In the Columbia River, we have the capacity to produce very large levels of gas. I believe our primary concern is to keep the levels lower.

In a sense, it's like walking up a hill; you get a small benefit from spill for low levels of gas. You reach some cliff and if you go beyond that, then you have a real problem. There is a chance that we have gone beyond that this year.

There are several observations that came out of this year's program. One is that we had high gas levels below Ice Harbor, up 130 percent of supersaturation. Another element is we had very high mortalities in pens and fish in pens below the dam up to 100 percent in some cases. In deep cages, they had 50 percent mortality.

Another observation was we saw very few effects of the gas on the fish downstream. How can we explain the high cage studies with the few effects downstream. The model we have allows us to balance these things and interpret both of these in terms of a consistent story. With the model, I could represent the cage studies and show the movements of fish through the river system. With the model, we are able to get the same levels of cage mortality or pen mortality, and then we project downstream. What we find is a very small but negative impact of the spill which means that according to our work, we're probably not affecting fish very much with the current levels of spill. One reason is that the fish are deeper in the water. We assume they are at average depth at 30 feet in which case, you maybe lose in total survival through the system, 1 percent of the fish with the spill in the Snake River.

What concerns me is if the fish are shallower in the water, such as 10 feet, as Mr. Mundy suggests they might be, then the amount of loss you get would go upwards of about 4 percent. The higher

the fish are in the water column, the more dangerous it becomes because the more they are being exposed to it.

These model results tell us that we can explain both the cage studies and the impact on the fish. The fact that we are not seeing many results in the river, we're not seeing a lot of impact on the fish. Of course as Dr. Ebel points out, I believe one of the reasons we're also not seeing a large impact on the fish is because you don't see dead fish. Other things consume them.

The net result of all this analysis is that we probably are not having much of an impact through the spill program. This is the conclusion that the Snake River Recovery Team has also come to. The important result from my concern is that I believe that our analysis to date might be underrepresenting the impacts of spill and we might actually have a much larger impact than we realize.

That concludes my results.

Senator KEMPTHORNE. Dr. Anderson, thank you.

Let me begin with some questions now. Mr. Fidler and Mr. Ebel, I appreciated your comments that you made at the opening. Let me ask you this. In many cases, under the Endangered Species Act we ask scientists like yourselves to provide the policymakers with the options. We also then ask the policymakers to make the best possible decisions based upon what they've been provided by the scientists. My question is, how has this process worked for you? Has your science been considered fully, in your opinion, by the policymakers; have you ever been asked to make any policy decisions? How is the process working and do you feel the science you've recommended is being considered?

Mr. FIDLER. Both Wes and I were members of the NMFS expert panel on dissolved gas supersaturation. The panel came up with a variety of recommendations to assist NMFS in their decisionmaking. Unfortunately, many of the recommendations were not included in the Biological Monitoring Program. The final design of the 1995 Biological Monitoring Program was never submitted to the NMFS expert panel for review. As I said earlier, I believe if that had happened, many of the flaws in that program would have been identified and some corrections could have been made so that it would be a much more viable program. So there seems to be a disconnection between what scientists like myself suggest in such panels and the actual policy that is developed.

Senator KEMPTHORNE. Any insight, Mr. Fidler, as to where that disconnect took place or what caused that?

Mr. FIDLER. I'm not sure. It's very apparent that has happened. I don't know that the problem really lies within organization like NMFS, or why they chose not to take advantage of the broad base of knowledge that is represented by those panels. I think if they had, we would have much better programs.

Senator KEMPTHORNE. I appreciate that.

Mr. Ebel, your comment.

Mr. EBEL. I think they have considered the research. I think the problem is the degree of emphasis that one bit has in relation to another bit of research and whether or not, for example, it's a good idea to spill x amount at Lower Granite or not to spill anything, and whether it is a good idea not to transport fish at all from McNary, for example. I think the agencies and NMFS have consid-

ered the information and they came up with conclusions that not all of the scientists agree with. I can't say that they haven't looked at the science.

Senator KEMPTHORNE. Mr. Bouck, I understand that you served on the NMFS Dissolve Gas Panel.

Mr. BOUCK. I did, but I'm not sure if I still do.

Senator KEMPTHORNE. What has been your experience on that panel?

Mr. BOUCK. I would have preferred that NMFS let us get organized, and attack the problem as we see fit rather than give us parts of the problem to look at. I didn't attend the second meeting. NMFS kept putting it off and they finally just asked me when couldn't I attend and I said during elk season and I'll be darned if they didn't hold the meeting during elk season. I don't know if they were trying to tell me something or not but that's what happened. So I can't say anything about the second one.

Senator KEMPTHORNE. So that goes back to your comment that you had made a series of recommendations and you felt that you were "not welcome" on the NMFS panel?

Mr. BOUCK. Yes. I offered to delay my elk hunting trip and you, coming from Idaho, know what a sacrifice that means.

Senator KEMPTHORNE. A lot of elk would have been happy with that.

[Laughter.]

Mr. BOUCK. I have argued that these kinds of committee functions have to be open, they have to deal with the merits of the issue, that no scientist who is well-qualified and has peer-recognized expertise in the gas bubble disease issue should be excluded as NMFS has done. My opinion was apparently not too well taken but I think that we can do a lot better than we have done.

Senator KEMPTHORNE. You had referenced, Mr. Bouck, the idea of opening up the closed shop and providing for peer review, and Mr. Mundy, you brought up peer review. I'd like to ask all members of this panel about peer review. As we think about the reauthorization of the Endangered Species Act, changes that we may wish to incorporate, how can we get pragmatic so that the scientific community that is willing to serve and provide us science will feel that it is worth their time and effort and that there is meaningful peer review? Can you help us with the nuts and bolts? Mr. Mundy, let's start with you but again, I'd like to hear from all of you on this.

Mr. MUNDY. Senator, I serve on the peer review panel for the Exxon Valdez Oil Spill Trustee Council, which administers fisheries research funding from a trust fund established as a result of the settlement in the Exxon Valdez oil spill. We have 10 years of funding and we get to spend about $100 million a year on salmon recovery in the Prince William Sound and Kodiak areas that were impacted by the Exxon Valdez oil spill.

The peer review process has been around for some time now. In this past year, it's come together quite effectively. An analogous situation occurs in the Columbia Basin, and this is what you're looking for in terms of nuts and bolts, because we have a pot of money that is established that comes out every year; we have Federal and State agencies who are primarily implementing the research with

some private entities involved. But unlike the Columbia Basin, we have a group of independent, privately-contracted peer reviewers and State and Federal agency studies cannot go forward unless they are certified by the peer review body.

This doesn't mean that we tell State and Federal agencies what to do, not at all. We simply ensure that the science is the best that we can find; we ensure that the objectives of the research projects contribute to the established program measures for salmon recovery in the Exxon Valdez oil spill area. So this process, I think, has been very effective. It doesn't keep State and Federal agencies from functioning; we're not a drag or a bottleneck. We simply bring on more people if a bottleneck appears to get the job done.

So I think that a peer review independent of the process that is now going on could very well benefit and give some direction because there are some critical quantities that we should have had by now. We've been spending lots of money. I don't accept $400 million a year for research, I think that's a figment of somebody's imagination. We probably spend maybe $25 million in what I would call hardcore research projects out of all of that. Those are the ones that I relate to measuring the impact of the hydroelectric system on the juvenile salmon.

I think we could focus that research program much better than we have and I think we could get a lot more for our money than we have with an independent peer review process.

Senator KEMPTHORNE. All right. Thank you very much.

Mr. Anderson, your comments.

Mr. ANDERSON. I think the peer review is essential. I also think it is very limited. The reason is because of the volume of information that we have to sift through. There was a peer review of the models a couple of years ago and it did not attain, in my opinion, all that it should have. Someone will come in, an outside scientist, and spend a week or 2 weeks reviewing information. They might end up understanding the basic elements of the system but to really get into peer review, they would have to understand the data and all the intricacies of the data, which means the people who are actually doing the work.

To do that, I thought of the idea of a jury panel where scientists doing the work would present their results in a more formal setting, and then have a jury of peers evaluate that. We, as individuals can point out the strengths and flaws in each other's work and then get those strengths and flaws evaluated by an outside group. It's a way to direct the peers to the essential parts. Right now, we don't have that ability.

Senator KEMPTHORNE. I may come back to you on that.

Ms. Filardo, if you could give us your comments on this meaningful peer review? How do you make it work?

Ms. FILARDO. I would welcome change in the present process whereby programs are developed and implemented and funded. I think the overall region needs a change in what is presently going on, something of the magnitude that Phil is speaking to, the Exxon Valdez peer review committee, elements that he referred to in that overall game plan and elements that Jim Anderson referred to in his game plan as well.

There is difficulty in finding an independent peer review group. Many people are established in the region and have some kind of gain in the region itself. If you take an independent peer review that has no resource management responsibilities, they look at something maybe completely different than a resource management agency with responsibilities would look at it. There may be a way to meld those two processes so you can have the best of both worlds, an independent peer review oversight team and then getting the input possibly from those people that are in the region who have something at stake in terms of resource management.

Senator KEMPTHORNE. We've heard from some of your colleagues that they were serving in a peer review capacity, they were on a panel, but that perhaps their science was not in keeping with perhaps where the policy was going and therefore, we had a disconnect.

Ms. FILARDO. I'd like the opportunity to address that. I'm a technical individual; I come at this from the perspective of monitoring programs and my role in the overall management. I have been involved in a committee that is presently co-chaired by the Environmental Protection Agency and by the National Marine Fisheries Service that has been set up to address the biological monitoring program. In developing our portion of the biological monitoring program, we took into consideration all the implementable information that had been given to us by the oversight team that NMFS convened last year.

The biological monitoring group is co-chaired by EPA and National Marine Fisheries Service. The first couple of meetings were spent just looking at each of the individual elements that had been recommended for near-term implementation and for long-term studies. All of those were addressed to the best of our ability in the program for 1995. I think that the work of the panel has taken into consideration the overall development of the program.

Senator KEMPTHORNE. Thank you.

Mr. Bouck, your views, please. How can we construct peer review so that it works?

Mr. BOUCK. That's a very interesting question. I've been involved in that for a very long time and I think there are plenty of models of how and how not to do peer review and project selection. My involvement in that sort of thing goes back to the old National Institutes of Health and their research review system. In 1983, when I went to work in the Fish and Wildlife Division of the Bonneville Power Administration, I tried to implement a peer review system there, but it wasn't accepted by the fishery agencies. So I would say that one of the very first problems is to get acceptance by the people who are going to be judged. If they won't accept it, and if you're not operating in a context in which those peer judgments have to be addressed somehow or other, then you're wasting your time.

Before I forget it, I'm talking about getting peer review and opening up this relatively closed fishery shop to the private sector and all, but I should point out that I don't have a conflict of interest. I'm not here trying to get money for myself because when I retired, I took the voluntary separation incentive and I can't contract with or work for the Government for another 5 years. So when I say I

really believe they should open things up and get peer review, it's because that has been my experience for a very long time.

I should mention a couple of other problems that I had over the years setting up peer review. First of all, you have to demand real qualifications to get real peers with real expertise; otherwise, review panels get loaded up with policymakers and other people who don't really have adequate qualifications.

A second problem is that you can't operate this very long on volunteers. I can barely imagine how busy you are. We probably aren't as busy as you are, but let's suppose we sent you a proposal and said we'd like you to review it and get comments back to us by next Friday. You just can't operate a peer review system on a volunteer basis like that, unless there is some kind of compensation there.

Third, and this addresses the second problem too, there has to be an air of open competition for at least part of the projects in order to stimulate interest in serving as peers, particularly by the university sector. The worse problem I had was trying to keep the university people interested and involved in a program in which they recognized that they didn't stand a chance of getting any of the money or projects.

Senator KEMPTHORNE. I'm going to continue this but this is all very helpful and I would invite any of you who, after this meeting on further reflection, just steps one through five, what have you, if you'd send those to me, it would be helpful because I appreciate this and it is helpful.

Mr. Ebel.

Mr. EBEL. I agree with just about everything that my colleagues said on the left here. I think one of the main difficulties is to find a peer group that is knowledgeable enough and unbiased without some kind of ax to grind to review these studies.

Senator KEMPTHORNE. Does that happen in the scientific community too?

Mr. EBEL. You bet. The other thing that Margaret mentioned is that something different needs to be done in the way the Northwest research proposals are handled. I agree with that but if something new is done, let's, for God's sake, eliminate some of the stuff that is being done now; otherwise, you're never going to get a project off the ground. If you're going to have peer review, that should be it and the proposal goes forward after that; let's not run it through nine more committees and State agencies.

Senator KEMPTHORNE. Good point.

Mr. Fidler.

Mr. FIDLER. I agree completely that there is a need for a review process. One of the difficulties I see is who establishes the people who make up the peer review panel, if you will. Is it the State and tribal agencies or NMFS? To me, this is like letting drug companies do their own clinical review and conduct their own clinical trials on new drugs. I think there needs to be some mechanism to allow truly independent input to the review process, independent review and participation.

I think another problem is there needs to be some mechanism to force people to participate in the peer review. For example, on the second NMFS Dissolved Gas Expert Panel meeting, the State, tribal agencies, along with the Fish Passage Center were invited to

participate in that. They all declined to participate. So there needs to be, as I say, some mechanism to force everyone to participate in this.

I've often said to colleagues, if we all were faced with jail sentences for professional incompetence, we wouldn't be here today, we'd be all hunkered over a table working very closely together to come up with a solution.

Senator KEMPTHORNE. So you would like us to hold that out as an alternative?

Mr. FIDLER. You may have to, given the situation as it is.

[Laughter.]

Senator KEMPTHORNE. Mr. Fidler, you stated in your opening comments that the monitoring program seemed as though it were specifically designed to avoid finding gas bubble trauma. Could you please expand on that?

Mr. FIDLER. Sure. One of the central recommendations of the NMFS Dissolved Gas Expert Panel was that gill lamellae are the most sensitive indicators of pending signs of gas bubble trauma and that they should be the primary site that should be examined for signs of gas bubble trauma. In the 1995 Monitoring Program, gill lamellae were excluded from the exams.

Senator KEMPTHORNE. Would you please define that?

Mr. FIDLER. The gill lamellae?

Senator KEMPTHORNE. Yes.

Mr. FIDLER. OK. Gill lamellae in fish are analogous to our lungs; that is, this is the way fish transport oxygen from the water into their vascular system and this is how they excrete things like CO_2 and ammonia. This is, in fact, how they transport the supersaturated dissolved gases from the water into the vascular system where they can then form bubbles. The gill lamellae have always, based on information in the literature, been very sensitive. That is one of the first locations you will see bubbles formed in the fish above certain levels of total gas pressure. There are thresholds involved for all of these arrays of signs of gas bubble trauma. I mean thresholds in total gas pressure. They don't all occur at the same total gas pressure, so total gas pressure has to rise to certain levels before you see specific signs of gas bubble trauma.

As I said, the 1994 Monitoring Program included the examination of gill lamellae as a central component of that. As I mentioned in my testimony, a large number of bubbles were found in 1994. In fact, it was these bubbles that led to the termination of the spill program in 1994. Again, as I mentioned before, 90 to 100 power microscopes were used in that examination in 1994. Now, the National Biological Service protocol for looking at bubbles in gill lamellae calls for 10 power magnification and not even the use of a microscope.

So it baffles me why when you had a process in 1994 that worked very well, why you would then back off to something that cannot resolve as well as the 90 to 100 power magnification. Really, the use of 90 to 100 power microscopes, most high school biology classes utilize that kind of work in laboratories, so it's not some new technology or anything like that; it's a very common thing to do and very effective.

Senator KEMPTHORNE. So let me see if I'm tracking with you. In the examination for the existence of bubbles, they would use 100 power magnification?

Mr. FIDLER. Right.

Senator KEMPTHORNE. And in 1994?

Mr. FIDLER. That was 1994.

Senator KEMPTHORNE. Yes. And in 1994, by utilizing that method, you were able to come up with some meaningful data and yet in 1995, they went to a 10 power magnification which apparently does not allow you to see the existence of the bubbles?

Mr. FIDLER. As I pointed out earlier, there's a very sharp contrast between all of the data from 1994 compared to 1995. In 1995, we've got much higher dissolved gas levels than we had in 1994 where we saw signs of gas bubble trauma. Yet, in 1995, the program is reporting very few signs. The net pen studies below Ice Harbor in 1995 have shown dramatically higher levels of mortality than occurred in similar studies in 1994. As I said earlier, there just seems to be such a contrast in these results that one has to question the validity of the monitoring program.

Senator KEMPTHORNE. All right. I appreciate that very much.

Ms. Filardo, I understand that it's common practice to have a test population—we just referenced that—and a controlled population when conducting an experiment or observing a particular phenomenon. What control did you use to compare the effects of spill on wild fish?

Ms. FILARDO. I'm unsure of the question. In the monitoring program, what you're looking at is fish that are run-of-the-river fish, including both hatchery and wild fish. In terms of experimentation that's done, I'd say the preponderance of the information that has been collected has been conducted on hatchery fish themselves. The monitoring itself is not a research program; it is to monitor the extent of the signs of gas bubble trauma in the population. There isn't any specific test and control group in that. There are specific test and control groups that National Biological Service is conducting under experiments they are subcontracting under the monitoring program.

Senator KEMPTHORNE. Thank you.

Mr. Bouck, I'd like you've referenced the term, if I jotted this down right, referring to the National Marine Fisheries Service that there was an "iron curtain of isolation." Would you tell me what you mean by that? Again, we're not being personal; this is just between you and me.

[Laughter.]

Mr. BOUCK. Admittedly, it's kind of hard to accept not being one of the boys I guess, having watched some of these young folks like Mike Schiewe come up through the line, and now he has replaced Wes Ebel. But when this issue came up, I was called and asked by Cramer Associates to go out on the river and have a look at how things were going and report back to them. I thought that had some merit and of course I was very interested. I think gas bubble disease is a tremendously interesting biological phenomena and it also just happens to have some important ecological and environmental implications.

So I went out with and I helped the NMFS, who had two people to do the work of four people. I saw some serious shortcomings in their techniques and I told them so. Then my colleague did the same upriver at Ice Harbor Dam and the next thing we knew, NMFS was offended by this and a news release that a third party put out. Thereafter, we were not permitted to go back out with the NMFS crew, look at their fish, or help them. I asked if I could at least look at the fish when NMFS got through with them, because NMFS kills them all, and I said if you're going to throw them in the garbage, can I have them when you get through and NMFS said no. I asked, can I buy your garbage and NMFS said no. The NMFS employees said if I wanted to talk to them, I had to call a PR person in Seattle and make formal arrangements. You can't get anything done that way.

Senator KEMPTHORNE. What would you have done with those specimens?

Mr. BOUCK. I would like to have looked at them to see if I could see bubbles or other lesions that the NMFS's staff of non-biologists couldn't see. I was primarily interested in the wild resident fish. We have quite a trophy fishery for walleye and small-mouthed bass in the Lower Columbia River. I was able to get the cooperation of the Oregon Department of Fish and Wildlife crew who let me look at their fish. We were not able to get an ESA permit to collect nonsalmonid fish or look at fish. We had to have the cooperation of somebody who had a permit; the NMFS people had a permit, the National Biological Service people had a permit, and we wanted to look at their nonsalmonid fish to see if we could expand the information base on gas bubble disease and so forth.

NMFS and NBS came up with a lot of reasons why we couldn't look at their fish but it all boiled down to the fact that they didn't want to cooperate. So that was the end of that.

Senator KEMPTHORNE. Were you invited by the National Marine Fisheries Service to participate in this?

Mr. BOUCK. No. I asked for permission and it was granted, then rescinded. I'm on their panel of gas experts, so I think that had something to do with it. I asked, "can I go out and have a look at the fish?" and NMFS said yes, but then they withdrew it and said no.

Senator KEMPTHORNE. So they would not allow you to look at these dead fish?

Mr. BOUCK. Not after the first time I went out there, no. This attitude immediately went to the National Biological Service and before we had a chance to go out with NBS, they let us know that they would not cooperate or allow us to look at any fish that they had looked at.

Senator KEMPTHORNE. All right. I appreciate that.

Mr. Anderson, your overall conclusions on the modeling and I guess the final point I'd like you to address is, is spill beneficial?

Mr. ANDERSON. Our work suggests that spill is not beneficial. It's not beneficial to fish passing through the river and it's not beneficial when you consider fish being transported, particularly when fish are being transported. Anytime you do not transport fish, you're losing some of the benefits of the transportation.

I'd also like to just follow up on this idea of bringing other information into the development of the ideas. The spill risk analysis that was performed, which is primarily the foundation for the spill, in that process they never considered or contacted us to do some runs, do some analysis with our model. We spent 7 years developing the system which is designed to analyze the risk for different actions. It was a tremendous amount of work and it was not utilized in this process.

Senator KEMPTHORNE. So in other words, it took you 7 years to develop a model. Then did National Marine Fisheries Services utilize that model in their draft plan?

Mr. ANDERSON. For the spill, they did not.

Senator KEMPTHORNE. Did they give any reason why they did not?

Mr. ANDERSON. My feeling is there are alternative models, the models give different results, and they concluded to back off from model results because they have uncertainties and I think there is a difference between scientific uncertainty and ignorance. We need to really separate the two.

Senator KEMPTHORNE. Is this something too when we ask about a meaningful peer review process, all of us must feel that if we're contributing something, that it will be considered but here is a model that was done that took 7 years and not utilized. Is that one of the things that is perhaps a demoralizing factor to then step forward again as a scientist to offer your services?

Mr. ANDERSON. It might be. In my case, it isn't. It just makes me want to bring this information out even more and try to get people to use our work and to understand it and criticize it so that we can improve it.

Senator KEMPTHORNE. All right.

I want to thank all of you. I appreciate greatly the input that you've provided us. This is the sort of discussion that I wish we could just continue for some time. I would suggest that our communication channels are open and as you have further thoughts on this issue, as well as the Endangered Species Act, I would welcome your input because I respect all of you that are here.

With that, I would ask the next panel if it would come forward. We will take a brief 2-minute recess as we do that.

[Recess.]

Senator KEMPTHORNE. Ladies and gentlemen, we will continue this hearing. I've been advised that at approximately 11:30 a.m., there will be a vote so what I'd like to do is we have three members of this panel that will be making opening comments and again, I would ask that you try to keep it to close to 5 minutes. Assuming we could get through the opening statements and they would then call for the vote, I would recess, I'll quickly run over and vote and be right back, and then we'll do our question part of this.

With that, let me first introduce Mr. Will Stelle who is the Director of the Northwest Region, National Marine Fisheries Service, accompanied by Michael Schiewe, Division Director, Coastal Zones. Mr. Stelle, if you'd like to proceed, please?

STATEMENT OF WILL STELLE, DIRECTOR, NORTHWEST REGION, NATIONAL MARINE FISHERIES SERVICE, ACCOMPANIED BY MICHAEL SCHIEWE, DIVISION DIRECTOR, COASTAL ZONE AND ESTUARINE STUDIES

Mr. STELLE. Thank you, Mr. Chairman, and I appreciate the opportunity to appear here today.

I have a written statement which I'd like to submit to the subcommittee for its record.

Senator KEMPTHORNE. It will be made a part of the record.

Mr. STELLE. I'd like to concentrate on several summary comments.

First of all, the goal of the National Marine Fisheries Service in this effort is to develop a scientifically-sound and legally-defensible recovery effort for salmon. That is our touchstone, that will remain our touchstone, and we will adhere to it as we proceed. It's very important for us to use that as our reference point throughout all of these proceedings.

To the issue of spill, the issue of this morning's hearing, first, to echo an earlier witness, spill is not new. Spill has been occurring voluntarily and involuntarily in the basin for decades. To give you a brief summary of that history, the fish and wildlife program of the Northwest Power Planning Council, the 1982 program, embraced voluntary spill at the Federal hydropower projects; there was a 1989 MOA between Bonneville and the State and tribal fishery agencies which again embraced and called for a spill program; the Federal Energy Regulatory Commission, in a set of proceedings both in the 1980's and as late as last year, ordered the mid-Columbia PUD projects, four of them, to institute a spill at their projects in order to pass fish safely around them. The States of Oregon, Washington, and Idaho, and the lower river tribes have recommended to us the institution of a spill program and spill was called for at all downstream collector and noncollector projects by the 1994 amendments in the Salmon Strategy of the Northwest Power Planning Council. So the first point would be, spill is not a new thing by any means.

The second point is that to understand the function of the spill program, one needs to reference the larger recovery effort that is directed at improving mainstem survivals. It's only in that larger effort that one can understand spill.

As you well know, our objective is to identify the best method to improve survivals in the mainstem, period. As you know, Senator, there is a sharp disagreement within the region on how to do that. There are those who believe that the best technique for improving survivals is the transportation system where you collect juvenile smolts and you move them around the projects. The reason for that is fairly simple, it boils down to arithmetic in my view. It is that you've got eight mainstem dams through which these juveniles have to pass on their way to the sea and those dams are not fish friendly. So the transportation system is based on the idea of let's pick them up and move them around them, not through them one by one.

On the other hand, there are also those who feel very strongly that transportation is a failed policy and that the best way to pro-

ceed now is simply to put the fish back in the river and improve in-river conditions. This is the heart of the debate in the region.

Our objective is to identify the best mix of mainstem passage measures to improve survivals, be it transportation or in-river migration. Our method to achieve that objective is fairly simple. First, improve the transportation system through aggressive implementation of quality control measures. What does that mean? It means simple things like don't put too many fish in the barges, take care of your water quality and temperatures, don't hold the young fish in the raceways too long. Simple things that we understand.

Second, improve the in-river conditions for in-river migrants and then evaluate the results over time to see what provides the most benefit. It's in this context that the National Marine Fisheries Service has embraced a spill program at the downstream projects, both collector and noncollector, because it's part of the effort to improve in-river migration systems so that we can settle the larger debate on good science, the larger debate about whether or not we should continue reliance on a transportation system or junk the transportation system and move to complete reliance on in-river migration.

If we don't do our best in testing out both alternatives, we will not be able to answer that question well and on a solid scientific basis and in a couple of years, we will be left with the flip of a coin as to which major option we choose to follow, including some major system reconfigurations and major drawdowns. So the function of the spill program is part of the larger, scientific evaluation of what works best. If we don't institute the spill program, we will not give fair credence to an effort to improve in-river migration.

The third point is that the National Marine Fisheries Services, in consultation with the Corps of Engineers, the Bureau, Bonneville, Fish and Wildlife, NBS, and the State and tribal agencies in the region, has, in my view, designed and implemented a scientifically sound and biologically safe voluntary spill program.

Dr. Schiewe is a principal architect of the biological monitoring component of that and if you have questions on how that was developed, then I would encourage those questions. I think we have good answers.

The next point, we are committed to continuing progress on improving this system through what is called an adaptive management approach. What that really means, Senator, is that we are committed to continuing to learn as we go and that we are committed to changing what we do as we learn. At the end of this migration season, the National Marine Fisheries Service, together with her sister agencies and the States and tribes of the region, will sit down together and review the operations of this season—did the technical management team that ran the river do a good job; did it have adequate guidelines; can we improve that system; and if so, let's go ahead and improve it, preparing for next year.

Let us also take a look at the spill parameters, the parameters governing the spill program. Do we have them right; are there ways we can improve them; and if there are, let's get on with it. We are absolutely open to continuing to make those improvements and we intend to do so.

Finally, I'd like to close by recognizing that this is not simply a Federal river and it is not simply a Federal issue. The States of the region and the tribes of the region have a substantial and direct interest in the way this system is operated and in the way we pursue our recovery effort for the listed salmon, the other anadromous runs and the resident fish and wildlife of the basin. Therefore, it is our practice and our policy to bring people into our effort and to open it up with doors and windows so that all of the governments of the region have a complete and full opportunity to participate with us.

To the issue of peer review, I would encourage additional questions because I agree with much of what is being said and we are now negotiating with the Northwest Power Planning Council to develop a science board that can help us institute that much more coherent, scientific approach to the larger basin issues.

With that, I'd like to conclude, and again, I want to thank you for the opportunity to be here this morning.

Senator KEMPTHORNE. Mr. Stelle, thank you very much.

Next, we have Colonel Bartholomew Bohn, Deputy Division Engineer, North Pacific Division, U.S. Army Corps of Engineers who is accompanied today by Doug Arndt, Senior Fish Program Planner, Department of Army. Colonel, if you would go ahead with your comments.

STATEMENT OF COLONEL BARTHOLOMEW BOHN, DEPUTY DIVISION ENGINEER, NORTH PACIFIC DIVISION, U.S. ARMY CORPS OF ENGINEERS, ACCOMPANIED BY DOUG ARNDT, SENIOR FISH PROGRAM PLANNER, DEPARTMENT OF THE ARMY

Colonel BOHN. Mr. Chairman, I am Colonel Bart Bohn, the Deputy Commander, North Pacific Division, Corps of Engineers, and Doug Arndt is here joining me today from our Pacific Salmon Coordination Office. I represent our division commander, Major General Ernest J. Harrell who is busily involved right now in preparing for his upcoming retirement.

Thank you for the opportunity to testify before the subcommittee today on an issue of great regional interest and of increasing national interest. Mr. Chairman, I'd request I be allowed to summarize my testimony and provide a more complete version for the record.

Northwest salmon stocks are in serious trouble. As you know, three species of Snake River salmon are now listed under the Endangered Species Act. The Corps' eight hydroelectric dams in the lower Columbia and Snake Rivers are widely believed to be a major factor in the decline in numbers of wild Snake River salmon stocks. We have sought and continue to seek solutions to the impacts of Federal dams.

Originally, we built fish ladders into all of those Federal dams and those fish ladders were designed to aid the adults in their returning to spawning grounds. Those fish ladders have worked very well. Now the issue is juvenile fish passage.

Many improvements have been made to juvenile fish passage routes at the dams. There are a number of ways that juvenile fish pass through the dams—through the turbines, over the spillways,

through juvenile bypass facilities, and specially designed tanks for transport by barge or truck. Based upon juvenile passage studies, projects are operated to provide optimum passage conditions. Survival numbers depend upon how many of the juvenile fish use each passage route and upon conditions they encounter. Turbine passage may disorient fish and allow predators to catch the fish. High levels of spill result in gas supersaturation levels that can cause gas bubble disease in fish.

Under the Endangered Species Act, the Corps prepared a biological assessment of the effects on listed species of the planned operation of Federal dams prior to the spring migration. Following consultations between the National Marine Fisheries Service and the Corps, NMFS issued a biological opinion. In its March 2 biological opinion for 1995 and future years, NMFS found that the Corps' planned operation of the Federal dams would jeopardize the continued existence of the listed salmon. Accordingly, the biological opinion provided reasonable and prudent alternative measures to avoid jeopardy.

On March 10, General Harrell, Division Engineer, signed a record of decision documenting the Corps' intent to fulfill the recommended actions in the biological opinion. In its decision, the Corps has relied upon NMFS professional, scientific determination that the reasonable and prudent alternatives and measures will provide the necessary actions to halt and reverse the decline of the listed Snake River stocks.

The biological opinion has called for a variety of actions and studies for salmon; flow augmentation, spills, juvenile transport, lowered reservoir levels, improvements to existing passage systems, and other actions are being implemented in the 1995 operating year. Future improvements and alternative configurations of the physical projects are being evaluated for the long term.

One of these is the surface bypass system for juvenile fish. This is a new technology whereby the juvenile salmon are collected in the top 20 feet or so of the reservoirs where they usually migrate and are passed through or over the dams.

In 1994, NMFS requested and the Corps implemented an emergency program of spilling at all eight lower Columbia and Snake River dams. This request went beyond the spill measures in the 1994 biological opinion. In 1995, the biological opinion again called for spill at eight dams, including the juvenile collector dams where a majority of juvenile fish would normally have been collected and transported.

In its 1995 biological assessment, the Corps expressed concern about exceeding current State water quality standards. In a prior letter to Federal agencies, the States and other regional interests, General Harrell had indicated the Corps would attempt to adhere to the State water quality standards in operating its projects. For 1995, we asked NMFS to request those waivers and they did and we have received waivers from the States of Washington, Oregon, and Idaho.

In consultation with NMFS, the agencies agreed to a well-monitored spill program, managed in near real time. The monitoring plan includes two components—physical monitoring which is being

conducted by the Corps of Engineers and biological monitoring being conducted by NMFS.

Regarding research efforts, the Corps assures that evaluations which it funds on salmon passage at its projects are fully coordinated with regional entities and programs. It accomplishes this through an interagency technical review and oversight process called Anadromous Fish Evaluation Program. The Corps is working with NMFS to bring this research program into processes established under the Pacific Salmon Coordinating Committee, or the forum currently proposed by NMFS for implementing the recovery plan. A coordination team will continue to consult with Indian tribes, Federal and State fish agencies, the Power Planning Council, and other interested parties to assure that they have adequate opportunity to review and to provide recommendations throughout the development and implementation of Corps-funded studies. We will continue the annual study review meetings to provide preliminary and final study reports to all interested parties.

In conclusion, we have underway in the region a comprehensive and ambitious plan of measures and evaluations to improve survival of the salmon at the Federal hydro projects. Because of the complex life cycle of the salmon and the many factors that influence their survival, there is much uncertainty whether all of these actions will result in benefits to the fish. We must continue to learn from our actions and modify them as necessary. The NMFS Biological Opinion, proposed recovery plan, and our research process are intended to assure just that.

Results from turbine efficiency studies, gas abatement studies, surface collection evaluations, among others, will be considered as we make future decisions.

Spilling for juvenile fish is to provide interim protection for the juvenile fish until long-term protection measures can be implemented. Spill is considered to be a safe method of passing the fish as long as it is carefully monitored to control gas supersaturation.

Mr. Chairman, that concludes my oral statement. I'd be happy to answer any questions you might have.

Senator KEMPTHORNE. Colonel, thank you very much.

I want to make a note on what you just said before we move on here.

Now, let me turn to Mr. Ed Bowles, the Anadromous Fish Manager, Idaho Department of Fish and Game.

STATEMENT OF ED BOWLES, ANADROMOUS FISH MANAGER, IDAHO DEPARTMENT OF FISH AND GAME

Mr. BOWLES. Good morning, Senator Kempthorne.

Thank you for the opportunity to testify on NMFS' spill policy which is an important plank in Northwest salmon and steelhead recovery efforts.

Idaho Department of Fish and Game supports spillway passage of juvenile salmon smolts as they migrate over dams in the lower Snake and Columbia Rivers. Managed spill is a valuable and scientifically valid recovery tool. NMFS' spill policy reflects this fact.

There are few on the scientific panel who were really in support of spill but I'd like to emphasize that this is not really representative of the issue. All of the State and tribal salmon management

agencies in the Columbia Basin are in consensus on the use of spill as a valid tool. As you're well aware, it's hard to get that diverse group to agree on anything, and yet on this issue, there is consensus. This group has really only one common agenda that ties them together and that's to bring adult salmon back to their regions.

Mr. Chairman, you have the pleasure of knowing firsthand that salmon and steelhead represent a tremendous heritage for the citizens of the Northwest. Snake River salmon once thrived by spawning far inland in Idaho's mountainous headwaters and sending their progeny to the ocean on the wave of natural snowmelt each spring. This journey has been altered dramatically by dams and reservoirs located between Idaho and the ocean. This broken link in the salmon's ecosystem must be repaired for recovery to occur. Managed spill at mainstem dams on the lower Snake and Columbia Rivers is one of the best, most practical tools to repair this broken link.

A carefully managed spill program is essential, first, because it is the best way available to get smolts past the dams and second, it is the best way to spread the risk between smolts transported in barges and those allowed to migrate in the river. A good question might be why not just transport all the smolts and not worry about the river? Quite frankly, we've been trying to do that for 15 years and the decline to extinction continues. If the bottom line is to try to turn the corner, doesn't it make sense to not put all our eggs in the transportation basket and allow for some in-river migration?

I'd also like to point out that even under full transportation as it currently exists, it is impossible to transport all the fish. So, for that component that is in the river, we must do everything we can to make that river environment as friendly as possible to them.

As you mentioned, Senator, there are three ways for these in-river, migrating smolts to pass the concrete. There is little dispute that managed spill provides the safest route for them to get past the dams and that going through the turbines is the worse route. Spill at mainstem dams is our best tool available to minimize this turbine route. I'd like to stress also that managing spill to reduce the turbine passage of these smolts requires no flow augmentation from upstream storage reservoirs. It simply reapportions existing water flowing past the dam.

Spill at mainstem dams is a management tool with known benefits, risks and applications. These benefits and risks are not fraught with uncertainty requiring extensive research prior to implementation. Spill is not driven by bad science. In fact, the scientific basis for spill was recognized recently by a Federal Energy Regulatory Commission judge who rejected smolt transportation in favor of spill and in-river migration associated with two mid-Columbia River dams.

Just because spill has a scientific basis does not preclude the need for rigorous monitoring and evaluation. Adaptive management requires continued critical analysis of the spill program in order to maximize benefits, minimize risks and test our assumptions. The NMFS spill policy embraces this need effectively.

Gas bubble trauma in fish associated with spill is a risk taken very seriously. Fortunately, this risk can be effectively managed.

I'm not aware of any salmon management agency and tribe in the Columbia Basin that does not believe the benefits associated with a carefully controlled and carefully monitored spill program don't far outweigh potential risks from gas bubble trauma.

NMFS' spill policy includes adequate provisions to adeptly manage spill and minimize risk of gas bubble trauma. This does not mean we shouldn't take rigorous action to better control gas. Ice Harbor Dam is a pertinent example where risk of gas trauma could be substantially reduced if the Corps could install gas abatement devices and get their turbines back on line.

Regarding the development of NMFS' spill policy, I think they did a good job this past year soliciting scientific information. From my perspective, this information helped formulate their spill policy, just as new information will help adjust that policy. After extensive input and debate, NMFS concluded that continued use of spillway passage is scientifically justified. State and tribal salmon management agencies concur.

Although NMFS has allowed ample opportunities for public comment on the general merits of spill, it has not done all it should to include State and tribal fishery professionals in the day-to-day decisions that implement that program. As a result, I believe that the region missed some opportunities to improve salmon survival in 1995. Correcting this flaw is important.

In conclusion, I believe existing knowledge supports spill as an important recovery tool. It is currently the best way to spread the risk more equitably between transportation and in-river migration. It's the best way to minimize the number of in-river migrants passing through turbines and it is the best way to get in-river migrants past the dams.

I think one of the key questions today is not whether there are people who disagree with the continued use of spill, but rather, did NMFS take into account all relevant evidence and make a decision to use spill that is supported by this information? In this case, it is clear that NMFS met this fundamental obligation. Can the NMFS spill program be improved? Absolutely, but that is the nature of adaptive management and something we should not be afraid of as we move forward in salmon recovery.

Thanks once again, Chairman Kempthorne, for this opportunity to testify. I hope my comments have been constructive. I have written comments that expand on this oral testimony.

Senator KEMPTHORNE. Thank you very much.

Let me start with you since you just completed your testimony. You stated just a moment ago that all State agencies share consensus that spill is a valid program. Does your testimony reflect the position of the Governor of the State of Idaho?

Mr. BOWLES. Essentially, my testimony represents the State and tribal salmon management agencies. These are the fisheries professionals that are obligated and responsible for salmon recovery within the States and tribes.

Senator KEMPTHORNE. Does the Governor concur with that?

Mr. BOWLES. In my opinion, yes. The Governor right now doesn't have his own personal salmon recovery plan that he has put forth but our department is working very closely with him, his staff and the Idaho representation on the Northwest Power Planning Council

with respect to this issue. As you're aware, the Governor just assumed office, kind of right in the hot seat of this winter's spill issues and is still, I think, coming to terms with the issue and all its complexity.

One of the key planks that there seems to be strong support in is utilizing spill at the mainstem dams below Idaho's borders to help get the fish across those dams and to spread the risk more equitably between transportation and in-river migration.

Senator I'd also like to mention that the comments that I prepared for this testimony were reviewed by the Governor and his staff and his input was taken very much to heart.

Senator KEMPTHORNE. All right. Mr. Bowles, you state in your written testimony that, "A carefully managed spill program is essential to interim salmon recovery efforts." Based on the testimony from the first panel, do you consider this a "carefully managed program"?

Mr. BOWLES. I think that it is a very good face put forward, a very good step and one that is put forward in very good faith. I do think it can be improved on several fronts, but the primary concept and basis of the spill program and the policy that drives it is sound. As I mentioned, I think all of us, in dealing with issues day to day, have to deal with managing when we have uncertainty; we have to make decisions anyway and move forward. The salmon issue accentuates this management under uncertainty.

I'd like to stress that this isn't just an experiment that we're doing to try to see what might work. The bottom line is we have fish that define the very nature of the Northwest that are about to go away. Steps have to be taken to stop that. Transportation can be an important, interim part of that, but it has not stopped the decline. Something else that also needs to be allowed is in-river passage, and spill to help those in-river migrating smolts is a part of that. Improving the program? Yes, I think we can do that. I think we have involvement to do that. It can be improved and I have written comments on some specifics, but the basis is there for a good program to continue.

Senator KEMPTHORNE. Mr. Bowles, let me also ask you, were you troubled by the testimony that we heard today that this year's monitoring program is substandard and that last year's monitoring program wasn't initiated until after the spill program had begun?

Mr. BOWLES. I was troubled by that testimony perhaps from a different perspective than what you're asking. I personally have not been directly involved in the monitoring program in my position, but we have scientists within the department who are tracking it very closely and have participated in developing that monitoring program. The States and tribes were represented in developing that program.

The monitoring program this year, I think, has done a very good job of responding adaptively to the issues and concerns that have been brought up, and there have been many. Some of them are issues that, over the course of the past year, the scientific community that has been reviewing the spill policy and implementation have come to a conclusion, for example, on internal versus external sampling protocols for gas symptoms. They came to the conclusion that

external was more reliable than the internal and implemented that as their measure.

When the issue came to a head in the Ice Harbor incident, I was very pleased with the responsiveness of NMFS and the monitoring program through the States and tribes to say, let's take a look at this and they implemented internal monitoring. Another issue came up where spill opponents said we're not finding the gas bubbles in the fish through the monitoring program because we sampled them after they go through the bypass system. They said, if you sample them before they go through the bypass system, then you'll find the gas bubbles. The program adapted to that issue and that concern, which was a legitimate concern. Intertribal Fishery Commission biologists and the National Biological Service went out and addressed that concern and found that, for both internal and external examinations, there were no gas bubble problems with the fish before they went through the bypass.

So I think the monitoring program has adequately assessed the risk to migrating smolts this year. Let me stress, *migrating* smolts, not necessarily smolts that are held in a cage for 4 days. The migrating smolts, I think, have done well this year.

Senator KEMPTHORNE. Thank you very much. I appreciate that.

Mr. Stelle, did you hold your current position in the National Marine Fisheries Service during the spills that were mentioned in the testimony of the preceding panel?

Mr. STELLE. Last year's spills, sir?

Senator KEMPTHORNE. Yes, 1994–95.

Mr. STELLE. No, I didn't. I was appointed to my current position effective September 7, 1994.

Senator KEMPTHORNE. Were you the individual who made the decision to pursue a spill rate regime at the lower Snake and mainstem Columbia Dams this year?

Mr. STELLE. Yes, sir, I was.

Senator KEMPTHORNE. As I understand it, last year, 1994, was the first time that the Federal Government decided to run an intentional spill program at the major dams on the Columbia and the lower Snake Rivers. That program was terminated within weeks after it began. Was that because monitoring results at different times showed gas bubble trauma in almost 100 percent of the fish that were tested?

Mr. STELLE. Yes. A couple of clarifications on that, Senator. First of all, I believe it was the first time that we instituted a voluntary spill program at the collector projects but prior to that, we had been for quite a while spilling intentionally at noncollector projects. The program was pursued at the request of the States of Idaho, Oregon and Washington and the lower river tribes. It was instituted, I believe, at the end of May and after a couple of weeks, because of repeated readings of elevated gas problems with the fish, we backed it down.

Senator KEMPTHORNE. Last year, the National Marine Fisheries Service testified before this subcommittee on the 1994 spill program. In that testimony, Dr. Nancy Foster with NMFS said that nitrogen levels were such that they were causing damage to both the species that you were trying to protect as well as to other species. Was Dr. Foster correct in that statement?

Mr. STELLE. I would guess so.

Dr. Schiewe.

Dr. SCHIEWE. Yes, those were the results we obtained last year.

Senator KEMPTHORNE. If her testimony then was correct, you must have some new data that justified initiating and expanding the spill program this year. In light of the testimony that we've just heard from the preceding panel, perhaps you would tell us what information you had that justified this year's spill?

Mr. STELLE. That's a good question, Senator. A couple of major pieces of information. First of all, on the issue of whether or not spill per se is a preferable way to move young fish around individual projects, I think there is a large body of information which answers that question in the affirmative.

The question then turns on the issue of gas levels and what is an acceptable level of gas supersaturation to protect these young fish against gas problems. On that, we discussed the matter with the parties to the IDFG Marsh litigation; we also discussed it with the States and tribes extensively in the development of our biological opinion; and our Science Center, after reviewing all of the information, made a recommendation to me on what it believed was a safe level for purposes of gas supersaturation. It was that recommendation which NMFS then sought to implement through applications for gas waivers to the States of Washington, Oregon, Idaho and the Nez Perce Tribe. Those waivers were granted.

Senator KEMPTHORNE. How do you respond to some of the comments by some of the scientists who had been on your panel that they felt that their recommendations were not well received, perhaps not even received at all, the idea that it was isolation, that the monitoring program was designed so that it would not identify the gas bubble trauma?

Mr. STELLE. If I may, Senator, may I turn it over to Dr. Schiewe as its chief architect?

Senator KEMPTHORNE. Sure, but then I'd like your input as well.

Mr. STELLE. Of course.

Dr. SCHIEWE. I would like to begin, Senator, with just a brief comment on the events of 1994. As Mr. Stelle has indicated, the spill program began in mid-May in a rather hasty, hurried fashion and the monitoring program had to be developed somewhat after the fact. We learned quite a bit from that and I believe we've incorporated much of what we learned last year into what we've done this year.

Senator KEMPTHORNE. Dr. Schiewe, let me ask you this question, and I appreciate that. As you stated and this is consistent with what members of the National Marine Fisheries Service stated last year, it was after the fact, it was an experiment. How do we justify that when we're dealing with an endangered species? What was the science that drove you to do this when you had not had good results on the spill in 1994?

Dr. SCHIEWE. For this year, in the framework of developing the necessary information to operate and manage the hydropower system in future years in the best way and for the benefit of fish, we consider a spill to be an integral component of improving in-river conditions and allowing us to make a scientifically sound evalua-

tion of how we want to balance transportation with in-river movement of fish for the years to come.

Senator KEMPTHORNE. Mr. Stelle, would you like to comment?

Mr. STELLE. Yes. I think, Senator, if I understand the thrust of your questions, it goes to the gas levels.

Senator KEMPTHORNE. Well, no, it goes to what the previous panel had stated, the number of scientists who said they just felt that their scientific recommendations were ignored and that if it was contrary to the policy direction the National Marine Fisheries Service was going to take, there was a disconnect.

Mr. STELLE. Senator, I think that is wrong, I think it's completely wrong. Again, I'd defer to Dr. Schiewe in part because he ran those panels. I believe those panels were conducted in a credible and scientifically sound manner and I believe that we listened and learned from it.

There are a couple of specific issues that were raised this morning and without getting into too much detail, there is a question of access to the monitoring program. Six weeks ago or so when the incident in Ice Harbor occurred, there was all sorts of what I would call a media frenzy on that subject and that frenzy ran the risk of substantially undercutting the quality of the monitoring effort. We couldn't have people and cameras crawling all over our monitoring boats looking over the people doing the monitoring and the research. Therefore, in order to avoid that and in order to protect the integrity of the monitoring program and to protect the safety of the people conducting the monitoring effort, we stipulated that anybody, any member of the public who wanted access to the monitoring effort need only call us and we would make arrangements for that access, but it had to be done in an orderly way both to protect the integrity of the monitoring program and the people doing it.

There were some specific issues as well. Clearly not every recommendation of every member of that panel was necessarily adopted either by the overall panel or by the National Marine Fisheries Service. I think what we heard this morning was some of that.

Senator KEMPTHORNE. Mr. Stelle, last year's testimony also talked about the National Marine Fisheries Service Spill Panel that was convened in the last few days of the 1994 spills. They recommended that the river be managed to confine total dissolved gas levels to the existing 110 percent standard if we intend to protect fish from harm. Can you tell me if the National Marine Fisheries Service accepted that recommendation from the panel?

Dr. Schiewe.

Dr. SCHIEWE. We considered that as the basic cornerstone from where we would go with that entire adaptive management approach to spill. The existing standards which were built upon the National Academy of Sciences' recommendations of 110 percent of saturation in the early 1970's have been adopted by all the States as well as the Federal Government. The panel's statement was very specifically that it was probably a good standard; going below that might afford greater protection; going above that would move in the direction of harm.

We also evaluated the current literature that has been developed in the scientific arena since those early reports of the National Academy of Science and we looked very hard at the issue of depth

compensation which was raised by several of the members of the scientific panel and that is, as a fish moves deeper in the water column, it, in essence, compensates hydrostatically for supersaturated gas levels. The equation is roughly 3 percent a foot. Therefore, if a fish is 10 feet below the surface, rather than being at 120 percent, they are effectively at 110 percent saturation, which is a safe level. Knowing that fish do not migrate solely in the top one foot of the water column, we were very comfortable in moving to a recommendation for 115 percent.

Senator KEMPTHORNE. Let me ask you, Mr. Stelle, what peer review or public review and comment process did you go through before making the policy decision to go ahead with the 1994 spill?

Mr. STELLE. With last year's spill program, Senator?

Senator KEMPTHORNE. 1995, excuse me.

Mr. STELLE. There were several processes. First, at the direction of the court, we engaged in a lengthy discussion with the parties to the Marsh litigation as it is so called, to discuss how the earlier plan of operations could be adjusted to better improve fish survival. During those discussions, the States of Oregon, Washington, and Idaho, and some of the environmental parties recommended spill as one of the recovery measures.

At the same time, we developed a written draft biological opinion which we circulated to all of the parties and sought comments from them, both written comments and we had a number of meetings with them, and it was based on those meetings and those comments that we made a final decision that was reflected on the spill program per se. It was reflected in the March 2 Biological Opinion.

At the same time but separately, our Science Center was reviewing the data from the 1994 spill program and had convened twice an expert gas panel to look at that spill program and to develop recommendations both on how to design a spill program and to design an effective, reliable monitoring program. That as a peer-reviewed—it wasn't a peer-reviewed exercise but it was basically a special panel of gas experts that helped us assemble that. So there was both the scientific side of it and then the policy side of it, and there was substantial participation from both.

Senator KEMPTHORNE. In light of the previous panel's testimony, did you plan from the outset of this year's spill program to look for internal signs of gas bubble trauma in fish by looking for bubbles forming within the gills or did the National Marine Fisheries Service do so only after independent review of your proposal forced the National Marine Fisheries Service to do so?

Mr. STELLE. I believe the answer is the latter but again, let me defer to Dr. Schiewe if I may.

Senator KEMPTHORNE. Dr. Schiewe.

Dr. SCHIEWE. The examination of gill filaments or gill lamellae was indeed one of the components of the monitoring program recommended by the peer panel. After the two peer panels, the National Marine Fisheries Service, in conjunction with the Environmental Protection Agency, convened a panel of regional scientists that have dealt with this issue for many years and they basically scrubbed the growing monitoring program that had been drafted. There was great discussion over whether to include this internal

examination specifically because it required sacrificing fish, and indeed, our goal is to save fish.

It never quite became resolved in that particular forum and within 2 weeks or so of the beginning of the spill program, we asked the National Biological Service to go ahead and begin examining gill lamellae, gill filaments, in steelhead at three of the six locations to get some idea of how important the monitoring of this site was to the program.

Senator KEMPTHORNE. Dr. Schiewe, what is the best way to find evidence of the gas bubble trauma and would you reference the 100 magnification versus the 10 power magnification, and in fact, was that a decision made and can you find the gas in the gills with a 10 power magnification?

Dr. SCHIEWE. You can find it under both magnifications. It, of course, depends on the size of the emboli in the filament. This is another area which we are actively researching as we speak and attempt to develop more information, it's not quite as crisp as it was presented earlier. Last year, it was being done at 90X and we saw things and this year, we're doing it at 10X and we don't see things.

An in-season inspection team last year, which included some outside consultants as well as some National Marine Fisheries Service scientists, looked at the methods used last year and there was question whether the removal, excision of the gill and the examination at the higher power was, in fact, introducing bubbles as an artifact. This is what we're attempting to sort out now. If indeed the analysis validates that this is a concern, we will implement that in the monitoring program, the higher power magnification.

Senator KEMPTHORNE. So did I hear you correctly when you said that at 90X, you did see things; at 10X, you do not see things?

Dr. SCHIEWE. No, I did not say that. Last year, at 90X, they saw a higher prevalence of bubbles in the gill filaments than they are seeing this year at roughly 10X, but they are two different years.

Senator KEMPTHORNE. But you saw more of it last year when you did use the 90X than you have this year using the 10X?

Dr. SCHIEWE. Exactly.

Senator KEMPTHORNE. I understand that almost 100 percent of the fish sampled in last year's spill program had signs of gas bubble trauma; yet, this year, the National Marine Fisheries Service has failed to report signs of the trauma. Is it possible that NMFS has designed a program so that it is ignoring this gas bubble trauma situation?

Dr. SCHIEWE. I would say that's not the case at all. Again, the prevalence of science last year was confounded by the possibility of the technique producing the bubbles as an artifact to the examination and I know of no instance last year. Certainly you cannot characterize the entire program last year as showing 100 percent prevalence of any sign. In select groups of fish at selected times at Bonneville Dam in hatchery-reared steelhead, I believe they showed prevalences as high as 60 percent, but this is a very small part of the overall program.

Senator KEMPTHORNE. Mr. Stelle, after the fish kill was reported below Ice Harbor raising doubts about the safety of the migrating fish, I cosigned a letter to Assistant Secretary of Commerce, Doug

Hall, with seven other Senators from the Northwest States that asked very clear questions about the spill program. To my knowledge, we've not yet received a response. Can you give me any insight on that?

Mr. STELLE. Yes, Senator, I can. I think to coin a phrase, "the check is in the mail." I'm not quite sure where in the mail system it is. I know that the response has been prepared and it is quite detailed, sir. My apologies for the delay, that's my fault.

Senator KEMPTHORNE. On that note, National Marine Fisheries Service Director, Rollie Schmitten, promised the Senate Appropriations Committee a side-by-side comparison of the salmon recovery team recommendations with the National Marine Fisheries Service draft recovery plan. Do you know if that document has been completed?

Mr. STELLE. No, I don't, Senator, but I'm happy to check and if not, I will provide it to you.

Senator KEMPTHORNE. Again, we do not have a copy of that.

[The document requested by Senator Kempthorne follows:]

Summary and Comparison of Regional Conservation Strategies For Columbia River Salmon

July 1995

INTRODUCTION

The following matrix summarizes and compares provisions of major regional conservation strategies for Columbia and Snake River salmon. The matrix includes specific recovery objectives for Snake River salmon, and is organized into biological categories and major management activities.

The references for this summary are as follows:

NMFS Proposed Recovery Plan: *The NMFS Plan as required under the Endangered Species Act, identifies specific recovery criteria and tasks to achieve these criteria.*

Recovery Team Recommendations: *Snake River Salmon Recovery Team recommendations presented to NMFS (May 1994).*

SUMMARY OF RECOVERY OBJECTIVES		
	NMFS Proposed Recovery Plan	Recovery Team Recommendations
Areas Necessary for Recovery	Production above Hells Canyon not required for delisting.	Same as NMFS Plan pending further information concerning reestablishment of fall chinook above Hells Canyon.
Spring/Summer Chinook	Salmon, Imnaha, Grande Ronde, Tucannon, Lochsa and Selway R. basins.	Same as NMFS Plan
Fall Chinook	Mainstem Snake River and Lower reaches of major tributaries below Hells Canyon Dam.	Same as NMFS Plan
Sockeye	At least 3 Stanley Basin Lakes and investigate feasibility of one lake outside Stanley Basin).	Same as NMFS Plan
Sockeye Abundance	8 year geometric mean of 1,000 naturally-produced sockeye in Redfish Lake and 500 natural spawners in each of two other Stanley Basin Lakes.	1,000 naturally produced sockeye in Redfish Lake, and 500 natural spawners to a second Stanley Basin Lake over 8 years.
Sockeye Productivity	Natural fish "cohort replacement rate". Must exceed 1.0 for at least two generations.	Same as NMFS Plan
Spring/Summer Chinook Abundance	8 year geometric mean of 31,400 natural adults at LGR and 8 year geometric mean of at least 60% of pre-1971 brood year average redd counts for 80% of available index areas.	Eight year geometric mean of 26,200 natural spring/summer chinook adults above Ice Harbor Dam.
Spring/Summer Chinook Productivity	Natural fish "cohort replacement rate". Must be greater than 1.0 for eight years.	Natural fish cohort replacement rate must exceed 2.0 for at least two generations.
Fall Chinook Abundance	8 year geometric mean of at least 2,500 natural spawners in the mainstem Snake River annually.	Annual escapement of at least 1000 natural spawners above Lower Granite Dam.
Fall Chinook Productivity	Natural fish cohort replacement rate must exceed 1.0 for at least two generations.	Natural fish cohort replacement rate must exceed 2.0 for at least two generations.
Sockeye Stocks	Redfish Lake Sockeye gene pool. However, in assessing demographics, each lake population should be considered relatively isolated.	Same as NMFS Plan
Spring/Summer Chinook Stocks	39 separate populations; evaluate subset of these for delisting. (See spring/summer chinook abundance)	Same as NMFS Plan
Fall Chinook Stocks	Single distinct population.	Same as NMFS Plan

SUMMARY OF MAINSTEM AND ESTUARINE ECOSYSTEM PROVISIONS		
	NMFS Proposed Recovery Plan	**Recovery Team Recommendations**
Inriver Passage Approach for Yearling Migrants in the Snake River	Year-round management by a Technical Management Team (TMT emphasized. TMT will call for required flows (see below), spill, and transportation based on juvenile and adult migration status, river conditions, and run-off expectations. Ensure most effective use of resources for spring and summer migrants and ensure sufficient reservoir refill probability. Evaluate the potential for flood control operations that provide additional storage volumes. Operate the hydrosystem year-round to meet flow objectives for anadromous fish.	Same as NMFS except calls for designated volumes (see below)
Actions for Yearling Migrants	4/10-6/20: 85-100 kcfs When April-July runoff forecast for Lower Granite Dam is >16 MAF and ≤20 MAF. When the forecast is >20 MAF, average flow will be at least 100 kcfs. Continue research to evaluate flow/survival relationship.	Calls for managing the following volumes instead of a minimum river condition objective in low flow years (see NMFS Plan and NPPC Amendments). Total volume: 1.2 MAF w/out FC shift; 1.44 MAF w/FC shift. Seek access to additional volumes for augmentation.
Inriver Passage Approach for Subyearling Migrants in the Snake River	Year-round management by TMT. The TMT will call for flows (see below), spill and transportation based on juvenile and adult migration status, inriver conditions, and run-off expectations. Ensure most effective use of resources for summer migrants and ensure sufficient reservoir refill probability.	Same as NMFS except will call for designated volumes (see below)
Actions for Subyearling Migrants	50-55 kcfs; when April-July runoff forecast for Lower Granite Dam is >16 MAF and ≤ 28 MAF. Average flow should be at least 55 kcfs, when the forecast is >28 MAF. Implement temperature control measures when possible by releasing cool water from Dworshak in coordination with releases from Hells Canyon complex. Continue research to evaluate flow/survival relationship.	Calls for managing the following volumes instead of a minimum river condition in low flows years (see NMFS Plan and NPPC Amendments). <u>Total volume:</u> .89 MAF. Plus a variable additional volume from operating Dworshak to lower elevations.

SUMMARY OF MAINSTEM AND ESTUARINE ECOSYSTEM PROVISIONS		
	NMFS Proposed Recovery Plan	**Recovery Team Recommendations**
Inriver Passage Approach for Yearling and Subyearling Migrants in the Columbia River	Year-round management by TMT. TMT calls for flows (see below), spill, and transportation based on juvenile and adult migration status, inriver conditions, and run-off expectations. Ensure most effective use of resources for spring and summer migrants, and sufficient reservoir refill probability (75-90%).	Same as NMFS except will call for designated volumes (see below).
Actions for Yearling Migrants	Operate the hydrosystem year-round to meet flows for anadromous fish. 4/20 - 6/30: 220-260 kcfs when January-July forecast at the Dalles is >85 MAF and ≤105 MAF. When the forecast is 15 > 105 MAF average flow at McNary Dam should be at least 260 kcfs. BPA and COE should obtain an additional 3.5 MAF of storage in Canadian reservoirs for augmenting flows. Continue to evaluate flow/survival relationship.	Calls for managing the following volumes only instead of including a minimum river condition in low flow years (see NMFS Plan and NPPC Amendments).
Actions for Subyearling Migrants	7/1 - 8/31: 200 kcfs	<u>Total volume</u>: 1.) 6.45 MAF to meet flow objectives, 2.) a variable volume from operating Grand Coulee to lower elevations (up to 380 kaf), and 3.) obtain over five years an additional 1 MAF available annually. Calls for managing the following volumes only instead of including a minimum river condition in low flow years (see NMFS Plan and NPPC Amendments). <u>Total volume</u>: Volumes to meet flow objectives included under spring measures.
Snake River Drawdowns	Operate Snake River pools now within one foot of MOP. Complete necessary feasibility studies. By mid-1996 decide on either spillway crest drawdown, natural river drawdown, or surface collection technology. By December 1998 complete engineering and design and implement by 2000.	Not proposed.

SUMMARY OF MAINSTEM AND ESTUARINE ECOSYSTEM PROVISIONS		
	NMFS Proposed Recovery Plan	**Recovery Team Recommendations**
John Day Drawdowns	Operate within 3 feet of MOP from March-October. Operate at MOP permanently by 1996.	Not recommended. Little or no short-term benefit since listed stocks are transported and anticipated benefits are too small to be measurable against environmental "noise."
Additional Water Available Above Brownlee Dam	BOR should secure an additional 427 kaf from the Upper Snake River in 1995-97. Draft Brownlee Reservoir to 2,069 feet in May, pass inflow, draft to 2,067 feet in July, pass inflow, and draft to 2,059 feet in August/September.	Same as NMFS Plan
Spill	During April 10-June 20 in the Snake River, and April 20-June 30 in the Columbia River, spill at all projects, including collection projects, to achieve 80% FPE. Do not spill at Lower Granite Dam when unregulated weekly average flows <100 kcfs. When unregulated weekly average flows <85 kcfs, do not spill at Lower Granite, Little Goose, or Lower Monumental dams. From June 21-August 31 in the Snake River and July 1-August 31 in the Columbia River spill at all noncollector projects to achieve 80% FPE. Reduce spill when 12 hour TDG >115% in dam forebays and >120% in dam tailraces. Reduce spill when instantaneous TDG>125% anywhere for 2 hours.	1. Evaluate spill as an alternative passage route. 2. Do not exceed 120% TDG. 3. Do not spill at collector projects (Lower Granite, Little Goose and Lower Monumental).
Predator Control	Continue squawfish removal and evaluate means to more effectively remove them. Evaluate avian predation and, if necessary, expand avian control measures.	More effectively remove squawfish and liberalize bag limits on non indigenous fish to reduce predator abundance. Achieve 50% reduction in predation within 5 years and 75% in 10 years. Develop method to directly measure salmon survival improvement.
Juvenile Fish Transportation	Transport all fish collected at Snake River collector projects. Do not transport spring migrants collected at McNary Dam. This operation is expected to result in between 56% and 74% of spring migrants being transported. Improve transportation efficiency through increased number of barges, changing release sites, improved collection and bypass facilities, etc.	Similar to NMFS Plan. Transport majority of juvenile migrants, with particular care to facilitate inriver passage and transportation studies. Reduce transportation only if river conditions are clearly favorable for inriver passage.
Upstream Collector at Lewiston	Not proposed.	Conduct design competition and construct if feasible and if transportation is determined to be a long term recovery action.
Structural Improvements	Modify stilling basins and spillways at Ice Harbor and John Day Dams based on gas abatement evaluations in 1995 and 1996 to reduce TDG. Immediately begin modification of the Wanapum Dam stilling basin to reduce TDG.	Same as NMFS Plan

SUMMARY OF MAINSTEM AND ESTUARINE ECOSYSTEM PROVISIONS		
	NMFS Proposed Recovery Plan	**Recovery Team Recommendations**
Surface Collectors	Evaluate feasibility. Design and test prototype beginning in 1995.	Same as NMFS Plan
Diversion Screens	Require that diversions be screened to meet or exceed NMFS criteria by December 1996. Diversions that do not meet this requirement should be closed when juvenile salmonids are present.	Same as NMFS Plan
Marine Mammal Management	Determine how pinniped abundances/distribution correlates with migration; implement non-lethal removal measures dependent on study.	Develop protocol of rationale and procedures for reducing marine mammal predation on salmon; implementation pending demonstrable urgency and legal basis.

SUMMARY OF HARVEST PROVISIONS		
	NMFS Proposed Recovery Plan	**Recovery Team Recommendations**
Non Treaty Leaseback/Buyback of Fishing Capacity	Reduce harvest capacity of ocean troll fishery by 50% by 2002.	Same as NMFS.
Alaskan Fall Chinook Harvest Rate	Provide harvest rate schedule for terminal fisheries tied to specific biological criteria and management of ocean fisheries (see below). Implement abundance based approach for management of PSC fisheries to rebuild coastwide natural stocks and achieve escapement goals established by PSC in 1984.	Total harvest rate (ocean and river) less than 50%. Establish harvest rates for all fisheries to minimize incidental take.
Canadian fall Chinook Fisheries		Not specified. Included in 50% rate.
PFMC Fall Chinook Fisheries		Not specified. Included in 50% rate.
Inriver Non Treaty Fall Chinook Fisheries	The incidental take of listed fall chinook should be limited using a harvest rate schedule tied to Snake River Fall chinook escapement and R/S rate and, secondarily, upriver fall chinook abundance. The minimum harvest rate represents a 61% reduction inriver harvest relative to the previous ten years.	Not specified. Included in 50% rate. All live release capable gear by 2002.
Inriver Treaty Fall Chinook Fishery		Included in 50% rate. All live release capable gear by 2002.
Inriver Treaty and Non Treaty Commercial and Recreational Sockeye Harvest	No commercial fisheries below confluence of Snake and Columbia rivers. Non-treaty limited to 1% incidental take. Treaty limited to 5% total, C&S and incidental rate, until substantial recovery occurs.	No commercial fishery below confluence of Snake and Columbia.
Ceremonial and Subsistence Sockeye Fishery		Request the release of marked Snake river sockeye and request reduced take of all sockeye from current levels.
Non Treaty Columbia River Commercial Gillnetting	Phase out use of gillnets in the lower Columbia River by 2002. Only approved live capture gear allowed.	Same as NMFS
Alternative Fishing Methods	Evaluate potential for size selective gear. Support development and implementation of selective fishery options and terminal fisheries opportunities.	Same as NMFS
Columbia River Fisheries Management Plan (CRFMP)	Modify CRFMP to explicitly provide for the conservation of Snake River salmon. (See species specific recommendations.)	Same as NMFS
Inriver Spring Chinook Harvest	1% harvest rate (HR) limit for nontreaty incidental impacts and 5% HR limit for treaty C&S and incidental impacts.	Hold to current levels (10-12%).

SUMMARY OF HARVEST PROVISIONS		
	NMFS Proposed Recovery Plan	**Recovery Team Recommendations**
Inriver Summer Chinook Harvest	1% HR limit for nontreaty incidental impacts and 3% HR limit for treaty C&S and incidental impacts.	None Specified

SUMMARY OF ARTIFICIAL PROPAGATION PROVISIONS		
	NMFS Proposed Recovery Plan	**Recovery Team Recommendations**
Hatchery Management	Develop specific hatchery management plans to address production, harvest, genetic, disease, and research/monitoring/evaluation issues for salmon subject to supplementation, captive broodstock or mitigation production.	Same as NMFS Plan
Natural Production	Natural populations are first priority. Only natural component of listed populations used in delisting thresholds. Preserving stock structure to maximize probability of sustained recovery is the primary objective.	Same as NMFS Plan
Improved Hatchery Practices	Modify Columbia River salmonid hatchery operations to improve fish quality and monitor those results.	Same as NMFS Plan
Use of Supplementation	Further research is needed to determine role of supplementation. In interim, support existing efforts and new programs necessary to preserve remnant populations until measures focused on impediments to recovery take effect. Use indigenous stock. Avoid supplementation where significant risks of genetic/ecological degradation affecting indigenous stocks.	Same as NMFS Plan
Use of Captive Broodstock	Continue for sockeye. Initiate for spring/summer chinook salmon populations at greatest risk of extinction. Use to preserve stock structure. Conduct further research to improve techniques and determine potential.	Same as NMFS except initiate fall chinook captive broodstock program also.
Increased Production or New Facilities	Columbia Basin hatchery production limited to 1994 levels. Only propagation to support recovery may be expanded. Find/Retrofit, etc. hatchery facilities for extended captive broodstock efforts.	Same as NMFS Plan
Transplants from other Watersheds	Preclude unless to recolonize vacant habitats to recover natural populations. Use stocks most similar to indigenous stock.	Same as NMFS Plan

SUMMARY OF TRIBUTARY ECOSYSTEM PROVISIONS		
	NMFS Proposed Recovery Plan	**Recovery Team Recommendations**
Habitat Management Authority	Habitat subcommittee to advise the Salmon Recovery steering committee which advises, NMFS on the most scientifically based policies, actions and decisions. Membership solicited from states, tribes, academics, private sector, etc. based on technical qualifications.	Same as NMFS Plan
Goals and Performance Standards	Basin-wide ecological goals established. Federal Lands: Riparian management objectives (RMOs) modified from PACFISH (see below); may be modified following watershed analysis and section 7 consultation. Until long-term ecosystem management plan developed, 1) designate, and protect riparian habitat conservation areas (RHCAs) from degradation; 2) provide for a network of Priority Watersheds containing best remaining and readily restorable habitat; and 3) minimize risk to Priority Watersheds.	Similar to NMFS Plan except calls for a moratorium on resource exploitation which imposes risks of measurable habitat degradation.
Habitat Status Assessment	NMFS should Identify Priority Watersheds. Compile a comprehensive inventory and summary of historic and present habitat quality and quantity. Assessments will provide baseline information for delisting decisions, identify areas needing immediate protection and improvement, and determine production potential to assess progress towards recovery. Determine instream flow needs and inventory hydropower facilities, push-up berms, water intakes, and water diversion screening.	Similar to NMFS Plan
Subbasin Management	(1) Develop long-term ecosystem management plan through the two proposed EISs for upper Columbia River Basin, Eastern WA & OR; (2) develop Snake River subbasin/watershed conservation and management plans, based on regional/local planning processes involving public and private sectors.	Similar to NMFS Plan
Water Diversion Screening	Accelerate screening of all diversions in critical habitat to meet or exceed NMFS criteria. Complete screening in Washington by 1995, in Oregon by 1996, and in Idaho by 2002 (prioritize diversions by threat to salmon). Screen all pump diversions in critical habitat by October 1998. NMFS and NPPC should develop a plan to involve state and Federal agencies in funding screens by October 1995. Through the FSOC, identify innovative alternatives to traditional screening.	Screen diversions in tributary stream with up-to-date equipment as soon as possible. Screen water intakes in the Lower Columbia River and its estuary (e.g. paper mills in Longview, WA) as needed to ensure harm to salmon is minimized.
Resident Trout Program	Work with state managers to release trout in areas where interactions with listed salmon can be avoided, and terminate introductions into primary chinook spawning and nursery areas.	Similar to NMFS Plan
Steelhead Program	Construct acclimation facilities to minimize interactions with natural salmon. Steelhead smolts should be 170-220mm total length at release.	Similar to NMFS Plan

SUMMARY OF TRIBUTARY ECOSYSTEM PROVISIONS		
	NMFS Proposed Recovery Plan	Recovery Team Recommendations
Water Quality	The EPA should: (1) Strongly encourage states to develop and enforce non-point source pollution control mechanisms; (2) determine the extent of the effects resulting from the mixing/dilution zones allowed in current water quality regulations for municipal/corporate discharges; (3) in conjunction with state agencies, review water quality standards, compliance, and adequacy of enforcement for Idaho, Washington, and Oregon; and, (4) if necessary, make recommendations for changes to the appropriate state.	Similar to NMFS Plan
Water Quantity	State/Federal/tribes: Determine instream flow needs for all salmon life stages. Use available authorities to obtain any necessary increases in stream flows during low flow periods. Identify other needed authorities and seek legislative approval. Work to continue the Conservation Reserve Program. State/Federal/tribes/local: Inventory water withdrawals and assess effects on fish passage/entrainment, and achievement of minimum flows by October 1996. Develop plans for combining withdrawal sites, removing withdrawal structures from rivers, enforcing withdrawal amounts, and maintaining minimum stream flows and passage routes. Federal/state: Develop incentives to encourage irrigators to modify techniques and repair/update water delivery systems. Develop outreach and education programs. States: Extend moratoria on issuing water rights and implementing unperfected rights. Ensure headgates installed and flows measured.	Similar to NMFS Plan
Lake Fertilization for Sockeye	Fertilize Stanley Basin Lakes to improve sockeye productivity beginning in 1995.	Same as NMFS Plan
Watershed Restoration	USFS and BLM should prioritize watershed restoration funding as soon as possible. Restoration activities should initially focus on Priority Watersheds with high restoration potential. Where possible, Priority Watershed restoration plans should be developed within the context of broader area plans (subbasin, Forest, etc.). Give special emphasis to multi-agency restoration plans. Restoration in RHCAs and stream channels (such as adding large woody debris) should be only be undertaken if the cause of habitat degradation (e.g., riparian logging) is changed.	Similar to NMFS Plan

SUMMARY OF TRIBUTARY ECOSYSTEM PROVISIONS		
	NMFS Proposed Recovery Plan	**Recovery Team Recommendations**
Riparian Areas	Riparian Habitat Conservation Areas (RHCAs) Fish-bearing streams: two site-potential tree heights, or 300 ft slope distance, or edge of 100-yr floodplain, or outer edge of riparian vegetation, or top of inner gorge, whichever is greater. Perennial, non-fish bearing streams: one site-potential tree height, or 150 ft slope distance, or edge of 100-yr floodplain, or outer edge of riparian vegetation, or top of inner gorge, whichever is greater. Intermittent streams: one site-potential tree height, or 100 ft slope distance, or outer edge or riparian vegetation, whichever is greater (NMFS' plan extends into Clearwater Basin except N. Fork above Dworshak Dam). Ponds/lakes/reservoirs and wetlands> 1 acre: one site-potential tree height, or 150 ft slope distance, or extent of moderately and highly unstable areas, whichever is greater.	Riparian Reserves as in FEMAT - Similar to NMFS Plan in size, but fewer activities permitted.
Restrictions in riparian areas	In Priority Watersheds, actions that exceed a *de minimis* risk of adverse effects to listed salmon and critical habitat. (*De minimis* is defined as very small, or of little significance.) Examples are given for silvicultural activities and mining.	No specific restrictions, although FEMAT's recommendation to only allow timber thinning and salvage where needed to attain riparian management objectives is implied by accepting FEMAT Riparian Reserves.
Roads	In Priority Watersheds: Where road density is greater than 2 miles/square mile, the USFS and BLM should reduce road mileage and emphasize road closure, obliteration, and revegetation. After watershed analysis, new road building and road widening should only proceed in RHCAs if there is no more than a *de minimis* risk of adversely affecting salmon or not attaining Ecological Goals and RMOs. The functions roadless areas fulfill in meeting the Ecological Goals and RMOs in Priority Watersheds should be carefully described by the USFS and BLM and evaluated by NMFS prior to proposing new actions in these areas. Road Management Plans and Transportation Management Plans required by PACFISH should be completed and implemented as soon as possible. The status of these plans, schedules for their completion, and the effects of not completing these plans should be analyzed and described in the ecosystem management EISs.	Notes problems with riparian roads. Recommends decommissioning of roads not needed for fire control.

SUMMARY OF TRIBUTARY ECOSYSTEM PROVISIONS		
	NMFS Proposed Recovery Plan	**Recovery Team Recommendations**
Riparian Grazing	All watersheds: To prevent harassment of spawning salmon and damage to spawning substrate and redds, the USFS and BLM should eliminate or adequately restrict stream access (by livestock, off-road vehicles, anglers, etc.) during spawning and incubation periods. Expand outreach and education programs, in cooperation with state agencies, that promote awareness of the need to protect spawning fish and redds.	Similar to NMFS Plan
Timber Harvest	In Priority Watersheds, the USFS and BLM should not propose any salvage or silvicultural activities within RHCAs that pose more than a *de minimis* risk of adversely affecting listed salmon or their critical habitat, unless both watershed and site-specific analyses show the action will avoid adverse effects and will not retard or prevent attainment of ecological goals and RMOs.	Similar to NMFS Plan
Irrigated Agriculture	(See Water Diversion Screening)	Similar to NMFS Plan
Mining	In Priority Watersheds, the USFS and BLM should use the full extent of their authorities to ensure that new mines are located outside of the RHCAs. There may be some exceptions for activities with a *de minimis* risk of adverse effects. Outside RHCAs in Priority Watersheds, the USFS and BLM should complete watershed analysis prior to deciding whether to approve plans of operation for mining activities that are likely to adversely affect listed salmon, designated critical habitat, or the ecological processes and functions. Based on results of the watershed analysis, the USFS and BLM should adjust proposed plans of operation or, if necessary, prohibit mining operations. Watershed analysis may not be necessary for mineral activities with *de minimis* risk of adverse effects. Outside Priority Watersheds, the USFS and BLM should work with the EPA, COE, and state water quality agencies to ensure that draft plans of operation for new mines that have the potential to produce acid rock drainage are conditioned so that the mines will not adversely affect groundwater or surface water quality.	Similar to NMFS Plan
Toxic Chemical Transport	All watersheds: the USFS and BLM should minimize risk of toxic fuel spills during transport through RHCAs by using alternate routes where feasible, and taking all other possible precautions.	Similar to NMFS Plan
Recreation Management	See riparian grazing.	Similar to NMFS Plan
Water Conveyance	USFS and BLM should ensure that water conveyance intakes with the potential to trap or impinge listed salmon meet NMFS' established intake screening criteria before use is approved and that permits would be authorized or re-authorized only if streamflows are adequate to prevent adverse effects on listed salmon.	None

SUMMARY OF TRIBUTARY ECOSYSTEM PROVISIONS		
	NMFS Proposed Recovery Plan	**Recovery Team Recommendations**
Sediment Delivery Objective	None	None
Fine Sediment Objective	Limit to <20% in spawning habitat of Priority Watersheds.	None
Cobble Embeddedness Objective	Optional alternative to fine sediment: Limit to <30% in rearing habitat of Priority Watersheds.	None
Pool Objective	Adopts PACFISH standard (varies with channel width)	Protect pools by protecting streambanks and riparian areas.
Streambank Stability	In Priority Watersheds, 90% (non-forested systems only)	Protect from breakdown.
Width/Depth Ratio	<10; stratify by channel type	None
Water Temperature	Adopts PACFISH standard (<60F in spawning habitat, <64F in rearing habitat).	Temperatures should benefit salmon (no numeric standard)
Large Woody Debris	Adopts PACFISH standard (20 pieces/mile)	None
Stream Morphology	None	None
Fire Suppression	In Priority Watersheds: By June 1, each year before each fire season, the USFS and BLM should submit to NMFS an outline that they will use to brief Fire Overhead Teams regarding ESA-based responsibilities for protecting salmon habitat. Following a fire that affects RHCAs in watersheds with designated critical habitat, the USFS and BLM should review suppression and rehabilitation efforts and determine if revegetation and rehabilitation of the burned area were effective. Reports on these reviews should be submitted to NMFS for review within 15 months following fire containment.	None

SUMMARY OF TRIBUTARY ECOSYSTEM PROVISIONS		
	NMFS Proposed Recovery Plan	**Recovery Team Recommendations**
Long-term approaches for ecosystem management Federal lands	Determine of levels of resource use which have a high probability of maintaining high quality habitat, restoring degraded habitat, and restoring connectivity between high quality habitats. Consider and refine criteria for prioritizing restoration actions among watersheds. The following steps may be necessary: a. Describe the range of historic conditions and disturbance regimes; b. Describe desired future conditions; c. Refine the delineation of important areas of biological diversity within watersheds; d. Adjust land allocations and outputs of goods and services from Federal lands to reflect the ecological requirements of listed salmon; e. Develop a monitoring program that will: document subbasin-scale trends in habitat quality and quantity, and fish populations; monitor and evaluate reference watersheds and other, more actively monitored watersheds to determine if watershed restoration and management programs are meeting habitat objectives; f. Coordinate with Federal/state/tribal/local governments and private landowners to develop long-term subbasin habitat management plans; g. Establish as one of the purposes of the EISs that all LRMPs and LUPs should promote the survival and recovery of listed salmon.	Same as short-term plan

SUMMARY OF TRIBUTARY ECOSYSTEM PROVISIONS		
	NMFS Proposed Recovery Plan	**Recovery Team Recommendations**
Monitoring and Evaluation	*The PACFISH monitoring committee should oversee experimental design, data collection, quality control, analysis methodologies, and reporting. Include: Implementation monitoring and reporting for all actions that may affect listed salmon or their designated critical habitat; effectiveness monitoring and reporting annually for groups of actions (by activity type, time, and subwatershed or watershed) that may affect listed salmon; permanent photo-monitoring plots; and plan and begin validation monitoring to determine whether the assumptions used in forming the aquatic ecosystem strategy described in this Recovery Plan are valid.* *NMFS, the USFS, and the BLM should establish a monitoring quality control team to conduct and oversee random spot checks of the implementation of PACFISH and guidelines from the USFS Land and Resource Management Plans (LRMPs), NMFS' March 1, 1995 Biological Opinion on the LRMPs, and BLM Land Use Plans.* *The USFS and BLM, in coordination with the Habitat Committee and the ICBEMP, should identify and protect enough pristine or relatively pristine, well-studied watersheds as "reference areas" against which the effects of restoration and land management projects can be measured (may require 10-15 watersheds).*	*Similar to NMFS Plan*

Senator KEMPTHORNE. At a hearing I attended last year, September 9, 1994, the National Marine Fisheries committed to providing a followup report on the results of last year's spill program. Do you know if that document has been completed?

Mr. STELLE. No, sir, I don't.

Senator KEMPTHORNE. Again, I do not have a copy of that.

[The document requested by Senator Kempthorne follows:]

Review of the National Marine Fisheries Service 1994 Supplemental Spring Spill Program

Background

Prior to May 10, 1994, the standard spill scenario for the Lower Snake and Columbia River dams was according to the National Marine Fisheries Service's (NMFS) 1994-98 Federal Columbia River Power System Biological Opinion which was issued on March 16, 1994 as a result of Endangered Species Act, Section 7 consultation on hydropower system operation. Briefly, the Biological Opinion states that spring spill shall occur at three dams at the following rates: Ice Harbor - 25 kcfs for 12 hours, The Dalles - 10% of project flow for 24 hours, and Bonneville - 50% of project flow for 24 hours.

On May 9, 1994 the National Marine Fisheries Service requested that the U.S. Army Corps of Engineers (COE) and Bonneville Power Administration (BPA), at the earliest opportunity, implement an emergency spill program at all Federally-operated dams on the lower Snake and lower Columbia rivers. This action was deemed necessary to improve survival of spring outmigrating juvenile salmonids and was developed by the technical staff of the U.S. Fish and Wildlife Service and National Marine Fisheries Service and with technical input from regional State and Tribal fishery agencies. This operation began at 2400 hours on May 10 and consisted of an increase or initiation of spill at all eight Federally operated dams on the lower Snake and Columbia rivers to a level necessary to pass 80 percent of the juvenile outmigrants through non-turbine routes (80% FPE) but not to exceed 120% total dissolved gas saturation.

Water Quality Standards

Discussions began January 13, 1994, between NMFS the Environmental Protection Agency (EPA), Oregon Department of Environmental Quality (ODEQ), and Washington Department of Ecology (WDOE) regarding the 110% total dissolved gas (TDG) standard. On May 10, a letter was sent by NMFS to WDOE requesting a short-term modification of the standard. Since the ODEQ had no provision for a modification, a letter was sent by NMFS to the Governor of Oregon requesting assistance in obtaining a variance from the ODEQ Commission to manage gas levels above the state standard (letters were also sent to the Governors of Washington and Idaho asking assistance with their water quality standards).

The ODEQ Commission held a public meeting on May 16 to hear justification for exceeding the water quality standards and, on May 17, issued a Temporary Rule allowing exceedance through June 20, 1994. The WDOE issued an executive order to allow a one week exceedance of the 110% standard on May 10 and a short-term

modification to NMFS on May 18, 1994, which extended the exceedance period through June 20, 1994. Both agencies stipulated that TDG levels should not exceed 120% on a 12 hour average at any location in the rivers.

Spill Management

Spill was managed by NMFS through weekly meetings with all the affected agencies. Every Thursday, technical meetings were held to review the biological and physical monitoring data and every Friday in-season management meetings were held to request necessary changes in spill levels. On May 27, as a precautionary measure due to uncertainty about risks associated with the high prevalence of interior signs of gas bubble disease (GBD), NMFS requested that the spill levels be reduced by one third. Subsequently, the director of the ODEQ issued an order for a reduction of the allowable gas level in the Columbia River to 110% TDG, with instantaneous values not to exceed 115% TDG. No other reductions in spill or TDG were made until June 15 when NMFS made the determination that continued spill was unwarranted in the lower Snake River because 95% of the spring migration of juvenile threatened and endangered salmon had passed these dams. At this time, voluntary spill was ended at Lower Granite, Little Goose, and Lower Monumental dams and cut in half (from 24 hours per day to 12 hours per day) at Ice Harbor Dam. On June 17, NMFS terminated voluntary spill at McNary Dam in response to migration status and concern for fish survival under projected low flow conditions in the lower Columbia River.

The Monitoring Effort

A biological and dissolved gas monitoring program was developed by the NMFS and forwarded to the state water quality agencies on May 20, 1994. An updated version was sent to the ODEQ and WDOE on June 21 which included all revisions made during the spring spill season. In summary, the monitoring plan included: (1) daily external assessment of juvenile in-river migrant condition at five smolt monitoring facilities, four fish guidance efficiency research projects, and two river reach locations; (2) every other day internal assessment of 30 juvenile hatchery steelhead at each of the five smolt monitoring locations; (3)juvenile net pen studies in two dam tailraces; (4) periodic monitoring of adult migrant condition at three lower Snake and lower Columbia river dams; and (5) gas supersaturation monitoring at 23 lower Snake and lower Columbia River sites.

The results of the monitoring effort were reported daily to a wide distribution list and posted on two electronic bulletin boards by the Fish Passage Center. NMFS also issued a daily monitoring report, primarily to Federal fishery and hydropower management agency personnel. On each Thursday, the NMFS report included a memo containing interpretation of the biological data

for that week.

Monitoring Results

Between May 10 and June 17, a total of 188,526 juvenile salmonids were examined externally for signs of GBD. A total of 138 fish or 0.07% exhibited external signs. Table 1 provides a summary of external sign data by sample method.

Table 1. External sings of GBD in juvenile salmonids by sample method. Affected fish exhibited at least one cutaneous gas bubble.

Sample Mode	Total	Total Affected	Percent Affected
Snake R. SMP[1]	61,905	54	0.09
Col. R. SMP	91,524	25	0.03
SMP Separator	11,549	26	0.23
FGE[2]	21,772	30	0.14
River Reach	1,776	3	0.17
Total	188,526	138	0.07

[1] SMP refers to the Smolt Monitoring Program.
[2] Fish Guidance Efficiency (FGE) testing. Of the 30 fish affected, 77% were coho observed at The Dalles Dam on May 15.

Internal signs were observed in 973 (40.8%) of 2,387 hatchery steelhead examined between May 13 and June 21. See Table 2 for a breakdown of signs observed by location. These internal signs were predominately of low severity and of questionable relevance. A working group of experts on gas bubble disease met in Seattle on June 21, 1994. Several members of this group (who had earlier inspected the gas monitoring program and data) expressed the concern that the internal lateral line and the internal signs (gas bladder, kidney) data were not very useful for determining the prevalence or severity of GBD. They also indicated that the gill filament data, while important for determining impacts of elevated TDG on juvenile salmonids, were useful only if the examination technique was improved and made consistent among monitoring sites.

Table 2. Internal signs of GBD in juvenile salmonids by sample location. A total of 2,387 fish were sampled, 446 at LGS, 417 at LMN, 585 at MCN, 488 at JDA, and 442 at BON. Data are in percent.

Site	External Lateral Line	Internal Lateral Line	Gill Filaments	Internal Signs	Total Affected
LGS	0	0	18.6	3.6	20.8
LMN	0	0.2	20.1	18.9	32.4
MCN	0	0	0.2	0.5	0.7
JDA[1]	4.5	46.1	28.1	8.8	62.9
BON[1]	30.1	96.8	41.2	24.4	98.2

[1] Data are incomplete for JDA and BON.

A total of 860 adult salmonids (459 in the Snake and 401 in the Columbia) were examined between May 10 and June 20, with no external signs observed. Eighty-one percent of the adults were spring/summer chinook salmon.

Invertebrates and non-salmonid fish were also sampled in the river below Ice Harbor and Bonneville dams. Between May 10 and June 16, 1,321 non-salmonids were sampled below Bonneville Dam with no observed signs of GBD. Between these same dates, 3,467 non-salmonids were sampled below Ice Harbor Dam with 72 or 2.1% exhibiting GBD signs. Over half of the organisms demonstrating GBD signs below Ice Harbor Dam were observed during a period (May 11 through 18) when hourly dissolved gas levels, resulting from involuntary spill, exceeded 130%.

Physical monitoring data were calculated from data available from the COE CROHMS reports. Table 3 presents period average TDG for the monitoring sites most used in in-season management. Twelve hour averages would be more meaningful since spill normally occurred on a 12 hour per day basis. However, at this time those data are available only for the forebay monitors and monitors below Bonneville Dam (see table 4).

Table 3. Total dissolved gas monitoring results from COE monitoring locations. Data are in percent TDG and are averages of hourly TDG readings between the dates noted.

Location	May 10-27	May 28-June 19	Season Average May 10-June 19
LGR Forebay	104	102	103
LGR Tailwater	111	108	110
LGS Forebay	108	106	107
LGS Tailwater	115	108	112
LMN Forebay	113	107	110
LMN Tailwater	114	111	112
IHR Forebay	112	108	110
IHR 3.6 mi.[1]	122	121	121

IHR 7.6 mi.[1]	113	112	113
MCN OR Forebay	113	110	112
MCN WA Forebay	114	110	112
MCN Tailwater	115	112	113
JDA Forebay	110	103	106
TDA Forebay	109	105	107
BONN Forebay	112	107	109
Warrendale	114	112	113
Skamania	116	113	115

[1] Ice Harbor monitoring sites located 3.6 miles downstream on the north bank and 7.6 miles downstream on the south bank.

Table 4. Dissolved gas data presented as the average of the highest 12 hourly readings per day measured at forebay monitor sites and at Warrendale and Skamania. Data are in percent TDG.

Location	May 10-27	May 28-June 19	Season Average May 10-June 19
LGR Forebay	104	103	104
LGS Forebay	109	107	108
LMN Forebay	113	108	110
IHR Forebay	113	109	111
MCN OR Forebay	115	112	113
MCN WA Forebay	115	111	113
TDA Forebay	111	106	109
BONN Forebay	113	108	110
Warrendale	115	113	114
Skamania	118	114	116

Senator KEMPTHORNE. Both in the private and the public sectors, and in fact, in the public sector it's from Federal agencies, it's been stated, for example, on the Section 7 consultation process, that the National Marine Fisheries Service is extremely behind in meeting deadlines on the consultation process.

It has been suggested that the National Marine Fisheries Service may not have the resources to carry out all of the duties and requirements that have been placed upon it. I look at the track record of documentation or responses we've asked for that have not been forthcoming. Would you comment on your assessment of National Marine Fisheries Service and the resources that you have and the aspect of deadlines that are missed?

Mr. STELLE. Senator, I think that is a fair point. I know that the people that I oversee and manage in the Northwest region work incredibly long hours; they work weekends and they are carrying an extraordinary load. The volume of work is enormous. Have we been able to make all the deadlines? No, Senator, we have not. As the program requirements continue, our resources get cut back. It's a huge problem and I would fully admit that. I think it's frankly a problem for most of the Federal agencies that are struggling to implement some of these complicated programs while our resource base is dwindling.

Senator KEMPTHORNE. Would you comment on this? I had a conversation with representatives of the National Marine Fisheries Service expressing my concern about the delays, my concern about the fact that consultations do not take place, the fact that in some instances it's caused a Federal court to impose an injunction. When I pressed this point with representatives of the National Marine Fisheries Service, they have stated, well, if you would please be patient with us because we are traditionally an oceanographic agency and the inland waterways is a relatively new assignment for us. Taking that into consideration, then when I asked what is happening then to the salmon in the ocean, then I'm told, we don't know because it's a black box, would you comment on that because on the one hand, we look to the National Marine Fisheries Service because of this charge that you're to do it in the inland waterways, but we're reminded that you're an oceanographic agency primarily but you can't tell us what is happening in the ocean?

Mr. STELLE. The issue of what is happening in the ocean is indeed, I think, largely not adequately researched and if there is one area of the salmon life cycle that we collectively have not done a good enough job on, it is in researching and developing the information on what is going on in the ocean habitat and how that may affect the life cycle.

Has the Service or any other entity developed that kind of body of knowledge and information? No, Senator, we have not as of yet. Most of the focus of the Service from an ocean standpoint has been the more traditional bread and butter management of fisheries in Federal jurisdiction.

Senator KEMPTHORNE. Would you also give me your insight on why is the National Marine Fisheries Service in the Department of Commerce?

Mr. STELLE. Senator, I don't know. I think it's quite comfortable there. I don't know what the historical origins of that circumstance are though.

Senator KEMPTHORNE. Is it also accurate though that one of the primary charges of the National Marine Fisheries Service is to assure the harvest of the fish in the ocean, which is a large business program for the United States?

Mr. STELLE. I would not state it that way, sir. I think one of the primary responsibilities for the Service is the proper husbandry of our fishery resources, a component of which is harvest, but only a small component. I think if you talk to some in the fishing industry, they might say that our job is not harvesting.

Senator KEMPTHORNE. That's interesting because that is a little different than what a previous spokesman for National Marine Fisheries Service said at a prior hearing that really, one of the primary purposes is to support that business of this country, which is the fish that are harvested. This is a large economic benefit to the United States.

Mr. STELLE. Yes. I was speaking from a fisheries management perspective, sir. I didn't want to leave the impression that our primary job from a fisheries management perspective was to catch fish; it was to manage fisheries for long-term sustainability.

Senator KEMPTHORNE. I have a copy of a letter dated May 26, 1995 from Langden March, the Oregon Department of Environmental Quality, detailing 30 violations of the spill standard from April 26th to May 16th. Are you familiar with this letter?

Mr. STELLE. Yes, Senator, I am.

Senator KEMPTHORNE. Again, based on this when I consider whether or not this was a well-controlled spill, should I ignore this letter or is there basis for this letter?

Mr. STELLE. No, you shouldn't ignore it and yes, there is a basis for it. The source of those violations, sir, is to my knowledge largely a large volume of fresh water coming off in big flows this spring that well exceeded the capacity of a couple of the projects to manage that water. It had nothing to do with NMFS' voluntary spill program. Particularly at one of the projects at Ice Harbor, the river has been running at 120, 130, 140 thousand cubic feet per second and yet the hydraulic capacity or the ability of the project to pass water safely through the turbines is limited to about 66 kcfs. That means that about half your river is going over your spillway and generating very high levels of gas. Those, I believe, sir, are either the exclusive or most of the violations which the Oregon letter cites and they are correct, it's a problem. It's a significant problem. It is not part of the Service's voluntary spill program though.

Senator KEMPTHORNE. I will make that letter a part of this record.

[The letter and supporting documents follow:]

Oregon
DEPARTMENT OF
ENVIRONMENTAL
QUALITY

May 26, 1995

Mr. Ernest J. Harrell
Major General, US Army - Division Engineer
Corps of Engineers, North Pacific Division
P.O. Box 2870
Portland Oregon 97208-2870

Dr. William Stelle
Regional Director
National Marine Fisheries Service
Northwest Region
7600 Sand Point Way NE
Bin C15700 Bldg 1
Seattle, WA 98115

Dear Major General Harrell and Dr. Stelle:

NOTICE OF NONCOMPLIANCE

On April 14, 1995 the Oregon Environmental Quality Commission issued an order that provided for a variance to the state's water quality standard for total dissolved gas. The variance was granted to enable spill over Columbia River dams to assist outmigrating Columbia and Snake river salmon smolts.

The dissolved gas levels permitted in the order are.

a daily (12 highest hours) average of 115 percent as measured at established monitors at the forebay of the next dam downstream from the spilling dam;

a daily (12 highest hours) average of 120 percent as measured at established tailrace monitors below the spilling dams;

a cap on total dissolved gas for the Columbia River during the spill program of 125 percent, based on the highest two hours during the 12 highest hourly measurements per calendar day;

811 SW Sixth Avenue
Portland, OR 97204-1390
(503) 229-5696
TDD (503) 229-6993
DEQ-1

This variance to the standard was granted for the period from midnight on April 19, 1995 to midnight on August 31, 1995.

The following violations have been recorded since that time:

Date	Dam	Forebay/Tailrace	TDG Level
April 26, 1995	John Day	Tailrace	123 percent
April 27, 1995	Bonneville	Forebay	116 percent
April 28, 1995	John Day	Tailrace	121 percent
April 28, 1995	Bonneville	Forebay	116 percent
April 29, 1995	John Day	Tailrace	121 percent
April 29, 1995	Bonneville	Forebay	117 percent
April 30, 1995	Bonneville	Forebay	118 percent
April 30, 1995	McNary	Forebay	117 percent
May 1, 1995	Bonneville	Forebay	119 percent
May 1, 1995	McNary	Forebay	117 percent
May 2, 1995	Bonneville	Forebay	117 percent
May 3, 1995	Bonneville	Forebay	116 percent
May 3, 1995	McNary	Forebay	120 percent
May 4, 1995	Bonneville	Forebay	117 percent
May 5, 1995	McNary	Forebay	116 percent
May 5, 1995	John Day	Tailrace	123 percent
May 6, 1995	McNary	Forebay	118 percent
May 7, 1995	McNary	Forebay	117 percent
May 8, 1995	McNary	Forebay	117 percent
May 9, 1995	McNary	Forebay	117 percent
May 10, 1995	John Day	Tailrace	122 percent
May 10, 1995	McNary	Forebay	120 percent
May 11, 1995	John Day	Tailrace	121 percent
May 11, 1995	McNary	Forebay	121 percent
May 12, 1995	John Day	Tailrace	122 percent
May 12, 1995	McNary	Forebay	120 percent
May 13, 1995	McNary	Forebay	117 percent
May 14, 1995	McNary	Forebay	117 percent
May 15, 1995	McNary	Forebay	120 percent
May 16, 1995	McNary	Forebay	118 percent

These are Class One violations under Oregon Administrative Rules (OAR 340-12-055 (1)(a) and (h)), and should be considered major violations of Oregon environmental law.

You are hereby requested to manage the spill program to remain within the water quality standard established by the Environmental Quality Commission in its Order of April 14, 1995. Failure to do so will result in more serious enforcement action up to and including termination of the spill program authorization, if necessary.

We recognize that compliance with the standard may become difficult with the impending spring runoff and snow melt. Nonetheless, we believe that this is a critical water quality standard, and we will seek to discuss compliance with you further at the appropriate time.

Sincerely,

Langdon Marsh
Director

LM:MD:RH:crw
SA\WC13\WC13497
cc: Rudy Rosen, ODFW
Michele DeHart, FPC
Michael J. Spear, USFWS
Roy Hemmingway, Governor's Office
Mary Riveland, Washington Department of Ecology
EQC Members

SNAKE RIVER SALMON

RECOVERY TEAM

May 30, 1995

Mr. William Stelle
Regional Director
National Marine Fisheries Service
7600 Sand Point Way N.E.
Seattle, WA 98115

Dear Will,

The Snake River Salmon Recovery Team (the Team) has reviewed the March version of the Proposed NMFS Recovery Plan. This letter is to convey the Team's more important comments on NMFS' proposed recovery actions.

The Team supports much of the draft Recovery Plan. Your Plan embraces most of the Recovery Team's final recommendations that call for the use of independant scientific reviews to design and evaluate recovery methods and implement the concept of adaptive management. Under the plan we should obtain significant new information that will allow us to understand more fully flow augmentation, spill, transportation, in-river migration and the benefits of surface collectors.

Our general support should not be understood to negate the seriousness of some of our differences. Moreover, some of the differences between our submission of Final Recommendations and the current proposals from NMFS have been exacerbated with more recent scientific information and continuing analysis.

We recognize that some of our recommendations are not popular with some, but that does not deter us from seeking improvements in the NMFS Plan that we believe will benefit the listed salmon.

Our major differences are these:

- **Summary Tables (Duration Column):** Time scales need to be shortened for various activities.

- **Institutional structure:** The Scientific Advisory Panel should handle research oversight and resolution of scientific disputes.

- **Drawdown:** We have not seen a reasonable experimental design to test drawdown. Until the problems of downstream and upstream passage for both juveniles and adults, which we believe will increase salmon mortality, are addressed there should be no drawdowns.

- **Flow augmentation:** We do not accept the Plan's wording that implies that there is a known flow-survival relationship. We cannot concur with a shift in priority to spring flows as described in the NMFS Plan. First priority should be given to summer flows. We are concerned that the NMFS Plan appears to discredit the NMFS/University of Washington 1993-1994 Snake River survival studies.

- **Spill:** Spilling at collector dams is not in our judgment a viable recovery method even without gas bubble mortality.

- **Harvest:** We do not believe that giving harvest management responsibility to the Pacific Fishery Management Council and the Pacific Salmon Commission will result in recovery.

- **Habitat:** Some specific actions the Team recommended (i.e., an immediate moratorium on further non-fish-related development of critical habitat areas), and which were included in earlier NMFS Plan drafts, became "watered down" in the final draft to the status of federal agency guidelines rather than ESA-mandated specific actions.

Proposed Recovery Plan Summary Table and the Duration Column at the end of Chapter VI

The duration column of the tables should be reviewed and the time scales revised to shorter more reasonable ones. For example, over a year is suggested for the establishment of the Implementation Team and the Scientific Advisory Panel. The State of Idaho, responsible for insuring that water diversions are screened, is allowed 8 years to complete the task. The Conservation Districts and the irrigators are given two years to eliminate illegal "berms."

The Team is aware that it takes time to make fundamental changes in the status-quo but the proposed time frames are too leisurely given the crisis that is occurring in the basin. It will be increasingly difficult to advocate aggressive implementation of the expensive mainstem measures while simultaneously going slowly with other critical elements elsewhere in the basin.

Institutional Structure

The Institution section is the place to stress the importance of setting priorities. Some groups hold the mistaken view that we have unlimited resources to recover salmon. We know that funding will be limited and NMFS with the help of the Implementation Team and the Scientific Advisory Panel (SAP) must set priorities that will improve survival over the interim while generating additional information through monitoring and evaluation that will enhance our prospect of making significant improvements in system operations or reconfigurations.

The new institutional structure is needed to bring order out of the present chaos. We cannot recover the salmon without a single and accountable decision point to implement recovery. The Team recommended that NMFS, because of its responsibilities under ESA, become the decision maker with regard to matters that affect the listed Snake River salmon. In order to develop the infrastructure and operating procedures NMFS requires the resources for it to proceed.

The section on data collection, managing and disseminating of data is well done and needs to be implemented immediately. These activities should be carried out through an open public process. We support using a distributed system such as the World Wide Web currently being developed on Internet. The Team strongly recommends that NMFS use an open public process to stimulate research and debate on the effectiveness of salmon recovery measures.

We question the NMFS' proposal that the Implementation Team should be an administrative identity that will "direct research" and the dispute resolution discussion is incomplete and inadequate. In the U.S. v. Oregon process unresolved disputes escalate to a district judge. This seems to be in conflict with statements elsewhere in the Plan that NMFS will make final decisions.

The Team's recommendation was that the Scientific Oversight Committee, (SOC) now your SAP should provide a process for resolving disputes and assessing scientific validity. The Team further recommended that the SOC should establish research priorities and review and approve research designs. In this way the SOC would handle research oversight.

Drawdown

The Team's final recommendations to NMFS were negative about drawdown however, we left open the possibility of a test if a reasonable experimental design was developed that would not put fish at significant risk. As of this date we have yet to see an experimental design that would successfully test drawdown as a recovery strategy. We note that you will make a decision on whether to conduct a short term drawdown in 1996. There are a number of problems with near-term spillway crest drawdowns such as: the loss of the collection facility, dipping fish out of the gatewells or removing screens, the operation of turbines at off-peak efficiency, the installation of rock weirs to protect the spilling basins and the passage of adult salmon past the drawdown experiment. These problems will, in our opinion, be detrimental and result in increased mortality to salmon. Until the problems of fish passage are resolved there should be no spillway crest drawdown.

Flow Augmentation

As we have commented before, we do not know how much water is needed for fish and there is large uncertainty about the relationship of flow to survival. The Team has acknowledged that there is a flow survival relationship that is yet undefined for presently existing river and reservoir conditions. We did not accept a specific flow survival relationship as implied by your wording: "[the Team] acknowledged the validity of the flow survival relationship." We have recommended that the amount of flow and its allocation needed careful testing. The plan is silent on the details of testing and we suggest that a more detailed plan of operations be developed.

We are concerned that the NMFS proposed plan recommends spring flows as the highest priority for use of available reservoir storage. The NMFS plan relegates what we believe to be the highest priority, the use of reservoir storage for augmentation in the summer, to "conserving *some* water for flow augmentation in July and August."

The Recovery Team has recommended that first priority be given to augmenting flows in the summer to aid fall chinook salmon juveniles because: (1) there is some evidence that flows of 50 kcfs aid fish passing through the reservoirs in the summer, (2) flows are likely to be below 50 kcfs during much of the summer migration season in years with average or below average runoff, (3) flows during the spring migration are both cooler and higher than in summer and (4) the warm reservoir temperatures in the summer could be reduced by drafting cooler water from reservoir storage. There is evidence that flows may be adequate during the spring migration in most years and that much of the water that is currently drafted in the spring could be better used to benefit adults and fall chinook juveniles in the summer. Only in years of extremely low runoff would significant amounts of augmentation be needed in the spring.

We believe the NMFS Plan for use of stored water to augment flows is not adequately described. We agree with the general goal of using flow augmentation to attempt to increase survival, but when and how much to augment is left to the Technical Management Team (TMT) with unclear guidance on priorities, interpretation of inconsistent recommendations and application of flow objectives. Flow augmentation in the spring should be minimized and used, if needed, primarily during the later part of April and May when most of the salmon and steelhead are moving downstream. If large numbers of chinook arrive at Lower Granite Dam in April and flows are low, it may be necessary to augment flows until natural runoff increases. The Team recommends that the highest priority for the use of the water in Dworshak Reservoir should be for fall chinook in late June, July and August. For this reason, the Team recommends that NMFS maximize the refill probability for Dworshak Reservoir so that the full storage capability is available during the summer.

We recognize the importance that NMFS places on the reach survival study and believe that the Plan should reflect that emphasis more strongly. The Proposed Recovery Plan seems to discredit the NMFS/UW survival studies conducted in the Snake River during 1993 and 1994 by claiming the studies cannot be used to assess mortality and condition of fish at the estuary. These studies were not designed or intended to measure survival in the estuary. The Plan should stress your belief that survival studies are critical to gaining an understanding of how juvenile salmon are surviving as they emigrate out of the system. The Team recognized that the studies were the best available information on downstream passage survivals even though they were limited to the Snake River. The Team recommends that the Plan more clearly express NMFS's support for the continuation and extension of reach survival studies down to, and including, the estuary.

The results of the first two years of the NMFS/UW studies have caused interested fishery scientists to rethink some of their assumptions on reach survivals. When the Team began the development of our Recovery Plan Recommendations, over three years ago, it was commonly thought that smolt survivals were exceptionally low in the first reservoir encountered as they migrate out of the system. For this reason, recovery recommendations were focused on decreasing water-particle travel time and presumably fish travel time. It was believed that this would reduce exposure to predators and increase survivals.

The first two years of the NMFS/UW survival study have not confirmed previous conventional wisdom. In fact, the results were similar in both years and showed reservoir survival in Lower Granite that approached 100 percent over a wide range of flows during the out-migration. This is precisely the type of information that is absolutely necessary for anyone to design and implement a recovery plan. With a better understanding of reach survivals, recovery measures can be tailored to reduce mortality as fish move through the system.

The NMFS Recovery plan states that NMFS/UW studies were made during a "very narrow range of flow condition and so cannot be used to compare survivals at different flow levels." The studies were conducted over the last two years and because the flows vary significantly during each season they were able to collect survival data over a wide range that varied from low to relatively high flows. The relationship of flow to survival will come from repeating these studies over many years. While the limitations of the data leave considerable uncertainty and unknowns, the Team has not seen a relationship between survivals of yearling chinook and flow in the upper two reservoirs.

Spill

The Team believes that the role of spill as a component of the interim operations of the hydropower system merits reexamination, and recommends to you that you undertake such a review .

In our February letter to you and in our extensive earlier discussions of this topic, we supported the conduct of a spill program at all non-collector projects and at collector projects under certain terms and conditions to create in-river conditions for a transport vs. in-river survival evaluation.

The Team has further considered its earlier view and is concerned about the risks of elevated dissolved gas concentrations associated with spill at all the dams. It appears to us that the risk to migrating fish may outweigh the benefits of spillway passage. We are still learning about what level of spill is appropriate and how we can evaluate the impacts of spill and high dissolved gas levels on migrating fish.

We now believe that a more limited use of spill will allow for the continued scientific evaluation – which we support – while minimizing the risks that excess spill may pose to listed salmon. We therefore recommend that the NMFS review the core elements of the spill program based upon the new information being collected. We believe that such a review would be the best example of applied adaptive management and would reflect your continuing commitment to the use of the best science available in the conduct of the recovery effort.

This recommendation is based on the Team's analysis of the likely changes in survivals due to the spill program. The Team has developed these estimates using assumptions from your staff for mortalities through the three possible dam passage routes and through the reservoirs. The three ways that fish pass a dam are over the spillway, through the turbines or via the bypass system. Using the survival assumptions that we received from NMFS staff, it appears that for those fish emigrating in the river, less than 40 percent of the fish that reach Lower Granite dam will survive to below Bonneville Dam. This is with an assumption of no increased mortality due to nitrogen supersaturation. With a small 2.0% increased mortality in each reservoir due to gas bubble disease the survival of fish emigrating in the river with spill will be less than without spill. The survival of fish that emigrate in the river is low because of the cumulative mortality of emigrating through eight reservoirs and over or through eight dams. With such low in-river survivals, spilling at the collector dams is not a viable recovery method even without a gas bubble disease problem.

Figure 1 illustrates the survivals that the Team calculated using NMFS assumed survival estimates for each reservoir below Lower Granite and for all passage routes through each dam. These survival calculations are based on the percentage of fish that pass each dam by the three alternate passage routes. During spill, at a dam with a bypass system, the fish will either go over the spillway, into the turbines or be captured in the bypass system for collection and transport or in some cases returned to the river. Figure 1 illustrates the in-river survival conditions with and without spill at all projects. The in-river survivals without additional spill are 37 percent to below Bonneville and with spill at all projects as recommended by NMFS the in-river survivals increase to 40 percent. This is a very small increase that probably cannot be measured and again assumes no increase in mortality caused by increased dissolved gas.

Figure 1 also illustrates the projected survival of fish to below Bonneville taking into account the fish that are collected and transported. The current transportation system when combined with fish emigrating in the river will result in approximately 78 percent of the fish that approach Lower Granite surviving to below Bonneville. Under the NMFS proposed spill program this survival is reduced to 74 percent because fewer fish are collected for transport and therefore more fish are exposed to the cumulative mortality of emigrating past eight dams and reservoirs. Again, the difference between these survival estimates is probably too small to measure but the general level of survival under the proposed spill program is likely to reduce survivals of listed salmon to below Bonneville dam.

The Team believes that spill is not a viable downstream passage solution. The current spill program will result in such a small change in survivals that it will be impossible to measure while at the same time presenting substantial survival risks due to gas bubble disease. While the Corps of Engineers (Corps) and NMFS are doing their best to manage dissolved gas levels, it is apparent that technical and management failures have led to gas supersaturation that exceeds the NMFS standards of 115% forebay and 120% tailrace. The result is that we do not have the ability to control gas concentrations to precisely set levels and the impacts of gas bubble disease could exceed the possible benefits of avoiding turbine mortality. Our analysis has shown that the reductions in mortality in passing dams with spill are more than offset by the increased risk of supersaturation and the cumulative mortality of passing multiple reservoirs and dams.

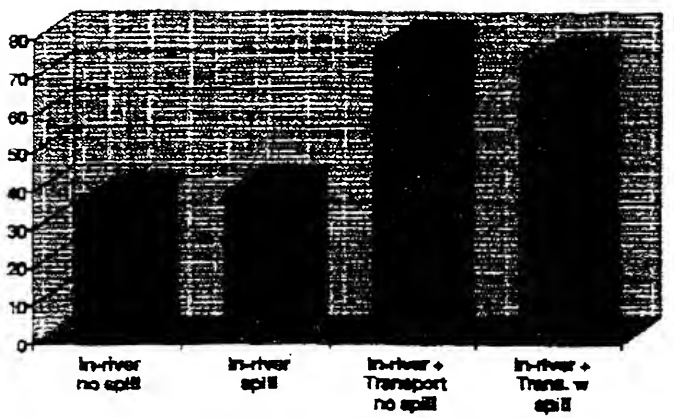

Figure 1 – Calculated survivals based on NMFS survival estimates

The Team continues to support the development of efforts on alternative surface collection and bypass systems because they offer the opportunity to move fish past a dam without creating gas supersaturation problems. Given the existing configuration of spillway gates and stilling basins, spill must be limited to reduce the impact of dissolved gas on survivals. In the future, reconfigured spillways may be able to safely pass greater amounts of spill than is presently prudent but there must be substantial amounts of research and engineering before this will be a reality.

Surface collection and vertical slot bulkhead gates at spillways currently hold promise of increasing the portion of the fish that avoid the turbines while increasing the numbers of fish spilled per volume of water spilled.

The Team has followed development in surface oriented bypassing and collection since publishing our Final Recommendations in 1994. We are now even more optimistic that preliminary prototype tests will show the ability to increase survival past dams. We suggest that efforts and expenditures for testing surface collection be increased, perhaps at the cost of de-emphasizing other alternatives such as installing extended length screens at the mainstem dams.

NMFS should follow closely the surface collection work by the Corps at Ice Harbor and Lower Granite; and by the PUD's at Rocky Reach and Wanapum.

Flood Control

The recent incident of mortality in fish pens below Ice Harbor Dam suggests that we should reconsider spring flood control and flow augmentation strategies. In hindsight, it seems that both the Team and NMFS concentrated on the situation when the years were dry and we needed to maximize the use of flow augmentation. Our recent experience with involuntary spill that results in high levels of gas supersaturation, shows that NMFS needs the ability to reduce river flow. The recent fish kill below Ice Harbor is an example where in-season management decisions could have reduced the flow augmentation and spill levels above Ice Harbor dam sooner when the turbine problem caused high gas levels below the project. As gas saturation levels increased into the lethal range, flow augmentation should have been reduced sooner to decrease the amount of water that needed to be spilled at Ice Harbor. Also the spills that were ordered above Ice Harbor contributed to the saturation level of the water in the forebay. This added to the amount of supersaturation below the project. With the present forecast of large involuntary spill at the end of May, it is a delicate balance to determine how much nitrogen we take over the short term in order to reduce the peak total dissolved gas in late May taking into account of the number of fish in the river. These types of operational decisions are precisely what is implied by the term in-season management.

The high gas levels at Ice Harbor emphasizes the importance of turbine maintenance and gas abatement measures such as "flip lips".

Dissolved Gas Levels

With your recent request to the Departments of Environmental Quality we recognize that the numbers in the NMFS Proposed Recovery Plan have been superseded. We have not seen data to indicate that 115% TDG should not be applied at all monitoring stations and the use of 120% as the limit in the tailrace concerns us. We understand that internal monitoring of gas bubble trauma will be carried out by the National Biological Service. We feel that last year's recommendations of NMFS's Expert Panel on Dissolved Gas should be fully implemented as soon as possible. This will require internal monitoring in order to determine the state of vascular tissue. The Expert Panel called for examination of fish obtained from the collector systems as well as the forebay so we can determine if bubbles are removed by decompression in the collector system. Techniques that will not introduce bubbles, (i.e. examination of gill lamellae), will be used with salmon as well as steelhead. We also recommend that hatchery steelhead be sacrificed for internal samples and that similar live samples be held in the river to provide a measure of mortality. With the almost certainty of high

dissolved gas in the next few weeks we should obtain as much information as possible to resolve the uncertainties for planning future monitoring.

Transport

The NMFS decision to rely primarily on the collection and transportation systems to get most of the smolts past the dams and the reservoirs, until in-river migration has been proven as a better option, is a wise choice in our view.

Harvest

Much of the harvest section of the draft Recovery Plan is very well done. The Harvest section should point out that since reductions in Harvest can have immediate effect on returning adults it is imperative that actions be initiated as quickly as possible. This will initiate the recovery process until other measures begin to take effect.

The draft Plan should specify that phasing out of the lower river gillnet fleet is required because of intermingling of Snake River fall Chinooks with healthy up-river brights and hatchery stocks. The Team is disturbed that some harvest alternatives have been removed from the latest NMFS Proposal. Specifically the Pacific Fishery Management Council (PFMC) and the Pacific Salmon Commission (PSC) are given the responsibility of recovering Snake River Salmon by controlling harvest. The Pacific Council does not have a management record that demonstrates a high concern for weak stocks. NMFS seems to propose that the Pacific Salmon Commission meet their Chinook rebuilding schedule that has not shown a trend toward rebuilding since it was started in 1984. This requires an assumption that the Commission will change their past harvest rules and adopt an immediate rebuilding schedule. The Team does not believe that the Commission will adopt the changes necessary to establish a rebuilding schedule. In fact, the Commission has repeatedly ignored its own bilateral scientific reports recommending that chinook harvest be reduced in order to meet the rebuilding schedule. The Team doubts that the Commission will develop, adopt and implement a rebuilding schedule that will meet the needs of coastwide Chinook populations in a timely fashion.

It would be desirable to manage harvest of Snake River Chinook within the framework of the overall PSC chinook rebuilding program. If that cannot be accomplished we must have a fall back position that places the burden on fisheries subject to U.S. jurisdiction. We agree that the sacrifice required to save a very small number of Snake River falls, most of which will be caught in Canada, is not practicable; hence the greatest reductions must occur in the entire in-river harvest plus the ocean catch off Oregon and Washington. We are encouraged by your report that the PMFC recognizes this need. The in-river harvesters must also be convinced of its critical importance.

If we cannot maintain tight control over the harvest of the endangered Snake River Chinook, many of the gains from other recovery methods will be lost.

Habitat

The Team commends the Plan's strong support for the our recommendations on the coordinating role of the Habitat Committee, emphasis on the effective monitoring of habitat protection and restoration progress; and the need for management agency and stakeholder participation in development of long-term sub-basin habitat management plans.

However, the Team is disappointed that the specific actions the Team recommended (e.g., an immediate moratorium on further non-fish-related development of critical habitat areas), and which were included in earlier NMFS Plan drafts, became "watered down" in the final draft to the status of federal agency guidelines rather than ESA-mandated specific actions. As a result, implementation of the proposed habitat protection and recovery measures will depend upon NMFS ability to persuade cooperative supportive action by other federal agencies, without the certainty of ESA-mandated directives. The Team urges NMFS to be strongly proactive in driving toward that essential multi-agency cooperative action.

I have sent copies of this letter to the two members of Congress who have asked us to review the NMFS Recovery Plan.

As we have said before, we appreciate the time and effort that you have made to attempt to bring the NMFS Proposed Recovery Plan into agreement with the Team's final recommendations.

We continue to hold the view that we expressed earlier. Time is not on our side and the continuation of argument or legal challenges, regardless of merit, will surely damage the Snake River sockeye and chinook salmon.

If you need further information or explanations of our comments please call upon us.

Sincerely yours,

Donald E. Bevan

Donald E. Bevan, Ph.D.

For the Snake River
Salmon Recovery Team

cc:
Senator Mark Hatfield
Congressman Norm Dicks

COMMENTS OF THE DIRECT SERVICE INDUSTRIES AND PACIFIC NORTHWEST GENERATING COOPERATIVE ON THE NMFS PROPOSAL TO INCREASE ALLOWABLE TOTAL DISSOLVED GAS IN THE COLUMBIA RIVER

Years ago, state and tribal fishery agencies and the United States Environmental Protection Agency conducted a "comprehensive review and syntheses of [gas bubble disease] research" which was also "reviewed by the Water Quality Section of the American Fisheries Society". (Tab 1, at 1; see also Tab 2.) The state and federal governments ultimately adopted a standard of 110% allowable total dissolved gas supersaturation that was specifically engineered to protect migrating fish in the Columbia River Basin (Tab 2, at 1; Tab 3).

L.B. Day, then Director of Oregon Department of Environmental Quality, supported a limit of 105%:

> "'I maintain that the risk of killing fish by setting the level too high is a much more serious one than the risk of taking a cautious approach so that the fish are protected.'" (Tab 4)

Since then, the effects of supersaturated water on salmon remain the same. Only the politics have changed. For the reasons set forth below, NMFS' eleventh-hour request to set aside a sound water quality standard should be rejected.

1. **Enormously significant relaxation of state water quality standards should not be adopted in abbreviated proceedings.** Last year, water quality decisionmakers reluctantly approved a spill "experiment" that state and tribal fishery agencies admit produced no evidence of increased survival from increased spill. (See Tab 5, at 3.) Fishery policy spokepersons have long known that water quality waivers would be required this year to support their desire for increased spill. They were advised by DEQ staff and others to present their justification for their proposals in a fashion that would allow reasoned consideration, and did not do so. A ten-day comment period on changing a water quality

standard that has protected aquatic life in the Columbia for many years does not promote well-informed decisionmaking. Our ability to respond to NMFS' proposal has been seriously hampered by the shortness of the time period allowed for public comment.

2. **The spill program will decrease salmon survival, not increase it.** NMFS recognizes that the most accurate computer model of juvenile salmonid survival is the CRiSP model, developed by University of Washington researcher Dr. James Anderson. Applying the model to NMFS' spill program, Dr. Anderson reports that it will decrease the survival of migrating spring chinook salmon by at least 2.5% (and probably more) (Tab 6, at 3-4), primarily because the spill program will decrease the percentage of salmon transported around the dams. A staff report by NMFS' own scientists offers an even higher estimate of the decrease in survival than Dr. Anderson: they report a 4% decrease in survival. (Tab 1, at 5 & Table 1 (decrease from 79% to 74% survival).) Dr. Don Chapman confirms that "relaxed restrictions on gas supersaturation, to the extent that they lead to increased voluntary spill, will do smolts no favor. The available data indicate that juveniles are better off if left in barges." (Tab 7, at 4.)

3. **The state and tribal "1995 Spill and Risk Assessment" document cannot be relied upon to support any increase in allowable TDG.** Two NMFS scientists who reviewed the Risk Assessment document identified "major deficiencies" in it. (Tab 5, at 1.) This conclusion is shared by former NMFS scientist Dr. Wes Ebel (Tab 8, at 2 & Exhibit A), Dr. Larry Fidler (Tab 9), Dr. Don Chapman (Tab 12), and Dr. James Anderson (Tab 22), all of whom have advised the Oregon DEQ that the Risk Assessment should not be relied upon. DEQ staff appears to share this assessment. (Tabs 18-21.) Frankly, the state

and tribal fishery agencies have not demonstrated the requisite scientific expertise on TDG to render informed judgments on this question. (Tab 13.)[1] We note that the agencies have been aware of these deficiencies for over two months, and have deferred responding until the very close of the public comment period.

4. **A massive spill program is unnecessary to achieve NMFS' goal of passing 80% of salmon around turbines.** As Dr. Ebel explains, NMFS and the states and tribes have erroneously assumed that the percentage of fish passed over a spillway is identical to the percentage of water spilled. Several studies deny this assumption, and indicate that almost all salmon can be passed around the turbines with much lower levels of spill that do not require water quality variances. (Tab 8, at 7-8.) The Snake River Salmon Recovery Team, keenly aware of the problems associated with high spill levels, has concluded that "spill is not a suitable long term recovery method". (Tab 15, at 2.)[2]

5. **The proposed monitoring is inadequate.** The U.S. Army Corps of Engineers, BPA and the Snake River Salmon Recovery Team all recommend that "any spill program should be based on TDG level measured in the tailrace of each dam". (Tab 14, at 4; Tab 15, at 2.) NMFS, however, wants TDG measured in the forebays of the dams and at downriver monitoring stations showing consistently lower TDG measurements (Tab 8, at

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[1]NMFS does have scientists with the requisite expertise, but we doubt they will appear in these proceedings. NMFS' scientists offered lukewarm support at best for an instantaneous limit of 120% of saturation (Tab 1, at 3 (such a standard "could be adopted on a temporary basis").

[2]This comment is contained in a letter to NMFS endorsing the January 25th draft biological opinion. When the Team learned that NMFS had increased spill and decreased transportation in the face of threats of litigation and political pressure from the state and tribal fishery agencies, the Chairman of the Team indicated that the Team's endorsement was no longer valid. (Tab 16.)

5). NMFS also proposes to monitor for visible external signs of gas bubble disease in migrating smolts, but this is "unlikely to provide adequate protection for salmon" because "[b]y the time gas bubble disease is widely apparent in either the juvenile or adult populations, it is likely that substantial losses will have occurred". (Tab 8, at 6.) NMFS' own scientists note that "[m]any researchers experienced in examining fish for external signs of GBD refute the validity of this method of assessment". (Tab 5, at 5 (referring to adults).) To the extent that a determination is made to relax the standards, Dr. Larry Fidler notes that it is essential to conduct a "microscopic examination of gill lamella and lateral lines" (Tab 11) -- monitoring apparently omitted from the NMFS monitoring plan.

6. **The spill program will cost Northwest electric ratepayers at least $40 million dollars.** Federal, Oregon and Washington law all require water quality standards to be set after consideration of all beneficial uses of the water, including hydropower generation, and consideration of economic impacts.[3] Douglas Faulkner, senior operations engineer for the DSIs, estimates that granting the water quality variance sought by NMFS will result in the loss of 4,500 megawatt-months of power, enough to power the entire City of Seattle for four-and-one-half months. (Tab 17, at 2.) This in turn will impose some $42 million in additional costs on BPA ratepayers. (Tab 17, at 3.)

Dated: April 7, 1995

Jacob Tanzer
Attorney for DSIs

R. Erick Johnson
Attorney for PNGC

[3]Indeed, Washington state law prohibits short-term modifications to water quality standards where, as here, doing so would "significantly interfere with . . . existing water uses". WAC 173-201A-110(2).

References

Tab	
1	"Recommendation and Rationale for a 115/120% Limit on Total Dissolved Gas in the Columbia and Snake Rivers", NMFS Internal Memorandum (1995)[4]
2	Summary Report on Nitrogen Supersaturation in the Columbia and Snake Rivers, U.S. Environmental Protection Agency, Region X (July 1971)
3	[Excerpt] Quality Criteria for Water, 1986. U.S. Environmental Protection Agency, EPA Doc. No. EPA440/5-86-001
4	"Fight against fish kill goes on", The Seattle Times, Nov. 14, 1971.
5	"Review of Gas Bubble Disease Risk Assessment", S. Grabowski (NMFS) to M. Schiewe (NMFS), March 7, 1995.
6	Affidavit of Dr. James Anderson, April 7, 1995.
7	"Comments on proposals to decrease constraints on gas supersaturation", Dr. Don Chapman, April 7, 1995.
8	Letter, W. Ebel to W. Wessinger & E. Schlorff, April 7, 1995.
9	Letter, L. Fidler to R. Baumgartner, Jan. 9, 1995.
10	Letter, L. Fidler to R. Baumgartner, March 13, 1995.
11	"An Incremental Spill Program", L. Fidler, April 7, 1995.
12	Comments on "Spill and 1995 risk management", Dr. Don Chapman, February 1995.
13	Letter, G. Bouck to R. Baumgartner, Dec. 22, 1994.
14	Comments on Draft Biological Opinion, U.S. Army Corps of Engineers & BPA, Feb. 9, 1995.
15	Letter, D. Bevan to W. Stelle, Feb. 14, 1995.
16	"NMFS to Release Recovery Plan; BO Spill Levels Defended", Clearing Up, March 21, 1995, at 6.

[4]According to NMFS's Donna Darm, this memo was originally written by NMFS scientist Michael Schiewe, and was then "finalized as a summary document".

17 Affidavit of Douglas Faulkner, April 7, 1995.

18 "Review of Flow Relationships in Spill and Risk Management 1995", R. Baumgartner, Feb. 2, 1995.

19 "Review of Adult Analysis in Spill and Risk Management 1995", R. Baumgartner, Feb. 3, 1995

20 "Review of Spill and Risk Management 1995", R. Baumgartner, Feb. 6, 1995.

21 "Review of Juvenile Mortality Functions in Risk Management 1995", R. Baumgartner, Feb. 8, 1995.

22 "A review of the mathematical approach used in 'Spill and 1995 Risk Management'", J. Anderson, Feb. 15, 1995.

Senator KEMPTHORNE. I also have a question relative to the letter dated May 30, 1995 from your own recovery team headed by Dr. Bevan. This letter is critical of the spill program. It says, "Spilling at collector dams is not, in our judgment, a viable recovery method even without gas bubble mortality." Have you responded to that letter and if so, what is the response?

Mr. STELLE. I haven't responded in writing, Senator. I have met with the team several times on that subject, both prior to and after the drafting of the letter. I believe that one, I don't quarrel with some of the assumptions and analyses that the team used in reaching that conclusion. The important point that I would offer, though, is that in my judgment, pursuing a spill program at the downstream projects doesn't necessarily represent a conclusion that it is better overall; it represents a conclusion that it is necessary to develop the information to test whether or not we can improve in-river migration conditions sufficiently so that they become an essential part of the recovery effort. It is, in essence, a large-scale, multiyear evaluation of both the benefits of transportation and in-river migrations. I think the team understands that. I think the team has made its own conclusion on that larger evaluation.

In my view, the team's point deserves to be reviewed. I mentioned earlier on in my testimony that it would be our intention to review this fall both the data generated by the 1995 program and the basic parameters governing that spill program with the team's recommendation.

Senator KEMPTHORNE. Does that mean that the spill program can be used as an experiment?

Mr. STELLE. The spill program is part of a larger evaluation, yes, sir.

Senator KEMPTHORNE. So it can be used as an experiment?

Mr. STELLE. Absolutely, sir.

Senator KEMPTHORNE. Colonel Bohn, would you respond to this? There are a number of people who are dedicated to the recovery of salmon. Are there too many players in the decisionmaking process to bring about the recovery of salmon?

Colonel BOHN. Mr. Chairman, I think I would say that each one of those players, each one of those interested parties has a very important role. In our negotiations and consultations with the National Marine Fisheries Service, we have tried to simplify the process by relying upon their best scientific judgment to make those tough biological calls on the biological justifications for each measure. We feel they are best qualified to do that. That has simplified the process for us and we get clear guidance from the National Marine Fisheries Service. We go into consultations over that; discuss it at great length and then we make final decisions on the operations of our projects.

Senator KEMPTHORNE. Maybe I should ask Mr. Stelle that question. Are there too many players in the decisionmaking process?

Mr. STELLE. Senator, that's a good question and a difficult question and I think the answer is necessarily no, on one basic level. That is, there are legitimate interests in this basin and in the region as you well know among a number of different governments. Each State has a substantial interest in the management of this basin and in the protection of its fish and wildlife resources. The

14 tribes are, themselves, independent sovereigns and they too have a very substantial interest and obviously the Federal agencies who own, operate and run those projects also have a substantial interest.

Any successful recovery effort, in my view, has to be part and parcel of the larger fish and wildlife program in the basin. It has to fit. The judgments that we make in executing our responsibilities in turn have to fit. Is it a simple system? No, Senator, it is not a simple system, but life in the Northwest is not simple and there are a number of different governments that must and should be involved in all aspects of it. It's a complexity but an appropriate and necessary complexity in our Federal system.

Senator KEMPTHORNE. Just for clarification, is the National Marine Fisheries Service in charge of the recovery effort under the Endangered Species Act?

Mr. STELLE. Yes, Senator.

Senator KEMPTHORNE. Colonel, relative to the spill program, what have your Corps biologists said with regard to whether the spill program should be pursued? Did they concur with the NMFS decision to pursue an aggressive spill program this year?

Colonel BOHN. Mr. Chairman, our biologists were in consultation with NMFS throughout the process of developing the biological assessment and the biological opinion, so we know exactly every facet of their studies and their data and we have shared any information we have.

We believe that the spill program is a valuable part of the overall program. We believe it is an interim step that helps, in some cases, if you carefully monitor the physical results of that spill program.

Senator KEMPTHORNE. That is a big if, isn't it, because wasn't the monitoring of the 1994 spill put in after the fact?

Colonel BOHN. Essentially, it was, sir.

Senator KEMPTHORNE. So it was purely an experiment?

Colonel BOHN. I wouldn't characterize it as an experiment; I think it was a very well thought-out, additional measure that could be added to assist in the survival of the juvenile salmon.

Senator KEMPTHORNE. But Colonel, it's been stated that experimenting is very appropriate and very much a part of this and if you're pursuing science, don't you need to have monitoring for an evaluation of results to determine if you're getting the results you want?

Colonel BOHN. That's correct, Mr. Chairman, and we take our role in the physical monitoring of this process in a very serious way. So we have, again, concentrated on the physical monitoring, identifying the actual gas levels in the rivers from over two dozen monitoring stations.

Senator KEMPTHORNE. Colonel, what is your attitude about the scientists that testified at the previous panel stating — and it was divided, it certainly was not unanimous—those scientists who felt that a spill was either not advantageous to the fish or, in fact, was causing damage?

Colonel BOHN. Mr. Chairman, again, we're going to rely upon the very careful, professional justifications from the National Marine Fisheries Service. We know that when you gather all the scientists in the region that are interested in the fisheries issue and the

salmon survival, there are many different opinions. We understand that and we, again, are going to rely upon NMFS to sort out those differences.

Senator KEMPTHORNE. That's a good response.

Can we recover the salmon, Colonel?

Colonel BOHN. Mr. Chairman, I think we can. We're showing some results already from NMFS' studies in 1993 and 1994, that survival through the pools and through the dams in the lower Snake River is, in fact, higher than previously understood from earlier studies in the 1970's, so we think that the measures and all the effort we've put into the facilities are improving survival.

What we can't comment on is how that improvement in those physical conditions as the salmon pass those eight hydroelectric projects will affect the overall life cycle of the salmon and if it will ever result in a greater return of adult salmon.

Senator KEMPTHORNE. Now, Colonel, we've discussed a lot of science today. You are an engineer by profession?

Colonel BOHN. Yes, Mr. Chairman.

Senator KEMPTHORNE. Could you and I agree, you're the engineer but I'm a layman, but could we agree that probably the major obstacle to the recovery of the salmon are the dams?

Colonel BOHN. Mr. Chairman, I'd say that the dams are an important factor in recovery of the salmon. It's really unclear as to exactly the role they play versus all the other factors that are impacting on the salmon.

Senator KEMPTHORNE. As an engineer, are we doing all that we could to modify those dams to your satisfaction?

Colonel BOHN. Mr. Chairman, we have I think every measure that is practical and usable built into the biological opinion. Of course the biological opinion for 1995 addresses operations between 1995 and 1998. However, it considers measures for improving the system well into the next decade. We think those measures have all been considered, those that are useful are in the program, and we want to pursue that in a very orderly fashion, identifying the useful measures and spending our funds wisely to achieve the best success.

Senator KEMPTHORNE. Would you put surface collection devices in place to collect the smolts?

Colonel BOHN. We'd like to go ahead as soon as we can and have workable designs for surface collection and install them. They probably hold the most promise of all the ideas out in the region, and again, we accept ideas from all sources, and surface collection is probably the best idea that we have going right now. We have projects ongoing both within the Portland District and the Walla Walla District to install prototype facilities this year and test some of the hydraulic features of surface collection. We want to be very careful that before we start going to full scale construction on these installations that they, in fact, work. We visit other projects where they are in place and we consult with those folks operating that kind of system now.

Senator KEMPTHORNE. Mr. Stelle, in his testimony, stated that the dams were "not fish friendly." Do you agree with that or is that hard for an engineer to say?

Colonel BOHN. Given the alternative, the installation of the dams has certainly made it more difficult for the salmon to move up and down through the river.

Senator KEMPTHORNE. Are you familiar with our efforts toward the development of a fish friendly turbine?

Colonel BOHN. Yes, I am, sir.

Senator KEMPTHORNE. We received the appropriation this year and Mr. Stelle, are you supportive of that effort?

Mr. STELLE. Yes, sir. I think that holds some promise. I think we should all get aggressive and creative in our efforts to make modifications to the dams, the surface collection, some of the passages around these dams.

Colonel BOHN. Mr. Chairman, we're currently addressing every possible way to streamline our processes and move out more quickly, move through the study phases, move through the prototype phases, and move on to the full scale implementation of as many good ideas as we can come up with.

Senator KEMPTHORNE. I appreciate that, Colonel.

Mr. Stelle, finally, do you see why a lot of folks are very concerned with the decision on spill when we look at the results of the 1994 spill, which were just a few weeks after the spill began, was stopped because the fish were dying from it; you had a 100-percent sample of the gas bubble trauma; the monitoring of that was put in after the fact; we've had professionals from the National Marine Fisheries Service state that in hindsight, they would have done it differently, in hindsight, we would have done peer review before the act.

Now, in 1995, based upon that record of 1994, you still are doing an aggressive spill program and yet the monitoring, we have scientists who say that we don't believe the monitoring is going to be as accurate because we're not using the same methodology that was used in 1994. Do you see why we are very bothered by this?

Mr. STELLE. Senator, yes, I do. I think the execution of the 1994 program was not adequate and I don't think there's any question about that. I think the design and execution of the monitoring program last year was also not adequate. It was precisely because of that that the Service, in combination with the other entities within the region, has put a hell of a lot of effort into developing a biologically sound and reliable monitoring program to accompany this year's spill program. When all is said and done, I frankly think that this monitoring program is solid and is reliable.

Is it perfect? No, I don't think it's perfect, sir, and we're prepared to make some adjustments in it, but I think, on the whole, it's very solid.

Senator KEMPTHORNE. I appreciate that but I don't understand when a particular methodology was used last year which yielded scientific evidence, as pointed out by Dr. Schiewe, with 90X, you saw things, and at 10X, you don't see as much; why don't you stay with 90X? I don't understand. Too, I just think there is a real situation here that NMFS may be overextended, and I think that some of the science that has been recommended, I'm concerned if it doesn't fit with the policy path that you want to follow, then those scientists, it's not convenient to have them back.

I think this has been a very helpful hearing because all of us are dedicated to bringing about the recovery of that salmon, but I think we need to lay some of these things on the table, both for that specific issue but also in light of the reauthorization of the Endangered Species Act and how we're going to rewrite that so that we can see more results because I think all of us have been saying we've been spending a bundle of money with very few results. I think it's time we alter course and get on with something that is going to work.

With that, this hearing is adjourned. Thank you.

[Whereupon, at 12:30 p.m., the subcommittee was adjourned, to reconvene at the call of the Chair.]

Aspen Applied Sciences Ltd.

Environmental Scientists and Consultants

June 20, 1995

The Honorable Dirk Kempthorne and Harry Reid
Senators, United States Senate
Senate Committee on Environment and Public Works
Senate Subcommittee on Drinking Water, Fisheries, and Wildlife
415 Hart Senate Office Building
Washington, D.C. 20510-6175

Dear Senators Kempthorne and Reid:

Thank you for the invitation to appear before your committee on June 22, 1995 and for the opportunity to comment on the National Marine Fisheries Service's policy on spill at the Columbia River hydropower dams, gas bubble trauma in threatened and endangered salmonids, and the scientific method used under the Endangered Species Act which resulted in that policy. In response to the five issues identified in your letter, I would like to offer the following testimony.

1. **Are the benefits of using spill as a fish passage mechanism established, especially in relation to other fish passage mechanisms? Comment on the scientific validity of the National Marine Fisheries Service (NMFS) spill policy.**

It is my opinion that NMFS has not validated the benefits of spill as a fish passage mechanism in comparison to other fish passage mechanisms. My main concern is that the benefits of spill have not been quantified to the extent that a comparative analysis of the various fish passage mechanisms can be made. Without a quantitative comparison of these mechanisms, it is impossible to establish, on a scientific basis, which mechanism (or combination of mechanisms) will produce the greatest overall survival of salmonids.

Furthermore, the data for juvenile and adult survival which have been presented by the state and tribal agencies to support high levels of spill do not show a clear benefit of spill. In fact, some of the data suggest that the passage of smolts through turbines leads to higher survival than the passage over spillways. In developing a basis for this view, I will cite data which comes from the document *Spill and 1995 Risk Management* which was prepared by fish and wildlife agencies of Idaho, Oregon, and Washington and the Columbia River Intertribal Fish Commission. This document is cited frequently throughout the NMFS 1995 *Biological Opinion*.

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In *Spill and 1995 Risk Management*, the agencies present data for the recapture of juvenile salmonids at McNary dam which were marked and released at Rock Island Dam on the mid-Columbia and at Little Goose Dam on the Snake River. Tables 1 and 2 are taken directly from *Spill and 1995 Risk Management*. I have added one additional column of information to the tables which shows the turbine flows (*i.e.*, Average Flow less Daily Average Spill) for the years examined in the agencies' report. The intent of the agencies in presenting these tables was to demonstrate that there was not a massive mortality resulting from dissolved gas supersaturation (DGS) during this period. However, as indicated in Table 1, most of the DGS levels are below the U.S. Environmental Protection Agency guideline of 110%. In fact, the highest total gas pressure (TGP) is 113.7 %, which is significantly below the maximum values of 120% - 125% recommended in *Spill and 1995 Risk Management*. Similarly, in Table 2, the TGP levels are also well below the allowable levels recommended in *Spill and 1995 Risk Management*. Consequently, the dissolved gas relationships shown in Tables 1 and 2 have no relevance to the dissolved gas levels proposed for the Columbia and Snake Rivers by the state and tribal agencies and which are present in these rivers in 1995.

The most important aspects of these data are the relationships between spill, turbine flow, and the proportion of recaptured fish. The argument advanced by *Spill and 1995 Risk Management* is that high recapture proportions reflect higher smolt survival in the sections of river examined (*i.e.*, Rock Island Dam to McNary Dam and Little Goose Dam to McNary Dam). In Table 1, it is clear that the highest recapture proportion occurs in 1993 when the spill is highest (*i.e.*, 41.7 kcfs). However, this is also the year with the highest flow through the turbines (*i.e.*, 88.1 kcfs). In fact, the second highest recapture proportion (0.466) occurred in 1989 when spill flow was well below the 1993 spill level, but turbine flow was the second highest for the period (*i.e.*, 70.0 kcfs). Clearly, because of the contrasting results, these data fail to demonstrate that spill produces the highest smolt survival in these river reaches.

Table 2 also yields important information about smolt survival, spill, and turbine flows. In the table, 1991 corresponds to the year of highest daily average spill (56.6 kcfs) with a corresponding recovery proportion of 0.32 for chinook salmon and 0.345 for steelhead trout. Yet, in 1989, when spill levels are about 1/2 those of 1991 (*i.e.*, 31.1 kcfs), the recover proportions are higher (*i.e.*, 0.342 for chinook salmon and 0.367 for steelhead trout). Similarly, in 1992, when spill is less than 1/2 that of 1991 (*i.e.*, 24.4 kcfs), the recovery proportion is again greater than that of 1991 (*i.e.*, 0.34 for chinook salmon and 0.381 for steelhead trout) and is the highest for steelhead trout shown in the table. When examined in terms of turbine flows, some of the highest recovery proportions shown in Table 2 correspond to the highest turbine flows (126.6 kcfs in 1989 and 130.9 kcfs in 1991). Again, because of the highly variable results, these data fail to demonstrate that spill is the optimal means of fish passage at dams.

In the case of adult survival, Figure 1 shows plots of migrant survival indices for two populations of Snake River chinook salmon for the period 1980 through 1990. These data are from Table 3 of *Spill and 1995 Risk Management*, which been included for reference. In the figure, it is seen that for Marsh Creek wild spring chinook, survival was high when spill levels were 54.8 kcfs. However, survival was also high when spill levels were only 8.2 kcfs. When spill levels were between 27.3 and 48.1 kcfs, survival was less than that for either 54.8 or 8.2 kcfs.

In the case of the Imnaha wild summer chinook, the highest survival occurred at a spill level of only 11 7 kcfs while the third highest survival occurred at a spill level of only 8.2 kcfs. The second highest survival occurred at a spill levels of 54 8 kcfs. Clearly, the data of Figure 1 show little consistency and there is no definable relationship between spill and the survival indices for the two populations of Snake River chinook.

A similar effect is found in data for the survival of fall chinook migrants from the Priest Rapids Hatchery for the period 1980 through 1987. Figure 2 shows a plot of migrant survival versus spill flow It is apparent that some of the highest survivals occur at spill levels of about 20 kcfs and again at spill levels of about 160 kcfs This constitutes a factor of 8 in the difference in spill rates. Based on this large difference, along with the other data of the figure, it is apparent that there is again no consistency or definable relationship between spill and survival of this population of chinook salmon. In summary, the available data on the survival of Snake River and mid-Columbia fish stocks are highly variable and fail to validate that spill is the best mechanism for fish passage at dams.

An additional concern regarding the validation of spill as an optimum means of fish passage is that the effects of DGS and gas bubble trauma (GBT) in fish, which are the primary deleterious effects of spill, have not been quantified in a manner which will allow a comparative analysis of the various fish passage mechanisms. Without such a comparison, it is impossible to scientifically establish which mechanism (or combination of mechanisms) will produce the greatest overall survival of salmonids.

Furthermore, the NMFS 1995 *Biological Opinion* ignores much of the data from the literature, especially those data which show adverse effects of DGS on fish The *Biological Opinion* often refers to the risk analysis described in *Spill and 1995 Risk Management*, which was prepared by the state and tribal agencies However, the analysis methods contained in this latter document have been criticized by NMFS' own staff, the Oregon Department of Environmental Quality, and several independent scientists. The flaws identified in this document are such that the analysis and conclusions are invalid.

The only justification which NMFS uses for seeking a variance to the state water quality guidelines for DGS (in order to permit high spill levels) is contained in the following statement taken from the 1995 *Biological Opinion*.

> "NMFS concluded that it was appropriate to seek an operation that would result in the EPA criteria of 110% being exceeded primarily because of 1) the ability of fish in a river environment to compensate hydrostatically for the effects of dissolved gas supersaturation, and 2, the daily fluctuation in levels of dissolved gas throughout most of the river."

The statement with regard to fish having the "ability to compensate hydrostatically" is not consistent with the scientific literature, which shows that in many cases where fish have adequate depth to compensate for DGS, they do not do so, and die of GBT as a result. NMFS' own 1995 net pen studies from below Ice Harbor Dam illustrate this point directly The high levels of mortality which occurred in early May should have been avoided if the fish had compensated hydrostatically for the effects of DGS. Based on the measured TGP levels of 128%, a compensation depth of about 1.0 meter would have prevented bubble formation in the vascular systems of these fish (Fidler and Miller

1994). The fish had 4 meters of depth available to them for compensation, yet 85% of them died from GBT (Dawley, NMFS - personal communication).

In 1994, NMFS convened two panels of experts in the fields of DGS and GBT for the purpose of advising NMFS on the effects of DGS on Columbia and Snake River Salmonids. However, the panels were never provided an opportunity to examine and comment on the dissolved gas sections of the 1995 *Biological Opinion* or *Spill and 1995 Risk Management*. Had this occurred, many of the flaws in these documents could have been avoided and a more scientifically defensible spill policy developed. As it stands, the NMFS spill policy has very little scientific basis and certainly no comparative quantitative analysis of the various fish passage mechanisms. Without validation, the spill policy is, at best, a guess and, at worst, scientifically irresponsible.

2. **What independent scientific research is being conducted to monitor the effects of spill and its alternatives in the Columbia River system?**

By independent, I am assuming this implies research conducted by universities or persons not associated with state, tribal, or federal agencies. At present, I know of only the work being conducted at the University of Washington by Dr. Jim Anderson on the development of the CRiSP computer model for salmon survival. In addition, research is being conducted by the Chelan County Public Utility District on the survival of fish through Kaplan turbines at their Rocky Reach hydroelectric facility. There has been one investigation by a semi-governmental agency on the effects of high hydrostatic pressure associated with the smolt bypass systems on the reduction or elimination of GBT signs in fish collected for biological monitoring. These experiments, which were conducted at Battelle Pacific Northwest Laboratories, demonstrated that the signs of GBT can be reduced or eliminated in five minutes or less of exposure to high hydrostatic pressure. These results indicate that the examination of fish collected from the smolt bypass systems for signs of GBT can under-estimate the extent of GBT in fish in the upstream reservoirs (Montgomery Watson 1995). I am not aware of any other independent research which is directly related to the monitoring of spill and its alternatives in the Columbia River System.

3. **Are there risks to migrating smolts and returning adults associated with high levels of dissolved nitrogen resulting from spill?**

The experience of the 1960's and 1970's involving both juvenile and adult salmonids clearly show that there are high risks of mortality to fish in the Columbia and Snake Rivers exposed to elevated dissolved gas levels (Weitkamp and Katz 1980). Chinook salmon and steelhead trout smolts held in cages up to 4.5 meters deep experience 58% mortality in 7 days at TGP levels of 127% (Ebel 1971). Fish held in 4 meter deep cages below Ice Harbor Dam in 1995 experienced significant levels of mortality in 4 days or less at TGP levels of 128% (Earl Dawley, NMFS - personal communication). Data from laboratory and field studies indicated that exposure to TGP levels of 115% at water depths of one meter or less can lead to 20% mortality in times of 100 hours (Jensen *et al.* 1986, Fidler 1988). At TGP levels of 120%, time to 20% mortality can be as low as 50 hours (Jensen *et al.* 1986, Fidler 1988).

Smith (1974), using varied mesh gill nets on adjustable frames, has shown that up to 18% of chinook salmon smolts and 7 9% of the steelhead smolts can be found in the upper meter of the water column upstream from Lower Monumental Dam on the Snake River Rondorf (1995), using hydroacoustic methods, has shown that the depth distribution of fish in Lower Granite Reservoir is quite variable. Although the hydroacoustic methods cannot sample accurately in the upper meter of the water column, Rondorf's data indicate that in some sections of the reservoir up to approximately 18% of the fish observed are in the 1 - 2 meter depths. Thus, the combination of fish distribution depths and time to mortality data from field and laboratory experiments indicate there is high risk of direct mortality to fish exposed to dissolved gas levels above 115%. Little is known about the level of indirect mortality (*i.e.*, predation, disease, failure to adapt to sea water, *etc.*) associated with the sub-lethal effects of GBT (NMFS 1994 Expert Panels on DGS and GBT).

Unfortunately, the 1995 biological monitoring program, as designed, will not yield an accurate assessment of the lethal or sublethal mortalities associated with the high levels of DGS present in the Columbia and Snake Rivers. The difficulty with the 1995 program is that it has not been designed with an understanding of how fish are distributed in the Columbia and Snake Rivers in relation to dissolved gas levels, periods of exposure, and potential for mortality. The NMFS 1994 Expert Panels on DGS and GBT made recommendations regarding the design of a biological monitoring program for 1995. Few of the recommendations were implemented and the panel was never consulted regarding the design of the 1995 monitoring program A team of scientists which reviewed the 1994 biological monitoring program also made recommendations for improving the design of the 1995 monitoring program (Montgomery Watson 1994) Again, few of these recommendations were implemented in 1995.

At present, the 1995 biological monitoring program is an unfocused collection of attempts by various agencies to sample fish without an understanding of the appropriate locations and conditions under which to assess the impacts of DGS on the Columbia and Snake River juvenile and adult salmonids In many cases, the examination methods are inferior to those used in 1994. For example, in 1994, hatchery steelhead smolts were examined for bubbles in gill lamella and lateral lines using 90 - 100 power microscopes. In May of 1994, signs of bubbles in gill lamella were present in up to 60% of the fish examined This led to a termination of spill in 1994 In 1995, examination was done with 10 power microscopes and no signs of GBT are being reported even though TGP levels are 10% to 15% higher than in 1994 Clearly, there is a credibility problem in the results of the 1995 monitoring program

In 1994, both the NMFS Expert Panels on DGS and GBT and the Montgomery Watson scientific review team pointed out the problem of high hydrostatic pressures in the smolt bypass systems reducing or eliminating the signs of GBT in fish before they are intercepted for monitoring Even with the experimental results obtained from the Battelle Pacific Northwest Laboratories experiments, the smolt bypass system sites continue to be the primary locations used in monitoring for signs of GBT

Another problem with the monitoring program is that many of the agencies which have been most vocal in their assertion that high levels of DGS will not cause significant mortality in Columbia and Snake River salmonids are, in many cases, the people responsible for much of the biological monitoring This presents a conflict of interest situation in that the credibility of these agencies may be

damaged if significant levels of mortality or signs of GBT are found in smolts of the Columbia and Snake Rivers. This situation may lead to a compromise of the results of the biological monitoring program. At present, there is no independent biological monitoring for signs of GBT being conducted on the Columbia and Snake Rivers. Consequently, the monitoring results reported by the Fish Passage Center cannot be independently verified.

Perhaps the most troubling aspect of the 1995 biological monitoring program is that because it is so unfocused and poorly designed and implemented, an opportunity to understand the effects of DGS on juvenile and adult salmonids of the Columbia and Snake Rivers has been lost. Scientists will face the 1996 salmonid migrations with little more information than was available at the beginning of 1995. This regrettable situation could have been avoided had NMFS keep the DGS and GBT Expert Panel involved in the design of the 1995 biological program and in an ongoing review of the data. Even at this late date, NMFS appears reluctant to reconvene the DGS and GBT Expert Panel in order to review the 1995 data, analyze the mistakes of 1995, and develop a comprehensive monitoring program for 1996.

4. Have there been investigations of the effect of supersaturated water on resident fish? Have the results of these studies been incorporated into current policy.

The effects of DGS and GBT on resident fish species has been quite limited in comparison to studies of migratory salmonids. The studies which have been conducted are summarized in Fidler and Miller (1994). NMFS is conducting some net pen studies on the effects of DGS on resident fish and invertebrate populations of the Columbia and Snake Rivers. However, the results of these studies have not been incorporated into the NMFS 1995 *Biological Opinion* in terms of action levels for controlling TGP levels.

5. To what extent has scientific research from the states been incorporated into the current spill policy? How can the decision making process be improved?

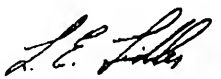
At present, a large proportion of the current spill policy is based on analyses developed by the state agencies. As pointed out earlier, the state and tribal agencies prepared a *Spill and 1995 Risk Management* analysis. The purpose of the analysis was to support their contention that spill levels which resulted in total gas pressures up to 125% produced greater juvenile survival than would occur for fish passage through turbines. This document was found to have numerous flaws in the analysis methods, to the extent that the analysis results were invalid and underestimated the effects of DGS on adult and smolt salmonids.

Furthermore, as a result of poor design and implementation, there will be very little usable information acquired from the 1995 biological monitoring program. These problems could have been avoided if a comprehensive peer review process were in place. In 1994, NMFS convened two panels of experts to advise them on the effects of DGS on Columbia and Snake River Salmonids. The panels also recommended components for a comprehensive biological monitoring program. Yet, when it came to developing a 1995 *Biological Opinion* and designing a biological monitoring program, NMFS failed to allow the expert panel to review either one. The NMFS 1995 *Biological Opinion* cites much of the information contained in the flawed *Spill and 1995 Risk Management* document. Although it was not

sought, an independent review of this latter document by the expert panel could have highlighted some of the problems it contains. Because the expert panel represents the broadest range of knowledge on DGS and GBT in fish, its role should be strengthened and this resource of knowledge used for the design of biological monitoring programs and peer review of analyses which form the basis for managing river DGS levels.

I hope that the information I have provided will be of some assistance in understanding many of the problems which have been encountered in the development of a scientific basis for managing Columbia and Snake River anadromous salmonid stocks. Please feel free to contact me if you have any questions about the information I have provided.

Sincerely,



Larry E. Fidler, Ph.D., R.P. Bio.
President

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Table 1. Little Goose SMP Juvenile Travel Time Releases

Year	Prop Recap	Average TDG[a] (May)	Average Flow[b] (May)	Daily Average Spill[c] (May)	TURBINE FLOW
1989 Ch	.466	108.4	82.9	12.9	70.0
1990 Ch	.093	107.5	69	10.7	58.3
1991 Ch[d]		108.3	80.8	15.9	64.9
1992 Ch	.333	107.3	59.9	10.8	49.1
1993 Ch	.547	113.7	129.8	41.7	88.1
1994 Ch	.394	111.0	76.8	19.5	57.3

[a] Average TDG for Little Goose, Lower Moounental, Ice Harbor, and McNary dams during May.
[b] Average flow for Ice Harbor Dam (kcfs).
[c] Average spill for Little Goose, Lower Monumental, and Ice Harbor dams.
[d] No releases were made in 1991.

Table 2. Rock Island SMP Juvenile Travel Time Releases

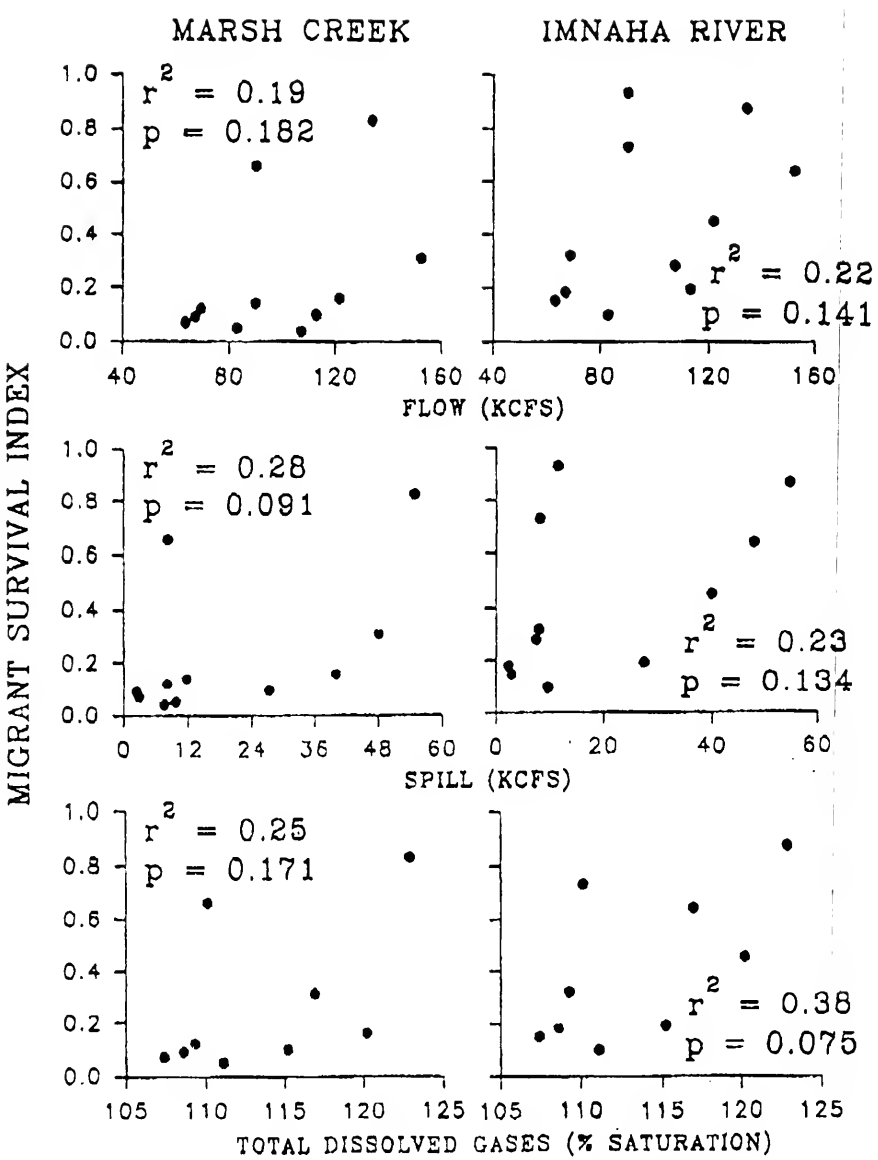
Year	Prop Recap	Average TDG[a] (May)	Average Flow[b] (May)	Daily Average Spill[c] (May)	TURBINE FLOW
1989 Ch St	0.342 0.367	112.3	157.7	31.1	126.6
1990 Ch St	0.240 0.257	111.5	151.1	32.5	118.6
1991 Ch St	0.320 0.345	114.6	187.4	56.5	130.9
1992 Ch St	0.340 0.381	112.1	140.7	24.4	116.3
1993 Ch St	0.211 0.172	118.5	149.6	39.4	110.2
1994 Ch St	0.303 0.238	112.6	124.6	20.4	104.2

[a] Average total dissolved gas for Rock Island, Priest Rapids, Wanapum and McNary dams during May.
[b] Average flow for Rock Island Dam (kcfs).
[c] Average spill for Rock Island, Priest Rapids and Wanapum dams (kcfs).

Table 3. Survival scalars and environmental data during the juvenile migration years 1980-1990.

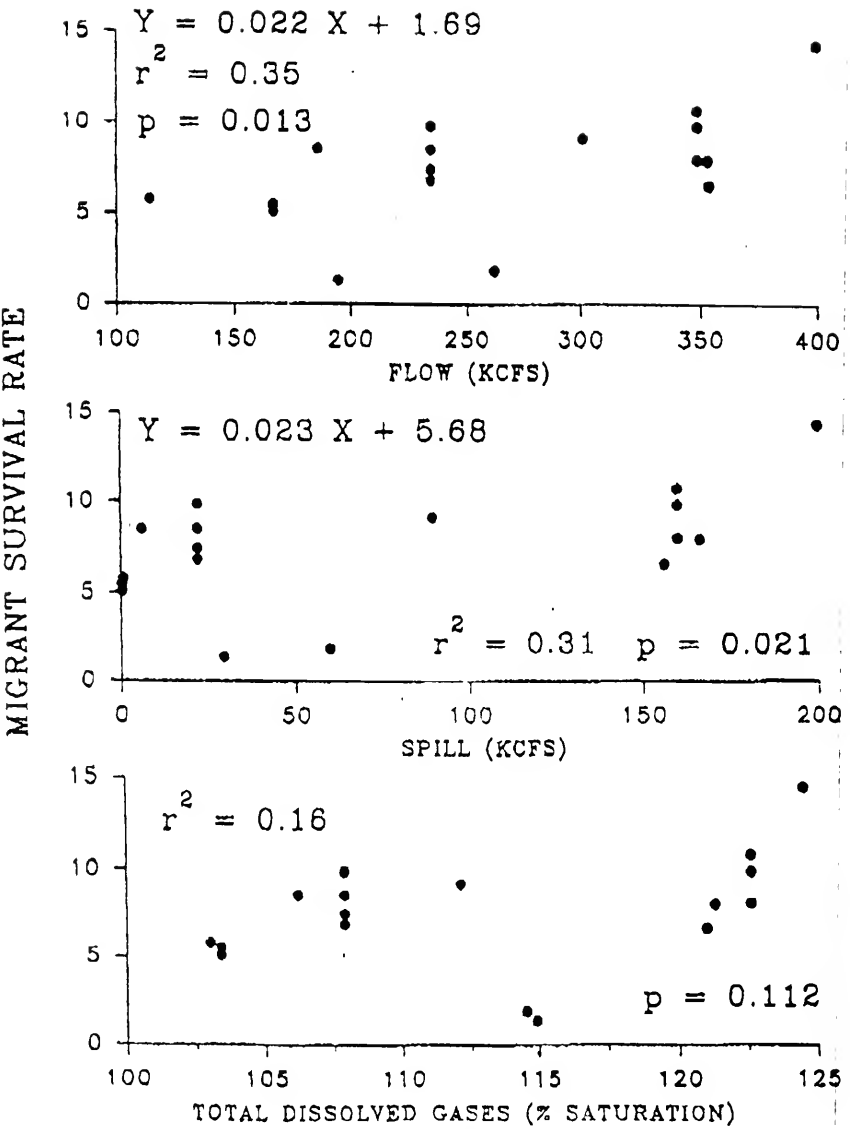
Juvenile Migration Year	ADULT SCALAR		%TDG[a]	Flow[b] (kcfs)	Spill[c] (kcfs)
	Marsh Creek Wild Spring Ck	Imnaha Wild Summer Ck			
1980	0.04	.28		107.3	7.54
1981	0.14	.93		89.9	11.68
1982	0.83	.87	122.9	1345.1	54.85
1983	0.16	.45	120.2	121.7	39.95
1984	0.31	.64	116.9	152.5	48.12
1985	0.66	.73	110.1	90.0	8.20
1986	0.097	.19	115.2	112.9	27.38
1987	0.07	.15	107.4	63.4	2.88
1988	0.09	.18	108.6	67.1	2.38
1989	0.05	.098	111.1	82.9	9.66
1990	0.12	.32	109.3	69.0	8.05

[a] Average daily TDG during May at Ice Harbor Dam.
[b] Average daily flow during May at Ice Harbor Dam.
[c] Average daily spill during May across the lower Snake River projects: Lower Granite, Little Goose, Lower Monumental, and Ice Harbor dams.



Relative survival of juvenile spring chinook migrants versus river conditions, 1980-90.

Figure 1



Survival (corrected for ocean conditions) of juvenile fall chinook migrants versus river conditions for marked releases from Priest Rapids Hatchery, 1980-87. Data is from Hilborn et al. (1993)

Figure 2

PREPARED STATEMENT OF WILLIAM STELLE, JR., DIRECTOR, NORTHWEST REGION, NATIONAL MARINE FISHERIES SERVICE

Good morning Mr. Chairman and members of the subcommittee. My name is Will Stelle and I am Director, Northwest Region of the National Marine Fisheries Service. I am pleased to be here this morning to discuss water flows and salmon on the lower Snake and Columbia Rivers.

BACKGROUND

For many people, salmon are one of the most profound and enduring symbols of the Pacific Northwest. Salmon have been the economic mainstay of many communities and Native American tribes and are representative of the wild character so cherished by the people of Idaho, Washington, and Oregon. Unfortunately, the salmon populations are now a small fraction of their former abundance. Where millions of salmon once returned to spawn, hundreds are expected in 1995.

After listing three stocks Snake River salmon as threatened or endangered, NMFS initiated an ambitious effort to develop a recovery plan for these stocks in January of 1993 by appointing an independent recovery team. Their final recommendations to NMFS comprised many of the major elements of NMFS' recently published *Proposed Recovery Plan for Snake River Salmon*. The Proposed Recovery Plan addresses all of the causes for the decline of salmon, including dams, harvest, habitat alteration, water withdrawals, the effects of hatchery fish on the survival and genetics of wild fish, and predation. While no single factor is responsible for the full extent of the decline of salmon populations in the Snake River, it is widely believed that hydroelectric dams have been the dominant reason for declines.

For this reason, the Proposed Recovery Plan contains critical measures designed to reduce the loss of juvenile fish caused by mainstem dams. NMFS is pursuing an adaptive management approach to increasing survival and, therefore, the probability of recovering the listed salmon. The agency is working through the Corps of Engineers (Corps) and Bureau of Reclamation to adapt or improve the operation of the power system while evaluating the effects of the modifications on fish survival. One part of this program is an evaluation of the merits of in-river migration (through the hydropower system) under the best conditions achievable compared with transportation (barging around the hydropower system) under the best conditions achievable. This evaluation relies upon augmenting flows and spilling at mainstem dams during both the spring and summer migration periods.

THE SPILL PROGRAM

HISTORY AND RATIONALE

Spill is not new. "Involuntary" spill occurs in the Snake and Columbia Rivers in most average and above average water years because river flows exceed hydraulic capacity at the dams (water that cannot be handled by the turbines must be passed over the spillways). "Voluntary" or controlled spill has been used since the 1970's to pass juvenile salmon around the dams on the lower Snake and Columbia Rivers. Spill has also been included in the Northwest Power Planning Council (NPPC) Columbia River Basin Fish and Wildlife Program since 1982. The first formal agreement specifying an amount of spill at the Corps' dams was a 1989 Regional Spill Agreement signed by the Bonneville Power Administration (BPA) and the region's fish and wildlife agencies and Native American tribes. This agreement was later incorporated as part of the NPPC's Columbia River Basin Fish and Wildlife Program.

Spill has also been a primary means of moving juvenile fish past the five mid-Columbia Federal Energy Regulatory Commission (FERC) licensed projects since 1979, when the Commission directed the three public utility districts (PUDs), who operate these five projects, to commence fish spill programs and develop bypass systems. Subsequently, through a continuing series of short-term stipulations and two long-term mitigation agreements (1979–1995), the FERC, the PUDs, and the Fishery Parties (including NMFS) continue to recognize spill as a cornerstone of fish passage protection at these Columbia River hydropower projects.

More recently, as upriver salmon runs continued to decline at an alarming rate, it became obvious that "business as usual" wasn't working. NMFS concluded in its Proposed Recovery Plan and in its Biological Opinion on the Federal Columbia River Power System (FCRPS) that spill is the only available method for providing an immediate increase in project survival of in-river migrants. (All other methods are longer-term solutions that require lengthy design, engineering, and construction.) As a result, the Proposed Recovery Plan calls for spill to meet an 80 percent fish pas-

sage efficiency standard (that is, 80 percent of the fish pass through non-turbine routes).

NMFS supports voluntary spill because studies have shown that passage through spillways is the safest route for juvenile salmon migrating past a hydroelectric project. The spill program reduces the number of young fish passing through the turbines at a dam, increasing overall survival of fish migrating in-river.

DISSOLVED GAS

Water spilled at dams entrains large amounts of air and forces it into a dissolved state. Thus, spill may cause total dissolved gas (TDG) levels in the river to exceed saturation—resulting in gas supersaturated water. When migrating juvenile (or adult) salmon are exposed to areas with high levels of total dissolved gas, they can develop a condition known as gas bubble trauma (GBT). The condition is characterized by air bubbles (embolisms) forming in various tissues of the affected fish (e.g., in fins, vascular systems, and gills, and along the lateral lines). In extreme cases, the condition can lead to death. At lower levels gas bubble trauma can result in reduced ability to avoid predators, increased susceptibility to disease, and impaired swimming performance. Reflecting their concerns about the effects of gas bubble trauma on resident and migrant fish, the states have adopted water quality standards consistent with EPA guidelines.

THE SPILL PROGRAM IN 1995

In developing the 1995 spill program, NMFS biologists used scientific literature regarding gas bubble trauma, spillway and turbine survival, fish guidance, and bypass and transportation operations. The NMFS analysis included peer-reviewed reports, unpublished government reports, a spill evaluation conducted by the state and tribal fishery agencies, and all the data collected through monitoring the 1994 spill program. NMFS also convened a panel of experts in gas bubble trauma on two separate occasions. The panel's purpose was to help interpret the 1994 monitoring results, to aid in developing protocols for a 1995 monitoring program, and to identify critical research needs. Much of the literature reviewed in developing the 1995 spill program is listed in the FCRPS Biological Opinion and in the State and Tribal Fishery Agencies' spill evaluation reference sections.

In addition, NMFS relied on the professional judgment of its biologists and received extensive input from other Federal Government scientists. The review drew on scientists from the Corps of Engineers, the U.S. Fish and Wildlife Service (USFWS), and the National Biological Survey (NBS) and utilized their expertise in the fields of dissolved gas supersaturation, fish biology, limnology, and many other disciplines in developing the scientific conclusions regarding the technical elements of the spill program.[1]

The spills on the Columbia and Snake River system have three components: Voluntary spill at non-collector projects in order to improve downstream migrant survival, voluntary spill at fish collector projects to determine the relative merits of transportation versus in-river migration, and involuntary spill caused by high runoff events combined with limited hydraulic capacities at some of the projects.

In the case of voluntary spill at non-collector projects (those projects where juvenile salmon are not collected for transportation), there is little debate regarding its value to the fish. Spill has long been used at these projects as safer than routing the fish through the turbines. The difference is that under the Proposed Recovery Plan, the spill level is somewhat higher than under past operations.

Voluntary spill at collector projects occurs only under high flow conditions, when conditions are better for in-river survival. This spill provides important information needed in NMFS' adaptive management strategy. By comparing the survival to adults of in-river migrants to that of transported migrants, NMFS obtains critical data on how to improve overall survival of salmon, which is NMFS' ultimate goal. Voluntary spill at both collector and non-collector projects is limited in NMFS' program to ensure that dissolved gas levels do not pose a danger to migrating fish.

Involuntary spill occurs due to high flows from snow melt and heavy rains. The storage (reservoir) facilities in the system have limited capacity to contain these flows. The flows which cannot be routed through the turbines are spilled. The volume of this involuntary spill increases when generating capacity at the Federal projects is impaired, for example during turbine outages. This uncontrolled spill causes the greatest challenge for the management of dissolved gases.

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[1](The details of the review are given in the last section of this document: Responses to Questions by Senator Kempthorne.)

THE GAS MONITORING/SPILL MANAGEMENT PROGRAM

The spill monitoring program was developed over a period of 10 months and built upon the lessons learned in the 1994 spill program. Its purpose is to ensure that the spill program does not harm migrating juvenile salmon by causing gas bubble trauma. The monitoring program is explained in detail in NMFS' Spill Monitoring Working Document (April 7, 1995). The monitoring closely follows the recommendations of two separate panels of gas bubble trauma experts that NMFS convened in 1994. The program has been comprehensively evaluated by a Gas Bubble Trauma Technical Work Group (co-chaired by NMFS and the Environmental Protection Agency), and provided to the Oregon State Department of Environmental Quality, and the Washington State Department of Ecology.

The monitoring program has two components: biological and physical. The biological monitoring consists of sampling juvenile migrants at several locations and examining them for both internal and external signs of gas bubble trauma. Also, resident fish are periodically examined for the same symptoms. total dissolved gas is physically monitored by instruments in place both above and below each dam.

In addition, though they are not strictly a part of the monitoring effort, several research studies related to the biological impacts of gas bubble trauma are presently underway. These include: using hatchery steelhead to develop a non-lethal procedure for measuring gas bubbles in gill filaments; holding resident fish species and hatchery-reared chinook salmon in net-pens below two dams and in one reservoir and regularly observing them for gas bubble trauma; identifying the most important signs of gas bubble trauma and determining their prognostic value; observing the length of time that radio-tagged individuals spend migrating through a collection system; examining total dissolved gas distribution in reservoirs relative to fish distribution; and comparing the prevalence of gas bubble trauma in fish captured in selected dam forebays to the prevalence of gas bubble trauma in fish collected in dam bypass systems. (This latter research is critical because preliminary laboratory observations suggest that bubbles may disappear (i.e., collapse) as fish pass a dam via a bypass system.)

The spill monitoring program and its associated research has provided the operating agencies with information used to adjust spill on a weekly and even a daily basis. The monitoring in 1995 has found that less than one percent of the outmigrating salmon are exhibiting any signs of gas bubble trauma. As recently as last year, it was not possible to make such a statement with any degree of certainty because comparable data did not exist. As the spill program continues, new information will emerge from the attendant monitoring and research. This information will be used to continuously redesign the operations to reduce the potential for harm from gas supersaturation.

The monitoring program has shown that, despite involuntary spill at several dams this spring and very. high concentrations of dissolved gas at Ice Harbor, only an extremely low frequency of gas bubble trauma has been observed. Between May 1 and June 1, over 24,360 river-run juvenile salmonids were examined at the dams, and only 0.2 percent showed any signs of gas bubble trauma. Of these, 0.06 percent of 17,657 juveniles showed exterior gas bubble trauma signs, 0.6 percent of 6055 juveniles exhibited at least one bubble internally in the lateral line, and 1.7 percent of 657 juveniles had at least one internal bubble in the gill lamellae. Furthermore, no gas bubble trauma signs have been recorded in the several hundred adult salmonids examined at Lower Granite and Bonneville Dams.

In-Season Management

A technical management team (TMT), comprised of NMFS, Corps, the Bonneville Power Administration, Bureau of Reclamation and U.S. Fish and Wildlife Service, meets at least once a week to review the most recent data on runoff, the system operations, dissolved gas levels, and numbers of salmon migrating in the river. The TMT prepares recommendations on spill, reservoir operations, etc. The purpose of these meetings is to improve fish passage to the greatest extent possible while managing the system to remain within state water quality standards for dissolved gas. The meetings also provide a forum for state and tribal fisheries managers to make recommendations on system operations. The Corps of Engineers and the Bureau of Reclamation, who are responsible for the operation of the dams, make the final decisions on how the system is to be run. Thus, spill management in 1995 is a highly integrated and adaptive process. It operates using the latest data, and operational adjustments are made rapidly.

Ice Harbor

An example of the spill program's real-time operational flexibility is seen in the incident that occurred at Ice Harbor Dam earlier this summer. In that instance, tur-

bine outages, and a higher-than-anticipated runoff event at the four lower Snake River projects combined to raise total dissolved gas levels above the state standards. In this case, even though Federal Managers could do little about the causes of the situation, a number of operational changes were made to reduce the impacts of the involuntary spill.

The options that have been pursued to date to control dissolved gas levels in the river system include: (1) filling Snake River reservoirs in a short-term effort to reduce spill; (2) distributing spill at Snake River dams above Ice Harbor over 24 hours, instead of 12 hours, to reduce instantaneous spill by 50 percent; (3) running turbine units at the lower three Snake River projects outside of peak (within one percent) efficiency to reduce water being spilled; (4) adjusting the spill pattern at Ice Harbor Dam. (i.e., spilling the same volume, but distributing it among spillways in a different manner) to reduce total dissolved gas levels; and (5) reducing spill below levels authorized in the FCRPS biological opinion at three lower Snake River dams to reduce cumulative total dissolved gas effects. Some of these measures may have some negative effects on juvenile survival (e.g., running turbines outside peak efficiency, reducing spill at Lower Granite Dam, and filling reservoirs), but the NMFS and the Corps are agreed that it is important to take all reasonable steps to comply with the state water quality standards.

SPILL AND RESIDENT FISH

NMFS is attentive to the fact that increased flows for salmon may affect resident fish. Augmentation flows affect resident fish both in the reservoirs and in the river reaches below them. The Idaho Department of Fish and Game (IDFG) offered testimony about impacts on resident fish at a May 10, 1995, hearing. They perform biological monitoring in the Clearwater River, and during the hearing they commented on spill at Dworshak Dam and total dissolved gas levels in the river below the dam. The impact of reservoir drawdown on kokanee and black bass populations in the reservoir was of particular concern to the citizens at the hearing. The district IDFG-biologist for the Lewiston/Orofino area testified that kokanee populations are in very good shape and have increased since the reservoir operation was changed from drafting in the winter (for power production) to drafting in the summer (for fish flows). He also indicated that the decrease in black bass populations is primarily due to lower populations of forage fish, primarily redside shiners, and not due to loss of shoreline spawning habitat from reservoir drawdown.

Augmentation flows that result in spill can affect resident species in two ways: By entraining and passing residents into the river below; and, if spill volume is high enough, by raising total dissolved gas levels in the river below the dam. In the case of Dworshak Reservoir and Dam, kokanee is the primary (and perhaps the only) species that is entrained. While this can have detrimental effects on the entrained individuals, there is no evidence that the kokanee population in the reservoir has been adversely affected.

During the past 3 years, while spill was occurring, the health of resident species has been monitored at several locations. The results to date indicate that resident species exhibit very little, if any, sign of gas bubble trauma when exposed to total dissolved gas levels generated by voluntary spill. IDFG is monitoring the health of resident fish in the North Fork and main Clearwater River below Dworshak dam. Spill would be reduced at the dam if monitoring indicated that serious impacts on resident fish. A very low prevalence of gas bubble trauma signs was noted in resident species during the spring 1995 spill at Dworshak Dam.

CONCLUSION

The 1995 spill program reflects the years of study and evaluation that were the basis for NMFS' Proposed Recovery plan for Snake River Salmon. It has brought Federal managers together in a spirit of cooperation to optimize operation of the Federal Columbia River Power System. At the end of the operating season, NMFS and other fisheries managers will perform a thorough evaluation of the lessons learned by reviewing the results of the operational decisions recommended by the TMT, analyzing the data from the gas monitoring program, and examining the results of the numerous research projects. The information derived from this adaptive management process will help resolve questions about alternative ways to improve the survival of migrating salmon.

In closing, I would like to emphasize several points:

First, NMFS has decided to employ a managed voluntary spill program as one of the few existing tools to achieve improved fish guidance around individual projects, and that improved in-river migrations are part and parcel of the larger effort to improve fish survivals in the system.

Second, spilling too much water can increase the risk of gas bubble disease in downstream areas, and therefore the voluntary spill program must be—and is—properly limited to minimize that risk. The NMFS and the Corps of Engineers have implemented a comprehensive and largely successful monitoring and research program that will both ensure that we are able to protect as best as possible against undue risks, and that we generate important information about fish survivals that will help us continue our efforts at improving survivals.

Third, the spill program ought to serve as an interim program only. The Proposed Recovery Plan instructs the Corps to modify the individual projects to reduce the amounts of gas they create through the use of vertical slots and surface collectors that would pass more fish over the spillways with smaller volumes of water. These modifications hold the promise of improving substantially the efficiency of the fish passage effort, and therefore save more fish and more money by reducing substantially the costs of the spill program. I would encourage this Subcommittee and Congress to support these efforts because they hold such promise.

Finally, the NMFS remains committed to operations based upon the best science available. It therefore intends to convene a group of operational experts and reconvene its gas technical working group this fall to review all components of the in-season management process and the spill program. We will review the enormous amount of data generated by it and we stand ready to make adjustments and improvements to the in-season management process and the spill program as the data dictate, in consultation with the states and tribes of the region.

This concludes my testimony, Mr. Chairman. I will be pleased to answer any question that you or other Members of the Subcommittee may have.

RESPONSES BY WILLIAM STELLE TO QUESTIONS BY SENATOR KEMPTHORNE

1. How did the National Marine Fisheries Service (NMFS) develop its 1994–1995 spill policy for the Columbia and Snake River hydropower facilities?

The 1994–1995 spill program was developed in the context of, and is provided in, the biological opinion on 1994–1998 on operation of the FCRPS and the Proposed Recovery Plan for Snake River Salmon. It is part of the overall operation of the system called for in these documents. The system operation proposed by the NMFS was developed as a result of extensive discussions among the NMFS, the U.S. Fish and Wildlife Service, the Federal operating agencies, the state fishery agencies and Native American tribes. These discussions took place primarily as part of the proceedings in the IDFG v. NMFS litigation. The NMFS also held several meetings with Recovery Team members and had public workshops with representatives from the power and environmental communities in attendance. The entire biological opinion, including the spill program, was provided to the parties in IDFG v. NMFS for comment prior to its issuance last March.

2. What scientific research supported decisions on the spill policy? What process did NMFS use to reach scientific conclusions? How was the spill policy announced to the public?

The spill program was announced to the public through publication of the biological opinion on the FCRPS in March, 1995 and through publication of the Proposed Snake River Salmon Recovery Plan (also in March, 1995). NMFS provided notice of the Proposed Recovery Plan through a press conference and a notice in the Federal Register.

The following excerpt from the 1995 biological opinion describes the rationale behind the spill program. (See also first two paragraphs under "The Spill Program in 1995" section, previously.)

> After reviewing available information on dissolved gas exposure as well as information and recommendations submitted by the parties during the IDFG v. NMFS discussions, NMFS concluded that 115 percent total dissolved gas measured in the forebays was a reasonable interim measure to adopt. Several commenters argued that the Environmental Protection Agency's recommended water quality limit of 110 percent represented an appropriate level and should not be varied. State and tribal entities developed a risk assessment that suggested that long term exposure to 120 percent did not pose significant risks to migrating fish and that the benefits of improved dam passage outweighed these minimal risks of TDG exposure at 120 percent. Still other commenters noted the spill at collector projects reduced the numbers of fish transported and that any risk assessment had to consider the benefits of transportation. The issue of transportation is addressed more fully in measure 3 below.

NMFS concluded that it was appropriate to seek an operation that would result in the EPA criteria of 110 percent being exceeded primarily because of: (1) the ability of fish in a river environment to compensate hydrostatically for the effects of dissolved gas supersaturation, and (2) the daily fluctuation in levels of dissolved gas throughout most of the river. In a river environment, depth of migration reduces total dissolved gas effects on migrants. Each meter of depth provides pressure compensation equal to a 10 percent reduction in total dissolved gas. Shew et al. (Undated) and Turner et al. (1984b) noted through tunnel studies that net entry rates through McNary and Bonneville Dam ladder entrance tunnels were highest for the deepest (3.4m) tunnels. Other studies indicate that adult and juvenile salmon tend to spend most of their time at or below one meter of depth (Smith 1974). Blahm (1975) concluded that shallow water tests were "not representative of all river conditions that directly relate to mortality of juvenile salmon and trout in the Columbia River." In deep tank tests, salmonids exposed to 115 percent TDG levels did not experience significant mortality until exposure time exceeded approximately 60 days (Dawley et al. 1976).

NMFS also concluded that it was not appropriate as an initial interim level to seek an operation that would result in chronic exposure to TDG level of 120 percent, as recommended by the states and tribes. In general, chronic exposure to TDG levels of 120 percent with hydrostatic compensation does not cause significant mortality until exposure time exceeds 40 days (Dawley et al. 1976). This is generally more time than it takes Snake River juvenile and adult migrants to travel between Lower Granite and Bonneville Dam. Nevertheless, NMFS concluded that the more conservative level of 115 percent is appropriate because of concerns about the potential sublethal effects of gas bubble trauma. The state and tribal report on "Spill and 1995 Risk Management" summarized the studies showing evidence that swimming performance, growth and blood chemistry are affected by high dissolved gas levels. The report correctly states that it is only inferential that these symptoms may result in susceptibility to predation, disease and delay. In fact, studies conducted in 1993 and 1994 by the National Biological Service indicated that juvenile chinook salmon that have been exposed for eight hours to high TDG (and exhibiting microscopic signs of gas bubble trauma) are no more vulnerable to northern squaw fish predation than control fish that had been held in equilibrated water (Mesa and Warren, in review). Ultimately the analysis in the state and tribal report did not assume any level of mortality as a result of these sublethal effects.

NMFS concludes that the impairments to migrating fish as a result of the sublethal effects of dissolved gas may be sufficiently grave to warrant caution in setting long term exposure levels above 110 percent. In particular, long term exposure to levels in excess of 110 percent decrease swimming ability (Dawley and Ebel, 1975); fish stressed with high levels of dissolved gas have been reported to have less swimming stamina (Dawley et al., 1975); and gas bubbles in the lateral line can impair sensory ability. In addition, although fish in deep tank studies are less affected by high levels of TDG than fish in shallow tanks, some mortalities still occur despite.a water depth that is apparently adequate for protection. There is no evidence that fish can "sense" TDG supersaturated water and deliberately sound to compensate.

At specific projects where specific levels of spill, particularly daytime spill have been shown to be detrimental to fish passage, timing and/or amounts of spill may have to be adjusted (for specific details see NMFS 1994b). Spill may also be limited at projects where it can be demonstrated that spill may be detrimental to system spill allocation. One such project is John Day Dam, where very low amounts of spill result in very high TDG levels. These high TDG levels then limit the amount of spill possible at dams downstream. For instance, by reducing spill by 10 to 20 kcfs at John Day Dam, it may be possible to increase spill at The Dalles or Bonneville Dams by 20 to 40 kcfs. The exact relationship will need to be developed through in-season spill/TDG testing. The limitation of spill may also apply at The Dalles Dam to minimize the passage of spilled flow and fish over the high predation risk area in the shoals below the dam (see specific details in NMFS (1994b). The details regarding this limitation will be decided in-season through consultation with predation experts and will likely depend on ambient flow and the spill levels obtainable under the TDG limitations. In 1995, spill at Ice Harbor, The Dalles, and John Day Dams may be modified

to accommodate research activities if NMFS determines that the spill modifications will not affect the validity of the transport vs. in-river survival study. These spill operations should be treated as interim until the effects of TDG on migrating salmonids are more fully evaluated and until a spill/transport rule curve can be developed. The rationale for flow targets associated with spill at collector projects is related to transportation policy and discussed under measure 3 below.

Migration over the spillways or through the bypass systems are the safest routes of passage at the dams. Injury and mortality can occur through each route of passage (turbines, spillways, ice and trash sluiceways, juvenile fish bypass systems), but loss rates via the spillways and bypass systems are low relative to passage by the turbines. For both spring/summer and fall chinook salmon, mortality of fish passing over the spillways or through the bypass systems generally ranges from 0–3 percent (Schoeneman et al. 1961; Heinle 1981; Ledgerwood et al. 1990; Raymond and Sims 1980; Iwamoto et al. 1994). Direct turbine mortality can range from 8–19 percent for yearling chinook salmon and 5–15 percent for subyearling chinook salmon (Holmes 1952; Long 1968; Ledgerwood et al. 1990; Iwamoto et al. 1994). Values of turbine and spill mortality are not available for sockeye salmon. However, it is reasonable to assume that these values are similar to or greater than values for yearling chinook salmon due to size and timing of migration and due to the greater susceptibility of sockeye to physical injury and mortality in project passage and handling (Gessel et al. 1988; Johnsen et al. 1990; Koski et al. 1990; Parametrix 1990; Hawkes et al. 1991)."

3. How was public review and comment solicited on the 1994 spills? What comments were received, and how was this information assessed by the Federal agencies involved in implementing the spill policy?

Public review and comment was not solicited for the 1994 spill program, which was implemented as an emergency measure in response to record low returns of Snake River spring/summer chinook. The spill program in 1994 was modified after internal examinations of steelhead revealed a high incidence of gas bubbles. After the 1994 program, NMFS solicited expert scientific input which took the form of convening two panels of experts on gas bubble trauma. The first examined the question of how the gas bubbles found in the internal examinations of the steelhead should be interpreted. The second met to recommend what elements should be included in a monitoring program in future spill operations.

The draft 1995 biological opinion containing the 1995 spill program was distributed to the parties in the IDFG v. NMFS litigation for review and comment before it was finalized. The spill program is also part of the Proposed Recovery Plan, which is currently undergoing extensive public review. With respect to spill specifically, there was a public hearing at the Oregon Department of Environmental Quality, both in 1994 and 1995, which provided an opportunity for public comments on the spill program.

4. How did NMFS incorporate scientific and other information gained during the 1994 spills into decision making for the 1995 spill policy?

See question number two, above, and the general text of this testimony.

5. Please comment on how NMFS works with the many government and independent entities and concerned stakeholders doing research on issues related to salmon mortality and the flow of scientific information.

The NMFS worked closely with many other Federal agencies, state fisheries agencies, Native American tribes and others during the development of the 1995 spill program. The agency also works closely with these parties in developing its research programs and coordinating them with those of others in the region. Most recently, the NMFS has proposed to pursue a project that would create a comprehensive research, monitoring and evaluation framework for all research in the Columbia River Basin. This project, called the Plan for Analyzing Testable Hypotheses (PATH), will be developed by experts from the Federal agencies, state fisheries agencies and tribes, with assistance from outside experts. The NMFS has proposed that development of the project be overseen by a group of Federal, state and tribal technical and management representatives. Once the comprehensive framework is completed, this same group of technical and management representatives would be responsible for ensuring that future research and monitoring in the Basin is consistent with this framework.

6. Please comment on the role that various government entities played and should play in the decisionmaking process and the advisability of establishing a single Columbia River policymaking body.

There are four states and 13 Native American tribes with a direct interest in the Columbia River Basin and its resources.

In addition, a host of Federal agencies have responsibilities for river operations, aquatic and watershed resource management, water quality, and dozens of other activities in the basin. All of these governments and entities must have a role in the many decisions that affect the health of the basin and its economic uses. There is presently no one organizational body that includes all of the various government entities with some interest or role in the Columbia Basin, and any single forum that tried to include every affected entity would collapse under its own weight.

NMFS, in its Proposed Recovery Plan, has recommended to the sovereigns of the region that they work with NMFS through a regional forum designed to bring together the state, tribal and Federal entities on those issues that are most contentious or have the greatest impact on the health of the basin and its resources. This forum is not intended to replace existing coordinating bodies, such as the Power Planning Council. Rather, it is intended to create a more open process in which all governments in the Basin can coordinate their activities, have input into Federal decisionmaking and ensure that entities with decisionmaking authority are accountable for their decisions. Ultimately, the goal is to ensure that decisions are based on the best available scientific information. To that end, NMFS has recommended that a Scientific Advisory Panel be established as part of that forum.

PREPARED STATEMENT OF DR. PHILLIP R. MUNDY, FISHERIES AND AQUATIC SCIENCES, LAKE OSWEGO, OR

Thank you for the opportunity to present this testimony. For the record, I am an independent fisheries scientist currently serving on the Independent Scientific Group, the scientific peer review body for the Northwest Power Planning Council (NPPC), Portland, Oregon. I also serve as a peer reviewer for the fisheries research program of the Exxon Valdez Oil Spill Trustee Council, Anchorage, Alaska. My specialties are the application of mathematical and statistical methods to the study of salmon biology, fisheries management, and the design of fishing regulations.

I will answer the questions posed to me in your letter of invitation of June 15 in the order they were presented, and then I will offer some comments on the how the nature of the institutional structure of salmon recovery research in the Columbia River basin may be modified to improve the decision making process.

1. Are the benefits of using spill as a fish passage mechanism established, especially in relation to other fish passage mechanisms ? Please comment on the scientific validity of the National Marine Fisheries Service (NMFS) policy.

The benefits of using spill as a juvenile fish passage mechanism are established for a broad variety of localities, however each hydroelectric dam is different, so the actual benefits achieved will depend on the design of the hydroelectric facility, the species, the life history type, and ambient physical conditions, among other factors. The benefits of spill are established in relation to the passage mechanisms of turbines and bypass in some localities for some species and life history types, however the same limitations of time and place apply to these comparisons as described above for the overall benefits of spill as a passage mechanism. As described below, the NMFS has recently completed data collection in its first attempt to compare the benefits of spill to those of transportation.

It should be noted that comparing the benefits of spill and transportation may be misleading. I do not view spill and transportation as comparable mitigative measures they are fundamentally different actions in terms of their effect on the juveniles. Although transportation of juvenile salmon in barges and trucks is often cited as a short term alternative to spill, I believe that transportation is at best a stop gap mitigation measure, and I note that the ability of transportation for returning adults to the spawning grounds is unknown, as a matter of science. Transportation is not acceptable as a long term recovery measure because collection of salmon for transportation inflicts bypass and handling mortalities which are not factored into the transport-to-control ratios which have been used to justify the use of transportation. Transportation is antithetical to the preservation of genetic and life history diversity of salmonids, since mechanical bypass collection methods discriminate against certain species and life history types which are among the endangered species.

Correcting the problems in the transportation program may come too late to help endangered salmon. It takes many years to engineer and implement changes in the bypass systems which serve to collect juveniles for transport, and time is running out for the Snake River salmon. The bypasses themselves may be little better than turbines as passage mechanisms; very few evaluations have been conducted to compare the benefits of spill, turbines, and bypass at the same time with the same species. In so far as the benefits of turbines and bypasses have been simultaneously

evaluated, the survivals of juvenile salmon-in bypasses have been slightly better, to slightly worse than in the turbines.

Transportation carries risks of its own. So far this year, more than 21 thousand mortalities of juvenile salmonids have been counted during the process of collection and loading for transport. Two single instances of mass mortality involving thousands of juvenile salmon as a consequence of human error have been documented in the transportation program since 1987. Since monitoring of the well being of the juveniles in the transport barges is difficult, I have little confidence that other than catastrophic mortalities during transportation could be detected.

In summary, I believe the National Marine Fisheries Service has acted prudently in selecting spill as a recovery tool for endangered salmon in the Snake River. I also note that the spill policy of NMFS is as scientifically valid as any recovery policy for Snake River salmon can be, given the limitations of the available data. I also note that the limitations of the available data are due to a research process which lacks coherent direction and independent peer review, even though it has been historically very well funded. I address improvements needed in the research process under decision making, item 5, below.

2. What independent scientific research is being conducted to monitor the effects of spill and its alternatives in the Columbia River system? Please comment on the results of relevant studies.

Since all scientific research on salmon in the Columbia River basin is financed by public and private institutions which can dictate the scope, objectives, and content of the work, I am not aware of any independent scientific research to monitor the effects of spill and its alternatives in the Columbia River system at the present time. There are a number of relevant studies being conducted by state, Federal and tribal entities.

A. THE NMFS JUVENILE FISH TRANSPORTATION STUDIES

Coastal Zone and Estuarine Studies Division (CZES) of NMFS is conducting a study to compare the survival of transportation to that of fish which have started via spill. The design of the study does not permit the effects of transport and spill to be measured on the spawning grounds, and the final results will not be available for several years, but potentially important information may be forthcoming. The effects of spill are averaged with those of turbine and bypass down river from where the fish are transported.

B. THE NMFS/UW JUVENILE SALMON REACH SURVIVAL STUDIES

Also by CZES/NMFS and the University of Washington (Skalski) is the reach (a portion of the river) survival study which should help to understand the ability of spill to deliver juveniles through the lower Snake River hydroelectric system. The effects of spill, turbines, and bypasses are not separable in these studies, but these data make it possible to compare average survivals during controlled spill to average survivals under no spill. Results from 1995 have been collected and they should be available in September, or earlier.

C. FISHERIES AGENCIES AND U.S. ARMY CORPS OF ENGINEERS TRIBES MONITORING PROGRAMS

Under the aegis of the Columbia Basin Fish and Wildlife Authority, a number of state, Federal and tribal entities are conducting individual and cooperative studies of gas bubble trauma, and the Corps is monitoring total dissolved gas levels at a number of localities adjacent to the dams it operates. Juvenile salmon, adult salmon, and resident fish species are monitored for symptoms of gas bubble trauma in the Columbia River system. Monitoring of juvenile salmon occurs at the hydroelectric dams where sampling facilities make this possible. Preliminary studies to observe gas bubble trauma in active emigrants in the reservoirs are in progress. Results from up to eight juvenile salmon dam sampling sites in the Snake River basin and the middle Columbia River are reported daily for juvenile salmon by the Fish Passage Center, Portland, Oregon. Adults are examined at the upper most of the lower Snake River dams after they have passed through the zone of nitrogen Supersaturated waters downstream. Resident fish are monitored below Dworshak Dam on a Snake River tributary.

Results so far show little if any symptoms in juveniles and adult salmon and resident species. These programs provide useful information, but they are relatively new so results need to viewed with caution. My best professional judgment is that the results indicate no apparent problems for the migrating juvenile salmon as a result of nitrogen supersaturation. Some symptoms of nitrogen supersaturation have been detected in a small portion of resident fish so far examined, however the

significance of these symptoms for the overall well being of resident fish populations is not known.

In contrast to the monitoring at the dams, pen holding studies of juvenile salmon conducted by NMFS below Ice harbor dam have produced quite a few dead juvenile salmon, especially during uncontrolled spill events earlier this year. The net pen studies are conducted for the purposes of reproducing effects of laboratory studies, and they are not indicative of survival of free swimming juveniles in the reservoirs. The net pens unnaturally restrict the movements of the juveniles, and small changes in depth can protect the juveniles from the effects of even severe supersaturation. Hence the pen holding studies are implemented for the purposes of describing pathology, and not for determining the survival benefits of spill.

3. Are there risks to migrating smolts and returning adults associated with high levels of dissolved nitrogen resulting from spill?

Nitrogen supersaturation poses risk to migrating salmon and to resident species, since prolonged exposure to nitrogen saturation levels above approximately 115 percent at the surface has been demonstrated in the laboratory and in net pens held in natural waters to be lethal to fish. The risks may be negligible or serious, depending on the degree to which the distribution of the fish coincides with the distribution of the supersaturated waters.

To put nitrogen supersaturation risk into perspective, I do not regard the risks of mortality for salmon which are actively migrating through nitrogen supersaturated waters to be as serious as the risks posed by migrating through turbines or bypasses for a number of reasons. Number one, supersaturation drops off sharply with depth. For example, the potentially lethal total dissolved gas level of 140 percent at the surface is reduced to the still potentially lethal, but lower, level of about 126 percent just 39 inches below the surface, and it is reduced to a safe level of about 113 percent less than eight feet below the surface. Number two, migrating adult chinook are known to travel closer to the bottom than to the surface of the reservoirs when they have the opportunity. Number three, although juveniles have been observed at all depths in the water column, the majority of juvenile salmon are likely to travel at an average depth of about ten feet according to one study. Number four, if gas bubble trauma is affecting large numbers of juveniles, I would expect to see much higher rates of symptomatic juveniles than the negligible rates observed in 1995. Number five, although the depths occupied by resident fish depend on factors such as feeding and reproductive behavior, monitoring studies have found few resident fish with gas bubble trauma symptoms. Number six, the effects of nitrogen supersaturation on juvenile salmon appear to be reversible, since juvenile salmon are frequently reported to recover from the effects of exposure to nitrogen supersaturated water when they are free to move.

4. Have there been investigations of the effect of supersaturated water on resident fish? Have the results of these studies been incorporated into current policy?

Yes, there have been studies which examine resident fish for symptoms of gas bubble trauma conducted by the Idaho Department of Fish and Game. Yes, the impacts of spill on resident species are incorporated into current spill policy. I understand the IDFG studies were conducted in order to advise Federal spill managers of the potential risks to resident fish species. Since these studies have revealed no apparent effects of nitrogen supersaturation on resident fish, there was no need to alter current spill management actions.

5. To what extent has scientific research from the states been incorporated into the current spill policy? How can the present decision making process be improved?

Analyses of available data conducted by scientists employed by the states of Idaho, Oregon and Washington, and the treaty fishing tribes were instrumental in establishing the current spill policy. These analyses called into question the effectiveness of juvenile salmon transportation, and at the same time indicated that spill could provide survival benefits under certain circumstances. Hence, the scientific work of the states and tribes was central to establishing the scientific basis of the NMFS spill policy.

The decision making process functions on at least two levels, the management process of executing operational procedures at the dams to implement the spill policy, and the research process of establishing the scientific basis of these management actions. I do not wish to comment on the management decision process, since I have never been a part of it. The management process now involves only representatives of Federal agencies with statutory authorities and responsibilities for implementation of the Endangered Species Act and operation of the Federal power system.

I do, however believe it is important for me to comment on how the decision making process may be improved by improving its scientific basis. The lack of estimates of the survivals of juvenile salmonids through the Federal hydroelectric power sys-

tem, despite the fact that applicable technology has been available for at least 20 years, should be seen as a stunning indictment of the institutional structures and policy frameworks under which fisheries research is conducted in the Columbia River basin. The ability to separate survival during hydroelectric passage from survival in the estuary and ocean is fundamental to understanding the relative benefits and cost effectiveness of various mitigation measures. Since the historical data base contains so few opportunities to separate the effects of the hydroelectric system from those of the ex-hydroelectric environments, there can be no resolution of competing scientific hypotheses about the benefits and risks of the role of actions such as spill and transportation in salmon recovery.

For example, the Oak Ridge National Laboratory study by Barnthouse et al., identified fundamental differences in the assumptions governing the Bonneville Power Administration's model of hydroelectric effects (Anderson, University of Washington) and the state, Federal and tribal version of the same model. The Barnthouse report concluded that the differences in these models, which are extensively used to forecast the benefits of salmon recovery actions, could only be resolved by collecting observations on the survivals of the fish through the hydroelectric system, among other data.

Hence a good deal of the present salmon recovery controversy is due to the fact that all parties rely on models which contain critical quantities which have never been estimated. These critical quantities are best professional judgments of the scientists involved, so the model results are no more, and no less, than the opinions of the scientists who create and operate the models. There is a widespread misconception that "running the model" with the latest data can add something to the decision making process which is superior to that which can be obtained by simply polling knowledgeable scientists for their views. If the Columbia basin models actually had critical quantities estimated by observation, these model runs would provide insight superior to informed opinion, but they do not, so they cannot.

It is therefore important to recognize that the decision making process for spill is guided by qualitative assessments of individual scientists, hence the comparison of benefits based on the percentage of juveniles supposed by the models to transit the hydroelectric system alive is not a statistically or mathematically valid procedure. The figures cited by the Snake River Recovery Team in its letter of May 30, 1995 to Mr. Will Stelle, Northwest Regional Director of NMFS, fall into this category. The Team notes in its letter that it does not know how to tell if the percentages calculated for the spill and no-spill scenarios are statistically significantly different from one another, but paradoxically, the Team goes on to conclude that the differences in benefits are, in fact, significant, and the Team rejects spill as a recovery option based on these differences. The logically inconsistent position taken by the Team in advising the decision making process is a direct consequence of the logical inconsistencies in its modeling approach. This modeling approach is an unhappy mixture of observation and bald speculation which is impossible to remedy without observations on the survivals of juvenile salmon in the hydroelectric system.

My contention is that the absence of data to estimate quantities so crucial to the validation of the modeling process that advises the management decision making process would never have been permitted by an independent scientific peer review process which had influence over the funding of projects. In my experience as an independent peer reviewer of proposed fisheries research for the Exxon Valdez Oil Spill Trustee Council, Anchorage, Alaska, the actions of the Federal and state agencies which conduct the research can be modified by independent peer review to conform to a central theme which produces logically consistent sets of observations for evaluation of specific effects. My experience as a fisheries scientist in the Columbia River basin is that the absence of independent scientific peer review allows Federal and state agencies to overlook critical information in implementing research programs, and to confound the mission of salmon recovery with the missions of the individual agencies.

Note that I am not presuming that a peer review process could, or would, usurp legislatively mandated agency prerogatives. Rather it is my view that when agencies take research money in the name of the Endangered Species Act and the closely allied Fish and Wildlife Program (NPPC), their proposed actions should be subject to an independent scientific review process which certifies that the proposed research actions are consistent with developing information critical to the implementation of the Fish and Wildlife Program. I am also counseling that research projects should not be funded without this certification. In my experience with the Trustee Council, the requirement for certification has not cost any agency its share of the oil spill funding, but rather it has imposed standards on the types of research which are conducted by the agencies with oil spill funding which focus the research efforts on the attainment of established restoration objectives.

There is much literature from the field of public administration to support my arguments. To cite one example, Clark and Harvey (1991; Chapter entitled, Implementing Recovery Policy: Learning As We Go? In Balancing on the Brink of Extinction, Cathryn A. Kohm, editor) argue that successful implementation of endangered species recovery programs is dependent on more than just good technical and biological tools. While participants in such recovery programs often attribute implementation failures to "bad luck, lack of resources, 'politics,' or lack of commitment in other organizations," Clark and Harvey (1991, p. 147) contend that implementation failures can be a result of inappropriate organizational and decisionmaking arrangements.

> Since most recovery challenges go well beyond the boundaries of a single organization, coalitions are formed that must integrate diverse structures, ideologies, and standard operating procedures. But agencies setting up a new recovery program rarely give explicit thought to how the recovery coalition should be structured. Programs are often set up along standard bureaucratic lines—not because this arrangement has proved most effective but because no other structure is considered. This in turn limits the set of solutions that seem plausible (Clark and Harvey, 1991, p. 153).

I believe that an independent peer review process with financial influence and extensive interagency participation and coordination would go a long way toward solving the institutional and organizational problems of the Columbia River basin's Endangered Species Act implementation decision making process.

In closing I note that most major national research programs such as those of the National Science Foundation, the Environmental Protection Agency, and the National Institutes of Health, have coherent program goals and peer review processes. Should the Fish and Wildlife Program and Endangered Species Act implementation, a research program that spends on the order of $100 million a year on information of vital national interest, not have a peer review process?

I appreciate the opportunity to share my information and professional opinions on this matter of importance to the implementation of salmon recovery under the Endangered Species Act. If I may be of further service to you or the Subcommittee, please let me know.

PREPARED STATEMENT OF EDWARD C. BOWLES, ANADROMOUS FISH MANAGER, IDAHO DEPARTMENT OF FISH AND GAME

OVERVIEW

Idaho Department of Fish and Game (IDFG) supports the concept of providing spillway passage of smolts as they migrate over dams in the lower Snake and Columbia rivers. Managed spill is a valuable and scientifically valid recovery tool that does not require flow augmentation from upriver storage reservoirs to be implemented. The National Marine Fisheries Service's spill policy reflects the potential benefits this management tool can provide to recovery efforts.

Salmon and steelhead represent a tremendous financial, recreational and cultural heritage for the citizens of the Northwest. The Snake River component of these fish represent an ecological cornerstone for spring/summer chinook and summer steelhead throughout the Columbia River basin. Loss of this resource would strike a devastating blow to the heritage and character of Idaho and the entire Northwest.

It is generally accepted that dams on the lower Snake and Columbia rivers are one of the major factors in the decline of Snake River salmon (CBFWA 1991; NPPC 1993; NMFS 1994, 1995). Most of these stocks once thrived by spawning far inland in mountainous headwaters and sending their progeny to the ocean on the wave of natural snowmelt each spring. This journey has been altered dramatically as a result of the mainstem hydroelectric system. This broken link in the salmon's ecosystem must be repaired for recovery to occur. Managed spill at mainstem dams on the lower Snake and Columbia rivers is one of our best and most practical tools to repair this broken link.

ANSWERS TO SPECIFIED QUESTIONS

1. Are the benefits of using spill as a fish passage mechanism established, especially in relation to other fish passage mechanisms?

Idaho Department of Fish and Game (IDFG) generally supports the NMFS spill policy. This policy is closely tied to spill measures recommended in the Northwest Power Planning Council's Fish and Wildlife Program (NPPC 1993). A carefully managed spill program at dams on the lower Snake and Columbia rivers is essential to interim salmon recovery efforts. Spill is necessary because: (1) it is the best way

to get in-river smolt migrants past the dams, and (2) it is the best way to provide an equitable balance between smolts transported in barges and those allowed to migrate in-river.

A key component of improving in-river migration is getting the smolts past each dam. There are currently three possible ways for in-river juvenile migrants to pass the dams: through the turbines, through the mechanical bypass and transport collection system, or through the spillway. IDFG, and all other fishery management agencies and tribes in the Northwest, believe that managed spill provides the safest route for in-river migrants to get past the dams. The turbine route (8–19 percent mortality) results in approximately five times more mortality than spill (0–3 percent) or mechanical bypass (1–3 percent) routes (NMFS 1995).

The best way to minimize turbine passage for in-river migrants is via a controlled spill program. Without spill, all fish that are not mechanically bypassed must go through the turbines. The efficiency of the bypass system at Lower Granite Dam is typically less than 60 percent. Thus, without spill, over 40 percent of the smolts will be forced to pass through the turbines.

Spill can be managed in concert with the bypass system at most dams to achieve an 80 percent fish passage efficiency (FPE). This means that 80 percent of the fish will be provided a non-turbine route past the dam (either spill or mechanical bypass), and only 20 percent of the in-river migrants will pass through the turbines. IDFG believes adopting an 80 percent FPE standard at all dams on the lower Snake and Columbia rivers is one of the most important interim steps we can take toward recovery. Managing spill to achieve an 80 percent FPE requires no flow augmentation from upstream storage reservoirs, but simply reapportions existing water flowing past the dam.

The National Marine Fisheries Service's spill policy includes an 80 percent FPE standard, but does not implement that standard unless flow targets (e.g., 85 kcfs or 100 kcfs) are met at the lower Snake River dams (NMFS 1995). These flow targets may not be met during much, or any, of the smolt migration season, resulting in over 40 percent of the smolts passing through the turbines at the first dam they encounter. IDFG believes spill should be decoupled from these flow targets, and that the 80 percent FPE standard should be implemented regardless of flows, except perhaps during extreme drought conditions.

IDFG also believes that spill should be provided at transportation collector dams as a means to achieve a more equitable balance between smolt transportation and in-river migration. This important interim strategy is necessary until long-term solutions can be implemented (e.g., dam modifications, surface collectors, etc.). The smolt transportation program—which often transports over 85 percent of the total number of migrating spring/summer chinook—has failed to reverse the downward trend in returning adult salmon (Olney et al. 1992; Mundy et al. 1994). Given the uncertainties regarding salmon biology, common sense dictates that we should not "put all our eggs" in the transportation basket. Providing spill at mainstem dams allows a portion of the downstream run to continue their in-river migration under the best dam passage conditions we can create.

Scientific information supports a more even balance between the number of fish transported and the number of fish allowed to migrate in the river. Higher adult returns are typically associated with smolt outmigration conditions that have higher flow and spill, with more smolts migrating in-river and fewer smolts transported (Figures 1 and 2). Preliminary adult return information from PIT tagged juveniles indicates that in-river migrating smolts returned at least as well as transported smolts, even though in-river conditions were far from optimal (Harza Northwest 1994). Independent scientific review also failed to support continued emphasis on transportation (Mundy et al. 1994).

Improving in-river smolt migration conditions will always be important because, even if full transportation is continued, it is impossible to transport all juvenile migrants. At maximum transport 40–50 percent of smolts leaving Idaho will go through the turbines at the first dam they encounter (Lower Granite Dam) and not be transported. This is because of the inefficiency of the smolt bypass system. Many of these fish will be picked up at downriver dams but at least 10–15 percent of the smolts will remain in the river. Improving in-river migration conditions is also important for getting smolts to the transportation collection facilities.

2. What independent scientific research is being conducted to monitor the effects of spill and its alternatives in the Columbia River system?

Spill is a management tool with known benefits, risks and applications. There are no critical uncertainties that preclude immediate implementation of spill as an adaptively managed recovery tool. As discussed above, there is firm scientific support of using managed spill to aid recovery now, not just implement as a limited experiment. This scientific basis for spill was recognized recently by a Federal En-

ergy Regulatory Commission (FERC) judge who rejected smolt transportation in favor of spill and in-river migration (FERC 1992; FERC 1994). This decision regarding two mid-Columbia River dams followed lengthy technical study and debate.

The scientific, legal and ecological basis for spillway smolt passage does not preclude the need for rigorous monitoring and evaluation to fine tune this management tool.

Adaptive management requires continued critical analysis of the spill program in order to maximize benefits and minimize risks. The NMFS spill policy embraces this need effectively. This approach allows managers to learn as they go in order to continually improve the effectiveness and efficiency of recovery efforts. These efforts allow managed spill levels to be modified on a real time basis to address specific concerns such as gas supersaturation or adult passage.

3. Are there risks to migrating smolts and returning adults associated with high levels of dissolved nitrogen resulting from spill?

Gas bubble trauma (GBT) in fish associated with operation of hydroelectric dams is a risk taken very seriously by the Federal and state fish management agencies and tribes. IDFG agrees with every other anadromous fish management agency and tribe in the Columbia River Basin that benefits associated with a carefully controlled spill program, coupled with extensive monitoring and evaluation, far outweigh potential risks associated with GBT.

Dissolved gas levels in rivers can be elevated by the operation of hydroelectric dams, particularly when spill occurs. Under such "supersaturated" conditions, gases tend to come out of solution, potentially affecting fish and other aquatic organisms. Gas bubbles or emboli can develop in circulatory systems and tissues. This occurrence is referred to as gas bubble trauma (GBT) because it is a physical, not pathological, response to an environmental condition (Jensen et al. 1986).

To reduce risk of GBT in migrating salmon, IDFG supports a controlled dissolved gas management program designed to keep gas concentrations in the 120–125 percent range. This range will allow for enough spill to reap the benefits of this recovery tool, yet maintain risk of GBT within acceptable limits. Gas supersaturation standards in most states typically call for no more than 110 percent saturation to avoid GBT in fish. This is a general standard and does not account for the ability of fish to effectively avoid GBT. All Snake and Columbia River dams have adequate water depth in their tailrace for GBT avoidance.

The spill policy implemented by NMFS includes adequate provisions to adaptively manage spill and minimize risk of GBT through monitoring, evaluation and research. State and Federal agencies and tribes worked collectively to develop the spill monitoring program. Implementation of the biological monitoring component of this program has run smoothly this year, and has maintained the flexibility to respond to in-season concerns and modifications.

The managed spill program implemented in 1995 has had virtually no detectable adverse impact on migrating juvenile and adult salmon and steel head. Extensive monitoring has consistently revealed that less than 1 percent of migrating juveniles sampled have symptoms of GBT. The symptoms that were found in a few fish were at very low levels and were unlikely to cause mortality. Adult salmon that have been sampled have not shown any symptoms of GBT. It is important to note that the monitoring program was able to respond quickly and effectively to sampling concerns voiced by scientists representing the power utilities (e.g., internal sampling for GBT symptoms, and examinations of fish collected prior to entering the bypass system).

This result is not surprising, and is the result of careful risk assessment by the agencies and tribes prior to implementation of the spill program this year. It is regrettable that the full benefits of spill have not been realized this year. NMFS and the Army Corps of Engineers had the opportunity to achieve 80 percent fish passage efficiency at the dams this spring, yet fell short because of excessive emphasis on transportation and lack of confident adherence to the spill program and its biological monitoring program. IDFG is concerned that this timid approach to spill has reduced survival from what could have been realized.

4. Have there been investigations of the effect of supersaturated water on resident fish? Have the results of these studies been incorporated into current policy?

IDFG monitored resident fish in the North Fork and mainstem Clearwater rivers below Dworshak Dam during and after spill events this past spring. The Corps of Engineers total dissolved gas monitoring sites indicate that dissolved gas levels in the river ranged up to 120 percent saturation during spill. No mortality of resident fish has been detected as a result of spill. Less than 1 percent of the 453 resident riverine fish sampled from April 24, 1995 through May 26, 1995, had external symptoms of GBT, and these symptoms were very low level (i.e., only one or two bubbles observed per fish).

Monitoring of resident fish associated with spill in the lower Snake and Columbia rivers has not indicated adverse effects to resident fish populations. There has been very limited mortality of caged resident fish held for 4 days in known areas of high gas concentrations. These fish were not allowed to seek out areas of the river with lower concentrations of gas. In spite of these adverse conditions that do not reflect mobile resident fish populations, mortality remained low.

Monitoring GBT in resident fish is part of the overall monitoring and evaluation program. Results from this program are used to make necessary in-season adjustments to fine tune the spill program and minimize risks of GBT in both resident and anadromous fish.

5. To what extent has scientific research from the states been incorporated into the current spill policy? How can the decisionmaking process be improved?

The National Marine Fisheries Service (NMFS) has done a complete job of soliciting scientific information regarding the benefits and risks of spill at mainstem dams. NMFS convened a panel of dissolved gas experts in the summer of 1994. This was followed in August of last year with a series of technical workshops with the state and tribal salmon management agencies as well as representatives of the Direct Service Industries, Public Power Council, Pacific Northwest Generating Cooperative, and environmental groups. The workshops were followed by a series of meetings at which all these parties had an opportunity to express their views on spill issues. NMFS also invited all interested parties to submit written information on spill in December 1994, and to comment on its draft biological opinion in February 1995.

Although NMFS has allowed ample opportunities for public comment on the general merits of spill, it has not done all it should to include the state and tribal salmon management agencies in the day-to-day decisions regarding the implementation of its spill program. NMFS and the dam operating agencies have not responded to a number of specific requests from the state and tribal fish managers regarding provision of spill and measures to abate dissolved gas. As a result, we believe that the region missed some opportunities to improve salmon survival in 1995. The decisionmaking process on spill policy can be improved by ensuring that the state and tribal salmon management agencies have a voice in decisions regarding in-season management of the hydropower system.

I would also like to call the Subcommittee's attention to two high priority actions that the states have long supported but have not yet been implemented by the Corps of Engineers. First, it is imperative that the Corps install dissolved gas abatement devices at Ice Harbor Dam. Much of the concern with dissolved gas levels at that dam this year could have been avoided if the dam were equipped with these devices. Second, the fish bypass system at Lower Granite Dam must be improved. This is the first dam that endangered salmon smolts encounter. Yet, the dam has one of the least effective bypass systems in the basin and results in the largest number of smolts passing through turbines of any of the lower Snake River dams. Important modifications are still years out in the Corps of Engineers's funding and implementation process, and the states and tribes are powerless to speed up this schedule.

SUMMARY

Managed spill is an important tool for salmon and steelhead recovery. It is the best interim tool available to spread the risk more equitably between transportation and in-river migration, the best tool to minimize the number of in-river migrants passing through turbines, and the best tool to get in-river migrants past the dams.

Gas bubble trauma associated with managed spill is a legitimate concern that is being effectively managed with a comprehensive monitoring and evaluation program. IDFG agrees with NMFS that a variance in state supersaturation standards to approximately 120 percent is necessary to meet flow targets and provide adequate spill provisions for springtime juvenile migrants.

Recovery of Snake River basin salmon can be accomplished with a net positive effect on the Northwest economy, culture and lifestyle. Managed spillway passage of migrating smolts is an important tool in this recovery process.

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PREPARED STATEMENT OF MARGARET J. FILARDO, FISH PASSAGE CENTER, PORTLAND, OR

My name is Dr. Margaret J. Filardo. I have worked for the past 8 years as a biologist for the Fish Passage Center (FPC) in Portland, OR. The Fish Passage Center was established in 1984 by the Northwest Power Planning Council. The Fish Passage Center staff consists of individuals with expertise in biology, biostatistics, hydrology, and data management. The FPC is responsible, in part, for the annual implementation of the Smolt Monitoring Program as well as collecting and distributing data to all interested parties. The Smolt Monitoring Program monitors juvenile salmon in the Snake and Columbia River systems at seven dams and five tributary traps. Information is collected relative to the overall species abundance and health, and timing of the migration for in-season management of flow, spill and hydrosystem operations. Since 1994 the Smolt Monitoring Program has been an integral pan of the overall Biological Monitoring Program (see attached figure) developed by the National Marine Fisheries Service (NMFS) for Spill Implementation under the Biological Opinion.

Spill is presently being implemented according to the NMFS Biological Opinion for 1995, with restrictions on the spill levels imposed by the State limits (Oregon, Washington, and Idaho) for total dissolved gas. The risks associated with the program have been analyzed and incorporated in the development of the present controlled spill program. The 1995 Spill Implementation Program includes both physical and biological monitoring programs. I am confident that the present monitoring program is accurately assessing the occurrence of total dissolved gas and will provide early indications of developing signs of gas bubble trauma (GBT).

The following are my comments developed in response to the questions posed to me by the Committee:

1. Are the benefits of using spill as a fish passage mechanism established, especially in relation to other fish passage mechanisms? Please comment on the scientific validity of the NMFS spill policy.

Spill for fish passage is not a new concept. it has been the long standing goal of the natural resource agencies and Indian tribes (A&T) to provide a safe passage route for fish passing a hydroelectric project. The goal of the A&T has been to achieve non-turbine passage routes for 80 percent of the fish passing a dam. Spill has long been considered a viable method of project passage because studies have consistently shown that it is the safest route of passage past a dam. in the early to mid-1980's the provision of spill was compatible with the operation of the hydrosystem. since there was an energy surplus and the power operators had excess water. As the region shifted from the energy surplus, the issue of spill became more problematic. The volume of spill called for through the Biological Opinion is actually substantially less than has occurred in past years. (See attached graph).

The evolution of the 1995 Spill Program began in the early 1980's. Spill was included in the original recommendations to the Northwest Power Planning Council's

Fish and Wildlife Program. Spill is the primary means of passage provided for mid-Columbia FERC licensed projects and is central to the court ordered settlement agreement. Spill was negotiated in a 1987 Regional Spill Agreement, which was later amended to the NPPC Fish and Wildlife Program.

The NMFS has made every effort to obtain and consider input from diverse organizations in the development of the 1995 Biological Opinion. The steps taken for the development of the Spill Program represent technical and scientific processes over the years. The risks associated with spill were analyzed and incorporated into the development of the present spill program.

The benefits of spill have been established through research and monitoring over several years. Direct studies of project mortality have been conducted at several mainstem projects and have shown that spillway mortality is consistently lower than other passage routes. Adult return and run reconstruction analyses have demonstrated that some of the highest smolt to adult return ratios have occurred under circumstances when high levels of spill (much higher than observed under recent planned spill programs) occurred during the juvenile migration period. Spill has been recognized and utilized as a fish passage mechanism for decades in the Columbia and Snake rivers.

In 1995 the agency and tribal resource management agencies reviewed all the available literature and studies to develop an assessment of the risks associated with a spill. The "risk" was measured in terms of trading off the benefits to fish by avoiding turbine passage, versus the detriments associated with mortality due to increased levels of total dissolved gases (Draft 1995 Spill and Risk management, available upon request). The A&T concluded that spill is beneficial at levels of total dissolved gas greater than the levels adopted by the NMFS in the Biological Opinion. Therefore, the NMFS spill policy can be considered both scientifically valid and conservative.

2. What independent scientific research is being conducted to monitor the effects of spill and its alternatives in the Columbia River system? Please comment on the results of relevant studies.

I am aware of research presently being conducted related to turbine passage survival, spill passage survival, juvenile reach survival, transportation benefits, and surface spillway collection. Spill research specifically includes studies to determine the association of the signs of GBT and potential for mortality, the impact of passage through bypass systems relative to the observation of signs of GBT, the amount of time spent in bypass systems, and the comparison of signs of GBT of fish observed in forebays and reservoirs versus observations at the projects after passage through a bypass system.

SUBLETHAL EFFECTS

You will hear references to the potential mortality associated with sublethal effects, such as increased vulnerability to predation and long term physiological impacts. These are valid concerns, but they are also valid concerns relative to other routes of dam passage. Fish suffer great changes in pressure as they pass through a turbine unit and are immediately either killed or stunned and pass through to the tailrace area. Here these fish also suffer from increased risk of predation. I might interject that one of the benefits of spill is that it disperses predators from the immediate fish passage area below the project by causing velocities that are too high for predators.

In addition, the potential impact for transportation on the long term survival of fish has been overlooked. The transportation program has long been described as the solution to the problems in the migration corridor, yet despite ever increasing transportation of fish we continue to see a decline in the species. It may be that there are other processes affecting the survival of these fish, or it may be that sublethal effects of transportation are manifesting in the population. Yet in spite of having no knowledge regarding this subject the Biological Opinion recommends implementing the transportation program and expands its implementation to fall chinook migrants from the Snake River while no research has ever been conducted with Snake River fall chinook.

INADEQUACY OF THE MONITORING PROGRAM

You will hear comments relative to the mortality being imposed on fish from dissolved gas and the inability of the monitoring program to be able to detect the signs of GBT. This is not true. There have been at least two instances in the last 5 years when the monitoring program detected fish with signs of GBT as a result of spill. The first was in 1990 when a fire at John Day Dam caused the entire powerhouse to fail and 100 percent of the river flow to be spilled approximately 300 kcfs for 5

days. A bargeload of fish being transported from the Snake River (approximately 0.6 million) was released above the project and passed in spill with high levels of dissolved nitrogen. Juvenile monitoring at The Dalles Dam immediately began detecting signs of GBT in fish with anywhere from 7 to 33 percent of salmonid species affected within two (Lays. Bonneville Dam monitoring indicated that approximately 74 percent of the steelhead sampled 4 days later exhibited visual signs of GBT. The second instance was in 1993 over the Memorial Day weekend. Power demands were extremely low and 100 percent of nighttime flow was spilled at Little Goose Dam. Dissolved gas levels in the forebay of Lower Monumental Dam (the next downstream project) were measured in excess of 130 percent. Subsequent to this high spill operation approximately 19 percent of fish at Lower Monumental Dam exhibited signs of GBT. Since these incidents our methods of detecting the early signs of GBT have improved with specific areas of fish being observed for GBT, extensive training and the use of magnification.

3. Are there risks to migrating smolts and returning adults associated with high levels of dissolved nitrogen resulting from spill?

There are certainly risks to migrating smolts and adults associated with high levels of dissolved nitrogen from spill. The program for spill that was developed by the NMFS recognizes those risks and limits the dissolved gas levels from fish spill. The operation of the hydrosystem is not benign to passing juvenile and adult salmonids. Passing the structure itself and through the slack water lake created by each project imposes mortality on fish. The responsibility of the resource management agencies is to adjust the passage of fish through the hydrosystem in a way that optimizes fish survival. Passage over the spillway is the most benign of the project passage routes, and if total dissolved gas levels are kept low enough, the benefits of spill passage exceed the detrimental effects imposed by high gas levels. The dissolved gas levels specified by the NMFS are conservative relative to the recommendations favored by the state and tribal fishery resource agencies. The recommendations of the states and tribes and the justification for those recommendations is contained in the draft 1995 Spill and Risk Management.

4. Have there been investigations of the effect of supersaturated water on resident fish? Have the results of these studies been incorporated into current policy?

The concern regarding the effects of dissolved gas on resident species has not been investigated on the Columbia and Snake systems to the extent that research has been conducted on salmonids. However, studies conducted on other river systems have prompted the region to be concerned regarding the impact of TDG on fish that are spending longer periods of time exposed to higher levels. Therefore, the NMFS has incorporated tasks related to assessing the extent of signs of GBT in resident fish and invertebrates into its monitoring efforts. In addition, the distinction has been made, at least by the state agencies, regarding their preferential management for native salmon over introduced exotic species.

5. To what extent has scientific research from the states been incorporated into the current spill policy? How can the decisionmaking process be improved?

To my knowledge the research conducted by the states has been incorporated into the current spill policy. There are some that view the current spill program as more conservative than necessary but support its implementation. The monitoring program currently being implemented is based on the recommendations of the expert panel on dissolved gas convened by NMFS and on recent research results on signs of gas bubble trauma. Additional research is being conducted in 1995, which will be incorporated into future monitoring programs. Research and monitoring recommended by state, tribal, Federal and private special interest consultants have been incorporated into the monitoring and into the research programs for 1995. Individual aspects of the present program are being conducted by state, tribal, Federal scientists and' independent consultants. Virtually all aspects of the impacts of dissolved gas trauma are presently being studied or will be addressed in the near future.

In conclusion, spill has been shown to be the safest route of dam passage. The controlled spill for fish passage program was developed on the basis of past research and monitoring. It was developed with broad regional input by public and private entities. The spill for fish program was developed using a conservative analysis of the risks and benefits associated with spill and dissolved gas. An extensive research and monitoring program has been implemented to verify the program. A broad range of research and monitoring data is being collected to evaluate the impacts and benefits of the spill program. All of this information will be incorporated into analyses to evaluate the effect of recovery (measures on Snake River salmon).

1995 GBD Biological Monitoring/Research Program

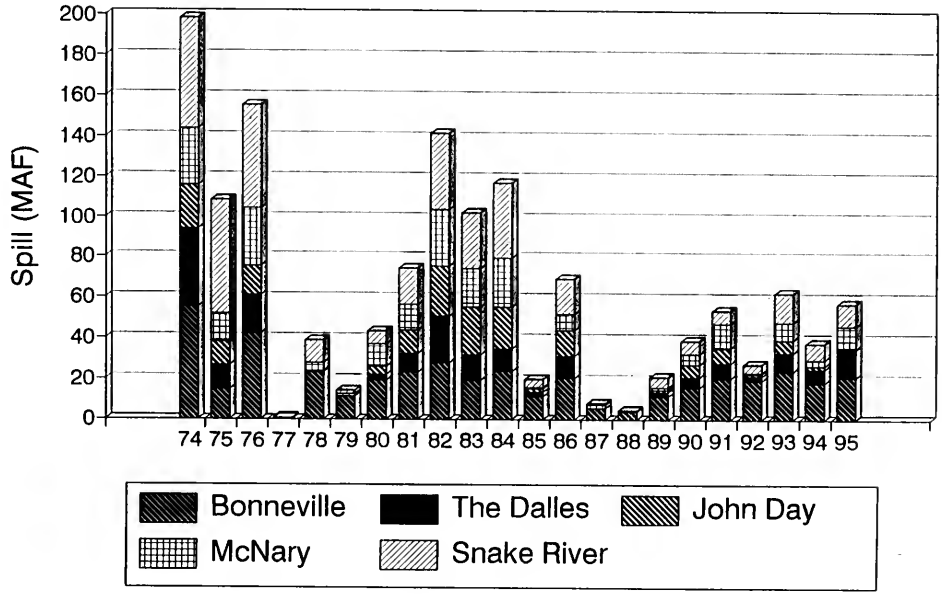
1. Monitoring
   - Juveniles
     - Smolt Monitoring Program (Fish Passage Center)
       1. External Observations
          - a.) Fins, Head, Mouth Area
          - B.) Lateral Line
   - Adults
     - Snake, Mid-Columbia, Lower Columbia
       1. External Observations (Columbia River Inter-Tribal Fish Commission and National Marine Fisheries Service)

2. Research
   - A.) Lab studies initiated Fall/Winter 1994 to develop monitoring techniques to determine link between signs of Gas Bubble Trauma and mortality. (National Biological Service)
   - B.) 1. Prevalance of signs of GBD in resident fish below Ice Harbor, Bonneville, and Priest Rapids dams.
     2. Holding of resident fish and fall hatchery chinook in net pens.
   - C.) Migration time through collection system. (National Biological Service)
   - D.) Fish distribution in reservoirs. (Columbia River Inter-Tribal Fish Commission)
   - E.) Reservoir versus collection system sampling. (National Biological Monitoring Service and Columbia River Inter-Tribal Fish Commission)
   - F.) Gill filament sampling versus external signs. (National Biological Service)

Total Spill in Snake and Lower Columbia

April 1 through August 31

1995 data through June 13



1995 COLUMBIA RIVER SPILL IMPLEMENTATION

- **SPILL IS BEING IMPLEMENTED ACCORDING TO:**
  - TERMS OF THE 1995 NMFS BIOLOGICAL OPINION
  - STATE VARIANCE ON DISSOLVED GAS STANDARDS
    *120% TAILRACE - 115% FOREBAY OVER 12 HOUR PERIOD WITH 125% INSTANTANEOUS MAXIMUM
  - SYSTEM WIDE PHYSICAL MONITORING OF DISSOLVED GAS LEVELS
  - SYSTEM WIDE BIOLOGICAL MONITORING OF GAS BUBBLE SYMPTOMS
    *ACTION LEVELS TO REDUCE SPILL, 15% OF FISH EXHIBIT ANY BUBBLES ON UNPAIRED FINS OR 5% OF FISH EXHIBIT BUBBLES COVERING 25% OF THE SURFACE OF AN UNPAIRED FIN.

    * ACTION LEVEL TO REDUCE SPILL WHEN ANY MONITORED ADULT FISH EXHIBITS GAS BUBBLE SYMPTOMS.

- **THE PHYSICAL MONITORING PROGRAM**
  - DISSOLVED GAS LEVELS ARE MONITORED BY THE CORPS OF ENGINEERS
  - CONTINUAL MONITORING IS CONDUCTED IN THE TAILRACE AND FOREBAY OF EACH PROJECT
  - REDUNDANT AND BACK UP MONITORS ARE ALSO OPERATED
  - GAS LEVELS ARE RECORDED AT EACH SITE 4 TIMES PER HOUR
  - RIVER TRANSECT DATA IS COLLECTED IN CONJUNCTION WITH RESEARCH

- **BIOLOGICAL MONITORING**
  - MONITORING PLAN WAS ESTABLISHED BY DISSOLVED GAS TECHNICAL WORK GROUP AND ON THE BASIS OF RESEARCH RESULTS
  - OCCURS AT ALL MAINSTEM DAMS WHERE SAMPLING TAKES PLACE
  - ADULT SAMPLING TAKES PLACE AT LOWER GRANITE AND BONNEVILLE DAMS
  - RESEARCH SAMPLES FISH IN THE RESERVOIRS
  - SAMPLING CRITERIA IS BASED UPON RESEARCH RESULTS
  - EXTERNAL LATERAL LINE AND PAIRED FINS ARE EXAMINED, ALL SITES
  - GILLS ARE EXAMINED AT THREE SITES AND THE RESERVOIRS

- **RESULTS OF PHYSICAL AND BIOLOGICAL MONITORING 1995**
  - DISSOLVED GAS HAS EXCEEDED THE STATE STANDARDS AT SOME SITES, DUE PRIMARILY TO UNCONTROLLED SPILL RESULTING FROM HIGH RIVER FLOWS AND TURBINE OUTAGES RATHER THAN THE FISH SPILL PROGRAM
  - BIOLOGICAL MONITORING HAS SHOWN THAT THE ESTABLISHED ACTION LEVELS HAVE NOT BEEN REACHED
  - RESERVOIR SAMPLING HAS NOT DOCUMENTED FISH WITH SYMPTOMS
  - DAM SAMPLING HAS DOCUMENTED LESS THAN .7% FISH WITH SYMPTOMS
    * PAIRED AND UNPAIRED FINS, GILL LAMELLAE, DAM AND RESERVOIR SITES
  - NET PEN RESEARCH BELOW BONNEVILLE AND ICE HARBOR IS SHOWING ANTICIPATED LEVELS OF RESPONSE BASED ON DISSOLVED GAS LEVEL AND EXPOSURE TIME
  - ADULT SAMPLING HAS NOT SHOWN FISH WITH DISSOLVED GAS SYMPTOMS
  - OVERALL THE CONDITION AND MOVEMENT OF THE FISH MIGRATION IN RESPONSE TO THE SPILL PROGRAM HAS BEEN EXCELLENT

PREPARED STATEMENT OF COL. BARTHOLOMEW B. BOHN, DEPUTY COMMAND, NORTH PACIFIC DIVISION, U.S. ARMY CORPS OF ENGINEERS

INTRODUCTION

Mr. Chairman and Members of the Subcommittee, I am pleased to be here today to provide information on the U. S. Army Corps of Engineers efforts related the development of the spill policy for the Columbia River hydropower dams. I am Colonel Bartholomew Bohn, Deputy Division Engineer of the North Pacific Division. Accompanying me today is Mr. Doug Arndt, Senior Fish Program Planner with the North Pacific Division.

Northwest salmon stocks are in serious trouble. Three species of Snake River salmon are listed under the Endangered Species Act. In 1994, only one Snake River Sockeye Salmon returned to the Redfish Lake spawning grounds in Idaho. Returns of listed spring/summer and fall chinook salmon runs were very disappointing last year, and are even more dismal this year so far.

The Corps of Engineers has been working with other Federal and State agencies, Tribes, Northwest Power Planning Council, and other interested parties in the region for years to determine the causes of salmon run declines and to find solutions. But the listing of these three salmon species and their precipitous declines over the past few years have focused our programs and directed us to more intensified efforts to improve conditions for this important resource.

A number of factors have contributed to the current state of the salmon stocks in the Columbia and Snake River Basin. These include: adverse effects of logging, mining, cattle grazing and pollution on spawning and rearing habitat; increased competition for food and spread of disease from hatchery stocks; dams that impede the migration of juvenile salmon from their upriver rearing areas to the ocean and as they return as adults to spawn; and, over harvesting—historically in the 1800s and since then by ocean take and sport and commercial fishery in the Basin. The situation is further compounded by poor ocean conditions which have also brought coastal salmon and steelhead stocks along the Pacific Northwest coast to similar levels of decline. All of these have combined to lessen survival chances of the wild salmon stocks.

OPERATION OF HYDROPOWER DAMS TO MINIMIZE IMPACTS ON SALMON

The Corps' eight hydroelectric dams on the lower Columbia and Snake Rivers are widely believed to be a major factor in the decline in numbers of wild Snake River salmon stocks. Besides physically impeding fish migration, the dams create reservoirs that alter water velocities and temperatures, interfering with juvenile migration patterns and improving conditions for predators.

We have sought and continue to seek solutions for the impacts of the Federal dams. Adult fish ladders have been built into each of the eight lower Snake and Columbia River dams. These allow adult fish to follow a series of graduated steps and pools to scale the 100-foot rise in elevation from the tailrace to the forebay of the dams. The ladders work very well.

In the years since the dams have been in operation, many improvements have been made to juvenile fish passage routes at the dams. There are a number of ways for juvenile fish to pass the dams: through the turbines, over the spillways, through the juvenile bypass systems, and in specially designed tanks for transport around the dams by barge and truck. Based upon juvenile passage studies, projects are operated to provide optimum passage conditions.

The survival rate for turbine passage ranges from about 85 percent to 95 percent, depending on the hydraulic and hydrologic conditions at the dam, type of turbine, efficiency range of turbine operation, and other factors. The survival rate for spillway passage is considered to be about 98 or 99 percent. Survival rate through the bypass systems is about 97 or 98 percent. The survival rate for barged fish is about 98 percent to the release point. Fish collected at the bypass systems for transport at four dams are conveyed past all remaining dams.

Survival numbers depend upon how many of the juvenile fish use each passage route and upon conditions they encounter. Turbine passage may disorient some fish, making them easy prey for squawfish and gulls in the tailrace downstream of the dam. High levels of spill result in gas supersaturation levels that can cause gas bubble disease in fish.

Another factor is the percentage of fish using each different passage route. Juvenile bypass systems deflect 80 to 90 percent of steelhead, 60 to 70 percent of spring/summer chinook and as few as 30 percent of fall chinook salmon away from the turbine intakes and through the bypass channel. Recent improvements in deflector screens—especially the extended length screens—are expected to improve this sig-

nificantly. Those screens are scheduled to be installed at Lower Granite and Little Goose Dams in 1996. Spilling is generally believed to have a one to one effect, that is, when 50 percent of the water is spilled, 50 percent of the juvenile fish are assumed to be passed over the spillway.

BIOLOGICAL ASSESSMENT OF HYDROPOWER DAMS EFFECTS ON FISH

Under the Endangered Species Act, the Corps prepares a Biological Assessment of the effects on listed species of planned operation of the Federal Columbia River Power System (FCRPS), prior to the Spring start of the operating year. Following consultations between the National Marine Fisheries Service (NMFS) and the Corps, NMFS issues a Biological Opinion.

In its March 2 Biological Opinion for 1995 and future years, NMFS found that the Corps planned operation of the FCRPS would jeopardize the continued existence of the listed salmon. Accordingly, the Biological Opinion provided reasonable and prudent alternative measures to avoid jeopardy.

On March 10, 1995, Major General Ernest J. Harrell, Division Engineer for the North Pacific Division, signed a Record of Decision documenting the Corps intent to fulfill the recommended actions in the Biological Opinion. In its decision, the Corps relied upon NMFS professional scientific determination that the reasonable and prudent alternatives and measures will provide the necessary actions to halt and reverse declines of listed Snake River salmon species.

The Biological Opinion calls for a variety of actions and studies for salmon. Flow augmentation, spills, juvenile transport, lowered reservoir levels, improvements to existing passage systems and other actions are being implemented in the 1995 operating year. Further improvements to the existing system, and alternative configurations of the physical projects, are being evaluated for the long term. One of these is the surface bypass system for juvenile fish. This is a relatively new technology whereby migrating juvenile salmon would be guided in the top 20 to 30 feet of the reservoir surface where they normally travel, and passed over or through the dam.

INFORMATION GAINED FROM 1994 SPILL FOR FUTURE SPILL POLICY

In 1994, NMFS, responding to the states of Idaho, Washington and Oregon and the four lower river Tribes, requested, and the Corps implemented, an emergency program of spilling at all eight of the lower Columbia and Snake River dams. The Nay 9, 1994, request went beyond spill measures in the 1994 Biological Opinion and previously agreed upon spill measures, such as those provided in the 1989 long-term spill agreement. The 1995 Biological Opinion again called for spill at all eight dams, including at "collector" dams where a majority of juvenile fish would normally have been collected and transported.

The Corps incorporated information from the Scientific Panel convened by NMFS on the 1994 spill operation in its Biological Assessment dated December 15, 1994.

The Corps expressed concern about exceeding current state water quality standards in the Biological Assessment and referenced a letter dated November 9, 1994, to Federal agencies, the states, and other regional interests, from General Harrell. That letter indicated the Corps would attempt to adhere to the state water quality standards in operating its projects, and that requests to exceed state standards should be coordinated by the requesting agency. For the 1995 out-migration season, NMFS has obtained waivers from Idaho, Oregon and Washington.

WORKING WITH OTHER STAKEHOLDERS ON SALMON MORTALITY ISSUES

The Corps assures that evaluations which it funds on salmon passage at its projects are fully coordinated internally and with regional entities and programs. It accomplishes this through an interagency technical review and oversight process called the Anadromous Fish Evaluation Program (AFEP). The Corps is working with NMFS to bring AFEP into coordination processes established under the Pacific Salmon Coordinating Committee (PSCC) or the forum currently proposed by NMFS for implementing the Recovery Plan.

Under the new structure, a Corps AFEP Coordination Team oversees the program and provides command and control, program management, quality assurance and regional interface for all anadromous fish evaluations. The Coordination Team will consult with appropriate Indian Tribes, assure regional coordination with the PSCC or some other body as identified by NMFS and the PSCC, and inform the Power Planning Council of activities.

A Technical Coordination Team provides a process for interfacing with Federal and State fish agencies, Tribes and other interested parties to assure that they have adequate opportunity for review and to provide recommendations throughout the development and implementation of AFEP studies. The Team will also coordinate sci-

entific peer review of AFEP proposals, test-fish needs, and study results with technical experts, the agencies, Tribes and others. Corps representatives are working with the agencies, Tribes and other interested parties to encourage active participation in the AFEP process.

We will continue the annual study review meetings to provide the region with preliminary results of current studies. Final study reports and data will be provided to all interested parties as they become available.

SUMMARY

In conclusion, we have underway in the region a comprehensive and ambitious plan of measures and evaluations to improve survival of salmon at the Federal hydroprojects. Because of the complex life cycle of the salmon and the many factors that influence their survival, there is much uncertainty about the quantitative improvements achievable from any individual measure. We must continue to learn from our actions and modify them as necessary. The NMFS Biological Opinion and proposed Recovery Plan and our research process are intended to assure that. Results from turbine efficiency, gas abatement and surface collection evaluations, among others, will be considered as we make future decisions.

Spilling is to provide interim protection for the juvenile fish until better techniques for moving juvenile salmon around individual projects can be implemented. Spill is considered to be a safe method of passing the fish as long as it is carefully monitored to control gas supersaturation. The Corps has a network of gas monitoring devices at locations throughout the basin. The physical monitoring is unique in its intensity and coverage, and allows us to closely align our spill levels with the water quality standards of the states and EPA.

We have relied upon NMFS to provide a biological monitoring plan of action. While there continues to be refinements in the biological monitoring plan, an all-out effort is being made in the monitoring to provide for the safety of the juvenile fish.

Thank you Mr. Chairman, that concludes my remarks. I would be very happy to answer any questions.

PREPARED STATEMENT OF DR. WESLEY J. EBEL, BIOLOGIST, SEATTLE, WA

My background: I was employed by the National Marine Fisheries Service and its predecessors for 31 years as a Fishery Research Biologist. For 26 of those 31 years I worked on fish passage problems in the Columbia River. I retired in 1988 as Director of the Coastal Zone and Estuarine Studies Division (previously called the Fish Passage Research Division). Since 1988, I have worked as a consultant on fish passage and other related research. I obtained a Ph.D. in Forestry and Wildlife Management from the University of Idaho in 1977.

My comments regarding the 5 questions you wish addressed are as follows:

1. Are the benefits of using spill as a fish passage mechanism established, especially in relation to other fish passage mechanisms? Please comment on the scientific validity of the National Marine Fisheries Service (NMFS) spill policy.

The benefits of using carefully controlled levels of spill as a fish passage mechanism are established if there is no other alternative than passage through turbines. Available research indicates that juvenile salmon will survive at a significantly higher rate passing over a spillway than through turbines at Columbia River dams. Thus spilling water at dams where fish are not collected and transported or where juvenile bypasses are inadequate does have some scientific validity as long as spill volumes are held at levels that do not cause excessive mortality from gas bubble trauma.

The benefits are spill are not established in relation to smolt transportation. To the contrary, the best available data indicates that survival of fish collected and transported is greater than in-river survival of migrants even during periods of high flow and spill. Since 1968, over 29 tests were conducted to evaluate the effects of transporting juveniles, spring, summer and fall chinook and steelhead. In these tests, marked groups of fish released in the river as controls and transported (by barge or truck) were enumerated when they returned as adults to the fishery and to the dam where they were marked. All but two of these tests showed a benefit from transportation (transported fish returned at a significantly higher rate than fish released in the river). Two tests that did not show a benefit indicated no significant difference in return of transported and non-transported fish.

Unfortunately, since 1983 there have been only 2 years (1986 and 1989) when both transport and control releases were marked for proper evaluation of the transport operation. During the remainder of the years, no fish were marked or only

transport groups were marked making comparison with in-river migrants impossible most years. However, the research results available today demonstrate unequivocally that transport of chinook and steelhead from the Snake River Dams benefits salmon and steelhead more than does in-river migration. I have seen no convincing scientific studies that indicate spilling at Lower Granite, Little Goose and McNary Dams is better than collecting and transporting the fish from these upstream dams. State and tribal fishery agencies have attacked the transportation research, but their criticisms lack merit. In an April 7th letter to Oregon and Washington water quality regulators (copy attached), I have addressed some of these issues (at p. 6 & Ex. A).

2. What independent scientific research is being conducted to monitor the effects of spill and its alternatives in the Columbia River system? Please comment on the results of relevant studies.

In 1995, substantial numbers of juvenile spring chinook were marked to evaluate transportation and in-river migrations. The results of these studies will determine whether transport is better or worse than in-river migration which included spill as specified in the biological opinion of the National Marine Fisheries Service (NMFS). These studies most likely will not be able to determine differences in survival of in-river migrants during periods of spill and non-spill because spill was occurring at several dams throughout the spring migration season.

3. Are there risks to migrating smolts and returning adults associated with high levels of dissolved nitrogen resulting from spill?

There are risks to migrating smolts and returning adults associated with high levels of dissolved gases. Whenever gas levels approach or exceed 120 percent saturation, mortality to juveniles and adults can be substantial depending on exposure time, depth distribution of the fish and level of gas saturation. In the April 7th letter (at 2–5), I have discussed some of the relevant effects of gas supersaturation.

The fishery agencies and tribes prepared a risk analysis, titled "Spill and 1995 Risk Management", addressing spills, gas saturation, and mortality. There are several errors in interpretation of results of some key studies cited in this analysis. As a result, some values used are incorrect and the conclusions drawn from some important research are either distorted or incorrect. Thus, the risk depicted in this analysis that is associated with spilling water at dams is underestimated. The April 7th letter addresses these issues (at p. 4).

4. Have there been investigations of the effect of supersaturated water on resident fish? Have the results of these studies been incorporated into current policy?

There have been investigations of the effect of supersaturated water on resident species of fish in the laboratory and in 1994 and 1995 in the Columbia River. Generally, resident fish are more resistant to supersaturated water, but those that reside in shallow water in the river (1 meter or less) would be severely affected. Presumably, the results of studies completed in 1994 are incorporated in the current policy to the extent that NMFS continues to monitor the effects of supersaturation on resident fish.

5. To what extent has scientific research from the states been incorporated into the current spill policy? How can the decisionmaking process be improved?

The states have not done any recent research on spill and gas bubble trauma. The agencies and tribes have conducted various analyses of studies conducted by others, including the risk analysis.

The decisionmaking process can be improved by continuing to properly evaluate the actions taken to increase adult returns of salmon and steelhead to the Columbia River. Key studies are those designed to evaluate transportation and in-river survival of juvenile migrants under various flow and spill scenarios. If the proper studies had been continued through the 1980's and 1990's as NMFS proposed, we wouldn't be here today testifying before this committee. NMFS proposed continued evaluation of transportation and in-river survival of juvenile migrants during the 1980's and 1990's, but these proposals were rejected by the various committees that must approve NMFS research proposals before they can go forward. Those committees are dominated by the state fishery agencies and tribes. Hiring freezes and lack of funding have also severely hamstrung the NMFS units charged with carrying out the above needed research.

April 7, 1995

William W. Wessinger, Chairman
Oregon Environmental Quality Commission
121 S.W. Salmon, Suite 1100
Portland, OR 97204

Eric Schlorff
Washington Department of Ecology
P.O. Box 47600
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Dear Sirs:

My understanding is that my letter of February 13, 1995, regarding the state and tribal "1995 Spill and Risk Assessment" document arrived at Oregon DEQ after the close of the last public comment period and has therefore not been considered by DEQ. For the convenience of all concerned, I have undertaken to consolidate the contents of that letter, a previously-filed affidavit, and some additional comments addressing the new proposal by NMFS to increase allowable levels of total dissolved gas in the Columbia River.

I worked as a fishery research biologist for the National Marine Fisheries Service and its predecessors for 31 years, retiring in 1988 as Director of the Coastal Zone and Estuarine Studies Division, formerly the Fish Passage Research Division. Since 1988, I have worked as a part-time consultant on fish passage research problems. I obtained a Ph.D. in Forestry and Wildlife Management from the University of Idaho in 1977.

In brief, my conclusions concerning NMFS' request are:

1. Denying the request would not likely to result in greater harm to salmonid stock survival through in-river migration than would occur by increased spill. Granting the request is likely to reduce salmonid stock survival because increased spill will decrease the percentage of fish that are transported in addition to any direct and indirect mortality arising from gas bubble disease.

2. Allowing the request does not provide a reasonable balance of the risk of impairment due to elevated total dissolved gas to both resident biological communities and other migrating fish and to migrating adult and juvenile salmonids when compared to other options for in-river migration of salmon. Indeed, allowing the request poses a risk of long-term harm to the Columbia River ecosystem.

3. Assuming proper monitoring and appropriately-designed experiments were in place, it might be reasonable to experiment with allowing spill to TDG levels of 115% in the stilling basin. Such an experiment should only be conducted at dams where salmon cannot be collected for transportation, since transportation remains a superior passage alternative.

(For purposes of these conclusions I have assumed that "in-river migration of salmon" may include transporting juvenile salmon downriver in barges.)

State and tribal fishery managers prepared the Risk Assessment document to justify increasing the dissolved gas concentration in a range of 120 to 125 percent based on 12 hour averages. The risk assessment model compares the predicted mortality that will occur to juvenile and adult migrants from TDG (total dissolved gas) induced by spilling against that which occurs from passage through turbines. A risk assessment model is only as accurate as the values used to calculate the risk. I found several errors in interpretation of the results from some of the literature cited. As a result, some of the values used are incorrect and some of the conclusions drawn from some important research are either distorted or incorrect. The specific deficiencies are set forth below and in the attached Exhibit A.

Background: General Effects of Gas Supersaturation

I have conducted a number of studies concerning the effect of gas supersaturation on juvenile salmon and other fish. Gas supersaturation arises when excess gas is dissolved in water; that is, an amount of gas over what the body of water would hold normally. In the Columbia and Snake Rivers, the process of spilling water over dam spillways concentrates atmospheric gases in the water in levels that exceed the norm. These excess levels are measured by percentages. Normal saturation is 100%. In the Columbia River, values as high as 148% have been recorded.

Gas supersaturation adversely affects fish in a number of ways. Excess nitrogen enters the circulatory system of the fish and diffuses out, causing gas bubbles or emboli in the circulatory system and gas bubbles under the skin. These gas bubbles have a number of adverse physical effects. Gas bubbles occlude blood flow in the gills, thus suffocating the fish. Gas bubbles also occlude the mouth and throat of the fish, and can cause blindness in the fish due to hemorrhaging or exopthalmia. The gas bubbles can also result in overextension or rupture of the swim bladder, particularly in juveniles under 50 mm in length. Collectively, these symptoms are referred to as gas bubble disease.

Sublethal effects of gas bubble disease are not always evident as external visible symptoms. For example, Schiewe (1974) and Dawley and Ebel (1976) determined that sublethal effects such as decreased swimming performance and growth occurred at gas supersaturation levels as low as 106%. Poor swimming performance can result in increased predation by predators in the river.

Laboratory research conducted by several researchers showed that the threshold levels for supersaturation where direct mortality begins occurring is about 110 to 115% for juvenile salmonids, depending on size and species. In shallow water, laboratory experiments have shown that, for example, at 125% saturation, 50% mortality to chinook occurs in 13.6 hours. At 120%, 50% mortality occurs in 26.9 hours for chinook. To my knowledge, recent studies do not contradict these results. I note that the U.S. Environmental Protection Agency relied upon some of these studies in establishing 110% TDG as the water quality criterion.

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The authors of the Risk Assessment place substantial emphasis on in-situ live cage studies done by Meekin, Turner and Weitkamp. The authors state that concentrations were as high as 126 and 128 percent and no mortality occurred. For most of the duration of these tests the concentrations were nearer 120 percent. Considering the clearer water (fish tend to be deeper in clear water, Dawley et al., 1975) and the duration of the tests (7 days), I would not expect mortality. They do not refer to a test done in the Snake River where concentrations of TDG were 127 percent for the entire duration (7 days) and 48 percent mortality occurred in the volitional cage 4.5 m. deep. It appears the modelers must have given more weight to in-situ experiments that showed lower mortality rates. In figure S, page 42, there are several observations above the mortality line between 120 and 130 TDG.

Depth Compensation

The depth of a fish in the water affects the level of gas supersaturation that the fish can tolerate. For example, each foot of depth compensates for approximately 3% excess saturation. Thus a fish at 3 feet of depth in water supersaturated at 120% will be subjected to the equivalent of a gas supersaturation level of only about 110%. Tests done in deep tanks and in four-and-one-half meter deep live cages in the river showed that significant mortality still occurred at exposure times as short as six days. Dawley et al. (1976); Ebel (1971).

NMFS has determined that "there is no evidence that fish can 'sense' TDG supersaturated water and deliberately sound to compensate". (Biological Opinion at 108). I agree with this conclusion. The authors of the Risk Assessment suggest that fish will detect and avoid supersaturated water by either sounding or moving laterally. There is some evidence that salmonids can avoid supersaturated water by moving laterally to normally saturated water, but this is irrelevant when large areas are supersaturated and there is no normally saturated water to escape to.

While fish cannot avoid TDG supersaturation, the normal depth distribution of salmon does compensate for some excess gas supersaturation. This compensating effect is limited by the fact that a significant portion of migrating juveniles travel in the upper 3 feet of the water column. For example, Smith (1973) found approximately 30% of juvenile chinook salmon in the upper three feet of the water column at Lower Monumental Dam. Dawley (1986) found similar distributions of chinook in the forebay of the The Dalles Dam.

It should also be remembered that juvenile salmon, particularly fall chinook juveniles, feed as they move downstream. Most of their food supply appears to be insects and insect larvae which are found at the surface, suggesting that juveniles spend a substantial fraction of the time in shallow water to feed.

According to press accounts, gas supersaturation recently killed a large proportion of juvenile salmon awaiting release in net pens in the Willamette River. Oregonian (1995). ODFW reports that mortality occurred at TDG levels measured by saturometer at 114-117%, and that the effective depth of the net pens was at least six feet. If juvenile salmon could

sound to avoid gas supersaturation, the Willamette net pens provided ample depth to compensate for the recorded gas levels and no fish should have died. Indeed, at the bottom of the net pen, juvenile salmon could have compensated for approximately 18% (3% times six) excess gas supersaturation.

Spill Passage vs. Turbine Passage

At reasonable levels, spill results in lower mortality to migrating juvenile salmon than passage by turbines or bypass facilities. As set forth below, however, conditions are different at every project. The available data do not suggest that the benefits of passage by spill are sufficiently clear or large to gamble with the known adverse effects of gas supersaturation in the way proposed by NMFS.

There is little information available concerning the comparative risk of passage by turbines at Bonneville Dam and passage by spill. Turbine mortality at Bonneville is assumed to be on the order of 12-15% based on an unpublished study in 1952. Holmes (1952). Since 1952, a second powerhouse has been constructed at Bonneville Dam with a more fish-friendly design. Direct turbine mortality at this powerhouse has consistently been estimated at 1-4% -- not terribly different than direct spill mortality (i.e., non-GBT mortality). Ledgerwood et al. (1990); Ledgerwood et al. (1994). Those studies did show very high predation mortality in the river below the second powerhouse which more than offset the benefits of the lower turbine mortality, but the consistent disuse of the second powerhouse has created slackwater conditions favoring resident predators; presumably, consistent use of the second powerhouse would avoid this problem and was in fact recommended by the study authors.

Spill mortality at Bonneville is uncertain. The Ledgerwood studies did show lower mortality for salmon passed by spill at Bonneville than when passed through either powerhouse. However, that spill program was specially designed to avoid use of the bays that spill onto large concrete tetrahedrons designed to dissipate the kinetic energy of the water, and involved spill levels that did not generate dangerous levels of total dissolved gas.

Data are available concerning spill mortality and turbine mortality at other projects. Probably the most serious errors in the Risk Assessment are in the values used for turbine mortality at these other projects. They use 32 percent for turbine mortality at Ice Harbor Dam. The correct value if 14.5 percent. Thirty two percent mortality was recorded by Long for releases in the backroll. Fifteen percent mortality was cited for Bonneville I. The study by Holmes gave a range of 12-15 percent. Thus 13.5 percent would be a more appropriate value. Eighteen percent turbine mortality is incorrect for Bonneville II. The correct value is 2-4 percent. Not recorded is a turbine mortality of 3.5-9.2 percent for Rocky Reach Dam and 5 percent recorded for Lower Granite Dam. A 27 percent spillway mortality (steelhead) for Lower Monumental Dam for Bonneville is not mentioned.

Adverse Effects on Adult Salmonids

Past research has shown that high spill at dams may lead to confusing tailwater currents that make it difficult for adults to find fishway entrances. Generally speaking, adult fish passage facilities were engineered on the assumption that a substantial portion of the flow would go through turbines. When spillway flows exceeded turbine flows at the Snake River dams in the 1960s and 1970s, adverse tailwater currents and delays of adult migrants were observed. Junge (1966); Junge (1971).

If the proposed spill levels recommended by NMFS are implemented, confusing tailwater currents may occur, with accompanying delays of migrating adults. Moreover, according to NMFS, spilling at the levels proposed will create gas supersaturation in the spillway side of the dam as high as 120% (12 hour average) and 125% (two hour maximum). (Biological Opinion at 106.) Adults exposed to these levels for extended periods of time are likely to suffer gas bubble disease.

For example, in 1968, when excess water was spilled at John Day, adults were delayed for several days and a substantial mortality of chinook and sockeye was recorded. The State of Oregon estimated that over 20,000 adult chinook were lost. Beiningen and Ebel (1970). Meekin and Allen (1974) estimated that 6% to 60% of adult salmonids in the middle region of the Columbia River died between 1965 and 1970; carcasses of adult salmon were found in the river when gas supersaturation reached 120% or higher.

The spill recommended by NMFS would occur from April through August. Endangered Snake River spring/summer chinook adult salmon will be returning during this period of time to pass upstream. NMFS spill plan will expose these adults to elevated gas levels during their entire migration past the eight mainstem dams, but also delay that migration. Since adult salmon have finite energy reserves, delay in their migration will tend to decrease survival in addition toany survival decrease resulting from gas bubble disease.

I note that when the United States Fish and Wildlife Service made its request to increase TDG, they asserted that a cap of 115% measured at the Camas/Washougal monitoring station would equate to approximately 125% TDG in the stilling basin. NMFS appears to assume that measurement of 115% at Camas Washougal will equate to levels of only 120% in the stilling basin. Before embarking on a spill program of this magnitude, it would seem appropriate to understand what levels of TDG will in fact result in stilling basins at given downstream TDG levels.

NMFS proposes to measure TDG at the Camas/Washougal monitoring station. The Camas/Washougal station has consistently the lowest TDG measurements at the first three monitoring stations downstream from Bonneville Dam: Warrendale, Skamania, and Camas/Washougal. Bonneville Dam is structured with the first powerhouse on the Oregon side, a man-made island, a spillway in the middle, another man-made island, and the second powerhouse on the Washington side. The second powerhouse is used last, so that most flow will pass through the first powerhouse and the spillway. These flows mix slowly as they

pass down the river, which can be seen by comparing the Warrendale (Oregon side) and Skamania (Washington side) measurements; when the second powerhouse is not fully operational, the Skamania measurements will tend to reflect the higher concentrations from the spillway water. In order to give maximum protection to Columbia River fish and wildlife, it would be prudent to measure TDG at the Skamania station.

Transportation as a Passage Alternative

In the Risk Assessment, collection and transportation is dismissed as having no value and it is unclear what value screening and bypass systems might have. Sublethal effects of higher than normal TDG levels are not addressed. I understand that this assessment only deals with survival of in-river fish and therefore the effects of transportation are omitted. However, if the goal is to increase adult returns, transportation and its value must be considered. As spill increases at collector dams, fewer fish are transported, thus fewer fish receive the benefit from transportation.

The reports by Mundy et al. and the Ad Hoc Transportation Review Group cited to dismiss transportation are seriously flawed. I am intimately familiar with the transportation studies because I initiated and carried out the first study in 1968 and was either co-investigator in later studies or assisted in planning and direction of the studies. From the first study conducted in 1968 to the present studies underway, the experimental design of the experiments mandates that the primary point of evaluation of adult returns is at the dam where the juveniles were marked and assigned to treatment groups. In addition, the studies were designed with replicates for both transport and control groups so that variance in return rates could be computed for various statistical tests. Thus, data must be treated in aggregate for proper analysis. The Ad Hoc review group chose to separate returns and analyze data from alternative sites such as hatcheries and spawning grounds where in many cases they were analyzing adult returns ranging from 0-15 fish from one or two replicates of one experiment. From this type of analysis they chose to draw their main conclusions, ignoring the main and most valuable data. They also did not review any data obtained prior to 1980. Since 1968, over 29 tests utilizing spring, summer and fall chinook in transport and control releases have been carried out. All but two of these tests showed a benefit from transportation. The two that did not show a benefit indicated no significant difference in returns of transported and non-transported (control) fish.

There are also some errors and omissions in the Mundy report, but the main flaw in this report is that the executive summary and conclusion do not always agree with the data and information contained in the text. The executive summary also omits commenting on the fall chinook data from McNary Dam which is clearly in favor of transportation. Generally, the executive summary highlights the negative aspects of transportation and omits the positive. The quote by the Mundy report: "available evidence is not sufficient to identify transportation as either a primary or supporting method of choice for salmon recovery" is simply incorrect. (See detailed comments attached as Exhibit A.)

The Adequacy of Biological Monitoring

Monitoring for visible signs of gas bubble disease is unlikely to provide adequate protection for salmon. By the time gas bubble disease is widely apparent in either the juvenile or adult populations, it is likely substantial losses will have occurred. During the serious dissolved gas problems in the 1960s and 1970s, it was uncommon for large numbers of migrants to be observed with gas bubble disease symptoms.

Why NMFS Can Achieve 80% FPE Without the Risk of Elevated TDG

NMFS' plan is designed to achieve 80% "Fish Passage Efficiency" or FPE, which is a measure of how many fish pass by a dam by means other than turbines. It is not a measure of how many fish pass the dam alive. For example, with 80% FPE, 20% of the fish would go through the turbines; assuming 10% turbine mortality and zero bypass or spill mortality, 2% of the fish would die, and 98% of the fish would pass the dam alive. When a significant portion of the fish are transported around the dam, the percentage of fish surviving passage around a particular project is even higher. If half the fish are transported, then 99% will pass the project alive (assuming insignificant barging mortality).

In the biological opinion, NMFS presents its estimates of the amount of spill required to achieve 80% FPE. NMFS does not present the bases of its calculations. To understand how the amount should be calculated, it is necessary to understand the concept of "Fish Guidance Efficiency" or FGE. Many of the projects have bypass systems to divert juvenile salmon away from the turbines, which generally consist of moving or "traveling" screens. By placing fyke nets behind these traveling screens and testing how many fish get past them, fishery agencies calculate the percentage of fish guided away from the turbines, or FGE.

Thus at projects with bypass systems (Lower Granite, Little Goose, Lower Monumental, McNary, John Day and Bonneville), to reach a given level of FPE, one must merely know the FGE, and then spill until the proportion of juveniles passing over the spillway reaches the desired level. For example, if FGE is 50%, and the target FPE is 80%, the amount of spill required to reach 80% FPE is the amount of spill that passes 30% of the juveniles over the spillway.

I have recently re-examined the latest data on fish guidance efficiency (FGE) of the traveling screen-bypass systems and some reports on fish passage behavior during periods of spill. I am convinced that the 80% FPE can be achieved at all the dams with bypass systems without exceeding 115 percent TDG in the spillway tailrace.

NMFS appears to assume that the number of fish passing by way of the spill is directly proportional to the volume of water being spilled. Several studies indicate that this is most likely not correct (Faurot et al. (1982), Stuehrenberg et al. (1986), and Giorgi et al. (1988)). In these studies, the effect of spill on juvenile spring chinook and steelhead behavior was examined at Lower Granite and John Day Dams. All indicated that significantly more fish pass via the spillway than the 1:1 ratio apparently assumed by NMFS.

For example, at 20 percent spill, 40 percent of the marked fish passed via the spillway at Lower Granite Dam; at 40 percent spill, 60 percent passed via the spillway. Studies at John Day indicated that passage of fish via the spillway was 44 to 56 percent higher than the percentage of water spilled.

Considering these studies, and that that the mean FGE of the improved bypass systems at Little Goose, Lower Monumental, McNary, and John Day all exceed 69 percent (Lower Granite 75-77%, Lower Monumental 69%, McNaruy 80%, and John Day 72%), a much smaller percentage of the water need be spilled than 80% specified by the Biological Opinion to achieve 80% FGE (Kroma et al. (1986), Ledgerwood et al. (1987), Brege et al. (1992), McComas et al. (1994)).

The Risk Assessment states that 30 to 92 percent of the fish pass through turbines even where screening and bypass systems are installed. This is a very misleading statement. As set forth above, the mean FGE is much higher. At dams where turbines are completely screened (Lower Granite, Little Goose, Lower Monumental, and John Day) guidance ranges from 40 to 80 percent for spring chinook, 75 to 86 percent for steelhead, and 25 to 35 percent for subyearlings. Guidance values for Bonneville II are lower, but testing continues there.

Some of the recent PIT-tag recovery information indicates that the FGE values measured during the studies cited may be too high and the real FGE may be closer to 50% at Little Goose and Lower Monumental Dams. Even accepting these lower FGEs as accurate, given that 40% of the fish will pass at 20% spill, it appears unlikely that TDG of 115% percent in the tailrace need be exceeded to achieve 80% FPE.

This is apparent from an examination of the data concerning specific projects. For example, at Lower Monumental Dam, where the lowest FGE occurs, 15% spill would achieve 80% FGE. Thus, at 100 thousand cubic feet per second (kcfs) river flow, only 15 kcfs spill would be required. Based on the rating curves for spillway deflectors, this level of spill would probably not exceed 110 percent TDG.

At Lower Granite Dam, fish guidance efficiency appears to range from 50% early in the season to 80% late the season. Early in the season up to 40 kcfs spill may be required to achieve 80% FPE, but if one considers the studies cited earlier, 20% should be more than sufficient. As the season progresses, this spill could be reduced and 80% FPE could still be achieved.

At Bonneville FGE for spring migrants is about 50%. Again 115% TDG does not need to be exceeded to achieve 80 percent FGE. The only dam where an FPE of 80% percent may not be achieved by maintaining the tailrace concentrations at or below 115 percent TDG would be Ice Harbor.

The efficiency of the sluiceway at the Dalles Dam without any screens is near 50 percent. Because of the configurations of the dam, small volumes of spill there can pass a

high percentage of fish. Again 115 percent does not need to be exceeded to provide reasonable fish passage conditions.

Conclusion

I see little merit in spilling up to 120% TDG at all dams, when I consider the above facts. The risk of GBT to both adults and juveniles at 120% TDG at all dams for the long duration proposed (April 14 to August 31) outweighs the possible benefit of improved FPE. I recommend that the Commission and the Department deny NMFS' request, and would restrict tailwater TDG concentration to a maximum of 115%.

Sincerely,

Wes Ebel

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Exhibit A

Specific Comments on the Risk Assessment Document

P. VI, Par. 2, Line 6:

30 to 92 percent is misleading at dams where turbines are completely screened (Lower Granite, Little Goose, Lower Monumental and John Day). Guidance ranges from 40 to 80 percent for spring chinook, 75 to 86 percent for steelhead and 25 to 35 percent for sub-yearlings. Guidance values at Bonneville second powerhouse are lower, but testing continues there. Guidance values for Bonneville First Powerhouse are similar to the upstream dams.

P. VI, Par. 3, Line 6:

Research carried out in the 1960's, 1970's and 1980's (Bjornn 1992) indicated high spill delays adult migrants. Observation of pre-spawning mortality during periods when gas levels ranged between 120 and 125 percent (p. 29) seem to refute this statement.

P. 4, Par. 2, Lines 8 and 9:

The direct and indirect mortality components are not known for bypasses except for the data obtained at Bonneville Dam.

P. 5, Par. 2, Line 3:

The turbine range 8-32 percent is not correct. See later comment page 30.

P. 5, Par. 3, Lines 1-3:

See comment P. VI, Par. 2, Line 6 above.

P. 5, Par. 3, Line 4:

There are no data to support this contention. In fact, data shows that stresses encountered in the bypasses are completely alleviated during holding and transport (Maulo et al. (1988) and Congelton et al. (1984)).

P. 5, Par. 3, Line 2:

This was true because mid-Columbia dams do not have bypass systems nor do they collect and transport.

P. 5, Par. 3, Lines 4-6:

Hilborn found this relationship for the same reason Raymond did. Petrosky's analysis is flawed because he does not account for fish transported. How does one know whether the high return rates were not due in large part to transport? In 1983, over 6,000,000 fish were transported. There is no disagreement over the fact that low adult returns result from extreme low flow years such as 1973 and 1977. Fish arriving at Lower Granite Dam were in very poor condition in spite of the fact that no dams had been encountered before their arrivals.

P. 5, Par. 3, Last Line:

Same comment at P. VI, Par. 3, line 6.

P. 7, Par. 2:

It is conceded that juvenile salmon receive compensation because of their normal depth distribution, but it isn't sufficient to completely avoid symptoms of GBT (gas bubble trauma) or mortality. Intermittent exposure is irrelevant to juvenile migrants. Once the fish are in a block of supersaturated water they have no means of recovering in unsaturated water.

P. 7, Par. 5:

Throughout the duration of the studies done by Meekin and Turner and Weitkamp and concentration of TDG were nearer 120 percent than 126 or 128 percent. The high concentrations of the 126 and 128 percent occurred only on one day of the tests. Considering the clear water (fish tend to be deeper in clear water, Dawley et al., 1975) and the duration of the tests, I would not expect mortality. They do not refer to a test done in the Snake River where concentrations of TDG were 127 percent for the entire duration and 48 percent mortality occurred in the volitional cage 4.5 m. deep.

P. 8, Par. 3:

Both the Ad Hoc Transport group report 1992, and the Mundy et al. 1994 report are seriously flawed. There are some errors and omissions of data in the Mundy report, but the main flaw in this report is that the executive summary and conclusions do not always agree with data and information contained in the text. There are criticisms of the experimental design throughout the report. Apparently the review group was not aware of the fact that many elements of the experimental design are dictated by the agencies. Such things as numbers of fish marked and location of releases were usually changed or regulated by state and tribal agencies. For example, on several occasions NMFS was not allowed to mark any experimental releases. The executive summary also omits commenting on the fall chinook data from McNary Dam which is overwhelmingly in favor of transportation. Generally, the executive summary highlights the negative aspects and omits the positive. The quote by the

Mundy report: "available evidence is not sufficient to identify transportation as either a primary or supporting method of choice for salmon recovery" is simply incorrect. See my detailed comments attached regarding the Ad Hoc Transport group report.

P. 8, Par. 4, Last Line:

Mundy's statement is incorrect. No controls returned from the groups marked, but 9 marked transported fish returned to Lower Granite Dam when trap efficiency was only 12 percent and 24 to upstream hatcheries. No statistical analysis was done because no controls returned. It is likely that if smolts had not been transported in 1977 no adults would have returned from that year's out-migration (Park et al. 1980 and 1981).

P. 9, Par. 1, Line 8:

"Physiological stress, such as that associated with transportation operation and salt water transition --." They should add: "and passing over spillways." There is no reason to suspect that passing over a high spillway does not cause stress!

P. 9, Par. 4, Line 3:

Same comment as above (p. 9, par. 1, line 8).

P. 14, Par. 2, Line 8:

There are numerous other studies that are also used.

P. 20, Par. 4, Line 2:

Lateral avoidance apparently does occur but this is irrelevant when there is no normally saturated water to escape to.

P. 27, Par. 3, Line 2:

The higher juvenile recovery proportions are based on adjustments for spill but not for fish guidance efficiency. Fish guidance efficiency must be adjusted, if for example, more turbines are placed on line during high flow periods. Again, adult returns could be in part due to the proportion transported especially if fish were in better condition in higher flow years.

P. 28, Par. 1, Line 9:

It appears the modelers must have given more weight to the in-situ experiments that showed lower mortality rates. In figure 5, page 42, there are several observations above the mortality line between 120 and 130 TDG.

P. 30, Table 4:

Some values are incorrect. Ice Harbor (1968) was 14.5 percent not 32 percent. 32 percent was recorded for releases in the backroll of the turbine discharge. Bonneville first powerhouse mortality estimate was 12-15 percent so 13.5 percent would be a more appropriate value. The Lower Monumental data was for 1975, not 1972. This same experiment indicated 27 percent mortality for steelhead passing over a standard spillway. It is interesting that they chose not to use this value. The value quoted for Bonneville II of 18 percent is not appropriate. This was based on only one year of adult returns. The adult returns were not sufficient from that one year of returns to conclude anything. The appropriate data to use is the combined juvenile recoveries from all years. When this is done the mortality ranges from 2-4 percent (Gilbreath et al., 1993 and Dawley et al., 1994). The value of 18 percent for turbine mortality obtained in 1993 should not be used. The study was designed mainly to determine if estimates of turbine, spill, and reservoir mortality could be accurately estimated. Experimental difficulties in 1993 may have compromised this estimate of turbine mortality. A revised, more accurate estimate will be available for the 1994 data. Not recorded is a turbine mortality 3.5 - 9.2 percent estimated by RMC 1994) at Rocky Reach Dam and 5 percent estimated by RMC (1994) at Lower Granite Dam.

P. 30, Par. 2, Line 1:

Smolt passage index. There are serious problems in using the smolt passage index to develop reasonably accurate population estimates because the method does not account for seasonal changes in FGE (fish guidance efficiency) which varies considerably through the season and numbers collected also vary drastically depending on volume of spill. Assuming a 1:1 ratio of spill volume to fish passage and a constant FGE for the season for each species results in significant error. The smolt passage index is useful for comparison between or among years, but could result in substantial errors, in estimating population at various locations (dams) in the river.

P. 43, Par. 3, Line 1:

In light of some of the errors (i.e. turbine mortality, FGE, and spillway mortality) noted in values used in the risk analysis, I don't believe this is very accurate.

P. 56, Par. 2, Depth Distribution:

Adults may remain at sufficient depth to compensate for fairly high levels TDG, but the fact remains that mortalities do occur when there are delays in migration and adults are seeking fishway entrances. Even if there are minimal delays, adults must ascend t a maximum of 6 feet of depth to enter and pass up the fish ladders.

P. 66, Par. 4, List of Activities:

One important research activity that was recommended by the NMFS working group of experts was research to determine the quantitative relationship among visible signs of GBT and direct effects (mortality) and indirect effects such as disease resistance and ability to avoid predators. This is extremely important information that is needed to determine what various symptoms of GBT mean when they become evident in the fish.

Phillip R. Mundy, PhD

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July 7, 1995 **COPY FOR ATTACHMENT TO TRANSCRIPT**

The Hon. Dirk Kempthorne, Chairman
Subcommittee on Drinking Water, Fisheries and Wildlife
Committee on Environment and Public Works
United States Senate
Washington, D.C. 20510-6175

RE: Response to your request for comments on the role of scientific peer review in the implementation of recovery actions for endangered salmon

Dear Senator Kempthorne:

As chair of the oversight hearing of Thursday, June 22nd, 1995, on the National Marine Fisheries Service policy on spills at Columbia River hydropower dams, gas bubble trauma in threatened and endangered salmon, and the scientific method used under the Endangered Species Act which resulted in the spill policy, you invited me, as a member of the scientific panel, to submit written comments on how to improve the process of applying science to recovery actions for endangered salmon. My comments are as follows.

The problem of getting a workable salmon recovery plan in place is not one of the nature and origin of scientific expertise, but of forming the appropriate institutional structure. As recognized by the Snake River Salmon Recovery Team, among others, factionalism and controversy in the salmon recovery program are guaranteed by the wide variety of federal, state, and tribal agencies now assigned to implement various pieces of the salmon recovery program. Ensuring that the salmon recovery plan is scientifically well grounded means developing an institutional structure that both requires, and enables, the monitoring, analysis and research to conform to relatively simple, yet clearly articulated, recovery objectives.

During my service as a scientific peer reviewer to the Exxon Valdez Oil Spill (EVOS) Trustee Council in Anchorage (907-278-8012, Molly McCammon, Executive Director), I have watched the oil spill peer review process evolve from a role of serving litigation to one of serving policy makers in shaping the scientific content of salmon restoration activities. The basic elements of both Endangered Species Act (ESA) salmon recovery and the EVOS programs are the same; many millions of dollars are paid annually to state and federal agencies for implementation of a salmon recovery program (EVOS addresses restoration of oil-injured species in addition to salmon). The two main institutional advantages of EVOS over the ESA salmon recovery are that 1) all science

projects must pass through an independent peer review process before they are 2) considered for funding by a single body of governmental representatives, the Trustee Council. The EVOS peer review examines two basic questions; 1) Is the proposed project consistent with restoration objectives established by the Trustee Council?, and 2) Are the proposed scientific methods likely to deliver the product intended?

Combining experiences with the EVOS Trustee Council those of the Columbia River basin, I see the elements of an institutional structure to serve endangered salmon recovery as follows;

A. Consolidate federal expenditures in the Columbia Basin for salmon recovery into one Salmon Recovery Fund.

B. Annually publish a request for proposals (RFP) to implement salmon recovery which explains the objectives of salmon recovery. The RFP is based on the federal salmon recovery plan which shows due deference to the salmon recovery plans of state and tribal governments; the Fish and Wildlife Program of the Northwest Power Planning Council, and the Tribal Recovery Plan of the Columbia River Inter-Tribal Fish Commission.

C. Annually send all responses from state, federal, tribal, university, and other sources through an independent scientific peer review process which certifies the extent to which each proposed project supports recovery objectives, and constitutes scientific methods appropriate to the proposed tasks.

D. Forward the proposals which pass peer review to a council of trustees of the Salmon Recovery Fund, composed of agency representatives, who develop an annual program based on available resources from among those projects which have passed peer review.

Creating such an institution and process would clearly take much effort and substantial re-direction of fiscal resources. However, having an appropriate institutional structure and process would go a long way toward effectively focusing expenditure of public monies on achieving salmon recovery objectives. It would also provide a regional forum for evaluating the science applied to salmon recovery actions. Such a regional forum could draw on scientific expertise from anywhere, as required by the circumstances.

Please call on me if I may be of further service.

Sincerely,

COPY

Phillip R. Mundy, PhD

Phillip R. Mundy, PhD

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July 13, 1995 **ORIGINAL FOR ATTACHMENT TO TRANSCRIPT**

The Hon. Dirk Kempthorne, Chairman
Subcommittee on Drinking Water, Fisheries and Wildlife
Committee on Environment and Public Works
United States Senate
Washington, D.C. 20510-6175

RE: Additional comments from in response to your request for comments on the role of scientific peer review in the implementation of recovery actions for endangered salmon.

Dear Senator Kempthorne,

As chair of the oversight hearing of Thursday, June 22nd, 1995, on the National Marine Fisheries Service policy on spills at Columbia River hydropower dams, gas bubble trauma in threatened and endangered salmon, and the scientific method used under the Endangered Species Act which resulted in the spill policy, you invited me, as a member of the scientific panel, to submit written comments on how to improve the process of applying science to recovery actions for endangered salmon. In response, I submitted a set of comments directly to your office earlier this month.

As additional commentary on how to focus the best science on endangered salmon recovery actions, I am attaching comments from Nancy M. Mundy, MPA. Ms. Mundy is a PhD candidate in Public Administration at Portland State University who is preparing a dissertation on how governmental institutional structure may hinder implementation of endangered species recovery measures.

Thank you for the opportunity to comment.

Sincerely,

Phillip R. Mundy, PhD

Attachment

Figure 1. Number and percent of smolts transported from 1975-92 and subsequent adult returns (from that out migration year) of spring/summer chinook to Lower Granite Dam.

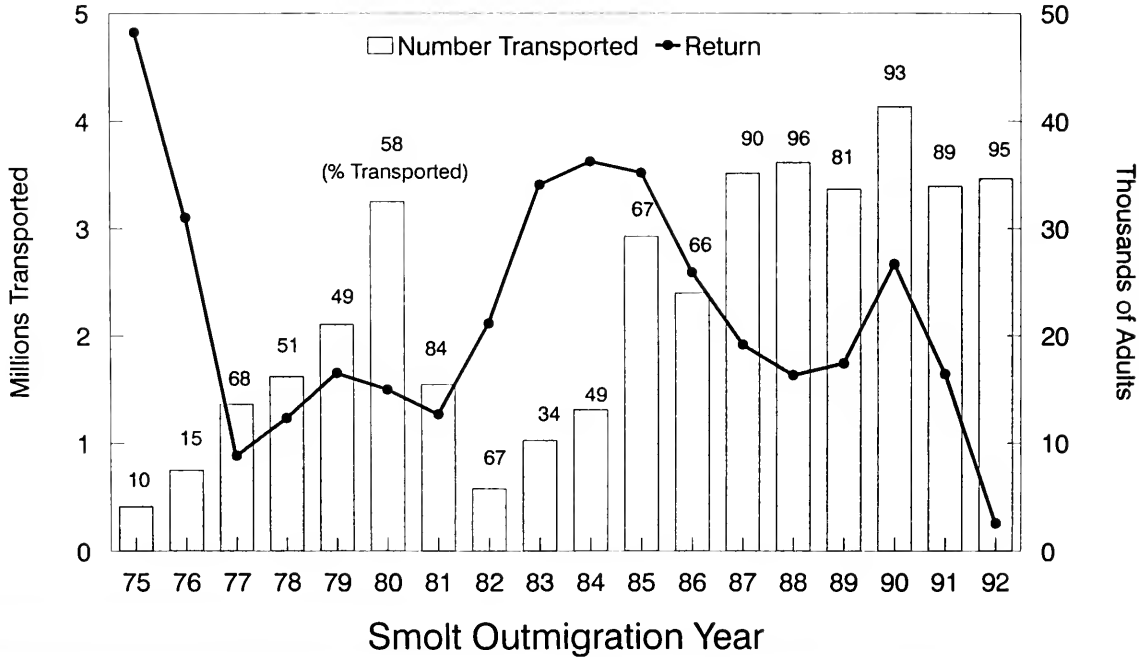
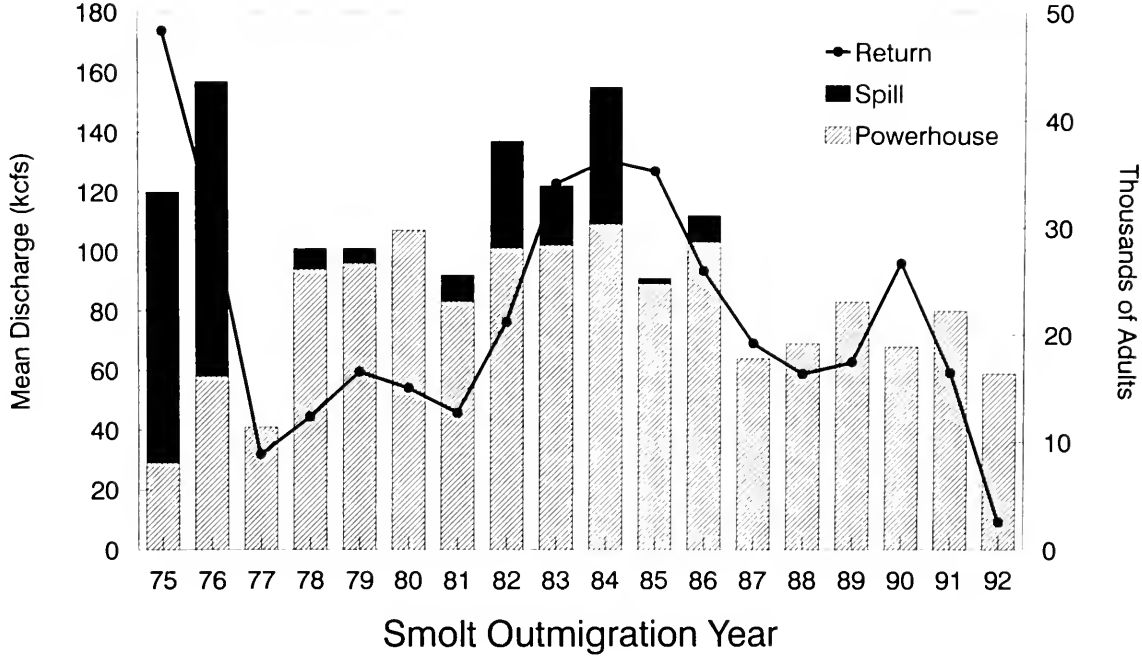


Figure 2. Lower Snake River flow during May of 1975-92 and subsequent adult returns of spring/summer chinook to Lower Granite Dam from that outmigration year.



Analysis of Snake River Spill Information Based on the CRiSP Research Project

remarks by

Dr. James Anderson
Associate Professor
School of Fisheries and Center for Quantitative Science
University of Washington
Seattle, Washington

before the

United States Senate
Fisheries, Drinking Water and Wildlife Subcommittee
Hon. Dirk Kempthorne, Chair

June 22, 1995

Analysis of Snake River Spill

Information based on the CRiSP[1] research project

James Anderson[2]
University of Washington

The impacts of the 1995 Snake River Spill actions were analyzed with the CRiSP smolt passage model. The CRiSP model considers mortality associated with dam passage and gas bubble trauma produced from spill-generated gas supersaturation. In addition, the model considers the effects of fish depth and exposure time on the gas bubble trauma. The model was calibrated with a variety of data sets and model predictions were checked against independent data in a model validation (page 2).

A model sensitivity analysis indicated that spill can have a small benefit on in-river passage if the total dissolved gas level is below 120% supersaturation. Above this level the mortality from gas bubble trauma is significant. Under the current assumptions on transportation of fish, spill at collector dams has no benefit since the survival of transported fish is larger than the survival of fish passing in-river (page 3).

The 1995 spill actions and monitoring studies were analyzed with CRiSP. The model produced levels of mortality similar to those observed in the cage studies below Ice Harbor dam. The model indicated that survival between Ice Harbor Dam tailrace and Bonneville Dam trailrace was between 31 and 34% depending on the depth of fish passing through the river. In comparison, with no spill the predicted in-river survival was 35% (page 4).

Monitoring of fish passing in-river has revealed few signs of gas bubble trauma and the CRiSP modeling has likewise predicted little impact. Furthermore, model analysis indicates that the small increase in dam survival resulting from the spill program was negated by a small increase in mortality from gas bubble trauma. Uncertainty exists as to the precise levels of the factors, but given the available information the result of the spring 1995 spill program was most likely small and negative.

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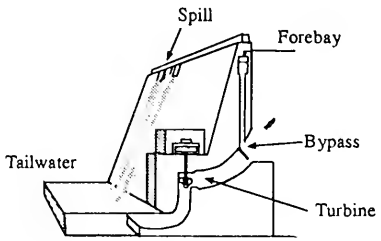
1. The University of Washington has developed the Columbia River Salmon Passage model under funding by Bonneville Power Administration. The project began in 1989.
2. Dr. James J. Anderson is an Associate Professor in the School of Fisheries and Center for Quantitative Science at the University of Washington. His work on salmon issues has been funded by Bonneville Power Administration and the Army Corps of Engineers. The views in this document are a result of that research. This paper was supported by the Direct Service Industries, Inc.

■
James Anderson
University of Washington
June 22, 1995

Spill as a recovery action

Spill is used to pass fish over dams. This reduces total mortality in dam passage since mortality resulting in passage by spill is less than passage resulting through turbine passage.



Spill also produces gas supersaturation in the water downstream of dams. Fish exposed to the supersaturation suffer some additional mortality from gas bubble trauma. The amount of mortality depends on:

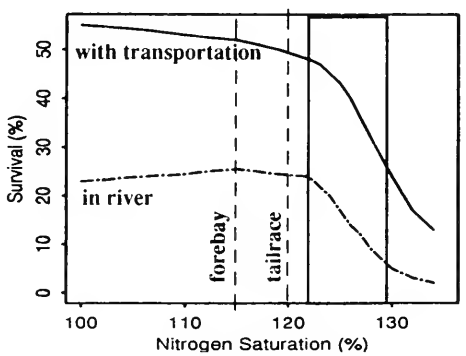
- level of gas supersaturation
- length of time fish are exposed to supersaturation
- depth of fish in the reservoir

■
James Anderson
University of Washington
June 22, 1995

The results of spill

Spill has counteracting effects:

- (+) Fish survival in spill passage is higher than in turbine passage.
- (-) Spill increases gas supersaturation in tailwaters and reservoirs.
- (-) Gas supersaturation in water kills fish downstream of dams.
- (-/+) Spill at transport dams lessens the fraction of fish transported, which, under current assumptions of transportation, lessens total survival.



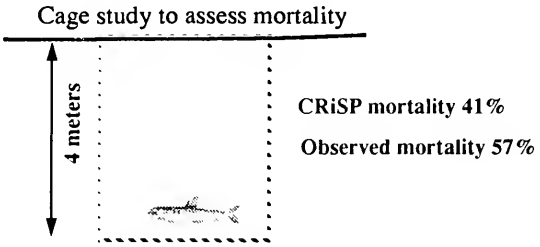
CRiSP-predicted survivals with spill-produced gas levels

The dashed line indicates forebay and tailrace gas levels allowed in the NMFS spill plan. The solid lines indicate the range of total dissolved gas below Ice Harbor Dam in the 1995 spill program.

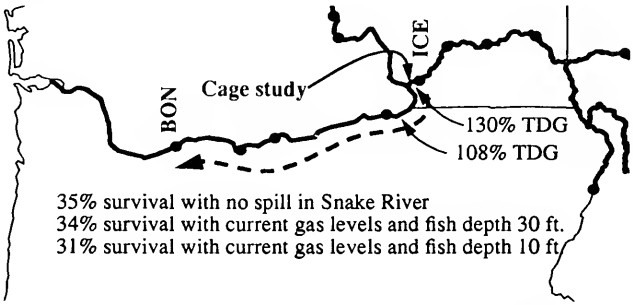
James Anderson
University of Washington
June 22, 1995

CRiSP predictions and cage studies

For the period June 9 to 13, 1995, the observed mortality in the cages downstream of Ice Harbor Dam were 88% in the 0 to 1 meter cage and 57% in the 0 to 4 meter cage. CRiSP-predicted mortalities were 94% for the 0 to 1 meter cage and 41% for the 0 to 4 meter cage.



CRiSP predicts higher in-river survival with no Snake River spill.



TDG = total dissolved gas under 1995 spring spill program

James Anderson
University of Washington
June 22, 1995

Gerald R. Bouck, Ph.D., Consulting Aquatic Biologist
9691 SW Alsea Dr., Tualatin, OR 97062 (503) 692-4907

June 20, 1995

Honorable Dirk Kempthorne and Harry Reid,
Senate Subcommittee on Drinking Water, Fisheries, and Wildlife,
415 Hart Senate Office Building,
Washington. D.C. 20510

Dear Senators Kempthorne and Reid:

I appreciate the opportunity to present my views regarding oversight of the National Marine Fisheries Service's (NMFS) policy on spills at Columbia River hydropower dams, gas bubble trauma (disease) in threatened and endangered salmon, and the scientific method used under the Endangered Species Act.

By way of introduction. I retired as Senior Fisheries Scientist in April, 1994 from the Division of Fish and Wildlife. Bonneville Power Administration. Most of my 31 years of Federal Service were spent researching the water quality requirements of Columbia River Pacific salmon, either in the Environmental Protection Agency (EPA) or the U.S. Fish and Wildlife Service (USFWS). I have published over 20 articles specifically concerning dissolved gas effects on fish. and I have provided free consultation to numerous persons and institutions both across the United States and around the world. At BPA my work concerned salmon hatcheries, habitat, and fish health. I received both a Gold and a Silver Medal from the EPA for my work on gas supersaturation and salmon, a special achievement award from the USFWS for my work on measuring dissolved gases, a BPA Administrator's award for achievement in environmental protection, and at my retirement. the BPA Administrator's award for Distinguished Service.

I serve on the National Marine Fisheries Service's (NMFS), Northwest Fisheries Center, Advisory Panel On Gas Bubble Disease and Supersaturation. This Panel has provided NMFS with recommendations on several issues, but we have not been asked to review the Fish Passage Center's Spill and 1995 Risk Management Analysis (dated 1/17/95), the NMFS's 1995 Biological Opinion. or the draft Snake River Salmon Recovery Plan.

Your questions and my specific comments are as follows:

1. Are the benefits of using spill as a fish passage mechanism established, especially in relation to other fish passage mechanisms? What is the scientific validity of the National Marine Fisheries Service (NMFS) spill policy?

No. I believe that definitive data from field studies of spill benefits are lacking, and therefore. it isn't clear whether spill *per se* actually recruits more adult salmon (or

steelhead), than would be the case without spill, given otherwise comparable conditions. In my risk analysis in Question # 3, I estimate that spill is, on balance, hurting survival.

The benefits of spill will be a difficult problem to research and resolve, mainly because the calculated incremental survival benefit of spill (assuming no mortality from gas) is a small percentage of the total run (ca. 1-3 %). The basic experimental design to test this has been worked out over many years and generally requires about 10 years to complete from beginning to end. Perhaps for this reason, NMFS has not developed a similar experimental design to evaluate spill, despite millions of smolts available at federal hatcheries in the Snake and Columbia Rivers. As a general rule, these evaluations require smolt releases from at least four consecutive brood years, each having marked experimental and control groups, each group with two or more replicates, and each replicate with about 100,000 smolts. This design is necessary to estimate variation within and between years, and thus form the confidence intervals about the mean for the experimental and control group. Since variation expands the confidence interval, and since variation is usually high, differences of less than 5 % survival are not likely to be statistically significant. This alone may preclude evaluation of spill.

As an alternative to the necessarily long and difficult experiment, some entities have addressed the spill/gas evaluation problem using laboratory data and computer modeling of various schemata. Many of these analyses are filled with good intentions, but bad assumptions. For example, the Fishery Agencies make the unwarranted assumption that all fish will detect and avoid gas supersaturation. This assumption must be rejected because several reports document that supersaturation has killed large numbers of wild fish in areas where the fish could have sounded to escape the excess gas. If supersaturation avoidance exists in Nature, it is certainly unreliable and untrustworthy.

Unfortunately, the resulting and often bitter debates over the validity of models, assumptions, appropriateness of data, and accuracy of results simply demonstrates that no consensus exists in the scientific community on the potential benefits of spill, except as dictated by agency policy.

The NMFS policy on spill may represent a well intended preference, but it is not science. The NMFS spill policy puts the entire river at risk, and its monitoring and evaluation is inadequate to test whether spill will benefit or depress smolt survival. NMFS apparently hasn't developed a research hypothesis for testing, criteria for judging the resulting data, or a coherent step down plan with protocols for acquiring the critical research data. The result is a hodge-podge of expanded ongoing efforts by various agencies who avoid peer review and work mostly *in camera* (secret). The physical gas monitoring is providing a glut of expensive but unreliable information which does not appear to be connected to administrative mechanisms for triggering lower gas levels. NMFS's biological monitoring of gas bubble disease is adequate to detect a serious fish kill, but it is inadequate to reveal a low or indirect mortality, and the investigative approaches and methodology skew downward the apparent incidence of GBD.

Historically, spill at dams has been a sword of Damocles and is a world wide problem. When the Columbia River dams were first constructed, heavy involuntary spill was unavoidable. For example, Bonneville Dam became operational in 1938, but it's first powerhouse could only pass 85 kcfs ---a small fraction of the remaining flows and floods--- hence the river was mostly spilled and supersaturated. By the early 1940's, biologists associated high flows with excessive mortality, but didn't know why it happened. After about 20 years of investigations, it was proven by Dr. Ebel that spill supersaturated the water and this killed the salmon. By 1968 excessive supersaturation killed ca. 20,000 adult salmon at John Day Dam and this shocked the Region. NMFS soon announced that gas supersaturation was endangering the salmon runs. Eventually a gas standard of 110 % was adopted and spill was greatly restricted or nonexistent. The region relied upon previously tested smolt collection and transportation via barges. With the passage of the Northwest Electric Power Planning and Conservation Act in 1980, the Northwest Power Planning Council created a water budget for augmenting spring flows. If any was to be spilled, we assumed that the environmental and fishery agencies would hold gas levels to safe limits, i.e. close to 110 % of barometric pressure. This assumption proved incorrect and supersaturation in the range of 120-130 % quietly returned to the Snake and Columbia Rivers. By 1992, hydro operators were faced with a dilemma: spill as requested and possibly kill endangered salmon, or don't spill and have their operation ruled to be jeopardizing endangered salmon. Fishery agencies requested suspension of the gas supersaturation standard, and this forced public hearings. Therefore the gas supersaturation problem has become *deja vu* all over again.

2. What independent scientific research is being conducted to monitor the effects of spill and its alternative in the Columbia River system? Please comment on the results of relevant studies.

Very little independent research is being conducted on any aspect of spill or Columbia River salmon. This is because there is little opportunity for independent researchers to tap the $400 million dollars/ year that are being spent on salmon by the Corps, BPA, NMFS, and NBS. Federal planning processes and difficult procurement regulations effectively preclude open, competitive procurement of most fishery projects. Contracting between fishery agencies (via interagency transfers and memos of agreement) is typical and far easier than contracting outside the government. Thus, fishery agencies have an enormous advantage over the private sector in securing funds because they identify regional fishery research priorities, they can claim any project as their business, and they have the resources of the tax payers. The result is essentially a closed shop that greatly minimizes participation by universities and private enterprise.

If the Senate wishes to expand the role of independent research (private or university) in the Columbia and Snake Rivers, adjustments will be necessary in the Federal Acquisition Regulations (FAR) and the Bonneville Power Administration Procurement Instructions (BPPI). Additionally, incentives are needed to encourage the cooperation and collaboration of fishery agencies with independent investigators.

3. Are there risks to migrating smolts and returning adults associated with high levels of dissolved nitrogen resulting from spill?

Absolutely! I believe that current dissolved gas levels are directly and indirectly killing salmon smolts in numbers greater than the incremental survival benefit from spill. However, I doubt that the smolts typically die directly from gas bubble disease *per se*; rather, gas bubble disease-weakened smolts are probably eaten rapidly by predators. Gas bubble disease signs are likely to be found in only 1 % of the smolts or less at any given time, because they are continuously removed from the river by predators and digested. Thus, predators remove evidence that a supersaturation problem exists, much to the frustration and confusion of all concerned, and we are asked to demonstrate and display that which no longer exists. Additionally, this syndrome makes it essentially impossible to accurately monitor the impact of gas levels from dams.

EPA and several states adopted a dissolved gas standard not to exceed 110 % of barometric pressure which is roughly equivalent to 75 mm Hg or 1.5 psi above barometric pressure. This criterion was supported by the National Academy of Sciences, and the NMFS's Panel on Gas Bubble Disease. Oregon and Washington granted a variance that allows gas levels in the river to average 120 % in the spill and 115 % well down river, but in fact, extensive area exceed these levels, and the Corps have been sent letters of non compliance from Oregon and Washington.

I approach the risk analysis for smolts differently than state fishery agencies. First I estimated the proximate portion of the smolt population that spill could benefit at a hypothetical dam, assuming no mortality related to spill or gas supersaturation (equation 1 below). I assumed that spill would increase non turbine passage or fish passage efficiency (FPE) from a conservative low of 60 % to a typical goal of 80 % (equation 2 below), although a rise from 70 % to 80 % would be more typical. I also assumed that smolt survival in turbines would be 85 % (although recent studies support higher survival) and that smolt survival via non turbine routes would be 98%, both being traditional values. Therefore:

smolt survival at 60 % FPE = (0.85 X 0.40) + (0.98 X 0.60) = 92.8 %; (1)

and smolt survival at 80 % FPE = (0.85 X 0.20) + (0.98 X 0.80) = 95.4 %. (2)

The potential benefit of spill at 80 % FPE is equation (2) minus (1) or 95.4% - 92.8 % = 2.6 % higher survival per day (3). Thus an 80% FPE might result in 2.6 % higher survival, while a 70% FPE would only result in 1.3 % higher smolt survival (but 70 % FPE usually doesn't require spill to achieve it). I believe this calculation illustrates the problem and applies to most Columbia River dams.

Next I estimated the potential adverse impact of gas supersaturation. Put simply, what is the risk that gas supersaturation would kill 3 % of the smolts per day, either directly or indirectly, and therefore destroy the potential benefit of spill? To assess the above risk, at least two additional conditions must be known:

5

(1) Are adequate proportions of the smolts likely to be found in shallow water?

I conclude that about 30 % of the smolts inhabit the shallow water, based on the reports of Smith (1973) who reported about 30 % of juvenile chinook were in the upper three feet of the water at Lower Monumental Dam on the Snake River. This was confirmed by Dawley (1986) who found a similar distribution of chinook juveniles in the forebay of the Dalles Dam on the Columbia River.

(2) Are times to mortality short enough to kill smolts at prevailing gas levels in shallow water?

I concluded that times to 5 % mortality are sufficiently short to be operative, as judged from Table 1. which lists the average times to 5 % mortality for juvenile rainbow trout in shallow water (30 cm) at various hyperbaric gas (dP) pressures.

Table 1. Hours to five percent mortality for rainbow trout *Oncorhynchus mykiss* at various hyperbaric gas pressures.

dP mm Hg=	300	250	200	150	100
% Sat.=	139	133	126	119	113
Average hrs to 5 %	1.6	4.0	5.7	27.1	215
95 % limit=	0.3	0.8	0.5	4.9	x
Range=	1.0-3.0	1.8-5.8	4.1-7.2	13.5-39.9	29.3-502
N tests=	16	10	14	14	9

The exposure times needed to kill 5 % of the fish generally falls well within the time period of a single night. That is. when nominal gas levels were 139 %. 133 %. and 126 %. 5 % of the fish were killed in 1.6. 4.0. and 5.7 hours respectively. When gas levels were 119 %. the mean time to 5 % mortality was slightly over one day (27 hours). Applying a 5 % mortality rate to 30 % of the population (which is found in shallow water) produces an estimated average kill of (5% mortality X 30 % of the fish X 24 27 of a day) = 1.3 % mortality of the total smolts per day at gas levels of about 119 %. If the gas level

approaches 133 %, as it has below Ice Harbor Dam, I would expect perhaps as much as 9 % mortality per day (5% mortality/day X 30 % of the fish X 24 /4 hrs day).

Applying these data to Endangered Snake River salmon, the calculated potential increase in survival of 2.6 % per day from spill to achieve 80 % FPE, would be off set by a loss of 1.3 % mortality per day at a gas level of 119 %, assuming no indirect mortality. However, at a gas level of 133 %, the same 2.6 % benefit would be destroyed in about 7 hours , which is approximately the gas level and travel time from Ice Harbor Dam to the confluence with the Columbia River.

The absence of floating dead smolts from gas bubble disease may trouble some, but consider this: turbines may kill upward of 15 % of the smolts, yet in nearly 30 years, I have never seen a single dead smolt in the Columbia River, nor do I know anyone who has seen one. (On the other hand, tests have shown that only about 2.7 % of the dead adult salmon are found; I have seen some adult carcasses in the Columbia.)

The risk to adult salmon is quite different than exists for smolts, because adults are unlikely to be preyed upon. The risk to adults is real and likely more important than smolt mortality, but unfortunately, it is not well documented. At 120 % or less, adults are unlikely to die directly from gas bubble disease, but if they did, each pair would cost the run about 5,000 eggs and invaluable genetic diversity. With adults, the main concern is causing sublethal dysfunctions that may interfere with migration, survival, and spawning. For example, in the late 1960's it was common to see blind adult salmon, which most of us ascribe to hemostasis from gas emboli in the ophthalmic rete, with subsequent degeneration of the eye and it rots out of the eye socket. Several scientists including myself, speculate that so called "head burn" lesions in salmon at Snake River Dams are the result of impaired vision from sub lethal gas bubble disease. Dr. Ted Bjornn and students believes that the timing of the spill and passage of chinook salmon with head scrapes over Lower Granite Dam are circumstantial evidence that the head scrapes were related to gas bubble disease. Whatever the case, in 1993 about 22% of the research-tagged adult salmon that passed Lower Granite Dam had some degree of head burn. Of those with head burn, approximately 38% are estimated to have died prior to spawning, which is almost 70 % higher pre spawning mortality than among non-head burned adults.

4. Have there been investigations of the effect of supersaturated water on resident fish? Have the results of these studies been incorporated into current policy?

Most of the investigations have been done in the laboratory, about 20 years ago, coincidental to studies of salmon. No work has been done on the effects of gas supersaturation on the population dynamics of resident fish in the Columbia River Basin. This paucity of information reflects the low priority NMFS assigns to other fishery resources, which they consider to be expendable trash. Conversely, many sportsmen value the trophy walleye and smallmouth bass fishery in the Columbia and Snake Rivers, as well as the sturgeon, catfishes, crappie, bluegills, and various other fishes. Equally important to the resident fish and salmon are the aquatic invertebrates, especially those

who live in the shallow but productive littoral zone, and fuel the food web. These components of the Columbia are very important to fish and wildlife, but our understanding of them is very superficial relative to gas supersaturation.

I attempted to investigate the incidence of gas bubble disease in resident fish in the lower Columbia, but lacking the necessary permits, I could only examine fish collected by Oregon's Department of Fish and Wildlife. Some of the wild resident fish near Portland's airport had signs of gas bubble disease at a level equal to NMFS's fall chinook juveniles near Bonneville dam, but I also found signs of GBD in yellow perch, bluegills, and peamouth (shiners). NMFS withdrew its offer to collaborate after we gave them some constructive recommendations (attached). Both NMFS and NBS soon declined to let me accompany them, or look at fish collected under their permits (see attached letter), even from a project that had nothing to do with the gas issue (project description attached).

Working independently of each other, Dr. Ralph Elston and I have both found epidermal scars in the fins of fish that were exposed to gas supersaturation in the Columbia River. While the cause of the lesion is uncertain, the size, shape, and location are strongly suggestive of previously healed lesions from gas bubble disease.

NMFS is looking for gas bubble disease in resident fish and some zooplankters, but I haven't seen the results. Further, NMFS has no administrative provision for protecting resident fish, i.e. an action level if exceeded to trigger reduced gas levels.

5. To what extent has scientific research from the states been incorporated into the current spill policy? How can the decision-making process be improved?

The States have provided considerable data on fish passage, population levels, and natural history, but they have not performed any gas supersaturation or gas bubble disease research. As far as I know, no one on their staffs has any expertise in gas bubble disease and supersaturation. They have provided a literature review, but it was very incomplete and biased. They have developed a computer model for investigating various fish passage issues, but results of these adventures in cyberspace should not be confused with real experimentation with real fish.

Aside from the recommendations in Question # 2, I believe that most of the

decisions could be greatly improved by peer review. In this context, peers must have recognized expertise of interest relative to the Program. At this point, I favor using the oversight committee approach in the Snake River Recovery Team's report.

Sincerely.

Gerald R. Bouck
Physiological Ecologist

S.P. Cramer & Associates, Inc.
Fisheries Consultants
300 S.E. Arrow Creek Lane
Gresham, OR 97080
503-669-0133 503-669-3437 (FAX)

DR. BOUCK ATTACHMENTS

#1

May 23, 1995

Earl Dawley
National Marine Fisheries Service
Point Adams Field Station
P.O. Box 155
Hammond, OR 97121

Dear Earl:

We greatly appreciate the opportunities you gave Ken Witty and Jerry Bouck to accompany your field crews, and observe your field studies to evaluate the prevalence of gas bubble disease (GBD) in the Snake and Columbia rivers. Ken Witty accompanied your crew to the live cages below Ice Harbor and examined some of the fish on May 8 and May 11. He also accompanied the electrofishing crew at that location on May 11. Jerry Bouck accompanied your crew to the live cages below Bonneville Dam and examined some of the fish on May 9. You and your staff have been most cooperative and pleasant to work with. Both Ken and Jerry were impressed with the dedication and industriousness of your field crews.

No one appreciates uninvited criticism, and here I am writing to offer you some constructive suggestions. We share with you a strong desire to preserve the salmon runs in the Columbia Basin, so we know that you want your studies to produce valid findings. We have some suggestions to offer that we believe are essential in order for your findings to be fully valid. We are aware that your field studies are just getting under way, and that you may already have made some of the adjustments we suggest. We have invested time in writing these suggestions, because we think your work is extremely valuable. Your live cages afford an opportunity count dead and traumatized fish after several days of exposure to the river, whereas such fish may never turn up at the smolt collection facilities or in beach or purse seine catches. We believe that traumatized fish are abnormally vulnerable to predators, such that a disproportionately low number of these fish show up at collection facilities or in seine or electrofishing catches.

GENERAL COMMENTS

- Field personnel need specific training on fish processing and examination

techniques for gas bubble disease symptoms, gas measurement, and data recording. The crews at both locations lacked confidence and precision in at least some aspect of what they were doing.

- A fish health specialist and appropriate equipment should be added to each crew. This will ensure that appropriate decisions are made in the event of non-standard occurrences. As your crews stated to Ken and Jerry, exception seems to be the standard.

- Larger test fish should be used, perhaps yearling steelhead, to make the examination of symptoms easier. The subyearling chinook are difficult to examine, because of their small size, and bubbles are easy to overlook.

- The live cages below Bonneville Dam should be moved to a location which receives more direct inflow from the spill plume. Your crew has noted that saturation levels tend to run about 2% lower near the live cages than in the main current of the river.

FISH PROCESSING PROTOCOL

- The field technicians for your GBD monitoring project urgently need a written, detailed protocol on how they are to deal with handling fish during initial capture, transport to the live cages, placement into the live cages, and recovery from the live cages. Your crews monitoring the live cages below Ice Harbor Dam and below Bonneville Dam had a good general idea of what to do, but had to fill in the details based on their own judgement. Since they are not trained fish biologists, nor are they trained in the physiology and identification of all gas bubble disease signs, they unknowingly choose some procedures that bias the results.

- Whenever MS-222 is used for anesthetizing fish, it should be buffered to prevent harm to fish from high acidity.

- Handling of hatchery chinook transported to the live cages should be minimized. These fish were anesthetized and measured prior to placement in the live cages at Ice Harbor. Is this really necessary, since these fish get measured at the conclusion of the test?

- Fish should be examined within 15 minutes of being removed from the river or live cages. We observed that fish at both locations were held up to two hours after being euthanized, before they were examined. This delay allows for some bubbles to redissolve, such that the number of fish with GBD signs would tend to be underestimated.

DATA RECORDING

- Standard data forms appeared cumbersome to use in the field. We observed that technicians were not sure what data to record, and they had difficulty finding the correct box to record data.

FISH EXAMINATION

- Fish should be examined with 25-40X magnification, rather than a 2X lens. We observed that bubbles along the lateral line could be seen under a dissecting microscope that were not visible through the head-mounted 2X lens. Your crew at Ice Harbor had both the microscope and the head-mounted lens with them on May 8, but only the head-mounted lens on May 11.

- The field technicians urgently need a written, detailed protocol on exactly what to examine on each fish, and what to record about their observations. For example, at Ice Harbor Dam, many of the dead fish were partially decomposed and GBD signs were not observable, because of the decomposition. Yet, it appeared that these fish were recorded as mortalities that have no sign of GBD. They should be recorded as unexaminable

- All field crews need to observe fish with known GBD signs, so they can be familiar with what the signs look like. We found that the crews both below Ice Harbor Dam and Bonneville Dam were uncertain about whether or not some features they observed in fish were bubbles.

- Written protocols should also be developed for examinations of invertebrates. Portions of the entire food chain may be affected by gas supersaturation, particularly those organisms that spend time in shallow water. Your crew has observed bubbles in the brood pouch of Cladocerans, so the risk to invertebrates is very real.

- Fish examinations should be expanded to include the gills and prominent internal vessels, especially since the hatchery chinook are killed anyway. This examination will require some routine dissecting equipment (scissors, scalpel, probe, pins, cradle), not currently available, as well as a microscope

GAS MEASUREMENTS

- Your practice of measuring gas levels at the live cage sites is excellent, and you also need to measure gas levels inside at least one of the live cages below Bonneville. Gas levels were measured inside the deep cage below Ice Harbor, but only in the river near the live cages below Bonneville. The netting of the

cages offers an excellent surface for bubble formation, so gas levels may be lower inside the cages than outside. The optimum procedure would be to measure the gas level in each cage.

- The calibration of each gas instrument should be checked weekly. The discrepancy between gas levels measured by your crew and those measured by the USACE indicate the need for this calibration. Gas levels in your cages below Ice Harbor Dam on May 11 were measured at over 128% when Ken Witty was present, while the 24 h high reported by the Fish Passage Center was only 122% for downstream of Ice Harbor. Such large discrepancies, in measurement are critically important and should be immediately accounted for.

- We suggest that levels of dissolved oxygen, as well as total dissolved gasses, should be monitored. The protocols listed in "Standard Methods" 18th Edition, should be followed.

STUDY DESIGN

- A statistical design, including specification of desired confidence intervals, should be developed. This design should specify the number of fish held in each live cage and the number of replicate live cages. Our experience with the variability in expression of GBD signs indicates that replication is essential to sound statistical inference.

- The net pens in use, particularly the volitional depth pen, are too small. Their size is adequate for holding the fish, but is confining enough that it probably affects fish behavior. Fish in the volitional depth pen could feel quite confined, and may not freely range in depth as an uncaptured fish would. This problem was aggravated by the tendency of the river currents to partially collapse the sides of the volitional depth pen. An internal frame, combined with greater width and length of the pen, are needed.

- Resident fishes should be thoroughly examined at the time they are captured in their natural environment, and a representative sample should be sacrificed for internal examination. The live pens in which resident fish are held should be substantially enlarged. The present small size of the live pens and the confinement they impose probably causes resident fish (some quite large) to hide at the bottom of the cage. Further, the trauma associated with their capture and processing, followed by lack of acclimation to the live cage, is likely to lead to abnormal behavior of the fish placed in live pens.

- Sampling of zooplankton and insect larvae should be added. This sampling is easy to do and would serve as an indicator of effects on the food chain. These organisms should be examined immediately after capture, and need not be held

in live cages. In particular the effects of supersaturation on emerging insect larvae should be examined.

Earl, we hope you will accept these suggestions as both friendly and sincere. Again, we greatly appreciated the opportunities you gave Ken Witty and Jerry Bouck to accompany your field crews. We were strongly disappointed at the new NMFS policy that prevented us from continuing to accompany your crews. We would like very much to be your allies rather than opponents in completing your important studies. There are few biologists in the region who are as capable of contributing to your field operations as Ken Witty and Jerry Bouck Please call Ken, Jerry, or me if you have questions regarding our suggestions.

Respectfully yours,

Steven P. Cramer

cc Jerry Bouck
Ken Witty
Nanci Tester (DSI)

S.P. Cramer & Associates, Inc.
Fisheries Consultants
300 S.E. Arrow Creek Lane
Gresham, OR 97080
503-669-0133 503-669-3437 (FAX)

Bouck #2

May 26, 1995

Dr. Allan Marmelstein
Director, NW Natural Science Center
National Biological Service
Bldg 204 Naval Station
Seattle, WA 98115-5007

Dear Dr. Marmelstein:

We believe there is an excellent opportunity to augment the ongoing sampling for signs of gas bubble disease (GBD) in the Columbia River, through work conducted by your staff for other purposes. As we understand it, Dr. Tom Poe will be collecting resident fish along the shoreline of John Day Reservoir during the week of June 5th, as baseline information for future draw-down tests, but does not anticipate examining these for GBD. We understand how busy your staff must be, and therefore seek your permission to provide the examinations for GBD at not cost to the government. We are formalizing this request because we were recently denied access to fish being examined for GBD signs by your staff. We are precluded from doing our own sampling, because we cannot obtain the necessary ESA permits before the spill season has passed.

As you probably know, there is a paucity of data regarding the effects of gas supersaturation on resident fish in the shallow, but productive, littoral zone. To my knowledge, no one is specifically studying the effects of gas supersaturation on this important zone in the Columbia And Snake Rivers. Additionally, a recent report by Donna Lutz (Trans. Am . Fish. Soc. 124:423-426) demonstrated that periodic fish kills from gas supersaturation can result from reservoir draw downs similar to that anticipated in John Day Reservoir. Therefore, we believe there is an important scientific opportunity available to the Region that can be captured with the cooperation of your staff.

We would be pleased if Dr. Alec Maule and his staff (NBS) could complete the examinations rather than us. Dr. Jerry Bouck and Ken Witty of my staff have observed Dr.Maule and his staff examining fish in the Snake and Columbia rivers for signs of GBD. As is characteristic of Alec, we found his work and that of his staff to be highly credible. Alec and his crew were following clearly defined protocols, were well trained in their task, and were properly equipped to complete their tasks.

We have discussed the possibility of collaborating on some beach seining activities with Dr. Poe, and believe we can complete the GBD examinations without interfering with normal operations of the draw-down research crew. We will provide our own boat, our own examination equipment, and expert biologists. Our biologists will gladly assist the NBS staff with seining and the associated activities on any sampling night we are present. We would be pleased to supply you immediately with the results of our examinations.

If we receive your approval, Dr. Jerry Bouck and Ken Witty of our staff would accompany Dr. Poe's crew. Each has a laudatory record of over 30 years service as a fish biologist for government agencies. Dr. Bouck is on the NMFS Technical Oversight Committee for Gas Bubble Disease Monitoring, and was awarded an EPA Gold Medal 20 years ago for his work with gas supersaturation on the Columbia River.

Thank you for considering our request.

Sincerely,

Steven P. Cramer

cc Dr. James Seelye (NBS)
Dr. Alec Maule (NBS)
Dr. Tom Poe (NBS)
Dr. Jerry Bouck (consultant)
Ken Witty (SPCA)
Nanci Tester (DSI)

United States Department of the Interior

NATIONAL BIOLOGICAL SERVICE
Northwest Biological Science Center
6505 NE 65th St
Seattle, WA 98115
(206) 526-6282

June 2, 1995

S.P. Cramer and Associates Inc.
Fisheries Consultants
300 S. E. Arrow Creek Lane
Gresham, OR 97080

Dear Mr. Cramer:

Thank you for the statements of support for our research programs on gas supersaturation in the Columbia and Snake rivers. We share your feelings about the research being conducted at the Columbia River Research Laboratory.

Concerning your request to work with our staff on currently funded research and specifically to examine fish collected by our staff, we must decline. We see the reasons as being quite obvious. We are working on permits that explicitly state they are not transferable. Therefore, we simply cannot allow any other use of the samples that we collect other than those stated in our applications.

In addition, we must not jeopardize our ability to complete the work we have agreed to do by modifying our plans to accommodate your needs. The type and amount of work we have planned is difficult enough without adding new dimensions that were not part of the original planning process.

We will provide our data and results to interested parties as required by law. We will also cooperate with your staff if they are working in the area under their own permits and approvals.

Please let me know if you wish to discuss this matter further.

Sincerely,

Allan Mamelstein
Acting Director

BOUCK #3

MILITARY INTERDEPARTMENTAL PURCHASE REQUEST — 3/15/95 — 1. PAGE 1 OF 1 PAGES

2. FSC	3. CONTROL SYMBOL NO.	4. DATE PREPARED	5. MIPR NUMBER	6. AMEND NO.
		10 March 1995	E96950022	BASIC

7. TO:
NW Biological Service Center
National Biological Survey
Bldg.,204 Naval Station
Seattle WA 98115-5007 Dr. Al Marmelstein

8. FROM: (Agency, name, telephone number of originator)
Commander, US Army Corps of Engineers
Portland District, PO Box 2946
Portland, OR 97208-2946

9. ITEMS [ ] ARE [ ] ARE NOT INCLUDED IN THE INTERSERVICE SUPPLY SUPPORT PROGRAM AND REQUIRED INTERSERVICE SCREENING [ ] HAS [ ] HAS NOT BEEN ACCOMPLISHED.

ITEM NO. a	DESCRIPTION (Federal stock number, nomenclature, specification and/or drawing No., etc.) b	QTY c	UNIT d	ESTIMATED UNIT PRICE e	ESTIMATED TOTAL PRICE f

1. This form authorizes the National Biological Survey (NBS) to conduct predator/preystudies in the John Day Pool of the Columbia River for the Corps of Engineers per the attached scope of work, budget, and research proposal.

2. NBS is authorized to spend up to $111,983 to conduct the work for the period, March 1995 through September 30, 1995.

3. The amount authorized by this order ($111,983) cannot be exceeded without prior written approval of this office. Invoices (original and two copies) will be submitted to address shown in block 13. Two copies of form DD 448-2 should be returned to the address shown in block 13 after acceptance in block 14.

4. This MIPR expires on September 30, 1995. The point of contact on for this MIPR is Mark Smith (503) 326-6135. This Economy Act order is placed in accordance with the provisions of AR 37-1/DODI 7220.9M.

RECEIVED
MAR 31 1995

OBL
APR 12 1995

FUNDS AVAILABLE
SIGNATURE
DATE MAR 17 1995
Finance & Accounting Officer

OPTIONAL FORM 99 (7-90)
FAX TRANSMITTAL # of pages ▶ 2

To Mark Smith	From Tom Poe
Dept./Agency COE-Port Dist	Phone # NBS
Fax # Signed MIPR	

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

10. ...ION AND PACKAGING INSTRUCTIONS, SHIP-... CONTRACTS AND RELATED DOCUMENTS.

11. GRAND TOTAL $ 111,983

13. MAIL INVOICES TO (Payment will be made by)
USAED, PORTLAND DISTRICT
ATTN: CENPP-RM-F, PO BOX 2946
Portland, OR 97208-2946

96 x 3123	CG	EL BFF0230CCF2AUDC		$111,983

15. AUTHORIZING OFFICER (Type name and title)	16. SIGNATURE	17. DATE
Steven L. Stockton, CH, NPP-PE		3/14/95

DD FORM 448, JUN 72 — PREVIOUS EDITION IS OBSOLETE

ACCEPTANCE OF MIPR

1. TO (Requiring Activity Address) (Include ZIP Code)	2. MIPR NUMBER	3. AMENDMENT NO.
Commander, US Army Corps of Engineers Portland District, PO Box 2946 Portland OR 97208-2946		BASIC
	4. DATE (MIPR Signature Date) 10 March 1995	5. AMOUNT (As Listed on the MIPR) $ 111,983

6. The MIPR identified above is accepted and the items requested will be provided as follows: (Check as Applicable)

a. ☐ ALL ITEMS WILL BE PROVIDED THROUGH REIMBURSEMENT (Category I)
b. ☐ ALL ITEMS WILL BE PROCURED BY THE DIRECT CITATION OF FUNDS (Category II)
c. ☐ ITEMS WILL BE PROVIDED BY BOTH CATEGORY I AND CATEGORY II AS INDICATED BELOW
d. ☐ THIS ACCEPTANCE, FOR CATEGORY I ITEMS, IS QUALIFIED BECAUSE OF ANTICIPATED CONTINGENCIES AS TO FINAL PRICE. CHANGES IN THIS ACCEPTANCE FIGURE WILL BE FURNISHED PERIODICALLY UPON DETERMINATION OF DEFINITIZED PRICES, BUT PRIOR TO SUBMISSION OF BILLINGS.

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7. ☐ MIPR ITEM NUMBER(S) IDENTIFIED IN BLOCK 13, "REMARKS" IS NOT ACCEPTED (IS REJECTED) FOR THE REASONS INDICATED.

8. TO BE PROVIDED THROUGH REIMBURSEMENT CATEGORY I			9. TO BE PROCURED BY DIRECT CITATION OF FUNDS CATEGORY II		
ITEM NO. a	QUANTITY b	ESTIMATED PRICE c	ITEM NO. a	QUANTITY b	ESTIMATED PRICE c
		1. This form authorizes the National Biological Survey (NBS) to conduct predator/prey studies in the John Day Pool of the Columbia River for the Corps of Engineers per the attached scope of work, budget, and research proposal. 2. NBS is authorized to spend up to $111,983 to conduct the work for the period March 1995 through September 30, 1995. 3. The amount authorized by this order ($111,983) cannot be exceeded without prior written approval of this office. Invoices (original and two copies) will be submitted to address shown in block 13. Two copies of form DD 448-2 should be returned to the address shown in block 13 after acceptance in block 14. 4. This MIPR expires on September 30, 1995. The point of contact on for this MIPR is Mark Smith (503) 326-6135. This Economy Act order is placed in accordance with the provisions of AR 37-1/DODI 7220.9M.			
		BFF42			
c. TOTAL ESTIMATED PRICE			d. TOTAL ESTIMATED PRICE		$ 111,983

FOR ACCEPTANCE, SIGN AND RETURN ONE COPY OF ACCEPTANCE OF MIPR TO CHIEF, PM-EC

10. ANTICIPATED DATE OF OBLIGATION FOR CATEGORY II ITEMS

11. GRAND TOTAL ESTIMATED PRICE OF ALL ITEMS

12. FUNDS DATA (Check if Applicable)

a. ☐ ADDITIONAL FUNDS IN THE AMOUNT OF $ _____ ARE REQUIRED (See Justification in Block 13)
b. ☐ FUNDS IN THE AMOUNT OF $ _____ ARE NOT REQUIRED AND MAY BE WITHDRAWN

13. REMARKS

14. ACCEPTING ACTIVITY (Address and Code)
NATIONAL BIOLOGICAL SERVICE
NW BIOLOGICAL SCIENCE CENTER
6505 NE 65TH STREET
SEATTLE WA 98115

15. TYPED NAME AND TITLE OF AUTHORIZED OFFICIAL
Allan Marmelstein, Acting Director

16. SIGNATURE

17. DATE 3/29/95

DD Form 448-2, JUL 71 PREVIOUS EDITION WILL BE USED UNTIL EXHAUSTED

SCOPE OF WORK

1. Project Title: Impact of Drawdown of John Day Reservoir on Level of Predation of Juvenile Salmonids.

2. Appropriation: Construction General, 96x3122

3. Authority: Economy Act (31 U.S.C. 1535) , 1982

4. Purpose and Scope: The proposed activities support the U.S. Army Corps of Engineers continuing efforts to understand the effects of the proposed drawdown of John Day Pool on levels of predation on juvenile salmonids. This study will focus on evaluating the existing predation levels and using predictive modeling, estimate effects of the proposed drawdown on predation levels.

5. National Biological Survey Obligations:

a. Research Objectives: Activities described in the attached detailed research proposal (attachment 1) will be conducted by NBS

b. NBS will calculate and estimate all statistical considerations regarding these studies.

c. NBS will provide all the necessary manpower and equipment needed to accomplish the objectives listed in attachment 1.

d. Schedule: Work described within the proposal covers the period March 1995 through September 1995.

e. Coordination. Periodic conferences will be held as needed, as determined by the Corps of Engineers District point of contact, Mr. Mark Smith (503 326-6135). Conferences will include but not be limited to coordination meetings with project personnel regarding equipment and unit scheduling, pre-season meetings, meeting during the season to discuss upcoming work, and post season meetings to discuss results and the direction of future research.

f. Reporting. NBS will attend and report to the Corps' research review committee the results of the research, and provide their opinions as to what direction the research should take in the future.

g. NBS will participate in the Corps' annual research review by presenting the results of this study, including any statistical analyses. A short summary report (abstract format, 3 pages or less) will be provided to the Corps prior to the review. Other presentations may be requested to inform other groups of the research activities conducted under this scope of work.

h. A report summarizing the work conducted and the data collected during the previous field season will be provided in draft form by January 1, 1995 to the Corps District point of contact. After a 30 day review period by the Corps and interested fishery agencies and tribes, a final report (with 10 copies) will be submitted to the same point of contact by March 1, 1996. The annual report will be a concise synopsis of the findings and will focus on a discussion of methodologies and techniques evaluated this year. A final project report will be submitted instead of an annual report if this is the only year or last year this study is conducted.

6. It is requested that publication of any results of this research in any internal or refereed document acknowledge Corps funding and participation. The Corps supports the publication of this research, after approving the manuscript.

7. Changes. All scope of work coordination will be between the principal investigator (Mr. Tom Poe) and the Corps point of contact (Mr. Mark Smith). Changes to the proposed research outlined in attachment 1 will not occur without prior approval of the Portland District. Changes to this scope of work will be coordinated through the appropriate chain of command by the Corps point of contact. If approved, changes will be authorized by modification to the DD 448 by the District Engineer. Requests for any project services should be directed to the Corps point of contact.

8. Funding: Funding is authorized to conduct the activities described in this scope of work and the attached research proposal for FY 95. Funding is not to exceed $111,983 for this period. If required and funds are available, a modification to this DD 448 will be issued when funds have been approved to authorize work to be conducted under this MIPR for the period October 1995 through December 1995.

9. For costs incurred in the execution of this scope of work NBS shall submit invoices quarterly to the Corps of Engineers (the original and two copies) to:

U.S.Army Engineer District, Portland
ATTN: CENPP-RM-F
P.O.Box 2946
Portland, Oregon 97208

10. Conditions:

a. All non-expendable equipment purchased under this work order will remain the property of the Corps of Engineers.

b. Endangered Species Act Permits: Unless otherwise approved by the Corps, prior to initiating work under the terms of this Memorandum of Agreement it is the responsibility of NBS

to obtain any permits which may be required by the Endangered Species Act, 16 U.S.C. Section 1531 et seq. In the event that such a permit is not obtained within the time contemplated for the work to be done under this agreement and/or an application for such a permit is denied for the research work contemplated by this agreement, this work order may be terminated in whole or part by the Corps of Engineers. Written notice of the partial or complete termination of this work order shall be provided by the Corps. Any work authorized and performed through the date of termination shall be reimbursed in accordance with paragraph 6 above.

Phase 1

STATEMENT OF WORK (COE) (FY95 & FY96)

TITLE: Impact of Drawdowns of John Day Reservoir on Level of Predation of Juvenile Salmonids

PROJECT LEADERS: Thomas P. Poe, Dena M. Gadomski, & Craig A. Barfoot
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Administrative Officer
National Biological Service
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ADMIN CODE:

PROJECT DURATION: Phase 1 - March 13, 1995 to March 14, 1996.

SUBMISSION DATE: February 16, 1995

Background

Drawdown of John Day Reservoir in 1996 is one action recently proposed in an effort to increase survival of outmigrating juvenile salmonids in the Columbia River Basin. Hydroelectric development of the Columbia River Basin has altered the timing and magnitude of water flows that juvenile salmonids are exposed to during outmigration. Historically, smolt emigration coincided with high spring and early summer discharges (Park 1969). Travel time during smolt migration is an important factor governing in-river survival of juvenile salmon and steelhead (Raymond 1979). Delays during outmigration can prolong smolt exposure to predators and disease (Raymond 1979). Smolt travel time is influenced by a complex array of factors; however, many fisheries scientists believe that more closely approximating a natural hydrograph through reservoir drawdowns will decrease travel time and increase outmigrant survival.

Many questions, however, remain about the ecological consequences of drawdown. Of particular importance are questions concerning physical alteration of the aquatic environment and trophic level interactions, particularly predator-prey

relationships. In 1994 the National Marine Fisheries Service initiated a study concentrating on water quality, primary productivity, and benthic invertebrates in shallow, littoral habitats of John Day Reservoir (Ledgerwood and Grabowski 1995). Similar studies with the additional objective of monitoring the nearshore fish community were initiated in Lower Granite Reservoir (Ledgerwood and Grabowski 1995; Bennett 1994). Primary objectives of these studies were to assess conditions prior to, during, and following proposed drawdowns in John Day and lower Granite reservoirs. Investigations of predator-prey related questions in the fish community have not been initiated for the John Day Reservoir.

Monitoring the nearshore fish community of the John Day Pool before, during, and after the proposed drawdown is important since juvenile fall chinook salmon rear in these areas along with many other species of resident fishes (both native and introduced). Physical changes resulting from drawdown may initiate disruptions in the nearshore fish community and these disruptions may change predator population structures and predator-prey relationships. For instance, drawdown could influence year-class strengths of predators if the amount and suitability of shallow littoral habitat is reduced. Drawdown may also impact the non-salmonid prey of predators, thus causing indirect impacts on juvenile salmonids.

Predation by resident fishes is an important source of mortality to juvenile salmonids in the Columbia River (Rieman et al. 1991). The northern squawfish Ptychocheilus oregonensis is a

native predator that accounts for a large percentage of the juvenile salmonids lost to predation (Rieman et al. 1991). Shallow, low-velocity shoreline areas are important rearing habitats for northern squawfish (Olney 1975; Beamesderfer 1992). Monitoring changes in the relative abundance of northern squawfish and other fishes in nearshore habitats of John Day Reservoir may help us further understand community-level interactions following abiotic changes in the reservoir environment.

Goals and Objectives

During phase 1 of this study, in 1995, we propose to evaluate and monitor the nearshore fish community in John Day Reservoir, concentrating on collecting and synthesizing predrawdown information. Efforts will focus on fishes $\leq$ 250 mm fork length (fl) using beach seines. We are targeting "prey-sized" fishes because this may allow for comparisons with a previous study of the nearshore fish community in the John Day Pool (Palmer et al. 1986). We will also review and analyze existing predator-prey data, which dates back to 1982, and use existing predator-prey models to better predict potential impacts of a John Day Reservoir drawdown. Modeling approaches for studying drawdown impacts will be reviewed and simulations will be conducted to identify critical processes and future data needs. The benefits of this study are multiple and will result in a better understanding of the abundance and distribution of nearshore fishes in the John Day Pool as well as

determine the most important indicators to study to evaluate the impacts of drawdown.

Objective 1. Conduct a review of literature on nearshore fish communities and the effects of water level fluctuation in reservoirs on fish populations.

Objective 2. Review existing prey abundance data from 1983-86.

Task 2.1 Determine locations of previous sampling sites and outline data collection methods.

Task 2.2 Review and summarize fish community information in the existing data set, focusing on major community attributes such as percent composition, species diversity, temporal variation in composition and catch, catch-per-unit-effort data, and size composition information.

Rationale: Determining major community attributes from the existing database is important since predrawdown data collection will be limited to one year. As part of the predrawdown proposal we will examine the feasibility and reliability of using previously collected data. Using the existing information is important because we do not know the magnitude of interannual or longterm fluctuations in major community attributes of resident fishes in the John Day Pool. Assessing gross changes between 1995

samples and the existing 1983-86 database should indicate whether the existing data set can be used to compliment data collected in 1995.

Methods: Summarize major community attributes for existing database. Analysis could range from simple comparisons of community attributes to more complex multivariate community analyses.

Products: Predrawdown data on the distribution, relative abundance, and community composition of resident fishes.

Schedule: Begin spring 1995, report results by spring 1996.

Task 2.3 Correlate catch-per-unit-effort data from 1983-86 for juvenile northern squawfish with subsequent year-class strength estimates from the squawfish removal program.

Rationale: The northern squawfish is an important predator on juvenile salmonids and the target species of an extensive removal program. Determining if juvenile catch-per-unit-effort data are indicators of subsequent adult squawfish

numbers will contribute to better understanding and management of the species.

Methods: Review existing data and determine age-classes of northern squawfish present in the samples based on length frequency and length-at-age information. Examine catch-per-unit-effort data for relationships with relative year-class-strength indices. This approach may have limitations since only three complete years of catch data are available from the prey abundance study. However, catches from each year may represent multiple year-classes of squawfish.

Products: Data on relationship between juvenile northern squawfish abundance and year-class strength.

Schedule: Review data and report results by spring 1996.

Objective 3. Replicate 1983-86 prey abundance studies in summer 1995. Describe the composition, relative abundance, and distribution of fishes in shallow littoral habitats of the John Day Pool.

Task 3.1 Determine sample sizes needed to detect largescale changes in catch and composition for major species at each sample location in previous prey abundance studies (Palmer et al. 1986).

Rationale: The ability to detect largescale differences in catch and community composition for major species in the prey abundance study is important since predrawdown data collection is limited to 1995. If major differences in catch and composition do not exist between the previous database and 1995 collections we may be able to use the prey abundance study as additional baseline information.

Methods: We will conduct a statistical power analysis on the existing data set to determine sample sizes needed to detect changes in the relative abundances of important nearshore species.

Products: Sample sizes needed at locations within the major strata of the John Day Pool study area.

Schedule: Prior to sampling in spring 1995.

This - Why can't we look at the fish?

Task 3.2 Conduct beach seining in selected habitats of the

John Day Pool. Collect environmental data concurrent with sampling efforts.

Rationale: Little information exists on fish communities and community-level interactions in Columbia River reservoirs. Information on fishes within selected shallow littoral habitats of the John Day Pool before, during, and after proposed drawdown is important to our understanding of habitat use and community composition in impounded segments of the Columbia River. Drawdown could potentially affect recruitment of both native and introduced resident fishes, depending on habitat requirements and the availability of suitable habitat during and following the proposed drawdown. The creation of impoundments and associated habitat alterations have favored some native species such as the northern squawfish and restructured fish assemblages which now contain many exotic midwestern species (Li et al. 1987). Drawdown may establish a new community equilibrium through restructuring of the current fish communities depending upon a complex array of factors including pool-level fluctuation, drawdown timing, and various limnological effects. Monitoring these changes will further our understanding of the potential effects

on salmonids.

Methods: Replicate 1983-86 prey abundance studies using identical gear and methodologies at the same sample locations. The prey abundance study used a 30.5 x 2.4 m bag seine with 6.4-mm knotless nylon mesh (Palmer et al. 1986). They sampled at six general locations (John Day forebay, Arlington, Irrigon, McNary tailrace, and in two backwaters--Paterson and Plymouth sloughs). At each location, four nighttime hauls were made during each sampling period. Samples were collected from April to September. Some 1995 locations may change slightly due to pool level operations. However, we will attempt to sample similar habitat types within the immediate area of the former site. Environmental data on variables such as substrate, vegetation, temperature, and turbidity will be collected concurrent with fish sampling. Additional data on dam operations can be obtained after sample collection.

Products: Community-level information for fishes in shallow littoral habitats of John Day Reservoir.

Schedule: April through August 1995.

Objective 4. Explore the potential effects of reservoir drawdown on predation through modeling studies. Identify critical processes and assumptions.

Task 4.1 Review literature and identify appropriate modeling techniques.

Task 4.2 Screen or develop software necessary for predation modeling studies.

Task 4.3 Conduct simulations to identify critical processes that may influence predation through drawdown-produced mechanisms.

Rationale: Manipulation of complex ecosystems, such as drawdown of John Day Reservoir, often produces unpredictable results. Models of the basic processes in ecosystems (predation, prey movement, habitat change, etc.) can often be constructed and used to identify critical processes and data needs (Adams and DeAngelis 1987). Drawdown of John Day Reservoir will be a major manipulation that could redistribute prey, reduce the foraging habitat of northern squawfish, and increase smolt migration rate. GIS models could be used to demonstrate how shallow-water habitat might change at different levels of drawdown, and individual-based models could be used to simulate smolt migration responses

to velocity during drawdown. Modeling will be a valuable tool for understanding how changes in resident fish communities (Objectives 2 and 3) might influence predation and, ultimately, juvenile salmon survival.

Methods: Various modeling approaches will be reviewed and considered (GIS-based approaches, trophic models, bioenergetic models, individual-based models, etc.).

Products: A report including: a literature review of existing fish ecology and predation data for JDR, a determination of the adequacy of existing littoral fish community data (1983-1986) for use in documenting drawdown effcts, model simulation results indicating magnitude of impacts of drawdown on predation levels on juvenile salmonids, and recommendations for studies of critical processes or assumptions.

Schedule: April 1995 - March 1996 (draft report due 01-19-96).

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