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OREGON
ENVIRONMENTAL QUALITY
COMMISSION MEETING
MATERIALS 07/21/1994

State of Oregon
Department of Environmental Quality

NOTICE

Special Meeting

Thursday, July 21, 1994
1:00 p.m.

Conference Room 3A
Department of Environmental Quality
811 S. W. Sixth Avenue
Portland, Oregon

SPECIAL MEETING OF THE COMMISSION TO CONSIDER A REQUEST FROM THE NATIONAL MARINE FISHERIES SERVICE (NMFS) FOR A TEMPORARY RULE

1:00 p.m.	Call to order
1:10 p.m.	Summary of Results and Impacts of 1994 National Marine Fisheries Service Supplemental Spring Spill Program (**Gary Fredericks**, NMFS)
1:30 p.m.	Summary of Results and Recommendations of the National Marine Fisheries Service Panel on Gas Bubble Disease (NMFS)
1:45 p.m.	Rationale for National Marine Fisheries Service Request for Temporary Rule on Total Dissolved Gas (NMFS)
2:15 p.m.	Staff Report on Request for Temporary Rule on Total Dissolved Gas (**Robert Baumgartner**, DEQ)
2:45 p.m.	Comment Period
3:30 p.m.	Commission Discussion and Action

A G E N D A

ENVIRONMENTAL QUALITY COMMISSION MEETING

Friday, July 22, 1994

Pacific University
Multi-Purpose Room
University Center
2043 College Way
Forest Grove, Oregon

REGULAR MEETING

REGULAR MEETING BEGINNING AT 9:00 A.M.

Notes: *Because of the uncertain length of time needed for each agenda item, the Commission may deal with any item at any time in the meeting. If a specific time is indicated for an agenda item, an effort will be made to consider that item as close to that time as possible. However, scheduled times may be modified if agreeable with participants. Anyone wishing to be heard or listen to the discussion on any item should arrive at the beginning of the meeting to avoid missing the item of interest.*

Public Forum: *The Commission will break the meeting at approximately* ***11:30 a.m.*** *for the Public Forum if there are people signed up to speak. The Public Forum is an opportunity for citizens to speak to the Commission on environmental issues and concerns not a part of the agenda for this meeting. Individual presentations will be limited to 5 minutes. The Commission may discontinue this forum after a reasonable time if an exceptionally large number of speakers wish to appear.*

A. Approval of Minutes

B. Approval of Tax Credits

C. Boundary Expansion for Portland Area Vehicle Inspection Program

ENVIRONMENTAL QUALITY COMMISSION SPECIAL MEETING
DEQ Headquarters, Room 3A
811 SW Sixth Avenue
Portland, Oregon
July 21, 1994

Revised Agenda

1:00 p.m.	Call to Order
1:10 p.m.	Summary of Results and Impacts of 1994 National Marine Fisheries Service Supplemental Spring Spill Program (**Gary Fredericks**, NMFS)
1:30 p.m.	Summary of Results and Recommendations of the National Marine Fisheries Service Panel on Gas Bubble Disease (**Steve Grabowski**, NMFS)
1:45 p.m.	Rationale for National Marine Fisheries Service Request for Temporary Rule on Total Dissolved Gas (**Merritt Tuttle**, NMFS)
2:15 p.m.	Rationale for Tribal Fisheries Agencies Request for Temporary Rule on Total Dissolved Gas (**Lewis** Louis **Pitt**, Confederated Tribe of the Warm Springs Reservation, and **Bob Heinith**, CRITFC)
[1]2:45 p.m.	Position of State Fisheries Agencies on need for TDG variance for summer supplemental spill program (**Douglas DeHart** and **Phil Schneider**, ODFW)
3:15 p.m.	Staff Report on Request for Temporary Rule on Total Dissolved Gas (**Robert Baumgartner**, DEQ)
3:45 p.m.	Comment Period
4:30 p.m.	Commission Discussion and Action

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[1] Please note the time set aside for State Fisheries Agencies

State of Oregon
Department of Environmental Quality Memorandum[†]

Date: July 21, 1994

To: Environmental Quality Commission

From: Fred Hansen, Director

Subject: Agenda Item 1, EQC Meeting

Total Dissolved Gas Temporary Rule, Columbia River

Statement of the Issue

The Commission is requested to adopt a temporary rule for total dissolved gas (TDG) in the Columbia River. The request comes from the National Marine Fisheries Service (NMFS) dated July 6, 1994. A second submittal sent to the Governors of Oregon and Washington, a copy of which was sent to us, was received on July 18, 1994. This came from the Columbia River Inter Tribal Fish Commission (CRITFC). This submittal speaks to a daily average TDG of 120% and a maximum of 125%. It is the understanding of the Department that this second submittal does not represent a separate request at this time but rather is intended to be information submitted in support of the NMFS request.

The current applicable criteria is 110% TDG. The proposed criteria for temporary rule adoption provided by the NMFS:

an average of 115% TDG with a maximum of 120%, until August 23, 1994

The NMFS request is supported by their Biological Opinion for the operation of the Columbia River projects through 1998.

The Commission is asked to adopt an temporary rule for TDG in the Columbia River to support a summer spill program. This rule would be similar to, and address the same issues as the temporary rule provided for a spring spill program. The maximum allowable period for temporary rule is 180 days. Since the Commission has already adopted two temporary rules on this same issue, the maximum time period that this proposed temporary rule could be operative is reduced by the 41-day period of the previous temporary rules, for a maximum of 139 days or through December 7, 1994.

[†]Accommodations for disabilities are available upon request by contacting the Public Affairs Office at (503)229-5317(voice)/(503)229-6993(TDD).

Background

One stock of salmon in the Columbia River has been identified as endangered; Snake River sockeye, and two as threatened; Snake River spring/summer chinook, and Snake river fall chinook. The NMFS has developed plans for addressing flow management and fish passage alternatives in the Columbia River. The methods of fish passage and relative benefits of these alternative transport options are debated. Consensus estimates of overall survival relative to alternative transport methods for juvenile fish passed through the Columbia, or as returning adults are not available.

One method of fish passage is increased spill. Increased spill results in reduced mortality at each dam compared to turbine passage, resulting in improved system in-river passage survival for juveniles. The NMFS also believes that increase spill results in an unmeasurable decrease in mortality of adult "fall backs".

Potential benefit from transport, via truck or barge, is debated, especially when measured as adults returning to spawning grounds. The relative increase in-river survival associated with spill is debated, often dependent upon controversial model application and model parameter selection. Total in-river passage, which excludes barge or truck transport, mortality for the summer juvenile migrants is variously estimated as greater than 95% to 99%.

The ODFW citing the "FLUSH" model estimated improved survival for instream migrants of ≈ 45 percent measured relative to the in-river passage survivors. For example, if in-river passage mortality was 99%, in-river survival would then be 1% [1-(99%/100)]. Under a higher spill program achieving 80% fish passage efficiency, a 45% increase would result in an increase for in-river passage survival increasing the estimated of 1% to near 1.45%. The in river passage mortality would decrease from 99.00% to 98.55%. Although the overall net difference for in-river passage appears small, the estimated difference relative to the survivors of 45% is significant. Information provided by ODFW estimates a range of in-river survival that depends on both reservoir volume management option and spill alternative that range from 0.3% to 2.9%.

The Bonneville Power Administration (BPA) applies a different model "CRiSP", which includes an estimate of the impact of elevated gas pressure on in-river survival, for assessing the NMFS flow requests. The predicted in-river survival improvement is limited, 1.1% for the current levels of spill and 1.13% under the biological opinion spills for a comparative increase of <3%. There is no estimate of differential survival for an option of 80% FPE for comparison with the estimates provide by ODFW. To simulate overall system survival through the estuary the "CRiSP" model calculates both transportation and in-river passage survival. The model simulates an overall system (transport + in river) survival of 25.12% under the current spill levels and 25.15% under the biological opinion spill levels. The benefit, if any, of transport measured as adults returning to the spawning grounds is debated.

Increased spill will result in increased levels of TDG. The effect of TDG has been extensively studied in the laboratory, however, limited field studies are available. Elevated levels of TDG can result in direct acute mortality, or sub acute mortality. The response of fish and aquatic life to elevated levels of TDG depends on several factors including hydrostatic compensation. Fish and aquatic life would avoid the effects of GBD if they increase total pressure by moving to deeper water. However, it is debatable how effective fish are at detecting and avoiding the influence of elevated gas pressure through hydrostatic compensation. Information on the depth distribution of fish in the Columbia River is limited.

The benefits of increased spill can only be achieved up to the point where negative impacts due to elevated gas pressure occur. Precise prediction of mortality in the Columbia River cannot be made. The degree of risk associated with elevated gas pressure is provided in a large body of published and peer reviewed literature. The perception of risk associated with elevated gas bubble disease will in part depend on the duration of exposure, the degree of exposure, and any deference given to in-situ studies in contrast to controlled laboratory studies.

The risk associated with alternative criterion levels is discussed in the attached report, and summarized in the following table:

Summary, Acute risk associated with elevated TDG levels		
TDG	Reference	Risk
< 105	Current criteria for shallow water	Negligible risk under almost all circumstances.
~ 110	Current criterion.	Mortality threshold under prolonged exposure under shallow water (1 m) conditions. Method of mortality may be indirect and uncertain. Negligible risk where depth compensation available.
~ 115	Acute Threshold for juveniles and adults in shallow water	Direct mortality thresholds identified for juveniles and adults. Signs of GBD will become apparent as bubbles in gills and blood circulatory system. Depth compensation would add additional levels of protection.
120-125	Acute threshold for juveniles in field studies.	Apparent threshold for juvenile salmonids held in deep volition live cage studies in Columbia River. Risk of mortality depends upon duration of exposure.
125 to 130	Significant signs and mortality, field bio-assays	From field bio-assays the degree of impact and rate of mortality is dependent upon exposure duration and TDG level. Any appreciable duration above these levels could be expected to result in some mortality to migrating juvenile salmonids.
130+	Acute levels	Field bio-assays and historical observations of acute response.

There is less information available for assessing the potential impacts to other aquatic life existing in the Columbia River. Increased levels of TDG would increase the risk to resident salmonids and other aquatic life, especially those inhabiting shallow water habitats. Limited information collected by NMFS during the spring spill program indicate that levels of TDG near 115% did not result in external signs, or increased mortality to resident fish.

Authority to Address the Issue

The EQC has authority to adopt rules, including water quality standards, under ORS 468.020 and 468B.048.

Alternatives and Evaluation

There are three alternatives;

1) reject the NMFS proposal,
2) accept the NMFS proposal, or
3) develop an alternative temporary criteria for TDG in the Columbia River.

In order to proceed with options 2 or 3 the Commission must make a statement of its findings that failure to act promptly will result in serious prejudice to the public interest or the interest of the parties concerned and the specific reasons for its findings of prejudice.

The supporting information for a finding of prejudice is contained in the NMFS biological opinion. Efforts to protect the threatened and endangered salmon include a variety of efforts. Included in these efforts is the spill program. To achieve the benefits of the spill program will require modification of the TDG criteria for the Columbia River.

The requested temporary criteria of 115% TDG level is not without risk. The level of risk is difficult to quantify. However, 115% TDG levels would be expected to be below the direct lethal thresholds for migrating juvenile or adult salmonids even under shallow depths. Depth compensation and limited exposure periods to intermittent spills would act to further reduce the potential risk to adult and juvenile salmonids. It is unlikely that migrating juveniles would be at shallow depths for long enough exposure periods to result in direct mortality due to elevated gas pressure. Although estimates of risk are not precise, the described benefits of the spill program appear to justify any potential additional risk of mortality associated with elevated levels of TDG in the range of 115%, with a maximum of 120% TDG.

The 115% TDG criteria allows the NMFS to achieve the spill levels defined in their 1994-1999 biological opinion. Therefore, option 3 for an alternative temporary TDG criteria is not recommended, nor is an alternative TDG criteria evaluated in this report. However, the long term enhancement of the threatened and endangered salmonid stocks in the Columbia River may need to evaluate the risk associated with higher levels of TDG and benefits to instream survival from higher spill levels.

Summary of Any Prior Public Input Opportunity

Given the timing of the submittal by NMFS the Department has had no time to allow for public or peer review of the information presented or staff reports.

Conclusions

- The spill program is an integral component of the NMFS biological opinion, and efforts to protect and preserve threatened and endangered stocks of salmonids in the Columbia River.

- The benefit of increased spill for passage over the dam compared to turbine passage for migrating juvenile salmonids is generally accepted at a range of 5-18% mortality for turbine passage and 0 to 3% for spill, per dam.

- Overall in-river mortality is high with estimates ranging from above 95% to near 99%. The net benefit of the spill program on overall in-river survival is debated, and estimates are dependent upon model theory and assumptions. However, even a small percentage increase in juvenile instream survival of the threatened or endangered fish is important. The net benefit to system survival is further debated due to alternative transport methods of fish passage.

- The benefits of spill can be achieved as long as the risk to mortality of increased TDG, whether direct or indirect, do not outweigh the benefits of the spill program.

- The proposed level of TDG of an average of 115%, with a maximum of 120% approaches thresholds identified as directly acute for long exposure in shallow water for adult and juvenile fish. Depth compensation and intermittent exposure will reduce the relative risk associated with a TDG level of 115%. The 115% level is below a threshold of observed acute conditions in field studies (120% TDG).

Proposed Findings

The proposed spill request is an integral component of the NMFS biological opinion. Failure to act will jeopardize the ability to achieve the goals described in the biological opinion for protecting migrating juvenile salmonids.

The benefits of spill can be obtained without undue risk due to elevated gas levels in the Columbia River at levels of 115% TGP.

Recommendation for Commission Action

As presented in Attachment A of the Department Staff Report together with the supporting findings presented in Attachment B, it is recommended that the Commission adopt the proposed temporary rule for TDG in the Columbia River.

Attachments

A. Proposed Action, temporary rule.
B. Supporting Findings, A.G. Approval.
C. Staff reports.
D. Statement of need.

Reference Documents (available upon request)

Available upon request
1. Statutory Authority
2. Applicable Rule(s)
3. Supporting Technical References

Approved:

Section: Neil Mullane

Division: Michael Downs

Report Prepared By: Baumgartner, Robert P.

Phone: 229-5877

Date Prepared: 7/20/84

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Draft

TEMPORARY RULE
Total Dissolved Gas - Columbia River

340-41-155 Effective on filing and until December 7, 1994, ending on midnight that day. This rule supercedes paragraphs 340-41-205(2)(n), 340-41-445(2)(n), 340-41-485(2)(n), 340-41-525(2)(n), 340-41-565(2)(n), 340-41-605(2)(n) and 340-41-645(2)(n) as these paragraphs apply to the Columbia River. In the Columbia River, the Total Dissolved Gas (TDG) concentration relative to atmospheric pressure at the point of sample collection may exceed the current standard of 110 percent. In no event, however, may the TDG exceed 120 percent, or a 24-hour average of 115 percent. The purpose of this temporary rule is to provide for emergency assistance to outmigrating salmon smolts in the mainstem of the Columbia River via increased spill over the mainstem dams. The responsible agency or agencies shall develop a monitoring plan acceptable to the Department. The responsible agency or agencies shall conduct monitoring for TDG concentrations and for the incidence of gas bubble disease (GBD) sufficient to determine whether the resultant TDG concentrations cause a significant increase in GBD as determined by the Department. If such an increase in mortality is documented, as determined by the Director, the Director shall make such alteration in the maximum allowable TDG level, until a satisfactory level is achieved.

Attachment B

Statement of Findings of Serious Prejudice
and
Attorney General Approval of Temporary Rule Justification

Agency:	Environmental Quality Commission
Temporary Rule:	OAR 340-41-155 Relating to Total Dissolved Gas in the Columbia River

1. The Environmental Quality Commission finds that its failure to promptly take this rulemaking action will result in serious prejudice to the public interest and to all individuals and groups that have a commercial, recreational or social interest in the enhancement of anadromous fish in the Columbia River.

2. This finding of serious prejudice is based upon the agency's conclusion that the following specific consequences would flow from failure to immediately take this rulemaking action:

Very recent data have revealed that the populations of adult salmon in the Columbia River basin are dangerously low.

The responsible state and federal fish management agencies, especially the National Marine Fisheries Service, have determined that migration efforts should be diversified by spilling additional water from certain mainstream dams on the Columbia River. In addition, a federal district court recently ruled that the prior migration plan was inadequate and did not comply with federal law.

Additional spills would likely violate the state's instream water quality standard for total dissolved gases in the Columbia River. The rule would temporarily raise the total dissolved gases standard, thereby permitting the spills, subject to several conditions. The conditions include a requirement for careful monitoring of possible impacts of the spills and preserve the authority of the Department of Environmental Quality to return to a lower total dissolved gases standard if there is significant increase in fish mortality.

3. The agency concludes that following the permanent rulemaking process, rather than taking this temporary rulemaking action, will result in the consequences stated above because the current outmigration of juvenile smolts will be complete before a permanent rule could be adopted.

4. This temporary rulemaking action will avoid or mitigate these consequences by allowing for additional, immediate spills at certain dams without violating state water quality standards.

ON BEHALF OF THE COMMISSION:

______________________ ______________________________

Date Fred Hansen, Director

I have reviewed this temporary rule as required by Oregon Laws 1993, chapter 729, section 6, and find that the above statement of agency findings is legally sufficient. I therefore approve this rule as required by, and for the purposes of, Oregon Laws 1993, chapter 729, section 6.

______________________ ______________________________

Date Assistant Attorney General

Staff Report
Review of the NMFS request for temporary rule modification relating to the TDG criteria for the Columbia River

Summary:

The National Marine Fisheries Service (NMFS) has requested that the Environmental Quality Commission modify the existing standard for total dissolved gas (TDG) to an average of 115%, with a maximum of 120% for the purpose of enhancing juvenile salmonid survival through the Columbia River Dams by increasing spill passage. The increased spill will result in exceedance of the 110% standard.

The existing dissolved gas criteria are based on a review of the available laboratory and field studies describing the effects of elevated TDG including compensation by depth. The benefits of additional spill on in-river survival did not appear to be a substantial concern during the standard development.

The benefit of increased spill to survival past a project appears to be reasonably well agreed upon. The relative change in survival over a dam depends both on changes in the fish passage efficiency (FPE) and differential survival rates by turbine and spill passage. Net system survival is more difficult to quantify and depends on potential benefits from transportation options, and a variety of factors influencing reach mortality. Overall system survival is low, with an estimated 95-99% mortality for in-river migrants. Quantifiable estimates of alternative transport strategies were not obtained, nor could such estimate be derived from the information presented. However, the survival at each project is quantifiable, and even small increases in net in-river survival may be important.

Precise measures of the influence of gas pressure on system mortality are not available. The effect of passage methods and TDG on system mortality are debatable. Analytical models have been developed to assess risk, however, neither the assumptions driving the models, nor the results are universally accepted. It is not possible with the information presented to calculate where the net benefit of spill to system survival is offset by the effect of the associated increase in TDG on system mortality rates.

The benefit of spill can be obtained only up to the point where the risk of mortality due to elevated TDG outweighs the benefits of spill. Lack of specific scientific information makes professional judgement difficult. The dilemma presented by this request is to balance the perceived benefits of spill with the perception of risk associated with higher TDG levels.

Perceptions of risk associated with elevated TDG levels have recently been presented by to the Commission by several noted researchers. No new published information has been documented

since these presentations. Based on a limited review of the available information, the perception of risk associated with various levels of TDG are described below:

Summary, of risk associated with alternative levels of TDG (% saturations)	
<105	Negligible Risk: A safe level under most if not all circumstances. Intensive laboratory studies indicate that below this level is safe for hatchery conditions. Levels above 105% may increase mortality under periods of prolonged exposure under shallow conditions.
<110	Negligible Risk where depth compensation is available: For fish at depths of greater than 1 meeter there is not indication of elevated mortality. Prolonged exposure under shallow water conditions may result in increased mortality or the appearance of signs of GBD. Only in special circumstances, such as hatchery raceways has direct or indirect mortality been observed between 105-110%.
~115	Acute threshold shallow water, chronic conditions with depth compensation: Signs of gas bubble disease are predicted and include cardiovascular system bubbles, bubbles in the gill lamella, and skin blisters at shallow depths. The influence of the signs of GBD on direct mortality, or secondary mortality due to infection or other mechanism is not known. Bubbles in the vascular system indicate some potential of mortality to the organism. Thresholds are defined near this range for direct mortality in adults and juvenile salmonids, under extended duration. Depth compensation would add additional protection.
120-125	Field observation acute threshold, juvenile salmonids: A smaller body of literature describes ambient measurements of GBD. By dismissing the results of laboratory studies, the field studies indicate a direct mortality threshold for juvenile migrating salmonids. Fish that do not sound, or are restricted to shallow water would be at significant risk. Little information is available for other than juvenile migrating salmonids. Low levels of mortality is only documented for long duration exposure in live cages. Potential secondary impacts due to predation are not defined.
125-130	High Risk, field studies: Significant mortality may occur in short periods, significant external signs if GBD are observed in relatively short tests (20 days). Substantial periods above 125 would be expected to result in acute mortality.
>130	Acute conditions: Indication of acute levels exceeded

Recommendation on the NMFS proposal:

The Department recommends a temporary rule modification consistent with the spill request provided by the NMFS.

The proposed 115% is not a no risk level of TDG. The potential risk appears limited under the spill program and appears outweighed by the expected increased survival associated with spill over the dams. However, relative benefits would be difficult to quantify with precision.

The 115% criteria provides a threshold for acute conditions, under extended exposure for both adults and juvenile salmonids in shallow water. Depth compensation would be expected to provide an added level of protection. However, even without substantial depth compensation acute conditions may not be encountered due to temporal spill patterns proposed.

The potential for sublethal effects can not be dismissed. Chronic signs of GBD that may occur include bubbles in the gill lamella and cardiovascular system if fish spend time near the surface. Bubbles would be expected to grow only under shallow depths, but once developed may continue to grow. Depth compensation would be expected to provide additional assurance against sub-acute mortality. The relationship between signs of GBD and mortality is not well defined.

Basis for the Current Standard:

The current Total Dissolved Gas standard was developed in 1979. The issue paper describing the TDG criteria addressed several of the issues currently being debated. In the development of the standard the knowledge that hydrostatic compensation occurs was evaluated. In developing the standard available instream bio-assays, and laboratory studies using deep tanks and instream observations of fish depth distribution were evaluated.

Findings 1979 TDG Issue Paper

- When juvenile or adult salmonids are confined to shallow water substantial mortality occurs at 115% TDG or above
- Some mortality occurs in shallow water at 110-115% TGP. These and higher levels of TDG may be safe for wild fish if they sound to compensatory depth.
- When juvenile or adult salmonids are free to sound to obtain hydrostatic compensation, in laboratory or field studies, substantial mortality still occurs when TDG exceeds 120%
- Juvenile salmonids subjected to sublethal levels of TDG can recover if returned to normally saturated waters, but adults may die from direct and indirect effects of exposure.
- Higher survival was observed during periods of intermittent exposure than continuous exposure

The criteria developed identified a 105% saturation level for shallow water and the 110% level for river systems where depth compensation, such as in the Columbia and lower reaches of the Snake rivers was possible. One of the most critical conditions was believed to be when adult salmonids searched for and entered fish ladders. During this time they might be restricted to depths of near 6 feet. The criteria were recognized as being conservative with a margin of safety. However, the criteria appears consistent with current standards being developed based on extensive review of current literature by Environment Canada (Fiddler and Miller (1994) DRAFT).

Difference between 1979 standard development and current issues:

The principle question when the criteria was developed was how conservative the criteria should be, five (5) respondents believed the criteria should be 105%, five (5) believed 110% was appropriate, and one (1) believed neither could be achieved. There was recognition that many factors influenced survival in the river. During low flow years, the level of TDG was not an apparent problem, such as in 1973, and gas bubble disease (GBD) was not observed. Typical summer ranges of TDG in the McNary forebay for the years 1983-1993, range from 100 - 115% TDG, with averages on the Oregon side being near 110% TDG. The levels of TDG at Warrendale were typically less than 110% TDG (Data from Fish Passage Center).

Since the time the standards were developed one species of salmon hase been listed as endangered, Snake River sockeye (*Onchorhynchus nerka* 12/20/91), and two as threatened, Snake river spring/summer chinook salmon (*O. tshawytscha*) and the Snake River fall chinook salmon (*O. tshawytscha* 5/22/1992). Multiple interacting factors have apparently lead to the decline of these species. One documented action influencing survival is the differential mortality related to outmigration passage strategies. It is generally agreed that survival of downstream migrating juveniles is relatively greater if passed by spill as compared to turbine passage. However, spill results in increased TDG levels, and the ability to optimize spill is constrained by achievement of the TDG standard. In the development of the standard the dilemma of the counteractive influence of spill requirements and the TDG gas criteria was not considered. The benefits of spill on the survival of migrating juveniles may influence the impression of an appropriate margin of safety associated with the standard.

BACKGROUND:

The National Marine Fisheries Service (NMFS) is the federal agency having the primary responsibility for actions taken under the Endangered Species Act to protect federally listed stocks of fish. The NMFS developed a biological opinion for the operation of the Federal Columbia River Power System in 1993. Exception to the biological opinion was identified by the State of Idaho, and subsequently by other states and tribes. In his decision Federal District Court Judge Malcolm F. Marsh observed that the NMFS has clearly made an effort to create a rational, reasoned process for determining how the action agencies (Federal Agencies operating the Columbia River Projects) are doing in their efforts to save the listed salmon species. But the process is seriously, "significantly flawed", flawed because it is too heavily geared towards a status quo that has allowed all forms of river activity to proceed in a deficit situation-- that is, relatively small steps, minor improvements and adjustments. Instead of looking at what <u>can</u> be done to protect the species from jeopardy, NMFS and the action agencies have narrowly focussed their attention on what the establishment is capable of handling with minimal disruption.

On March 16, 1994 the NMFS issued a 1994-1998 biological opinion covering the Federal Columbia River Power System Operations for 1994-1998. In Review of the 1994-98 biological opinion Judge Marsh indicated that this biological opinion appears to have similar deficiencies.

Responding to a request from the NMFS, the EQC on May 16, 1994 adopted a temporary rule allowing TDG levels to increase to and average 120% TGP. The temporary rule was in effect until June 20, 1994. Due to a high frequency of internal signs of gas bubble disease in hatchery steelhead the NMFS reduced spill in the Columbia River resulting in levels of TDG below the 120% criteria.

The NMFS convened a "working group" of scientist to review the results of the monitoring and provide recommendations to the NMFS. A presentation of the finding of this group are attached. Since , individual members of this group continue to provide clarification the report may either be draft or not be a consensus opinion.

Although a similar summer spill was identified by the NMFS and other fisheries agencies, lack of an identified spill request resulted in cancellation of two special commission meetings. On July 6, 1994 a request for temporary rule modification was received from NMS and supporting information received from ODFW on July 8, 1994. The EQC agreed to hear the request from NMFS on July 21, 1994. On July 18, 1994 a alternative request for rule modification was received from the Columbia River Intertribal Fish Commission.

Requested Action:

The National Marine Fisheries Service (NMFS) requests modification of the current Total Dissolved Gas (TDG) criterion for the Columbia River to an average of 115% TDG with a maximum of 120% TDG. The justification for the request is contained in the 1994-98 Biological Opinion.

The Columbia River Inter-Tribal Fish Commission (CRITFC) requests a modification of the standard using the same language as developed in the spring spill program of an average of 120% TGP with a maximum of 125% TGP. The CRITFC request is designed to support an aggressive management action in response to apparent salmon stock collapse observed this year in the Columbia (CRITFC DRAFT) and is supported by a [DRAFT] scientific rational.

As of the development of this staff report the EQC had agreed only to discuss the NMFS request.

SUMMARY of NMFS Spill Request:

The NMFS summer spill program would begin immediately and extend through August 23, 1994.

NMFS spill Program, Summer 1994		
Location	**Spill**	**TDG**
Ice Harbor	**25 Kcfs, 24-hours**	**120%**
McNary	**As required**	**115%**
John Day	**20% of project flow for 10 hours**	**115%**
The Dalles	**15% of project flow for 8 hours**	**115%**
Bonne-ville	**42% of project flow for 24 hours**	**115%**

The controlled Spill provides a method for passing juvenile fish past the hydroelectric facilities with relatively low mortality. The summer spill is identified as being especially important since the summer migrants apparently do not guide through turbine bypass systems nearly as well as the spring migrants.

There are three principle methods for juvenile passage: spill, turbine, and transport. The relative merits of the passage methods are debated. The relatively better survival due to spill bypass as compared to turbine passage appears reasonably well accepted (NMFS Biological Opinion and CRITFC DRAFT).

The NMFS cites ranges of mortality for turbine passage are 10-19% for yearling salmon and 5-15% for subyearling, spill mortality ranges from 1 to 3%. The CRITFC cites a spill survival of 98%, and 85% for turbine passage and provides a range of survival associated with turbine passage of 8-35 (32% SIC), with 15-18% for subyearling chinook at Bonneville (I) and (II) respectively (Holmes 1952, and Giorgi and Stuehrenberg 1987 in CRITFC).

Example calculations, relative influence of summer spill program						
Loca-tion			**Calculated Survival**		**Differential survival**	
	Base FPE	**Spill FPE**	**Base**	**Spill**	**Spill-base**	**@80% FPE**
Ice harbor	**45**	**??**	**91 (88-96)**	**----**	**---**	**3.5**
John Day	**37**	**37**	**91 (88-96)**	**91 (88-96)**	**0**	**4.4**
Dalles	**48**	**43**	**92 (89-96)**	**92 (89-96)**	**-0.3**	**3.2**
Bonne-ville	**32**	**50**	**90 (87-96)**	**92 (90-97)**	**1.8**	**4.5**

Estimates of relative system survival related to the different passage methods are not provided. The attached table provides examples of estimated passage survival at various projects during the summer spill program. Passage survival estimates used direct spill mortality of 2 and 3%, and turbine mortality of 5,15, and 18% to develop ranges. The averages were determined as the mean of all the various combinations of spill and turbine mortality for. The fish passage efficiencies (FPE) were obtained from the NMFS biological opinion.

Relative survival is calculated as the difference between the survival estimates under the proposed spill and the base conditions. The base condition may not accurately represent the conditions that would occur without spill this summer. Survival is calculated as the percentage of fish avoiding turbine passage (FPE) multiplied by spill survival plus the percentage of fish passing through turbines (1-FPE) multiplied by the survival rate for turbine passage. Greater relative survival would occur if the identified objective of 80% FPE were obtained.

Total system mortality due to the hydrosystem could exceed 95% of the juvenile summer migrants as document during similar low flow years (CRITFC 1994).

Survival Result of CRisP model runs, D. Askren (1994)

	In-River	In River + Transport
Current	1.10	25.12
Spill	1.13	25.15

The Bonneville Power Administration uses the CRiSP model for theoretically addressing system survival under different transport methods. Recent application of this model suggests that mean in river survival through the river is low (1%) and therefore relative differences between alternative is also low. The relative increase in survival of in river passage is 3% ({1.13-1.1}/1.1 *100). However, the value of any increase in these stocks of fish is significant. Modeled survival estimate depend strongly on the assumptions made.

Selected results of "FLUSH" model runs for alternative reservoir management options and spill alternatives (ODFW, 1994)

	% In River Survival	
	MOA spill	80% FPE at all Projects
Base	0.3	0.4
40 KCFS Snake 160 KCFS in Columbia	1.8	2.9

The ODFW provided, on 7/19/94, survival estimates for fall chinook in 1994, using 1992 as a surrogate flow year. Various reservoir management options were evaluated along with five alternative spill programs. The results demonstrate that management options on reservoir volume control and spill alternatives can be predicted to have significant influence on instream survival. Although there is no information to indicate that 40 KCFS minimum and a 120 KCFS minimum in the Columbia river is planned or achievable through July, the model estimates an improvement of 61% [(2.9%-1.8)/1.8 * 100] in river survival. The ODFW has estimated an improvement of 45% at the 80% FPE level. (Boyce, Person. Communication, 1994).

The estimates of system survival that have been presented do not appear to be either very accurate or precise and may be greatly influenced by modelling assumptions. Overall system survival is greatly influenced by transportation. The NMFS biological opinion states that because of less favorable river conditions during the summer migration period, it is likely that transport positively affects the survival of Snake River fall chinook to greater degree than for spring migrants. The CRITFC cites the Ad Hoc Transportation Review Group (1992) that there is information that indicated that transportation may have reduced survival of wild Snake River spring and Chinook to spawning grounds. There is substantial disagreement on the overall benefits of transport to system survival and adult returns. Other factors influencing system survival, such as predation, temperature, travel time are also difficult to predict and accurately simulate.

Adults that fallback may also be benefited by increased spill. Both the NMFS and CRITFC identify potentially reduced mortality due to "fallback" of adults through either turbines or spillways. Extended spill programs are qualitatively expected to increase survival of "fallback" salmon, but quantitative estimates are not available. Fallback of adults can be significant, greater than 50% (Monan and Liscom (1975) in NMFS biological opinion and mortality in steelhead was measured as 22-41% (Wagner and Ingram 1973 in NMFS Biological Opinion)

Precise and accurate estimates of survival under alternative strategies are not available. Predictions made using various models (e.g. FLUSH CRiSP.1) appear debated by different management agencies. In his opinion Federal Judge Marsh observed that the NMFS made concededly rough estimates of passage mortality for the purposes of relative comparisons and that further apportionment, although desirable, is not possible with any degree of reliability.

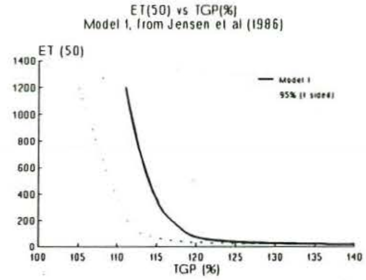
With the information available it is not possible to develop a risk assessment that compares the relative mortality due to alternative methods for passage and the level of dissolved gas that would be associated with the various spill options. The benefits of passage alternative and the risk associated with Total Dissolved Gas (TDG) concentrations are debated and predictions are not precise. It is generally agreed, as illustrated in the example calculations, that there is overall benefit to spill as compared to turbine passage. The benefits of the spill can only be achieved up to the point where gas pressure levels result in decreased system survival.

TDG and associated risk:

Extensive literature reviews were used to develop the current dissolved gas criteria. There have been relatively recent published and peer reviewed compilations and evaluations of available dissolved gas literature, including Fiddler and Miller (1994), and Jensen et al (1986). Compilation and reviews of TDG literature are also available in Weitkamp and Katz (1980, 1973) and Ebel et al (1975) and Weitkamp (1977). These reports and others are discussed in previous review by the Department (Spring spill request) and memoranda (attached).

Information developed since the current TDG criteria was developed in 1979 have not provided any substantial changes in the understanding of the influence of dissolved gas on fish and aquatic life. Recent published literature reviews and the British Columbia Water Quality Guidelines (DRAFT) standard development documentation support the existing state standard. The DRAFT British Columbia Water Quality Guidelines developed on a comprehensive review of available information recommend a 110% TGP for deep rivers, and more restrictive criteria for shallow water.

Jensen et al (1986) developed dose response models, similar to toxics, to summarize the available literature. This analytical approach provides a means for illustrating the relationship between the TDG levels, duration, and acute (time to 50% mortality) conditions. The illustrated model summarizes all data sets. A similar model which improved predictive capabilities, included the refinements of depth and fish size to improve the observed relationships and was discussed in an earlier memorandum.



ET 50 using Model 7 (Jensen et al 1986)		
TDG	Surface	1 meter
130	< 24	<24
120	< 24	240
115	80	960
110	480	>1200

The time it takes to result in 50% mortality of organisms in a controlled test is used as a measure of acute conditions. Results read from Jensen et al model 7, indicate the length of exposure required to achieve acute conditions at the surface and at one (1) meter. Jensen et al (1986) recommend that criteria be developed using a conservative model; relatively large fish at the surface, and using the lower bounds of a confidence interval. The authors recommend TDG criteria of 103.8%. This recommendation is consistent with the current no risk standard for shallow depth of 105%. The dose response model approaches an asymptote of 110% at depths of 1 meeter, consistent with the current water quality standard. Extended duration of exposure (≈40 days) at 1 meter will result in acute mortality. Review of the dose response models summarizing available literature of laboratory controlled studies does indicate the influence of even relatively shallow depth of 1 meter under TDG levels of less than 130% on the acute levels of TDG. The time it takes to result in acute conditions varies with depth and time.

Mortality Threshold		
Species	Δ P	TGP %
Sockeye	125	116%
Cutthroat	116	115
Steelhead	115	115
Steelhead	76	110
Chinook	130-140	117-118
Chinook	76-78	110
Coho	130	117
Coho	87	117
Cutthroat (Kittle)	145	119

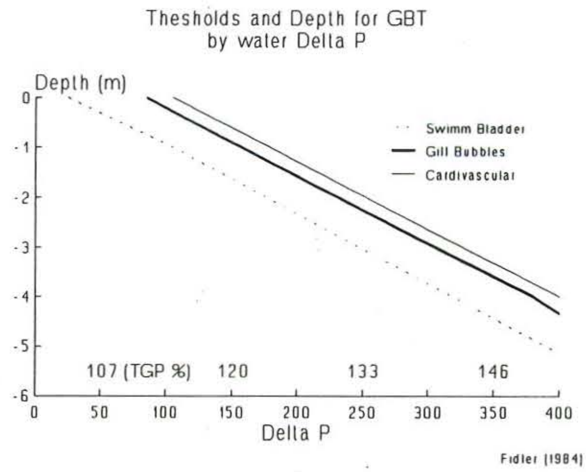
By plotting the time it takes to result in significant, between 20% and 70%, mortality for fish greater than 50 mm in length Fiddler and Miller (1994) developed species specific dose response curves similar to those of Jensen et al (1986). The threshold of the dose response curves are described by partitioning the plotted data by where significant mortality occurs from where mortality is not indicated. In some (steelhead, chinook, and coho) a second, or perhaps range, of thresholds may be indicated. The indication of more than one threshold may indicate different mechanism of mortality. (Fiddler and Miller 1994). Bouck observed a similar indication of a lower threshold related to indirect mortality under shallow water hatchery conditions associated with TDG at levels near 107%. (Bouck personal communications 1994).

The analysis described by both Fiddler and Miller (1994) and Jensen, et. al. (1986) provide an indication, and measure of mortality thresholds. However, there is no indication oh how the thresholds are associated with the various symptoms of Gas Bubble Trauma (Fiddler and Miller 1994).

Fiddler and Miller also reviewed the results of instream live cage experiments conducted by Kittle (1980). These results indicate a threshold and that the time to mortality is dependent on water depth.

The dose response analysis describes acute thresholds. Chronic conditions may also influence population survival rates through a variety of mechanism, such as predator prey relationships. Alderice and Jensen (1985) suggest a division mortality response into two categories, chronic and acute, resulting from extravascular and intravascular bubble growth. Jensen et al. (1986) observed an apparent division of chronic and acute response near 108-110% TGP.

Fiddler and Miller (1994) cited several biophysical studies that were used to develop equations which predict thresholds for specific symptoms of GBT in fish. As illustrated, water depth, or the depth at which fish exists, is a major factor influencing symptoms of GBD.



Experimental data and studies are cited by Fiddler and Miller (1994) to support the equations described by Fiddler (1984). In an evaluation of biophysical studies Fiddler and Miller (1994) argue that a threshold of $\Delta P \approx 76$ (110 % TGP) corresponds to extracorporeal bubble formation in the gill lamellae, and that a higher threshold near $\Delta P \approx$ 115-145 (TGP% 115-119) corresponds to bubble growth in the cardiovascular system. Swim-bladder over inflation is a problem for small fish only (Fiddler and Miller 1994). However, swim bladder inflation may influence the fishes responses for hydrostatic compensation. No specific relationships between GBT signs and mortality are described.

Dawley, et al. (1976) observed that emboli in brachial arteries, gill filaments, and heart were rarely observed on live subsamples but were prevalent on dead fish, indicating these signs are directly associated with the death of the animal. At 115% of saturation in shallow tanks substantial (80%) mortality occurred within 60 days of exposure. In deep tanks substantial mortality (25%) occurred at 127% saturation after 7 days of exposure.

The NMFS "working group" reported and listed thresholds for sign of GBD. A variety of ancillary factors, such as depth, and temperature, would be expected to influence these thresholds. No specific correlation between thresholds and subsequent mortality is described.

NMFS "working Group; Signs of Gas Bubble Trauma in Salmonids		
Sign	TDG (0 ft)	Age/class
Cardiovascular bubbles	~110%	Juv @ Adults
Subdermal emphysema including mouth	~110	Juv. @ Adults
Latteral Line Bubbles	~110%	Juv @ Adults
Swimbladder overinflation	~103%	<= Juv.
Swimbladder rupture	~110%	<= Juv
Exopthalmea, ocular lesions	??, 102%	Juv. @ Adult
Loss of swimming ability	~106%	Juv.@ Adults
Reduced Growth	102-105%	Juv.
Immuno Suppression	>108%	Juv. @ Adult
Reduced Saltwater Adaptation - Seep Shrimpton 1983		Juv.

Field Studies:

The physiological relationship between depth compensation and bubble formation, and the potential problems with gas bubble trauma is well described, and illustrated in laboratory studies. Field studies using live cage or deep tanks may provide an indication of the potential influence of "sounding" to, at or below hydrostatic compensation depth, avoid the effects of elevated gas pressure.

Review of fixed depth, volition live cage, and deep tank studies described during the previous spill program review suggested a threshold of mortality near 120% TGP. This finding is consistent with the review of Weitkamp and Katz (1980) and the research by Weitkamp (1977) that juvenile salmon appear to spend adequate time at adequate depths to avoid acute mortality at about 120-125% TGP.

Fish under field exposures may experience intermittent exposure to elevated levels of gas pressure due to changes in depth. The live cage studies do not report internal signs of GBD. Weitkamp reported external signs of GBD. At levels approaching 125% TGP signs of gas bubble disease were apparent in 38% of the fish in 0-4 meter volition cages. At 125% or higher there was a marked increase in mortalities of fish which spent 8 hours a day or more within 1 meter of the surface.

The results of Weitkamp (1976?) have been identified as "highly significant that no fish were killed in the surface to 4 meter cages in a series of three test at total gas pressures of 120-128% saturation". It is also "highly significant" that mortality has been observed in other deep volition live cage studies. Previously identified conclusions that juveniles will remain at depth adequate to compensate for total gas pressures up to 126% saturation appear to be hopeful. Weitkamp (1977) concludes that below a depth of 1 meter significant mortality can only be expected to occur in exposure of 20 days at TGP levels of 123% or greater, above 125% for any appreciable period results in significant risk of mortality (WeitkamP 1994, personal communication). Limited studies exist at TDG levels below 120%, and conclusions that field studies indicate these are "safe" levels for any exposure period are extrapolations.

Selected Deep Volition cage bio-assays (Weitkamp and Katz, Dawley-Backman)		
Source	**TGP - Exposure**	**% Mort.**
Dawley 1986	110% - 5d	1%
Ebel (1969)	118% - 92 D	6%
Ebel 1971	127 - 7d	45-68%
Ebel 1971	130 - 7d	58%
Beingen and Ebel (1969)	135 - ?/	28%
Ebel 1969 (Coho)	130 - 8d	16%

Avoidance / Depth compensation:

It has been generally accepted that fish are not able to detect supersaturation and avoid it. However, several reports indicate that this theory may not be valid for all condition (Weitkamp and Katz (1980). Ebel (1971) found that juvenile chinook salmon held in 0-4.5 meter volition cages suffered much higher mortality from GBD that did fish forced to remain in deeper water (3-4 m) suggesting that these fish were unable to detect or were unwilling to avoid, supersaturation. Similarly, Weitkamp's volition age experiments demonstrated fish in the deeper volition cages suffered less mortality than those confined to shallow cages indicating a mechanism of avoiding the impact of GBD at the surface. Neither of these studies demonstrated a behavioral response due to elevated TGP.

Dawley, et al. (1976) observed that chinook detected and avoided elevated TGP in deep tanks after 3 days exposure, but steelhead did not. Both Chinook and Steelhead showed vertical movement "sounding" as an indicator of avoidance to supersaturation. However, the avoidance behavior was not sufficient to prevent mortality. The avoidance behavior changed when turbidity was introduced, i.e. fish remained in shallow water. Depth distribution also changed from night to day (Dawley et al., 1975).

Stevens et al (1980) observed avoidance in Sockeye and Chinook smolts and Rainbow trout. Steelhead did not consistently avoid elevated TDG and suffered higher mortality. The salmon and rainbow trout generally avoided 125-145% TGP, but not 115% TGP. The response by sockeye occurred more rapidly than other species, in successive tests high levels were avoided within 2-3 hours.

Fiddler and Miller (1994) suggest that gas bladder overinflation provides a mechanism for some fish to use water depth to compensate for elevated levels of TDG. Fiddler and Miller cited Shrimpton et al (1990) who established that small fish exposed to elevated TDG would descend in the water column to a level of depth compensation or greater. These studies also found that as a consequence of not experiencing gas bladder overinflation, as fish grew in size, there was less and less tendency to use depth as a means of compensation.

Two "common sense" test have been cited during this review process. First, that elevated levels of GBD above 115-120% have routinely been observed in the Columbia: so that if fish died due to GBD as reported there would be no fish. Since we have fish this indicated depth or other means of compensation. Firstly, we do not know the mortality rate associated with GBD. Some level of depth compensation occurs due to natural travel depths of juveniles and adults, which are not well defined. However, these no quantifiable observations do not indicate detection and avoidance. If detection and avoidance were occurring the observed acute mortality would not have occurred and we would not expect to observed internal and external signs of GBD. External and internal signs of GBD are apparent in recent sampling efforts at low to moderate levels of TDG.

The effectiveness of passive, or active, avoidance and depth compensation can not be indicated with the information presented or discovered in literature review.

DEPTH DISTRIBUTION IN RIVER:

Depth distribution is important to a determination of the potential effect of hydrostatic compensation.

Dawley et al (1975) report that of the fish caught in the upper 3.7 meeters, that 80% of the Chinook and Steelhead trout (combined) were in the upper 1.8 meters of the river, and that 46% of the Chinook and 29% of the Steelhead were caught between the surface and 1.8 meters.

Vertical distribution of juvenile salmon and steelhead caught in the forebay of Lower Monumental Dam (1973), Dawley et al (1957)

	Chinook		Steelhead	
Depth (m)	N	%	N	%
0-3.7	143	58	441	36
3.7-7.3	63	26	291	24
7.3-11	19	8	189	15
11-15	4	2	106	8
15-18	3	1	61	5
18-22	6	2	62	6
22-26	2	1	32	2
26-29	5	2	48	4

Weitkamp and Katz (1980) discuss several studies to provide information concerning the depth distribution of migrating juvenile salmonids in the Columbia River. Smith (1974) found 56% of juvenile chinook salmon and 36% of juvenile steelhead were taken in the upper 4 meeters of the water collum, 46% of the

Chinook and 28% of the steelhead were collected above 2 meeters, and 19% of the chinook and 8% of the steelhead were above 1 meeter. Results appear similar to Dawley (1975) indicating a significant portion of the population residing within 2 meters of the surface. However, Weitkamp (1974) in a different study found less than 5% of the chinook salmon were collected above 2 meters, 20% of the coho, and 10% of the steelhead were collected above 2 meters. Blaham (1974) and Blaham et al (1976) approximate that 72% of the fish encountered with sonar transducers were between 0.9 and 2.1 meters deep.

The review by Weitkamp and Katz (1980) provides results similar to those reported by Dawley (1975), however these studies are interpreted differently by ODFW. The ODFW (letter July 8, 1994) reports that according to studies conducted by Smith (1974) Weitkamp (1974), Blahm (1974) and Blahm et al. (1974) significant numbers of juvenile salmonids occupy water deeper than 4 meters in Columbia Reservoirs.

The depth distribution studies reviewed did not provide measure of TDG, and would likely not have provided information on whether fish were actively avoiding elevated TDG levels. The fish could also be expected to exhibit diurnal depth migration patterns. The NMFS biological opinion notes that fall chinook juveniles rear in backwaters and shallow water areas through mid-summer prior to smolting. In personal communications Weitkamp (1994) suggest that the live cage bio-assays may indicate a level of TDG that would not protect the juvenile fall chinook juveniles rearing in shallow backwaters. However, Dual (1994) also in personal communication acknowledged the concern, but observed that they have not seen significant (10%) signs of GBD in juvenile fall chinook monitored below Priest Rapids or Bonneville.

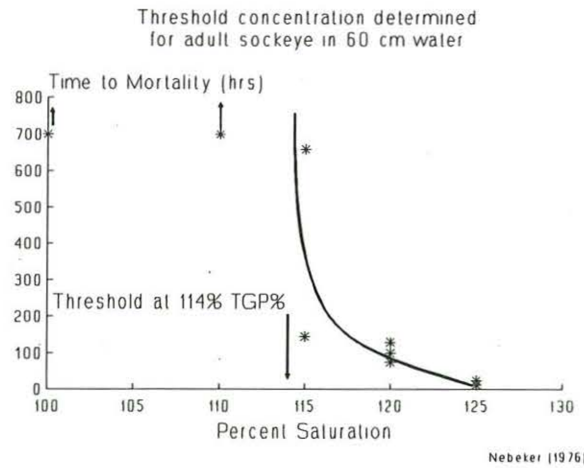
Based on the observed depth distribution data reported it would not appear appropriate to conclude that fish natural spend adequate time at depths great enough to compensate for all potential levels of TDG.

ADULTS:

Nebecker et al (1976) determined a lethal threshold for adult sockeye from data illustrated and other unpublished data near 114% TGP. No lesions of gas bubble disease were observed in fish held at 110% saturation and the observed behavior was similar to that of fish held at 100% saturation. Fish held at 115% saturation exhibit external lesions and bacterial and fungal infections became apparent in tissues devitalized by these lesions. Some of the fish that died exhibited fungal infections but no external emphysema was observed.

Based on the results of their studies, Nebecker et al (1976) concluded that Sockeye migrating through the Columbia River would probably not be affected by GBD if TDG levels remained below 115%. If salmon were swimming in deeper water hydrostatic compensation would provide an additional safety factor.

Time to mortality in shallow water exposure (Bouck et al 1976)			
	Adult	**Smolt**	**Parr**
115	**309**	**154**	**125**
120	**18**	**17**	**24**



Bouck, et al. (1976) also evaluated the time to 20% mortality for adult and other life stages for salmonids. Prolonged exposure was required to reach significant mortality at 115% TGP, 125% was lethal after 12 hours. Based on their analysis of adults a threshold of 115% is identified for significant mortality. Depth compensation would provide additional protection.

Gas bubble mortality in adults salmonids was reported by Westgard (1962) and in Weitkamp and Katz (1973) in the McNary Spawning Channel. A nitrogen saturation of 119% was measured in the area of the channel where fish spent considerable time.

Weitkamp and Katz (1973) also report a substantial mortality of adult salmonids below John Day Dam in 1968. This mortality was attributed to elevated gas levels by Beiningen and Ebel (1970) in Weithkamp and Katz. Dissolved nitrogen concentrations during the mortality ranged from 123 to 143% saturation. It was estimated that over 20,000 Summer Chinook were missing in this area.

Weitkamp and Katz (1973) also discuss Bouck (1979). Fish had been naturally exposed to water of 118% of saturation or higher. Fish were held for 44 days in shallow water of near 100% saturation. At least 13 of 129 fish had macroscopic bubbles in the skin or fins when they were collected. For fish held in temperatures of 10 and 16 C, mortality was 19 and 32% respectively. At these temperatures 35 and 29% of the fish developed blindness in at least one eye. Bouck concluded that blindness and latent mortalities may be important. Higher mortalities occurred at higher temperature (> 20C) due to pathogenic bacteria.

Adults are forced to utilize restricted depths when entering and negotiating fishway dams. Radio tracking studies (Monan and Liscom (1973) in Ebel et al (1975) have shown that the amount of time adult salmon spend negotiating fishways can be substantial. For example, a group of spring migrant at Bonneville took from 4 to 57 hours through the fishways. However, Weitkamp (1973) reports (Beiningen (1973) as finding water is degassed within the top few weirs of the fishway. Exposure time and effect of stress from fish equilibrated to high gas levels entering fishways is not defined.

WHERE and WHEN to MEASURE:

The Corp of Engineers maintains a limited automated monitoring system within the lower Columbia River. These monitors provide the information available for determining compliance with the water quality standards. In recent meetings the COE suggested that additional monitoring stations may be added, and additional grab sampling would occur.

The Department will review all available monitoring data to determine compliance with water quality standards. Appropriate locations to measure compliance include those stations located approximately 1 to 1.5 miles below the tailrace.

Existing Monitoring Lower Columbia		
Location	**Fore-bay**	**Tailwater**
McNary	**2A, 1AR**	**1DL**
John Day	**1A**	**2 Grab**
The Dalles	**1A 1AR**	**NA**
Bonnyville	**1A**	**1 Grab**
Warrendale	**1A, 1AR**	
Scamania	**1A**	
Camash	**1A**	
Washougal	**1A**	
Wauna	**1A**	

Attachment D

ENVIRONMENTAL QUALITY COMMISSION

OF THE STATE OF OREGON

In the Matter of Rule 340-41-155 Relating to Total Dissolved Gas in the Columbia River	)))	STATEMENT OF NEED AND JUSTIFICATION OF TEMPORARY RULE

TO ALL INTERESTED PERSONS:

1. Effective May 16, 1994, the Environmental Quality Commission (EQC) is adopting Rule 340-41-155 relating to total dissolved gas in the Columbia River. (The new temporary rule is similar to another temporary rule adopted by the EQC on May 9, 1994, which was limited in duration to seven days.)

2. Statutory Authority: The EQC has authority to adopt rules, including water quality standards, under ORS 468.020 and 468B.048.

3. Need for Rule: The rule is needed to allow the U. S. Corps of Engineers to spill temporarily water over certain dams on the mainstem of the Columbia River. The purpose of these spills is an emergency operation aimed at assisting the outmigration of juvenile salmon.

The spills proposed by the U. S. Corps of Engineers would likely violate the state's instream water quality standards for total dissolved gases (TDG) in the Columbia River.

The rule would address this problem by temporarily raising the TDG standard subject to several conditions. The conditions include a requirement that the responsible federal agencies monitor the spills to determine the impact on beneficial uses.

4. Documents Relied Upon:

Columbia Basin Fish and Wildlife Authority. 1993. Dissolved gas review and 1993 summary. Fish Passage Center, Portland.

Dawley, Earl M. and Margaret A. Toner. 1994. Preliminary Proposal: Evaluation of the effects of dissolved gas supersaturation on fish and invertebrates in the mainstem Columbia and Snake Rivers. National Marine Fishers Service, Northwest Fisheries Science Center, Hammond.

Ebel, Wesley J., Howard L. Raymond, Gerald E. Monan, Winston E. Farr, And George K. Tanonaka. 1975. Columbia River supersaturation. Effect of atmospheric gas supersaturation caused by dams on salmon and steelhead trout of the Snake and Columbia Rivers. National Marine Fisheries Service, Northwest Fisheries Center, Seattle.

Edsall, Donald A. and Charlie E. Smith. 1990. Oxygen induced gas bubble disease in rainbow trout (Oncorhynchus mykiss). U.S. Fish and Wildlife Service, Fish Technology Center, Bozeman.

Fidler, L.E., and S.B. Miller. 1994. Draft report on British Columbia water quality guidelines for dissolved gas supersaturation. B.C. Ministry of Environment, Canada Department of Fisheries and Oceans, Environment Canada.

Jensen, J.O.T. 1988. Combined effects of gas supersaturation and dissolved oxygen levels on steelhead trout (Salmo gairdneri) eggs, larvae, and fry. Aquaculture 68:131-139.

Jensen, J.O.T., J. Schnute and D.F. Alderice. 1986. Assessing juvenile salmonid response to gas supersaturation using a general multivariate dose-response model. Canadian Journal of Fisheries and Aquatic Science 43:1694-1708.

Montgomery Watson. 1994. Task 5. Review of monitoring plans for gas bubble disease signs and gas supersaturation levels on the Columbia and Snake Rivers. Bonneville Power Administration, Portland.

National Council of the Paper Industry for Air and Stream Improvement, Inc. 1985. A literature review of the possible effects of gas supersaturation on aquatic organisms. NCASI Bulletin No. 476.

National Marine Fisheries Service. 1994a. Scientific rationale for implementing a spill program to increase juvenile salmon survival in the Snake and Columbia Rivers. National Marine Fisheries Service, Environmental and Technical Services, Portland.

National Marine Fisheries Service. 1994b. Biological Opinion. Consultation regarding 1994-1998 operation of the federal Columbia River power system and juvenile transportation program 1994-1998. National Marine Fisheries Service, Environmental and Technical Services Division, Portland.

Nebeker, Alan V., Donald G. Stevens and Richard K. Stroud. 1976. Effects of air-supersaturated water on adult sockeye salmon (Oncorhynchus nerka). Journal of the Fisheries Research Board of Canada 33:2629-2633.

Quan, E.L., and Mary Halliburton. 1979. Proposed water quality standards revisions. Oregon Department of Environmental Quality, Portland.

Raymond, Howard L. 1988. Effects of hydroelectric development and fisheries enhancement on spring and summer chinook salmon and steelhead in the Columbia River basin. North American Journal of Fisheries Management 8:1-24.

Steven, Donald G., Alan V. Nebeker and Rocky J. Baker. 1980. Avoidance responses of salmon and trout to air-supersaturated water. Transactions of the American Fisheries Society 109:751-754.

U. S. Environmental Protection Agency. 1986. Quality Criteria for Water (Gold Book). Office of Water Regulations and Standards, Washington.

Weitkamp, Donald E. 1977. Gas bubble disease of resident fish and juvenile salmonids in the Columbia River system. Ph.D. Dissertation, University of Washington, Seattle.

Weitkamp, Don E., and Max Katz. 1980. A review of dissolved gas supersaturation literature. Transactions of the American Fisheries Society 109:659-702.

5. Justification of Temporary Rule: See attached statement.

6. Documents are available for public review during regular business hours, 8 a.m. to 5 p.m., Monday through Friday, at the Department of Environmental Quality, 811 S. W. Sixth Avenue, Portland, Oregon 97204.

ON BEHALF OF THE
ENVIRONMENTAL QUALITY COMMISSION

JUL 2 0 1994
Date

Fred Hansen
Fred Hansen, Director

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July 21, 1994

Enviornmental Quality Commission
811 S.W. Sixth Ave.
Portland, OR

Dear Commissioners:

Today you are meeting to discuss the implications of a proposed controlled spill program designed to provide a survival advantage for outmigrating juvenile salmon in the Columbia River as they pass through the State of Oregon. There is a concern, that a by-product of spill -elevated gas levels, may adversely affect salmon. Part of the information being brought before you is a draft report on Gas Bubble Trauma (GBT) recently released by the National Marine Fisheries Service (NMFS).

This draft report is a draft in progress by a panel of scientists convened by the NMFS to address specific questions regarding GBT. We have not agreed as a group about the accuracy of the statements or data presented. As a member of that panel I have two primary concerns about your utilization of the unfinished report. The first is that the Panel has not completed the report. On this note I concur with Dr. Jerry Bouck , a fellow Panel member, in his note dated July 11, 1994. Dr. Bouck stated "the Panel neither delegated authority to finalize its report, nor was the Panel given the opportunity to review and approve the June 28 draft, before it was submitted to NMFS. The NMFS prematurely released the working draft.

The second concern is the context for the draft report and draft recommendations. The subject is controversial, subject to confusion, and easily missrepresented. For example a recent article in the Seattle Weekly by Cyrus Noe stated that "the panel recommended adherence of the 110 percent standard [in the Columbia river] or lower", which was not the case [emphasis added for clarity]. At the conclusion of the panel's meeting Dr. Chuck Coutant summarized the results in progress to the public. He indicated that people are free to misinterpret or misrepresent what the panel did, something that is beyond the Panel's control. Such is now occurring. Thus, I would like to provide you with additional framework comments to aid you in placing the unauthorized draft report into perspective and with a goal of diffusing or preventing further misinterpretations or misrepresentation.

The panel met very hastily under an extremely structured process, that included biased presentations from speakers and then a set of poorly chosen and written questions. This oriented the panel toward a stilted synthesis and an exclusive synopsis of laboratory studies. Thus, the relative relationship of GBT scientific knowledge to real-time riverine conditions was not presented nor summarized. For example, the group indicated under question 1 (b) that much is known about mortality of fish exposed in captivity, for certain gas levels, physiological conditions, and selected species, but 1(d) much less is known about the pathogenicity in the river system. Further, the study results summarized in a table in Question 2 are from laboratory studies. River study results summarized by Earl Dawley (Attachment

1) were not included in the table. It might be noted that the field investigations demonstrate that when the fish have the option of seeking a compensation level, they do so thereby avoiding the lethal effects of prolonged exposure to supersaturated gas.

Unfortunately, the comments and discussions by the panel during the public part of the meeting were not part of the NMFS-released report. The panel was very concerned about the need for additional in-river study and monitoring programs to determine the relationship, if any, between observed signs of GBT and increased risk to lethal or sub-lethal impacts on salmonids. I raised the issue that the current monitoring program does not evaluate the relationship of signs of GBT and survival. The current monitoring programs evaluates fish passing through a mechanical bypass system, which from a study design perspective is a different treatment. Numerous, passage problems have been identified with mechanical bypass systems, which are substantually different than the spill bypass. Thus, it is improper to suggest that the results of observations from one treatment can be extrapolated to a different treatment. Additionally, there was a concern over the accuracy and reliability of the biological monitoring observations, especially those associated with lateral line measurements. In the public part of the testimony it was evident that bubbles are often found in the absence of elevated gas levels and additionally there was a concern about the skill levels of the observers. Also, none of the observed signs were being measured relevant to survival. .

The relationships between the current 110% standard, proposed controlled spill, and elevated gas levels were not addressed by the Panel. The Panel recognized that fishery managers must weigh the benefits and risks for various options to pass fish and that GBT is but one of those factors. We recognized that water quality standards are often established to allow for a margin of safety . We wanted to reassure the managers that when gas levels are below 110% we believe that there is no need for direct biological measures for signs of GBT. The current standard is most relevant to hatchery rearing practices rather than in river situations because the laboratory studies upon which the standard was developed occurred in conditions similar to those found in fish hatcheries. Committee members, including myself, indicated their availablity to assist in the development and execution of study and evaluation programs to reduce future uncertainty associated with visual signs of GBT and survival.

We had before us information that indicated that, more often than not, gas levels exceed the current standard in the Columbia River Basin. Therefore, we recommended that a long term solution be found which may require serious consideration in changing the physical form of the existing hydro-facilities. We did not address the issue of spill, thus did not make any recommendation as to whether the program should or should not continue. This is a management/policy call beyond the specific tasks before the ad-hoc panel on GBT.

I am available if you have questions.

Thank-you

Thomas W. H. Backman Ph.D.
Senior Fishery Scientist

SALMONID HOLDING TESTS AT AMBIENT RIVER SATURATION

Researcher	Site	Species	Avg. TGP	Period	Death
	0-3 FEET DEPTH				
Ebel (1969)	Priest Rap. Dam	Coho	142%	< 8d	100%
Beiningen and Ebel (1969)	The Dalles Dam	Chin.(0's)	135%	--	98%
Ebel (1971)	Ice Harbor Dam	Chin.(0's)	130%	7d	100%
Ebel (1969)	Priest Rap. Dam	Coho	130%	< 8d	100%
Ebel (1971)	Ice Harbor Dam	Chin.(1's)	127%	7d	100%
Meekin and Turner (1974)	Rocky Reach Dam	Chin.(0's)	126%	3d	100%
		Steelhead	126%	3d	100%
		Coho	126%	3d	100%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	124%	3d	100%
Meekin and Turner (1974)	Wells Dam	Chin.(0's)	123%	7d	97%
		Steelhead	123%	3d	92%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	123%	20d	88%
			121%	10d	53%
Blahm et al.(1976)	Prescott Ore.	Chin.(0's)	120%	55d	80%
		Steelhead	120%	55d	80%
Ebel (1969)	Priest Rap. Dam	Chin.(1's)	118%	92d	7%
Dawley (1986)	The Dalles Dam	Chin.(1's)	110%	5d	9%
	3-5 FEET DEPTH				
Meekin and Turner (1974)	Wells Dam	Coho	125%	7d	18%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	124%	20d	30%
Meekin and Turner (1974)	Wells Dam	Chin.(0's)	123%	3d	92%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	123%	20d	1%
			121%	20d	0%
Dawley (1986)	The Dalles Dam	Chin.(1's)	110%	5d	2%
	4-6 or 5-7 FEET DEPTH				
Ebel (1971)	Ice Harbor	Chin.(0's)	130%	7d	53%
Meekin and Turner (1974)	Wells Dam	Chin.(0's)	123%	10d	25%
		Coho	125%	13d	0%
	6-9 FEET DEPTH				
Ebel (1969)	Priest Rap. Dam	Coho	142%	8d	70%
		Coho	130%	8d	5%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	124%	20d	1%
			123%	20d	1%
			121%	10d	0%
Ebel (1969)		Chin.(1's)	118	92d	2%

OPTIONAL FORM 99 (7-90)

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To Tom Backman. From Earl Dawley

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0-7 FEET OF DEPTH

Meekin and Turner (1974)	Rocky Reach Dam	Chin.(0's)	126%	30d	65%
		Steelhead	126%	30d	60%
		Coho	126%	30d	4%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	124%	20d	61%
			123%	20d	17%
			121%	10d	0%
Blahm et al.(1976)	Prescott Ore.	Chin.(0's)	120%	55d	11%
		Steelhead	120%	55d	6%

0-10 FEET OF DEPTH

Meekin and Turner (1974)	Rocky Reach Dam	Chin.(0's)	126%	21d	3%
		Steelhead	126%	21d	0%
		Coho	126%	21d	0%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	124%	20d	8%
			123%	20d	3%
			121%	10d	0%

0-13 or 0-18 FEET OF DEPTH

Beiningen and Ebel (1969)	The Dalles Dam	Chin.(0's)	135%	--	28%
Ebel (1971)	Ice Harbor Dam	Chin.(0's)	130%	7d	58%
Ebel (1969)	Priest Rap. Dam	Coho	130%	8d	16%
Ebel (1971)	Ice Harbor Dam	Chin.(1's)	127%	7d	45%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	124%	20d	0%
			123%	20d	0%
			121%	10d	0%
Ebel (1969)	Priest Rap. Dam	Chin.(0's)	118%	92d	6%
Dawley (1986)	The Dalles Dam	Chin.(1's)	110%	5d	1%

AVOIDANCE TESTS

Meekin and Turner (1974)	Chinook (0's)	>115%	lateral	Avoided
	Coho	>115%	lateral	None
McConnell and Davis(1975)	Chinook (0's)	130%	lateral	Avoided
	Steelhead	130	lateral	None
Dawley et al. (1975)	Chinook (1's)	130%	vertical	Avoided
	Steelhead	130%	vertical	None

Attention: Chris Rich

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
729 N.E. Oregon, Suite 200, Portland, Oregon 97232
Telephone (503) 238-0667
Fax (503) 235-4228

MEMORANDUM

TO: DISTRIBUTION

BH

FROM: BOB HEINITH, FISH PASSAGE SPECIALIST

DATE: JULY 18, 1994

RE: TRIBAL AND AGENCY SUMMER SPILL RATIONALE AND RISK ASSESSMENT

The document entitled, " Scientific Rationale for Implementing a Summer Spill Program to Increase Juvenile Salmonid Survival in the Snake and Columbia Rivers", was inadvertently distributed with several errors in the main section. On Page 4 there were both grammatical errors and one technical error, and on a few other pages there were grammatical errors. Please substitute the enclosed corrected document and discard the original. On behalf of the agency technical representatives who developed the document, I apologize for this inconvenience.

spcor.4

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
729 N.E. Oregon, Suite 200, Portland, Oregon 97232
Telephone (503) 238-0667
Fax (503) 235-4228

July 18, 1994

Honorable Barbara Roberts
Governor of Oregon
207 State Capitol
Salem, OR 93720

Honorable Michael Lowry
Governor of Washington
Capitol Office Building
Olympia, WA 98504

Dear Governor Roberts and Governor Lowry:

The river conditions for this summer's outmigrating juvenile fall chinook in the Columbia River Basin are very poor. At the same time, the 1994 summer migration represents one of the best in recent years in terms of the predicted abundance of juvenile salmon. Unfortunately, federal hydrosystem operators will not achieve the minimum flow targets specified in NMFS's biological opinion under the ESA. To maximize the survival of these important salmon, a comprehensive summer spill program must be and can be immediately and carefully implemented at each mainstem dam.

The enclosed spill program and risk assessment was developed by technical staffs of our Commission, the fishery agencies of Oregon, Washington, Idaho and the United States Fish and Wildlife Service. On behalf of our member tribes, I urge you and your state water quality agencies to take whatever steps are necessary to expedite this program.

Thank you for your immediate attention to this issue.

Sincerely,

Ted Strong
Executive Director

Enclosure

cc: F. Gary Smith, NMFS

SCIENTIFIC RATIONALE FOR IMPLEMENTING A SUMMER SPILL PROGRAM TO INCREASE JUVENILE SALMONID SURVIVAL IN THE SNAKE AND COLUMBIA RIVERS

By
Columbia River Inter-Tribal Fish Commission
Idaho Department of Fish and Game
Oregon Department of Fish and Wildlife
U.S. Fish and Wildlife Service
Washington Department of Fish and Wildlife

July 15, 1994

Overview

This document provides scientific justification for implementation of the attached 1994 summer spill programs at Corps of Engineers (Attachment 1) and Mid-Columbia PUD mainstem dams (Attachment 2) in the Columbia River Basin. It is the intent of these programs to substantially increase juvenile anadromous fish survival through the hydrosystem. The programs and supporting rationale and risk assessment were jointly developed by the combined technical staffs of the Columbia River Inter-tribal Fish Commission, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, and Washington Department of Fish and Wildlife (hereinafter fishery managers). Anadromous fish that will be protected by the spill programs include salmon stocks both listed and petitioned for listing under the Endangered Species Act, non-listed salmon stocks, and other anadromous stocks such as Pacific lamprey which are in serious decline. These programs will compliment other protection and restoration programs in the Columbia Basin.

The object of the summer spill programs is to achieve an 80% fish passage efficiency (FPE) objective at all Corps projects on the lower Snake and Columbia Rivers, and other passage efficiency goals at the various Mid-Columbia PUD dams (DFOP 1993). In accomplishing this, the fishery managers propose that the operation of the hydrosystem be managed so that an average of 120% or less total dissolved gas pressure be maintained in the river. Further, the fishery managers propose that the 120% criterion be measured well downstream of tailrace areas, after gas levels have had a chance to dissipate. In addition, because of problems with accurate measurement of gas levels, fishery managers recommend that up to an instantaneous reading of 125% total dissolved gas pressure be allowed to provide a reasonable margin of measurement error.

Based upon historical migration estimates (DFOP 1993), the fishery managers recommend that the spill program be implemented at all Corps run-of- river projects in the Snake and Columbia Rivers until August 31, 1994 to insure that the juvenile summer migration is protected (DFOP 1993). Duration of spill programs at individual mid-Columbia PUD dams will be determined by the various Coordinating Committees based upon ongoing FERC proceedings, settlements and stipulations.

These summer spill programs are partially in response to the apparent salmon stock collapse observed this year in Columbia River spring and summer chinook and expected to occur in fall chinook. From 1993 to 1994, adult spring chinook escapement to Bonneville Dam has decreased from 112,000 to less than 21,000 which is the previous all time record low. The trend is similar for adult summer chinook escapement which is projected to be less than 10,000 salmon at Bonneville Dam this year down from over 22,000 salmon in 1993 (TAC 1994). The predicted escapement of wild Snake River fall chinook adults at Bonneville Dam is 803 (Swartz 1994), the second lowest on record since 1986 and 41% of the 1986-93 average. Under these conditions, tribal ceremonial and subsistence harvest and non-treaty harvest have been severely restricted and in some cases, curtailed.

The stock collapse of Columbia River chinook is likely related to the continuation of extremely poor flow and migration conditions that occurred in 1992 (FPC 1993; Columbia River Water Management Group 1993-4), complicated by possible impacts of low ocean productivity resulting from El Nino conditions as noted by Johnson (1984), Ware and Thompson (1991), and Lichatowich (1993). Because the effects of ocean impacts cannot be controlled and federal agencies are either unwilling or unable to dedicate available storage in upriver reservoirs for flow augmentation, the fishery managers strongly recommend implementation of these spill programs. Spill is the only alternative left to reduce hydrosystem mortality, which could exceed 95% of juvenile summer migrants as documented during similar low flow years (Raymond 1979; Raymond 1988; Ebel et al. 1989).

Because 1993 basin summer and fall chinook adult escapement was relatively high under good environmental conditions, the relatively abundant 1994 subyearling progeny of these stocks must be afforded the best protection possible as they migrate downstream through the hydrosystem. Impacts to an abundant juvenile year class on stock viability can be substantial. Junge (1970), through use of a Ricker-type reproduction curve, demonstrated that a smolt kill of 50% reduced a stock by 60% whereas an adult kill of 50% would reduce a stock by 20%. Such losses on a relatively strong outmigrating year class could have severe if not irreversible consequences on stock abundance and diversity (Riggs 1986).

The fishery agencies and tribes have chosen a conservative approach to the implementation of the spill programs. Spill volume caps are provided to avoid exceeding either 120% daily average or 125% instantaneous total gas pressure criteria. Where possible, spill is confined to nighttime hours which reduces power and possible adult fish passage impacts. When it is not possible to confine spill to nighttime hours to achieve a 80% FPE, some daytime spill is proposed with caps to avoid impacts to adult passage. As will be discussed below, the fishery managers believe a 120% total gas pressure (TGP) criterion is conservative and will result in minimal impacts, if any, to juveniles and adults.

Through a comprehensive review of pertinent literature and extant river conditions, and based upon professional experience, the fishery managers have conducted the following risk assessment. This assessment carefully weighs the factors of various passage mortality rates and other impacts to summer migrating anadromous fish as they pass through the hydrosystem. Based upon this analysis, the fishery managers have concluded that controlled spill will substantially enhance the in-river survival of summer anadromous fish over other available alternatives.

Spill has been repeatedly demonstrated to be the most effective and safest means of project passage and is the only means to enhance survival without additional flow augmentation. Juvenile salmon that pass a project through spill have a significantly higher rate of project survival (98% point estimate) than fish that pass through turbines (85% point estimate). Specific mortality ranges are given later in this document. Without spill, the majority of juvenile chinook will pass through turbines since only 8-35% of summer migrants are guided and collected by mechanical bypass systems at Corps projects. Further, spill will improve survival and other impacts upon fish production by reducing delay of juveniles at the projects and reducing predator/prey interactions by dispersing predators in tailrace areas. And finally, spill for fish passage addresses the substantial scientific uncertainty associated with transportation of summer chinook juveniles, especially Snake River fall chinook.

Monitoring program

The extensive physical and biological monitoring program to assess the occurrence of gas bubble trauma (GBT) in both spring and early summer migrating juvenile and adult salmon at each dam will be continued for the remainder of the summer migration (DFOP 1993, appendices 4-13 and 4-14). Because sampling of internal tissues of juvenile salmon which have passed through mechanical bypass systems is of questionable value, this practice will not be continued. Instead, external symptoms will be monitored. It is imperative that the Corps of Engineers be more diligent and consistent in operating the physical monitoring system. Total gas pressure measurements should be taken at all dam forebays, with backup monitoring to allow for better and more consistent measurements. The 1994 DFOP includes criteria to allow for flexibility for adjustments in the spill program based upon the possible occurrence of GBT in both juveniles and adults.

Technical Basis for the Summer Spill Program

Spill has been shown to be the most biologically effective and safest means of project passage

Spill is not an "experimental measure", but has been shown to be the most effective management tool for improving passage survival of migrating salmon and steelhead at mainstem hydroelectric projects. Controlled spill has been implemented at mid-Columbia PUD dams since 1983 under the mid-Columbia Federal Energy Regulation (FERC) Commission Proceedings (Bodi 1986) and at Corps dams since 1989 under the 1989 Memorandum of Agreement to provide protection of juveniles until adequate functioning mechanical bypass systems have been installed. As previously stated, controlled spill to safely pass 80% of juvenile salmon migrants is the goal of this proposed spill program (DFOP 1993). Protocol for specific spill patterns for juveniles and adults at each dam is provided in the 1994 DFOP and represents years of model and field studies by the fishery agencies, tribes and dam operators. During the 1994 spring migration, controlled spill was implemented at all mainstem basin dams to increase juvenile survival.

Extensive studies at mainstem Columbia and Snake River dams have documented that juvenile mortality from turbine passage is much greater than spillway passage. Studies have shown that mortality from turbine passage ranges from 8-32% compared to only 0-4% for spillway passage (Tables 1 and 2). In studies of subyearling fall chinook at McNary, John Day, and Bonneville powerhouses I and II, turbine mortality ranged from 11-18%, while spillway mortality ranged from 0-4%. Although research investigating the magnitude of turbine passage impacts to adults which fallback through turbines is limited, mortality ranges from 22-51% for adult steelhead have been documented (DFOP 1993).

Juvenile mechanical bypass systems, are only able to guide and collect 8-35% of summer juvenile migrants (Ceballos 1992; Gessel et al. 1990; 1991; Ledgerwood et al. 1988;1991). Mortality and injury rates to subyearling migrants undergoing passage through mechanical bypass systems can exceed that from spillway passage, particularly at transportation dams due to additional delay, handling, and stress. Bypass system mortality of subyearling chinook at McNary Dam during 1992, a similar low flow year as 1994, ranged from 4-6% (WDF 1992). During peak migration periods in 1992, mortality rates through the McNary mechanical bypass system approached 9%, chiefly because of poor water quality (WDF 1992). Despite a new bypass system completed for the 1994 migration, recently an estimated 50,000 juvenile migrants were lost at McNary Dam in only a few days due to poor water quality conditions in the mechanical bypass system (Filardo 1994). WDF (1992) found that subyearling chinook descaling from travel through juvenile bypass systems during 1988-92 ranged from 1.6 to 21%. Available comparative studies between Lower Granite spillway, turbine and mechanical bypass systems indicate that smolts which passed through the dams via the spillway suffered the least from both partial descaling (5.8%) and severe descaling injuries (1%) (Park and Achord 1987). Unfortunately, the recently installed mechanical bypass systems at Little Goose, Lower Monumental and McNary Dams have never been adequately evaluated for specific impacts to subyearling migrants (Barilla 1993). The fishery agencies and tribes have never supported operation of these systems for the migration at large without adequate evaluation.

Spill will improve survival of fish by reducing delay of juveniles at the projects and reducing predator/prey interactions and reduce exposure to high levels of dissolved gas, and reduce residualism

Spill will improve survival of fish by reducing delay of juveniles in forebays and tailraces where predator populations and predation rates are highest. Spill can greatly reduce delay of smolts in forebays as has been observed at The Dalles Dam (Snelling 1994). Spill establishes a large flow with increased velocity that disperses predators from the forebay and tailrace areas thus reducing predator/prey interactions (Faler et al. 1988).

Smith (1982) found that because subyearling salmon travel passively downstream, higher velocities provided by spill would save these juveniles critical energy reserves necessary for parr to smolt transitions, as well as move them more quickly through the river. This in turn would reduce migrant susceptibility to predators and disease, and would reduce the likelihood that smolts would revert to freshwater parr (non-migratory status) by excessive delay in traversing the hydrosystem.

Spill addresses the substantial uncertainty associated with the Corps transportation program

Spill at transportation collector projects addresses the uncertainty associated with the juvenile salmon transportation program by spreading the risk between in-river passage and transportation (Ad Hoc Transportation Review Group 1992; Mundy et al. 1994; FERC 1994). As recently concluded by an expert team of independent scientists, "[t]ransportation alone, as presently conceived and implemented is unlikely to halt or prevent the continued decline and extirpation of listed salmon in the Snake River Basin"...and that "available evidence is not sufficient to identify transportation as either a primary or supporting method of choice for salmon recovery" (Mundy et al. 1994). This is consistent with the findings of Raymond (1988) and Congleton et al. (1985) who found that transportation had been ineffective in reversing the decline of runs of spring and summer chinook and steelhead returning to the mid-Columbia and Snake rivers during 1962-84. Evidence provided by the Ad Hoc Transportation Review Group (1992) indicated that transportation may have reduced survival of wild Snake River spring and summer chinook to spawning grounds. Adult homing impairment and disruption of freshwater life histories are two key problems attributed to the juvenile transportation process (TRG 1992, Mundy et al. 1994; Heinith 1993).

The USFWS (1993), Steward (1993) and Congleton et al. (1985) noted that handling in the transportation process may greatly increase stress and mortality to juvenile migrants, particularly when water quality conditions deteriorate and may override any perceived benefits of transportation. For example, Mundy et al. (1994) noted that in 1977, an extremely low flow year similar to this year, transportation treatment and control fish died equally because no adults returned from the study. The cause was likely indirect or delayed mortality from screen guidance, collection, holding, transportation, and concentrated release into high predation areas. This is a particular problem for summer subyearling migrants as they are usually trucked instead of barged, because few of them are collected at mainstem dams, and operation of barges on this basis is not cost-effective. Numerous studies have documented that trucking migrants is even more stressful than barging and that stressed

migrants are highly susceptible to predators at the time of release (TRG 1992; Congleton et al. 1985; Mundy et al. 1994; USFWS 1993).

No transportation studies have been conducted on subyearling chinook salmon at Snake River dams. Transport studies of subyearling chinook at McNary Dam in 1986, 1987, and 1988 were conducted under no spill conditions. In addition, the control fish were released in small numbers from the old bypass outfall. They were the only fish released from the bypass because all fish collected, except for the controls, were transported. We suspect that predation rates on the control releases were very high because of the no-spill and low flow conditions in the tailrace that occurred during these studies. Hence, the results of these studies are not applicable to subyearling chinook salmon passing the project under spill conditions.

It has consistently been the position of the fishery managers that transportation is an interim and experimental mitigation program that cannot substitute for the provision of adequate in-river passage conditions provided by flow and spill. A Federal Energy Regulatory Commission (FERC) administrative law judge upheld this position in a 1992 ruling against transportation at two mid-Columbia dams and ordered immediate spill at a 70% and 50% FPE level for spring and summer migrants, respectively, until completion of fish bypass systems (FERC 1992). On May 27, 1994, fully taking into account voluminous technical information on dissolved gas complied over a two year period, FERC ordered implementation of this spill program at Priest and Wanapum dams (FERC 1994). On July 1, 1994 the Washington Department of Ecology granted an administrative order modifying the state water quality criteria so that the FERC summer spill program could be implemented (Attachment 3).

Spill protects critical life history diversity

The Columbia River juvenile summer outmigration is comprised of a mosaic of many stocks from all basin tributaries and mainstem reach areas. Within each stock of the migration, multiple life histories within a single salmon stock have evolved over millions of years to provide stock resiliency and stability for dealing with different types of environments (Winemiller and Rose 1992). Because of these different life histories, which include diverse migration timing and the use of different spawning and rearing areas, there is a reduced chance that a single or multiple environmental disturbances, such as a low flow year, will impact overall stock fitness and diversity (Schluchter and Lichatowich 1977).

Spill and associated in-river migration allow adequate time for rearing and physiological maturation of subyearling chinook stocks to reach a proper size prior to saltwater entry to survive (Mundy et al. 1994; CBFWA 1991). This has been confirmed by numerous studies involving scale analysis (Schluchter and Lichatowich 1977; Lichatowich 1976; Reimers 1973) and physiological studies examining osmoregulatory processes (Wagner et al. 1969; Ewing and Birks 1982; Wedemeyer et al. 1980). Interruptions to the critical freshwater rearing life history stage, such as that imposed by the Corps transportation program and selective mortality from turbine passage, may have serious implications to stock survival and overall production characteristics such as adult age at maturity and

fecundity (Groot and Margolis 1991; Nicholas and Hankin 1989; Thompson 1959, Schluchter and Lichatowich 1977;1993).

Studies clearly show that adult survival is enhanced with spill

The historical record clearly demonstrates that better adult returns of summer and fall chinook had occurred during years when juveniles migrated under high flow and high spill conditions. Raymond (1988) reported that the lack of spill and installation of additional turbine units in the basin were primarily responsible for extremely low smolt to adult return rates of mid-Columbia summer chinook. Hilborn (1993) demonstrated a strong relationship between flow and adult survival of Priest Rapids Hatchery fall chinook during 1977-87 similar to the relationship found for Snake River wild spring/summer chinook by Petrosky (1991). In both analyses, the highest survivals occurred in 1982, a year of high flow and spill. In contrast, 1977 was characterized by low flows and no spill. Under these conditions, estimated mortalities in excess of 95% of the outmigration at large occurred, based upon analysis of adult returns in subsequent years. In a recent analysis of the 1994 controlled spring spill program on adult passage, the Fish Passage Center found that there was no impact on adult passage based upon interdam conversion rates for adult spring chinook (DeHart 1994, Attachment 4).

Model results indicate that in-river survival will be improved

Model results demonstrate that the in-river survival of fall chinook will be enhanced by the proposed spill program. Using the FLUSH Model developed by the state fishery agencies and tribes, the in-river survival of Snake River fall chinook was estimated under various flow and spill options (Attachment 5). The analysis shows that with the flows proposed by the NMFS and 80% FPE spill at each project, in-river survival of Snake River fall chinook to below Bonneville Dam would be increased by 61% from 1.8 to 2.9%. This improvement in survival will likely increase future adult returns and help prevent additional declines of Snake River fall chinook and mid-Columbia summer chinook and other anadromous stocks.

Studies show that juveniles and adults can tolerate dissolved gas levels that will occur as a result of spill

Susceptibility of juvenile salmon to gas bubble trauma (disease) depends on a number of important factors ancillary to total gas pressure. These factors must be considered when evaluating possible gas bubble trauma to the summer migration at large. Based upon the past information, lower summer flows and resultant lower volumes of spill are not expected to result in gas bubble trauma especially at flows projected to occur this year (Columbia River Water Management Reports). Physical factors include: water temperature and total dissolved particulates (Jensen et al. 1986; Alderdice and Jensen 1985) and atmospheric pressure (Jensen et al. 1986; Alderdice and Jensen 1985). Biological factors include: size, species, genetic composition and physiological condition of the fish (Jensen et al. 1986; Alderdice and Jensen 1985) and proximity and length of exposure to total gas pressure (Weitkamp and Katz 1980).

There are also behavioral factors that allow salmonids to withstand what otherwise might be harmful levels of total dissolved gas. Juvenile and adult salmonids have been documented to sound in the natural environment and achieve hydrostatic compensation, thus avoiding impacts of elevated levels of total gas pressure (Weitkamp and Katz 1980; Weitkamp 1976;1977; Gray and Haynes 1977). Knittel et al. (1980) and Weitkamp and Katz (1980) reported that juvenile salmon could recover from symptoms of gas bubble trauma in 30 minutes to 2 hours time by sounding. Intermittent exposure may increase the level of gas supersaturation fish are able to tolerate because it increases the time over which a specific exposure accumulates. It also provides an opportunity for recovery to occur, particularly if it is accompanied by depth compensation. The effects of intermittent exposure on tolerance to supersaturation has been demonstrated by Meekin and Turner (1974), Blahm et al. (1976), and Bouck (1980). Bouck noted that, "..[f]ish in deeper water or exposed intermittently are least susceptible (to GBT) if susceptible at all."

Several studies have been conducted in the laboratory and the field under various depth and dissolved gas levels to determine the effects of depth compensation for salmonids in supersaturated water (Table 3; DFOP 1993). The most relevant studies were the volitional live cage studies conducted in-situ at Wells Dam (Meekin and Turner 1974), and Rock Island Dam (Weitkamp 1976) where fish were allowed to sound to avoid impacts of supersaturation (Table 3).

Depth of the live cages extended from the surface to 3.1-4 meters below the surface. Meekin and Turner (1974) also held fish in cages at variable depths from surface to 1, 2, 3, and 4 meters. These studies indicate that the effects of hydrostatic compensation due to depth is as predicted by theory and that when given the opportunity, that juveniles will remain deep enough to compensate for total gas pressures up to 126% saturation. It is highly significant in Weitkamp's study that no fish were killed in the surface to 4 meter cages in a series of three tests at total gas pressures of 120-128% saturation. It should be noted that even in the surface to 4 meter cage, fish are confined to shallower water than they normally occupy in the reservoirs (Smith 1974; Weitkamp 1974; 1977; Blahm 1974; Blahm et al. 1976).

Toner (1993) examined salmonids, resident fish and invertebrates for signs of GBT below Bonneville Dam by seines and other field sampling gear. During high spring spills which caused total gas levels to reach 128% saturation, she found that external signs of GBT were rare. Less than 1% of chinook salmon and resident fish showed signs and no evidence of GBT was noted in sampled invertebrates.

1994 NMFS Dissolved Gas Panel Report

Unfortunately, the National Marine Fisheries Service prematurely released a draft report by a panel of dissolved gas experts before all panel members could concur with the contents of the report (Backman 1994; Bouck 1994; Attachment 6). The current draft report should be disregarded. The NMFS should retract the draft report and a final report should be issued in which all panel experts can concur. This was the intent of the panel, and was their charge by the NMFS.

Summary and Recommendations

Based upon the risk analysis performed above which considered the best available and pertinent scientific literature and data, current river conditions, and professional judgement, the fishery agencies and tribes strongly recommend immediate implementation of the above controlled spill program to protect migrating juvenile summer and adult anadromous fish populations as they traverse the Columbia Basin hydrosystem. In order to implement this program, we also recommend a modification of Oregon's and Washington's water quality criteria to allow total dissolved gas levels to reach a daily average of 120% saturation, or an instantaneous measurement to reach up to a 125% saturation level. We recommend that the spill program and modifications to the existing total dissolved gas standard be implemented until August 31, 1994 to allow protection of summer migrants through the mainstem Snake and Columbia Rivers.

We also strongly encourage the Oregon Environmental Quality Commission and the Washington Department of Ecology to direct hydrosystem operators to expedite investigation and installation of structural modifications at dams, such as spillway deflectors. Addition of these modifications will further protect remaining anadromous stocks passing through the hydrosystem by establishment of better in-river water quality. This is particularly important for control of total dissolved gas in normal and high flow years, and when the operation of dam powerhouses, even without spill, still results in elevated levels of dissolved gas being discharged into the river (Figure 1).

Tables 1-3
Figure 1
Attachments 1-5

REFERENCES

Alderdice, D.F.,and J.O.T. Jensen. 1985. Assessment of the influence of gas supersaturation on salmonids in the Nechako River in relation to Kemano completion. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1386. 48 pages.

Barilla, T. Research coordinator for the Walla Walla District, United States Army Corps of Engineers. November 22, 1993. Personal communication.

Blahm, T.H. 1974. Report to U.S. Army Corps of Engineers. Gas supersaturation research. Prescott Facility-1974. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Blahm, T.H., R.J. McConnell, and G.R. Snyder. 1976. Gas supersaturation research, National Marine Fisheries Service Prescott Facility. Pages 11-19 in Fickeisen and Schneider (1976).

Bodi, F.L. 1986. Restoration under the Federal Power Act. Environmental Law. Volume 16. Number 3. Pages 556-581.

Bouck,G.R. 1980. Etiology of gas bubble disease. Transactions of the American Fisheries Society. Volume 109. Pages 703-707.

Brege. D.A., S.J. Grabowski, W.D. Muir, S.A. Hirtzel, and S.J. Mazur. 1992. Studies to determine the effectiveness of extended traveling screens and extended bar screens at McNary Dam, 1991. Report to the United States Army Corps of Engineers, Contract DACW68-84-H-0034. By the Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington. 32 pages plus appendices.

Ceballos, J.R. 1992. FGE estimates for BPA CRiSP model runs. March 31, 1992 memorandum to F/NWO3 Operations Branch files. National Marine Fisheries Service. Portland, Oregon. 4 pages.

Ceballos J.R., S.W. Pettit, J.L. McKern, R.R. Boyce, and D.F. Hurson. 1993. Fish Transportation Oversight Team Annual Report-FY 1992. Transport operations on the Snake and Columbia Rivers. National Marine Fisheries Service, Portland, OR.

Columbia Basin Fish and Wildlife Authority. 1991. The biological and technical justification for the flow proposal of the Columbia Basin Fish and Wildlife Authority. Portland, Oregon.

Columbia Basin Tribes and Fishery Agencies. 1993. Detailed fishery operating plan with 1994 operating criteria. Fish Passage Center, Portland, Oregon.

Columbia River Water Management Reports. Water Years 1982-1992. By the Columbia River Water Management Group. North Pacific Division, United States Army Corps of Engineers. Portland, Oregon.

Columbia River Water Management Group. 1993 and 1994. Columbia River Water Management Reports for 1992 and 1993. North Pacific Division. United States Army Corps of Engineers. Portland, Oregon.

Congleton, J.L, T.C. Bjornn, B.H. Watson, J.I.Irving, and R.R. Ringe. 1985. Effects of handling and crowding on the stress response and viability of chinook salmon parr and smolts. By the Idaho Cooperative Fishery Research Unit. Department of Fish and Wildlife Resources. University of Idaho. Moscow, Idaho. To Bonneville Power Administration. Project 82-5. Contract DE-AC79-83BP11196. Portland, Oregon.

Ebel W.J. 1969. Supersaturation of nitrogen in the Columbia River and its effects on salmon and steelhead trout. National Marine Fisheries Service Fishery Bulletin 68:1-11.

Ebel W.J. 1971. Dissolved nitrogen concentration in the Columbia and Snake rivers in 1970 and their effect on chinook salmon and steelhead trout. National Marine Fisheries Service Special Scientific Report Number 646.

Ebel, W.J., C.D. Becker, J.W. Mullan, and H.L. Raymond. 1989. The Columbia River-toward a holistic understanding, p. 205-219. In D.P. Dodge [ed.] Proceedings of the International Large River Symposium. Can. Spec. Publ. Fish. Aquat. Sci. 106.

Ewing, R.D. and E.K. Birks 1982. Criteria for parr-smolt transformation in juvenile chinook salmon (Oncorhynchus tshawtscha). Aquaculture. Volume 28. Pages 185-194.

Faler, M.P., L.M. Miller, and K.I. Welke. 1988. Effects of variation in flow on distributions of northern squawfish in the Columbia River below McNary Dam. North American Journal of Fisheries Management 8:30-35.

FERC. 1992. Initial decision of Judge Stephen Grossman. Project Number 2114-024. Docket Number E-9569-003 (Grant County Phase). Washington, D.C. 27 pages.

FERC. 1994. Order on interim license conditions. Project Number 2114-024. Docket Number E-9569-003 (Grant County Phase). Washington, D.C. 19 pages.

Filardo, M. Chair, Fish Passage Advisory Committee, Portland, OR. July 18, 1994. Personal Communication.

FPC (Fish Passage Center). 1994. Fish Passage Center 1993 annual report. Columbia Basin Fish and Wildlife Authority, Portland, Oregon.

Gessel, M.H., D.A. Brege, B.H. Monk, and J.G. Williams. 1990. Continued studies to evaluate the juvenile bypass systems at Bonneville Dam- 1989. Report to the United States Army Corps of Engineers, Delivery Order E8689095. By the Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington. 20 pages plus appendices.

Gessel, M.H., J.G. Williams, D.A. Brege, and R.F. Krcma. 1991. Juvenile salmonid guidance at the Bonneville dam second powerhouse, Columbia River, 1983-1989. North American Journal of Fisheries Management. Volume 11. Pages 400-412.

Gilbreath, L.G., E.M. Dawley, R.D. Ledgerwood, P.J. Bentley, and S.J. Grabowski. 1993. Relative survival of subyearling chinook salmon that have passed Bonneville dam via the spillway or second powerhouse turbines of bypass system: adult recoveries through 1991. Annual report submitted to the U.S. Army Corps of Engineers. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, Washington.

Giorgi, A. and L. Stuehrenberg. 1988. Lower Granite pool and turbine survival study, 1987. Annual report submitted to the Bonneville Power Administration. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, Washington.

Gray, R.H. and J.M.Haynes. 1977. Depth distribution of adult chinook salmon (Oncorhynchus tshawytscha) in relation to season and gas-supersaturated water. Transactions of the American Fisheries Society. Volume 109. Pages 755-759.

Groot, C. and L. Margolis (eds.). 1991. Pacific salmon life histories. UBC Press, University of British Columbia, Vancouver, British Columbia. 564 pages.

Heinith, R. 1993. Affidavit in support of the Yakama Indian Nation in NRIC et al. v. NMFS. United States District Court for the District of Oregon. Case Number CV-93-469-MA.

Heinle, D.R. and F.W. Olson. 1980. Survival of juvenile coho salmon passing through the spillway at Rocky Reach Dam. CH2M Hill Report to Chelan County PUD, Washington.

Hilborn, R., R. Donnelly, M. Pascual, and C. Coronado-Hernandez. 1993. The relationship between river flow and survival for Columbia River chinook salmon. Draft report to the Bonneville Power Administration, Portland, Oregon.

Holmes, H.B. 1952. Loss of salmon fingerlings in passing Bonneville dam as determined from marking experiments. Unpublished manuscript. U.S. Fish and Wildlife Service.

Iwamoto, R.N., W.D. Muir, B.P. Sanford, K.W. McIntyre, D.A. Frost, and J.G. Williams. 1993. Survival estimates for the passage of juvenile chinook through Snake River dams and reservoirs. Annual report submitted to the U.S. Army Corps of Engineers. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Jensen, J.O.T., J. Schute and D.F. Alderdice. 1986. Assessing juvenile salmonid response to gas supersaturation using a general multivariate dose-response model. Canadian Journal of Fisheries and Aquatic Sciences. Volume 43. Pages 1694-1709.

Johnsen, R.C. and E.W. Dawley. 1974. The effect of spillway flow deflectors at Bonneville Dam on total gas supersaturation and survival of juvenile salmon. Final report submitted to U.S. Army Corps of Engineers.Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Johnson, S.L. 1984. The effects of the 1983 El Nino on Oregon's coho and chinook salmon. Oregon Department of Fish and Wildlife. Information Reports. Number 84-8. Portland, Oregon.

Junge, C.O. 1970. The effect of superimposed mortalities on reproductive curves. Fish Commission of Oregon Research Reports. Volume 2. Pages 56-63.

Knittel, M.D., G.A. Chapman and R.R. Garton. 1980. Effects of hydrostatic pressure on steelhead survival in air-supersaturated water. Transactions of the American Fisheries Society. Volume 109. Pages 755-759.

Ledgerwood, R.D., E.M. Dawley, L.G. Gilbreath, P.J. Bentley, B.P. Sandford, and M.H. Schiewe. 1990. Relative survival of subyearling chinook salmon which have passed Bonneville dam via the spillway or the second powerhouse turbines of bypass system in 1989, with comparisons to 1987 and 1988. Report to the United States Army Corps of Engineers, Contract E85890024/E86890097. By the Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington.

Ledgerwood, R.D., W.T. Norman, G.A. Swan, and J.G. Williams. 1988. Fish guiding efficiency of submersible traveling screens at Lower Granite Dam and Little Goose Dams-1987. Report to the United States Army Corps of Engineers, Contract Number DACW-68-84-H-0034. By Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington.

Lichatowich, J.A. 1976. Rogue River Basin Evaluation Program. Annual Report. Contract Number DACW57-75-C-0109 to the United States Army Corps of Engineers, Portland District. By the Oregon Department of Fish and Wildlife. Portland, Oregon.

Lichatowich, J.A. 1993. Ocean carrying capacity. Recovery issues for threatened and endangered Snake River salmon. Technical Report 6 of 11. Prepared for the United States Department of Energy, Bonneville Power Administration. Project No. 93-013. Contract No. DE-AM79-93BP99654. Portland, Oregon.

Long, C.W. 1968. Research on fingerling mortality in Kaplan turbines-1968. Internal report. Bureau of Commercial Fisheries, Seattle, WA.

Long, C.W., F.J. Ossiander, T.E. Ruehle, and G.M. Mathews. 1975. Survival of coho salmon fingerlings passing through operating turbines with and without perforated bulkheads and of steelhead trout fingerlings passing through spillways with and without a flow deflector. Final report submitted to U.S. Army Corps of Engineers. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Meekin, T.K. and B.K. Turner. 1974. Tolerance of salmonid eggs, juveniles, and squawfish to supersaturated nitrogen. Washington Department of Fisheries Technical Report 12:78-126.

Mundy, P.R., D. Neeley, C.R. Steward, T.P. Quinn, B.A. Barton, R.N. Williams, D. Goodman, R.R. Whitney, M.W. Erho Jr, and L.W. Botsford. 1994. Transportation of juvenile salmonids from hydroelectric in the Columbia River Basin: An independent review. Final report submitted to the U.S. Fish and Wildlife Service, Portland, Oregon.

Nicholas, J.W., and D.G. Hankin. 1989. Chinook salmon populations in Oregon coastal river basins: description of life histories and assessment of recent trends in run strengths. Information Report Number 88-1, Fish Division, Oregon Department of Fish and Wildlife, Corvallis, Oregon.

Park, D.L. and S. Achord. 1987. Evaluation of juvenile salmonid passage through the bypass system, turbines and spillway at Lower Granite Dam in 1986. Contract DACW68-84-H-0034 to the United States Army Corps of Engineers. By Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington.

Petrosky, C.E. 1991. Influence of smolt migration flows on recruitment and return rates of Idaho spring chinook. Idaho Department of Fish and Game, Boise, Idaho.

Raymond, H.L. 1979. Effects of dams and impoundments on migration of juvenile chinook salmon and steelhead from the Snake River, 1966-1975. Transactions of the American Fisheries Society 109:505-529.

Raymond, H.L. 1988. Effects of hydroelectric development and fisheries enhancement on spring and summer chinook salmon and steelhead in the Columbia River basin. North American Journal of Fisheries Management 8:1-24.

Raymond, H.L. and C.W. Sims. 1980. Assessment of smolt migration and passage enhancement studies of 1979. Final report submitted to U.S. Army Corps of Engineers. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Reimers, P.E. 1973. The length of residence of juvenile chinook salmon in the Sixes River, Oregon. Fish Commission of Oregon Research Reports. Volume 4. Number 2. 43 pages.

Riggs, L.A. 1986. Genetic consideration in salmon and steelhead planning. Final Report to the Northwest Power Planning Council, Portland, Oregon.

Sims, C.W. and F.J. Ossiander. 1991. Migrations of juvenile chinook salmon and steelhead trout in the Snake River from 1973 to 1979- a research summary. Final Report submitted by the National Marine Fisheries Service to the U.S. Army Corps of Engineers, Portland, Oregon.

Schluchter, M.D. and J.A. Lichatowich. 1977. Juvenile life histories of Rogue River spring chinook salmon Oncorhynchus tshawytscha (Walbaum), as determined by scale analysis. Research Section, Oregon Department of Fish and Wildlife. Information Report Series, Fisheries Number 77-5. Corvallis, Oregon.

Schoeneman, D.E., R.T. Pressey, and C.O. Junge. 1961. Mortalities of downstream migrant salmon at McNary Dam. Transactions of the American Fisheries Society 90(1):58-72.

Smith, J.R. 1974. Distribution of seaward-migrating chinook salmon and steelhead trout in the Snake River above Lower Monumental Dam. U.S. National Marine Fisheries Service Marine Fisheries Review 36(8):42-45.

Smith, L.S. 1982. Decreased swimming performance as a necessary component of the smolt migration in salmon in the Columbia River. Aquaculture. Volume 28. Pages 153-161.

Snelling, J. Researcher for Oregon Cooperative Fishery Research Unit, Oregon State University, Corvallis, Oregon. March 15, 1994. Personal communication.

Steward, C.R. 1993. Assessment of the flow-survival relationship obtained by Sims and Ossiander (1981) for Snake River spring/summer chinook salmon smolts. Report to S.A. Cramer and Associates, Inc. Portland, Oregon.

Swartz, Don F. 1994. Personnel communication. Oregon Department of Fish and Wildlife, Clackamas, Oregon.

Technical Advisory Committee (TAC). 1994. Columbia River chinook fishery simulation model output-1994. Number 94-11. Portland, Oregon.

Thompson, W.F. 1959. An approach to population dynamics of the Pacific red salmon. Transactions of the American Fisheries Society. Volume 88. Number 3. Pages 206-209.

TRG (Ad Hoc Transportation Review Group). 1992. Review of salmon and steelhead transportation studies in the Columbia and Snake Rivers, 1984-89. Submitted to the Columbia Basin Fish and Wildlife Authority.

USFWS. 1993. Review of transportation of spring/summer chinook salmon in the Snake River (1968-1990) for the Recovery Team. Peer review comments by individual Fish and Wildlife Service (Region 1) technical staff, December 6, 1993. U.S. Fish and Wildlife Service. Portland, Oregon.

Wagner, H.H., F.P. Conte and J.L. Fessler. 1969. Development of osmotic and ionic regulation in two races of chinook salmon (Oncorhychus tshawytscha). Comparative Biochemical Physiology. Volume 29. Pages 325-341.

Ware, D.M. and R.E. Thompson. 1991. Link between long-term variability in upwelling and fish production in the northeast Pacific Ocean. Canadian Journal of Fisheries and Aquatic Sciences. Volume 48. Pages 2296-2306.

WDF (Washington Department of Fisheries). 1992. McNary Dam weekly summary reports. Olympia, Washington.

Wedemeyer, G.A., R.L. Saunders, and W.C. Clarke. 1980. Environmental factors affecting smoltification and early marine survival of anadromous salmonids. Marine Fishery Review. Volume 42. Pages 1-14.

Weitkamp, D.E. 1974. Dissolved gas supersaturation in the Columbia River system; salmonid bioassay and depth distribution studies, 1973 and 1974. Parametrix Inc. Report to Utility Cooperative, Idaho Power Company, Boise, ID.

Weitkamp, D.E. 1976. Dissolved gas supersaturation: live cage bioassays at Rock Island Dam, Washington. Pages 24-36 in Fickeisen and Schneider (1976).

Weitkamp, D.E. 1977. Gas bubble disease of resident fish and juvenile salmonids in the Columbia River system. Doctoral dissertation. University of Washington, Seattle, Washington. 242 pages.

Weitkamp, D.E., D. McKenzie, and T. Schadt. 1980. Survival of steelhead smolts Wells Dam turbines and spillway. Parametrix Inc., Bellevue, WA.

Weitkamp, D.E. and M. Katz. 1980. A review of dissolved gas supersaturation literature. Trans. Amer. Fisheries Society 109:659-702.

Winemiller, K.O. and K.A. Rose. Patterns of life-history diversification in North American fishes: implications for population regulation. Canadian Journal of Fisheries and Aquatic Sciences. Volume 49. Pages 2196-2218.

Table 1. Turbine mortalities of juvenile chinook, coho, and steelhead from studies at Columbia River dams with kaplan-type turbines.

Dam	Year(s)	Species	(%) Mortality
Bonneville I[a]	1942-47	Subyearling chinook	15
McNary[b]	1955-56	Subyearling chinook	11
Ice Harbor[c]	1968	Yearling chinook	32
L. Monumental[d]	1972	Yearling coho	20
John Day[e]	1979	Subyearling chinook	13
Wells[f]	1980	Yearling steelhead	16
L. Granite[g]	1987	Yearling chinook	17
Bonneville II[h]	1989	Subyearling chinook	18
L. Granite[i]	1993	Yearling chinook	18
L. Goose[i]	1993	Yearling chinook	8

Source

[a] Holmes 1952.
[b] Schoeneman et al. 1961.
[c] Long 1968.
[d] Long et al. 1975.
[e] Raymond and Sims 1980.
[f] Weitkamp et al. 1980.
[g] Gilbreath et al. 1993.
[h] Giorgi and Stuehrenberg 1987.
[i] Iwamoto et al. 1993.

Table 2. Spillway mortalities of juvenile chinook, coho, and steelhead from studies at Columbia River dams

Dam	Year(s)	Species	(%) Mortality
Bonneville I[a]	1942-47	Subyearling chinook	3
McNary[b]	1955-56	Subyearling chinook	2
L. Monumental[c]	1974	Yearling coho	0
		Yearling steelhead	2
Bonneville I[d]	1974	Subyearling chinook	4
John Day[e]	1979	Subyearling chinook	0
Wells[f]	1980	Yearling steelhead	0
Rocky Reach[g]	1980	Yearling coho	1
Bonneville II[h]	1989	Subyearling chinook	1
L. Goose[i]	1993	Yearling chinook	0

Source

[a] Holmes 1952.
[b] Schoeneman et al. 1961.
[c] Long et al. 1975 (with spillway deflectors).
[d] Johnsen and Dawley 1974 (with spillway deflectors).
[e] Raymond and Sims 1980.
[f] Weitkamp et al. 1980.
[g] Heinle and Olson 1980.
[h] Gilbreath et al. 1993.
[h] Giorgi and Stuehrenberg 1987.
[i] Iwamoto et al. 1993.

Table 3. Mortalities of juvenile chinook, coho, and steelhead held in surface to deep live cages in the Snake and Columbia Rivers.

Species	Depth (m)	Exposure (d)	TDG (%)	Mortality (%)
Coho[c]	0-3.1	21	128	0
Chinook[c]	0-3.1	21	128	3
Steelhead[c]	0-3.1	21	128	0
Chinook[d]	0-1	20	120-128	88-100
	0-2	20	120-128	17-61
	0-3	20	120-128	3-8
	0-4	20	120-128	0

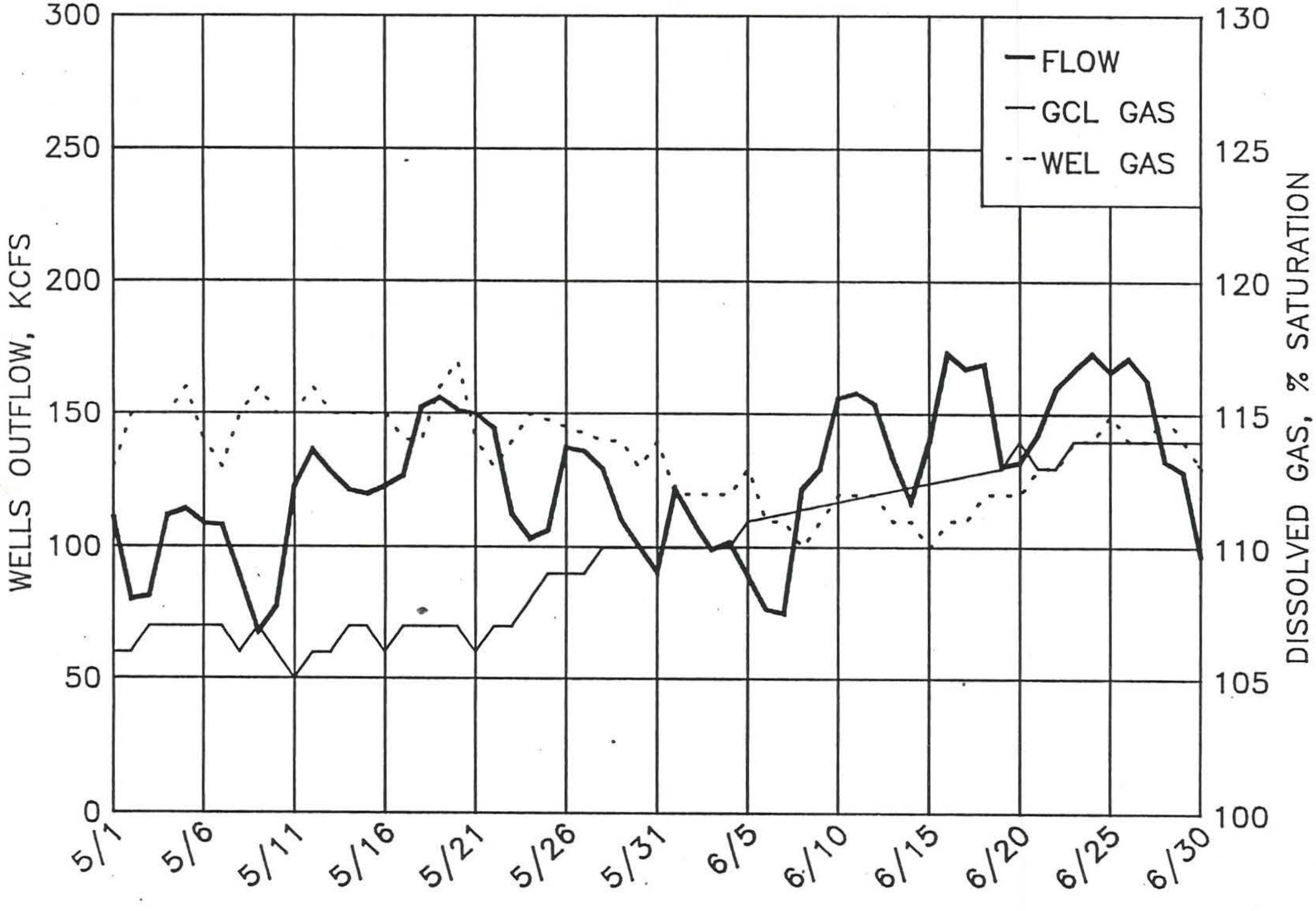
Source

[c] Meekin, T.K. and B.K. Turner (1974)

[d] Weitkamp, D.E. (1976)

FIGURE 1

1992 DISSOLVED GAS LEVELS AT GRAND COULEE AND WELLS DAMS (FOREBAYS) WITH NO SPILL BETWEEN PROJECTS



92SPILL1

7/15/92

ATTACHMENT 1

FISH PASSAGE CENTER

2501 S.W. FIRST AVE. • SUITE 230 • PORTLAND, OR 97201-4752
PHONE (503) 230-4099 • FAX (503) 230-7559

SYSTEM OPERATIONAL REQUEST

TO: FEDERAL EXECUTIVE IN-SEASON MANAGEMENT TEAM:

NMFS-Seattle	Gary Smith
USFWS-Ptld	Bill Shake
USBR-Boise	Ken Pedde
COE-PE	Dave Geiger
BPA-P	Walt Pollock

FROM: Fish Passage Manager Michele DeHart
Michele DeHart

REQUEST # 94-41:

DATE: June 22, 1994

SUBJECT: June and July Migration Flow and Spill for Fish Passage (additional operations will be submitted for August migration)

SPECIFICATIONS:

- Meet NMFS Opinion Flow targets in the Lower Columbia River, through June and July, 1994.
- Take additional actions in the Snake River to minimize the deficit in meeting summer flow target at Lower Granite Dam.
- Provide summer spill according to the attached schedule for fish passage in the Columbia and Snake rivers beginning June 21 in the Snake River and July 1 in the lower Columbia River.

JUSTIFICATION:

Historical passage distribution data and present passage data show that yearling migrants are present in the Snake River and lower Columbia River through June. PIT tag recaptures of upper Snake River tributaries indicate that these fish are still migrating through the lower Columbia River.

USFWS has predicted that peak passage of Snake River fall chinook will occur at Lower Granite Dam beginning in the last week of June and continuing through mid-July. Clearwater River fall chinook are expected to be present at Lower Granite from mid-July through the first part of August.

Flows:

The NMFS Opinion included flow levels for the protection of summer migrants in the Snake and Columbia rivers. In the Columbia River, flow targets for July 1 through 31 were established at 160 kcfs at McNary Dam and targets for Lower Granite Dam in the Snake River were established at 50 kcfs from July 1 through 31. The summer flow targets established by NMFS are extremely conservative and do not provide generous protection for anadromous fish. The original commitment of the federal parties was established in terms of reservoir elevations. It is apparent from the June 13 SSARR that the reservoir elevations and volumes agreed upon in the 1994-1998 NMFS Opinion will not meet the intended NMFS flow targets and will not provide the necessary protection for extremely depressed stocks of listed chinook.

The present unexpectedly low returns of spring and summer migrating chinook in 1994 indicate that the outmigrating groups of fall chinook in 1994 and spring chinook in 1995 require the protection of the target flows identified by NMFS at a minimum for these Snake River listed stock. The NMFS Opinion flow targets are extremely conservative, providing only bare minimum protection. The migration periods identified by NMFS are also conservative and do not cover the entire migration period. The low level of spring chinook adults returning in 1994, and the poor outlook for returning adults in future years, call for additional measures to improve survival for this year's juvenile migration.

The Snake River Basin has limited options to provide the NMFS flow targets for the summer migration period, but additional measures are possible in the Snake River. Although the flow targets will still not be met, higher flows in the Snake River will result through implementation of these measures. In the Columbia River, the original agreement among the federal parties was based upon reservoir elevations. In 1994, it is clear that the flow targets will not be met in the lower Columbia River with the volume and reservoir elevations in the Biological Opinion. Additional measures are required in the lower Columbia River and are possible in order to meet the flow targets.

Snake River

There are limited options for additional flow augmentation in the Snake River. Additional water volume from Brownlee and the upper Snake River and Dworshak Reservoir are the only available options. Dworshak Reservoir has provided the largest contribution to spring flow augmentation. A significant additional draft of Dworshak Reservoir is required to enhance Snake River summer flows. The additional draft of Dworshak Reservoir increases the potential risk of not being able to meet flow targets for the 1995 spring Snake River juvenile outmigration. The agencies and tribes are extremely concerned about the risk to spring migrants in 1995 of additional draft of Dworshak in 1994 to protect summer migrants. Although the additional draft of Dworshak Reservoir is necessary to enhance Snake River summer flows in 1994, the agencies and tribes recognize the risk management decision associated with this action, and recognize that it may affect migration priorities and decisions for the 1995 juvenile outmigration.

Columbia River

There are several options for meeting flow targets in the Columbia River, although they all require additional measures. We are requesting that the federal operators and regulators utilize all of the available water sources to meet the flow targets. The State of Washington has suggested 200 KAF from Banks Lake, and Bonneville Power Administration has suggested 200 KAF of non-treaty storage water. The present deficit from meeting the flow targets is approximately 1.5 MAF. The following additional measures will assure that the flows in the lower Columbia River will be met. Since the federal parties decided not to meet spring flow targets in the lower Columbia River for the last two weeks of June, the remaining deficit is actually smaller than previous weeks. Meeting the flow targets is particularly important because the flow targets were not provided in the early part of the migration and were not provided in the first or last part of the spring chinook migration in the Snake River.

Spring migrants in the Columbia River were not provided with target flow levels until the first week of May. The passage distribution was delayed because adequate flows were not provided. The historical passage distributions (attached) for McNary and Lower Granite for listed fish shows that historical passage distributions for spring migrants extend beyond the end of June. In addition, the Biological Opinion passage dates have built in to them a truncation of historical timing. Further truncation through the in-season management process minimizes the cost of the program, but further truncates each end of the run.

Flow targets for the remainder of the spring and summer can be met in the lower Columbia River and enhanced in the Snake River by implementing the following additional measures. A key consideration in this proposal is the concept of equity among the reservoir projects to avoid disproportional impact to resident species in one location. The exception is Dworshak Reservoir, which carries a disproportionate impact compared to other systems reservoirs.

The latest flow projection from the COE shows that the McNary flow target will not be met for the remainder of the spring and the summer. Over the objections of the state agencies and tribes, the federal parties have chosen not to meet the spring flow targets for the lower Columbia River. Projected flows indicate that summer flows in the lower Columbia River will average 151 kcfs during July, indicating a deficit of about 1.4 MAF in meeting the NMFS Opinion flow targets. Additional measures in the Snake and Columbia will improve conditions in the Snake River and allow summer flow targets to be met in July. BPA has planned to use 200 KAF of non-treaty storage, which is not presently included in flow projections. This reduces the deficit to 1.2 MAF.

The following table shows the projected Columbia River storage reservoirs elevations on July 31 under the current plan, which does not meet the flow targets. Most of the reservoirs are projected to be more than 80% full by July 31, except Arrow and Hungry Horse. Our proposal to meet the summer target flows and enhance Snake River flows seeks to address the deficit through an equity-based approach in which a part of the deficit is met by each reservoir. However, it is clear that Dworshak Reservoir is providing more than the proportional contributions of other reservoirs. Even with the additional drafts of the system reservoirs to meet summer flow targets, the critical year designation for the 1994-95 water year would be unchanged. Meeting summer flow targets will not change the third year critical designation.

Table 1.

Project	Projected July 31 Elevation (6-20c projection)	% full Active Storage
Albeni Falls	2062.25	98.4%
Arrow	1432.50	79.5%
Duncan	1891.85	99.7%
Grand Coulee	1277.00	80.4%
Hungry Horse	3518.25	69.8%
Libby	2451.67	93.3%
Mica	2443.20	82.9%
Dworshak	1520.26	39.0%
Brownlee	2058.00	74.4%

Draft seven Columbia reservoirs proportionally by 2.5% of active storage capacity. Draft Dworshak to elevation 1490. Draft Brownlee to elevation 2054 by July 31 or lower if additional upper Snake River water or Owhyee Reservoir water becomes available and is shapable through Brownlee Reservoir.

Table 2.

Project	Additional Draft (KAF)	July 31 Elevation	% full Active Storage
Albeni Falls	29	2062.0	95.9%
Arrow	177	1431.1	77.0%
Duncan	35	1889.8	97.2%
Grand Coulee	130	1275.2	77.9%
Hungry Horse	79	3514.5	67.3%
Libby	124	2440.3	83.2%
Mica	471*	2438.2	80.4%
Dworshak	354	1490.0	21.4%
Brownlee	46	2054.0	69.7%

* Mica draft includes 200 KAF of non-treaty storage.

Recent and future SSARR projections will change as runoff and water availability changes. The recent decision by the federal parties not to meet opinion flow targets for the remainder of the spring migration has shifted water into the summer migration period. As the deficit in meeting flows changes, the basic approach of this request to proportionally contribute from all reservoirs can be implemented by modifying the contribution.

Spill for Fish Passage:

The agencies and tribes are requesting spill to achieve the 80% fish passage efficiency objective at all hydroelectric projects where the objective is physically possible to obtain. The threatened status of fall chinook stocks requires additional protection. Spill for fish passage will enhance the survival of in-river migrating fall chinook. Spill has been shown to be the most effective, safest means of project passage. It is also the only means of enhancing in-river survival without additional flow augmentation.

Fish that pass the project in spill have a significantly higher rate of survival (98%) than do fish that pass through turbines (80-90%). The Fish Guidance Efficiency estimates for sub-yearling chinook are extremely low. Few fish are guided away from turbine unit passage under normal no spill operations. A high percentage of fall chinook pass through the turbines at each project. Provision of spill also provides additional benefits in dispersal of predators, and it has been demonstrated that squawfish avoid areas of high current velocity, therefore a decreased opportunity for predator/prey interaction occurs. In addition, research has shown that squawfish tend to feed on debilitated fish, therefore increasing the mortality associated with turbine passage. These are conservative, temporary dissolved gas levels and are not anticipated to cause harm for first established by DOE and DEQ based on research studies.

This proposal is established for implementation to prevent any harm to adult or juvenile migrants as a result of dissolved gas. Volume caps to avoid exceeding the 120% dissolved gas standard are included. Daytime adult spill caps are also included to avoid impact to adult migration.

Spill at all lower Snake River (June 21 to July 31) and lower Columbia River dams (July 1 to July 31) according to the following schedule, in order to provide 80% FPE if possible within established constraints for summer migrants.

Summer Spill

Project	% of Fish Passing 1800-0600 hrs	FGE	Spill Hours	Percent Spill	Spill Cap
Lower Granite	70%	35	2100-0400	100%	52 kcfs
			0400-2100	50%	25 kcfs
Little Goose	70%	35	2100-0400	100%	30 kcfs
			0400-2100	50%	25 kcfs
Lower Monumental	70%	31	2100-0400	100%	34 kcfs
			0400-2100	50%	34 kcfs
Ice Harbor	50%	43	Spill 25 kcfs 24 hours		
McNary	70%	47	1800-0600	Spill 110 kcfs	
			0600-1800	Spill 80 kcfs	
John Day	86%	26	Spill 25 kcfs 24 hours		
The Dalles	Spill 40% instantaneous flow 24 hours				
Bonneville	50%	10	1800-0600	Spill 120 kcfs	
			0600-1800	Spill 75 kcfs	

*August operations will include spill through August 22 in the lower Columbia River.

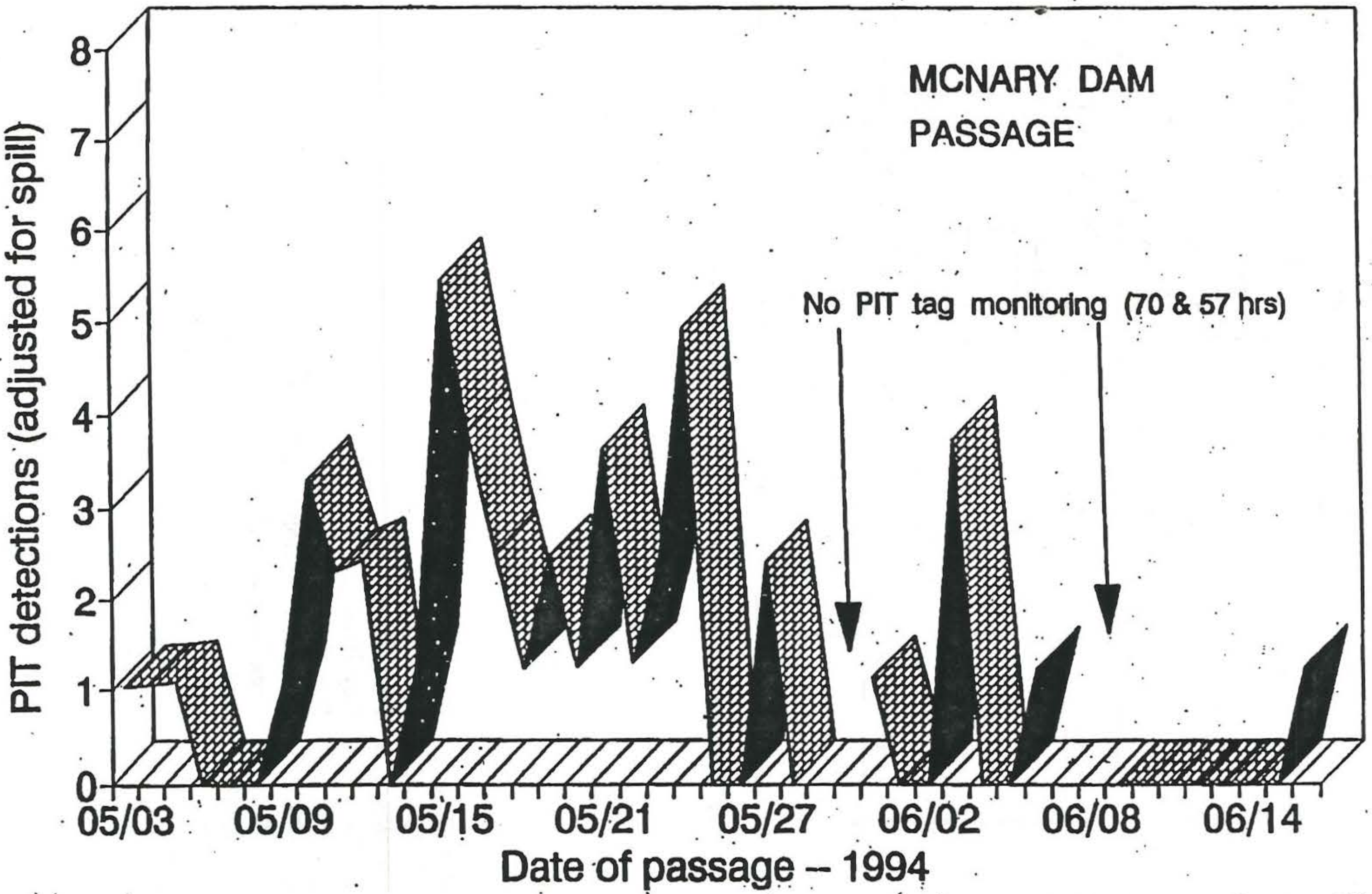
cc:

NMFS-Sea	Donna Darm
NMFS-Ptld	Chris Ross
USFWS-Vanc	Fred Olney
USFWS-Boise	Roy Heberger
USBR-Boise	Dan Yribar, Doug James, Harry Taylor
COE-RCC	Russ George, Bolyvong Tanovan
BPA-PSH	Greg Delwiche, Bruce MacKay
BPA-PJI	Judi Johanson
NPPC-Oly	Ted Bottiger
NPPC-Ptld	Jim Ruff
PNUCC	John Stevenson

520-94.md

Upper Salmon Wild Chinook

PIT tagged as parr July to Dec 1993



Source: Fish Passage Center 6/16/94

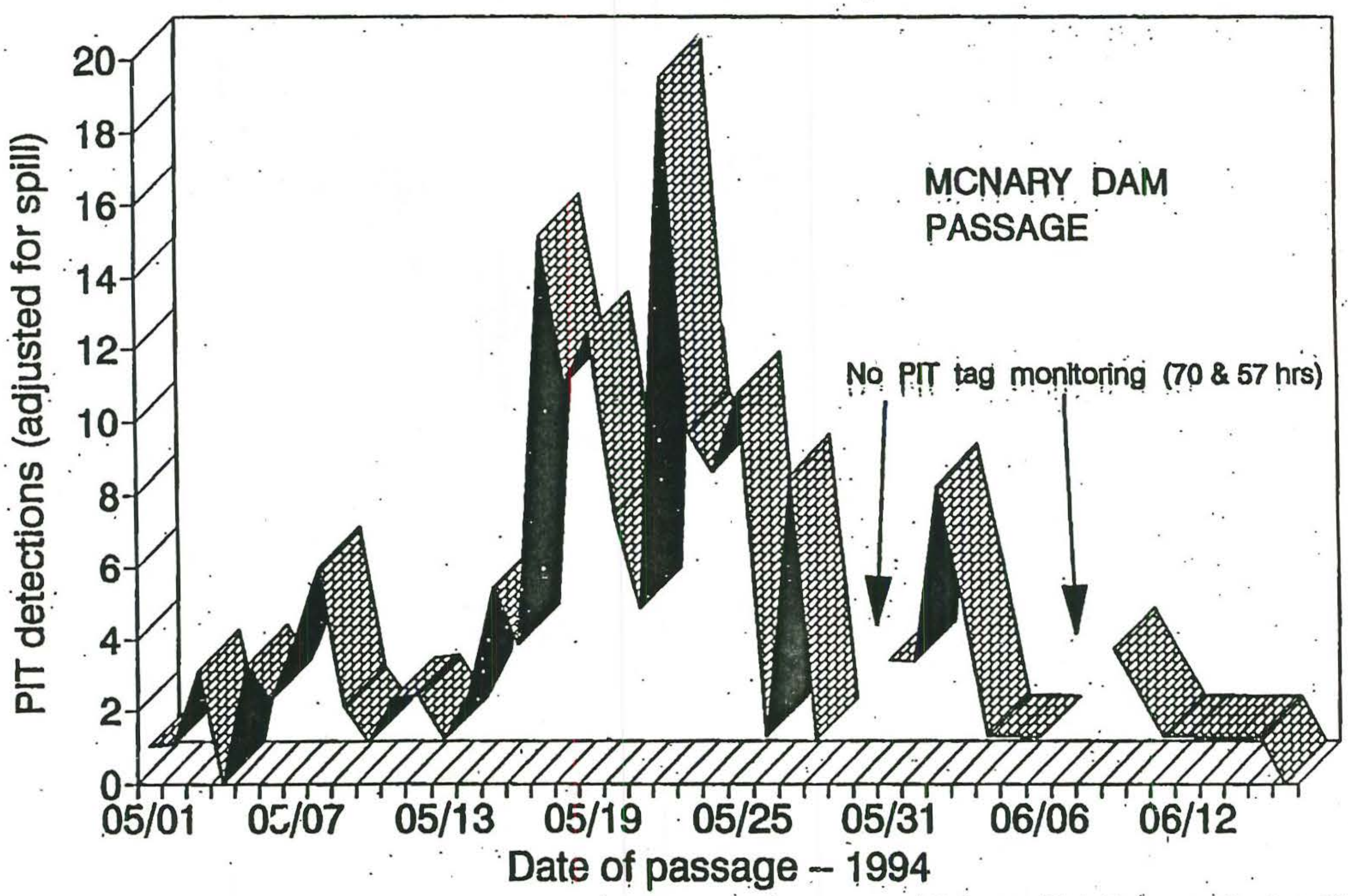
JUN 22 '94 01:27PM FPC 503 230 7559

P.7/14

9

Upper Grande Ronde Wild Chinook

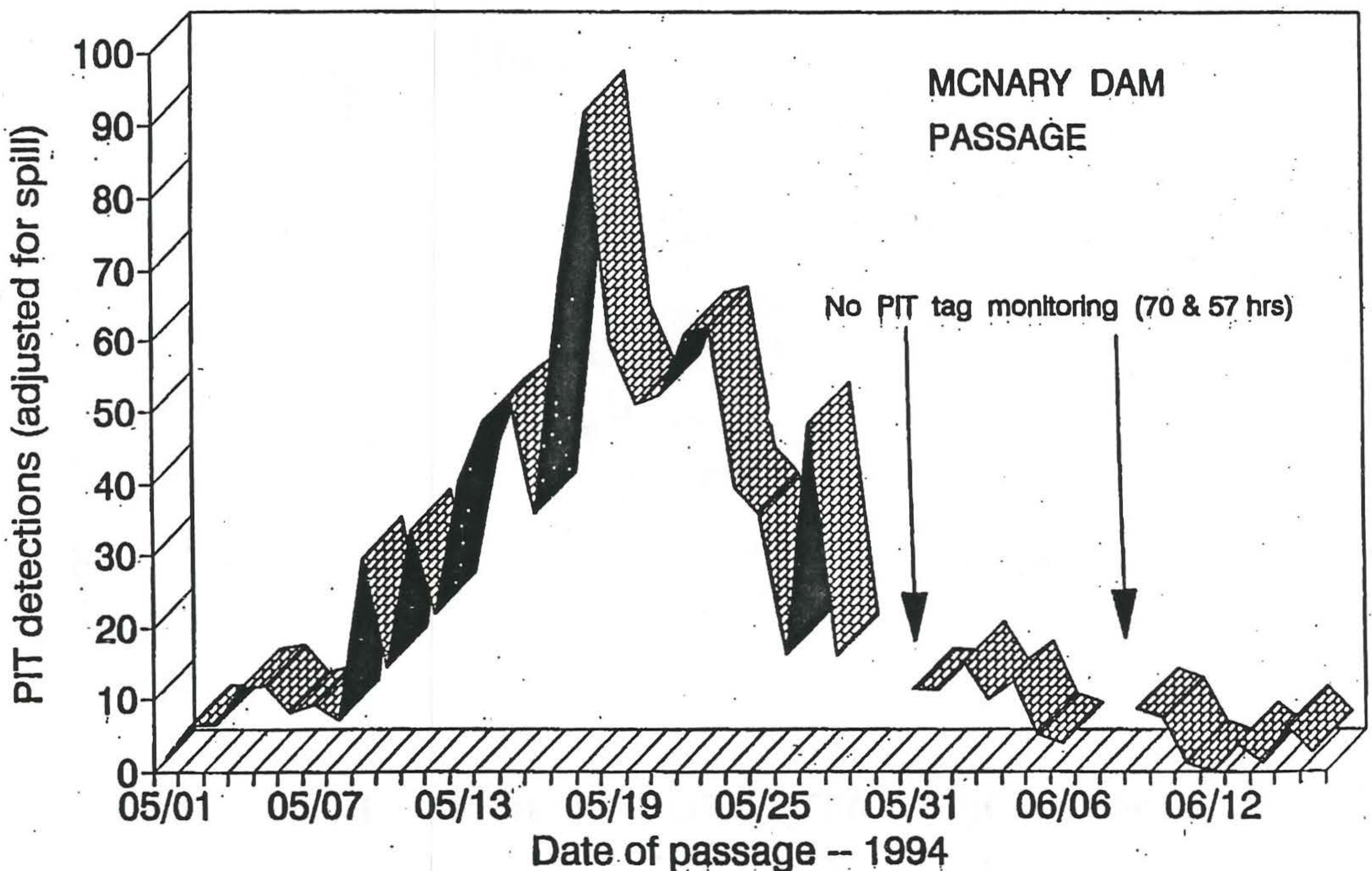
PIT tagged as parr July to Dec 1993



Source: Fish Passage Center 6/16/94

Middle Fork Salmon Wild Chinook

PIT tagged as parr July to Dec 1993

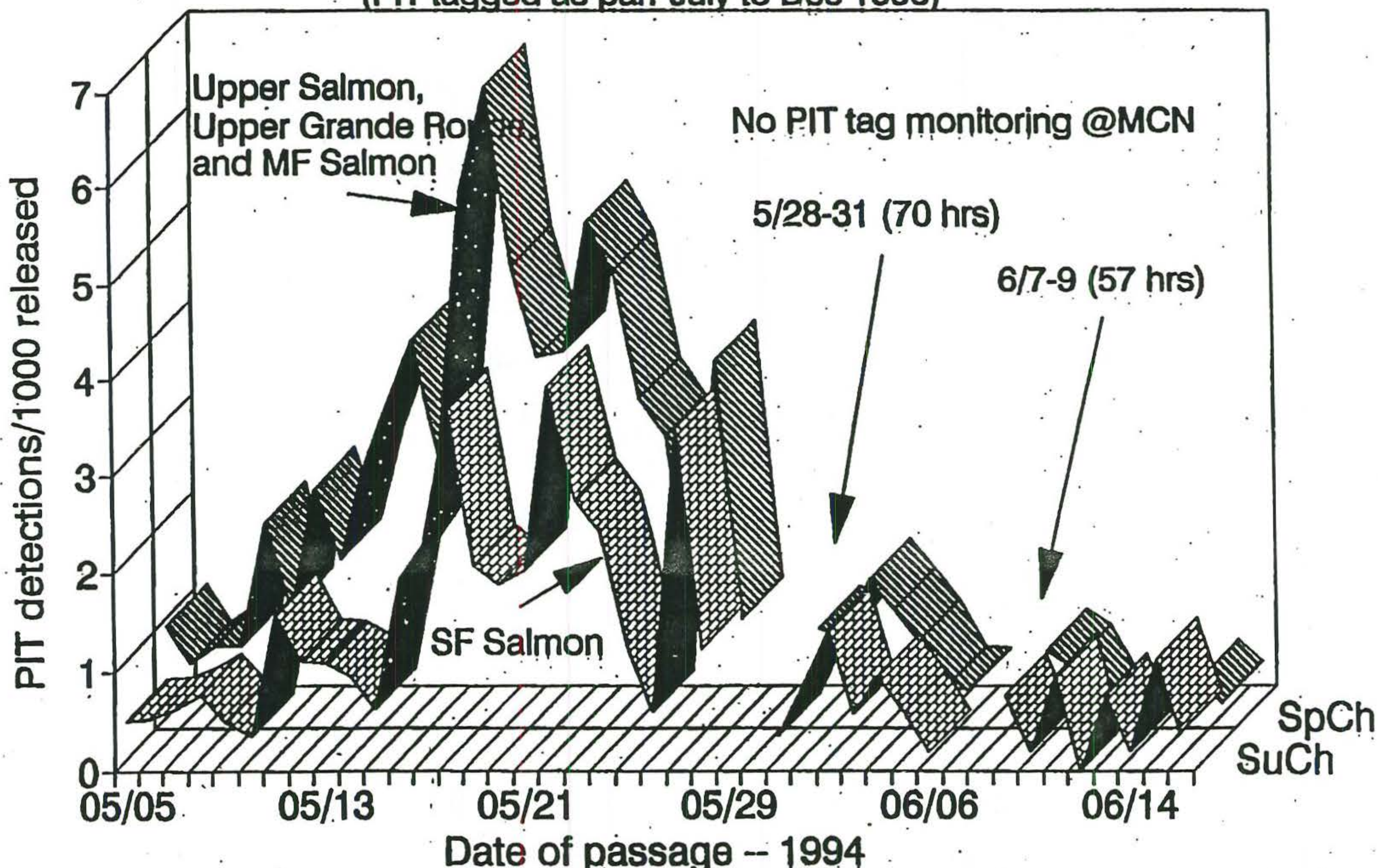


Source: Fish Passage Center 6/16/94

Combined Listed Snake R Wild Chinook

Passage at McNary (adjusted for spill)

(PIT tagged as parr July to Dec 1993)

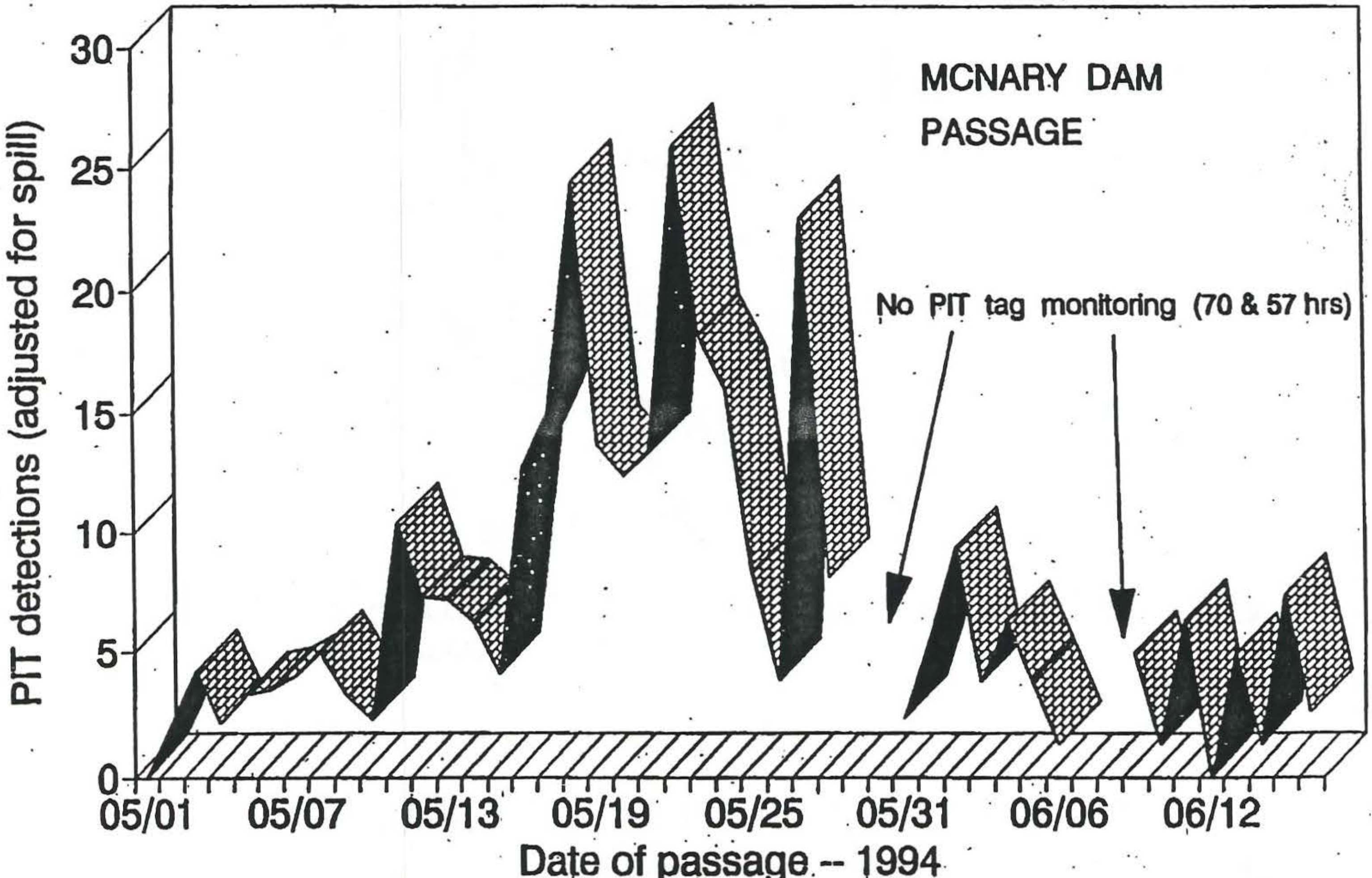


Source: Fish Passage Center 6/16/94

6

South Fork Salmon Wild Chinook

PIT tagged as parr July to Dec 1993



Source: Fish Passage Center 6/16/94

Dates of Wild Chinook Passage at Lower Granite Dam
(from PIT Tag Data)

River Reach & Stock	Detection Year	Detection Dates				Number Detected
		Minimum	5%	95%	Maximum	
Imnaha River Summer Chinook	89	04/04	04/04	05/27	06/05	73
	90	04/05	04/09	05/12	05/27	161
	91	04/14	04/14	05/15	05/15	19
	92	04/06	04/08	06/03	06/08	94
	93	04/15	04/22	05/30	06/23	160
	Summary	04/04	04/04	06/03	06/23	507
Lower Grande Ronde Spring Chinook	90	04/30	04/30	05/31	05/31	8
	91	04/20	04/24	06/04	07/09	90
	92	04/12	04/14	05/21	06/02	92
	93	04/14	04/18	05/18	06/03	310
	Summary	04/12	04/14	06/04	07/09	500
Upper Grande Ronde Spring Chinook	89	04/27	05/09	06/23	07/22	242
	90	04/16	04/16	04/23	04/23	2
	91	04/17	04/26	06/12	06/23	77
	92	04/09	04/15	05/28	06/29	67
	93	04/23	04/30	06/16	06/26	190
	Summary	04/09	04/15	06/23	07/22	578
Lower Snake River Fall Chinook	91	06/14	07/13	08/28	09/05	42
	92	05/04	06/03	07/03	07/21	43
	93	05/28	06/14	07/26	07/27	147
	Summary	05/04	06/03	08/28	09/05	249
South Fork Salmon Summer Chinook	89	04/09	04/16	06/19	07/19	275
	90	04/10	04/12	06/27	07/21	162
	91	04/13	04/18	06/27	07/20	177
	92	04/05	04/10	07/02	07/27	124
	93	04/21	04/22	07/03	07/15	313
	Summary	04/05	04/10	07/03	07/27	1051
Mid Salmon River Spring Chinook	90	04/09	04/15	07/06	07/18	584
	91	04/17	04/20	06/27	07/01	230
	92	04/05	04/06	06/24	07/13	466
	93	04/14	04/21	06/29	07/27	602
	Summary	04/05	04/06	07/06	07/27	1882
Upper Salmon River Spring Chinook	89	04/07	04/15	07/08	07/08	369
	90	04/11	04/14	06/14	06/28	89
	91	04/16	04/16	06/28	07/13	175
	92	04/07	04/10	07/20	07/20	202
	93	04/19	04/20	07/16	07/27	426
	Summary	04/07	04/10	07/20	07/27	1261

Dates of Wild Chinook Passage at McNary Dam
(from PIT Tag Data)

River Reach & Stock	Detection Year	Detection Dates				Number Detected
		Minimum	5%	95%	Maximum	
Imnaha River Summer Chinook	89	04/21	04/23	05/24	05/31	30
	90	04/20	04/24	05/26	05/27	33
	91	05/06	05/06	05/22	05/22	5
	92	04/22	04/24	06/14	06/19	40
	93	05/03	05/04	06/15	07/13	43
	Summary	04/20	04/23	06/15	07/13	151
Lower Grande Ronde Spring Chinook	90	06/03	06/03	06/03	06/03	1
	91	05/07	05/07	06/21	06/21	19
	92	04/26	04/27	06/01	06/08	41
	93	05/03	05/04	06/07	06/15	102
	Summary	04/26	04/27	06/21	06/21	163
Upper Grande Ronde Spring Chinook	89	05/16	05/16	06/27	07/02	52
	91	05/11	05/11	06/15	06/15	7
	92	04/03	04/26	06/02	06/06	26
	93	05/10	05/11	06/25	07/01	73
	Summary	04/03	04/26	06/27	07/02	158
Lower Snake River Fall Chinook	91	08/10	08/10	09/06	09/06	4
	92	06/01	06/01	08/08	08/08	7
	93	05/08	05/08	07/10	07/10	5
	Summary	05/08	05/08	09/06	09/06	16
South Fork Salmon Summer Chinook	89	04/21	04/25	06/15	06/22	85
	90	04/26	04/26	06/07	06/13	34
	91	04/26	04/26	06/18	06/18	23
	92	04/18	04/18	07/16	07/16	16
	93	05/04	05/04	07/02	07/05	84
	Summary	04/18	04/18	07/16	07/16	242
Mid Salmon River Spring Chinook	90	04/26	04/27	06/19	07/07	92
	91	05/06	05/06	06/28	06/28	14
	92	04/23	04/23	07/18	07/18	104
	93	05/01	05/01	07/19	07/19	160
	Summary	04/23	04/23	07/19	07/19	370
Upper Salmon River Spring Chinook	89	04/22	04/26	08/09	08/09	122
	90	04/26	04/30	06/19	06/19	31
	91	04/19	04/22	07/04	07/04	68
	92	04/24	04/24	07/16	07/16	51
	93	05/03	05/03	07/24	07/24	109
	Summary	04/19	04/22	08/09	08/09	381

Dates of Snake River Sockeye Passage at Lower Granite and McNary Dams (from PIT Tag Data)

Detection Site	Detection Year	Detection Dates				Number Detected
		Minimum	5%	95%	Maximum	
Lower Granite	91	05/22	05/22	06/15	06/15	10
	92	05/08	05/08	07/19	07/19	11
	93	05/14	05/14	06/04	06/04	6
	Summary	05/08	05/08	07/19	07/19	27
McNary	92	05/18	05/18	06/10	06/10	2
	93	05/22	05/22	06/07	06/07	3
	Summary	05/18	05/18	06/10	06/10	5

ATTACHMENT 2

PUBLIC UTILITY DISTRICT NO. 2 OF GRANT COUNTY

P. O. BOX 878 • EPHRATA, WASHINGTON 98823 • 509/754-3541

MEMORANDUM

June 27, 1994

TO: Mid-Columbia Coordinating Committee

FROM: Stuart Hammond, Fish and Wildlife Manager

SUBJECT: Summer Fish Spill, Wanapum and Priest Rapids

You should have received a fax describing a spill proposal after last Thursdays conference call. This memo is intended to clarify the Districts position with regard to certain aspects of the proposal.

The proposed program is as follows. At Wanapum, spill 35% for 14 hours. At Priest, spill 40% for 10 hours. Spill to last for 40 days. At both projects the skim spill gate will be open for 24 hours, gatewells will be dipped, and diversion screens will be operated for fish salvage. Start of spill can be determined hydroacoustically or otherwise.

The FPE calculations you received were intended only to provide one possible example of a set of assumptions and estimates. As I stated during last Thursdays discussions, the PUD does not consider that this or any other set of like estimates necessarily describes what the effect of this spill program will be.

The PUD believes that this proposed program will in total provide sufficient benefit for the fish. The challenge to the Committee now is to reach agreement on this program so that it may be implemented without delay and in time to benefit this summers outmigration.

I look forward to our upcoming discussions this afternoon.

9457

Rock Island Project Spill For Juvenile Fish Protection

Spring And Summer Spill Plans For 1994

Charles M. Peven

Chelan County Public Utility District
Fish and Wildlife Operations
P.O. Box 1231
Wenatchee, WA 98807

17 January 1994

Introduction

The Rock Island Dam Settlement Agreement (Agreement) has been entered into by the Public Utility District No. 1 of Chelan County (District) and Puget Power and Light Company, with the National Marine Fisheries Service (NMFS), Washington Departments of Fisheries and Wildlife, the Oregon Department of Fish and Game, the Confederated Tribes and Bands of the Yakima Indian Nation, the Confederated Tribes of the Colville Indian Reservation, the Confederated Tribes of the Umatilla Indian Reservation, and the National Wildlife Federation ("Fishery Agencies and Tribes"). The Agreement provides that during bypass system development (Phase I), the District will spill water for the protection of juvenile salmon and steelhead trout passing Rock Island Dam. Phase I spill implementation is defined in an Annual Spill Plan, developed jointly by designated representatives of the District and the Fishery Agencies and Tribes. Separate spill plans are developed for protection of spring and summer migrating fish, following requirements defined in the Agreement.

Spring Spill Plan

Requirements for Phase I Spring Spill

The District will implement a controlled spill program at Rock Island Dam during the middle 80% of the spring juvenile salmonid migration past the dam. The Agreement states that the District shall spill a volume equal to 10% of the daily average flow through powerhouse 2 and 50% of the daily average flow through powerhouse 1, assuming powerhouse flow conditions which would occur in the absence of spill for fish passage. In addition to the 10%/50% program, the Agreement also required that a minimum of 20% of the total daily average project flow was to be spilled until hatchery compensation facilities were operational.

Since the hatchery compensation facilities are complete, the 20% minimum spill requirement no longer applies. Consequently, the District will implement only the 10%/50% spill program until a working bypass system is installed at the Rock Island Dam.

The prototype fish guidance system tests at powerhouse 1 may require increased flows through powerhouse 1 to assure that sufficient fish are collected to validate the tests. In this event, the District will calculate the spill requirement assuming powerhouse flow conditions which would have occurred in the absence of the powerhouse 1 prototype fish guidance tests. The spill requirement was calculated in this manner in 1987, when flows through powerhouse 1 were increased for the purposes of fish distribution studies related to development of the prototype fish guidance system.

Spring Spill Plan

The District will initiate spill at Rock Island Dam at 2000 hours on the day when it is estimated that 10% of the spring migration of smolts has passed the dam. We have seen a strong relationship between the release of the Leavenworth National Fish Hatchery's yearling chinook and the 10% passage date at Rock Island Dam. For most years since 1985, 10% of the yearling salmonids have passed the dam approximately 3 days after the Leavenworth releases in mid-April (Truscott 1985; Fielder and Peven 1986; Peven et al. 1987; Peven 1988; Peven and Duree

1990). If the sockeye outmigration begins before the Leavenworth hatchery releases, the District agrees to provide spill as directed by the designated representatives until sockeye numbers collected at the bypass trap decline.

Once spill is initiated (except as stated for sockeye above), it will continue until it is estimated that 90% of the spring juvenile salmonid migration has passed the dam. The 90th percentile of spring migrants will be estimated from the expanded Rock Island bypass counts. The expanded counts are derived by taking the actual trap counts and multiplying by the inverse proportion of water passing through powerhouse 2 during the sampling period (0900 - 0900 hrs). This has usually occurred between the last week of May and the first week of June.

The volume of water spilled during a day will be determined by the distribution of flows during the previous day. The spill volume will be the sum of percentages of the daily average flow through the second powerhouse (10%) and first powerhouse (50%), and respective percentages of flow spilled for fish passage that would have gone through these powerhouses. To calculate the powerhouse flow conditions which would occur in the absence of spill for fish passage, the fish passage spill will be assumed to have passed through the second powerhouse until its hydraulic capacity is reached, then remaining fish passage spill will be added to the daily average flow for the first powerhouse.

A similar method of calculation will be used in the event that flows through powerhouse 1 are increased for purposes of the prototype tests. Powerhouse 1 will be assigned 500 cfs of total project flow for maintenance of station electrical service with the house unit. The remaining project flow will be assumed to have passed through powerhouse 2 until its hydraulic capacity is reached. Flow in excess of the second powerhouse's hydraulic capacity will be assigned to powerhouse 1. Spill for regulation of forebay water level is excluded from the fish spill calculations.

Spill will be concentrated during a 12 hour period, from 2000 h - 0800 h (Pacific Advanced Standard Time), except early in the season. The spring spill efficiency study in 1984 found that more than 70% of the fish passed the project during this 12 hour spill period (Raemhild, et al. 1985). Recent studies have shown that spill between the hours of 0600 - 0800 results in entrainment of newly hatched broods of Canada geese (*Branta canadensis*) as they leave their nests on the island in the Rock Island Dam forebay (Fielder and Duree 1990). The District will spill from 2000 - 0600 until all Canada goose nests on the islands above the dam have hatched and goslings have left the forebay area (generally by the end of the first week in May - P. Fielder, pers. comm.). Subsequently, spill will be from 2000 - 0800 for the remainder of the spring spill season.

Spill will occur at the 12 shallow spill gates located in the south channel of the river. These spill gates have a nominal hydraulic capacity of 120,000 cfs. Spill will occur in a prioritized order which uses the spill gates which have the highest fish passage efficiency (Raemhild, et al. 1985). For high spills (above 60,000 cfs, or whenever a gate crew is needed), the priority of spill gates used will be automatic gates 19, 24, 25 and 20, and manual gates 27, 21, 18, 23, 26, and 28, in that order, holding auto gates 17 and 22 until last for forebay regulation. For low spills (less than 60,000 cfs), when a gate crew is not needed, spill priority will be from gates

19, 24, 25, 20, 17 and 22, in that order.

The difficulty in implementing the spill program lies in determining the 90th percentile of the spring migration before 100% of the fish have passed the dam. The smolt migration past the dam has been monitored since 1985 (Truscott 1985, 1992; Fielder and Peven 1986; Peven et al. 1987; Peven 1988; Peven and Duree 1990; Peven 1991). Since 1985, the 90% passage date has been between May 24 - June 8, while the ending spill date has ranged from May 26 - June 3. Spill will end when we have estimated that 90% of the yearling salmonids have passed Rock Island Dam. The District will determine the 90% passage date based on cumulative counts to date and projected counts for the following days (based on historical bypass trap data). The District will contact the designated representatives of the Fisheries Agencies and Tribes before spill is ended.

Summer Spill Plan

Requirements for Phase I Summer Spill

The Agreement called for implementation of a summer spill evaluation for fish passage. Subsequent provision for an annual summer spill program was contingent upon completion of the summer spill evaluation (completed in 1990), and the summer spill effectiveness determined from that evaluation had to be at least 75% as effective as that shown during a 1984 evaluation of spring spill. These conditions were met and the District implemented an annual summer spill program in 1991.

The Rock Island Agreement specifies that the summer spill program will use 500,000 acre feet of water during the months of June, July and August. No more than 20% of the 500,000 acre feet may be spilled in August and spill must end by August 15. Spill in August is also contingent on the District's ability to purchase replacement energy to meet the District's and Puget's respective firm loads during the actual time of spill and the total cost of the replacement energy cannot exceed an amount determined by a formula specified in the agreement.

Goals of the Summer Spill Plan

The goal of this summer spill plan is to use the 500,000 acre feet of water allocated for spill in a manner that maximizes fish passage efficiency of that spill during the middle 80% of the sub-yearling chinook migration. The Agreement limits the volume of water that may be spilled during the summer spill program. The spill program may either use the volume to provide large instantaneous spills (30,000 cfs or more) over a short time period (either limit the number of hours per day or the number of days when spill is provided) or low instantaneous spills (10,000 cfs - 20,000 cfs) over an extended number of hours and days.

In the summer spill plan for 1991, the District examined available data regarding the migration timing, diel passage rate, horizontal distribution and spill effectiveness for summer migrant chinook salmon. Several scenarios were modeled to determine the most effective spill program for use of the 500,000 acre feet allocated for spill. The most effective spill plan rationed the volume of water spilled in order to provide spill throughout the middle 80% of the summer fish migration.

The most effective spill program used a low spill rate of 10,000 cfs (which is nominally equal to one spill gate fully open) over a 10 hour spill period. Spilling at that rate allowed spill to continue throughout the 60 day period between the 10th and 90th percentiles of the subyearling chinook migration (usually between mid-June and the first week of August), with the cumulative volume of spill reaching 500,000 acre foot on the 60th day. This strategy also accounted for unpredictability in the migration timing. Attempting to hit just the peaks in the migration with higher spill volumes would be risky because the daily migration rate shifts unpredictably.

Summer Spill Plan

The summer spill program at Rock Island Dam will use 500,000 acre feet of spill as defined in the Rock Island Agreement. The summer migration at Rock Island Dam generally begins in early June and ends in August. Spill will be initiated based on criteria defined below. Generally, the criteria will trigger the initiation of the spill program at about the 10th percentile of the sub-yearling chinook migration.

The summer spill program will be initiated on the day after the date when both of the following criteria are met:

After the spring spill program has ended; and

When the number of sub-yearling chinook caught in the bypass trap at Rock Island Dam (expanded count) exceed either:

300 or more sub-yearling chinook in a single day, or

100 or more sub-yearling chinook have been captured over three consecutive days.

Spill will be provided at the Rock Island Project at the rate of 10,000 cfs per hour for 10 hours daily beginning at 2000 and ending at 0600 the following morning. Spill will be from gate 19, which was shown to pass more fish (20% of total) than the other spill gates during the 1990 summer spill efficiency study (Steig and Ransom 1991). Spill will continue for approximately 60 days, ending when the cumulative amount of water spilled reaches 500,000 acre feet, or by August 15, whichever comes first. Spill in August will be contingent on the Chelan's and Puget's ability to procure replacement energy to meet firm loads and cost of such replacement energy does not exceed levels specified in the Rock Island Agreement.

References

Fielder, P.C., and C.M. Peven. 1986. Rock Island Dam smolt monitoring, 1986. P.U.D. No. 1 of Chelan County, Wenatchee, WA.

Fielder, P.C., and N.A. Duree. 1990. Canada goose gosling mortality in the Rock Island Dam forebay, Columbia River, Washington 1990. Annual report. P.U.D. No. 1 of Chelan County, Wenatchee, WA.

Peven, C.M. 1988. Rock Island Dam smolt monitoring, 1988. P.U.D. No. 1 of Chelan County, Wenatchee, WA.

Peven, C.M. 1991. Rock Island Dam smolt monitoring, 1991. P.U.D. No. 1 of Chelan County, Wenatchee, WA.

Peven, C.M., D.H. Sheffield, and P.C. Fielder. 1987. Rock Island Dam smolt monitoring, 1987. P.U.D. No. 1 of Chelan County, Wenatchee, WA.

Peven, C.M., and N. A. Duree. 1990. Rock Island Dam smolt monitoring, 1990. P.U.D. No. 1 of Chelan County, Wenatchee, WA.

Raemhild, G.A., T.W. Steig, E.S. Kuehl, S. Johnston and J. Condiotty. 1985. Hydroacoustic assessment of downstream migrating salmon and steelhead at Rock Island Dam in 1984. Biosonics, Seattle, WA.

Steig, T.W. and B.H. Ransom. 1991. Hydroacoustic evaluation of the effectiveness of passing downstream juvenile salmon through the south channel spillway at Rock Island Dam during the summer of 1990. Hydroacoustic Technology, Seattle, WA.

Truscott, K.B. 1985. Rock Island Dam smolt monitoring, 1985. P.U.D. No. 1 of Chelan County, Wenatchee, WA.

Truscott, K.B. 1992. Rock Island Dam smolt monitoring, 1992. P.U.D. No. 1 of Chelan County, Wenatchee, WA.

Rocky Reach Project Spill For Juvenile Fish Protection

Spring and Summer Spill Plans For 1994

DRAFT

Charles M. Peven

January 25, 1994

Chelan County Public Utility District
P.O. Box 1231
Wenatchee, WA 98807

Introduction

In 1975, the Directors of the Washington Departments of Fisheries (WDF) and Game (now Wildlife; WDW) wrote letters to the managers of the mid-Columbia Public Utility Districts concerning the problems affecting the fisheries resources in the mid-Columbia River basin. Through the Federal Energy Regulatory Commission (FERC) process, a Settlement Agreement (Agreement) was reached in 1979 between the Fisheries Resource agencies, Indian Tribes, and the three mid-Columbia PUDs. As part of the Agreement, the PUDs were required to spill a set amount of water through their spillways each spring to increase the survival of juvenile salmonids passing their projects.

In 1984, the mid-Columbia Coordinating Committee (Committee) recognized that the original deadline of five years outlined in the Agreement for studies to determine a long term program to protect downstream migrants would not suffice, and the Parties to the Agreement negotiated what is known as the mid-Columbia Stipulation for 1985 and beyond. The Fisheries agencies and Tribes and the mid-Columbia PUDs have negotiated separate Stipulations for their respective projects under the FERC process. Chelan PUD (District) and the Fisheries Resource agencies and Indian Tribes have now entered into three revised Stipulations since 1984 for Rocky Reach Dam.

Between 1976 and 1993, the spill program at Rocky Reach Dam consisted of spilling 10% of the previous daily average flow (PDAF) for 10 hr per night for 30 days. It was agreed that the middle 80% of the juvenile migration passed the project in a 30 day period, starting around April 20.

In October, 1993, the Parties to the original Agreement signed the Third Revised Interim Stipulation. The following outlines the District's responsibilities from this Stipulation as relating to spill:

Spring Spill

For 1994 and 1995, the District will spill 15% of the PDAF for 30 days during the spring outmigration of juvenile salmonids. The starting date will be determined by the Designated Representatives from the District, Fisheries Resource agencies, and Indian Tribes. In addition, the District will provide up to six extra days of spring spill (at 15% PDAF) if necessary to encompass 90% of the run of Okanogan sockeye salmon. The 90th percentile for Okanogan sockeye will be estimated from the fish caught at the fish guidance studies at unit one. If insufficient numbers of fish are being caught at the fish guidance studies, the Designated Representatives will decide on what index to use for determining the 90th percentile of the sockeye outmigration.

Summer Spill

For 1994 and 1995, the District will spill 10% of the PDAF for a total of 34 days between June 15 and August 15. This spill will occur four nights per week (Tuesday through Friday). The Designated Representatives have the authority to arrange the days of spill differently if desired in order to encompass periods when large numbers of migrants are present.

ATTACHMENT 3

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
P.O. Box 47600 • Olympia, Washington 98504-7600
(206) 407-6000 • TDD Only (Hearing Impaired) (206) 407-6006

July 1, 1994

Mr. Don Zeigler
Director of Natural Resources
Public Utility District No. 2 of Grant County
P.O. Box 878
Ephrata, WA 98823

Dear Mr. Zeigler:

Enclosed is Order No. DE 94WQ-227. All questions and correspondence relating to this document should be directed to Eric Schlorff, Department of Ecology, P.O. Box 47600, Olympia, Washington 98504-7600, (206) 407-6478.

This Order is issued to allow exceedance of the total dissolved gas criteria as shown in the surface water quality standards (Chapter 173-201A WAC) to aid summer fish passage on the middle reach of the Columbia River. This order will be effective through August 9, 1994.

Sincerely,

Michael T. Llewelyn
Program Manager
Water Quality Program

ML:ES:ak
Enclosure

DEPARTMENT OF ECOLOGY

IN THE MATTER OF THE REQUEST BY PUBLIC UTILITY DISTRICT NO. 2 OF GRANT COUNTY FOR TEMPORARY MODIFICATION OF THE STATE SURFACE WATER QUALITY STANDARDS FOR TOTAL DISSOLVED GAS CRITERIA ON THE COLUMBIA RIVER	))))))	ADMINISTRATIVE ORDER No. DE94-WQ227

To: Mr. Don Zeigler
Public Utility District No. 2 of Grant County
P.O. Box 878
Ephrata, WA 98823

Public Utility District No. 2 of Grant County, hereby referred to as the responsible party, submitted a request on June 30, 1994, to the Department of Ecology (Ecology) for temporary modification of the State's surface water quality standards for the purpose of exceeding water quality standards for total dissolved gas on the Columbia River.

The responsible party is authorized to perform activities which will exceed water quality standards for total dissolved gas; any actions resulting in exceedance of water quality standards for total dissolved gas shall comply with the conditions listed in this Administrative Order.

Any actions resulting in exceedance of water quality standards for total dissolved gas shall neither interfere with nor become injurious to beneficial uses.

The Department of Ecology retains continuing jurisdiction to make modifications hereto through supplemental Order if it appears necessary to protect beneficial uses or the public interest. This includes protection of wildlife, aquatic, and wetland resources.

This Order is issued under the provisions of Chapter 90.48 RCW and WAC 173-201A-110.

The responsible party shall comply with the following conditions during all activities covered under this Order:

1. Name of Waterbody: Middle Reach of the Columbia River

2. Locations: Wanapum and Priest Rapids dams.

3. A timing restriction is imposed for all activities resulting in exceedance of the water quality standards to the following period: Immediately upon issuance of this Order through August 9, 1994, or at such time as 80% of the summer migration is complete, which ever occurs first.

4. The responsible party shall obtain advance written approval from Ecology before making variations to this, and any, amended Order.

5. The responsible party performing the activities resulting in exceedance of water quality standards shall have this Administrative Order in possession and on site.

6. The responsible party shall allow an authorized representative of the Department of Ecology:

   A) To enter the premises where activity resulting in exceedance of water quality standards is taking place.

   B) To have access to and copy any records that must be kept under the terms of this Order.

   C) To inspect any monitoring equipment or method of monitoring required in this Order.

   D) To sample.

   E) To inspect operations.

7. The responsible party shall provide a reasonable estimate of the time and location where these permitted activities will take place and an emergency telephone number where they can be reached immediately upon the request of Ecology. A message by voice mail or FAX shall suffice for this condition.

   Contact Name: Eric Schlorff Contact Number: (206) 407-6478

8. A) The responsible party shall be responsible for monitoring. Monitoring shall be in place for total saturated gas when levels are in excess of 110% relative to atmospheric pressure.

   B) Total dissolved gas and biological monitoring shall be conducted in accordance with a monitoring plan to be submitted by the responsible party and approved in writing by Ecology. The monitoring plan will be designed to demonstrate that total dissolved gas concentrations do not exceed limits on this order and do not cause a significant increase in gas bubble disease related to mortality in salmon populations.

   C) A monitoring plan shall be submitted by July 8, 1994. Prior to written approval by Ecology of this monitoring plan, those monitoring activities undertaken in compliance with Order No. DE 94WQ-225, issued on May 26, 1994 to Public Utility District No. 2 of Grant County, shall remain in effect.

   D) Total dissolved gases shall not exceed a 24 hour average of 115%, or a one hour maximum of 120%, relative to atmospheric pressure. The responsible party shall at all times operate the river system in a manner to minimize total dissolved gas whenever the total dissolved gas levels exceed 110 percent.

   E) Total dissolved gas shall be measured at biological sampling sites.

F) At a minimum, summaries of monitoring results will be forwarded to Ecology each Monday for the previous week, with the first summary report due July 11, 1994, or upon request by Ecology officials.

9. The responsible party shall immediately notify Ecology of any exceedances of this order or any significant mortality or disease in aquatic organisms affected by the authorized activities.

10. Ecology may make such modifications to this order as it deems necessary in order to protect beneficial uses and the public interest.

Any person carrying out this project's activities who fails to comply with this Order may be subject to the issuance of civil penalties or other action, whether administrative or judicial, to enforce the terms of this Order.

This Order may be appealed. Your appeal must be filed with the Pollution Control Hearings Board, P.O. Box 40903, Olympia, Washington 98504-0903 within thirty (30) days of your receipt of this Order. At the same time, your appeal must also be sent to the Department of Ecology c/o The Enforcement Officer, P.O. Box 47600, Olympia, Washington 98504-7600; and to the Water Quality Program, P.O. Box 47600, Olympia, WA 98504-7600. Your appeal alone will not stay the effectiveness of this Order. Stay requests must be submitted in accordance with RCW 43.21B.320. These procedures are consistent with Ch. 43.21B RCW.

DATED this 1st day of July, 1994, at Olympia, Washington

Michael T. Llewelyn
Program Manager
Water Quality Program

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ATTACHMENT 4

COLUMBIA BASIN FISHERY AGENCIES AND TRIBES

FISH PASSAGE CENTER

2501 S.W. FIRST AVE. • SUITE 230 • PORTLAND, OR 97201-4752
PHONE (503) 230-4099 • FAX (503) 230-7559

MEMORANDUM

DATE: July 8, 1994

TO: Earl Dawley, NMFS - Hammond Field Station

FROM: Michele DeHart

RE: Potential impact of the spill program Snake River adult spring chinook delay and survival

In early June you requested the Fish Passage Center to address whether the spring spill program impacted adult passage through delay. The passage of fish through a river can be affected by, among other things, flow, project operations and temperature. To best address the question that you asked we summarized the cumulative passage timing distributions for the past ten years at Bonneville, Ice HarboR and Lower Granite dams. Keeping in mind that several environmental and physical factors affect passage, we developed the 95% confidence interval around the cumulative passage distribution.

The attached graphs show the 1984-1993 average cumulative distribution with the 95% confidence interval for Bonneville (Figure 1), Ice Harbor (Figure 2) and Lower Granite (Figure 3) dams. The 1994 cumulative passage distribution is plotted on each of the graphs. The experimental SPILL program was initiated on May 11, 1994. At that time approximately 90-100 percent of adult spring chinook were past Bonneville Dam and in the Columbia/Snake rivers. At this same time about 50% of the spring chinook had entered the Snake River. As can be seen from the graphs the adult migration timing was well within the 95% confidence interval at all three projects considered. We can conclude from this that compared to the past ten years of record there appeared to be no significant delay associated with the 1994 spill program. Keep in mind that while the percentages of spill were relatively high at each project, the overall flows in 1994 were quite low and therefore, the volume of spill was quite low.

In addition, we addressed whether there was an increase in adult mortality of Snake River spring chinook that could be attributed to the increased spill and increased levels of dissolved gas. While the dissolved gas levels exceeded the state standards, the level remained below 120%, and were not as high as measured in past years. For example at Ice Harbor Dam the actual levels of dissolved gas during this spring in most cases did not exceed the mean of the daily averages for 1982 to 1993 (Figure 4).

To determine if there was unusual levels of mortality we calculated the conversion rates for spring chinook between Ice Harbor and Lower Granite dams over the ten year record and compared the historic conversion rates to that observed for spring chinook in 1994. A one sample t-test was conducted between the 1994 conversion rates and the 10-year record. Based on this analysis we conclude that 1994 conversion was no different than any other year, and no increase in mortality can be ascribed to the 1994 spill program. If you have any further questions please contact Margaret Filardo (503) 287-2345.

Figure 1. Conversion rates of adult spring chinook between Ice Harbor and Lower Granite dams from 1984-1994.

YEAR	IHR COUNT	LGR COUNT	CONVERSION RATE
1984	8137	6511	0.880
1985	31306	25207	0.805
1986	38040	31576	0.830
1987	31276	28835	0.922
1988	33336	29495	0.885
1989	15376	12955	0.843
1990	20512	17315	0.844
1991	10171	6623	0.651
1992	25401	21391	0.842
1993	24693	21035	0.852
1994	3378	2982	0.883

Attachments

cc: FPAC

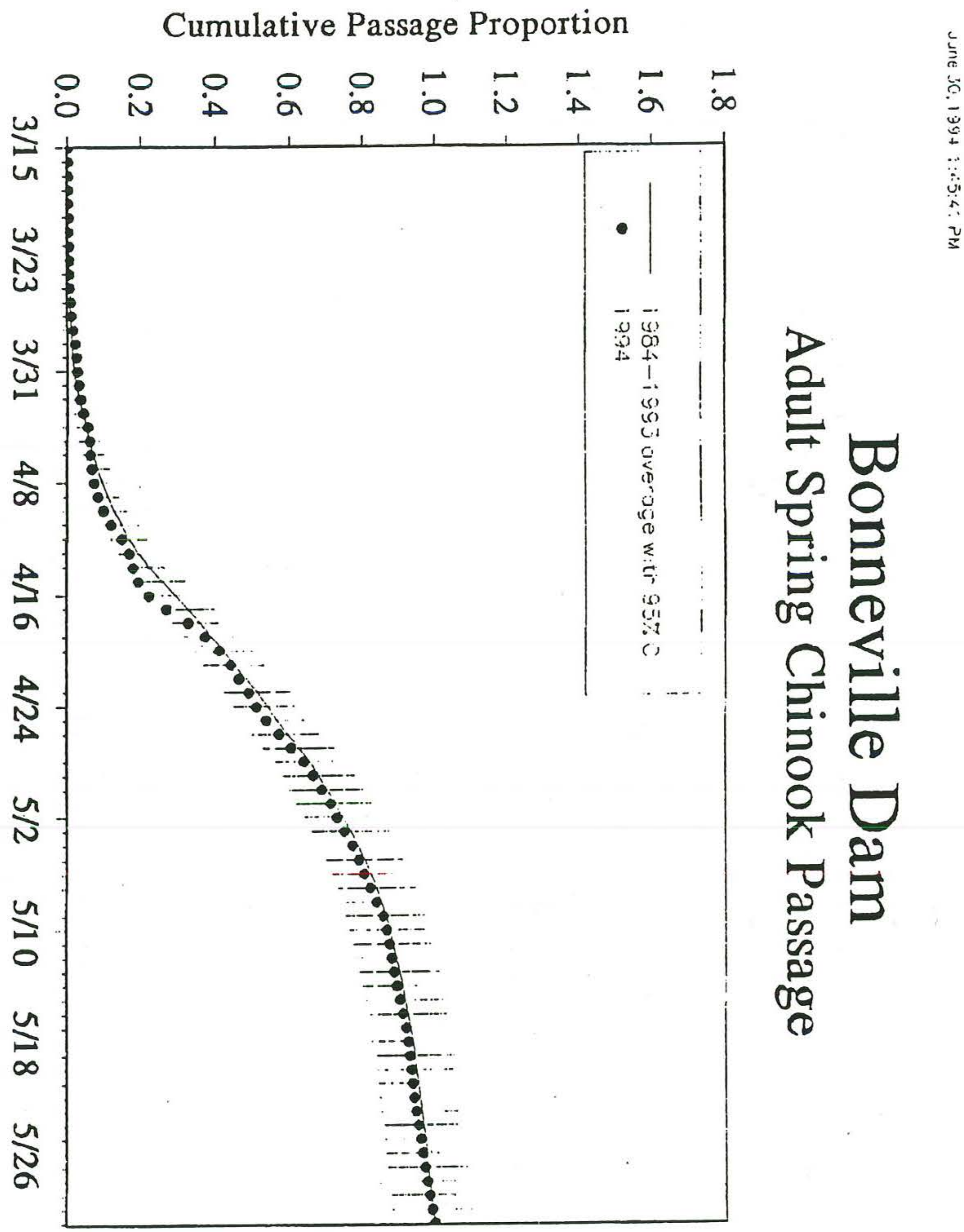


Figure 1. Historic cumulative passage distribution at Bonneville Dam.

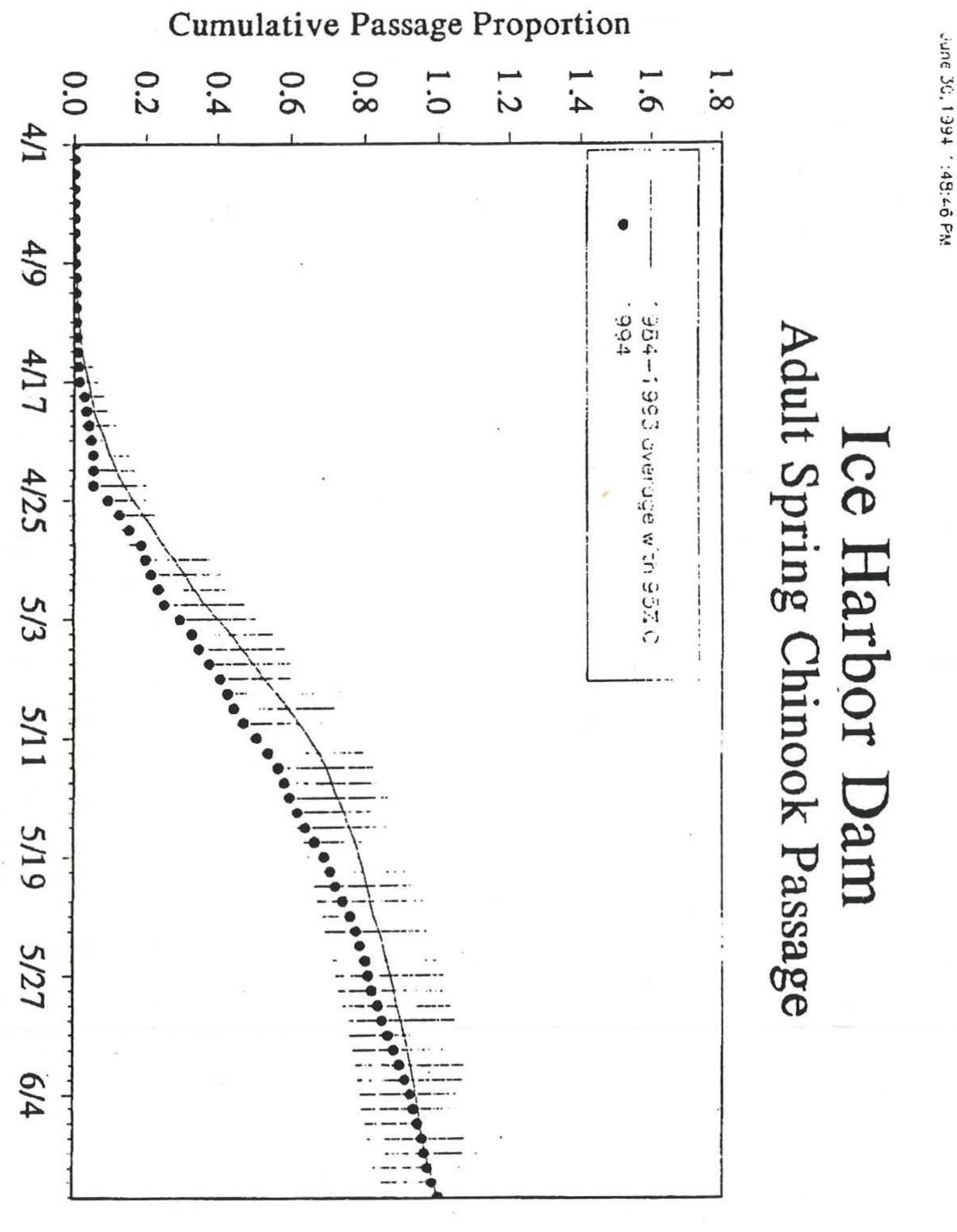


Figure 2. Historic cumulative passage distribution at Ice Harbor Dam.

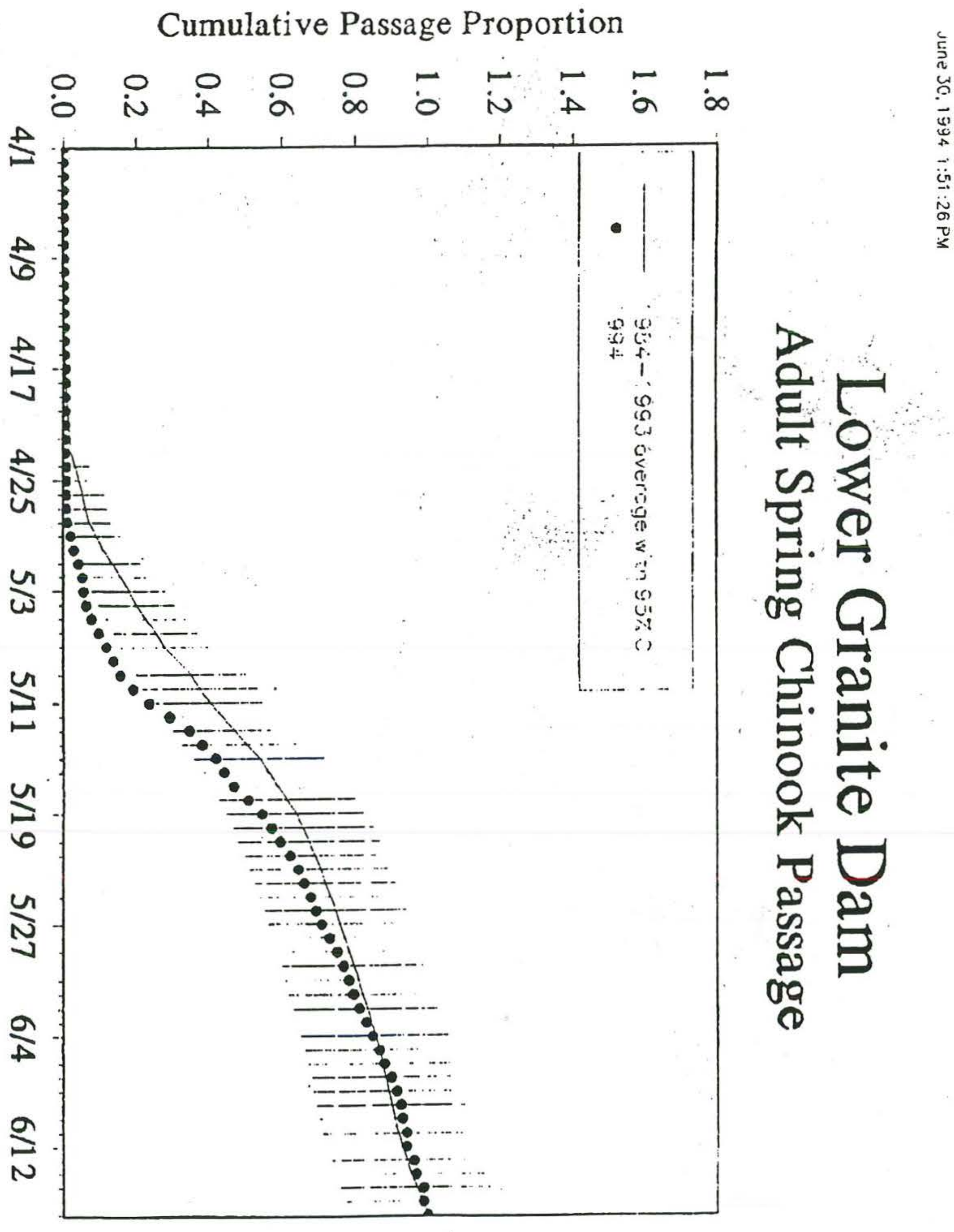


Figure 3. Historic cumulative passage distribution at Lower Granite Dam.

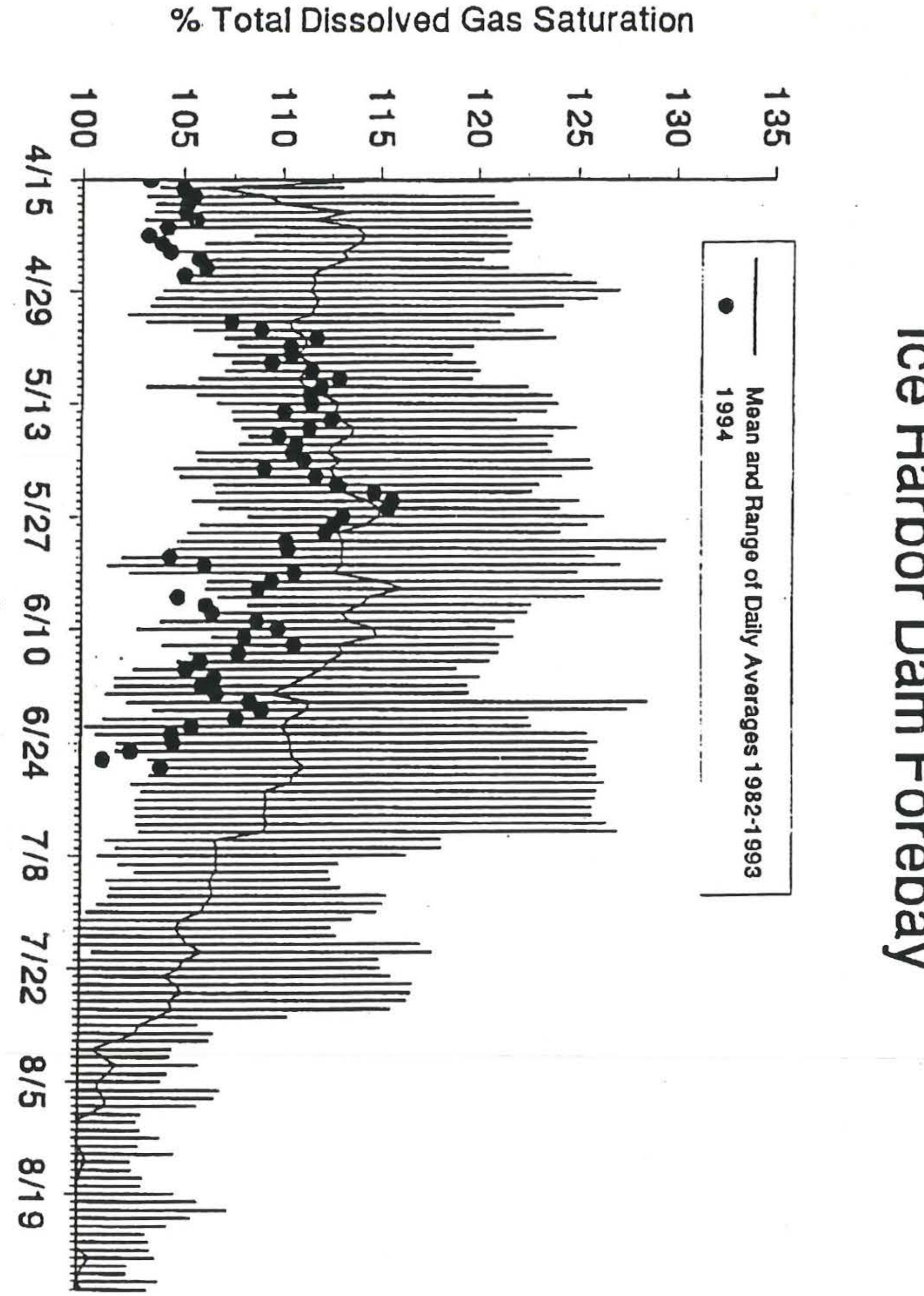


Figure 4. Historic mean values for dissolved gas in Ice Harbor Dam forebay.

Summer migrants timing in Lower Columbia River

Information on the migration timing of listed Snake River fall chinook in the lower Columbia River is limited. In the past three years, a total of 15 listed fall chinook PIT tagged by USFWS in the Snake River have been detected at McNary Dam. McNary Dam detections spanned periods of one to two months each year (Table 1). The 1994 fall chinook migration past Lower Granite Dam appears later than expected based on USFWS predictions of emergence timing. Current flow levels are more similar to what occurred in 1991 during July. Fall chinook timing appears to be delayed, and may follow the 1991 passage pattern closer than that of the other two years. This would place the bulk of listed Snake River fall chinook which originate above Lower Granite Dam in the lower Columbia River during August. Currently, increased numbers of wild subyearling chinook have been passing Lower Monumental Dam. These fish are presumed to be fall chinook from the Tucannon River. These fall chinook are tending to be larger size, averaging around 130 mm at Lower Monumental Dam, than their counterparts passing Lower Granite Dam, which have been averaging less than 110 mm. The anticipated migration timing of these listed fall chinook through the lower Columbia River would be in July. Altogether, Snake River origin fall chinook are expected to be present in the lower Columbia River during both July and August.

Table I. Listed fall chinook detections at McNary Dam, 1991-93.

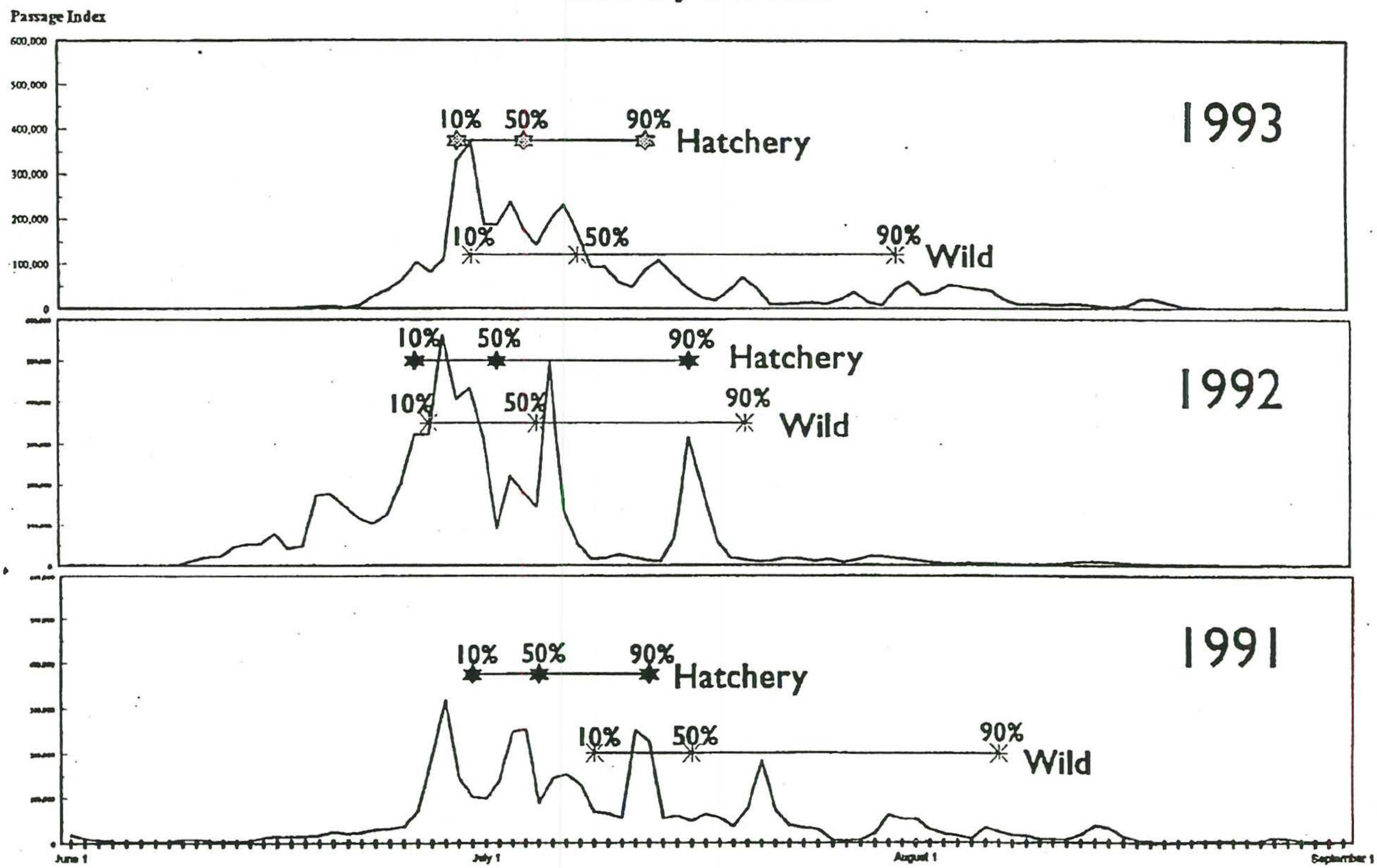
Year	Earliest	Latest	Number
1991	8/10	9/6	4
1992	6/1	8/8	7
1993	6/26	8/18	4

Subyearling chinook from the Mid-Columbia River are currently in the lower Columbia River in large numbers at this time. Collections at McNary Dam approached 417,000 on July 6. These would include fish from the 12 million released from Priest Rapids, Wells, Turtle Rock, and Ringold hatcheries. In addition wild fall chinook from the Hanford reach are currently passing McNary Dam. The hatchery stocks will predominately pass McNary Dam during July, while the Hanford reach wild fall chinook will be present during both July and August, based on recoveries of marked fish in prior years (see Figure 10 from Wagner 1994). Freeze branded fall chinook from 2.8 million released from Umatilla Hatchery continue to pass John Day and Bonneville dams at this time. All together there are millions of subyearling chinook currently migrating through the lower Columbia River at this time, and large numbers of subyearling chinook will continue to migrate there during the remainder of July and August. The time when the 90% date of passage occurs at a downstream site for a given year is variable and dependent on both physical and biological factors. Since 1986, the 90% passage date at John Day Dam for subyearling chinook has ranged from August 15 to September 18, with the later date occurring during the low flow year of 1987.

567-94.tb

Figure 10. Subyearling Chinook Passage Index with the 10%, 50%, and 90% Passage Dates.

Hatchery and Wild



Source: Wagner, 1994

MEMORANDUM

June 10, 1994

To: Rob Lothrop

EW

From: Earl Weber & Paul Wilson

Subject: Fall chinook analysis

This memo describes an analysis of management options being considered for fall chinook in 1994. In all simulations, the flow year 1992 was used as a surrogate for 1994 in terms of flows, temperatures and reservoir elevations. Because 1992 conditions were used as a baseline situation, it was necessary to subtract volumes of water added during specific periods in 1992 and, also, to remove the effects of cold (46 degree F.) water drawn from Dworshak Reservoir in July of 1992. The temperature profile that would have occurred in 1992 without cold water from Dworshak was estimated with the model COLTEMP developed by the Army Corps of Engineers and applied by the Columbia River Inter-Tribal Fish Commission . Survival of fall chinook under different management options was estimated with the FLUSH Model developed cooperatively by the State Agencies and Tribes (STFA).

The four reservoir/flow options analyzed were:

1. Base - 1992 conditions with flow augmentation that was applied that year removed.

2. Option 1 - Dworshak to 1520 beginning July 1 (616 KAF; 15 KCFS for 21 days); Brownlee to 2055 beginning July 1 (286 KAF; 10 KCFS for 15 days). Columbia Flows of 200 KCFS in July and 160 KCFS in August.

3. Option 2 - Dworshak to 1490 beginning July 1 (969 KAF; 15 KCFS for 33 days); Brownlee to 2045 beginning July 1 (397 KAF; 10 KCFS for 20 days). Columbia Flows of 200 KCFS in July and 160 KCFS in August.

4. NMFS - 40 KCFS minimum in Snake June 21 - July 31, 160 KCFS minimum in Columbia in July.

For each of the above flow options, survivals were computed for five different spill programs (Table 1, Figure 1). The five spill programs were:

1. Spill proportions from the 1989 Spill MOA (constant proportion spill at non-collector projects, no spill at collector projects)

2. Spill for 80% Fish Passage Efficiency (FPE) at all projects

3. Spill for 80% FPE at non-collector projects, no spill at collector projects

4. Spill for 80% FPE at all projects, except no spill at McNary Dam

5. Spill for 80% FPE at non-collector projects, spill for 50% FPE at collector projects

In all scenarios it was assumed that all fish surviving the bypass at collector projects would be transported. However, because transportation studies on Snake River fall chinook have not been conducted, no attempt was made to estimate the survival of transported fish and only in-river survival estimates are presented.

Water drawn from Dworshak in the STFA Options is water of approximately 46 degrees F. The cold water is allocated among the first three or four weeks of July. Simulations assumed a 12.5% reduction in predator mortality in each reservoir. Other parameters have those values delineated in previous documents.

RESULTS

Results of the simulations are shown in Figure 1. The NMFS option showed the highest survival values but whether or not this is realistic depends on the ability to maintain a 40 KCFS minimum in late June and July. In actuality, Option 2 drafts of Dworshak and Brownlee may be the most optimistic scenario for any of the options. All options indicate poor survival but a combination of flow augmentation and spill provide substantial relative gains.

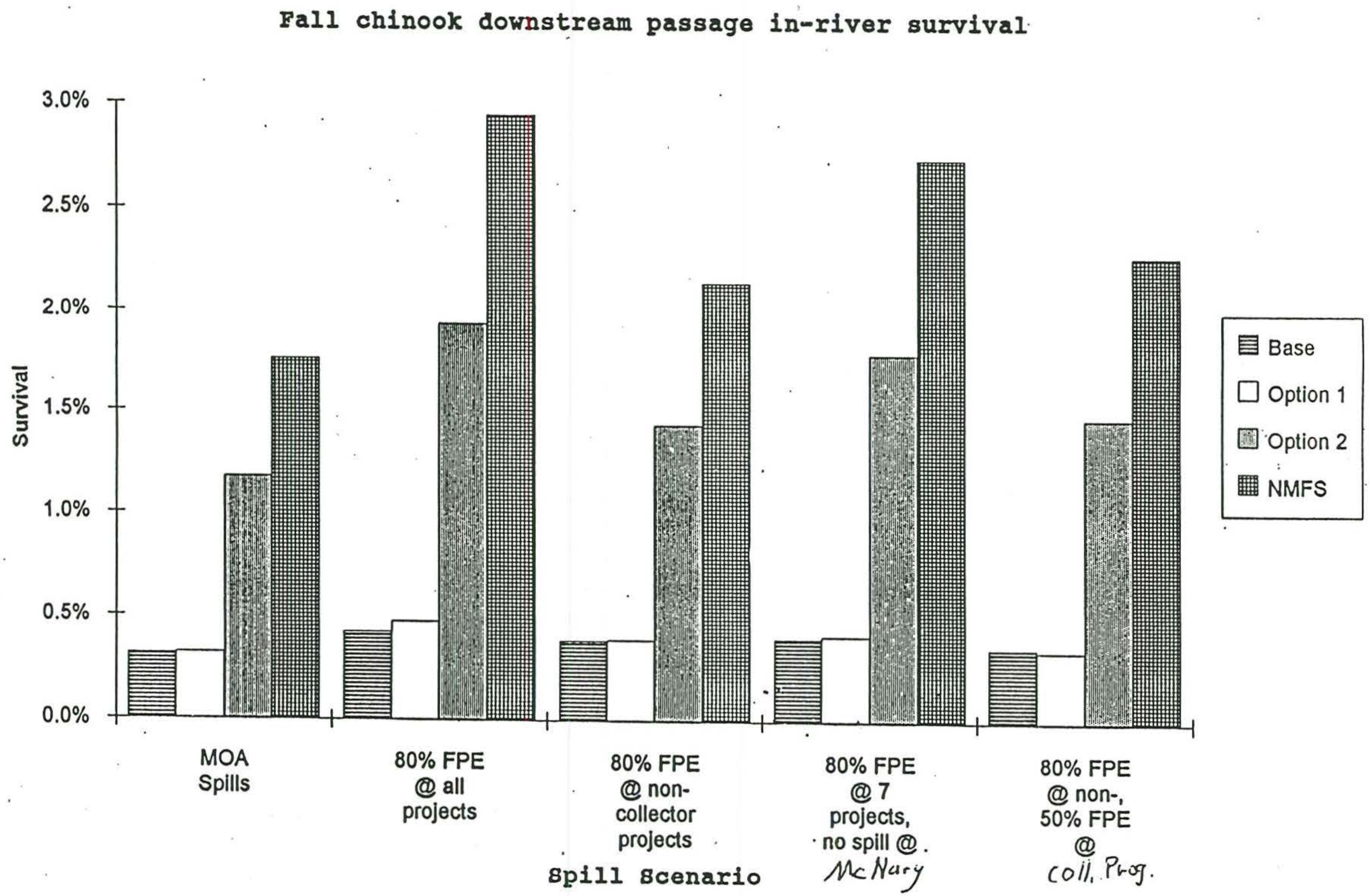

Fall chinook downstream passage in-river survival
3.0%
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
Survival
Base
Option 1
Option 2
NMFS
MOA Spills
80% FPE @ all projects
80% FPE @ non-collector projects
80% FPE @ 7 projects, no spill @ McNary
80% FPE @ non-, 50% FPE @ coll. Proj.
Spill Scenario

Figure 1

ATTACHMENT 6

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
729 N.E. Oregon, Suite 200, Portland, Oregon 97232
Telephone (503) 238-0667
Fax (503) 235-4228

July 1, 1994

Dr. Charles Coutant
Oak Ridge National Laboratory
Post Office Box 2008; Mail Stop 6036
Oak Ridge, Tennessee
37831-6036

Dear Dr. Coutant:

Upon reviewing the latest draft of the NMFS Dissolved Gas Panel Report and Recommendations, I have found some statements in which I cannot concur. Some of them I had commented upon in the previous draft and my comments did not appear in this current draft. Other statements are incomplete and are likely to be easily misinterpreted. I offer the following comments with respect to these statements.

Management use of the Report

It would be inappropriate to use the report to determine the feasibility of continuing future spill programs, because it was not the panel's intent for the report to be used in this fashion.

The panel meeting was formed in haste and addressed a very limited scope of issues. The questions posed to the panel and time restraints directed the panel's attention away from an analysis of in-river aspects of the effects of elevated gas levels toward summation of the more abundant information derived from laboratory studies. These points should be given emphasis in the report.

Gas Bubble "disease"

As I had commented on in the earlier draft, the term "gas bubble disease" was used by the panel as a matter of convention but leads to misunderstanding. The cause of the bubbles is not pathogenic, but a physical response resulting from pressure imbalances between liquid and gas phases as described by Jensen et. al (1986). Fidler (1982) suggested that, "gas bubble trauma" is a more appropriate phrase. I recommend that trauma be used in the report and that this important point be clarified in the report.

Implications of environmental and other variables on GBT occurrence

I am particularly concerned that the panel did not acknowledge and describe the impact of environmental and stock variables in conjunction with total gas pressure on the occurrence of GBT. Examples of these are water temperature, atmospheric pressure, fish physiological condition, size, species and life history stage. Jensen et al. (1986) and Alderdice and Jensen (1985) stressed that the biological response to total gas pressure is strongly influenced by the synergistic effect of these factors which have a "sparing effect" with respect to GBT occurrence. It is too simplistic and misleading to characterize the 110% standard as adequate without acknowledging consideration of these other factors and their influence on GBT.

Table of cited literature

The panel must state at the beginning that studies in the table are only laboratory studies and are not necessarily applicable to in-river situations. After I had sent you my comments on the previous draft, Earl Dawley faxed me a summation of a number of in-river studies. It is now evident to me that the report should acknowledge that there have been some extensive in river studies performed (Toner 1993; Weitkamp 1977; Weitkamp and Katz 1980; Dawley 1986; Gray and Haynes 1977) which generally indicate that fish in the river are able to tolerate gas levels in excess of 110% likely because of hydrostatic compensation and other mitigative elements.

BPA and NMFS Monitoring Review Document

It seems premature to recommend consideration of this document before the panel has had a chance to review it.

110% standard

We need to be consistent in what we say about this standard. In one place we say it is adequate, but in another we say that signs of GBT may be expected to occur in salmonids inhabiting shallow waters at the 110% level. Without the panel's review of existing in-river studies, we cannot say that this standard, while perhaps appropriate in a laboratory situation, is applicable as an in river standard.

It was the paucity of information available to the panel on the direct effects of spill and associated total dissolved gas that prompted the panel to recommend scientifically sound monitoring, evaluation and scientific studies to improve the knowledge base when gas levels exceed the state and EPA standard of 110%. The panel recognized that the 110% standard has a built-in safety factor such that actual tolerance to elevated gas is above the 110% level. The panel acknowledged that Columbia and Snake River gas levels frequently exceed the 110% standard.

I strongly support the panel's recommendation that river managers seek a long term permanent solution to high levels of total dissolved gas, which may require substantial structural changes at dams. Research is not an end in itself. Even though research may provide managers a better understanding of risks to survival, in the long term successful management should eliminate the need to conduct risk analysis investigations involving handling and subsequent impacts to declining stocks at risk of extinction.

Sincerely,

Dr. Thomas Backman

cc: reference lists

backgas.4

REFERENCES

Alderdice, D.F. and J.O.T. Jensen. 1985. Assessment of the influence of gas supersaturation on salmonids in the Nechako River in relation to Kemano completion. Canadian Technical Report of Fisheries and Aquatic Sciences. 1386: 48 pages.

Dawley, E.M. 1986. Effects of 1985-6 levels of dissolved gas on salmonids in the Columbia River. Coastal Zone and Estuarine Services Division. National Marine Fisheries Service. Seattle, Washington.

Gray, R.H. and J.M. Haynes. 1977. Depth distribution of adult chinook salmon (Oncorhynchus tshawytscha) in relation to season and gas-supersaturated water. Transactions of the American Fisheries Society. Volume 106. Page 6.

Jensen, J.O.T., J. Schnute and D.F. Alderdice. 1986. Assessing a juvenile salmonid response to gas supersaturation using a general multivariate dose-response model. Canadian Journal of Fisheries and Aquatic Sciences. Volume 43. Pages 1694-1709.

Toner, M.A. 1993. Evaluation of the effects of dissolved gas supersaturation on fish and invertebrates downstream of Bonneville Dam. 1993. Coastal Zone and Estuarine Services Division. National Marine Fisheries Service. Contract E96930036 to the United States Army Corps of Engineers. North Pacific Division. Portland, Oregon.

Weitkamp, D.E. 1977. Gas bubble disease of resident fish and juvenile salmonids in the Columbia River system. Doctoral dissertation. University of Washington College of Fisheries. Seattle Washington.

Weitkamp, D.E. and M. Katz. 1980. A review of dissolved gas supersaturation literature. Transactions of the American Fisheries Society. Volume 109. Pages 659-702.

SALMONID HOLDING TESTS AT AMBIENT RIVER SATURATION

Researcher	Site	Species	Avg. TGP	Period	Death
	0-3 FEET DEPTH				
Ebel (1969)	Priest Rap. Dam	Coho	142%	< 8d	100%
Beiningen and Ebel (1969)	The Dalles Dam	Chin.(0's)	135%	--	98%
Ebel (1971)	Ice Harbor Dam	Chin.(0's)	130%	7d	100%
Ebel (1969)	Priest Rap. Dam	Coho	130%	< 8d	100%
Ebel (1971)	Ice Harbor Dam	Chin.(1's)	127%	7d	100%
Meekin and Turner (1974)	Rocky Reach Dam	Chin.(0's)	126%	3d	100%
		Steelhead	126%	3d	100%
		Coho	126%	3d	100%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	124%	3d	100%
Meekin and Turner (1974)	Wells Dam	Chin.(0's)	123%	7d	97%
		Steelhead	123%	3d	92%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	123%	20d	88%
			121%	10d	53%
Blahm et al.(1976)	Prescott Ore.	Chin.(0's)	120%	55d	80%
		Steelhead	120%	55d	80%
Ebel (1969)	Priest Rap. Dam	Chin.(1's)	118%	92d	7%
Dawley (1986)	The Dalles Dam	Chin.(1's)	110%	5d	9%
	3-5 FEET DEPTH				
Meekin and Turner (1974)	Wells Dam	Coho	125%	7d	18%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	124%	20d	30%
Meekin and Turner (1974)	Wells Dam	Chin.(0's)	123%	3d	92%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	123%	20d	1%
			121%	20d	0%
Dawley (1986)	The Dalles Dam	Chin.(1's)	110%	5d	2%
	4-6 or 5-7 FEET DEPTH				
Ebel (1971)	Ice Harbor	Chin.(0's)	130%	7d	53%
Meekin and Turner (1974)	Wells Dam	Chin.(0's)	123%	10d	25%
		Coho	125%	13d	0%
	6-9 FEET DEPTH				
Ebel (1969)	Priest Rap. Dam	Coho	142%	8d	70%
		Coho	130%	8d	5%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	124%	20d	1%
			123%	20d	1%
			121%	10d	0%
Ebel (1969)		Chin.(1's)	118	92d	2%

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL | # of pages ▶ 2

To Tom Backman | From Earl Dawley

Dept./Agency | Phone #

Fax # for your Info.

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

0-7 FEET OF DEPTH

Meekin and Turner (1974)	Rocky Reach Dam	Chin.(0's)	126%	30d	65%
		Steelhead	126%	30d	60%
		Coho	126%	30d	4%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	124%	20d	61%
			123%	20d	17%
			121%	10d	0%
Blahm et al.(1976)	Prescott Ore.	Chin.(0's)	120%	55d	11%
		Steelhead	120%	55d	6%

0-10 FEET OF DEPTH

Meekin and Turner (1974)	Rocky Reach Dam	Chin.(0's)	126%	21d	3%
		Steelhead	126%	21d	0%
		Coho	126%	21d	0%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	124%	20d	8%
			123%	20d	3%
			121%	10d	0%

0-13 or 0-18 FEET OF DEPTH

Beiningen and Ebel (1969)	The Dalles Dam	Chin.(0's)	135%	--	28%
Ebel (1971)	Ice Harbor Dam	Chin.(0's)	130%	7d	58%
Ebel (1969)	Priest Rap. Dam	Coho	130%	8d	16%
Ebel (1971)	Ice Harbor Dam	Chin.(1's)	127%	7d	45%
Weitkamp (1976)	Rock Isl. Dam	Chin.(0's)	124%	20d	0%
			123%	20d	0%
			121%	10d	0%
Ebel (1969)	Priest Rap. Dam	Chin.(0's)	118%	92d	6%
Dawley (1986)	The Dalles Dam	Chin.(1's)	110%	5d	1%

AVOIDANCE TESTS

Meekin and Turner (1974)	Chinook (0's)	>115%	lateral	Avoided
	Coho	>115%	lateral	None
McConnell and Davis(1975)	Chinook (0's)	130%	lateral	Avoided
	Steelhead	130	lateral	None
Dawley et al. (1975)	Chinook (1's)	130%	vertical	Avoided
	Steelhead	130%	vertical	None

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION

1994 REQUEST TO THE OREGON AND WASHINGTON GOVERNORS

FOR

IMPLEMENTING A SUMMER SPILL PROGRAM

IN THE COLUMBIA AND SNAKE RIVERS

KEY POINTS

1. ALLOW UP TO A DAILY AVERAGE OF 120% TGP

2. ALLOW UP TO AN INSTANTANEOUS AVERAGE OF 125% TGP

3. IMPROVE THE EXISTING PHYSICAL MONITORING PROGRAM

4. CONTINUE THE EXISTING BIOLOGICAL MONITORING PROGRAM

5. IMPLEMENT THE PROGRAM IMMEDIATELY AND CONTINUE THROUGH AUGUST 31, 1994 TO PROTECT THE SUMMER ANADROMOUS FISH MIGRATION

SCIENTIFIC RATIONALE
FOR IMPLEMENTING A SUMMER SPILL PROGRAM TO INCREASE JUVENILE SALMONID SURVIVAL IN THE SNAKE AND COLUMBIA RIVERS

By

Columbia River Inter-Tribal Fish Commission
Idaho Department of Fish and Game
Oregon Department of Fish and Wildlife
United States Fish and Wildlife Service
Washington Department of Fish and Wildlife

RISK ASSESSMENT

1. LITERATURE REVIEW

a. gas bubble trauma literature

b. bypass literature

2. REVIEW OF CURRENT IN-RIVER CONDITIONS

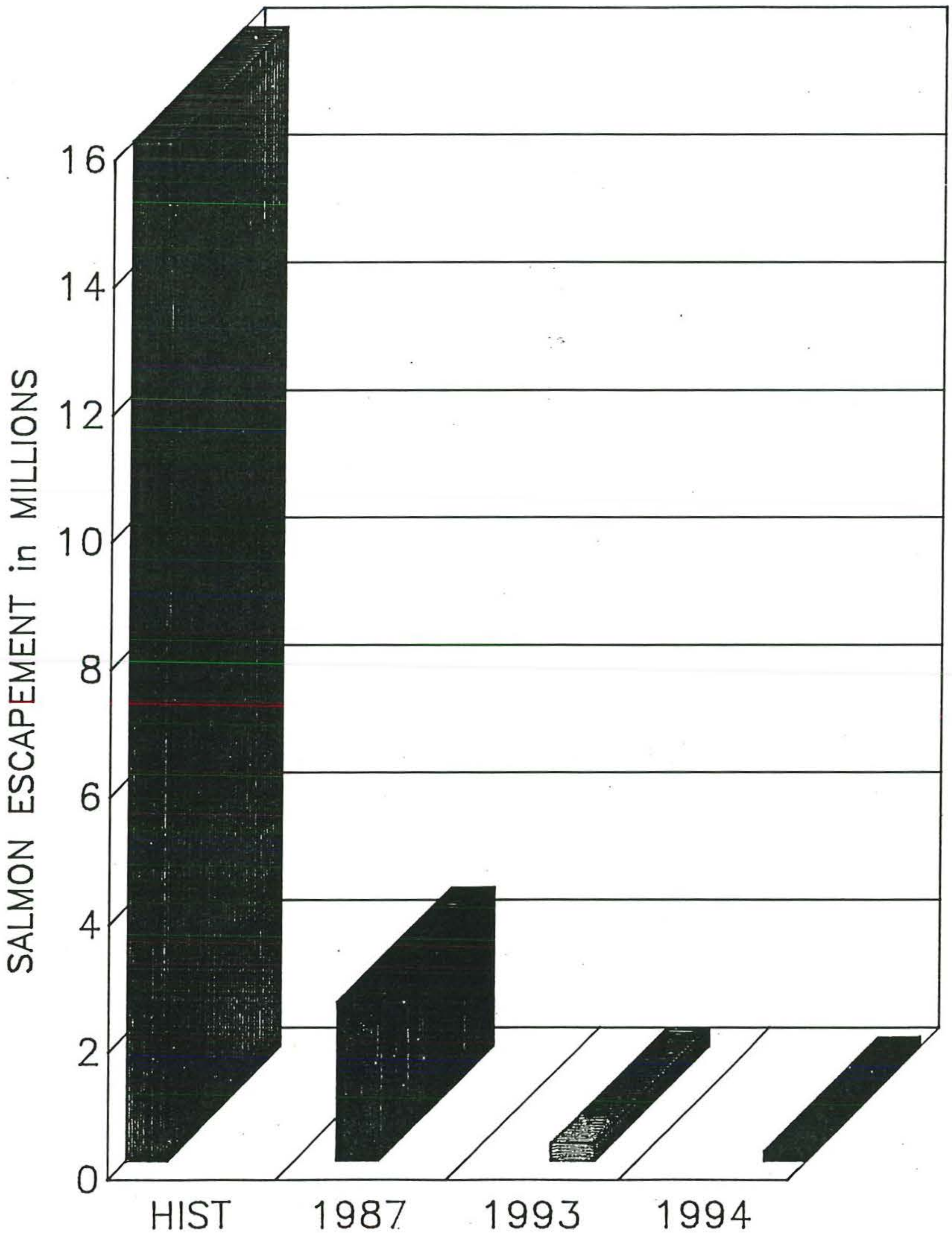
3. PROFESSIONAL JUDGEMENT OF THE FISHERY MANAGERS

RECOMMENDATIONS OF THE FISHERY MANAGERS

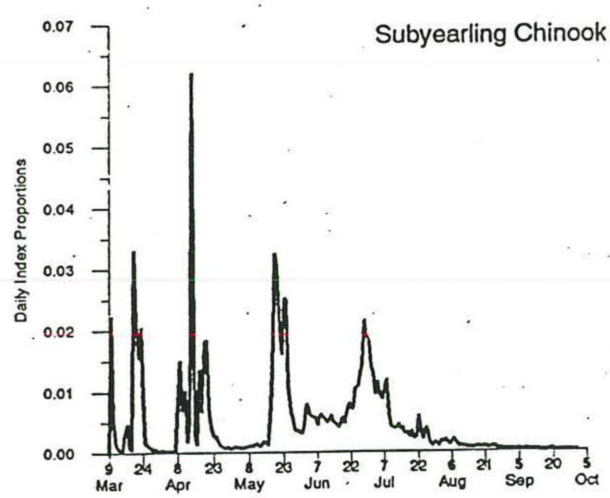
1. **ADOPT 120/125% TGP STANDARD WITH THOROUGH PHYSICAL AND BIOLOGICAL MONITORING PROTOCOLS**

2. **DIRECT HYDROSYSTEM OPERATORS TO IMPLEMENT STRUCTURAL AND OPERATIONAL CHANGES AT DAM TO ALLEVIATE ALL WATER QUALITY IMPACTS TO ANADROMOUS FISH (TEMPERATURE, NON-POINT AND POINT SOURCE POLLUTION)**

DECLINE IN COLUMBIA RIVER SALMON ESCAPEMENT



Bonneville Dam
1988 - 1993



Juvenile passage timing at Bonneville Dam.

much slower migration this year

Table 1. Turbine mortalities of juvenile chinook, coho, and steelhead from studies at Columbia River dams with kaplan-type turbines.

Dam	Year(s)	Species	(%) Mortality
Bonneville I[a]	1942-47	Subyearling chinook	15
McNary[b]	1955-56	Subyearling chinook	11
Ice Harbor[c]	1968	Yearling chinook	32
L. Monumental[d]	1972	Yearling coho	20
John Day[e]	1979	Subyearling chinook	13
Wells[f]	1980	Yearling steelhead	16
L. Granite[g]	1987	Yearling chinook	17
Bonneville II[h]	1989	Subyearling chinook	18
L. Granite[i]	1993	Yearling chinook	18
L. Goose[i]	1993	Yearling chinook	8

Source

[a] Holmes 1952.
[b] Schoeneman et al. 1961.
[c] Long 1968.
[d] Long et al. 1975.
[e] Raymond and Sims 1980.
[f] Weitkamp et al. 1980.
[g] Gilbreath et al. 1993.
[h] Giorgi and Stuehrenberg 1987.
[i] Iwamoto et al. 1993.

Table 2. Spillway mortalities of juvenile chinook, coho, and steelhead from studies at Columbia River dams

Dam	Year(s)	Species	(%) Mortality
Bonneville I[a]	1942-47	Subyearling chinook	3
McNary[b]	1955-56	Subyearling chinook	2
L. Monumental[c]	1974	Yearling coho	0
		Yearling steelhead	2
Bonneville I[d]	1974	Subyearling chinook	4
John Day[e]	1979	Subyearling chinook	0
Wells[f]	1980	Yearling steelhead	0
Rocky Reach[g]	1980	Yearling coho	1
Bonneville II[h]	1989	Subyearling chinook	1
L. Goose[i]	1993	Yearling chinook	0

Source

[a] Holmes 1952.
[b] Schoeneman et al. 1961.
[c] Long et al. 1975 (with spillway deflectors).
[d] Johnsen and Dawley 1974 (with spillway deflectors).
[e] Raymond and Sims 1980.
[f] Weitkamp et al. 1980.
[g] Heinle and Olson 1980.
[h] Gilbreath et al. 1993.
[h] Giorgi and Stuehrenberg 1987.
[i] Iwamoto et al. 1993.

Table 3. Mortalities of juvenile chinook, coho, and steelhead held in surface to deep live cages in the Snake and Columbia Rivers.

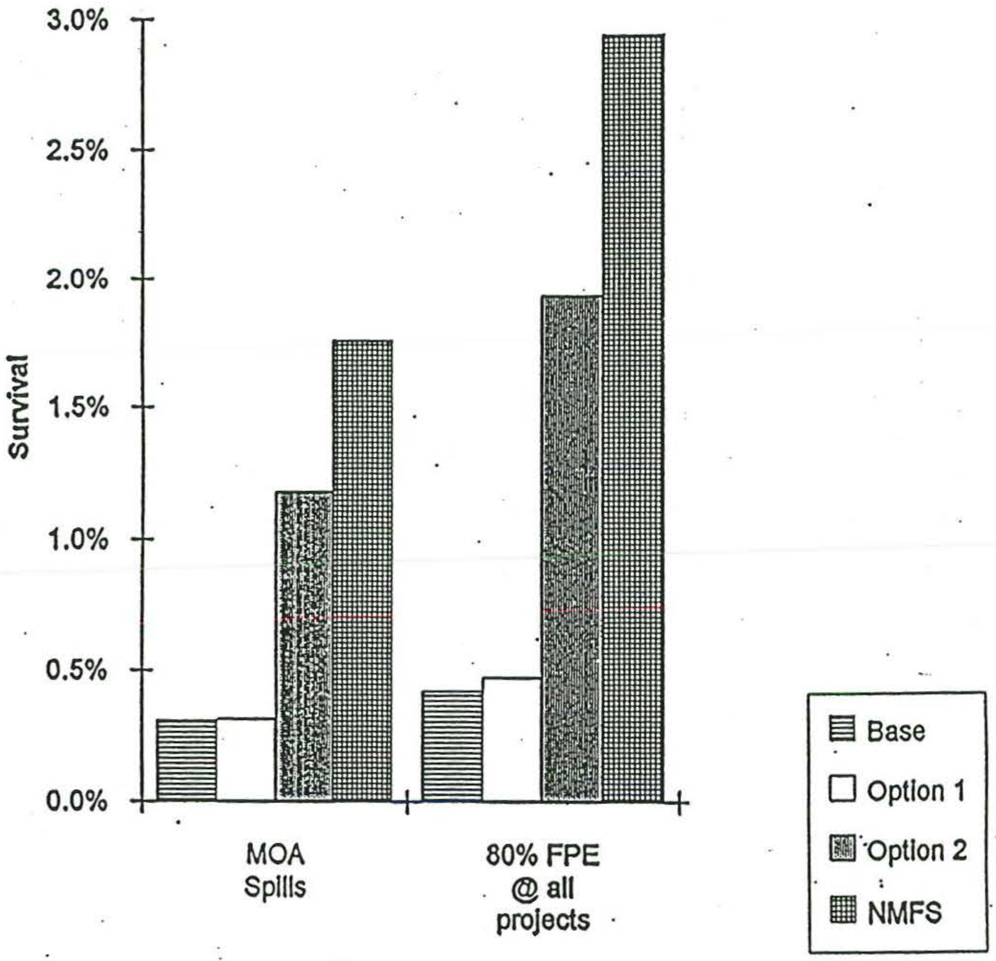
Species	Depth (m)	Exposure (d)	TDG (%)	Mortality (%)
Coho[c]	0-3.1	21	128	0
Chinook[c]	0-3.1	21	128	3
Steelhead[c]	0-3.1	21	128	0
Chinook[d]	0-1	20	120-128	88-100
	0-2	20	120-128	17-61
	0-3	20	120-128	3-8
	0-4	20	120-128	0

<u>Source</u>

[c] Meekin, T.K. and B.K. Turner (1974)

[d] Weitkamp, D.E. (1976)

Fall chinook downstream passage in-river survival



Spill Scenario

OREGON NATURAL RESOURCES COUNCIL

MAIN OFFICE

YEON BUILDING, SUITE 1050
522 SOUTHWEST FIFTH AVENUE
PORTLAND, OREGON 97204
503-223-9001

Protecting Oregon's lands, waters and natural resources

21 July 1994

Oregon Department of Environmental Quality
811 SW 6th
Portland, Oregon 97204

RE: Comments on exceeding total dissolved gas standards to allow spill

ONRC encourages the Environmental Quality Commission to grant a temporary rule for exceedance of water quality standards for total dissolved gasses, in order to allow spill from dams of at *least* the level called for in the National Marine Fisheries Service's Biological Opinion and preferably also *higher* levels as called for in the Columbia Basin Fish and Wildlife Authority's "Detailed Fish Operating Plan" with the goal of providing 80 percent fish passage efficiency. Additionally, ONRC supports an amendment to the dissolved gas standard, specific to relevant dams and time periods, to end the need to re-argue the case every time spill is needed. We believe that an average of 120 percent TDG, with instantaneous levels up to 125 percent, does not pose an undue risk to fish.

ONRC recognizes that the science is not complete or conclusive regarding the exact relationship between spill, nitrogen supersaturation, gas bubble disease and mortality. However, to hide behind our inexact knowledge as an excuse for doing nothing is inexcusable. The fish can't wait while we study the situation to death. We have to keep in mind that the status quo in the Columbia/Snake system is so lethal to fish that "doing nothing" is not the conservative position it would be if we were considering new impacts to a natural river. The status quo is not benign, and the effectiveness and risks of spills must be considered in the existing context of the hydrosystem and compared to other available means for moving juvenile salmon downstream.

Mortality estimates vary, but passage through turbines clearly kills many more fish than succumb to gas bubble disease related to spill. (Turbine mortality is estimated to be 10 - 30 percent per dam, while spill mortality is estimated at only 0 - 3 percent.) Bypass systems have limited fish passage efficiencies that vary widely from species to species. And "transportation," the method of choice for the past 15 years, has been shown to be a failure by the continuing decline of salmon. Last weekend's kill of at least 50,000 fish waiting to be barged (which apparently is not unusual), is only one of the most obvious examples of the problems with this program. In fact, if transportation were subject to the same degree of scrutiny that spill has been, it would not be occurring.

Spill continues to be supported by the state fish and wildlife agencies, the tribes, and conservation organizations, all entities with an interest in recovering salmon populations, and opposed by the operators and industrial users of the hydropower system, entities with an interest in maximizing power production. The National Marine Fisheries Service, while charged with protecting endangered salmon, is under extreme political pressure not to disrupt the status quo. Unfortunately, Bonneville Power Administration, the Army Corps of Engineers, the Bureau of Reclamation, and the Direct Service Industries have managed to confuse the issue by hiding behind their proclaimed concern for fish; a concern that ONRC must dismiss as disingenuous. In high water years, excess water is spilled over the dams, often exceeding TDG standards with no outcry from any of these groups. It is only when water is diverted from power (money) production that spill and the accompanying gas supersaturation becomes an issue. Along the same lines, temperature standards are regularly exceeded by operation of the hydrosystem as we so dramatically witnessed recently. The Corps is talking out of both sides of its mouth when it refuses to implement NMFS' request for spill, ostensibly due to TDG standards, while at the same time blaming NMFS in the press for the recent barging and temperature-related fish kill.

ONRC hopes that EQC will do right by the fish rather than succumbing to the wishes of the status quo, and approve TDG standards that will allow the much-needed spills to go forward. There is no time to waste.

Sincerely,

Diane Valantine

Diane Valantine
Salmon & Rivers Program Leader

Oregon

DEPARTMENT OF
FISH AND
WILDLIFE

OFFICE OF THE
DIRECTOR

July 20, 1994

Mr. Fred Hansen, Director
Oregon Department of
Environmental Quality
811 S.W. Sixth Avenue
Portland, OR 97204-1390

Dear Mr. Hansen:

I am writing to express my support for temporary rulemaking on total dissolved gas (TDG) and to share with you my concern for juvenile salmonids currently migrating through the lower Snake and Columbia rivers.

As you know, spill on the lower Columbia was all but eliminated on June 20 following expiration of the Environmental Quality Commission's (EQC) previous temporary rule allowing TDG to reach 120% of atmospheric pressure. Since June 20, spill levels have been far less than those recommended by the regional fishery management agencies and tribes at Ice Harbor, McNary, John Day, The Dalles, and Bonneville dams and even less than what has been provided in the last several years under the National Marine Fishery Service's (NMFS) Biological Opinions for endangered species, the 1989 Fish Spill Memorandum of Agreement for federal Columbia River dams, and the Northwest Power Planning Council's Strategy for Salmon.

Migrating juvenile salmon needing protection this summer include federally listed fall chinook from the Snake, as well as subyearling migrants from the mid-Columbia and lower Columbia rivers, including Oregon's wild fall chinook from the Grande Ronde and Deschutes rivers and hatchery fall chinook from the Umatilla River. Increased spill is the only additional mitigation action that can be readily implemented this summer to improve the in-river survival of these stocks.

Flows in the lower Snake and Columbia rivers are alarmingly low and high water temperatures have already contributed to high mortalities such as the recent

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large kill of juvenile fall chinook at McNary Dam where over 50,000 fish died on July 16-17. Immediate action is needed to protect these valuable stocks. The analysis which we have conducted with our resource comanagers (enclosed) shows that in-river survival of salmon migrants is significantly improved by adequate spills.

I recognize that there has been a tremendous amount of discussion over this year's spill program. Particularly vocal have been those affected by reduced power generation and revenues due to spill. While concern is understandable, much of the current discussion has served to cloud the facts.

There is no disagreement among the fishery agencies and tribes that spill is the most biologically effective means to reduce turbine mortality, reduce delay at projects, and avoid adverse impacts from bypass systems passage.

We need to act now to avoid further declines of upriver salmon stocks by such near-term actions as the spill program, if we are to avoid even more drastic and possibly more disruptive and costly actions in future years.

In order to implement an effective spill program, we support modification of Oregon's water quality criteria on the mainstem Columbia and Snake rivers to allow dissolved gas levels up to a daily average of 120% saturation and an instantaneous level of up to 125% when required to implement spills and other measures to improve fish survival. While there has been concern expressed about possible fish mortality due to gas supersaturation-associated trauma, studies have shown that juvenile and adult salmon can readily tolerate the dissolved gas levels recommended in a river or reservoir environment by changing their depth in the water, as noted in the enclosed analysis. More importantly, we have consistently observed good survival and adult returns in years of substantial spills and observed no mortality to migrating salmon during the spill program implemented this spring. This validates the practical effectiveness of a sound spill program.

I understand that the specific proposal before the EQC on July 21 calls for a temporary rule change allowing TDG levels up to 115% daily average and 120% instantaneous at the mainstem Columbia

River projects. The department prefers a more aggressive approach both in respect to spill levels and to locations for spills, but in the interest of timely action, we support immediate adoption of the current proposal and believe that this will provide significant added benefits to migrating fish during the remainder of the summer. We also wish to begin working together with your staff to craft a mutually supportable approach to TDG management in concert with planning for fish protection measures for 1995. We believe this is necessary to prevent possible more drastic federally mandated action in the future.

I appreciate your efforts to work with us in this unprecedented effort to protect a valuable aquatic resource. I look forward to working more closely together on this important issue in the coming months.

Sincerely,

Rudy Rosen, PhD
Director

c: Gary Smith, Donna Darm (NMFS)
Michael Llewelyn (WDOE)
Jack Donaldson (CBFWA for LG/FPAC distn)
Anne Squier (Governor's Office)

Enclosure

SCIENTIFIC RATIONALE FOR IMPLEMENTING A SUMMER SPILL PROGRAM TO INCREASE JUVENILE SALMONID SURVIVAL IN THE SNAKE AND COLUMBIA RIVERS

By
Columbia River Inter-Tribal Fish Commission
Idaho Department of Fish and Game
Oregon Department of Fish and Wildlife
U.S. Fish and Wildlife Service
Washington Department of Fish and Wildlife

July 15, 1994

Overview

This document provides scientific justification for implementation of the attach 1994 summer spill programs at Corps of Engineers (Attachment 1) and Mid-Columbia PUD mainstem dams (Attachment 2) in the Columbia River Basin. It is the intent of these programs to substantially increase juvenile anadromous fish survival through the hydrosystem. The programs and supporting rationale and risk assessment were jointly developed by the combined technical staffs of the Columbia River Inter-tribal Fish Commission, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, and Washington Department of Fish and Wildlife (hereinafter fishery managers). Anadromous fish that will be protected by the spill programs include salmon stocks both listed and petitioned for listing under the Endangered Species Act, non-listed salmon stocks, and other anadromous stocks such as Pacific lamprey which are in serious decline. These programs will compliment other protection and restoration programs in the Columbia Basin.

The object of the summer spill programs is to achieve an 80% fish passage efficiency (FPE) objective at all Corps projects on the lower Snake and Columbia Rivers, and other passage efficiency goals at the various Mid-Columbia PUD dams (DFOP 1993). In accomplishing this, the fishery managers propose that the operation of the hydrosystem be managed so that an average of 120% or less total dissolved gas pressure be maintained in the river. Further, the fishery managers propose that the 120% criterion be measured well downstream of tailrace areas, after gas levels have had a chance to dissipate. In addition, because of problems with accurate measurement of gas levels, fishery managers recommend that up to an instantaneous reading of 125% total dissolved gas pressure be allowed to provide a reasonable margin of measurement error.

Based upon historical migration estimates (DFOP 1993), the fishery managers recommend that the spill program be implemented at all Corps run-of- river projects in the Snake and Columbia Rivers until August 31, 1994 to insure that the juvenile summer migration is protected (DFOP 1993). Duration of spill programs at individual mid-Columbia PUD dams will be determined by the various Coordinating Committees based upon ongoing FERC proceedings, settlements and stipulations.

These summer spill programs are partially in response to the apparent salmon stock collapse observed this year in Columbia River spring and summer chinook and expected to occur in fall chinook. From 1993 to 1994, adult spring chinook escapement to Bonneville Dam has decreased from 112,000 to less than 21,000 which is the previous all time record low. The trend is similar for adult summer chinook escapement which is projected to be less than 10,000 salmon at Bonneville Dam this year down from over 22,000 salmon in 1993 (TAC 1994). The predicted escapement of wild Snake River fall chinook adults at Bonneville Dam is 803 (Swartz 1994), the second lowest on record since 1986 and 41% of the 1986-93 average. Under these conditions, tribal ceremonial and subsistence harvest and non-treaty harvest have been severely restricted and in some cases, curtailed.

The stock collapse of Columbia River chinook is likely related to the continuation of extremely poor flow and migration conditions that occurred in 1992 (FPC 1993; Columbia River Water Management Group 1993-4), complicated by possible impacts of low ocean productivity resulting from El Nino conditions as noted by Johnson (1984), Ware and Thompson (1991), and Lichatowich (1993). Because the effects of ocean impacts cannot be controlled and federal agencies are either unwilling or unable to dedicate available storage in upriver reservoirs for flow augmentation, the fishery managers strongly recommend implementation of these spill programs. Spill is the only alternative left to reduce hydrosystem mortality, which could exceed 95% of juvenile summer migrants as documented during similar low flow years (Raymond 1979; Raymond 1988; Ebel et al. 1989).

Because 1993 basin summer and fall chinook adult escapement was relatively high under good environmental conditions, the relatively abundant 1994 subyearling progeny of these stocks must be afforded the best protection possible as they migrate downstream through the hydrosystem. Impacts to an abundant juvenile year class on stock viability can be substantial. Junge (1970), through use of a Ricker-type reproduction curve, demonstrated that a smolt kill of 50% reduced a stock by 60% whereas an adult kill of 50% would reduce a stock by 20%. Such losses on a relatively strong outmigrating year class could have severe if not irreversible consequences on stock abundance and diversity (Riggs 1986).

The fishery agencies and tribes have chosen a conservative approach to the implementation of the spill programs. Spill volume caps are provided to avoid exceeding either 120% daily average or 125% instantaneous total gas pressure criteria. Where possible, spill is confined to nighttime hours which reduces power and possible adult fish passage impacts. When it is not possible to confine spill to nighttime hours to achieve a 80% FPE, some daytime spill is proposed with caps to avoid impacts to adult passage. As will be discussed below, the fishery managers believe a 120% total gas pressure (TGP) criterion is conservative and will result in minimal impacts, if any, to juveniles and adults.

Through a comprehensive review of pertinent literature and extant river conditions, and based upon professional experience, the fishery managers have conducted the following risk assessment. This assessment carefully weighs the factors of various passage mortality rates and other impacts to summer migrating anadromous fish as they pass through the hydrosystem. Based upon this analysis, the fishery managers have concluded that controlled spill will substantially enhance the in-river survival of summer anadromous fish over other available alternatives.

Spill has been repeatedly demonstrated to be the most effective and safest means of project passage and is the only means to enhance survival without additional flow augmentation. Juvenile salmon that pass a project through spill have a significantly higher rate of project survival (98% point estimate) than fish that pass through turbines (85% point estimate). Specific mortality ranges are given later in this document. Without spill, the majority of juvenile chinook will pass through turbines since only 8-35% of summer migrants are guided and collected by mechanical bypass systems at Corps projects. Further, spill will improve survival and other impacts upon fish production by reducing delay of juveniles at the projects and reducing predator/prey interactions by dispersing predators in tailrace areas. And finally, spill for fish passage addresses the substantial scientific uncertainty associated with transportation of summer chinook juveniles, especially Snake River fall chinook.

Monitoring program

The extensive physical and biological monitoring program to assess the occurrence of gas bubble trauma (GBT) in both spring and early summer migrating juvenile and adult salmon at each dam will be continued for the remainder of the summer migration (DFOP 1993, appendices 4-13 and 4-14). Because sampling of internal tissues of juvenile salmon which have passed through mechanical bypass systems is of questionable value, this practice will not be continued. Instead, external symptoms will be monitored. It is imperative that the Corps of Engineers be more diligent and consistent in operating the physical monitoring system. Total gas pressure measurements should be taken at all dam forebays, with backup monitoring to allow for better and more consistent measurements. The 1994 DFOP includes criteria to allow for flexibility for adjustments in the spill program based upon the possible occurrence of GBT in both juveniles and adults.

Technical Basis for the Summer Spill Program

Spill has been shown to be the most biologically effective and safest means of project passage

Spill is not an "experimental measure", but has been shown to be the most effective management tool for improving passage survival of migrating salmon and steelhead at mainstem hydroelectric projects. Controlled spill has been implemented at mid-Columbia PUD dams since 1983 under the mid-Columbia Federal Energy Regulation (FERC) Commission Proceedings (Bodi 1986) and at Corps dams since 1989 under the 1989 Memorandum of Agreement to provide protection of juveniles until adequate functioning mechanical bypass systems have been installed. As previously stated, controlled spill to safely pass 80% of juvenile salmon migrants is the goal of this proposed spill program (DFOP 1993). Protocol for specific spill patterns for juveniles and adults at each dam is provided in the 1994 DFOP and represents years of model and field studies by the fishery agencies, tribes and dam operators. During the 1994 spring migration, controlled spill was implemented at all basin dams to increase juvenile survival.

Extensive studies at mainstem Columbia and Snake River dams have documented that juvenile mortality from turbine passage is much greater than spillway passage. Studies have shown that mortality from turbine passage ranges from 8-32% compared to only 0-4% for spillway passage (Tables 1 and 2). In studies of subyearling fall chinook at McNary, John Day, and Bonneville powerhouses I and II, turbine mortality ranged from 11-18%, while spillway mortality ranged from 0-4%. Although research investigating the magnitude of turbine passage impacts to adults which fallback through turbines is limited, mortality ranges from 22-51% for adult steelhead have been documented (DFOP 1993).

Juvenile mechanical bypass systems, are only able to guide and collect 8-35% of summer juvenile migrants (Ceballos 1992; Gessel et al. 1990; 1991; Ledgerwood et al. 1988;1991). Mortality and injury rates to subyearling migrants undergoing passage through mechanical bypass systems can exceed that from spillway passage, particularly at transportation dams due to additional delay, handling, and stress. Bypass system mortality of subyearling chinook at McNary Dam during 1992, a similar low flow year as 1994, ranged from 4-6% (WDF 1992). During peak migration periods in 1992, mortality rates through the McNary mechanical bypass system approached 9%, chiefly because of poor water quality (WDF 1992). Despite a new bypass system completed for the 1994 migration, recently an estimated 50,000 juvenile migrants were lost at McNary Dam in only a few days due to poor water quality conditions in the mechanical bypass system (Filardo 1994). Ceballos et al. (1993) found that subyearling chinook descaling from travel through juvenile bypass systems during 1988-92 ranged from ranged from 2.4% to 12.7%. Available comparative studies between Lower Granite spillway, turbine and mechanical bypass systems indicate that smolts which passed through the dams via the spillway suffered the least from both partial descaling (5.8%) and severe descaling injuries (1%) (Park and Achord 1987). Unfortunately, the recently installed mechanical bypass systems at Little Goose, Lower Monumental and McNary Dams have never been adequately evaluated for specific impacts to subyearling migrants (Barilla 1993). The fishery agencies and tribes have never supported operation of these systems for the migration at large without adequate evaluation.

Spill will improve survival of fish by reducing delay of juveniles at the projects and reducing predator/prey interactions and reduce exposure to high levels of dissolved gas, and reduce residualism

Spill will improve survival of fish by reducing delay of juveniles in forebays and tailraces where predator populations and predation rates are highest. Spill can greatly reduce delay of smolts in forebays as has been observed at The Dalles Dam (Snelling 1994). Spill establishes a large flow with increased velocity that disperses predators from the forebay and tailrace areas thus reducing predator/prey interactions (Faler et al. 1988).

Smith (1982) found that because subyearling salmon travel passively downstream, higher velocities provided by spill would save these juveniles critical energy reserves necessary for parr to smolt transitions, as well as move them more quickly through the river. This in turn would reduce migrant susceptibility to predators and disease, and would reduce the likelihood that smolts would revert to freshwater parr (non-migratory status) by excessive delay in traversing the hydrosystem.

Spill addresses the substantial uncertainty associated with the Corps transportation program

Spill at transportation collector projects addresses the uncertainty associated with the juvenile salmon transportation program by spreading the risk between in-river passage and transportation (Ad Hoc Transportation Review Group 1992; Mundy et al. 1994; FERC 1994). As recently concluded by an expert team of independent scientists, "[t]ransportation alone, as presently conceived and implemented is unlikely to halt or prevent the continued decline and extirpation of listed salmon in the Snake River Basin"...and that "available evidence is not sufficient to identify transportation as either a primary or supporting method of choice for salmon recovery" (Mundy et al. 1994). This is consistent with the findings of Raymond (1988) and Congleton et al. (1985) who found that transportation had been ineffective in reversing the decline of runs of spring and summer chinook and steelhead returning to the mid-Columbia and Snake rivers during 1962-84. Evidence provided by the Ad Hoc Transportation Review Group (1992) indicated that transportation may have reduced survival of wild Snake River spring and summer chinook to spawning grounds. Adult homing impairment and disruption of freshwater life histories are two key problems attributed to the juvenile transportation process (TRG 1992, Mundy et al. 1994; Heinith 1993).

The USFWS (1993), Steward (1993) and Congleton et al. (1985) noted that handling in the transportation process may greatly increase stress and mortality to juvenile migrants, particularly when water quality conditions deteriorate and may override any perceived benefits of transportation. For example, Mundy et al. (1994) noted that in 1977, an extremely low flow year similar to this year, transportation treatment and control fish died equally because no adults returned from the study. The cause was likely indirect or delayed mortality from screen guidance, collection, holding, transportation, and concentrated release into high predation areas. This is a particular problem for summer subyearling migrants as they are usually trucked instead of barged, because few of them are collected at mainstem dams, and operation of barges on this basis is not cost-effective. Numerous studies have documented that trucking migrants is even more stressful than barging and that stressed

migrants are highly susceptible to predators at the time of release (TRG 1992; Congleton et al. 1985; Mundy et al. 1994; USFWS 1993).

No transportation studies have been conducted on subyearling chinook salmon at Snake River dams. Transport studies of subyearling chinook at McNary Dam in 1986, 1987, and 1988 were conducted under no spill conditions. In addition, the control fish were released in small numbers from the old bypass outfall. They were the only fish released from the bypass because all fish collected, except for the controls, were transported. We suspect that predation rates on the control releases were very high because of the no-spill and low flow conditions in the tailrace that occurred during these studies. Hence, the results of these studies are not applicable to subyearling chinook salmon passing the project under spill conditions.

It has been consistently been the position of the fishery managers that transportation is an interim and experimental mitigation program that cannot substitute for the provision of adequate in-river passage conditions provided by flow and spill. A Federal Energy Regulatory Commission (FERC) administrative law judge upheld this position in a 1992 ruling against transportation at two mid-Columbia dams and ordered immediate spill at a 70% and 50% FPE level for spring and summer migrants, respectively, until completion of fish bypass systems (FERC 1992). On May 27, 1994, fully taking into account voluminous technical information on dissolved gas complied over a two year period, FERC ordered implementation of this spill program at Priest and Wanapum dams (FERC 1994). On July 1, 1994 the Washington Department of Ecology granted an administrative order modifying the state water quality criteria so that the FERC summer spill program could be implemented (Attachment 3).

Spill protects critical life history diversity

The Columbia River juvenile summer outmigration is comprised of a mosaic of many stocks from all basin tributaries and mainstem reach areas. Within each stock of the migration, multiple life histories within a single salmon stock have evolved over millions of years to provide stock resiliency and stability for dealing with different types of environments (Winemiller and Rose 1992). Because of these different life histories, which include diverse migration timing and the use of different spawning and rearing areas, there is a reduced chance that a single or multiple environmental disturbances, such as a low flow year, will impact overall stock fitness and diversity (Schluchter and Lichatowich 1977).

Spill and associated in-river migration allow adequate time for rearing and physiological maturation of subyearling chinook stocks to reach a proper size prior to saltwater entry to survive (Mundy et al. 1994; CBFWA 1991). This has been confirmed by numerous studies involving scale analysis (Schluchter and Lichatowich 1977; Lichatowich 1976; Reimers 1973) and physiological studies examining osmoregulatory processes (Wagner et al. 1969; Ewing and Birks 1982; Wedemeyer et al. 1980). Interruptions to the critical freshwater rearing life history stage, such as that imposed by the Corps transportation program and selective mortality from turbine passage, may have serious implications to stock survival and overall production characteristics such as adult age at maturity and

fecundity (Groot and Margolis 1991; Nicholas and Hankin 1989; Thompson 1959, Schluchter and Lichatowich 1977;1993).

Studies clearly show that adult survival is enhanced with spill

The historical record clearly demonstrates that better adult returns of summer and fall chinook had occurred during years when juveniles migrated under high flow and high spill conditions. Raymond (1988) reported that the lack of spill and installation of additional turbine units in the basin were primarily responsible for extremely low smolt to adult return rates of mid-Columbia summer chinook. Hilborn (1993) demonstrated a strong relationship between flow and adult survival of Priest Rapids Hatchery fall chinook during 1977-87 similar to the relationship found for Snake River wild spring/summer chinook by Petrosky (1991). In both analyses, the highest survivals occurred in 1982, a year of high flow and spill. In contrast, 1977 was characterized by low flows and no spill. Under these conditions, estimated mortalities in excess of 95% of the outmigration at large occurred, based upon analysis of adult returns in subsequent years. In a recent analysis of the 1994 controlled spring spill program on adult passage, the Fish Passage Center found that there was no impact on adult passage based upon interdam conversion rates for adult spring chinook (DeHart 1994, Attachment 4).

Model results indicate that in-river survival will be improved

Model results demonstrate that the in-river survival of fall chinook will be enhanced by the proposed spill program. Using the FLUSH Model developed by the state fishery agencies and tribes, the in-river survival of Snake River fall chinook was estimated under various flow and spill options (Attachment 5). The analysis shows that with the flows proposed by the NMFS and 80% FPE spill at each project, in-river survival of Snake River fall chinook to below Bonneville Dam would be increased by 61% from 1.8 to 2.9%. This improvement in survival will likely increase future adult returns and help prevent additional declines of Snake River fall chinook and mid-Columbia summer chinook and other anadromous stocks.

Studies show that juveniles and adults can tolerate dissolved gas levels that will occur as a result of spill

Susceptibility of juvenile salmon to gas bubble trauma (disease) depends on a number of important factors ancillary to total gas pressure. These factors must be considered when evaluating possible gas bubble trauma to the summer migration at large. . Based upon the past information, lower summer flows and resultant lower volumes of spill are not expected to result in gas bubble trauma especially at flows projected to occur this year (Columbia River Water Management Reports). Physical factors include: water temperature and total dissolved particulates (Jensen et al. 1986; Alderdice and Jensen 1985) and atmospheric pressure (Jensen et al. 1986; Alderdice and Jensen 1985). Biological factors include: size, species, genetic composition and physiological condition of the fish (Jensen et al. 1986; Alderdice and Jensen 1985) and proximity and length of exposure to total gas pressure (Weitkamp and Katz 1980).

There are also behavioral factors that allow salmonids to withstand what otherwise might be harmful levels of total dissolved gas. Juvenile and adult salmonids have been documented to sound in the natural environment and achieve hydrostatic compensation, thus avoiding impacts of elevated levels of total gas pressure (Weitkamp and Katz 1980; Weitkamp 1976;1977; Gray and Haynes 1977). Knittel et al. (1980) and Weitkamp and Katz (1980) reported that juvenile salmon could recover from symptoms of gas bubble trauma in 30 minutes to 2 hours time by sounding. Intermittent exposure may increase the level of gas supersaturation fish are able to tolerate because it increases the time over which a specific exposure accumulates. It also provides an opportunity for recovery to occur, particularly if it is accompanied by depth compensation. The effects of intermittent exposure on tolerance to supersaturation has been demonstrated by Meekin and Turner (1974), Blahm et al. (1976), and Bouck (1980). Bouck noted that, "..[f]ish in deeper water or exposed intermittently are least susceptible (to GBT) if susceptible at all."

Several studies have been conducted in the laboratory and the field under various depth and dissolved gas levels to determine the effects of depth compensation for salmonids in supersaturated water (Table 3; DFOP 1993). The most relevant studies were the volitional live cage studies conducted in-situ at Wells Dam (Meekin and Turner 1974), and Rock Island Dam (Weitkamp 1976) where fish were allowed to sound to avoid impacts of supersaturation (Table 3).

Depth of the live cages extended from the surface to 3.1-4 meters below the surface. Meekin and Turner (1974) also held fish in cages at variable depths from surface to 1, 2, 3, and 4 meters. These studies indicate that the effects of hydrostatic compensation due to depth is as predicted by theory and that when given the opportunity, that juveniles will remain deep enough to compensate for total gas pressures up to 126% saturation. It is highly significant in Weitkamp's study that no fish were killed in the surface to 4 meter cages in a series of three tests at total gas pressures of 120-128% saturation. It should be noted that even in the surface to 4 meter cage, fish are confined to shallower water than they normally occupy in the reservoirs (Smith 1974; Weitkamp 1974; 1977; Blahm 1974; Blahm et al. 1976).

Toner (1993) examined salmonids, resident fish and invertebrates for signs of GBT below Bonneville Dam by seines and other field sampling gear. During high spring spills which caused total gas levels to reach 128% saturation, she found that external signs of GBT were rare. Less than 1% of chinook salmon and resident fish showed signs and no evidence of GBT was noted in sampled invertebrates.

1994 NMFS Dissolved Gas Panel Report

Unfortunately, the National Marine Fisheries Service prematurely released a draft report by a panel of dissolved gas experts before all panel members could concur with the contents of the report (Backman 1994; Bouck 1994; Attachment 6). The current draft report should be disregarded. The NMFS should retract the draft report and a final report should be issued in which all panel experts can concur. This was the intent of the panel, and was their charge by the NMFS.

Summary and Recommendations

Based upon the risk analysis performed above which considered the best available and pertinent scientific literature and data, current river conditions, and professional judgement, the fishery agencies and tribes strongly recommend immediate implementation of the above controlled spill program to protect migrating juvenile summer and adult anadromous fish populations as they traverse the Columbia Basin hydrosystem. In order to implement this program, we also recommend a modification of Oregon's and Washington's water quality criteria to allow total dissolved gas levels to reach a daily average of 120% saturation, or an instantaneous measurement to reach up to a 125% saturation level. We recommend that the spill program and modifications to the existing total dissolved gas standard be implemented until August 31, 1994 to allow protection of summer migrants through the mainstem Snake and Columbia Rivers.

We also strongly encourage the Oregon Environmental Quality Commission and the Washington Department of Ecology to direct hydrosystem operators to expedite investigation and installation of structural modifications at dams, such as spillway deflectors. Addition of these modifications will further protect remaining anadromous stocks passing through the hydrosystem by establishment of better in-river water quality. This is particularly important for control of total dissolved gas in normal and high flow years, and when the operation of dam powerhouses, even without spill, still results in elevated levels of dissolved gas being discharged into the river (Figure 1).

Tables 1-3
Figure 1
Attachments 1-5

REFERENCES

Alderdice, D.F., and J.O.T. Jensen. 1985. Assessment of the influence of gas supersaturation on salmonids in the Nechako River in relation to Kemano completion. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1386. 48 pages.

Barilla, T. Research coordinator for the Walla Walla District, United States Army Corps of Engineers. November 22, 1993. Personal communication.

Blahm, T.H. 1974. Report to U.S. Army Corps of Engineers. Gas supersaturation research. Prescott Facility-1974. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Blahm, T.H., R.J. McConnell, and G.R. Snyder. 1976. Gas supersaturation research, National Marine Fisheries Service Prescott Facility. Pages 11-19 in Fickeisen and Schneider (1976).

Bodi, F.L. 1986. Restoration under the Federal Power Act. Environmental Law. Volume 16. Number 3. Pages 556-581.

Bouck, G.R. 1980. Etiology of gas bubble disease. Transactions of the American Fisheries Society. Volume 109. Pages 703-707.

Brege. D.A., S.J. Grabowski, W.D. Muir, S.A. Hirtzel, and S.J. Mazur. 1992. Studies to determine the effectiveness of extended traveling screens and extended bar screens at McNary Dam, 1991. Report to the United States Army Corps of Engineers, Contract DACW68-84-H-0034. By the Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington. 32 pages plus appendices.

Ceballos, J.R. 1992. FGE estimates for BPA CRiSP model runs. March 31, 1992 memorandum to F/NWO3 Operations Branch files. National Marine Fisheries Service. Portland, Oregon. 4 pages.

Ceballos J.R., S.W. Pettit, J.L. McKern, R.R. Boyce, and D.F. Hurson. 1993. Fish Transportation Oversight Team Annual Report-FY 1992. Transport operations on the Snake and Columbia Rivers. National Marine Fisheries Service, Portland, OR.

Columbia Basin Fish and Wildlife Authority. 1991. The biological and technical justification for the flow proposal of the Columbia Basin Fish and Wildlife Authority. Portland, Oregon.

Columbia Basin Tribes and Fishery Agencies. 1993. Detailed fishery operating plan with 1994 operating criteria. Fish Passage Center, Portland, Oregon.

Columbia River Water Management Reports. Water Years 1982-1992. By the Columbia River Water Management Group. North Pacific Division, United States Army Corps of Engineers. Portland, Oregon.

Columbia River Water Management Group. 1993 and 1994. Columbia River Water Management Reports for 1992 and 1993. North Pacific Division. United States Army Corps of Engineers. Portland, Oregon.

Congleton, J.L, T.C. Bjornn, B.H. Watson, J.I.Irving, and R.R. Ringe. 1985. Effects of handling and crowding on the stress response and viability of chinook salmon parr and smolts. By the Idaho Cooperative Fishery Research Unit. Department of Fish and Wildlife Resources. University of Idaho. Moscow, Idaho. To Bonneville Power Administration. Project 82-5. Contract DE-AC79-83BP11196. Portland, Oregon.

Ebel W.J. 1969. Supersaturation of nitrogen in the Columbia River and its effects on salmon and steelhead trout. National Marine Fisheries Service Fishery Bulletin 68:1-11.

Ebel W.J. 1971. Dissolved nitrogen concentration in the Columbia and Snake rivers in 1970 and their effect on chinook salmon and steelhead trout. National Marine Fisheries Service Special Scientific Report Number 646.

Ebel, W.J., C.D. Becker, J.W. Mullan, and H.L. Raymond. 1989. The Columbia River-toward a holistic understanding, p. 205-219. In D.P. Dodge [ed.] Proceedings of the International Large River Symposium. Can. Spec. Publ. Fish. Aquat. Sci. 106.

Ewing, R.D. and E.K. Birks 1982. Criteria for parr-smolt transformation in juvenile chinook salmon (Oncorhynchus tshawtscha). Aquaculture. Volume 28. Pages 185-194.

Faler, M.P., L.M. Miller, and K.I. Welke. 1988. Effects of variation in flow on distributions of northern squawfish in the Columbia River below McNary Dam. North American Journal of Fisheries Management 8:30-35.

FERC. 1992. Initial decision of Judge Stephen Grossman. Project Number 2114-024. Docket Number E-9569-003 (Grant County Phase). Washington, D.C. 27 pages.

FERC. 1994. Order on interim license conditions. Project Number 2114-024. Docket Number E-9569-003 (Grant County Phase). Washington, D.C. 19 pages.

Filardo, M. Chair, Fish Passage Advisory Committee, Portland, OR. July 18, 1994. Personal Communication.

FPC (Fish Passage Center). 1994. Fish Passage Center 1993 annual report. Columbia Basin Fish and Wildlife Authority, Portland, Oregon.

Gessel, M.H., D.A. Brege, B.H. Monk, and J.G. Williams. 1990. Continued studies to evaluate the juvenile bypass systems at Bonneville Dam- 1989. Report to the United States Army Corps of Engineers, Delivery Order E8689095. By the Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington. 20 pages plus appendices.

Gessel, M.H., J.G. Williams, D.A. Brege, and R.F. Krcma. 1991. Juvenile salmonid guidance at the Bonneville dam second powerhouse, Columbia River, 1983-1989. North American Journal of Fisheries Management. Volume 11. Pages 400-412.

Gilbreath, L.G., E.M. Dawley, R.D. Ledgerwood, P.J. Bentley, and S.J. Grabowski. 1993. Relative survival of subyearling chinook salmon that have passed Bonneville dam via the spillway or second powerhouse turbines of bypass system: adult recoveries through 1991. Annual report submitted to the U.S. Army Corps of Engineers. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, Washington.

Giorgi, A. and L. Stuehrenberg. 1988. Lower Granite pool and turbine survival study, 1987. Annual report submitted to the Bonneville Power Administration. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, Washington.

Gray, R.H. and J.M.Haynes. 1977. Depth distribution of adult chinook salmon (Oncorhynchus tshawytscha) in relation to season and gas-supersaturated water. Transactions of the American Fisheries Society. Volume 109. Pages 755-759.

Groot, C. and L. Margolis (eds.). 1991. Pacific salmon life histories. UBC Press, University of British Columbia, Vancouver, British Columbia. 564 pages.

Heinith, R. 1993. Affidavit in support of the Yakama Indian Nation in NRIC et al. v. NMFS. United States District Court for the District of Oregon. Case Number CV-93-469-MA.

Heinle, D.R. and F.W. Olson. 1980. Survival of juvenile coho salmon passing through the spillway at Rocky Reach Dam. CH2M Hill Report to Chelan County PUD, Washington.

Hilborn, R., R. Donnelly, M. Pascual, and C. Coronado-Hernandez. 1993. The relationship between river flow and survival for Columbia River chinook salmon. Draft report to the Bonneville Power Administration, Portland, Oregon.

Holmes, H.B. 1952. Loss of salmon fingerlings in passing Bonneville dam as determined from marking experiments. Unpublished manuscript. U.S. Fish and Wildlife Service.

Iwamoto, R.N., W.D. Muir, B.P. Sanford, K.W. McIntyre, D.A. Frost, and J.G. Williams. 1993. Survival estimates for the passage of juvenile chinook through Snake River dams and reservoirs. Annual report submitted to the U.S. Army Corps of Engineers. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Jensen, J.O.T., J. Schute and D.F. Alderdice. 1986. Assessing juvenile salmonid response to gas supersaturation using a general multivariate dose-response model. Canadian Journal of Fisheries and Aquatic Sciences. Volume 43. Pages 1694-1709.

Johnsen, R.C. and E.W. Dawley. 1974. The effect of spillway flow deflectors at Bonneville Dam on total gas supersaturation and survival of juvenile salmon. Final report submitted to U.S. Army Corps of Engineers.Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Johnson, S.L. 1984. The effects of the 1983 El Nino on Oregon's coho and chinook salmon. Oregon Department of Fish and Wildlife. Information Reports. Number 84-8. Portland, Oregon.

Junge, C.O. 1970. The effect of superimposed mortalities on reproductive curves. Fish Commission of Oregon Research Reports. Volume 2. Pages 56-63.

Knittel, M.D., G.A. Chapman and R.R. Garton. 1980. Effects of hydrostatic pressure on steelhead survival in air-supersaturated water. Transactions of the American Fisheries Society. Volume 109. Pages 755-759.

Ledgerwood, R.D., E.M. Dawley, L.G. Gilbreath, P.J. Bentley, B.P. Sandford, and M.H. Schiewe. 1990. Relative survival of subyearling chinook salmon which have passed Bonneville dam via the spillway or the second powerhouse turbines of bypass system in 1989, with comparisons to 1987 and 1988. Report to the United States Army Corps of Engineers, Contract E85890024/E86890097. By the Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington.

Ledgerwood, R.D., W.T. Norman, G.A. Swan, and J.G. Williams. 1988. Fish guiding efficiency of submersible traveling screens at Lower Granite Dam and Little Goose Dams-1987. Report to the United States Army Corps of Engineers, Contract Number DACW-68-84-H-0034. By Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington.

Lichatowich, J.A. 1976. Rogue River Basin Evaluation Program. Annual Report. Contract Number DACW57-75-C-0109 to the United States Army Corps of Engineers, Portland District. By the Oregon Department of Fish and Wildlife. Portland, Oregon.

Lichatowich, J.A. 1993. Ocean carrying capacity. Recovery issues for threatened and endangered Snake River salmon. Technical Report 6 of 11. Prepared for the United States Department of Energy, Bonneville Power Administration. Project No. 93-013. Contract No. DE-AM79-93BP99654. Portland, Oregon.

Long, C.W. 1968. Research on fingerling mortality in Kaplan turbines-1968. Internal report. Bureau of Commercial Fisheries, Seattle, WA.

Long, C.W., F.J. Ossiander, T.E. Ruehle, and G.M. Mathews. 1975. Survival of coho salmon fingerlings passing through operating turbines with and without perforated bulkheads and of steelhead trout fingerlings passing through spillways with and without a flow deflector. Final report submitted to U.S. Army Corps of Engineers. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Meekin, T.K. and B.K. Turner. 1974. Tolerance of salmonid eggs, juveniles, and squawfish to supersaturated nitrogen. Washington Department of Fisheries Technical Report 12:78-126.

Mundy, P.R., D. Neeley, C.R. Steward, T.P. Quinn, B.A. Barton, R.N. Williams, D. Goodman, R.R. Whitney, M.W. Erho Jr, and L.W. Botsford. 1994. Transportation of juvenile salmonids from hydroelectric in the Columbia River Basin: An independent review. Final report submitted to the U.S. Fish and Wildlife Service, Portland, Oregon.

Nicholas, J.W., and D.G. Hankin. 1989. Chinook salmon populations in Oregon coastal river basins: description of life histories and assessment of recent trends in run strengths. Information Report Number 88-1, Fish Division, Oregon Department of Fish and Wildlife, Corvallis, Oregon.

Park, D.L. and S. Achord. 1987. Evaluation of juvenile salmonid passage through the bypass system, turbines and spillway at Lower Granite Dam in 1986. Contract DACW68-84-H-0034 to the United States Army Corps of Engineers. By Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington.

Petrosky, C.E. 1991. Influence of smolt migration flows on recruitment and return rates of Idaho spring chinook. Idaho Department of Fish and Game, Boise, Idaho.

Raymond, H.L. 1979. Effects of dams and impoundments on migration of juvenile chinook salmon and steelhead from the Snake River, 1966-1975. Transactions of the American Fisheries Society 109:505-529.

Raymond, H.L. 1988. Effects of hydroelectric development and fisheries enhancement on spring and summer chinook salmon and steelhead in the Columbia River basin. North American Journal of Fisheries Management 8:1-24.

Raymond, H.L. and C.W. Sims. 1980. Assessment of smolt migration and passage enhancement studies of 1979. Final report submitted to U.S. Army Corps of Engineers. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Reimers, P.E. 1973. The length of residence of juvenile chinook salmon in the Sixes River, Oregon. Fish Commission of Oregon Research Reports. Volume 4. Number 2. 43 pages.

Riggs, L.A. 1986. Genetic consideration in salmon and steelhead planning. Final Report to the Northwest Power Planning Council, Portland, Oregon.

Sims, C.W. and F.J. Ossiander. 1991. Migrations of juvenile chinook salmon and steelhead trout in the Snake River from 1973 to 1979- a research summary. Final Report submitted by the National Marine Fisheries Service to the U.S. Army Corps of Engineers, Portland, Oregon.

Schluchter, M.D. and J.A. Lichatowich. 1977. Juvenile life histories of Rogue River spring chinook salmon Oncorhynchus tshawytscha (Walbaum), as determined by scale analysis. Research Section, Oregon Department of Fish and Wildlife. Information Report Series, Fisheries Number 77-5. Corvallis, Oregon.

Schoeneman, D.E., R.T. Pressey, and C.O. Junge. 1961. Mortalities of downstream migrant salmon at McNary Dam. Transactions of the American Fisheries Society 90(1):58-72.

Smith, J.R. 1974. Distribution of seaward-migrating chinook salmon and steelhead trout in the Snake River above Lower Monumental Dam. U.S. National Marine Fisheries Service Marine Fisheries Review 36(8):42-45.

Smith, L.S. 1982. Decreased swimming performance as a necessary component of the smolt migration in salmon in the Columbia River. Aquaculture. Volume 28. Pages 153-161.

Snelling, J. Researcher for Oregon Cooperative Fishery Research Unit, Oregon State University, Corvallis, Oregon. March 15, 1994. Personal communication.

Steward, C.R. 1993. Assessment of the flow-survival relationship obtained by Sims and Ossiander (1981) for Snake River spring/summer chinook salmon smolts. Report to S.A. Cramer and Associates, Inc. Portland, Oregon.

Swartz, Don F. 1994. Personnel communication. Oregon Department of Fish and Wildlife, Clackamas, Oregon.

Technical Advisory Committee (TAC). 1994. Columbia River chinook fishery simulation model output-1994. Number 94-11. Portland, Oregon.

Thompson, W.F. 1959. An approach to population dynamics of the Pacific red salmon. Transactions of the American Fisheries Society. Volume 88. Number 3. Pages 206-209.

TRG (Ad Hoc Transportation Review Group). 1992. Review of salmon and steelhead transportation studies in the Columbia and Snake Rivers, 1984-89. Submitted to the Columbia Basin Fish and Wildlife Authority.

USFWS. 1993. Review of transportation of spring/summer chinook salmon in the Snake River (1968-1990) for the Recovery Team. Peer review comments by individual Fish and Wildlife Service (Region 1) technical staff, December 6, 1993. U.S. Fish and Wildlife Service. Portland, Oregon.

Wagner, H.H., F.P. Conte and J.L. Fessler. 1969. Development of osmotic and ionic regulation in two races of chinook salmon (Oncorhychus tshawytscha). Comparative Biochemical Physiology. Volume 29. Pages 325-341.

Ware, D.M. and R.E. Thompson. 1991. Link between long-term variability in upwelling and fish production in the northeast Pacific Ocean. Canadian Journal of Fisheries and Aquatic Sciences. Volume 48. Pages 2296-2306.

WDF (Washington Department of Fisheries). 1992. McNary Dam weekly summary reports. Olympia, Washington.

Wedemeyer, G.A., R.L. Saunders, and W.C. Clarke. 1980. Environmental factors affecting smoltification and early marine survival of anadromous salmonids. Marine Fishery Review. Volume 42. Pages 1-14.

Weitkamp, D.E. 1974. Dissolved gas supersaturation in the Columbia River system; salmonid bioassay and depth distribution studies, 1973 and 1974. Parametrix Inc. Report to Utility Cooperative, Idaho Power Company, Boise, ID.

NMFS Proposed Summer Spill Program

Estimates of Increased Fish Survival

July 21, 1994

	Bonneville	The Dalles	John Day	McNary
River Mile	146.1	191.5	215.6	292
Collector Project	No	No	No	Yes
Current Spill	33% of project flow for 24 hours	15% of project flow for 8 hours	13% of project flow for 10 hours	7% of project flow for 24 hours
Planned Spill	42% of project flow for 24 hours	15% of project flow for 8 hours	20% of project flow for 10 hours	7% of project flow for 24 hours
Date Spill Ends	23-Aug	22-Aug	22-Aug	
Fish Guidance Efficiency, FGE	10%	42%	26%	47%
Fish Passage Efficiency, FPE				
Current	42%	45%	34%	50%
Projected	50%	45%	39%	50%
Increased Fish Passage Survival per 100,000 fish/day	1040	0	650	0

Total summer subyearling run is projected at approximately 25 million wild and hatchery fish.

Passage at McNary is approximately 75% complete.

By the end of August approximately 90% of fish will have passed Bonneville.

Wild, listed Snake River salmon comprise < 5% of subyearlings currently at McNary.

All wild fish comprise approximately 40-50% of subyearlings currently at McNary.

Passage at McNary has been:
- July 9th: ~ 1 million fish/day
- July 11th: ~ 80,000 fish/day
- July 16th: ~ 450,000 fish/day

P.O. Box 9235
Portland, OR 97201
July 21, 1994

Oregon Environmental Quality Commission

RE: Total Dissolved Gas Temporary Rule for the Columbia River

I am the Conservation Director of the Anglers' Club of Portland. We are a social and conservation organization with just over 100 members. We represent in no small way those who have a major stake in the outcome of today's proceedings.

The Oregon Environmental Quality Commission is today saddled with what may be a historic responsibility. Whether or not it will be possible to restore anadromous fish runs to the Columbia River Basin will in no small part be determined by the results of your deliberations today.

At issue is whether or not to allow higher total dissolved gas levels as a result of increased spill at hydroelectric dams on the Columbia River. This is a difficult question whose answer should rely on the best of fishery biology scientific assessments. To suggest that the future of salmon and steelhead depend on those assessments is not a histrionic overstatement. The scientific analysis of this issue is highly complex. It is fraught with conflicting facts and it is easy to lose sight of the objective of the studies done to date once enmeshed in the details of those studies.

Your decision though should be based on only one question, and that is what method of transport down the Columbia River will provide the highest survival of anadromous fish. Although laboratory studies provide important background information, they do not capture all the variables present in as complex an environment as the Columbia River. I am specifically referring to the studies done by Ebel and Dawley in 1975, Shirahata in 1966, Harvey and Cooper in 1962, and Nebeker in 1976. These studies failed to consider mitigating factors such as fish behavioral responses to increased gas saturation, time of exposure to dissolved gases in situ, and the complex interaction of biological and environmental variables. Bouck in a 1980 Environmental Protection Agency study concluded that "obviously, interplay of behavioral and environmental variables allows higher tolerance to supersaturation than is evident in laboratory assays."

I would thus suggest that your decision be based on the results not of laboratory studies, but on the results of previous high flows with spill in the Columbia River and their affect on fish migration and survival.

In 1993 high flows in the Snake and Columbia Rivers forced more uncontrolled spill than had occurred during the preceding low flow years, this in turn led to high total dissolved gas (TDG) levels. Daily average TDG saturations exceeded 120% for one to twelve days at all monitoring stations except Lower Granite Dam. The highest levels of daily average dissolved gas recorded were at Lower Monumental Dam, where 130% was exceeded for 4 days (May 17-20), and an instantaneous high of 141% was recorded. Saturations at John Day, The Dalles, and Bonneville exceeded 125% for one to two days. During the period when the highest dissolved gas saturations occurred, low incidence of mostly mild external signs of Gas Bubble Disease (GBD) were observed on juvenile migrants. With the exception of Lower Granite Dam, where no GBD was seen, the rest of the monitoring stations recorded low percentages (typically 1-2%) of the daily sample affected with symptoms of GBD.

Based on smolt monitoring program observations, it is apparent that the impacts of high dissolved gas saturation on fish were minor in 1993. (The preceding information is from the Fish Passage Center report "1993 Dissolved Gas Supersaturation").

Historically, better adult returns have followed years in which juveniles migrated under conditions of high flow and spill. High flow and spill did not have adverse impacts on adult returns. Four of the five best adult return ratios for Snake River spring and summer chinook from 1974 to 1989 occurred in 1975, 1982, 1983, and 1984. Spill levels were substantially higher in those years than are currently being requested.

Finally, your deliberations should include an analysis of the impact of not enacting an allowance for increased TDG. Other passage routes through dams cause higher levels of mortality. Turbine passage causes from 10 to 20% direct mortality. Mechanical bypass systems (which are not installed at all dams), only guide and collect 35 to 70% of juvenile migrants. Mortality to juvenile salmon which are guided by mechanical bypass systems ranges from 2 to 8%. (Source: Northwest Power Planning Council, 1986). This means that the 1 to 2% incidence of GBD observed during 1993 spill conditions would represent comparatively less danger to downstream migrating smolts than would other transportation schemes. This is emphasized by the recent loss of 50,000 smolts on board one smolt transportation barge.

In conclusion, increased flow with the spill required to provide that flow in the Columbia River is not without risk. However, it still provides one of the few opportunities that we have left to protect Columbia River anadromous fish from extinction. It is clear that if prior management practices are continued that there will be no change in the ongoing disappearance of salmon and steelhead from the complex fabric of Pacific Northwest culture and natural history.

It is thus the Anglers' Club of Portland's recommendation that an allowance to at least 120% TDG be granted to facilitate increased flow and spill at hydropower projects on the Columbia River. Allowances for higher TDG should be made not based on the actual TDG, but instead should be linked to mortality observed in smolt monitoring programs.

Respectfully submitted,

Greg McMillan
Conservation Director
Anglers' Club of Portland

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
Testimony of Jim Weber, Policy Assistant

Mr. Chairman and Members of the Commission, as you are all well aware, there has been a tremendous amount of focus on Oregon's total dissolved gas standard and how this affects the operation of the Federal Columbia River Power System. Utility interest groups, who have a financial interest in minimizing spill and maximizing the amount of water run through turbines, have vocally campaigned for strict adherance to the dissolved gas standard. They state that their concern is based on the need to protect fish from the potential risk of gas bubble trauma. Similarly, the Corps of Engineers has used the dissolved gas standard as a reason to avoid spill for fish -- even though the Corps appears to be unconcerned about violating the dissolved gas standard when it implements spill for other reasons, such as the lack of a suitable power market.

As this Commission is well aware, there are other water quality standards that apply to the Columbia River. One of them is water temperature. Over the weekend of July 16-17, there was a massive fish kill at McNary Dam. The Corps of Engineers estimates that 36,000 juvenile chinook died. The Idah Department of Fish and Game estimates that at least 50,000 died. The fish that died were in a holding area, fed by Columbia River water, waiting to be barged down-river. According to the Corps, these fish died because of high stream temperatures, ranging from 71-73 degrees Fahrenheit. The Corps concedes that temperatures in this range are generally accepted as being lethal for salmonid species. Oregon's water quality standard for temperature applicable to this area of the Columbia River sets a maximum limit of 68 degrees.

In its press release on the fish kill, the Corps states that: "It is not unusual to see thermal mortality at McNary Dam. Rates in the past have been as high as 15-20 percent. We try to do all we can to minimize fish kills from high temperatures." Even so, the Corps still captures juvenile fish and holds them in these high stream temperatures so that it can barge them down-river instead of having to spill them. When has the Corps of Engineers ever come before this Commission to request a variance to the state's temperature standard so that it could implement its transportation program? When has the Corps ever presented an analysis of the potential risk to fish from intentionally holding them in water that violates the state's temperature standard versus the potential risk of gas bubble trauma that might occur as a result of implementing spill? It appears that the Corps of Engineers is only interested in complying with those state standards that it can use to support its argument that barging is the best way of moving juvenile fish down-river.

Attached is the Corps' press release on the fish kill. It is very revealing and I urge you to read it carefully. As you read it, ask yourselves whether you believe that the Corps is doing its best to comply with this state's water quality standards and whether it is minimizing the amount of time that juvenile fish are exposed to lethal water temperatures. Ask yourselves whether you believe that the Corps has assessed the risks to fish of the hazards of lethal water temperatures versus the hazards of gas bubble trauma. You have heard the Corps speak regarding its strong concern over the hazards of gas bubble trauma and the symptoms of gas bubble trauma identified in the monitoring program implemented earlier this summer. I think it is noteworthy that this monitoring program found no fish that had died of gas bubble trauma. In contrast, we have at least 36,000 to 50,000 dead fish due to high stream temperatures. If the Corps had found that 36,000 to 50,000 fish had died due to gas bubble trauma, do you think that the Corps would have issued a press release similar to this one? Has the Corps implemented a monitoring program to assess the symptoms and mortality of fish exposed to high stream temperatures?

We believe that implementing spill is the best way to minimize the amount of time that juvenile salmon are exposed to high stream temperatures in the water immediately behind dams and in fish holding areas for barging. Yes, there is a risk of gas bubble trauma due to implementing spill. But we have a monitoring program in place to allow adjustments to be made on a real-time basis. We also believe that the risk of gas bubble trauma is considerably less than the risk of mortality due to high stream temperatures.

At present, the Columbia River is not safe for the salmonid beneficial use. We very much want to work with you to help make the river safe for fish. Thank you.

News Release
Walla Walla District
United States Army Corps of Engineers

July 19, 1994
FOR IMMEDIATE RELEASE

Contact Nola Conway
Release No. 94-53

High temperatures cause fish kill at McNary Dam

Umatilla, Ore. -- Increased Columbia River water temperatures near Umatilla, Ore., have caused the deaths of an estimated 36,000 juvenile summer and fall chinook salmon passing through McNary Dam, said officials today from the Walla Walla District, U.S. Army Corps of Engineers.

The fish, mostly wild stocks, from the mid-Columbia River, which are not currently listed as protected under the Endangered Species Act, were discovered dead in the dam's fish collection system.

"It's unfortunate that this fishkill occurred. These salmon are part of a precious and valuable resource to the history and heritage here in the Pacific Northwest," said Lt. Col. James S. Weller, District Commander. "I've got some of my best people working to find out what happened and what we can do to try and prevent this from happening in the future."

"At the time of this incident, water temperatures were averaging 71-73 degrees Fahrenheit," said John McKern, the District's fish passage coordinator. "Temperatures between 70 and 75 degrees Fahrenheit are generally accepted as lethal levels for salmonid species. Healthy fish tend to die at these temperatures from any kind of additional stress, including being pursued by predators. Passage through reservoirs and dams does cause additional stress," said McKern.

-More-

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McNary fishkill, 2-2-2

"The average mortality rate for fish at the McNary facility is one percent," said McKern. "A facility technician discovered on the evening of July 16 that this rate was increasing. The rate eventually rose to approximately eight percent," said McKern. These juvenile salmon were among approximately 240,000 fish which were being collected at McNary Dam to be transported downriver. The juveniles clogged a screen which slowed the flow of water to the raceway holding area where fish which had previously been collected were awaiting transport.

Fish from the holding area were released back into the river and the fish collection facility was shut down Saturday evening. McKern estimates that 13,000 fish were killed in a dewatering screen and 23,000 more died in the holding area. Fish are currently being routed away from the turbines and the normal fish collection system through the emergency bypass system in the sluiceway.

"It is not unusual to see thermal mortality at McNary Dam," said McKern. "Rates in the past have been as high as 15-20 percent. We try to do all we can to minimize fishkills from high temperatures. This situation, however, was unusual because we have new fish facility and an automatic screen cleaner that did not work properly," McKern said. "There have been some problems noted previously with this system, but which did not cause fishkills like this one."

Fish will continue to be bypassed through the emergency system until water temperatures drop. Corps officials are working to repair the screen-cleaning system and plan to have a decision about returning the facility to regular operations on July 27. Passing fish over the spillway at McNary may be considered as an option to aid migrating juvenile salmon in a future emergency.

Federal and state fisheries agencies were notified, according to McKern, of the thermal mortality rates at McNary on July 17.

-30-

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
729 N.E. Oregon, Suite 200, Portland, Oregon 97232
Telephone (503) 238-0667
Fax (503) 235-4228

MEMORANDUM

TO: GREG MCMURRY, OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY

FROM: BOB HEINITH, CRITFC, FISH PASSAGE BIOLOGIST

DATE: SEPTEMBER 13, 1993

RE: REVIEW OF MAINSTEM COLUMBIA RIVER DISSOLVED GAS STANDARD

Recommendations

1. The Columbia River Inter-Tribal Fish Commission (CRITFC) believes the mainstem Columbia River dissolved gas standard, as set by the states of Oregon and Washington, precludes protection of the tribes' federally reserved salmon resources. The majority of the state and federal agencies of the Columbia Basin Fish and Wildlife Authority (CBFWA) also have similar concerns with respect to the protection of anadromous fish migrating through the Columbia River hydrosystem and the current dissolved gas standard.

2. The CRITFC and CBFWA recommend the extant dissolved gas standard be modified to allow flexibility for fishery management purposes during the anadromous fish migration periods on a real time basis as conditions warrant.

3. We request the Department of Environmental Quality coordinate a review and modification of the standard with the CRITFC and other CBFWA agencies.

Background

In 1993, management of Columbia Basin hydrosystem for the protection and safe passage of salmon stocks, both listed and not listed under the Endangered Species Act, has been directed by the 1993 National Marine Fisheries Service Biological Opinion for the hydrosystem (BIOP). In turn the BIOP was formulated from 1993 biological assessments from the "action agencies", including the Corps of Engineers. A key part of the Corps biological assessment was based upon the real time operation of the hydrosystem during salmon migration periods, which was directed by the Corps 1993 Fish Passage Plan. The plan contained operational constraints to spill as a primary mode of juvenile fish passage, because such spill would create in river dissolved gas levels in excess of levels already exceeding the EPA standard of 110%.

In 1993, a majority of the agency and tribal members of the Columbia Basin Fish and Wildlife Authority, including the USFWS, ODFW, IDFG, and CRITFC, proposed management of spill for juvenile passage to be conditioned upon real time monitoring of effects gas bubble disease (GBD) on juvenile and adult salmonids at the dams. Actual monitoring revealed only very limited, isolated occurrences of GBD at a few dams during limited periods of extremely high **forced spill** when the dams experienced load distribution problems. At these times, total dissolved gas levels exceeded 130%. The daily proportion of juvenile migrant GBD occurrence during this period ranged from 1-5% at all Snake River Projects except Lower Monumental, where for four days GBD proportions were greater than 5%. During the rest of the juvenile migration, GBD proportions averaged between 1-2%, and adult symptoms averaged less than 1%. (CBFWA 1993 Attachment 1; WDW 1993).

Despite this evidence, the Corps and NMFS rejected the fishery agency and tribal recommendation, and instead conditioned voluntary spill upon total dissolved gas levels measured by an incomplete physical monitoring system in the hydrosystem reservoirs. In this manner, 1993 voluntary spill levels at dams were substantially decreased over 1992 levels despite favorable flow, water quality and fish condition.

It has been well documented in the scientific literature that direct spill mortality for juvenile and adult salmon which fall back over the dam (0-2%) is much lower as compared to direct mortality through the turbines or through mechanical bypass systems (10-15%). Thus, any potential increased mortality due to elevated total dissolved gas levels remains substantially below mortality incurred through passage routes other than spill.

It has also been well documented in the scientific literature that high levels of total dissolved gas are not an inclusive indication of levels of acute or chronic GBD. The combination of many other variables, including fish size, stock, physiological condition, exposure time, water temperature, turbidity, and existing atmospheric pressure, are responsible for GBD.

Despite only isolated findings of GBD during high flows in 1993, the Corps is proposing similar spill management in their draft 1994 Fish Passage Plan, **solely based upon the EPA and states 110% standard.**

Attachment 1

REFERENCES

CBFWA. 1993. Dissolved gas review and 1993 summary. Fish Passage Center. Portland, Oregon.

WDW. 1993. July 21, 1993 Memorandum from T. Kleist, adult fish supervisor to members of the FPDEP Operations and Maintenance Subcommittee.

cc:

Bill Sobolewski, EPA Portland
Rick Albright, EPA Region 10
Mark Hicks, Washington Department of Ecology

IDAHO STEELHEAD & SALMON UNLIMITED

Committed to Recovering Idaho's Anadromous Fish Runs

July 18, 1994

Chris Rich
Oregon Department of Environmental Quality
811 SW Sixth Ave.
Portland, OR 97204-1390

Dear Mr. Rich:

Idaho Steelhead and Salmon Unlimited representatives would very much like to present oral comments at your Columbia River hydro-spill hearing on July 21 in Portland, Oregon. However, travel and time constraints preclude us from attending in person. We request that the following written comments be submitted into the record.

Idaho Steelhead and Salmon Unlimited was formed in 1985 by a diverse group of businessmen, guides, conservationists, sport fishermen and concerned citizens from throughout the Columbia/Snake River region. ISSU was formed to help protect, preserve and restore Idaho's valuable anadromous resources and presently represents approximately 2000 members.

I'm sure you can appreciate ISSU's frustration with the posturing of the federal government and others with Idaho's steelhead and salmon resources. Action to protect these truly genetically unique creatures has been slow in coming. The 1994 spill measures implemented for spring migrants was a blessing to all of us who have tracked the increases and declines of Snake River salmon for over three decades.

Please believe me when I say that if spill did not kill baby kilowatts, you would have no opposition to a spill program for juvenile salmonoids. I'm sure you have reviewed the literature surrounding the effect on anadromous fish as a result of spilling water at mainstem hydro-projects just as we have. Therefore, you know that as far back as 1952 it has been documented that spill offers the best of all solutions for juvenile passage past the hydro-projects (Holmes, 1952). More recently the Northwest Power Planning Council (1986) and many others all agreed.

Historic data available from Idaho salmon anglers documents the catching of many adult spring chinook throughout the late 1950's and all of the 1960s with

EXECUTIVE COORDINATOR
Mitch Sanchotena

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nitrogen gas burns on their heads and other parts of their bodies. This was even pre flip-lip days. At that time we thought that excessive spill and subsequent nitrogen gas was bad for salmon. However, we have since learned that it was not nearly as bad as other alternatives that have been implemented in the past fifteen-years, for example, mechanical by-pass, collection and transportation of juveniles, etc.

Idaho anglers have also discovered that whenever high water run off years occur and excessive water passes through the Snake and Columbia Rivers causing forced spill, adults return in far greater numbers than in no-spill years. Four of the five best adult return ratios for Snake River spring and summer chinook from 1974 to 1989 occurred in 1975, 1982, 1983 and 1984. Spill levels during these years were substantially higher than those currently being implemented.

ISSU recognizes there may be some affects from spill to Snake River salmon. But we are convinced that the scientific literature and three decades of stream bank history bears out the fact that spill is the only proven measure to protect Snake River salmon in an otherwise lethal river environment.

ISSU has only one purpose -- to protect, preserve and restore Idaho's once abundant salmon and steelhead resources. We don't' generate electricity (baby kilowatts), we don't irrigate fields nor do we own any sea ports or grain warehouses. We have no hidden agendas when it comes to protecting Idaho's anadromous salmonoids.

ISSU is willing to take the risk of increased total dissolved gas (TDG) as a result of spill at mainstem hydro-projects as the best chance for our spring migrants. Won't you please help us give these once great runs of fish a fighting chance?

Thank you in advance for your cooperation this very important matter.

Very truly yours,

Mitch Sanchotena
Executive Coordinator

CRYSTAL IMAGES

Technical Research/Writing/Photography/Publishing

KATHLEEN MARIE MENKE

PO Box 2031 **McCall, Idaho 83638** **Phone/Fax:(208)634-3909**

Education: B.A. University of Northern Colorado, 1969, Biology, Chemistry
Graduate Education: (60+ semester hours) Sciences, Environmental and Natural Resource Education, Forestry, Photography, Journalism, Computers, Graphic Design, Misc.(1972-93) Water and Wastewater Treatment Courses, Boulder CO, 1980-5.

Professional Affiliations: Member Idaho Chapter American Fisheries Society, serve on anadromous fishes and water quality and quantity committees.

Publications/ Reports: Editor and Publisher of Idaho's Sockeye Scene, quarterly newsletter on the status of Idaho's sockeye and other anadromous fishes.

"The Relationship of River Velocity and Salmon Survival", 4 page information sheet prepared for the Idaho Deparment of Fish and Game, 1994.

"Threatened and Endangered Snake River Salmon Stocks --Of Fish, Politics, Risks, and Professional Choices," essay, Fisheries, 1993.

"Barging, Stress, BKD, and Listed Snake River Salmon," report, 1993.

"A Water Efficiency Coordinator for IDWR," draft proposal, 1992.
"Water Efficiency-A Resource for Utility Managers, Resource Planners, and Other Decision Makers," report for EPA and Rocky Mountain Institute CO 1990.

"Tahltan Sockeye-Indians Reclaim a Heritage," "In Danger of Diluting the Salmon Gene Pool," and "Snake River Salmon: Dammed to Extinction?" Pacific Fishing, 1989-1992.

"And Then There Was Light"--History of Holy Cross Electric, Colorado Life, 1984.

Collection and Distribution Standards, O&M Manual, Plan of Operations, for Town of New Castle and Westwater Engineering, Colorado, 1983.
"The Colorado River," Aspen Magazine, 1980.
"Needed: Water for Fish," Colorado Outdoors, 1979.

Presentations: Club 20, Colorado; Idaho Chapter of American Fisheries Society, Idaho Assoc. of Grain Producers, Idaho Assoc. of Soil Conservation Districts, Northwest Power Planning Council, National Marine Fisheries Service, NPPC Flow Aug. Committee.

Awards: Colorado Water Pollution Control Commission--for outstanding contribution to prevention of pollution of state waters, 1983.

Colorado Div. of Wildlife--for significant contribution to minimum streamflow, 1978.

Certification: Colorado Class A (highest of four levels) Water and Wastewater Treatment Operator.
Colorado Class II (Class I is highest) Distribution and Collection System Technician.
Idaho & Colorado Teaching Certificates, secondary science.

Work Exp./ Recent Own technical research, writing, photography, publishing business, six years. Water and wastewater treatment operations, five years. Teaching. Water quality analysis. Recent contracts include work with the Rocky Mountain Institute, Northwest Resource Information Center, Valley Soil & Water Conservation District, Idaho Dept. of Fish & Game, Idaho Governor's Office, and Payette NF.

Idaho's
SOCKEYE SCENE

"Moving Toward Recovery"

Volume I Issue 3 Summer 1994

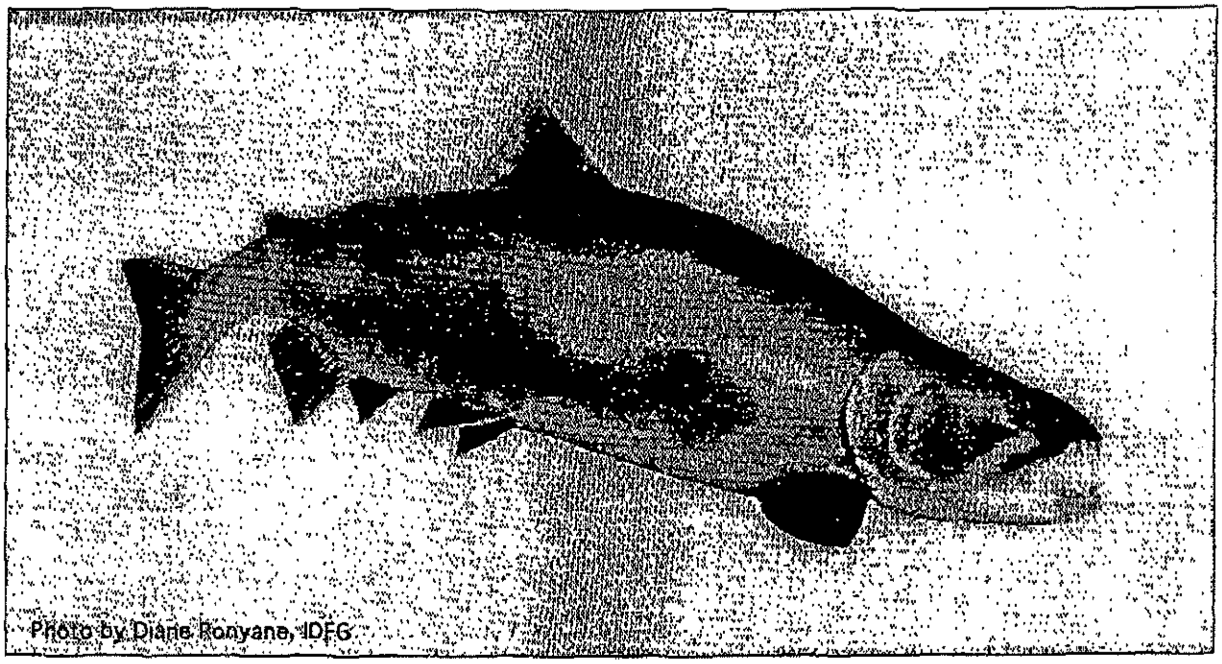

Photo by Diane Ronyane, IDFG

While no adult sockeye are expected to return to Redfish Lake from the ocean this summer, 60 adult sockeye and approximately 10,000 juvenile sockeye from the captive broodstock program, first and second generation offspring from this male sockeye, one of four sockeye (three males and one female) to return to Redfish Lake in 1991, will be released into Redfish Lake this year. The juveniles were put into net pens in Redfish Lake in late June as 4 gram fish and will be released to free-swim in the lake in October as 10-12 gram fish. These juveniles will be outmigrating to the ocean in 1995 along with about 2,000 naturally produced smolts. The adults will be released into Redfish Lake in late summer to spawn and produce eggs in Redfish Lake this fall.

1995 Critical Migration Year for all of Idaho's Salmon

The spring of 1995 will be a critical migration year for all of Idaho's salmon, according to the Idaho Department of Fish and Game (IDFG).

For sockeye, 1995 marks the first year smolts from the captive broodstock program, second generation offspring from the four adults which returned in 1991, will be migrating downstream. "We need to make certain we provide the best migrating conditions possible for these sockeye smolts," said Keith Johnson, fisheries biologist in charge of the sockeye captive broodstock program at Eagle. "The captive broodstock program is not a substitute for natural habitat. The sockeye program is intended to be a one-time emergency jump start for the last of Idaho's wild sockeye. If these sockeye are to remain wild, these smolts must get downstream and return in sufficient numbers to begin a recovery of their own."

Likewise, 1995 will be a critical migration year for Idaho's rapidly diminishing chinook and steelhead. "1995 is one of the last years we will have a significant number of our wild chinook and steelhead migrating downstream," said Dexter Pitman, IDFG's Anadromous Fisheries Manager. The region's fish agencies and tribes are recommending that migrating salmon smolts in 1995, and future years, be spilled over dams, allowed to migrate in-river, and receive significantly increased velocities through the mainstem passage during the spring migration season. Velocity recommendations are 110 to 140 kcfs through Lower Granite and 250 to 300 kcfs at the Dalles during the spring migration.

Such actions will allow salmon smolts to arrive at the ocean in a condition which will allow them to return in greater numbers as adults. Dismal adult salmon returns to Idaho in 1994 were due to deplorable juvenile migration conditions in 1992--velocities through Lower Granite averaging 48 kcfs during the juvenile migration season and collection and barging of most juvenile salmon smolts.

Needed: Honest Risk Assessments and Firm Choices by Fish and Water Managers

Idaho's salmon populations (sockeye, chinook, and steelhead) have reached a critical juncture. Salmon returns this year (the worst ever -- a small fraction of the previous ten-year average) demonstrate that continuing current operations on the Snake and Columbia Reservoir System is a clear, and no longer slow, path to extinction. It is not hard to understand why. Slow velocities through reservoirs (and resulting higher temperatures) combined with the stress of the collection process and confining healthy, wild salmon in high density raceways and barges with salmon which have infectious diseases (most specifically bacterial kidney disease -- a particular threat to Redfish Lake sockeye and Salmon River wild chinook) create conditions which facilitate the spread and progress of these diseases and result in juvenile salmon arriving at the ocean too weakened to survive to adulthood and return. Slow velocities through reservoirs also deplete the energy reserves of juvenile salmon and make them highly susceptible to predation from squawfish and other predators that have adapted well to the slow-velocity, high-temperature reservoir environment. The region's fish agencies and tribes are calling for spill passage over dams, in-river migration, and increased velocities and lower temperatures through the system for the juvenile migration period to reduce the risks of disease, predation, stress, and death in turbines. Spill passage in 1993 and in 1994 resulted in little or no observable negative impacts to juvenile or adult salmon as a result of nitrogen gas supersaturation, according to the monitoring by the Fish Passage Center. When spill passage, in-river migration, and increased velocity risks are compared to the risks of current operations, the choice seems clear. As Judge Marsh has declared, the system needs a major overhaul.

Water managers also need to ask, what is the best way to provide the needed velocities through the system? Water managers have been unable to meet recommended velocities with flow augmentation alone, and flow augmentation is creating extreme water system management problems upstream for all water users, as well as conflicts between those who favor using all flow augmentation for spring releases, and those who favor holding some back for summer releases. Flow augmentation may be part of the equation and should be used when needed. However, drawing down the reservoirs in the Lower Snake Reservoirs temporarily for a couple of months can give the salmon the spring velocities they need (in 48 out of 50 years without additional flow augmentation from upstream, according to the Army Corps of Engineers). The only real biological problem of drawdowns is getting the adult salmon upstream during a drawdown mode. This requires redesigning the adult fish ladders at the four Lower Snake reservoirs to provide a path through the dams during drawdown mode -- a problem, but not an insurmountable one. And since these dam modifications are going to have to be made sooner or later, sooner is better. Perhaps those who rebuilt the Santa Monica freeway in record time could be assigned to the task -- since the Army Corps of Engineers (who prefers operations as they are) has failed to deliver us a timely plan. Drawing down John Day Reservoir to minimum operating pool and leaving it there can also significantly increase velocities for both Snake and Columbia River stocks all season. By drawing down the lower reservoirs, the upper reservoirs and aquifers can be better managed to maintain minimum pool levels, provide spring flushes and late summer minimum streamflows, be available for irrigation and carry-over irrigation storage, power production, water quality improvement, flow augmentation for salmon that will be useful, etc. all of which are important tools for wise water resource management throughout the entire system. Decision makers must now make some firm choices. Extinction of these salmon, so significant to the Northwest, is not an acceptable option. KMM

Idaho's **SOCKEYE SCENE**

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Thank you for your support!

Research in Fisheries

Impacts of Gas Supersaturation a Function of Travel Time

According to a report in the Marine Fisheries Review, July 1976, by Wesley J. Ebel and Howard L. Raymond, there is a direct relationship between travel time, gas supersaturation of nitrogen, and survival of juvenile salmon.

In 1970, juvenile chinook salmon migrated from the Salmon River to Ice Harbor Dam in 25 days with nitrogen gas supersaturation levels averaging 130% at Lower Monumental forebay. During this period (from 4/19-5/13), juvenile salmon survival was 25%.

However, when travel time was reduced to 12 days (velocities through the system increased) and nitrogen gas supersaturation increased to 136% (5/14-5/31), survival of the juvenile chinook salmon increased to 50%.

In 1971, the study was repeated. Results showed that with nitrogen gas supersaturation levels of 109 to 131% (109% during a flow control period from 4/27-29) and a travel time of 26 days (4/7-5/3), survival of the juvenile chinook salmon was 37%.

When travel time was reduced to 13 days (velocities increased through the system) and nitrogen gas supersaturation levels increased to 135%, survival of the juvenile chinook salmon again increased to 50%.

The study indicates that the negative impacts of nitrogen gas supersaturation can be reduced if velocities through the system are increased (travel time is reduced).

Idaho's SOCKEYE SCENE

"Getting the Smolts Down Through the System"

Volume I Issue 2 Spring 1994

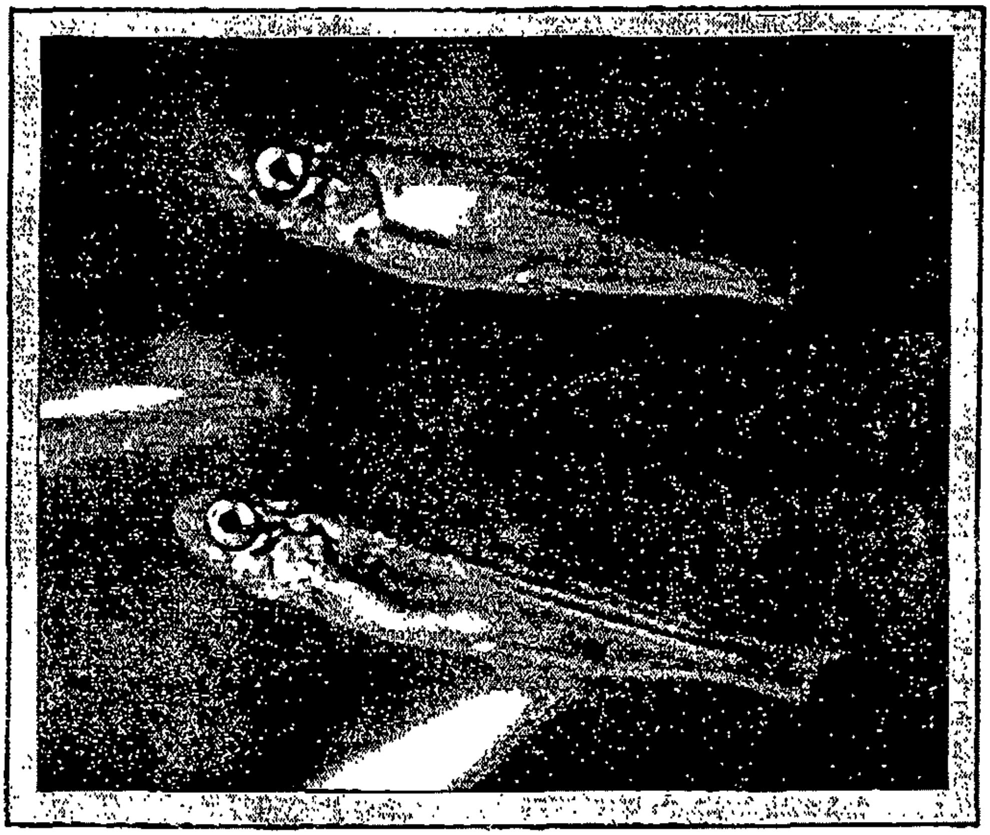
CONTROVERSY SURROUNDS DOWN-STREAM PASSAGE

Despite recommendations to the contrary from the Northwest's fish agencies and tribes, as many as possible of the last vestiges of Idaho's naturally produced sockeye smolts will be collected at Lower Granite Dam below Lewiston and placed into barges to be transported below Bonneville Dam this spring.

Steve Huffaker, Chief of the Bureau of Fisheries with the Idaho Department of Fish and Game (IDFG) predicts, "However many sockeye smolts are heading downstream this year, none will return."

Some smolts will die due to natural attrition on their way to Lower Granite Dam, as they have for millenianis. The deaths caused by the federal hydrosystem once they reach lower Granite Dam will include deaths in hydropower turbines, deaths from predators and disease in the slackwater reservoirs, and deaths from the collection and transportation process, including those caused by handling, stress, and post-ocean mortality due to arriving downstream in poor health.

Regional fish agencies and tribes are recommending that the dams be modified, velocities through the system be increased, and these smolts be spilled over dams and allowed to migrate in-river. (See p.3)



500 to 1000 sockeye smolts will migrate downstream to the Pacific Ocean from Redfish Lake this spring. None are expected to return. The National Marine Fisheries Service (NMFS) has ruled that, although the eight federal dams and reservoirs on the Lower Snake and Columbia in Washington are likely to cause the death of up to 84% of the sockeye smolts that reach Lower Granite, this federal hydrosystem is "not jeopardizing" this species. On March 28, 1994, Federal District Court Judge Malcolm Marsh ruled the "no jeopardy" opinion "arbitrary and capricious" and ordered NMFS to revise their opinion within 60 days.

SOCKEYE EXPECTED TO MIGRATE DOWNSTREAM IN THE NEXT FEW YEARS:

as estimated by the Sockeye Technical Oversight Committee Feb. 1994

1994: **500 to 1000** (all produced naturally from Redfish Lake)

1995: **approximately 12,000** (includes 10,000 from first wave of supplemental juveniles from the captive broodstock program--of these, 1600 will be pit-tagged and all will have adipose fins clipped. Fry will be placed into net pens in Redfish Lake in June 1994 and released to free-swim in Redfish Lake in October.)

1996: **hopefully over 100,000** (includes second wave of supplemental juveniles from the captive broodstock program)

Research in Fisheries

Smolts and Squawfish at Lower Granite Tailrace Studied

)an J. Isaak, a graduate student ıder the supervision of Dr. Ted ȷjornn, fisheries professor at the 'niversity of Idaho, has been ıvestigating the behavior of ɥuawfish below Lower Granite)am. The following was taken ·om a presentation made to the laho Chapter of the American 'isheries Society in February 994.

ixt ıree northern squawfish *Ptychochelius oregonensis* were nplanted with radio transmitters ınd released below Lower Granite Dam during 1993. Northern squawfish movements vere monitored using a boat equipped with a Yagi antenna, by riangulation, and with fixed eceiving sites.

'n 1993, the greatest abundance ıf tagged northern squawfish ccurred in the tailrace of Lower Granite Dam after the completion ıf the smolt migration and peak ıver discharge. Northern squaw- ısh that were in the tailrace uring the peak of the smolt ıigration typically were not ɔund in the high flow areas here they would encounter molts.

This study suggests that during high flows, the number of smolts ıst to squawfish predation within 'am tailraces may not be as great ; previously believed.

What's the Best Way to Pass Sockeye Smolts Through the Hydrosystem?

John L. McKern, Chief, Fisheries Management Operations Division, Army Corps of Engineers

"The Corps of Engineers, in our ESA Section 10 Permit application for 1994-1995, recommended maximizing the transportation of all species. According to the scientific information and empirical data we have reviewed, maximizing transportation affords the greatest protection to both listed and unlisted species."

Steve Huffaker, Chief Bureau of Fisheries Idaho Department of Fish and Game

"Sockeye, like our spring/summer chinook and steelhead, are spring migrants. The draft biological opinion of the National Marine Fisheries Service proposes to attempt to reach flows of 85 kcfs for spring migrants and to cap flow at 100 kcfs to save water for summer flow targets. What that means is spring migrants will not get the extra benefits that higher spring flows would normally give them in wet years. The fish passage experts (at least those I believe to be credible) tell me that 85 kcfs in the Snake River is the minimum to allow the species to hold their own, and what they need is 140 kcfs. Populations can live through drought years only if they can gain advantages in wet ones to make up the losses.

There is not enough storage in the Snake River basin for anadromous fish to persist if they are dependent on stored water flushed through full reservoirs. Drafting the mainstem reservoirs in Washington is the only long-term solution, but that doesn't solve the immediate problem.

This spring's migration is inevitable. What little we can do to help it will be critical, as water yield predictions are dismal. We should empower those people with the most experience and expertise in fish migration to make the decisions. That expertise resides in the Fish Passage Center, with input from the fishery agencies and Tribes."

Ted Strong, Executive Director Columbia River Inter-tribal Fish Commission (from letter to NMFS, Feb. 1994)

"The benefits of spill render it as a preferred alternative for dam passage. Direct mortality incurred to juveniles from spillway passage has been estimated to range from 0-3%..."

Michelle DeHart Fish Passage Center Manager Fish Passage Center, Portland

"The fishery resource managers (state, tribal and federal entities) technical staffs have developed passage recommendations. Those recommendations are contained in the Detailed Fishery Operating Plan recommendations. The Fish Passage Center will follow the specific instructions of the fishery managers, and request adequate flows for instream migration of juvenile sockeye salmon. Specifically, this means no transportation of juvenile sockeye and spill will be requested to facilitate project passage. Actual timing of requests will depend upon migration monitoring."

Steve Pettit, Idaho Department of Fish and Game; Ron Boyce, Oregon Department of Fish and Wildlife; Ron Woodin, Washington Department of Fisheries; Jim Nielson, Washington Department of Wildlife as representatives of respective agencies to the Corps' Drawdown Technical Advisory Group (from letter to Corps and NMFS, Jan. 1994)

"The agencies and tribes do not and have not supported transportation of juvenile migrants as a long-term mitigation measure and instead believe that measures must be taken to provide acceptable conditions for instream migration. Drawdown is one alternative for achieving this goal, along with spill and flow augmentation..."

Donald E. Bevan, Professor Emeritus, Univ. of Wash., Chair of Snake River Salmon Recovery Team, Personal View

"The river is presently a very dangerous place, as is the estuary and the ocean...they [pages of the Recovery Plan] include many changes in both downstream and upstream passage. Much more important than what I or someone else thinks should be done, is what do the results of scientific endeavor suggest should be done. I fear that far too many believe that there is some "magic bullet" that can be applied immediately to improve migration conditions and that the migration corridor is the only part of the life history of sockeye that needs to be addressed to improve survival and ensure recovery. It will not be a trivial task to forge a political consensus to give us the resources to make changes that can be measured and to modify or abandon them as science catches up. However, I am sure that many agree that we must proceed with recovery without waiting for better science."

Cecil D. Andrus Governor of Idaho

"The salmon's situation is dire...We need to modify the dams and draw the reservoir levels down briefly each spring to create the river velocity that will restore our salmon runs."

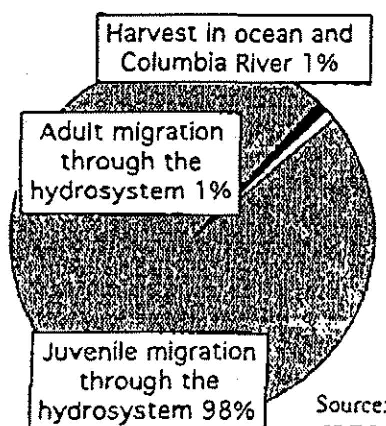
Biological Opinion, National Marine Fisheries Service, March 1994

"..All fish collected at Lower Granite Dam are [to be] transported regardless of flows...Spill at collector dams ...is not proposed...and is not recommended for 1994 through 1998..."

Federal District Court Ruling on NMFS' Biological Opinions, Judge Malcolm Marsh, March 1994

"...The process is seriously, 'significantly' flawed because it is too heavily geared towards a status quo that has allowed all forms of river activity to proceed in a deficit situation--that is, relatively small steps, minor improvements and adjustments--when the situation literally cries out for a major overhaul...The idea that the dams are immutable and uncontrollable like the weather ignores decades of fish protection improvements (such as bypass facilities and ladders) and other structural and operational enhancements...Thus, operational changes as well as systemic or facility changes to the dams' existence may well be available... The ESA does impose substantive obligations with respect to a [federal] agency's consideration of significant information and data from well-qualified scientists such as the fisheries biologists from the states and tribes."

Deaths of Wild Snake River Sockeye Caused by Man



Source: IDFG

ALL ALTURAS LAKE OUTMIGRANTS RELEASED IN '93

Originally 20 of the approximately 200 Alturas Lake outmigrants that were captured in 1991and reared in the captive breeding program were to be released in 1993. These fish were released into Alturas Lake in August, just before the Redfish Lake outmigrant adults were released. Later another 16 were released because they were females who had matured and no males had matured to breed with them.

Finally, in October, the remaining 160 Alturas Lake outmigrants of 1991 and 1992 were released whether they were sexually mature or not due to space limitations in the captive breeding program.

Technically not classified as endangered species, the '91 Alturas Lake outmigrants are an interesting study. Because most of them spawn early and have tested genetically to be more similar to kokanee, most are believed to be kokanee. Data from the radio-tagged original 20 that were released show that most of these adults spawned with the kokanee in the Alturas inlet stream. Biologists from the Shoshone-Bannock Tribe will continue observations on Alturas Lake outmigrants. Searches are also underway for sockeye residuals in Alturas.

No adult sockeye have returned to Alturas Lake in recent years, although many did in the past. Recent instream flow improvements in the access to Alturas Lake may help reestablish sockeye populations in Alturas Lake.

SOCKEYE STATS

** A sockeye's life cycle is four to five years from egg to spawning adult.

** Idaho's sockeye travel farther than any other sockeye in the world, over 950 miles each way.

** Eight federal dams and reservoirs block the migration path of Idaho's sockeye.

** Of the man-caused mortalities of sockeye, 1% are killed by harvest in the ocean and Columbia River, 1% are killed as adults through the migration corridor, and 98% are killed as juveniles through the migration corridor.

** Studies (Stevens 1980) on avoidance behavior of anadromous fish to gas supersaturation showed that sockeye were the quickest to avoid supersaturated conditions, perhaps aided by schooling behavior, and avoided supersaturated water within two hours.

Oregon Joins Idaho's Lawsuit on the Hydrosystem

Governor Barbara Roberts announced on January 7 that the State of Oregon has begun the process for intervening in the lawsuit, initiated by the State of Idaho, challenging the National Marine Fisheries Service's claim that hydroelectic operation in 1993 did not jeopardize endangered Columbia River salmon runs.

"We are concerned that the federal government is basing management plans for Columbia River dams for the next five years on assumptions similar to those under which it approved 1993's operations on the Columbia, which included the finding that a 90% mortality for downsteam migrating fall chinook poses no jeopardy to those runs," "

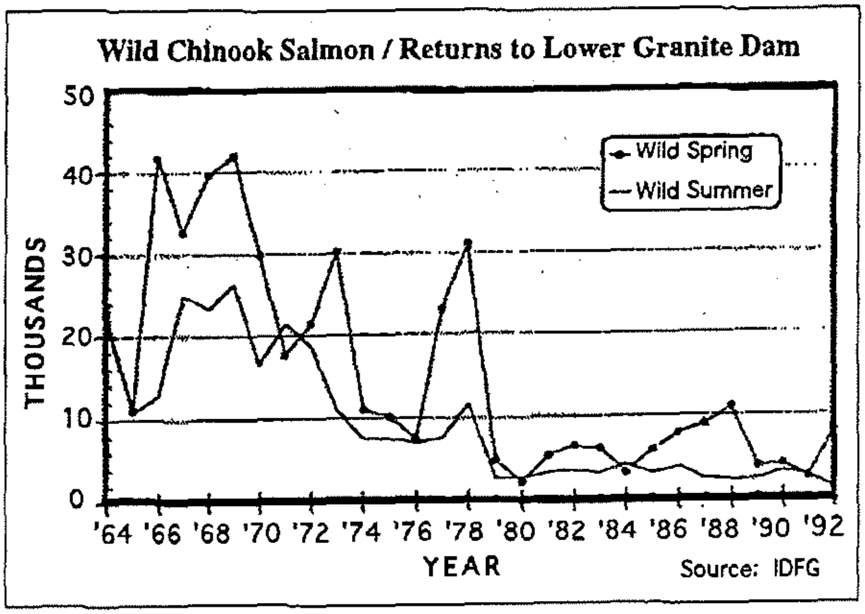
"I do not believe such a finding is supportable," said Roberts. "I now believe that unless the state joins the litigation to challenge the 1993 assumptions, NMFS will permit them and the flawed process by which they were reached to stand as precedents. That we cannot allow."

Every year, NMFS must review plans for the Columbia River hydroelectric operations managed by the Bonneville Power Administration, the Army Corps of Engineers and the Bureau of Reclamation. NMFS must evaluate whether those plans jeopardize threatened and endangered salmon runs. Governor Roberts, Governor Andrus, and the other NW governors have long pressed for full state consultation in this decision making process.

The Relationship of River Velocity and Salmon Survival

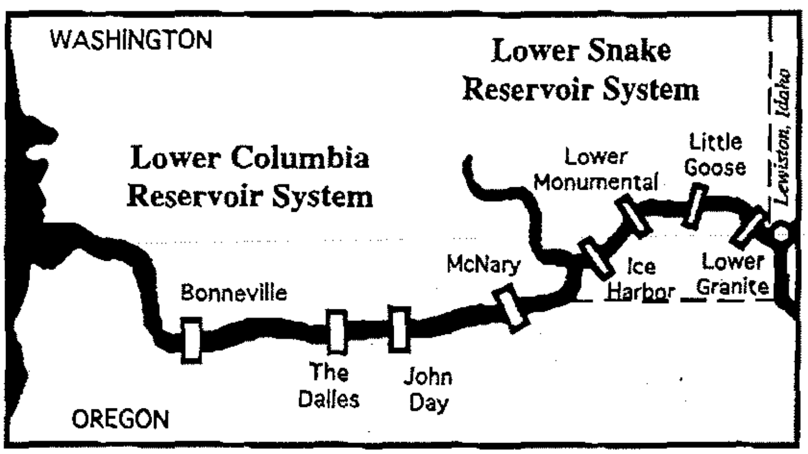
INFORMATION PREPARED BY THE IDAHO DEPARTMENT OF FISH AND GAME

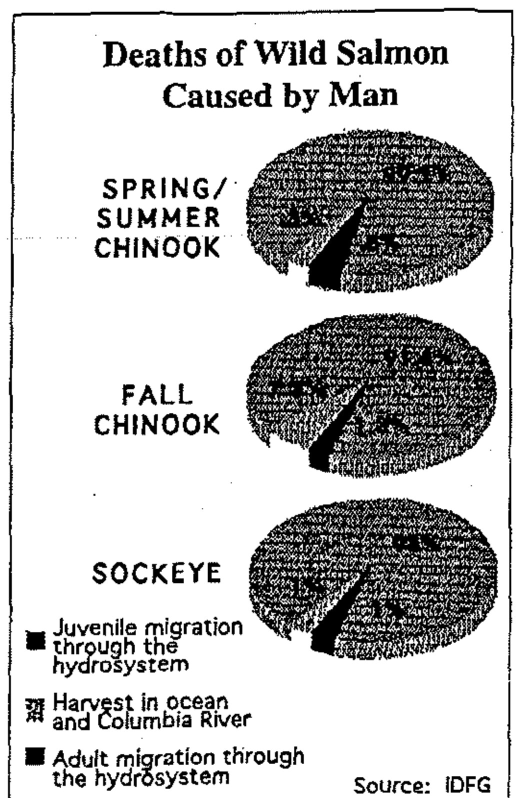
The Columbia River Basin once contained the largest salmon and steelhead runs in the world. The Snake River is the largest tributary of the Columbia, and contributed nearly half of the basin's spring and summer chinook and steelhead runs. As recently as the1960's the Snake River spring and summer chinook runs numbered in the tens of thousands of adult fish returning up the Columbia River to spawn in the tributaries of the Snake River Basin. These runs also provided substantial fisheries to tribal and nontribal fisheries.



In 1991 Snake River sockeye salmon were listed by the National Marine Fisheries Service (NMFS) as "endangered" under the Endangered Species Act, and in 1992 wild Snake River spring/summer chinook and fall chinook joined the Snake River sockeye salmon as threatened species.

Several factors contributed to the decline of the Snake River runs, including fisheries and habitat losses from dams and land use practices. But by far the largest cause of human-induced mortality is from the federal hydroelectric system.

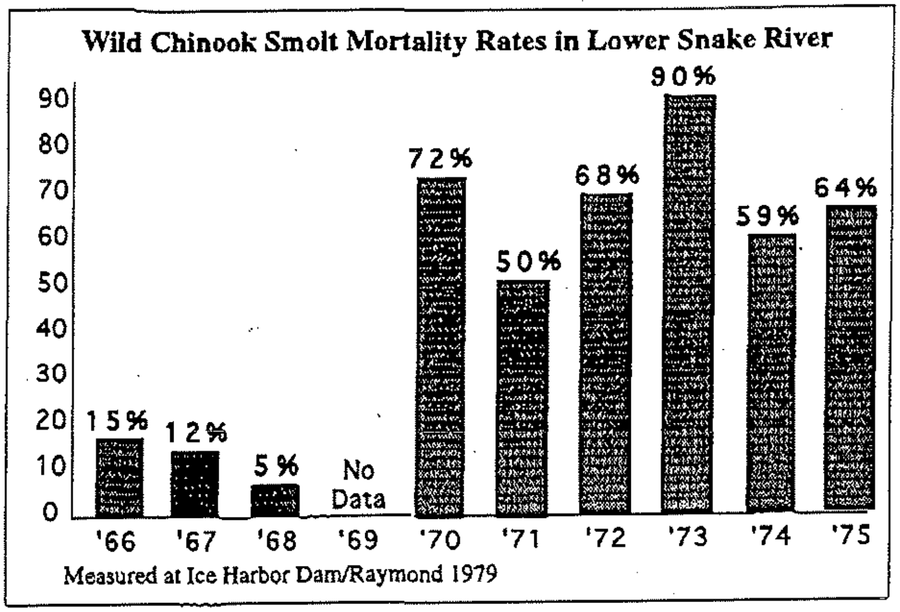




Snake River salmon migrate to and from the sea through eight dams on the lower Snake and mainstem Columbia Rivers. These dams were built between the years 1938 and 1975, with five of the eight dams completed in only thirteen years between 1962 and 1975. During this period of great change to the river system, government scientists began studying the effects of the dams on salmon survival.

The accompanying charts show the decline of salmon over time, and that over 95 percent of human-induced mortality is due to the hydroelectric system.

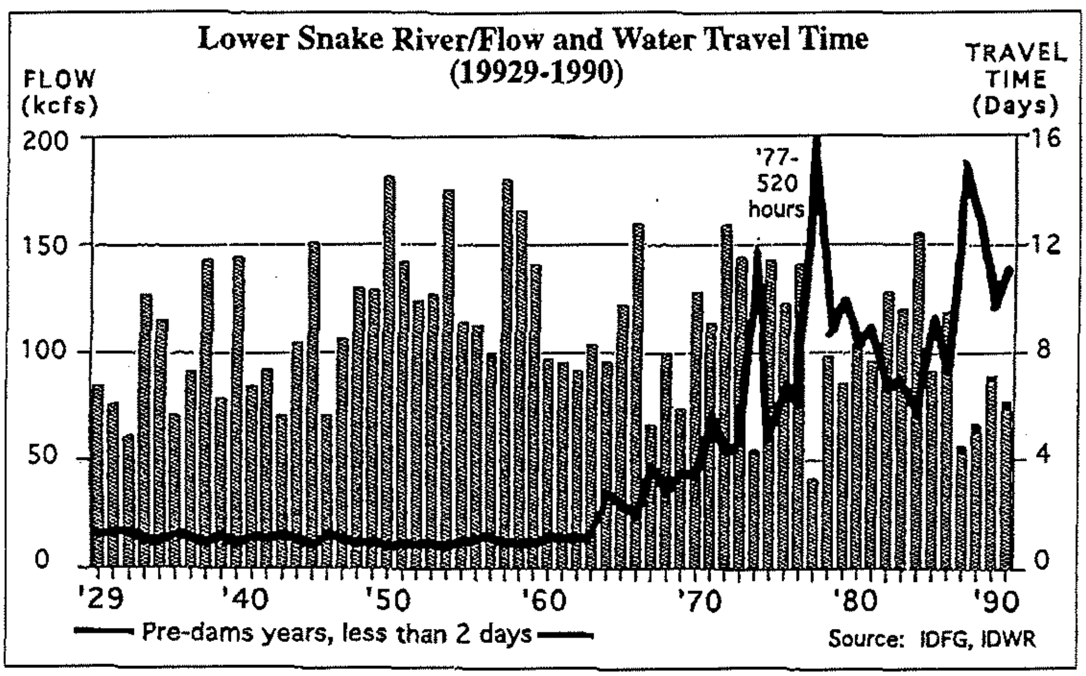
Biologists recognized the four lower Snake River federal dams would cause significant juvenile fish mortality. Therefore as part of the authorization of these dams, Congress ordered the study of the impacts of these dams on migrating salmon and steelhead, and mitigation of the impacts. These studies were done by the National Marine Fisheries Service (NMFS) in the 1960s and 1970s.



One finding was the significant increase in mortality of smolts in the lower Snake River. Mortality in the late 1960's was low (5 to 15 percent) but then increased greatly (50 to 90 percent) after two more mainstem dams were added in 1970 and 1971. Another study showed that when Ice Harbor was the only project, smolt mortality averaged ten percent. With the addition of Lower Monumental and Little Goose dams, mortality in the Lower Snake became five to nine times higher.

Early studies showed that on average a 15 percent mortality rate of smolts passing through the turbines of the dams. Conversely, only two percent of the smolts were killed when spilled over a dam. These mortality rates have been confirmed by studies done in 1993.

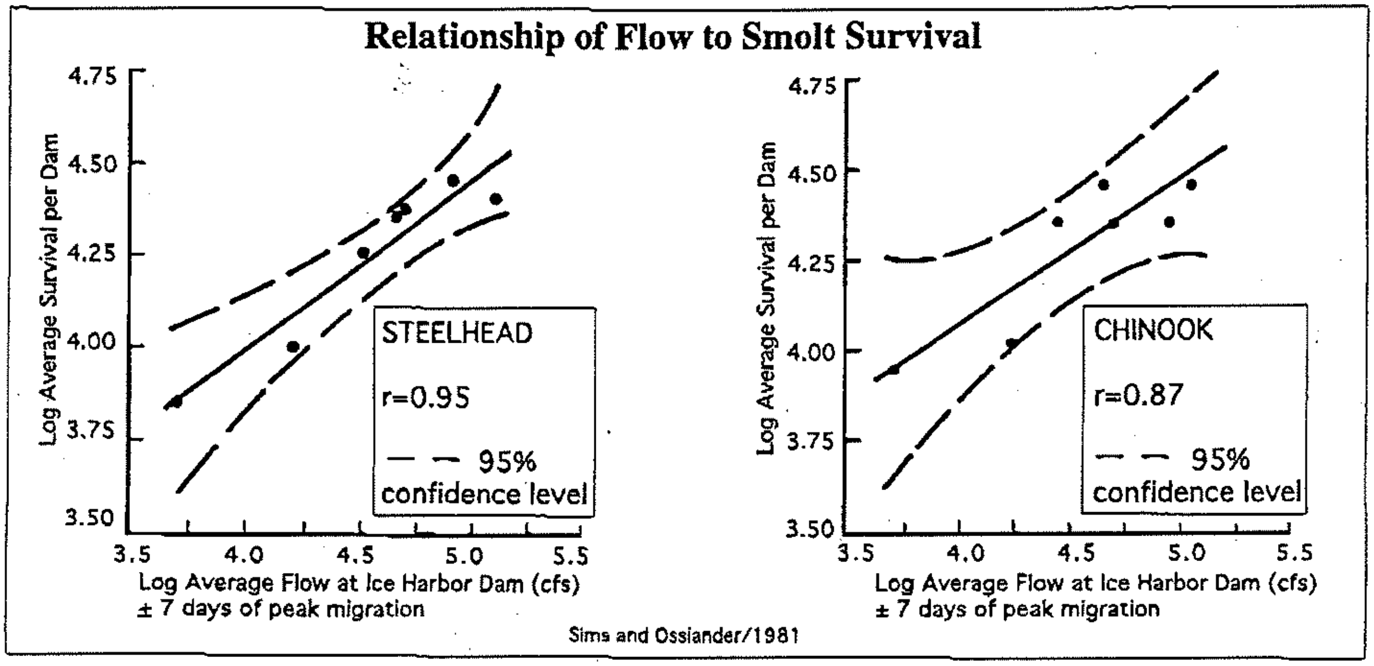
Smolt losses due to trubines and spillway passage over successive dams could not explain all the pronounced increase in mortality from the new dams. Survival through the reservoirs was also very important. Prior to the construction of the mainstem dams, the different inflow into this segment of the smolt migration corridor--whether a drought in the early 1930's or the flood years of 1948--did not greatly influence water velocity (travel time) through this section, and migrating salmon had free passage downstream. After the construction of the four lower Snake River Dams, water velocities greatly slowed and fluctuated in response to the inflow.



The graph here illustrates these differences. The bars represent average spring inflows over the years, and the line drawn over these bars shows how travel time of water has increased incrementally since1960 with the construction of the four lower Snake River Dams: Ice Harbor (1961), Lower Monumental (1969), Little Goose (1970), and Lower Granite (1975) in Washington. If one were to overlay the two figures on this page, a strong correlation can be seen between increased travel time and increased juvenile salmon mortalities.

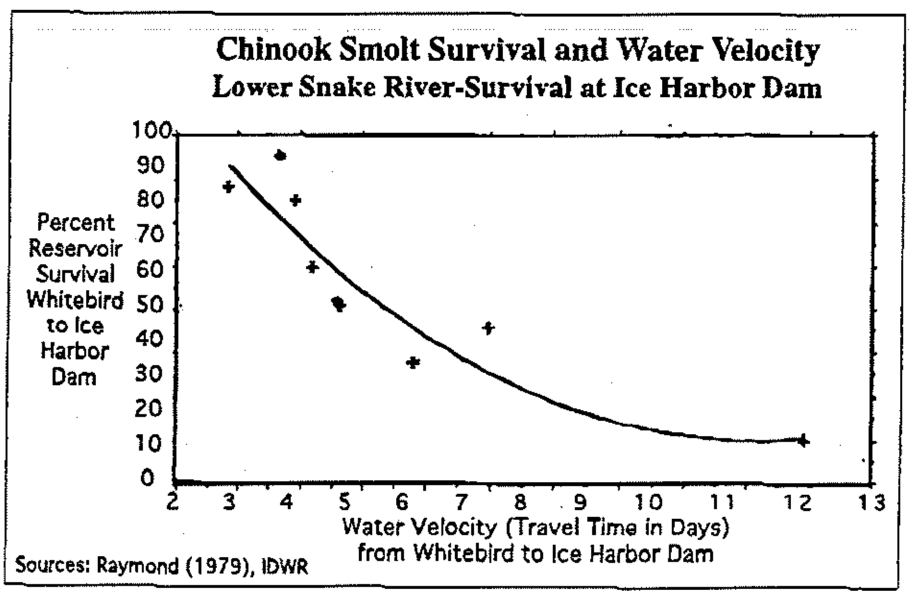
Continuing studies have shown that water travel time, smolt travel time, and survival are closely correlated. Smolts have a "biological window" within which their migratory behavior, seawater tolerance, and other physical attributes permit successful freshwater to salt water adjustments. Longer migration time and warmer water temperatures increase losses from disease and predation during migration. Predation rates and deaths due to disease at the ocean can be significant when the smolts have been subjected to increased stress, increased migration time, increased temperatures, and increased exposure to disease. Their salinity tolerance is lowered.

SMOLT SURVIVAL STUDIES--One of the most commonly referred to studies of river flow and smolt survival is a NMFS study by Sims & Ossiander (1981). It is important to understand that these studies were influenced by specific dam passage conditions during the study period. Dissolved gas supersaturation lowered smolt survival during high water years and obscured the survival benefits of high inflow and reduced smolt migration travel time. A conclusion that 85 kcfs through the lower Snake River reservoirs during springtime migration provides optimum survival only holds true if one ignores the influence of the dissolved gas supersaturation in these high flow years under these particular dam passage conditions. A more accurate judgement would take these factors into account, showing survival gains up to and beyond flows of 140 kcfs. The charts below illustrate the positive flow/survival relationship for yearling steelhead and chinook according to Sims and Ossiander.

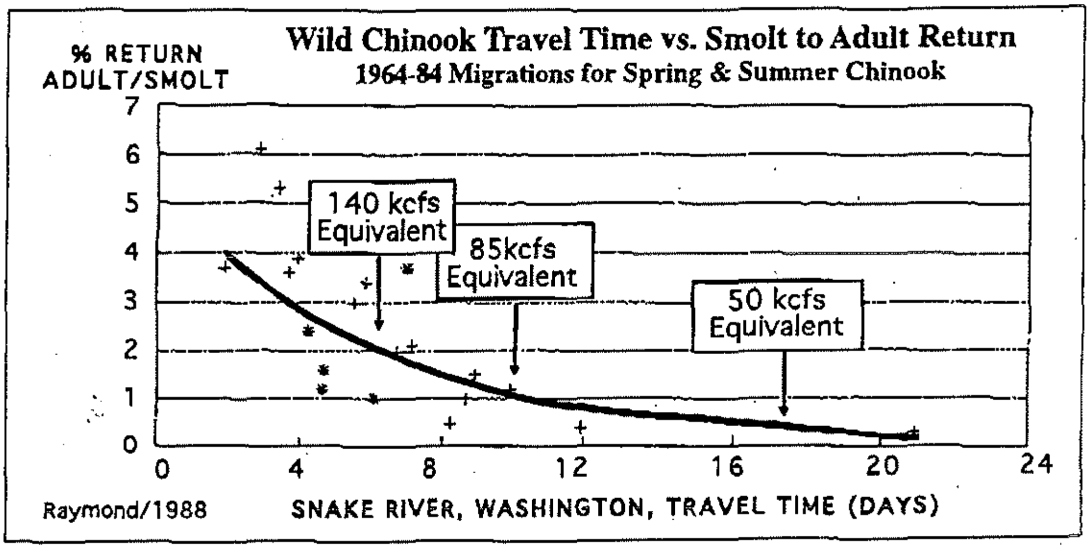


Published smolt survival studies conducted by Howard L. Raymond, NMFS, supports this latter interpretation of the Sims and Ossiander data.

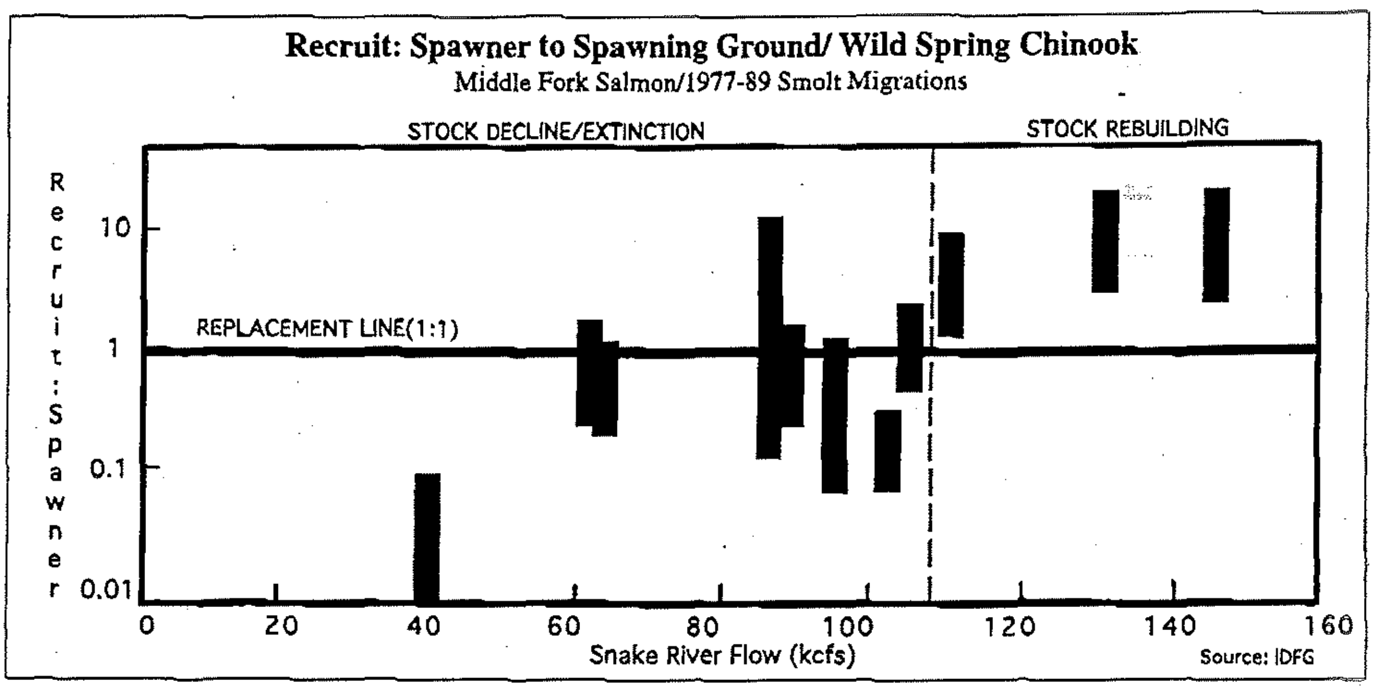
Raymond evaluated yearling smolt survival between Whitebird, Idaho, on the Salmon River and Ice Harbor Dam. Raymond's studies also included years of good inflow with low nitrogen gas supersaturation levels. Raymond's data, adjusted to account for turbine mortalities, show a very strong relationship between water velocity and juvenile survival. Raymond's data are especially relevant for Snake River salmon because the survival rates are for chinook smolts in the Snake River and during the time when the river was transformed from a free-flowing river into a series of reservoirs.



BEST EVIDENCE: ADULTS RETURNING TO SPAWN--Studies of adult salmon and steelhead surviving different migration conditions and returning to spawn provide further evidence of this relationship. Adult studies can extend over a greater period of time. Dr. Charles Petrosky of Idaho Fish and Game compared adult returns to Marsh Creek, a tributary of the Middle Fork of the Salmon River, to the flow and velocity conditions the fish experienced during their migration to sea two or three years previous. The adult returns to Marsh Creek for nearly thirty years shows a consistent link of adult fish returns to river velocities in the Lower Snake reservoir migration corridor when these fish migrated to sea as juveniles. Raymond (1988) estimates of smolt-to-adult returns at Ice Harbor show the same pattern of higher adult returns followed higher velocity conditions for the juveniles when migrating downstream.



An essential consideration is comparing the population of one generation to the population size of the parents' generation, and how this relationship is affected by juvenile migration velocities. The final chart below shows that since 1977 low flow/velocities result in survival rates plunging the salmon toward extinction, and even that average flow/velocities in the 85 kcfs to 110 kcfs produce problematic conditions preventing salmon recovery. Only river flow/velocites above 110 remove the risk of extinction and lead to rebuilding.



CONCLUSION--As demonstrated with this data, the best available scientific knowledge indicates that faster water velocities during juvenile Snake River spring/summer chinook migration significantly improve smolt survival and adult returns. The Northwest Power Act's vision for a rejuventated anadromous fish resource can only be met by a major improvement in juvenile migrant survival. Rebuilding efforts that focus on increasing water velocities during smolt migration are essential for success.

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Reply to
Attention of:

JUL 21 1994

State of Oregon
DEPARTMENT OF ENVIRONMENTAL QUALITY
RECEIVED
JUL 21 1994
OFFICE OF THE DIRECTOR

Environmental Resources Division

Mr. J. Gary Smith
Acting Regional Director
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
7600 Sand Point Way NE
Seattle, Washington 98115-0070

Dear Mr. Smith:

Please reference the enclosed letter from Ms. Anne Squier, Senior Policy Advisor for Natural Resources to Governor Roberts, addressing the Oregon Department of Environmental Quality's application of the current water quality standard for dissolved gas. It is described as a maximum 24-hour average of 110 percent total dissolved gas (TDG) measured at the McNary Dam forebay stations (north, south, and south redundant). The level of TDG currently being measured at these sites is approximately 110 percent. Therefore, unless the Oregon Environmental Quality Commission grants a waiver of the current water quality standard at its July 21 meeting, I cannot approve higher spills at Ice Harbor Dam.

Ms. Squier references spill levels identified in the 1994-1998 Biological Opinion. It is our understanding that National Marine Fisheries Service (NMFS) discussed both the potential that these spill amounts could cause high TDG levels with representatives of the State of Oregon and the possibility of waiving the State water quality standard. We believe that it is appropriate for NMFS to coordinate with the States of Oregon, Washington, and Idaho when actions contained in a biological opinion, if implemented, could result in violation of State water quality standards.

With regard to Idaho, your request to increase Dworshak discharge from 20 kcfs to 25 kcfs has resulted in TDG levels of 121 to 122 percent downstream of the project. Recent transect measurements conducted by Walla Walla District personnel show that only about 5 percent of the dissolved gas is dissipated in the 30-mile stretch of river between Dworshak Dam and the confluence of the Clearwater and Snake Rivers. We would like to be apprised of your discussions with Idaho and the Environmental Protection Agency regarding the exceeding of the 110 percent water quality standard in Idaho.

As a final note, we understand the current Washington Department of Ecology (DOE) water quality standard waiver for TDG covers only Ice Harbor tailrace downstream to the Oregon border. Should the Oregon Environmental Quality Commission choose to grant a waiver for summer spill, I could not authorize additional spill at Lower Columbia River projects without clarification of what other areas DOE's waiver is intended to cover. I am providing DOE a copy of this letter as a means of expediting any further action on their part that might be necessary.

Sincerely,

Ernest J. Harrell
Major General, U.S. Army
Division Engineer

Enclosure

Copies Furnished:

Washington DOE (Llewelyn)
Oregon DEQ (Hansen)
BPA (Hardy)

BARBARA ROBERTS
GOVERNOR

OFFICE OF THE GOVERNOR
STATE CAPITOL
SALEM, OREGON 97310-0370
TELEPHONE: (503) 378-3111
TDD (503) 378-4859

July 15, 1994

Major General Ernest J. Harrell
U.S. Army Corps of Engineers
North Pacific Division
P.O. Box 2870
Portland, OR 97208

RE: Request for assessment of the proposed spill relative to water quality standard for total dissolved gas

Dear General Harrell:

On behalf of Governor Barbara Roberts, I am responding to Mr. Jackson's letter of July 12, 1994. That letter expressed the Corps' concern regarding the potential total dissolved gas (TDG) levels in the McNary pool which may result from proposed spill at Ice Harbor dam. It is not possible at this time for the Department of Environmental Quality to assess compliance with the Oregon TDG standard because necessary information is not available. I address the Department's application of the current standard below.

Mr. Jackson noted that the National Marine Fisheries Service (NMFS) has requested that the state Environmental Quality Commission (EQC) change the state TDG standard to allow spills to assist summer out migration of salmon smolts, in accord with the Biological Opinion issued to you on March 16, 1994. Governor Roberts asked me to communicate her serious concern about the circumstances and timing of that request, particularly given that controversy has surrounded spill matters for many weeks. She queries why the Corps did not make that request, directly to the EQC and in a timely fashion after receipt of the Biological Opinion. That would have allowed the EQC to consider the matter under a normal time frame and without the extraordinary demands on staff and Commission that the current situation has created. Certainly in the future, the Corps should take direct responsibility for such matters with respect to its forecast operations.

The Commission will consider the NMFS request at a special meeting to be held July 21, 1994 in room 3A of the Department of Environmental Quality offices. After this meeting the Department may contact you regarding a temporary TDG standard for spills this summer.

Major General Ernest J. Harrell
July 15, 1994
Page 2

We believe that additional spill at Ice Harbor dam can be accomplished under existing standards. For the purpose of determining compliance in the McNary pool with the proposed Ice Harbor spill request, the State of Oregon interprets the TDG criterion as a maximum 24 hour average of 110% TDG. That is, TDG could exceed 110% on an instantaneous basis so long as the average TDG over a 24 hour period remains at or below 110%, taking into consideration the normal allowances that must be made for instrumentation limitations and ambient TDG fluctuations. Until further notice the appropriate sampling location are the sites identified as the McNary forebay stations (McNary North, South and South redundant). If you have any further questions, please contact Neil Mullane of the Oregon Department of Environmental Quality.

Sincerely,

Anne W. Squier

Anne W. Squier
Senior Policy Advisor
Natural Resources

cc: Gary Smith, NMFS Seattle
Ron Boyce, ODFW
David Peeler, Washington Department of Ecology
Jack DeYonge, Governor Lowry's Office
Gary Fredericks, NMFS
Randy Hardy, BPA

ATTACHMENT 4

Report and Recommendations

Panel on Gas Bubble Disease

National Marine Fisheries Service
Northwest Fisheries Science Center
Seattle, Washington
June 21 - 22, 1994

Introduction

The following is a meeting summary and list of recommendations to the National Marine Fisheries Service (NMFS) from its panel on gas bubble disease (GBD) in Pacific salmon. The recommendations are based on the group's one and one-half-day meeting held in Seattle, Washington on June 21-22, 1994. The GBD panel consisted of leading fisheries biologists with expertise in gas bubble disease.

The meeting was organized as a combination of panel deliberations and interactions with agency representatives and other interested public. It began with a three-hour series of brief presentations by several entities to the panel members, followed by a two-hour discussion in which the GBD panel directed questions to the audience. From this information, the experts then convened separately to develop recommendations based largely on their answers to eight sets of questions posed by NMFS as a frame of reference for the meeting. These recommendations should be useful for water and fisheries management in the region by the U. S. Army Corps of Engineers, the Bonneville Power Administration, NMFS, Oregon, Washington, Idaho, and several Tribes.

The Panel

The following scientists served on the panel:

Dr. Thomas Backman (Columbia River Inter-Tribal Fisheries Commission), Dr. Gerald Bouck (EPA, USFWS, BPA, retired), Dr. Charles C. Coutant (Oak Ridge National Laboratory, and panel chair), Mr. Earl Dawley (National Marine Fisheries Service),
Dr. Lawrence E. Fidler (Aspen Applied Sciences, Ltd.), Dr. William Krise (National Biological Survey), and Dr. Alan Nebeker (U.S. Environmental Protection Agency).

Purpose

The panel was asked to consider some specific aspects of GBD in Pacific salmon. At issue was the significance of certain signs of gas bubble disease in outmigrating juvenile salmonids, what these signs mean for the short- and long-term survival of juveniles, and what physiological or ecological impacts could occur to these fish. Although the immediate concerns focused on outmigrating juvenile salmonids, a broader, ecosystem consideration, including adult salmon migrating upstream, was suggested as appropriate. These aspects of GBD were the basis of a list of formal discussion questions that set the frame of reference for the meeting.

Because the development of summary nuggets of information appeared to be the objective for convening the panel, the responses are presented in bullet form.

Status/Continuation of the Panel

The questions asked the panel involved a wide range of lethal and sublethal considerations regarding the effects of dissolved gas supersaturation on fish. The time provided to the panel was insufficient to address many of these questions in a comprehensive manner. As result, the response to these questions is the panel's best effort, given the time available.

The panel recommends that until TGP is lowered to existing EPA Water Quality Criteria levels the monitoring and evaluation program should be continued and expanded to produce a comprehensive response to the problem of dissolved gas supersaturation on the Columbia and Snake rivers in relation to other needs for ensuring successful fish passage. This effort should include a list of experiments that will provide river managers with data that can form the basis for decisions for 1995 and beyond. The effort should include detailed descriptions of experimental objectives, protocols, and schedules for completion. The program should also include a review of the literature of GBD in fish in the context of monitoring for signs of gas bubble trauma. The panel recommends that it be reconvened with adequate budget and time to contribute to the formulation of such a program.

Questions and Answers

The following are the questions posed by NMFS and the answers of the GBD panel. The panel used these questions and their answers to make additional recommendations, which follow this section, in response to our charge.

Question 1 - Pathogenesis: What is known about the pathogenesis of gas bubble disease (GBD) in salmonids? Is it the same in juveniles and adults?

Answers:

a. Syntheses of GBD research have been written and translated into criteria and standards. For example, see National Academy of Science/National Academy of Engineering (1973), Water Quality Criteria 1972, USEPA Report EPA-R3-73-033, Washington, DC and Fidler, L. E., and S. B. Miller (1993), Draft British Columbia Water Quality Guidelines for Dissolved Gas Supersaturation, Prepared for B.C. Ministry of Environment, Canada Department of Fisheries and Oceans, and Environment Canada by Aspen Applied Sciences, Ltd., Valemount, BC.

b. Much is known about mortality of fish exposed in captivity, for certain gas levels, physiological conditions, and selected species.

c. Pathogenicity has been related to gas levels and gas composition (largely for mortality and a few selected other indices of pathogenicity)

d. Much less is known about pathogenicity in the river system. More research is needed.

e. We know little about sublethal and behavioral effects both in the laboratory or the river system, although there are suggestive observations. More research is needed.

f. Responses of adult and juvenile salmon to gas supersaturation are similar, but relative sensitivities, detailed differences in responses, and their significance must be quantified differently because the fish function differently at different ages and sizes.

g. The biophysics of bubble formation and coalescence in fish is understood in principle, but not enough is known about its variability between species, under different conditions, and in systems other than the controlled laboratory.

Question 2 - Signs: What are the signs of GBD? Are different signs observed in juveniles compared with adults?

Answer: The following table shows some of the general relationships between signs of GBD and age of fish.:

Signs of Gas Bubble Trauma in Salmonids

Sign	TDG Threshold (sea level)	Age/Class
Cardiovascular bubbles	acutely lethal at ~115 - 118%	Juveniles & adults
Subdermal emphysema including lining of mouth	~110%	Juveniles & adults
Bubbles in lateral line	~110%	Juveniles & adults
Overinflation of swimbladder in small fish	~103%	Swimup fry & juveniles
Rupture of swimbladder in small fish	~110%	Swimup fry & juveniles
Exopthalmia and ocular lesions	unknown, 102% for ocular lesions	Juveniles & adults
Bubbles in intestinal tract	102 - 110%	Juveniles & adults larval (physoclistous)
Loss of swimming ability	~106% see Schiewe 1974	Juveniles & adults
Reduced growth	102 -105% (Chinook, lake trout)	Juveniles
Immuno suppression (if present)	>108% see Krise 1994 and unpublished	Juveniles & adults
Reduced ability to adapt to saltwater	refer to Shrimpton 1993	Juveniles
Source: NMFS GBD Panel, June 1994		

Question 3 - Methods: Are there established methods for measuring and/or quantifying internal and external (macroscopic) signs of GBD in juvenile and/or adult fish?

Answer:

a. There are no standardized methods for measuring and quantifying GBD signs, although certain qualitative measures have been implemented in lab testing and field monitoring.

b. There are some commonly used (established) methods that could be standardized through formal publication.

Question 4 - Severity: Can the severity of GBD be quantified based on the presence or absence of specific signs? If so, do the same signs indicate the same severity in juveniles and adults?

Answer:

a. Severity of damage or probability of death (survivability) is poorly quantified by the presence or absence of specific signs used today across a full range of effects.

b. Severe signs are well coupled to probable mortality based on laboratory observations—mostly with juveniles.

c. Incipient threshold for mortality is especially poorly related to GBD signs.

d. Juveniles and adults have differing categories of vulnerability in the field that make the severity of different signs important (i.e., predation on juveniles, blindness in adults).

e. There is no adequate review of what the signs and vulnerabilities are and how to quantify them. This would require both reference review and additional research. In concept, these points could be added as additional columns to the table constructed for question 2.

Question 5 - Lethal or Sublethal Effects: Is there a specific impact or biological outcome (i.e., a lethal or sublethal effect) that can be linked to specific signs of GBD? Is the impact or biological outcome the same for juveniles and adults?

Answer:

a. The primary physiological impact or outcome of gas supersaturation is vascular embolism resulting (after sufficient exposure) in acute signs of respiratory, cardiac, and capillary blockage. Secondary impacts include emphysema in skin tissues, blindness, and flotation dysfunction.

b. Survivability impact or outcome for the fish depends on field exposure of the organism, which differs with age and behavior.

c. Some specific impacts and biological outcomes can be linked to specific GBD signs, although most are problematic. For example, loss of feeding, growth and survivability have resulted from fish in hatcheries being exposed to greater than 105%; exopthalmia, loss of sight has followed corneal swelling, perforation and collapsed eye; and loss of stamina could result from blockage of gill filaments. Specific signs can be linked to effects with varying degrees of certainty including these categories: reliably documented, known from selected examples, likely but not demonstrated specifically, suspected, and totally unknown. A full compilation of these relationships has not been done, but information is available in recent reviews. Much additional research would be required to relate specific signs to biological or ecological outcomes with clarity.

d. Previous reviews has not been conducted from a perspective of monitoring signs for real-time decision management.

Question 6 - Signs of Lethal or Sublethal Effects: Are certain signs or combinations of signs more significant with regard to lethal and sublethal effects? Are there potential sublethal effects of dissolved gas supersaturation that occur prior to the appearance of any sign? Is so, do they have the same significance in juveniles and adults?

Answer:

a. Yes, internal emboli (gas bubbles) in blood and other tissues that form before macroscopic bubbles can be seen are primary indicators of potential mortality. It is unclear which external signs (where bubbles accumulate and grow to macroscopic size) are most indicative of pending mortality.

b. There are undoubtedly physiological effects of GBD on fish and resulting effects on performance that would be experimentally observable (related to behavior, growth, survival, reproduction) before there are GBD signs visible to an observer.

c. Techniques might be developed to detect small gas bubbles before effects on fish survival would occur. Doppler meters were tried experimentally for this purpose in the early 1970s and ultrasound is being explored currently.

d. Additional research into early detection of potentially lethal and sublethal effects is needed.

Question 7 - GBD Signs and Monitoring Programs: In a monitoring program, are there certain signs of GBD in juveniles and/or adults that are more or less "significant" or that have more value than other signs? Is there any relationship between "headburns" observed on some adults and GBD or spill?

Answer:

a. The answers to question #6 addressed this question, as well.

b. As noted above, significant signs can be linked to effects with varying degrees of certainty from reliably documented to totally unknown. A full compilation of these relationships has not been done, but information is available in recent reviews and ongoing studies. Most of the more subtle signs that could be early indicators of problems for fish survival are not well documented and require more study.

c. Relationship of "headburn" to GBD is undocumented.

Question 8 - Species Differences: Are there species differences in susceptibility to gas supersaturated water?

Answer:

Yes, although salmonids have been studied most often, especially those receiving high gas saturation levels in hatchery environments (Pacific salmon, rainbow trout, lake trout). Only a small percentage of species typical of any regional fish assemblage has been examined, even in cursory fashion.

Other Recommendations

After reaching consensus on their answers to the eight frame-of-reference questions, the panel made several additional recommendations. Their recommendations addressed points raised in the letter of invitation and charge to the panel, including suggestions for the monitoring program now in place on the Snake and Columbia rivers, research needs, the value of biological monitoring, significance of gas saturation, and setting GBD into the context of river management overall.

Suggestions for Monitoring Program

The following are the NMFS GBD panel's suggestions for the current monitoring program of river fish:

a. Reliability of the observation should be a primary criterion for its selection, an evaluation of which would consist of:

- Consistency among observers, assuming similar training,
- Observation should be consistently related to TDG

b. Fish of known origin are most valuable, to understand exposure history.

c. Monitored fish should include examples all relevant locations in the river, not just bypasses.

d. Non-destructive monitoring methods should be explored, especially for adults.

e. Monitoring should be planned with adequate sampling design for statistical analysis.

f. The monitoring review document currently being prepared by a team for BPA and NMFS addresses specific, detailed recommendations about the field monitoring program, and it should be considered when available.

Research Needs

The following are what the group considers the major GBD-related research needs categories (more specific needs are addressed in answers to questions):

a. Research is needed at the river basin scale to provide bioengineering and water management approaches to reduce TDG while providing adequate fish passage.

b. Research is needed at physiological and fish population scales to relate TDG, GBD signs in fish, and conditions of exposure in the river system (% saturation, duration of exposure, location in the water column, fish size and age) to ultimate survival of outmigrants and return of adults.

c. Research is needed on instruments and techniques to develop methods for monitoring development of GBD at early stages without damaging fish.

Regulation of Water Quality by TDG or Biological Monitoring

The panel felt that in weighing the issue of whether use physical measurements or biological monitoring to regulate TDG in the river for protection of fish the following should be considered:

a. Physical measurements of TDG in water are currently more appropriate for regulation than biological signs because TDG is readily and reliably measured, and it can (and should) be done with published standard methods (Standard Methods for the Examination of Water and Wastewater, 18th Edition). Use of difference in total gas pressure (delta P) as the gas measure, as recommended in Standard Methods, seems most appropriate.

b. Scientific literature does not currently support a clear relationship between GBD signs monitored in river fish and ecological damage that provide firm biological and ecological thresholds.

c. Real-time management of TDG by detection of signs that may already indicate probable mortality is not likely to fully protect fish populations.

d. Water quality regulation by physical-chemical parameters (supported by documentation of biological effects) is well established in practice for water quality management (National Academy of Sciences water quality criteria, state standards).

e. Biological monitoring for GBD signs in river fish should continue so as to help establish physical-biological-ecological relationships for further development of scientific criteria.

f. The panel believes the existing standard of 110% will adequately protect fish on purely biological grounds. Effects above 110% are uncertain but in the direction of damage. More recent reviews suggest that more stringent levels of TDG are advisable for full protection. Further development of information for gas supersaturation criteria is needed for detailed balancing of TDG conditions and availability for water for outmigration.

Reduction of TDG

The panel has three major recommendations on reduction of TDG based on its review of actual spring 1994 TDG values in the Columbia and Snake rivers in relation to the GBD literature and concurrent GBD signs in river fish. These recommendations are offered because TDG levels have occurred that are demonstrably detrimental to fish in many controlled laboratory tests. The recommendations are:

a. An active search should be made for mechanisms to provide water for outmigration at levels of TDG that are not detrimental fish.

b. An active program is needed to reduce TDG below the current standards of 110% of barometric pressure in the Columbia and Snake rivers.

c. Carefully evaluated, innovative engineering and water management projects should be identified and implemented to lower TDG and provide adequate fish passage.

GBD in the Context of Overall River Management

As a final point in their work, the panel placed GBD into the larger framework of water and fisheries management, the perspective emphasized by many participants in the agency and public presentations:

a. TDG and GBD are but one consideration among many for management of flow and fish passage in the Columbia and Snake rivers.

b. Risk management among the many sources of biological damage depends on having reasonably complete quantitative knowledge of the effects of each source, including TDG and GBD.

c. Overall reduction of risk to fish may require other groups to consider reconfiguration of engineering structures and water management rather than minor operational adjustments to alter TDG.

Conclusions

The induction of GBD in both juvenile and adult Pacific salmon is one of the important risks to be balanced in water management in the Columbia and Snake rivers. The panel's review of GBD signs and monitoring at the request of the NMFS Northwest Fisheries Science Center confirmed that much is known about the sensitivity of salmonids to gas supersaturation and that signs of GBD may be expected in salmonids inhabiting shallow waters near the current water quality standard of 110% saturation. The panel highlighted that key information is needed about biological (physiological) effects of gas bubbles in fish and survivorship of fish with GBD signs in the river before it is reasonable to depend on real-time monitoring of symptoms to protect fish populations. This information can be obtained by carefully planned laboratory and field studies and continued biological and physical monitoring of the river environment during experimental spill programs.

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
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A Primer On Spill

The Best Available Means To Move Young Salmon Downstream

Most Columbia basin juvenile salmon migrate to the ocean sometime during the spring and summer. Before the 19 mainstem Columbia and Snake river dams, natural water flows flushed young salmon stocks from Snake River spawning areas to the ocean in about 20 days during low flow years. Today that journey can take more than 60 days in low flow conditions such as this year's.

Biologically Timely

Duration of the downstream journey can be a life and death matter. A young fish's adaptation from freshwater to saltwater must occur within a fixed period; if downstream movement is interrupted or slowed, the ability to adapt may be lost, and many of the fish will die. Also, when downstream movement is slowed, the young fish are subjected to long periods of predation. In sum, smolt survival increases as travel time from rearing areas to saltwater decreases.

What's Best For Salmon

The dams on the mainstem Columbia and Snake rivers have transformed the river to a series of slow moving reservoirs. Today most outmigrating juvenile salmon are transported around dams by barges and trucks to get them to the ocean. However, studies indicate that controlled spill is actually the safest and most timely way to move young salmon through the river and to the ocean. Spill refers to the release of water through the spillways of hydroelectric dams instead of through the spinning blades of generating turbines and/or mechanical screen bypass systems.

What's Best For Power

While controlled spill is the best available alternative for fish, it is not so good for power generation. When river flow is spilled rather than sent through generating turbines, no electricity is produced, and that means less power to sell. Those whose interests are most closely tied to using the river's water for electricity (or for other non-fish purposes) do not favor spill. They advocate collecting and transporting the juvenile salmon around dams—thus avoiding having to use water for fish.

What the Studies Show

•Among all known passage choices, spill—not barging and trucking—causes the fewest mortalities. Extensive studies show that juvenile salmon mortality from spill ranges from 0-3 percent at each hydrosystem (Iwamoto et. al. 1993; Ledgerwood 1990; Raymond 1988; NPPC 1986; Holmes 1952).

•Also, the historical record indicates that better adult returns followed from juveniles that migrated during high flow and high spill conditions. Some of the best adult return ratios for Snake River spring and summer chinook occurred in 1975, 1982, 1983 and 1984 when spill levels were high.

•Other passage routes cause higher levels of mortality: Passage through turbines causes from 10-30 percent direct mortality *at each dam* (NPPC 1986; Raymond 1988; DFOP 1993).

•Where mechanical bypass systems are installed (not all dams have them), only 35-70 percent of the juvenile salmon that reach the dam are guided by screens, collected and then bypassed or transported. (The fish not collected, go through turbines.) The mortality for the collected fish ranges from 2-8 percent *at each bypass facility* (Dawley 1991; Monk et. al. 1991;WDF 1992).

•Mortalities from barging and trucking include death from guidance, collection and handling, and predation within transport vessels and at downriver release points. When fish are transported rather than spilled, mortalities also include the juveniles not collected and barged but passed through mechanical bypass systems and through turbines. After nearly 20 years of trucking and barging juveniles, transportation has failed to demonstrate clear benefits for salmon (Mundy et. al. 1994).

The prevailing research supports controlled spill as the best available alternative—aside from dam removal, of course. State and federal fish agencies agree with the tribes that controlled spill needs to be used to help young salmon through the treacherous Columbia-Snake hydrosystem.

Monitoring Spill Prevents Gas Bubble Problems

Spill for fish is referred to as "controlled" spill in contrast to uncontrolled spill, a frequent occurrence under current river operations. Whenever system operators—the Army Corps of Engineers, the Bonneville Power Administration and the Bureau of Reclamation—have more water flow than is needed to meet power demand (and irrigation withdrawals), spill occurs. But it is not monitored for its effects on fish.

Large amounts of spill *can* cause dissolved gas levels high enough to harm adult and juvenile salmon. However, dissolved gas saturation levels can be controlled by transferring spill among dams and by lowering spill levels. To locate nitrogen saturation problems, the Fish Passage Center, which was originally established under the regional power act's Fish and Wildlife Program, has a network of more than 15 monitoring sites. Based on monitoring data and recommendations from the Center's passage experts, spill configurations are altered to make it an effective means of fish passage.

Also, since the mid-1970s spill deflectors have minimized nitrogen supersaturation by scattering the spilled water across the spillway area rather than allowing it to plunge directly below the spillway. Except for the John Day and Ice Harbor dams, all the dams had spill deflectors installed.

What About Spill Costs?

No actual additional dollars are spent on spill. Existing program dollars are used to implement the controlled spill program. The million dollar figures bandied about by skeptics and opponents represent money that might have been made if the spilled water had been used to generate electricity.

When there is more flow in the river than is needed to meet power demands, spill is routinely used without complaints about lost revenues or hand-wringing about nitrogen supersaturation's effect on salmon.

Use of Spill Not Untested Experiment

Controlled spill has been used for fish for the last decade at all mid-Columbia public utility district projects as a result of settlements and stipulations in the re-licensing process of the Federal Energy Regulatory Commission. Controlled spill has also been routinely used at Army Corps projects, including Bonneville, The Dalles, John Day and Ice Harbor dams.

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FISH PASSAGE CENTER
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PHONE (503) 230-4099 • FAX (503) 230-7559

SYSTEM OPERATIONAL REQUEST

TO: **FEDERAL EXECUTIVE IN-SEASON MANAGEMENT TEAM:**

NMFS-Seattle	Gary Smith
USFWS-Ptld	Bill Shake
USBR-Boise	Ken Pedde
COE-PE	Dave Geiger
BPA-P	Walt Pollock

FROM: Fish Passage Manager Michele DeHart

REQUEST # 94-48:

DATE: July 18, 1994

SUBJECT: Spill at McNary Dam

SPECIFICATIONS:

Spill the following at McNary Dam to achieve a project FPE of 80%:

0600-1800 spill 80 kcfs;
1800-0600 spill 110 kcfs.

The project is to follow the adult patterns for spill contained in the DFOP. Adult fish passage counts will be monitored to assure that passage is not impeded at this spill rate. The justification for the spill levels is included in SOR # 94-41.

JUSTIFICATION:

The McNary project is in emergency bypass at this time because of high temperatures in the collection system which caused mortality to collected fish. It is estimated that approximately 50,000 mortalities occurred this past Saturday and Sunday (July 16 and 17). Temperatures in the gatewells and in the emergency bypass system remain unacceptably high. Temperature problems are unlikely to subside in the near future. The present operation of the project, in a no spill condition, does not address the mortality associated with passage at McNary Dam. In addition, the operation of the bypass under present high temperature conditions will certainly cause stress and increased mortality. Spill is the safest means of project passage and will disperse predators. As the COE was officially advised on Sunday, July 17, the agencies and tribes recommend the COE begin to immediately spill at this project. We also recommend that the South turbine units (Units 1-6) be shut down and have their orifices closed, to avoid drawing fish to this end of the powerhouse where the temperature problem is most extreme.

In addition, the fish guidance efficiency at McNary Dam for subyearling chinook is only 47%. The no spill/maximize transport option recommended by NMFS was predicated on some benefit associated with transport. Since the project is not presently capable of transport, the project should be spilling and not imposing additional mortality on fish by passing them through turbine units. We recommend the project begin spilling immediately.

594-94.SOR

COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION
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July 20, 1994 Contact: Laura Berg, 503-731-1283
For Immediate Release

Portland—"With spill at the dams, this never would have happened," said Bob Heinith, fish passage specialist for the Columbia River Inter-Tribal Fish Commission (CRITFC). Heinith was referring to the 50,000 fish that died at McNary Dam last weekend while they were being collected for barging around the Columbia's four lower river dams.

Most of the juvenile fish killed were wild summer and fall chinook. The fish died because of the combined factors of water temperatures ranging from 71-73 degrees F. and a malfunctioning screen at the fish collection area at McNary Dam.

If dam operators had been spilling sufficient water as requested by the state and tribal fish agencies, these juvenile salmon would have gone over the spillway (and through the warm water more quickly than if they were being barged, trucked or bypassed mechanically around generating turbines.)

In fact, of all known downstream passage alternatives—except dam removal—spill is the safest method. Extensive studies show that salmon mortality from spill ranges from 0-3 percent at each dam, which is the smallest mortality rate among passage alternatives.

Dam operators—the Army Corps of Engineers—indicated that they turned down the request for additional spill at the dams because more spill would exceed dissolved gas levels set by Oregon Environmental Quality Commission (OEQC) and Washington's Department of Ecology (WDOE).

Tomorrow tribal and state biologists will recommend that OEQC increase the allowable level of nitrogen gas in the river so that spill can be used at eight Columbia and Snake river dams.

—continued—

"It's interesting to note that even though dam operators frequently spill water for various reasons, OEQC and WDOE have not—until this time—been involved in monitoring dissolved gas levels or in enforcing and adjusting dissolved gas standards," said CRITFC's Heinith.

"We are waiting for ODEQ to get just as concerned about the water temperatures that are now violating Oregon's maximum limit of 68 degree F. as they have been about gas levels," said Jim Weber, policy analyst for CRITFC.

ODEQ will meet tomorrow July 21 at 1 pm to consider a variance to its allowable nitrogen gas standards in the Columbia and Snake. The meeting is in room 3A at 811 SW 6th Ave in Portland.

-30-

copy for EQC

R1-57

UNITED STATES GOVERNMENT — FISH AND WILDLIFE SERVICE

Memorandum

TO : Assistant Regional Director - AFF
Region 1, Portland OR

DATE: May 31, 1994

FROM : Project Leader, Lower Columbia River Fish Health Center
Underwood, WA

SUBJECT: Gas Bubble Disease Summary of Observations

Starting on May 12, this laboratory trained a total of 16 people at the various fish passage facilities at Little Goose, Lower Monumental, McNary, John Day, and Bonneville dams to observe signs of Gas Bubble Disease in outmigrating steelhead smolts. What we covered was:

- Gas in the gills by 1) cutting the filament underwater to observe bubbles coming out and 2) microscopic examination of approximately 20 filaments for bubbles.
- External lateral line exams with the dissecting microscope
- Internal lateral line exams under the dissecting scope by peeling the skin of the fish away from the musculature while observing the lateral line pocket.
- A gross internal exam looking at 1) overextended gas bladders, and 2) bubbles in the kidney or intestine

May 12 and 13 there were no signs of gas bubbles in fish examined at McNary, Bonneville and John Day. On May 16 during a training session at Little Goose, the first signs of bubbles were observed in the lateral line, with May 17 at Lower Monumental showing bubbles in some gill filaments, and along the lateral line. May 18 at John Day and at Bonneville, bubbles were seen in the gill filaments of some fish, and in some lateral lines. At the lower dams these minor signs are continuing. May 26 fish examined at the Lewiston trap (at the confluence of the Snake and the Clearwater) showed no bubbles, while 4 fish of 15 at Lower Granite dam showed signs (2 with overinflated swim bladders, 2 with internal lateral line bubbles).

My direct observations on various days at several sites are that these signs are minor ones of gas bubble disease. When bubbles are observed in the gill filaments, they are small, and have not completely blocked the gill capillaries. The gill filaments above and below the bubbles are still healthy looking, and still receiving a blood supply. Most often there is only one bubble per filament, with only 2 instances where more than one bubble per filament were observed. The bubbles are all small.

The lateral line bubbles are also very small. They are difficult to observe through the skin, but when the skin is peeled back, they appeared in the pockets of the lateral line. When I observed bubbles in the lateral line, the number of bubbles per fish averaged 2, with the most I observed per fish being 3.

The internal signs are the most subjective. The swim bladder and kidney observations are the most likely to be overestimated, and gas bladder distention could even be caused by the process by which these fish are collected. Some of the swim bladders I saw were very over extended, but this observation will vary from person to person.

The fish being sampled are otherwise appearing healthy.

The extent of the bubbles seen in these fish is very small. The impact on the gills is minor, as good blood flow was observed above and below the bubbles on the individual filaments. The internal signs have also been at a very minor level.

In hatchery fish, my experience with these low levels of signs and small number and size of bubbles are that the fish can fully recover from these effects. These levels are not lethal to the fish. Once the levels of supersaturation in the water is reduced or eliminated, the fish begin to rid themselves of the bubbles.

Phyllis Barney

cc Brian Brown, for distribution to Dailly Spill Report list

Oregon

DEPARTMENT OF
ENVIRONMENTAL
QUALITY

July 14, 1994

Mr. J. Gary Smith
Acting Regional Director
National Marine Fisheries Service
7600 Sand Point Way NE
Seattle, WA 98115-0070

Re: Total Dissolved Gas Concentrations in the Columbia River

Dear Mr. Smith:

The Department received on July 11, 1994 your letter dated July 6, 1994, wherein you request:

1. Immediate interpretation of the current total dissolved gas (TDG) standard, and

2. A temporary rule to allow exceedence of this standard to allow full implementation of required summer fish spill.

As to your first request for immediate interpretation of the TDG standard there are two points. First the interpretation provide to NMFS on June 3, 1994 was under the authority granted to me by the temporary rule (OAR 340-41-155) adopted by the EQC on May 16, 1994. The June 3, 1994 interpretation stated:

> "Pursuant to the cited rule, I hereby alter the allowable TDG levels. The TDG levels should not increase above the concentrations achieved by the reduced spill, spill should be controlled to minimize daily average levels above 110 percent TDG, and the hourly maximum within any one day should not exceed 115 percent TDG."

The temporary rule adopted by the EQC on May 16th gave me the authority to make an interpretation of the standard as I did in the June 3rd letter after you requested the Corps to reduce the spill. The broad authority granted to me in the temporary rule no longer exists. The Department must base any current interpretation of the existing TDG standard on the most recent standards revision documents. Attached is the staff assessment of these materials.

STATE OF OREGON 1859

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Based on this assessment the Department interprets the TDG criteria as a maximum 24 hour average of 110% TDG, with the maximum variation around the 24 hour average to be consistent with the sampling precision associated with instrumentation and ambient variation.

As to your second request, the Environmental Quality Commission (EQC) has scheduled a special meeting for July 21, 1994 at 1:00 pm in room 3A of the Department of Environmental Quality headquarters office to consider and then take action upon your request for a temporary rule.

Sincerely,

Fred Hansen
Director

FH:njm:crw
SA\WC12\WC12753.5

Enclosure: DEQ staff memo to Fred Hansen
cc: Mike Downs, DEQ
Jim Athearn, US Corps of Engineers
Ron Boyce, Oregon Department of Fish and Wildlife
Michael Huston, Oregon Department of Justice
David Peeler, Washington Department of Ecology
Anne Squier, Oregon Governor's Office
Gray Fredericks, NMFS

State of Oregon
Department of Environmental Quality

Memorandum

Date: July 13, 1994

To: Fred Hansen, Director

From: Robert Baumgartner, ODEQ

Subject: Interpretation of the Total Dissolved Gas criterion.

TDG Standard Development:

The current form of the Total Dissolved Gas (TDG) standard is discussed in the State of Oregon Department of Environmental Quality Standards Revisions, January 1979. Review of this document and the State-wide water quality management plan summary of testimony from public hearings provides the information relied upon to describe the intent of the adopted dissolved gas standard.

At the time the standard was adopted, criteria were perceived as representing extreme values. In the public testimony, especially as related to dissolved oxygen, there is extensive discussion of the weakness of relying on averages. Biological systems may be controlled by extreme values, and an average provides no guarantee against extremes. To be effective a criteria defined as an average would need to describe an acceptable variation around the mean and describe an appropriate averaging period. None of these descriptions are associated with the dissolved gas criteria indicating that the TDG is consistent with other existing standards in describing extreme (maximum) conditions.

The public testimony review also describes "technical violations", which were perceived as conditions outside of the criteria, but not necessarily violations of the standards. Discussions focused on oxygen and pH violations, and the 'technical violations" described were related to natural conditions such as photosynthesis and stream warming. In the TDG issue paper examples were used to describe natural and man-made sources of supersaturated water. The "technical violations" do not appear to be associated with controllable human activities such as increased spill.

The information presented in the 1979 issue paper indicates that many of the same issues and much of the same information being debated today were discussed then. The issue paper correctly stated that:

- Some mortality occurred among sensitive species at TDG levels of 110-115% when restricted to shallow water and that substantial mortality at less than 1 m depth occurs at greater than 115%,
- When juveniles sound and obtain hydrostatic pressure there is still substantial mortality when TDG levels exceed 120%, and
- Higher survival occurs with intermittent exposure compared to continuous exposure at the same levels of TDG.

The Department, when developing the standard, recognized that when dissolved gas levels rarely exceeded 110% the TDG is not an apparent problem and gas bubble disease (GBD) is not apparent in juveniles and adults (Ebel 1973). There does appear to be some flexibility in application of the criteria. The discretion in interpreting and applying the standard should be focused on what is needed to protect the resource relative to the standard, and may be influenced by factors such as the level of risk associated with the criteria, the measurement accuracy, and any site specific and unique conditions.

Measurement Accuracy

The issue paper discussed the relative accuracy of the existing measurements of TDG. Reported as standard deviations chromatograph techniques varied by ±2.95 or using the Van Slyke method by ±3.5%. The issue paper cited Fickeisen et al (1975) that chromatography techniques and a Wiess saturometer by paired analysis were not significantly different. The Corps of Engineers estimates an accuracy of ± 3.0% associated with their current monitoring methods (B. Tannavon pers. Comm.)

Site Specific Conditions

The development of the 110% total gas pressure (TGP) standard acknowledged that the adequacy of the TDG criteria should be viewed with respect to river systems, such as the Columbia, where depth compensation may occur. Recognizing the physical 3% total gas pressure hydrostatic compensation, the standard was designed to protect the perceived critical conditions as adult fish seek the fish ladders. The 110% criteria applies to rivers where depth compensation may occur, and a criteria of 105% saturation applies to shallow rivers or hatchery sources where depth compensation does not occur.

Exceedence Period

The TDG standard does identify an exceedence period, "Shall not exceed 110% except when stream flows exceeds the 10-year 7-day average flood". This language provides a precise description of conditions for which the measured levels of TDG can exceed 110% TDG. The direct connection to an exceedence interval makes it difficult to determine an exceedence interval based on 50% of the time, (e.g. average) is intended in the standard.

The duration of exceedence does not appear to be discussed in the development of the standard. Several researchers have documented a relationship between duration of exposure and risk of GBD due to TDG levels (Jensen et al (1985), Weitkamp and Katz, (1980), Nebeker et al (1976), Fidler and Miller (1994) and Weitkamp(1977)). The 110% criteria is recognized as a conservative criteria with an unspecified margin of safety. At these low levels acute conditions, even in shallow water would not be expected to occur except at long duration periods (480-1200 hours in Jensen et al (1985)), if at all. Acute conditions measured as 50% mortality in controlled tests, would not be expect to occur with duration periods of a day (24 to 240 hours) at higher levels of TDG on the order of 115-120% TGP. Less information is available regarding subacute responses. Depth compensation or periods or intermittent exposure may ameliorate the effects of TDG.

Conclusions

The above assessment does not indicate that the criteria was intended as an average nor does it indicate what would be the averaging period. No document describing the historical application of the criteria was discovered that would allow a discussion of consistent application of the standard. It does appear that the criteria was intended to establish goals for instream water quality with a reasonable margin of safety and an understanding of the variation inherent in measurements. It was also recognized during the development of the criteria that occasional exceedences of the criteria would not jeopardize aquatic resources. There appears to be justification for recognizing potential impacts related to the duration of exposure.

Taking into account the precession and accuracy of the current monitoring methods, inherent margin of safety, and recognition that occasional exceedances of 110% TDG are not associated with observation of gas bubble disease in the Columbia, it would be reasonable to interpret the standard as an average condition, with the variation around the average to be consistent with the inherent precision in the data collection methods, and inherent variability in instream conditions. The Department should reserve the interpretation of an appropriate averaging period. The averaging period should not be great enough that exceedences above what may be expected due to measuring error or natural variation can be averaged out into compliance with the standard by values below the criteria. The averaging period should be consistent with the release period, but in no condition exceed 24 hours. Any recorded measurements that can not be explained due to sampling precision or inherent variation in ambient monitoring under conditions of constant spill would be interpreted as a violation of water quality standards.

Oregon

DEPARTMENT OF
FISH AND
WILDLIFE

OFFICE OF THE
DIRECTOR

July 20, 1994

Mr. Fred Hansen, Director
Oregon Department of
Environmental Quality
811 S.W. Sixth Avenue
Portland, OR 97204-1390

Dear Mr. Hansen:

I am writing to express my support for temporary rulemaking on total dissolved gas (TDG) and to share with you my concern for juvenile salmonids currently migrating through the lower Snake and Columbia rivers.

As you know, spill on the lower Columbia was all but eliminated on June 20 following expiration of the Environmental Quality Commission's (EQC) previous temporary rule allowing TDG to reach 120% of atmospheric pressure. Since June 20, spill levels have been far less than those recommended by the regional fishery management agencies and tribes at Ice Harbor, McNary, John Day, The Dalles, and Bonneville dams and even less than what has been provided in the last several years under the National Marine Fishery Service's (NMFS) Biological Opinions for endangered species, the 1989 Fish Spill Memorandum of Agreement for federal Columbia River dams, and the Northwest Power Planning Council's Strategy for Salmon.

Migrating juvenile salmon needing protection this summer include federally listed fall chinook from the Snake, as well as subyearling migrants from the mid-Columbia and lower Columbia rivers, including Oregon's wild fall chinook from the Grande Ronde and Deschutes rivers and hatchery fall chinook from the Umatilla River. Increased spill is the only additional mitigation action that can be readily implemented this summer to improve the in-river survival of these stocks.

Flows in the lower Snake and Columbia rivers are alarmingly low and high water temperatures have already contributed to high mortalities such as the recent

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large kill of juvenile fall chinook at McNary Dam where over 50,000 fish died on July 16-17. Immediate action is needed to protect these valuable stocks. The analysis which we have conducted with our resource comanagers (enclosed) shows that in-river survival of salmon migrants is significantly improved by adequate spills.

I recognize that there has been a tremendous amount of discussion over this year's spill program. Particularly vocal have been those affected by reduced power generation and revenues due to spill. While concern is understandable, much of the current discussion has served to cloud the facts.

There is no disagreement among the fishery agencies and tribes that spill is the most biologically effective means to reduce turbine mortality, reduce delay at projects, and avoid adverse impacts from bypass systems passage.

We need to act now to avoid further declines of upriver salmon stocks by such near-term actions as the spill program, if we are to avoid even more drastic and possibly more disruptive and costly actions in future years.

In order to implement an effective spill program, we support modification of Oregon's water quality criteria on the mainstem Columbia and Snake rivers to allow dissolved gas levels up to a daily average of 120% saturation and an instantaneous level of up to 125% when required to implement spills and other measures to improve fish survival. While there has been concern expressed about possible fish mortality due to gas supersaturation-associated trauma, studies have shown that juvenile and adult salmon can readily tolerate the dissolved gas levels recommended in a river or reservoir environment by changing their depth in the water, as noted in the enclosed analysis. More importantly, we have consistently observed good survival and adult returns in years of substantial spills and observed no mortality to migrating salmon during the spill program implemented this spring. This validates the practical effectiveness of a sound spill program.

I understand that the specific proposal before the EQC on July 21 calls for a temporary rule change allowing TDG levels up to 115% daily average and 120% instantaneous at the mainstem Columbia

River projects. The department prefers a more aggressive approach both in respect to spill levels and to locations for spills, but in the interest of timely action, we support immediate adoption of the current proposal and believe that this will provide significant added benefits to migrating fish during the remainder of the summer. We also wish to begin working together with your staff to craft a mutually supportable approach to TDG management in concert with planning for fish protection measures for 1995. We believe this is necessary to prevent possible more drastic federally mandated action in the future.

I appreciate your efforts to work with us in this unprecedented effort to protect a valuable aquatic resource. I look forward to working more closely together on this important issue in the coming months.

Sincerely,

Rudy Rosen, PhD
Director

c: Gary Smith, Donna Darm (NMFS)
Michael Llewelyn (WDOE)
Jack Donaldson (CBFWA for LG/FPAC distn)
Anne Squier (Governor's Office)

Enclosure

SCIENTIFIC RATIONALE FOR IMPLEMENTING A SUMMER SPILL PROGRAM TO INCREASE JUVENILE SALMONID SURVIVAL IN THE SNAKE AND COLUMBIA RIVERS

By
Columbia River Inter-Tribal Fish Commission
Idaho Department of Fish and Game
Oregon Department of Fish and Wildlife
U.S. Fish and Wildlife Service
Washington Department of Fish and Wildlife

July 15, 1994

Overview

This document provides scientific justification for implementation of the attach 1994 summer spill programs at Corps of Engineers (Attachment 1) and Mid-Columbia PUD mainstem dams (Attachment 2) in the Columbia River Basin. It is the intent of these programs to substantially increase juvenile anadromous fish survival through the hydrosystem. The programs and supporting rationale and risk assessment were jointly developed by the combined technical staffs of the Columbia River Inter-tribal Fish Commission, Idaho Department of Fish and Game, Oregon Department of Fish and Wildlife, U.S. Fish and Wildlife Service, and Washington Department of Fish and Wildlife (hereinafter fishery managers). Anadromous fish that will be protected by the spill programs include salmon stocks both listed and petitioned for listing under the Endangered Species Act, non-listed salmon stocks, and other anadromous stocks such as Pacific lamprey which are in serious decline. These programs will compliment other protection and restoration programs in the Columbia Basin.

The object of the summer spill programs is to achieve an 80% fish passage efficiency (FPE) objective at all Corps projects on the lower Snake and Columbia Rivers, and other passage efficiency goals at the various Mid-Columbia PUD dams (DFOP 1993). In accomplishing this, the fishery managers propose that the operation of the hydrosystem be managed so that an average of 120% or less total dissolved gas pressure be maintained in the river. Further, the fishery managers propose that the 120% criterion be measured well downstream of tailrace areas, after gas levels have had a chance to dissipate. In addition, because of problems with accurate measurement of gas levels, fishery managers recommend that up to an instantaneous reading of 125% total dissolved gas pressure be allowed to provide a reasonable margin of measurement error.

Based upon historical migration estimates (DFOP 1993), the fishery managers recommend that the spill program be implemented at all Corps run-of- river projects in the Snake and Columbia Rivers until August 31, 1994 to insure that the juvenile summer migration is protected (DFOP 1993). Duration of spill programs at individual mid-Columbia PUD dams will be determined by the various Coordinating Committees based upon ongoing FERC proceedings, settlements and stipulations.

These summer spill programs are partially in response to the apparent salmon stock collapse observed this year in Columbia River spring and summer chinook and expected to occur in fall chinook. From 1993 to 1994, adult spring chinook escapement to Bonneville Dam has decreased from 112,000 to less than 21,000 which is the previous all time record low. The trend is similar for adult summer chinook escapement which is projected to be less than 10,000 salmon at Bonneville Dam this year down from over 22,000 salmon in 1993 (TAC 1994). The predicted escapement of wild Snake River fall chinook adults at Bonneville Dam is 803 (Swartz 1994), the second lowest on record since 1986 and 41% of the 1986-93 average. Under these conditions, tribal ceremonial and subsistence harvest and non-treaty harvest have been severely restricted and in some cases, curtailed.

The stock collapse of Columbia River chinook is likely related to the continuation of extremely poor flow and migration conditions that occurred in 1992 (FPC 1993; Columbia River Water Management Group 1993-4), complicated by possible impacts of low ocean productivity resulting from El Nino conditions as noted by Johnson (1984), Ware and Thompson (1991), and Lichatowich (1993). Because the effects of ocean impacts cannot be controlled and federal agencies are either unwilling or unable to dedicate available storage in upriver reservoirs for flow augmentation, the fishery managers strongly recommend implementation of these spill programs. Spill is the only alternative left to reduce hydrosystem mortality, which could exceed 95% of juvenile summer migrants as documented during similar low flow years (Raymond 1979; Raymond 1988; Ebel et al. 1989).

Because 1993 basin summer and fall chinook adult escapement was relatively high under good environmental conditions, the relatively abundant 1994 subyearling progeny of these stocks must be afforded the best protection possible as they migrate downstream through the hydrosystem. Impacts to an abundant juvenile year class on stock viability can be substantial. Junge (1970), through use of a Ricker-type reproduction curve, demonstrated that a smolt kill of 50% reduced a stock by 60% whereas an adult kill of 50% would reduce a stock by 20%. Such losses on a relatively strong outmigrating year class could have severe if not irreversible consequences on stock abundance and diversity (Riggs 1986).

The fishery agencies and tribes have chosen a conservative approach to the implementation of the spill programs. Spill volume caps are provided to avoid exceeding either 120% daily average or 125% instantaneous total gas pressure criteria. Where possible, spill is confined to nighttime hours which reduces power and possible adult fish passage impacts. When it is not possible to confine spill to nighttime hours to achieve a 80% FPE, some daytime spill is proposed with caps to avoid impacts to adult passage. As will be discussed below, the fishery managers believe a 120% total gas pressure (TGP) criterion is conservative and will result in minimal impacts, if any, to juveniles and adults.

Through a comprehensive review of pertinent literature and extant river conditions, and based upon professional experience, the fishery managers have conducted the following risk assessment. This assessment carefully weighs the factors of various passage mortality rates and other impacts to summer migrating anadromous fish as they pass through the hydrosystem. Based upon this analysis, the fishery managers have concluded that controlled spill will substantially enhance the in-river survival of summer anadromous fish over other available alternatives.

Spill has been repeatedly demonstrated to be the most effective and safest means of project passage and is the only means to enhance survival without additional flow augmentation. Juvenile salmon that pass a project through spill have a significantly higher rate of project survival (98% point estimate) than fish that pass through turbines (85% point estimate). Specific mortality ranges are given later in this document. Without spill, the majority of juvenile chinook will pass through turbines since only 8-35% of summer migrants are guided and collected by mechanical bypass systems at Corps projects. Further, spill will improve survival and other impacts upon fish production by reducing delay of juveniles at the projects and reducing predator/prey interactions by dispersing predators in tailrace areas. And finally, spill for fish passage addresses the substantial scientific uncertainty associated with transportation of summer chinook juveniles, especially Snake River fall chinook.

Monitoring program

The extensive physical and biological monitoring program to assess the occurrence of gas bubble trauma (GBT) in both spring and early summer migrating juvenile and adult salmon at each dam will be continued for the remainder of the summer migration (DFOP 1993, appendices 4-13 and 4-14). Because sampling of internal tissues of juvenile salmon which have passed through mechanical bypass systems is of questionable value, this practice will not be continued. Instead, external symptoms will be monitored. It is imperative that the Corps of Engineers be more diligent and consistent in operating the physical monitoring system. Total gas pressure measurements should be taken at all dam forebays, with backup monitoring to allow for better and more consistent measurements. The 1994 DFOP includes criteria to allow for flexibility for adjustments in the spill program based upon the possible occurrence of GBT in both juveniles and adults.

Technical Basis for the Summer Spill Program

Spill has been shown to be the most biologically effective and safest means of project passage

Spill is not an "experimental measure", but has been shown to be the most effective management tool for improving passage survival of migrating salmon and steelhead at mainstem hydroelectric projects. Controlled spill has been implemented at mid-Columbia PUD dams since 1983 under the mid-Columbia Federal Energy Regulation (FERC) Commission Proceedings (Bodi 1986) and at Corps dams since 1989 under the 1989 Memorandum of Agreement to provide protection of juveniles until adequate functioning mechanical bypass systems have been installed. As previously stated, controlled spill to safely pass 80% of juvenile salmon migrants is the goal of this proposed spill program (DFOP 1993). Protocol for specific spill patterns for juveniles and adults at each dam is provided in the 1994 DFOP and represents years of model and field studies by the fishery agencies, tribes and dam operators. During the 1994 spring migration, controlled spill was implemented at all basin dams to increase juvenile survival.

Extensive studies at mainstem Columbia and Snake River dams have documented that juvenile mortality from turbine passage is much greater than spillway passage. Studies have shown that mortality from turbine passage ranges from 8-32% compared to only 0-4% for spillway passage (Tables 1 and 2). In studies of subyearling fall chinook at McNary, John Day, and Bonneville powerhouses I and II, turbine mortality ranged from 11-18%, while spillway mortality ranged from 0-4%. Although research investigating the magnitude of turbine passage impacts to adults which fallback through turbines is limited, mortality ranges from 22-51% for adult steelhead have been documented (DFOP 1993).

Juvenile mechanical bypass systems, are only able to guide and collect 8-35% of summer juvenile migrants (Ceballos 1992; Gessel et al. 1990; 1991; Ledgerwood et al. 1988;1991). Mortality and injury rates to subyearling migrants undergoing passage through mechanical bypass systems can exceed that from spillway passage, particularly at transportation dams due to additional delay, handling, and stress. Bypass system mortality of subyearling chinook at McNary Dam during 1992, a similar low flow year as 1994, ranged from 4-6% (WDF 1992). During peak migration periods in 1992, mortality rates through the McNary mechanical bypass system approached 9%, chiefly because of poor water quality (WDF 1992). Despite a new bypass system completed for the 1994 migration, recently an estimated 50,000 juvenile migrants were lost at McNary Dam in only a few days due to poor water quality conditions in the mechanical bypass system (Filardo 1994). Ceballos et al. (1993) found that subyearling chinook descaling from travel through juvenile bypass systems during 1988-92 ranged from ranged from 2.4% to 12.7%. Available comparative studies between Lower Granite spillway, turbine and mechanical bypass systems indicate that smolts which passed through the dams via the spillway suffered the least from both partial descaling (5.8%) and severe descaling injuries (1%) (Park and Achord 1987). Unfortunately, the recently installed mechanical bypass systems at Little Goose, Lower Monumental and McNary Dams have never been adequately evaluated for specific impacts to subyearling migrants (Barilla 1993). The fishery agencies and tribes have never supported operation of these systems for the migration at large without adequate evaluation.

Spill will improve survival of fish by reducing delay of juveniles at the projects and reducing predator/prey interactions and reduce exposure to high levels of dissolved gas, and reduce residualism

Spill will improve survival of fish by reducing delay of juveniles in forebays and tailraces where predator populations and predation rates are highest. Spill can greatly reduce delay of smolts in forebays as has been observed at The Dalles Dam (Snelling 1994). Spill establishes a large flow with increased velocity that disperses predators from the forebay and tailrace areas thus reducing predator/prey interactions (Faler et al. 1988).

Smith (1982) found that because subyearling salmon travel passively downstream, higher velocities provided by spill would save these juveniles critical energy reserves necessary for parr to smolt transitions, as well as move them more quickly through the river. This in turn would reduce migrant susceptibility to predators and disease, and would reduce the likelihood that smolts would revert to freshwater parr (non-migratory status) by excessive delay in traversing the hydrosystem.

Spill addresses the substantial uncertainty associated with the Corps transportation program

Spill at transportation collector projects addresses the uncertainty associated with the juvenile salmon transportation program by spreading the risk between in-river passage and transportation (Ad Hoc Transportation Review Group 1992; Mundy et al. 1994; FERC 1994). As recently concluded by an expert team of independent scientists, "[t]ransportation alone, as presently conceived and implemented is unlikely to halt or prevent the continued decline and extirpation of listed salmon in the Snake River Basin"...and that "available evidence is not sufficient to identify transportation as either a primary or supporting method of choice for salmon recovery" (Mundy et al. 1994). This is consistent with the findings of Raymond (1988) and Congleton et al. (1985) who found that transportation had been ineffective in reversing the decline of runs of spring and summer chinook and steelhead returning to the mid-Columbia and Snake rivers during 1962-84. Evidence provided by the Ad Hoc Transportation Review Group (1992) indicated that transportation may have reduced survival of wild Snake River spring and summer chinook to spawning grounds. Adult homing impairment and disruption of freshwater life histories are two key problems attributed to the juvenile transportation process (TRG 1992, Mundy et al. 1994; Heinith 1993).

The USFWS (1993), Steward (1993) and Congleton et al. (1985) noted that handling in the transportation process may greatly increase stress and mortality to juvenile migrants, particularly when water quality conditions deteriorate and may override any perceived benefits of transportation. For example, Mundy et al. (1994) noted that in 1977, an extremely low flow year similar to this year, transportation treatment and control fish died equally because no adults returned from the study. The cause was likely indirect or delayed mortality from screen guidance, collection, holding, transportation, and concentrated release into high predation areas. This is a particular problem for summer subyearling migrants as they are usually trucked instead of barged, because few of them are collected at mainstem dams, and operation of barges on this basis is not cost-effective. Numerous studies have documented that trucking migrants is even more stressful than barging and that stressed

migrants are highly susceptible to predators at the time of release (TRG 1992; Congleton et al. 1985; Mundy et al. 1994; USFWS 1993).

No transportation studies have been conducted on subyearling chinook salmon at Snake River dams. Transport studies of subyearling chinook at McNary Dam in 1986, 1987, and 1988 were conducted under no spill conditions. In addition, the control fish were released in small numbers from the old bypass outfall. They were the only fish released from the bypass because all fish collected, except for the controls, were transported. We suspect that predation rates on the control releases were very high because of the no-spill and low flow conditions in the tailrace that occurred during these studies. Hence, the results of these studies are not applicable to subyearling chinook salmon passing the project under spill conditions.

It has been consistently been the position of the fishery managers that transportation is an interim and experimental mitigation program that cannot substitute for the provision of adequate in-river passage conditions provided by flow and spill. A Federal Energy Regulatory Commission (FERC) administrative law judge upheld this position in a 1992 ruling against transportation at two mid-Columbia dams and ordered immediate spill at a 70% and 50% FPE level for spring and summer migrants, respectively, until completion of fish bypass systems (FERC 1992). On May 27, 1994, fully taking into account voluminous technical information on dissolved gas complied over a two year period, FERC ordered implementation of this spill program at Priest and Wanapum dams (FERC 1994). On July 1, 1994 the Washington Department of Ecology granted an administrative order modifying the state water quality criteria so that the FERC summer spill program could be implemented (Attachment 3).

Spill protects critical life history diversity

The Columbia River juvenile summer outmigration is comprised of a mosaic of many stocks from all basin tributaries and mainstem reach areas. Within each stock of the migration, multiple life histories within a single salmon stock have evolved over millions of years to provide stock resiliency and stability for dealing with different types of environments (Winemiller and Rose 1992). Because of these different life histories, which include diverse migration timing and the use of different spawning and rearing areas, there is a reduced chance that a single or multiple environmental disturbances, such as a low flow year, will impact overall stock fitness and diversity (Schluchter and Lichatowich 1977).

Spill and associated in-river migration allow adequate time for rearing and physiological maturation of subyearling chinook stocks to reach a proper size prior to saltwater entry to survive (Mundy et al. 1994; CBFWA 1991). This has been confirmed by numerous studies involving scale analysis (Schluchter and Lichatowich 1977; Lichatowich 1976; Reimers 1973) and physiological studies examining osmoregulatory processes (Wagner et al. 1969; Ewing and Birks 1982; Wedemeyer et al. 1980). Interruptions to the critical freshwater rearing life history stage, such as that imposed by the Corps transportation program and selective mortality from turbine passage, may have serious implications to stock survival and overall production characteristics such as adult age at maturity and

fecundity (Groot and Margolis 1991; Nicholas and Hankin 1989; Thompson 1959, Schluchter and Lichatowich 1977;1993).

Studies clearly show that adult survival is enhanced with spill

The historical record clearly demonstrates that better adult returns of summer and fall chinook had occurred during years when juveniles migrated under high flow and high spill conditions. Raymond (1988) reported that the lack of spill and installation of additional turbine units in the basin were primarily responsible for extremely low smolt to adult return rates of mid-Columbia summer chinook. Hilborn (1993) demonstrated a strong relationship between flow and adult survival of Priest Rapids Hatchery fall chinook during 1977-87 similar to the relationship found for Snake River wild spring/summer chinook by Petrosky (1991). In both analyses, the highest survivals occurred in 1982, a year of high flow and spill. In contrast, 1977 was characterized by low flows and no spill. Under these conditions, estimated mortalities in excess of 95% of the outmigration at large occurred, based upon analysis of adult returns in subsequent years. In a recent analysis of the 1994 controlled spring spill program on adult passage, the Fish Passage Center found that there was no impact on adult passage based upon interdam conversion rates for adult spring chinook (DeHart 1994, Attachment 4).

Model results indicate that in-river survival will be improved

Model results demonstrate that the in-river survival of fall chinook will be enhanced by the proposed spill program. Using the FLUSH Model developed by the state fishery agencies and tribes, the in-river survival of Snake River fall chinook was estimated under various flow and spill options (Attachment 5). The analysis shows that with the flows proposed by the NMFS and 80% FPE spill at each project, in-river survival of Snake River fall chinook to below Bonneville Dam would be increased by 61% from 1.8 to 2.9%. This improvement in survival will likely increase future adult returns and help prevent additional declines of Snake River fall chinook and mid-Columbia summer chinook and other anadromous stocks.

Studies show that juveniles and adults can tolerate dissolved gas levels that will occur as a result of spill

Susceptibility of juvenile salmon to gas bubble trauma (disease) depends on a number of important factors ancillary to total gas pressure. These factors must be considered when evaluating possible gas bubble trauma to the summer migration at large. Based upon the past information, lower summer flows and resultant lower volumes of spill are not expected to result in gas bubble trauma especially at flows projected to occur this year (Columbia River Water Management Reports). Physical factors include: water temperature and total dissolved particulates (Jensen et al. 1986; Alderdice and Jensen 1985) and atmospheric pressure (Jensen et al. 1986; Alderdice and Jensen 1985). Biological factors include: size, species, genetic composition and physiological condition of the fish (Jensen et al. 1986; Alderdice and Jensen 1985) and proximity and length of exposure to total gas pressure (Weitkamp and Katz 1980).

There are also behavioral factors that allow salmonids to withstand what otherwise might be harmful levels of total dissolved gas. Juvenile and adult salmonids have been documented to sound in the natural environment and achieve hydrostatic compensation, thus avoiding impacts of elevated levels of total gas pressure (Weitkamp and Katz 1980; Weitkamp 1976;1977; Gray and Haynes 1977). Knittel et al. (1980) and Weitkamp and Katz (1980) reported that juvenile salmon could recover from symptoms of gas bubble trauma in 30 minutes to 2 hours time by sounding. Intermittent exposure may increase the level of gas supersaturation fish are able to tolerate because it increases the time over which a specific exposure accumulates. It also provides an opportunity for recovery to occur, particularly if it is accompanied by depth compensation. The effects of intermittent exposure on tolerance to supersaturation has been demonstrated by Meekin and Turner (1974), Blahm et al. (1976), and Bouck (1980). Bouck noted that, "..[f]ish in deeper water or exposed intermittently are least susceptible (to GBT) if susceptible at all."

Several studies have been conducted in the laboratory and the field under various depth and dissolved gas levels to determine the effects of depth compensation for salmonids in supersaturated water (Table 3; DFOP 1993). The most relevant studies were the volitional live cage studies conducted in-situ at Wells Dam (Meekin and Turner 1974), and Rock Island Dam (Weitkamp 1976) where fish were allowed to sound to avoid impacts of supersaturation (Table 3).

Depth of the live cages extended from the surface to 3.1-4 meters below the surface. Meekin and Turner (1974) also held fish in cages at variable depths from surface to 1, 2, 3, and 4 meters. These studies indicate that the effects of hydrostatic compensation due to depth is as predicted by theory and that when given the opportunity, that juveniles will remain deep enough to compensate for total gas pressures up to 126% saturation. It is highly significant in Weitkamp's study that no fish were killed in the surface to 4 meter cages in a series of three tests at total gas pressures of 120-128% saturation. It should be noted that even in the surface to 4 meter cage, fish are confined to shallower water than they normally occupy in the reservoirs (Smith 1974; Weitkamp 1974; 1977; Blahm 1974; Blahm et al. 1976).

Toner (1993) examined salmonids, resident fish and invertebrates for signs of GBT below Bonneville Dam by seines and other field sampling gear. During high spring spills which caused total gas levels to reach 128% saturation, she found that external signs of GBT were rare. Less than 1% of chinook salmon and resident fish showed signs and no evidence of GBT was noted in sampled invertebrates.

<u>1994 NMFS Dissolved Gas Panel Report</u>

Unfortunately, the National Marine Fisheries Service prematurely released a draft report by a panel of dissolved gas experts before all panel members could concur with the contents of the report (Backman 1994; Bouck 1994; Attachment 6). The current draft report should be disregarded. The NMFS should retract the draft report and a final report should be issued in which all panel experts can concur. This was the intent of the panel, and was their charge by the NMFS.

Summary and Recommendations

Based upon the risk analysis performed above which considered the best available and pertinent scientific literature and data, current river conditions, and professional judgement, the fishery agencies and tribes strongly recommend immediate implementation of the above controlled spill program to protect migrating juvenile summer and adult anadromous fish populations as they traverse the Columbia Basin hydrosystem. In order to implement this program, we also recommend a modification of Oregon's and Washington's water quality criteria to allow total dissolved gas levels to reach a daily average of 120% saturation, or an instantaneous measurement to reach up to a 125% saturation level. We recommend that the spill program and modifications to the existing total dissolved gas standard be implemented until August 31, 1994 to allow protection of summer migrants through the mainstem Snake and Columbia Rivers.

We also strongly encourage the Oregon Environmental Quality Commission and the Washington Department of Ecology to direct hydrosystem operators to expedite investigation and installation of structural modifications at dams, such as spillway deflectors. Addition of these modifications will further protect remaining anadromous stocks passing through the hydrosystem by establishment of better in-river water quality. This is particularly important for control of total dissolved gas in normal and high flow years, and when the operation of dam powerhouses, even without spill, still results in elevated levels of dissolved gas being discharged into the river (Figure 1).

Tables 1-3
Figure 1
Attachments 1-5

REFERENCES

Alderdice, D.F.,and J.O.T. Jensen. 1985. Assessment of the influence of gas supersaturation on salmonids in the Nechako River in relation to Kemano completion. Canadian Technical Report of Fisheries and Aquatic Sciences No. 1386. 48 pages.

Barilla, T. Research coordinator for the Walla Walla District, United States Army Corps of Engineers. November 22, 1993. Personal communication.

Blahm, T.H. 1974. Report to U.S. Army Corps of Engineers. Gas supersaturation research. Prescott Facility-1974. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Blahm, T.H., R.J. McConnell, and G.R. Snyder. 1976. Gas supersaturation research, National Marine Fisheries Service Prescott Facility. Pages 11-19 in Fickeisen and Schneider (1976).

Bodi, F.L. 1986. Restoration under the Federal Power Act. Environmental Law. Volume 16. Number 3. Pages 556-581.

Bouck,G.R. 1980. Etiology of gas bubble disease. Transactions of the American Fisheries Society. Volume 109. Pages 703-707.

Brege. D.A., S.J. Grabowski, W.D. Muir, S.A. Hirtzel, and S.J. Mazur. 1992. Studies to determine the effectiveness of extended traveling screens and extended bar screens at McNary Dam, 1991. Report to the United States Army Corps of Engineers, Contract DACW68-84-H-0034. By the Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington. 32 pages plus appendices.

Ceballos, J.R. 1992. FGE estimates for BPA CRiSP model runs. March 31, 1992 memorandum to F/NWO3 Operations Branch files. National Marine Fisheries Service. Portland, Oregon. 4 pages.

Ceballos J.R., S.W. Pettit, J.L. McKern, R.R. Boyce, and D.F. Hurson. 1993. Fish Transportation Oversight Team Annual Report-FY 1992. Transport operations on the Snake and Columbia Rivers. National Marine Fisheries Service, Portland, OR.

Columbia Basin Fish and Wildlife Authority. 1991. The biological and technical justification for the flow proposal of the Columbia Basin Fish and Wildlife Authority. Portland, Oregon.

Columbia Basin Tribes and Fishery Agencies. 1993. Detailed fishery operating plan with 1994 operating criteria. Fish Passage Center, Portland, Oregon.

Columbia River Water Management Reports. Water Years 1982-1992. By the Columbia River Water Management Group. North Pacific Division, United States Army Corps of Engineers. Portland, Oregon.

Columbia River Water Management Group. 1993 and 1994. Columbia River Water Management Reports for 1992 and 1993. North Pacific Division. United States Army Corps of Engineers. Portland, Oregon.

Congleton, J.L, T.C. Bjornn, B.H. Watson, J.I.Irving, and R.R. Ringe. 1985. Effects of handling and crowding on the stress response and viability of chinook salmon parr and smolts. By the Idaho Cooperative Fishery Research Unit. Department of Fish and Wildlife Resources. University of Idaho. Moscow, Idaho. To Bonneville Power Administration. Project 82-5. Contract DE-AC79-83BP11196. Portland, Oregon.

Ebel W.J. 1969. Supersaturation of nitrogen in the Columbia River and its effects on salmon and steelhead trout. National Marine Fisheries Service Fishery Bulletin 68:1-11.

Ebel W.J. 1971. Dissolved nitrogen concentration in the Columbia and Snake rivers in 1970 and their effect on chinook salmon and steelhead trout. National Marine Fisheries Service Special Scientific Report Number 646.

Ebel, W.J., C.D. Becker, J.W. Mullan, and H.L. Raymond. 1989. The Columbia River-toward a holistic understanding, p. 205-219. In D.P. Dodge [ed.] Proceedings of the International Large River Symposium. Can. Spec. Publ. Fish. Aquat. Sci. 106.

Ewing, R.D. and E.K. Birks 1982. Criteria for parr-smolt transformation in juvenile chinook salmon (Oncorhynchus tshawtscha). Aquaculture. Volume 28. Pages 185-194.

Faler, M.P., L.M. Miller, and K.I. Welke. 1988. Effects of variation in flow on distributions of northern squawfish in the Columbia River below McNary Dam. North American Journal of Fisheries Management 8:30-35.

FERC. 1992. Initial decision of Judge Stephen Grossman. Project Number 2114-024. Docket Number E-9569-003 (Grant County Phase). Washington, D.C. 27 pages.

FERC. 1994. Order on interim license conditions. Project Number 2114-024. Docket Number E-9569-003 (Grant County Phase). Washington, D.C. 19 pages.

Filardo, M. Chair, Fish Passage Advisory Committee, Portland, OR. July 18, 1994. Personal Communication.

FPC (Fish Passage Center). 1994. Fish Passage Center 1993 annual report. Columbia Basin Fish and Wildlife Authority, Portland, Oregon.

Gessel, M.H., D.A. Brege, B.H. Monk, and J.G. Williams. 1990. Continued studies to evaluate the juvenile bypass systems at Bonneville Dam- 1989. Report to the United States Army Corps of Engineers, Delivery Order E8689095. By the Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington. 20 pages plus appendices.

Gessel, M.H., J.G. Williams, D.A. Brege, and R.F. Krcma. 1991. Juvenile salmonid guidance at the Bonneville dam second powerhouse, Columbia River, 1983-1989. North American Journal of Fisheries Management. Volume 11. Pages 400-412.

Gilbreath, L.G., E.M. Dawley, R.D. Ledgerwood, P.J. Bentley, and S.J. Grabowski. 1993. Relative survival of subyearling chinook salmon that have passed Bonneville dam via the spillway or second powerhouse turbines of bypass system: adult recoveries through 1991. Annual report submitted to the U.S. Army Corps of Engineers. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, Washington.

Giorgi, A. and L. Stuehrenberg. 1988. Lower Granite pool and turbine survival study, 1987. Annual report submitted to the Bonneville Power Administration. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, Washington.

Gray, R.H. and J.M.Haynes. 1977. Depth distribution of adult chinook salmon (Oncorhynchus tshawytscha) in relation to season and gas-supersaturated water. Transactions of the American Fisheries Society. Volume 109. Pages 755-759.

Groot, C. and L. Margolis (eds.). 1991. Pacific salmon life histories. UBC Press, University of British Columbia, Vancouver, British Columbia. 564 pages.

Heinith, R. 1993. Affidavit in support of the Yakama Indian Nation in NRIC et al. v. NMFS. United States District Court for the District of Oregon. Case Number CV-93-469-MA.

Heinle, D.R. and F.W. Olson. 1980. Survival of juvenile coho salmon passing through the spillway at Rocky Reach Dam. CH2M Hill Report to Chelan County PUD, Washington.

Hilborn, R., R. Donnelly, M. Pascual, and C. Coronado-Hernandez. 1993. The relationship between river flow and survival for Columbia River chinook salmon. Draft report to the Bonneville Power Administration, Portland, Oregon.

Holmes, H.B. 1952. Loss of salmon fingerlings in passing Bonneville dam as determined from marking experiments. Unpublished manuscript. U.S. Fish and Wildlife Service.

Iwamoto, R.N., W.D. Muir, B.P. Sanford, K.W. McIntyre, D.A. Frost, and J.G. Williams. 1993. Survival estimates for the passage of juvenile chinook through Snake River dams and reservoirs. Annual report submitted to the U.S. Army Corps of Engineers. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Jensen, J.O.T., J. Schute and D.F. Alderdice. 1986. Assessing juvenile salmonid response to gas supersaturation using a general multivariate dose-response model. Canadian Journal of Fisheries and Aquatic Sciences. Volume 43. Pages 1694-1709.

Johnsen, R.C. and E.W. Dawley. 1974. The effect of spillway flow deflectors at Bonneville Dam on total gas supersaturation and survival of juvenile salmon. Final report submitted to U.S. Army Corps of Engineers.Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Johnson, S.L. 1984. The effects of the 1983 El Nino on Oregon's coho and chinook salmon. Oregon Department of Fish and Wildlife. Information Reports. Number 84-8. Portland, Oregon.

Junge, C.O. 1970. The effect of superimposed mortalities on reproductive curves. Fish Commission of Oregon Research Reports. Volume 2. Pages 56-63.

Knittel, M.D., G.A. Chapman and R.R. Garton. 1980. Effects of hydrostatic pressure on steelhead survival in air-supersaturated water. Transactions of the American Fisheries Society. Volume 109. Pages 755-759.

Ledgerwood, R.D., E.M. Dawley, L.G. Gilbreath, P.J. Bentley, B.P. Sandford, and M.H. Schiewe. 1990. Relative survival of subyearling chinook salmon which have passed Bonneville dam via the spillway or the second powerhouse turbines of bypass system in 1989, with comparisons to 1987 and 1988. Report to the United States Army Corps of Engineers, Contract E85890024/E86890097. By the Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington.

Ledgerwood, R.D., W.T. Norman, G.A. Swan, and J.G. Williams. 1988. Fish guiding efficiency of submersible traveling screens at Lower Granite Dam and Little Goose Dams-1987. Report to the United States Army Corps of Engineers, Contract Number DACW-68-84-H-0034. By Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington.

Lichatowich, J.A. 1976. Rogue River Basin Evaluation Program. Annual Report. Contract Number DACW57-75-C-0109 to the United States Army Corps of Engineers, Portland District. By the Oregon Department of Fish and Wildlife. Portland, Oregon.

Lichatowich, J.A. 1993. Ocean carrying capacity. Recovery issues for threatened and endangered Snake River salmon. Technical Report 6 of 11. Prepared for the United States Department of Energy, Bonneville Power Administration. Project No. 93-013. Contract No. DE-AM79-93BP99654. Portland, Oregon.

Long, C.W. 1968. Research on fingerling mortality in Kaplan turbines-1968. Internal report. Bureau of Commercial Fisheries, Seattle, WA.

Long, C.W., F.J. Ossiander, T.E. Ruehle, and G.M. Mathews. 1975. Survival of coho salmon fingerlings passing through operating turbines with and without perforated bulkheads and of steelhead trout fingerlings passing through spillways with and without a flow deflector. Final report submitted to U.S. Army Corps of Engineers. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Meekin, T.K. and B.K. Turner. 1974. Tolerance of salmonid eggs, juveniles, and squawfish to supersaturated nitrogen. Washington Department of Fisheries Technical Report 12:78-126.

Mundy, P.R., D. Neeley, C.R. Steward, T.P. Quinn, B.A. Barton, R.N. Williams, D. Goodman, R.R. Whitney, M.W. Erho Jr, and L.W. Botsford. 1994. Transportation of juvenile salmonids from hydroelectric in the Columbia River Basin: An independent review. Final report submitted to the U.S. Fish and Wildlife Service, Portland, Oregon.

Nicholas, J.W., and D.G. Hankin. 1989. Chinook salmon populations in Oregon coastal river basins: description of life histories and assessment of recent trends in run strengths. Information Report Number 88-1, Fish Division, Oregon Department of Fish and Wildlife, Corvallis, Oregon.

Park, D.L. and S. Achord. 1987. Evaluation of juvenile salmonid passage through the bypass system, turbines and spillway at Lower Granite Dam in 1986. Contract DACW68-84-H-0034 to the United States Army Corps of Engineers. By Coastal Zone and Estuarine Services Division, National Marine Fisheries Service. Seattle, Washington.

Petrosky, C.E. 1991. Influence of smolt migration flows on recruitment and return rates of Idaho spring chinook. Idaho Department of Fish and Game, Boise, Idaho.

Raymond, H.L. 1979. Effects of dams and impoundments on migration of juvenile chinook salmon and steelhead from the Snake River, 1966-1975. Transactions of the American Fisheries Society 109:505-529.

Raymond, H.L. 1988. Effects of hydroelectric development and fisheries enhancement on spring and summer chinook salmon and steelhead in the Columbia River basin. North American Journal of Fisheries Management 8:1-24.

Raymond, H.L. and C.W. Sims. 1980. Assessment of smolt migration and passage enhancement studies of 1979. Final report submitted to U.S. Army Corps of Engineers. Coastal Zone and Estuarine Studies Division. Northwest Fisheries Science Center. National Marine Fisheries Service, Seattle, WA.

Reimers, P.E. 1973. The length of residence of juvenile chinook salmon in the Sixes River, Oregon. Fish Commission of Oregon Research Reports. Volume 4. Number 2. 43 pages.

Riggs, L.A. 1986. Genetic consideration in salmon and steelhead planning. Final Report to the Northwest Power Planning Council, Portland, Oregon.

Sims, C.W. and F.J. Ossiander. 1991. Migrations of juvenile chinook salmon and steelhead trout in the Snake River from 1973 to 1979- a research summary. Final Report submitted by the National Marine Fisheries Service to the U.S. Army Corps of Engineers, Portland, Oregon.

Schluchter, M.D. and J.A. Lichatowich. 1977. Juvenile life histories of Rogue River spring chinook salmon Oncorhynchus tshawytscha (Walbaum), as determined by scale analysis. Research Section, Oregon Department of Fish and Wildlife. Information Report Series, Fisheries Number 77-5. Corvallis, Oregon.

Schoeneman, D.E., R.T. Pressey, and C.O. Junge. 1961. Mortalities of downstream migrant salmon at McNary Dam. Transactions of the American Fisheries Society 90(1):58-72.

Smith, J.R. 1974. Distribution of seaward-migrating chinook salmon and steelhead trout in the Snake River above Lower Monumental Dam. U.S. National Marine Fisheries Service Marine Fisheries Review 36(8):42-45.

Smith, L.S. 1982. Decreased swimming performance as a necessary component of the smolt migration in salmon in the Columbia River. Aquaculture. Volume 28. Pages 153-161.

Snelling, J. Researcher for Oregon Cooperative Fishery Research Unit, Oregon State University, Corvallis, Oregon. March 15, 1994. Personal communication.

Steward, C.R. 1993. Assessment of the flow-survival relationship obtained by Sims and Ossiander (1981) for Snake River spring/summer chinook salmon smolts. Report to S.A. Cramer and Associates, Inc. Portland, Oregon.

Swartz, Don F. 1994. Personnel communication. Oregon Department of Fish and Wildlife, Clackamas, Oregon.

Technical Advisory Committee (TAC). 1994. Columbia River chinook fishery simulation model output-1994. Number 94-11. Portland, Oregon.

Thompson, W.F. 1959. An approach to population dynamics of the Pacific red salmon. Transactions of the American Fisheries Society. Volume 88. Number 3. Pages 206-209.

TRG (Ad Hoc Transportation Review Group). 1992. Review of salmon and steelhead transportation studies in the Columbia and Snake Rivers, 1984-89. Submitted to the Columbia Basin Fish and Wildlife Authority.

USFWS. 1993. Review of transportation of spring/summer chinook salmon in the Snake River (1968-1990) for the Recovery Team. Peer review comments by individual Fish and Wildlife Service (Region 1) technical staff, December 6, 1993. U.S. Fish and Wildlife Service. Portland, Oregon.

Wagner, H.H., F.P. Conte and J.L. Fessler. 1969. Development of osmotic and ionic regulation in two races of chinook salmon (Oncorhychus tshawytscha). Comparative Biochemical Physiology. Volume 29. Pages 325-341.

Ware, D.M. and R.E. Thompson. 1991. Link between long-term variability in upwelling and fish production in the northeast Pacific Ocean. Canadian Journal of Fisheries and Aquatic Sciences. Volume 48. Pages 2296-2306.

WDF (Washington Department of Fisheries). 1992. McNary Dam weekly summary reports. Olympia, Washington.

Wedemeyer, G.A., R.L. Saunders, and W.C. Clarke. 1980. Environmental factors affecting smoltification and early marine survival of anadromous salmonids. Marine Fishery Review. Volume 42. Pages 1-14.

Weitkamp, D.E. 1974. Dissolved gas supersaturation in the Columbia River system; salmonid bioassay and depth distribution studies, 1973 and 1974. Parametrix Inc. Report to Utility Cooperative, Idaho Power Company, Boise, ID.

Weitkamp, D.E. 1976. Dissolved gas supersaturation: live cage bioassays at Rock Island Dam, Washington. Pages 24-36 in Fickeisen and Schneider (1976).

Weitkamp, D.E. 1977. Gas bubble disease of resident fish and juvenile salmonids in the Columbia River system. Doctoral dissertation. University of Washington, Seattle, Washington. 242 pages.

Weitkamp, D.E., D. McKenzie, and T. Schadt. 1980. Survival of steelhead smolts Wells Dam turbines and spillway. Parametrix Inc., Bellevue, WA.

Weitkamp, D.E. and M. Katz. 1980. A review of dissolved gas supersaturation literature. Trans. Amer. Fisheries Society 109:659-702.

Winemiller, K.O. and K.A. Rose. Patterns of life-history diversification in North American fishes: implications for population regulation. Canadian Journal of Fisheries and Aquatic Sciences. Volume 49. Pages 2196-2218.

Editorials

NW governors need to lead in salmon-recovery efforts

It is time, Gov. Lowry, Gov. Roberts and Gov. Andrus, that the three of you got behind the idea of a broad, multipurpose plan for salmon recovery. At the moment, various state and federal officials are acting crazy on salmon recovery, and people of the region strongly need consensus.

Maybe you wouldn't bet a lot of money that these governors of Washington, Oregon and Idaho would endorse a salmon recovery effort that pays attention to all river use interests. But it should be clear that the present situation is not bringing progress:

- In response to a court suit by Idaho, a federal judge ruled that the Northwest must do something to save the salmon. He said a 1993 management plan to help salmon runs was inadequate.

- Clinton administration officials responded with a $50 million plan to spill water over eight dams on the Snake and Columbia rivers to try to move fish downstream more quickly. The spilled water made most of the fish sick, apparently from gas-bubble syndrome. After the fiasco, a scientist with the Northwest Power Planning Council said it would be impossible to measure the effectiveness of the spills.

- A recent newsletter from the Idaho Department of Fish & Game described one list of groups and agencies as "fish savers" and another group as "fish killers."

The fact is, no one knows why the salmon runs are in peril, so some people are grasping for anything that looks promising.

Is the problem the dams on the Columbia and Snake? Is it that spawning habitat in the region has been damaged so much? Is it overfishing by both Indians and non-Indians? Is it El Nino or other changes in oceanic or atmospheric conditions?

It could be any one of those or any combination of them. Public officials, scientists and others concerned about Northwest salmon know that. The problem is that key officials are not showing in their salmon actions that they don't know the answer. Instead, they have tried to focus on a quick fix — increasing flows on the Snake and Columbia from environmental and recreation groups push them into taking action without enough counsel of scientists.

As the Portland Oregonian commented on spilling water over the dams: "It was launched without the knowledge or advice of the fisheries service's Snake River Salmon Recovery Team. The advice of regional fish pathologists and the experts on nitrogen supersaturation was ignored."

At the order of the Oregon Water Resources Commission, staff of the Oregon Water Resources Department is drafting rules that would require handling of water right applications to take endangered salmon runs into account. The Northwest Power Planning Council has said the states should either deny water right applications or grant them conditionally. But that step, too, implies that the rate of flow in the Columbia or Snake is the critical factor in the health of salmon runs — as if we knew.

Water officials have lots to consider in processing water right applications. They have applications for instream public uses and for ag producers and municipalities wanting to withdraw water. They need to consider flow volumes and groundwater levels. But why try to take on responsibility for fish run enhancement, especially when almost every other public agency in the Northwest is also in the act? Besides, irrigators in Oregon are withdrawing less than half of 1 percent of the flow of the Columbia.

Probably the soundest salmon recovery plan on paper is that of the National Marine Fisheries Service. A team of independent scientists called for efforts on various fronts — improving fish habitat, regulating fishing and so on. The breadth of the plan acknowledges that the answer to declining salmon runs is not known.

Idaho Gov. Andrus, for one, chooses not to endorse the National Marine Fisheries Service plan. No law says he has to go along with it. But he along with Gov. Roberts and Gov. Lowry have some obligation to try to settle on a course geared to the overall needs of the region and relying on the best scientif-

into conservation mgt.

started."

Turning to spring barley to get the stripping started added some grain to the 1994 harvest, but when the stripping is all completed, the 1995 harvest actually will have less standing grain because the strips will mean the Millers have about 30 percent less grain on the same ground as for '94, he said.

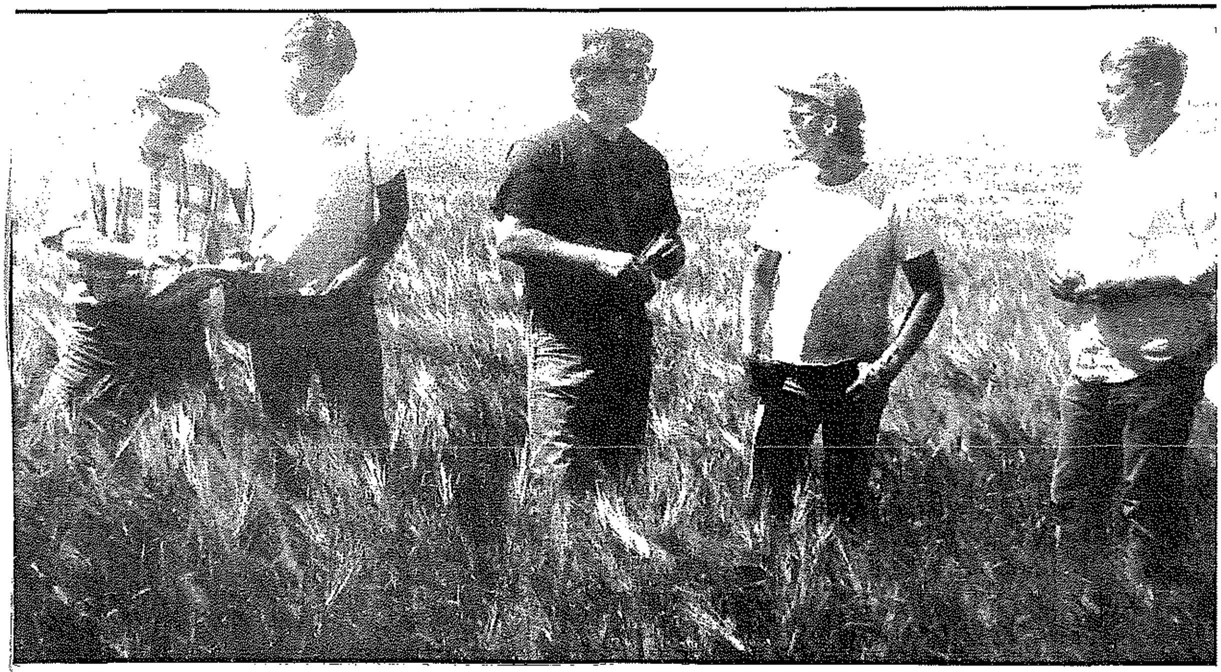
Eddy says that in writing a conservation plan several factors are weighed. Among these are residue, the percent of green cover on the planted ground, strips, terraces, rainfall zone, soil type, management practice, rotation and soil type.

Strip-cropping can be substituted for the residue requirement in some cases. It is up to the producer to decide whether to strip-crop, Eddy said.

The practice is in widespread use in other parts of the country. Eddy came to Oregon from an assignment near D. ton, Wash., where the pract is used.

Strip-cropping retains mo ture, prevents runoff, stor snow and allows the produc to retain established tilla methods, Eddy said.

"We hope to get more peop to look into strip-cropping. I really up to the operator on the figures are worked out ar the options are available," l said.



SOMETHING NEW — Conservationist Dusty Eddy, left; Harry, John and Chris Miller; and Wasco County Conservation District Manager Ron Graves inspect spring barley on strip crop site. (Photo by Austin Abrams)

Parametrix, Inc. Consultants in Engineering and Environmental Sciences

5808 Lake Washington Blvd. N.E. Kirkland, WA 98033-7350
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Mr. Bruce Lovelin
Columbia River Alliance
825 NE Multnomah, Suite 955
Portland, Oregon 97232

June 2, 1994
55-2723-01

Dear Bruce:

I have just received the latest table listing results of the 1994 Smolt Monitoring Program Gas Bubble Symptoms for Juvenile Hatchery Steelhead. This table shows results through May 29.

At Little Goose, Lower Monumental, John Day, and Bonneville Dams, substantial percentages of the steelhead examined have been showing some signs of gas bubble disease. The fact that many of these fish show bubbles in the gill filaments is of great concern. This indicates that bubbles are forming in the fishes vascular system. If these bubbles reach vital areas, the fish will die.

We cannot say what percentage of the fish will die or have died. However, such a high incidence of gas bubble disease symptoms is an indication a substantial mortality is occurring.

I believe it would be prudent for the appropriate state and federal agencies to rigorously evaluate the relationship of supersaturation to the recorded incidence of gas bubble disease before proceeding with the existing spill program.

The threat that supersaturation poses to juvenile salmon, adult salmon and resident fish is real. We may have difficulty evaluating the degree of this threat, however, that is not an adequate reason to endanger this valuable resource.

The following are several examples of why this issue should be of great concern to all who are attempting to protect our salmon resources. Each adult lost to gas bubble disease is the equivalent of thousands of smolts. Subyearling fall chinook are exceptionally susceptible to gas bubble disease because of their shallow distribution in the water column.

The fact that supersaturation has occurred in recent years without regulatory evaluation is not an excuse for continuing this practice. Supersaturation with relatively low flow conditions is probably the most severe situation.

Sincerely,

Don Weitkamp, Ph.D.
Principal

DW:sr

Columbia River Alliance

For Fish, Commerce and Communities

June 2, 1994

Gary Smith, Acting Regional Director
National Marine Fisheries Service
7600 Sand Point Way, NE
Seattle, WA 98115

Major General Ernest Harrell
U.S. Army Corps of Engineers
PO Box 2870
Portland, OR 97208-2870

Dear Mr. Smith and Major General Harrell:

We appreciate the quick response by your agencies to reduce spill levels on May 27, 1994. Given the high percentage of gas bubble symptoms in juvenile steelhead taken at four of the five collection sites, your action was a step in the right direction. We were also pleased of your decision to convene immediately a meeting of gas bubble disease experts to examine these results and recommend future actions.

However, we are concerned that despite a 30 percent reduction in spill, gas bubble symptoms continue to be observed in juvenile steelhead. In fact, as of May 31, 25 of 30 steelhead have shown signs of bubbles in the gill filaments (see enclosed Fish Passage Center June 1 table). As described in the enclosed memorandum from Dr. Don Weitkamp, this is a serious condition and "indicates that bubbles are forming in the fishes vascular system". Dr. Weitkamp continues that "if these bubbles reach vital areas, the fish will die". Dr. Weitkamp is a nationally recognized expert on gas bubble disease and is cited in numerous literature on the subject.

What happened to your plans to convene immediately a meeting of gas bubble specialists? As of this date, we have no knowledge of any meeting conducted or scheduled in the future. If this was truly important, a meeting should have been held on Monday or Tuesday of this past week. Experts on the subject such as Dr. Weitkamp, Dr. Bouck, Dr. Ebel, and Dr. Fidler were all available to assist you.

Finally, we are concerned with Dr. Weitkamp's conclusion that "such a high incidence of gas bubble disease symptoms is an indication a substantial mortality is occurring". Based on this recent information, we again ask you to stop this spill experiment today.

Sincerely,

Bruce J. Lovelin

Bruce J. Lovelin
Executive Director

Enclosure

cc: Northwest Congressional Delegation
Oregon Department of Environmental Quality
Washington Department of Ecology

1994 Smolt Monitoring Program Gas Bubble Symptoms - Lateral Line and Internal Symptoms
Juvenile Hatchery Steelhead

Site	Date	# Sampled	Lateral Line External	Lateral Line Internal	Gill Filaments	Internal Symptoms	Total Affected
Little Goose Dam	5/20	30	0	0	8	2	10
	5/22	30	0	0	11	2	12
	5/24	30	0	0	9	0	9
	5/26	30	0	0	10	3	11
	5/28	30	0	0	6	0	6
	5/30	30	0	0	10	1	10
	6/01	15	0	0	1	1	1
Lower Monumental Dam	5/19	30	0	0	15	6	17
	5/21	30	0	0	7	7	11
	5/23	30	0	0	7	8	14
	5/25	30	0	0	11	7	16
	5/27	30	0	1	6	6	11
	5/29	30	0	0	10	6	11
	5/31	30	0	0	4	6	6
McNary Dam	5/19	30	0	0	0	1	
	5/21	30	0	0	0	0	0
	5/23	30	0	0	0	0	0
	5/25	30	0	0	0	0	0
	5/27	30	0	0	0	0	0
	5/29	30	0	0	0	1	1
	5/31	30	0	0	0	0	0
John Day Dam	5/19	30	0	1	10	2	13
	5/21	30	0	2	9	2	13
	5/23	30	2	7	13	7	19
	5/25	30	2	19	13	3	26
	5/27	30	3	17	6	2	19
	5/29	30	0	24	7	0	24
	5/31	30	2	14	14	2	22
Bonneville Dam	5/19	30	22	30	13	8	30
	5/21	22	11	19	5	2	19
	5/23	12	5	10	3	4	10
	5/25	30	16	28	21	7	29
	5/27	30	24	30	21	10	
	5/29	30	20	29	18	6	29
	5/31	30	19	30	25	4	30

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way, N.E.
Bin C15700, Bldg. 1
Seattle, Washington 98115-0070

JUL - 6 1994

Mr. Michael Downs, Administrator
Water Quality Division
State of Oregon
Department of Environmental Quality
811 SW Sixth Avenue
Portland, Oregon 97204

Dear Mr. Downs:

The special spill operations initiated by the National Marine Fisheries Service on May 10, 1994, to facilitate the spring juvenile salmon outmigration ended on June 20, 1994. The ending of these special operations does not, however, end voluntary spill at some Snake and Columbia River dams for fish passage purposes. The purpose of this letter is to request an immediate interpretation of the current total dissolved gas (TDG) standard and a temporary rule to allow exceedance of this standard to allow full implementation of required summer fish spill.

The required summer fish spill for these dams can be found in our 1994-98 Federal Columbia River Power System Biological Opinion which we issued to the Corps of Engineers (COE), Bonneville Power Administration (BPA) and Bureau of Reclamation on March 16, 1994, as a result of Endangered Species Act, Section 7 consultation on hydropower system operation. Briefly, the Biological Opinion (and by reference, the COE's Fish Passage Plan) states that spill will occur at four dams at the following rates: Ice Harbor - 25 kcfs for 24 hours, John Day - 20% of the project flow for 10 hours, The Dalles - 5% of the project flow for 24 hours, and Bonneville - 42% of the project flow for 24 hours. In practice, The Dalles Dam spill would be concentrated to 15% of the project flow for 8 hours to improve fish passage effectiveness. This spill scenario was to begin directly after spring operations ended and extend through July 31 at Ice Harbor Dam, August 22 at The Dalles and John Day Dams and August 23 at Bonneville Dam. With the exception of spill at Bonneville Dam and the duration of spill at Ice Harbor Dam, these spill levels are specified in a 1989 Fish Spill Memorandum of Agreement (MOA) among BPA and all the Columbia Basin Fish and Wildlife Authority agencies and tribes (see enclosed spill table). While the COE was not a signatory, they have agreed to implement the MOA on a year to year basis. These spill levels have been provided under that MOA every year since 1989.

According to COE Reservoir Control Center predictions, these spill levels will result in exceedance of the 110% total dissolved gas water quality criterion in the tailraces of Ice Harbor, John Day and Bonneville Dams. Gas levels in the tailraces of these three dams are expected to be approximately 122, 116 and 111 percent, respectively. These gas levels are similar to or lower than the spring special operations spill and in some cases of shorter duration.

These spill levels were developed and included in the Biological Opinion to reduce juvenile salmon mortality as a result of hydrosystem operation and ultimately avoid jeopardizing the continued existence of Snake River fall chinook. As you already know from our discussions regarding spring spill, controlled spill is an important method of passing fish through hydroelectric dams with relatively low mortality. This passage route is even more important for summer migrants since these fish do not guide through turbine bypass systems nearly as well as spring migrants. In addition, we are continuing to monitor salmonid and non-salmonid condition for exterior signs of gas bubble disease at most of the locations and TDG levels at all the locations mentioned in our revised spring spill monitoring and management program plan.

In a June 3, 1994, letter to the National Marine Fisheries Service, the Oregon Department of Environmental Quality (DEQ) indicated that the 110% criterion could be interpreted as applying to an average TDG level with a permissible instantaneous upper limit of 115%. This is not, however, how the COE is interpreting the criterion at this time. The COE is currently limiting spill at all projects to that which causes less than 110% TDG at any point in the river. This level is substantially less than what our Biological Opinion calls for and is, in effect, the lowest level of protection provided to summer migrants in the last five years. We request that you ask the COE to follow the water quality criteria rationale presented in DEQ's June letter as soon as possible to allow immediate spill levels at or near the Biological Opinion levels.

To allow full implementation of the Biological Opinion spill levels, we request a temporary rule to allow maximum average TDG levels of 115% with an allowable instantaneous TDG of 120%. We are currently putting together the information supporting this request (as requested in Mr. Robert Baumgartner's June 29, 1994, letter) and we will be sending you this information as soon as possible.

Thank you for your cooperation and help in dealing with this difficult situation. Please contact Gary Fredricks at 503/230-5454 if you have questions or wish to discuss this request.

Sincerely,

J. Gary Smith
Acting Regional Director

cc: Jim Athearn, US Army Corps of Engineers
Ron Boyce, Oregon Dept. of Fish & Wildlife
Jim Nielson, Washington Dept. of Fish & Wildlife
Michele DeHart, Fish Passage Center
Michael Huston, Oregon Dept. of Justice
Ann Squier, Oregon Governor's Office
David Peeler, Washington Dept. of Ecology
Steven Saunders, Washington Dept. of Ecology

Monitoring Plan Overview:

Smolt Monitoring: (100 or more fish/species)

Rock Island 3/week
Granite 3/week

<u>Collector Dams</u>
Lower Granite
Little Goose
Lower Monument
McNary

- Fish are collected over 24 hours
- Sampled each morning
- An additional 100 Hatchery steelhead and chinook (2 @ 50 each), No holding as egress
- Sampled Daily

<u>Other Dams</u>
John Day Collected daily,
Bonneville Several times daily

Internal Observations 30 Hatchery steelhead at:

Little Goose
Lower Monumental
McNary
John Day
Bonneville

- 30 hatchery Steelhead
- Alternate Days
- Internal and External Signs

In Situ Juvenile Salmonids and Resident Fish

Ice Harbor (Chinook @ Resident)
Bonneville (Chinook @ Resident)
Priest Rapids (Resident)

- 4 Days
- Deep control, volition test

Adult monitoring:

Bonneville: Adults entering the North Shore trap, anesthetized and examined visually, expect to observe 3.1-4.2% of adults (30-90 fish), 6 days per week, for 6 to 8 hours/day.

Ice Harbor Adults captured by trap, evaluations by gross observation through a window in the trap, individual fish may be anesthetized for closure observation, for a maximum of 24 fish or 10% of adults, 5 days per week.

L. Granite Adults trapped and anesthetized and visually examined. Trap is operated for 8 hours/day, 7 days a week, and captures about 10% of the fish passing the dam.

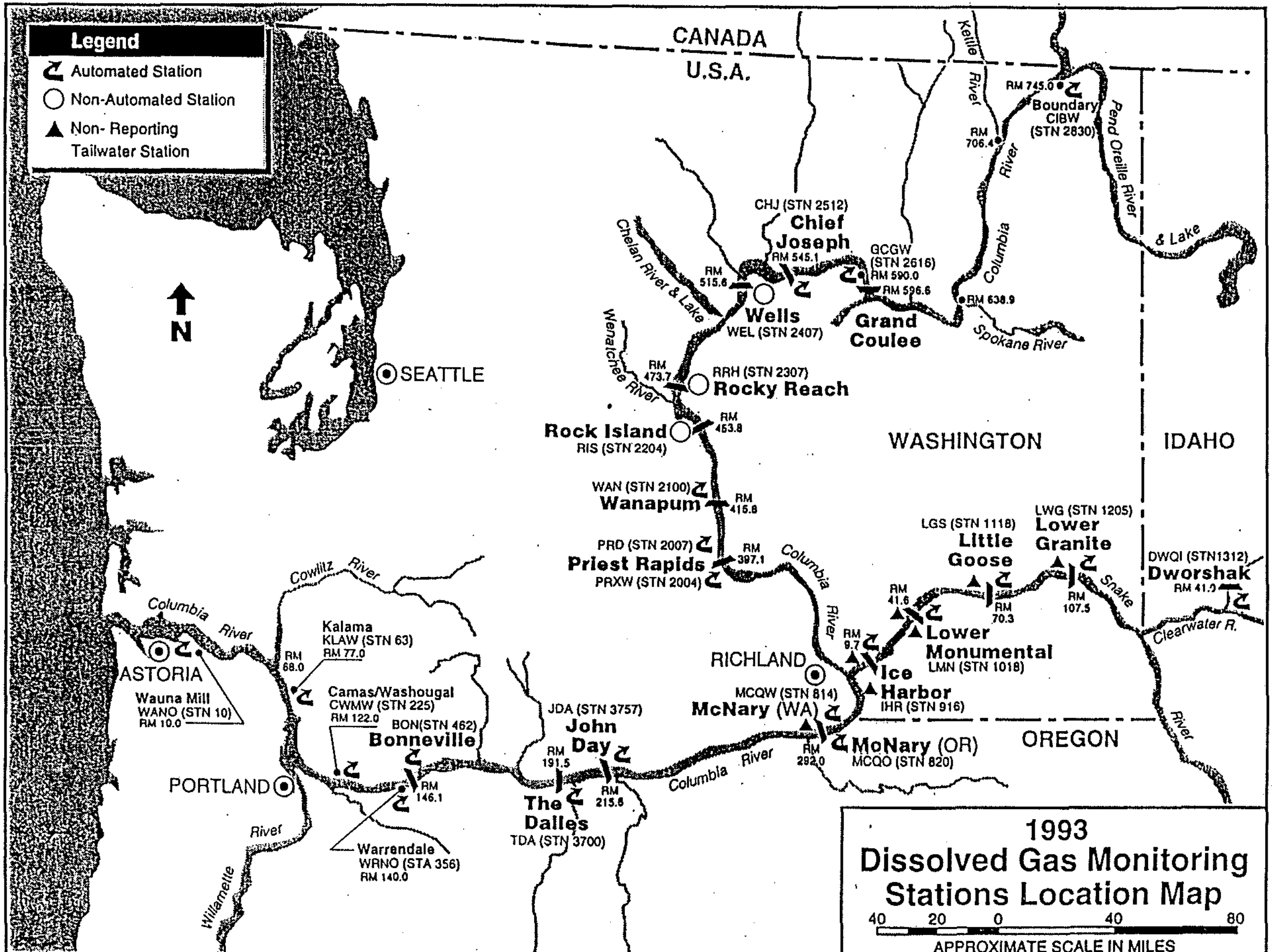
Action Levels:

The **volume of spilled water** will **be reduced** at upriver dams when **external signs of GBD exceed** the following action levels: **5% in juvenile salmonids and/or 2% in adult salmonids in any location. If at any time GBD is detected through internal examination exceeds the above action levels at two consecutive projects** in any daily sampling period, or any unusual or unexpected events occur which would negatively impact survival of migrant salmonids, **spill levels at upstream projects will be decreased** to avoid detrimental impacts to fish.

Additional (Ad Hoc):

Little Goose Electro-fishing: Samples of Northern squawfish will be observed for GBD
John Day Reservoir Beach Seining: Resident fish sampled will be observed for GBD

Figure 1



1993 Dissolved Gas Monitoring Stations Location Map

Excepted from meeting notes:

TDG measures:

The COE observed that it was taking more effort to enter data from the loggers into CHROMS than originally believed. The COE was also having difficulty with operation and installation of some recently obtained recorders. The monitoring locations for reference to the TDG measures are described

Location	method	Closest Continuous	Closest telemetry
McNary	Logger	----	4-Bay
John Day	Grab	4-Bay	4-Bay
The Dalles	Grab	4-Bay	4-Bay
Bonneville	Grab	Warrendale / Scamania	Warrendale / Scamania

The TDG measures that would be most meaningful would integrate the change in TGP with the duration and depth of exposure for fish. Such measures would likely be different for various species and life stages of aquatic life. In any event such information on TGP concentrations, and residence time and depth variation for fish is not readily available.

The fisheries agencies observed that juvenile and adult salmonids and resident fish do not spend any significant time in the tailraces, and exposure time to higher TDG prior to mixing with the rest of the Columbia river water is therefore limited. The **analogy between the tailraces and mixing zones** was drawn. In applying mixing zones resource protection agencies recognize that a zone of immediate mixing can occur without significant harm to the aquatic resources as long as acute conditions are not encountered throughout the mixing zone, and that chronic conditions occur outside of the mixing zone. The mixing zone allows for substantial, although not complete mixing to occur. Most of the work done relating to TDG and GBD focuses on chronic, or several day exposure levels. The NMFS informs us that their experts find that only average, and not maximum, criteria values are appropriate for TDG.

Bubbles occurring within the tailrace may result in lower TGP than measured further downstream (Brian D'Aoust, Common Sensing). The single best readily available information exists downstream of the tailraces. The data below the tailraces usually exists as grab samples. Continuous, or hourly, data would be preferable since temporal statistics could be calculated. The grab sample data should be compared with the continuous data to ascertain these measures provide measure of the 12-hour mean. The continuous data should provide an indication of the degree of variation in TDG measures associated with the 12-hour spilling schedule. If the temporal statistics indicate that the grab samples do not reasonable approximate the 12-hour mean then more frequent monitoring, or alternative locations should be selected.

External Observations:

Mostly zero

Exceptions:

Bonneville

5/17	1%	Hatchery Steelhead
5/17	4%	Wild Steelhead
5/18	1%	Wild Steelhead
5/19	5.6%	Wild Steelhead
5/20	1.1%	Hatchery Steelhead
5/20	3.3%	Wild Steelhead
5/26	2.7%	Wild Sockeye
5/27	1.9%	Wild Steelhead
5/28	0.9%	Wild Steelhead

McNary

5/22	2%	Hatchery Chinook
5/24	1.2%	Hatchery Steelhead
5/26	0.5%	Hatchery Steelhead
5/28	2.2%	Hatchery Steelhead
5/30	1.4%	Hatchery Steelhead

Ice harbor

5/16	21.4%	Non Salmonids
5/17	4.3%	Non Salmonids
5/18	4.1%	Non Salmonids
5/23	1.3%	Non Salmonids
5/24	3.8%	Non Salmonids
5/25	0.9%	Non Salmonids

Priest Rapids

5/26	1.3%	Non Salmonids
5/31	1.3%	Non Salmonids

Umatilla

5/22	11.1%	**Adult** Chinook (1/9)

L Monumental

5/23	1.2%	Hatchery Steelhead

Summary Internal Observations (FPC)							
	Swim Bladder	Lateral Line	Kidney	Gill Filaments			
Lewiston							
5/26							
L. Granite							
5/26 (15)	2	2					
Little Goose							
5/26 (30)	3			6 <20	4 20-50		
5/28 (30)				6 (4-50)			
5/30 (30)			1	7 <10	1 < 25	1 < 50	1> 50
L. Monumental							
5/27 (30)	4	1	2	3 <=2	2 @ 3	1 @ 10	
5/29 (30)	5		1	3 <=4	3 @ 5	3 5-8	1 @ 10
McNary							
5/27 (?)							
5/29 (?)			1				
5/31 (?)							
Bonneville							
5/24 (30)	7	28	2	3 several	1 many in 8 filaments		
5/26 (30)	1	24	2	20, mostly small	1 80% of filaments 1 side		
5/28 (15)	3	12	1	12 Most < 3			
5/29 (15)		14		6 3-8			
5/30 (30)	3	30		25 Small Number			

No assessment has been provided that would indicate the reported observation of GBD are associated with increased mortality of juvenile salmonids.

Net Pen Studies, Columbia River, Selected Locations, (NMFS)							
	Test (Volition)			Control (Depth)			
Location	N	GBD	Morts	N	GBD	Morts	Date
Bonneville	60	**12 (20%)**	0	20	0	0	9-13
	30	0	0	20	0	0[1]	16-20
1) 2 fish were unaccounted for for the period 9/13 the test cage showed indications of GBD							
Location	N	GBD	Morts	N	GBD	Morts	Date
Ice Harbor	62	17 (27%)	4 (6.6%)	10	2 (20%)	1 (5%)	9-13
	67	1 (1.5%)	2 (2.9%)[2]	12	0	0	16-20
2) 39 fish were unaccounted for; either escaped or undocumented mortality Differences in test and control numbers unfortunate. Differences between observation of GBD and mortality on 9/13 may not be significant (chi-squared 0.57, 0.34) Assumptions on the applicability of depth compensation as a control, and autopsies for cause of death would provide useful information.							

Resident Fish:

Data for resident fish cage bio-assays has not been provided. Mr. Earl Dawley (NMFS) provided qualitative data on his experiments, significant sines of GBD were observed in resident fish caged below Ice Harbor for the period 5/23-27, Fewer observations were recorded for resident fish in net pens below Bonneville.

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FAX COVER LETTER

May 31, 1994

Please deliver this transmission to:

NAME	COMPANY	FAX NUMBER
Bill Wessinger		**(503) 464-2299**

This transmission is from **Henry C. Lorenzen**

Number of pages (including cover page): 3

Client No.: N/C

This transmission is being sent on a Ricoh 3200L fax machine. If you do not receive all of the pages, or if you have other problems receiving this transmission, please call **Tammy** at (503) 276-3331.

Dear Bill: ***Enclosed is an interesting article relating to the spills and resultant gas bubble disease. Please call me this afternoon if your schedule allows.***

Henry

customers' bills, but what really happens is the participant's bill goes down and the nonparticipant's bill goes up. Explaining that a rate increase is necessary "because the utility paid to weatherize your neighbor's home" doesn't sell in Peoria, Mukilteo, or Oso. These rate impacts can and must be managed.

Snohomish is considering a steady effort to gather between 5 aMW and 10 aMW a year of demand side savings. We estimate that this level of effort should have small rate impacts, if any, and allow us to continue to reap a steady harvest of conservation. We believe we can balance a steady conservation effort with the associated rate impacts and meet the needs of our customers.

Environment

Fish

[17] Less Gas, More Spill as Fish Head Downstream; FPC Book Cooking? ■ *from [1]*

As pressured mounted in the region to assure that the controversial spill program was not turning into a fish kill, NMFS at week's end reportedly ordered a rollback of five percent in dissolved nitrogen levels at The Dalles and Bonneville Dams. The actual order to the Corps from NMFS could not be confirmed at press time, nor could it be learned how much flow would be cut in order to achieve the reduction in gas levels.

But FERC ordered Grant PUD late last week to start spilling water over Priest's Rapids and Wanapum Dams as "temporary rough-and-ready measures" to benefit fish. PUD power manager Don Long figures the cost at $200,000 per day. Grant PUD biologists are concerned about fish health effects of the order. "We are monitoring nitrogen levels near our dams and will be discussing this concern with the Washington Dept. of Ecology," Long said.

Monitors hastily trained to check for signs of gas bubble disease in the wake of the NMFS decision to spill more water over the last eight dams in the Snake and Columbia Rivers and push more chinook downstream continued to funnel data into the Fish Passage Center last week. NMFS said that some dissected steelhead showed signs of gas bubbles in their organs, which Donna Darm, NMFS special assistant to the regional director, said NMFS was taking as an "early warning sign of gas bubble disease."

Darm said earlier last week that NMFS had decided to continue the spill because the gas bubble disease trigger to shut off the program--5 percent in juveniles and 2 percent in returning adults--had not been reached. But retired BPA fish biologist Jerry Bouck, a bubble disease expert, said the data he has seen suggests that 100 percent of juveniles have the disease to some extent by the time they reach Bonneville Dam and that adults are even more susceptible than juveniles to the malady.

Although the official Fish Passage Center reports displayed an array of zeros, sources looking at raw data noted that some monitoring was showing relatively high indications in steelhead samples of nitrogen, particularly at Bonneville Dam. Steelhead are being used for testing instead of chinook as a chinook conservation measure. Of a sample of 79 fish collected from May 17 through May 23, 48 percent showed gas bubbles in the external lateral line, 87 percent in the internal lateral line and 29 percent in gill filaments. There were internal symptoms in 19 percent of the Bonneville Dam fish.

Is the Fish Passage Center cooking the books on the gas bubble danger? Having the FPC monitoring the spill program impresses many fish war veterans as a risky decision. The agency, a creation of the power council's F&W program, has 11 employees, costs $800,000 a year and is, sources agree, accountable to no one. Anecdotes abound illustrating the FPC's almost legendary non-cooperation, including once denying a request from the Corps for data because the Corps did not meet the PFC's "need to know" policy, and on another occasion denying the NMFS recovery team information because "it would only confuse them."

Sources also objected to having the Fish Passage Center involved in spill monitoring because its manager, Michele DeHart, has been an outspoken advocate of spill as the best means of passing downstream migrants through the dams. Primary sources on why the FPC was giving spill a clean bill of health could not be reached, but reliable secondary sources said that a US Fish and Wildlife fish pathologist had decided that the symptoms were nothing to worry about.

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Jerry Bouck disagreed. Most fish pathologists, Bouck said, are studying bacteriological disorders in fish, not gas bubble disease. "Anyone who knows anything about fish physiology would never make a statement that gas bubbles in the blood are no problem," he told *Clearing Up*. He criticized the NMFS/FPC decision to limit monitoring to external signs. He said even juveniles with no external signs of the disease can, if they are infected, exhibit behavioral changes that lessen their chances of survival on their way downstream.

Bouck is reportedly one of the scientists that NMFS is asking for a second opinion on the levels of nitrogen being detected in monitoring efforts at Snake and Columbia dams. There was no official confirmation of who would serve on that team of scientists or what they would be asked to decide--if anything.

Other sources in Portland late in the week said there may be legal and even criminal repercussions from the spill program, considering the high risks that the upshot of the action will be killing of listed fish--a crime under provisions of the Endangered Species Act. There has been no official indication of such action, however.

On the added flows front, as of early last week there had been no decision made by NMFS to request additional water for flows later this year, Darm said. She said she did not expect NMFS to make a flow decision by the end of last week.

Reports circulated early last week that one side effect of the NMFS spill program would be to degrade the Skalski-Williams research project designed to relate flows and survival in between dams. Darm and other sources indicate that the effect of the spill was minor on the research and that the project researchers were satisfied that confidence intervals, while increased, were still acceptable.

Senator Mark Hatfield, meantime, followed up on his letter with Montana Senator Max Baucus and House Speaker Tom Foley to President Clinton denouncing spill and wanting the US Treasury to pay for the costs by writing a newspaper column. Appearing in several papers in the region, the Oregon senator's op-ed piece (reprinted in THE CLIPS) denounced spill and referenced Judge Malcolm Marsh's ruling on the 1993 biological opinion as "the final indication that the [Endangered Species] Act cannot work as currently written."

Washington Senator Slade Gorton also protested the spill action in a letter to Commerce Secretary Ron Brown denouncing the science and cost of the spill and reminding the secretary that the Environmental Protection Agency's "Quality Criteria for Water" "clearly states that the gas saturation levels contemplated in the NMFS spill order pose a significant danger to both adult and juvenile salmon and steelhead."

Fish News in Brief: Michael Spear, former US Fish & Wildlife Service assistant director for ecological services, has become the new Northwest regional director of the service. He succeeds Marvin Plenert, who retires July 3. Sources say Speak is an advocate of having Fish & Wildlife take over salmon protection responsibilities from NMFS.

NMFS has accepted an ESA petition filed by the Oregon Natural Resources Council and other environmental groups seeking protection for 178 stocks of steelhead in the Pacific Northwest. A statement from the environmental group said that the main problem associated with steelhead decline was habitat degradation. NMFS has until February 14, 1995 to decide on listing some or all of the petitioned stocks *[Cyrus Noë]*.

Supply & Demand

[18] Contested Case Delays Add to Costs of PGE Coyote Springs Project ■ *from [9]*

Delays caused by the continuing contested case hearing over PGE's 496 MW Coyote Springs project are adding millions of dollars to its cost, according to the IOU.

Oregon Energy Facility Siting Council staff issued a proposed order for a final site certificate for Coyote Springs in January. A request for a contested case hearing was filed by the Don't Waste Oregon Committee, the Utility Reform Project and Colleen O'Neil.

An attempt to begin the evidentiary phase of the hearing did not commence until May 16 and now will not resume until June 30. Once the hearings are complete, any revised proposed order prepared by hearing officer Jeff Chicoine will still have to go before the EFSC for final approval. Even then, a court appeal could still be filed.

"We knew it would take several months, but we hoped to have a site certificate by now," said PGE spokesman Dave Heintzman. The extra cost being added to the project will total between $5 million and $10 million, he said. The hearings could ultimately delay the fall 1995 on-line date, and there may be other contract implications down the road, Heintzman said.

The fact that PGE has not sited a major facility since Boardman in the late 1970s complicates the situation, as does the fact that many of EFSC's siting rules have been revised. One of those rules states that site certificates should be issued within nine months of the date the application for the certificate is deemed complete. Coyote's schedule is already past that date, though this is due in part to amendments PGE added to the application.

Dan Meek, attorney for the intervenors, said the challenge focuses in part on a rule EFSC adopted which had the effect of exempting Coyote and US Generating's Hermiston project from having to demonstrate

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June 2, 1994

Mr. Fred Hansen, Director
Oregon Department of
Environmental Quality
811 S.W. Sixth Avenue
Portland, Oregon 97204

Re: Spill in the Lower Snake and Columbia Rivers

Dear Mr. Hansen:

Yesterday, we submitted materials for your consideration in connection with the deliberations of the Oregon Environmental Quality Commission and the Department of Environmental Quality concerning the ongoing spill program in the Lower Snake and Columbia Rivers.

Later yesterday, I received a copy of the Fish Passage Center's monitoring data for juvenile hatchery steelhead dated May 31. A copy of that table is enclosed. This table includes data taken on May 28 and 29, after the Corps of Engineers reduced spill by one-third from levels prevailing on May 26. Not surprisingly, these data show that the incidence of gas bubble disease in juvenile hatchery steelhead sampled has not declined, and may have increased. Tellingly, the data shows that an average of 91% of the juveniles sampled at Bonneville for internal and external signs of GBD have shown one or more such signs since this monitoring began.

While it can be debated whether such data is statistically significant, at a minimum it shows an appalling trend.

We also received late yesterday a copy of a letter dated May 26 from Senator Hatfield to Governor Roberts. The Senator's letter, written after consultation with biologists and responsible agency officials, outlines the grave concerns we share. Assuming no mortality from GBD, the Senator points out the putative net benefits of this spill will cost over $925,000 per fish. Taking into account the likelihood of mortality, the fiscal and biological absurdity of this exercise is starkly apparent.

We continue to encourage the DEQ and the EQC to act consistent with their responsibilities to protect this state's clean water resources and to shut down this irresponsible spill program by returning to a strict adherence to established state water quality standards for total dissolved gas.

Very truly yours,

R. Erick Johnson
Attorney for
Pacific Northwest
Generating Cooperative

Gregory J. Miner by REJ

Gregory J. Miner
Attorney for
Public Power Council

Enclosures

cc (w/encl.): EQC Members

1994 Smolt Monitoring Program Gas Bubble Symptoms - Lateral Line and Internal Symptoms
Juvenile Hatchery Steelhead

Site	Date	# Sampled	Lateral Line External	Lateral Line Internal	Gill Filaments	Internal Symptoms	Total Affected	%
Little Goose Dam	5/18	30	0	0	7	1	7	23
	5/20	30	0	0	8	2	10	33
	5/22	30	0	0	11	2	12	40
	5/24	30	0	0	9	0	9	30
	5/26	30	0	0	10	3	11	37
	5/28	30	0	0	6	0	6	20
	5/30	15	0	0	3	0	3	20
Lower Monumental Dam	5/19	30	0	0	15	6	17	57
	5/21	30	0	0	7	7	11	37
	5/23	30	0	0	7	8	14	47
	5/25	30	0	0	11	7	16	53
McNary Dam	5/17	30	0	0	0	0	0	0
	5/19	30	0	0	0	1	1	3
	5/21	30	0	0	0	0	0	0
	5/23	30	0	0	0	0	0	0
	5/25	30	0	0	0	0	0	0
	5/27	30	0	0	0	0	0	0
	5/29	30	0	0	0	1	1	3
John Day Dam	5/17	30	n/a	6	9	0	14	47
	5/19	30	0	1	10	2	13	43
	5/21	30	0	2	9	2	13	43
	5/23	30	2	7	13	7	19	63
	5/25	30	2	19	13	3	26	87
	5/27	30	3	17	6	2	19	63
	5/29	30	0	24	7	0	24	80
Bonneville Dam	5/17	15	0	10	2	1	11	73
	5/19	30	22	30	13	8	30	100
	5/21	22	11	19	5	2	19	86
	5/23	12	5	10	3	4	10	83
	5/25	30	16	28	21	7	29	97
	5/27	30	24	30	21	10	30	100
	5/29	30	20	29	18	6	30	100

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United States Senate

WASHINGTON, DC 20510-3701

May 26, 1994

The Honorable Barbara Roberts
Governor of Oregon
State Capitol
Salem, OR 97310-0370

Dear Governor ~~Roberts~~ Barbara:

Thank you for your letter outlining your support for the National Marine Fisheries Service's decision to spill additional water in the Columbia and Snake Rivers. While I appreciate being apprised of your position and afforded the opportunity to review the information on which you relied for your decision, I remain unconvinced that this decision was based on the very best scientific information available.

I am in full agreement that we should spread the risk to the salmon to the greatest extent possible, but see little conclusive evidence that the new spill regime will accomplish that objective. While there are various theories on the potential positive aspects of spill on the juvenile salmon, I am not aware that they are accepted broadly by the scientific community.

From discussions I have had with several biologists it appears that we actually may be increasing the risk, especially with regard to the returning adult salmon. In a conference call in which I recently participated with Doug Hall, Assistant Secretary of Commerce, Gary Smith, Acting Regional Director of NMFS, and biologists Dr. Michael Schiewe and Dr. Donald Bevan, it was generally acknowledged that the adult salmon are more susceptible to gas bubble disease, and may have greater difficulty locating the fish ladders because of the additional spill. And unlike the juveniles whose theorized benefits from spill may outweigh the mortality resulting from gas bubble trauma, adult mortality from increased gas levels will likely not be offset by other spill-related benefits.

I am concerned about the growing impression that we have not attempted to spread the risk over the years, and have relied totally on the transportation system to move the juveniles down the rivers. Mundy, et al., in their transportation study, may be correct in asserting that "...transportation alone, as presently conceived and implemented, is unlikely to halt or prevent the continued decline and extirpation of listed species....". We have not, however, relied solely on transportation over the years. We have depended on both transportation and spill, and

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the states and tribes have participated in these decisions.

When the states and tribes joined in the call for increased transportation in low water years, I can only assume that one objective then was to spread the risk. It may be appropriate to increase the percentage of fish that are spilled, but we are obligated to ensure that such a decision will result in more returning salmon, not less. If our primary concern is to recover the salmon, the emphasis should not only be placed on risk spreading, but also on survivability of both juveniles and adults. Dr. Mundy and his colleagues are also correct in saying that, "Before a 'spreading the risks' policy can be implemented, the risks need to be known.". The evidence that I have seen suggests that the risks were not fully understood before the spill decision was made.

My most serious concern regarding the decision to spill is that it was made hastily with little consultation with Members of Congress and the public, without the involvement of the Snake River Salmon Recovery Team, and with little thought of proper design and monitoring. In its present form, this activity will probably not maximize our knowledge of using spill as a recovery tool. In addition, I believe the regime is now incorrectly characterized as an "experiment." It is difficult to believe that any true experiment would require all eight reservoirs as a model to test a hypothesis. The unfortunate result of this action is to subject all species in the river to the stress which will inevitably occur, as we know from well-documented research conducted nearly two decades ago. While there may be sufficient evidence to indicate that juvenile salmon can detect and avoid high levels of gas, can the same be said for the mollusks, crustaceans, and the other species in the top two meters of the water? Probably not.

In the paper sent to me by your office as justification for the spill, it was stated that the action would be "... evaluated in the long term as part of an adaptive management approach, used to assist in improving juvenile survival with respect to recovery." While this objective certainly is desirable, it may not be possible without an adequate monitoring program that will evaluate the results properly. I find it unconscionable that the final monitoring plan for the spill regime was not in place until May 20th, ten days after the first spill was ordered. In effect, little valuable monitoring was done during these first days of the spill regime, and is an indication of the lack of forethought and planning that went into the decision.

Another major concern to me is the prospect of the spill being extended on the basis of inadequate analysis of information. If the decision is made by NMFS to extend the spill regime beyond June 20th, I hope you will join me in insisting that a complete review of data which is gathered be conducted, that a scientifically defensible monitoring plan be in place prior to the beginning of the juvenile fall chinook migration, and that the experiment be designed to maximize our understanding of the efficacy of this and future spill decisions.

Finally, I believe a discussion of the cost of the spill regime, especially as it relates directly to increased survivability, is appropriate. While the Endangered Species Act limits the degree to which costs can be considered in recovery actions, policy makers cannot afford to lose their concepts of fiscal responsibility. In this particular case, I am dismayed at the minimal increase, if there is any increase at all, in survivability that may result from this decision, even under the best of circumstances, and the amount of money the public is being asked to pay for these benefits.

According to NMFS, the estimated increase in juvenile survivability is 5.3 percent. This increase in survival applies only to the percentage of fish that remain in the river and are not transported. According to NMFS data, the percentage of fish transported during the spill is 83 percent, while 17 percent of juvenile spring chinook will remain in the river and be spilled over the dams, go through the fish bypass systems, or pass through the turbines. It is this 17 percent of the juveniles that the 5.3 percent increase in survivability is applied. This translates into a spill regime that has an overall estimated increase in survivability of 0.9 percent. The spill regime began at midnight on May 11th. NMFS estimates that more than 50 percent of the spring chinook run had passed Lower Granite Dam before the spill began. Therefore, the 0.9 percent increase in survivability applies only to the remaining 50 percent of the run remaining in the river.

NMFS further estimates that the number of threatened wild spring chinook in this year's run to be approximately 600,000 fish. Applying the 0.9 percent to half of the 600,000 juveniles, or 300,000 fish, the number of additional juveniles surviving to the ocean is approximately 2,700 fish. Although in recent years less than one percent of the fish have returned as adults to the Columbia River, for the purposes of this letter let us assume that one percent, or about 27 fish, actually will return as adults. NMFS and the other Federal agencies estimate the total

The Honorable Barbara Roberts
May 26, 1994
Page four

cost of the spill regime to be at least $25 million. This translates into a total estimated cost of at least $925,926.00 per returning adult salmon. If you also assume that some of the fish will die from gas bubble trauma, and that the costs will increase beyond $25 million, the cost per fish rises even higher. It can be argued that the cost per fish of the spill regime would be lower if the runs had not been allowed to sink to such precariously low numbers in the first place, but the fact remains that, under the present conditions, the costs are considerable.

I can recall few other decisions in the natural resource arena, or any other arena, where a decision having such a minuscule cost-benefit ratio was implemented with so little planning and consultation. At the very least, I would have expected an analysis of other options which may have resulted in comparable increases in fish survival. I would imagine that we could convince Canadian fishers to sell their rights to catch 27 wild chinook salmon for a lot less than $925,926.00 per fish.

I remain open to receiving additional information which further justifies this decision, and look forward to working with you in the coming weeks to ensure that future actions will be better planned, designed, implemented, and more cost-effective.

With warm regards.

Sincerely,

Mark O. Hatfield
United States Senator

MOH:mw

Tina | M / Chris /
WQ – please note
and comply with

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June 13, 1994

HAND DELIVERED

Mr. Fred Hansen, Director
Oregon Department of Environmental Quality
811 SW Sixth Avenue
Portland, OR 97204

Re: Spill in the Lower Snake and Columbia Rivers

Dear Fred:

The DEQ's current temporary exemption from Oregon's water quality standards on dissolved gases, instituted to accommodate NMFS' adventurous spill program, will expire June 20, 1994. We understand that although no meeting or hearing before the Environmental Quality Commission is presently scheduled to consider proposals or testimony to extend this exemption, such a meeting or hearing could be scheduled on short notice. Should such a meeting or hearing be scheduled, we would appreciate receiving notice by telephone as soon as possible. We have out-of-state expert witnesses with whom we would need to make arrangements to fly to Portland in order to testify at such a hearing. Your cooperation is greatly appreciated.

Very truly yours,

Bill Masters

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State of Oregon
DEPARTMENT OF ENVIRONMENTAL QUALITY
RECEIVED
JUN 13 1994
OFFICE OF THE DIRECTOR

Columbia River Alliance

For Fish, Commerce and Communities

FOR IMMEDIATE RELEASE
May 26, 1994
For more information contact:
Bruce Lovelin: (503) 238-1540

"GAS BUBBLE DISEASE" IN SALMON DETECTED
Spill experiment should be stopped immediately, group says

"Gas bubble disease," the fatal syndrome that affects fish the way the bends hurts deep sea divers, has been found in high numbers of salmon spilled over the dams of the Columbia and Snake rivers.

Nearly 50 percent of juvenile steelhead examined below Bonneville Dam are showing visible external signs of the disease, an indication that the disease has reached fatal levels. Eighty-seven percent of the sampled fish are showing internal signs of the disease, meaning many more than previously thought are being harmed by high nitrogen levels in the spilling water. Juvenile steelhead are being collected and sampled, but all fish, including salmon and resident fish, will suffer equally from the disease.

"Two weeks ago we wrote to the U.S. Army Corps of Engineers and the National Marine Fisheries Service to request an immediate halt to the emergency spill program, but the spill continued," said Bruce Lovelin, executive director of the Columbia River Alliance for Fish, Commerce and Communities. "And the fisheries service assured us that dissolved gas levels can be controlled. But despite a monitoring program, gas bubble disease is showing up in most of the fish that are collected at Bonneville Dam. But this means that most of the fish that aren't being examined have it too."

The Columbia River Alliance is a coalition of agricultural, navigation, labor, community, manufacturing and electric utility groups throughout Oregon, Washington, Idaho and Montana.

In a letter sent Thursday to the corps of engineers and the federal fisheries service, the alliance again asked the federal agencies to halt the spill. "We again question the logic in continuing a spill program which could harm the very fish that we are trying to aid," the letter read. "Now, unfortunately, our fears are backed by empirical data. Please stop this spill experiment today."

-30-

825 NE Multnomah, Suite 955 • Portland, Oregon 97232 • (503) 238-1540 • Fax (503) 238-1554

Columbia River Alliance

For Fish, Commerce and Communities

May 26, 1994

Gary Smith, Acting Regional Director
National Marine Fisheries Service
7600 Sand Point Way, NE
Bin C-15700, Bldg. 1
Seattle WA 98115

Major General Ernest Harrell
U.S. Army Corps of Engineers
PO Box 2870
Portland OR 97208-2870

Dear Mr. Smith and Major General Harrell:

On May 11, 1994, the Columbia River Alliance requested a termination of the spill program of the lower Columbia and Snake river dams. At the time of that request we provided you with scientific information that noted the historical incidence of gas bubble disease resulting from high dissolved gas saturation levels caused by spill in the Columbia and Snake rivers.

Enclosed is a table distributed by the National Marine Fisheries Service examining external and internal signs of gas bubble symptoms for juvenile steelhead collected at five Snake and Columbia river dams. The table shows a high incidence of both internal and external symptoms of gas bubble disease. For fish collected at Bonneville Dam on May 19, all 30 fish sampled showed "lateral line internal" gas bubble symptoms. Twenty-two of the 30 fish sampled showed external signs, which as we are told, is an indicator of imminent mortality. Gas bubble symptoms were also found in high percentages of sample size of dissected juvenile steelhead at John Day, Lower Monumental, and Little Goose dams. Although monitoring has been clearly deficient during this spill experiment, the methods used in this aspect of the smolt monitoring program are superior than others employed.

We again question the logic with continuing a spill program which could harm the very fish that we are trying to aid. Now, unfortunately, our fears are backed by empirical data. Please stop this spill experiment today.

Sincerely,

Bruce J. Lovelin

Bruce J. Lovelin
Executive Director

Enclosure
cc: Northwest Congressional Delegation
Oregon Department of Environmental Quality
Washington Department of Ecology

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Received from National Marine Fisheries Service 5/26/94

1994 Smolt Monitoring Program Gas Bubble Symptoms - Lateral Line and Internal Symptoms
Juvenile Hatchery Steelhead

Site	Date	# Sampled	Lateral Line External	Lateral Line Internal	Gill Filaments	Internal Symptoms
Little Goose Dam	5/18	15	0	0	4	1
	5/20	15	0	0	4	1
	5/22	30	0	0	11	2
Lower Monumental Dam	5/19	30	0	0	15	6
	5/21	30	0	0	7	7
McNary Dam	5/13	30	0	0	1	1
	5/15	30	0	0	0	0
	5/17	30	0	0	0	0
	5/19	30	0	0	0	1
	5/21	30	0	0	0	0
	5/23	30	0	0	0	0
John Day Dam	5/17	30	n/a	6	9	0
	5/19	30	0	1	10	2
	5/21	30	0	2	9	2
	5/23	30	2	7	13	7
Bonneville Dam	5/17	15	0	10	2	1
	5/19	30	22	30	13	8
	5/21	22	11	19	5	2
	5/23	12	5	10	3	4

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June 2, 1994

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21755 Hwy. 138 West
Elkton, Oregon 97436

Linda R. McMahan
The Berry Botanic Garden
11505 S.W. Summerville Avenue
Portland, Oregon 97219

Re: Harmful Levels of Total Dissolved Gas Caused by Spill in the Lower Snake and Columbia Rivers

Dear Sir/Madam:

We advocate a comprehensive approach to salmon enhancement and recovery actions and continue to endorse reasonable scientifically derived actions to restore salmon populations. However, we do not believe that the current spill program contributes to salmon recovery efforts and in fact is deleterious to all fish and biota in the Columbia River.

This letter is written to inform you of recent developments which show that the increased spill of water over Columbia River dams is having a significant detrimental effect on fish in the Columbia and Snake Rivers, including endangered and threatened Snake River salmon. On May 16, 1994, this Commission amended OAR 340-41-155 to allow the Army Corps of Engineers to operate the dams on the Columbia River in a manner which would allow total dissolved gas ("TDG") concentration to increase up to a maximum of 120 percent. The Commission was aware that such levels could cause gas bubble disease ("GBD") in fish. Accordingly, the Commission included in its rule a requirement that the federal agencies monitor for TDG concentrations and GBD. If GBD increased, the rule provided that "the Director shall make such alteration in the maximum allowable TDG, until a satisfactory level is achieved."

Recent developments show that the increased spill program is killing fish. The data released from the limited monitoring program shows that fish are suffering from GBD. A June 1, 1994 memorandum from the Fish Passage Center shows that between May 17 and May 31 significant numbers of juvenile hatchery steelhead were experiencing gas bubble symptoms. (Tab 1). Indeed, since May 19, 1994, there have been several occasions when 100% of the juvenile hatchery steelhead tested revealed internal lateral line symptoms. The data shows that the juvenile steelhead continue to experience GBD symptoms notwithstanding the decrease in spill since May 27, 1994. Indeed, as recently as May 31, 1994, 100% of the juvenile steelhead showed GBD symptoms.

In addition, on May 31, 1994 at the Washington Department of Ecology meeting on spill monitoring, NMFS indicated that significant data from its own ongoing research involving net pen studies had not been evaluated. Dr. Earl Dawley of NMFS stated at the Washington meeting that net pen studies reported GBD mortality nine miles downstream from Ice Harbor. Regardless of its research nature, this Commission should request the net pen study data -- which we believe would show that salmon are dying in the river now because of Temporary Rule 340-41-155 -- and independently evaluate the environmental impacts of this spill regime.

The United States Fish & Wildlife Service memorandum from the Lower Columbia River Fish Health Center also indicates that gas bubble symptoms were appearing in fish at Lower Monumental, Bonneville, and John Day dams. (Tab 2). In particular, the sample at Bonneville of 15 fish produced 11 with lateral line bubbles, two with bubbles in the gills, and one with a bubble in the kidney.

These two reports are in striking contrast to a May 19, 1994 Fish Passage Center memorandum. (Tab 3). The Fish Passage Center reported that based on the data collected through the smolt monitoring program, "all sites are reporting no symptoms of GBD or minor incidents." We find such a report incongruent with recent data and disturbing given the juvenile steelhead data and USFWS memo.

We understand that based on NMFS' May 27, 1994 letter, NMFS has determined to reduce spill by one-third at six of the eight mainstem dams. (Tab 4). Significantly, NMFS determined to reduce spill by one-third even though it was not in possession of all of the fish monitoring data when it decided to reduce spill.

Monitoring data since then shows that further reduction is necessary. From the May 31, 1994 juvenile hatchery steelhead data, it is obvious that the impacts of the spill program continue. It is apparent that opposition to transportation of salmon smolts has motivated entities to develop a program which poses unacceptably high risks to all fish and other biota in the Columbia River.

We are also enclosing a May critique by Dr. James Anderson of NMFS' efforts to assess the net effects of the emergency spill plan. (Tab 5). The Commission in its Statement of Need for OAR 340-41-155 stated that the "purpose of these spills is an emergency operation aimed at assisting the outmigration of juvenile salmon." The Anderson critique demonstrates that the transportation analysis relied upon by NMFS to institute the spill plan is significantly flawed, and thus NMFS' conclusion that the spill program will aid outmigration is erroneous.

The only attempt by NMFS to assess the net effects of the spill plan in any quantitative manner is through the state fishery agency and tribal computer model FLUSH which purports to represent the effects of passage through the dams on juveniles migrating downstream. The particular versions of the model used to assess the spill program have never been peer-reviewed.

Three versions of the FLUSH model were run to assess the effects of the spill plan. Model 2 assumes only 42.5% survival of transported fish (in fact, approximately 99% juvenile salmon are released alive from the transport barges). Even with this pessimistic assumption, FLUSH Model 2 showed that, on balance, the spill plan would decrease the survival of migrating juvenile salmon.

Two additional versions of the FLUSH model assume even lower transportation survivals, and in particular assume (contrary to the evidence) that transportation survival decreases in low flow years. These assumptions are rationalized by arbitrarily looking at a subset of the available data on transportation. Model 3 assumes no benefit at all from transportation in high flow years, and Model 4 assumes that transportation is significantly harmful in high flow years. Models 3 and 4, which show a small positive effect to the spill program, are the sole quantitative justification for that program. The positive predictions of these two versions of the FLUSH model arise from a misuse of the existing data on the benefits of transportation, and from the fact that all versions of the FLUSH model make no meaningful attempt to take account of the negative effects of gas supersaturation.

The FLUSH models also rely on data from the 1970's to determine the effect on juveniles which are not transported. That data has been determined by NMFS and others to be inapplicable to present passage conditions. By ignoring more recent and applicable data, all versions of FLUSH assume that survival in the river is much lower than is in fact the case. Given Mr. Anderson's critique, the Commission should reconsider the basis for its finding that an emergency exists warranting degradation of water quality to implement this spill plan.

Finally, the spill program continues to ignore effects on the most important fish under the Endangered Species Act: returning adults. Enclosed please find a letter from Dr. Wes Ebel regarding NMFS' Final Gas Bubble Disease Monitoring and Management Plan dated May 20, 1994. (Tab 6). Dr. Ebel's letter shows that the monitoring plan for TDG submitted by NMFS on May 20, 1994 will not protect adult salmon. The Commission may recall that Dr. Ebel testified at the May 16, 1994 hearing. Dr. Ebel worked for NMFS for 31 years and personally conducted much of the research on gas supersaturation in the Columbia and Snake Rivers.

NMFS has requested that monitoring of TDG occur in the forebays of the dams. Dr. Ebel notes that, in contrast, the most biologically relevant gas saturation levels are those in the tailraces. Monitoring in the tailrace is necessary because adult passage problems at the dams on the Columbia and Snake Rivers are usually caused by delays in fish finding the fishway entrances, and that during these periods of delay, adults are searching in the tailraces of the dams on both the spillway and turbine sides of the dam for fishway entrances. High concentrations of TDG in the tailrace therefore threaten the survival of adults during their upstream migration. Because NMFS' proposal fails to monitor in the tailrace and does not adequately address impacts on adults, the Commission should reject NMFS' proposed monitoring program as unacceptable.

We hope that the Commission appreciates that the spill program has caused a significant deterioration of water quality notwithstanding the Commission's order that the federal agencies operate the river in a manner to minimize total dissolved gas. It is incumbent upon EQC to consider all environmental impacts resulting from this spill program. The limited and insufficient analysis of effects on salmon, and the failure to address effects on other biota, does not justify a deviation from the EPA standard for TDG. We strongly suggest that the Commission review its temporary rule and take steps to protect endangered salmon by lowering TDG standards to safe levels -- the 110% level set by EPA to protect all fish in the rivers.

We encourage an open public process which allows interested parties to be included in the decision making process. We hope that the information included with this letter is helpful to you when evaluating the water quality impacts of the spill program. Please contact me if you any questions.

Very truly yours,

Nanci Tester
Environmental Manager,
Direct Service Industries, Inc.

Enclosure

FISH PASSAGE CENTER
2501 S.W. FIRST AVE. • SUITE 230 • PORTLAND, OR 97201-4752
PHONE (503) 230-4099 • FAX (503) 230-7559

MEMORANDUM

DATE: June 1, 1994

TO: Internal Signs of GBT Discussion Group

FROM: Margaret Filardo

RE: Data collected May 26 - June 1

I am providing a detailed description of the GBT signs observed in the sacrificed hatchery steelhead as agreed on the conference call last Thursday. The summary sheets will be distributed on Monday, Wednesday and Friday, with the complete update on Wednesday. I anticipate that these data will be forwarded by NMFS to the Operations Team for discussion at their Friday meeting. These are the most complete data as of the writing of this memo. I will be prepared to discuss any additional data that is received prior to the conference call tomorrow morning.

Lewiston Trap

5/26 - A total of fifteen fish were examined. 0/15 with GBT signs.

Lower Granite Dam

5/26 - A total of fifteen fish were observed. 4/15 with GBT signs.
2 fish with distended swim bladders.
2 fish with one bubble each observed in the lateral line.

Little Goose Dam

5/26 - No external or internal lateral line. 11/30 with signs of GBT. 10/30 with gill filament bubbles; 6 with less than 20 bubbles, 4 with 20-50 bubbles. 3 distended swim bladders.

5/28 - No internal or external lateral line bubbles. 6/30 with gill filament bubbles (4 to 50). No internal body cavity signs.

5/30 - No internal or external lateral line bubbles. 10/30 with signs of GBT. Gill filament bubbles; 7 less than 10, 1 less than 25, 1 less than 50 and 1 greater than 50. 1 fish with bubble in kidney.

Lower Monumental Dam

5/27 - No observations of bubbles in the external observation of lateral line. 15/30 affected. 1/30 with internal lateral line signs. 6/30 with gill filament bubbles; 2 fish with one bubble, 1 with 2 bubbles, 2 with three bubbles, and 1 with ten bubbles. 4 fish observed with distended swim bladder and 2 with a few bubbles on the kidneys.

5/29 - Thirty fish observed, no lateral line bubbles observed. 10/30 observed with bubbles in the gill filaments - 1 with one bubble, 1 with 3 bubbles, 1 with 4 bubbles, 3 with 5 bubbles, 1 with 6 bubbles, 1 with 7 bubbles, 1 with 8 bubbles and 1 with 10 bubbles. 5/30 observed with distended swim bladder and 1/30 with bubbles on the kidney.

McNary Dam

5/27 - no signs observed

5/29 - one fish observed with a bubble in the kidney.

5/31 - no signs observed.

John Day Dam

Bonneville Dam

5/24-25 - A total of 30 fish were sampled. 29/30 with GBT signs. 28/30 with a small number of internal lateral line bubbles. 21/30 with bubbles in gill filaments. All observations are of bubbles in one or two filaments. 3 out of 21 were described as several small bubbles and 1 was described as many bubbles in 8 filaments. 7/30 with distended swim bladders and 2 out of 30 with bubble in kidney.

5/26-27 - A total of thirty fish were sampled. 30/30 with GBT signs. 24/30 with external lateral line bubbles. Most described as small, a few described as occluding in a limited area. 21/30 with bubbles in gill filaments. Most are described as small and in the ends of one or a few filaments. One fish described as having small bubbles in 80% of the filaments observed on the slide. Another described as having many small bubbles in many filaments observed. 7/30 with distended swim bladder, 1 with distended swim bladder and bubbles in intestine. 2/30 with 2 small bubbles in the kidney.

5/28-29 - A total of 15 fish examined. 12/15 with external lateral line signs; most with small numbers, some with limited occlusion. 1 fish reported with 11 and 1 with 30. All with internal lateral line, 12/15 with gill filament. Observation under microscope with 100X magnification. Most with 1, 2 or 3 small bubbles, in up to 8 filaments. 3 fish with distended swim bladder and 1 with 3 small bubbles in the kidney.

5/29-30 - A total of 15 fish examined. 8/15 with external lateral line, 14/15 with internal lateral line, 1 with no signs at all. Magnification for internal lateral line bubbles ranged from 20-45x. 6/15 with gill filament bubbles; 3-8 bubbles in the gill filaments.

5/30-31 - Thirty fish examined. 19/30 with bubbles in external lateral line, some occluding in a limited area. 30/30 on internal lateral line (20x). 25/30 with gill filament bubbles; small number of bubbles in a small number of filaments. 3/30 with a distended swim bladder and 1/30 with bubbles in the intestine.

Juvenile Hatchery Steelhead

Site	Date	# Sampled	Lateral Line External	Lateral Line Internal	Gill Filaments	Internal Symptoms	Total Affected
Little Goose Dam	5/20	30	0	0	8	2	10
	5/22	30	0	0	11	2	12
	5/24	30	0	0	9	0	9
	5/26	30	0	0	10	3	11
	5/28	30	0	0	6	0	6
	5/30	30	0	0	10	1	10
	6/01	15	0	0	1	1	1
Lower Monumental Dam	5/19	30	0	0	15	6	17
	5/21	30	0	0	7	7	11
	5/23	30	0	0	7	8	14
	5/25	30	0	0	11	7	16
	5/27	30	0	1	6	6	11
	5/29	30	0	0	10	6	11
	5/31	30	0	0	4	6	6
McNary Dam	5/19	30	0	0	0	1	1
	5/21	30	0	0	0	0	0
	5/23	30	0	0	0	0	0
	5/25	30	0	0	0	0	0
	5/27	30	0	0	0	0	0
	5/29	30	0	0	0	1	1
	5/31	30	0	0	0	0	0
John Day Dam	5/19	30	0	1	10	2	13
	5/21	30	0	2	9	2	13
	5/23	30	2	7	13	7	19
	5/25	30	2	19	13	3	26
	5/27	30	3	17	6	2	19
	5/29	30	0	24	7	0	24
	5/31	30	2	14	14	2	22
Bonneville Dam	5/19	30	22	30	13	8	30
	5/21	22	11	19	5	2	19
	5/23	12	5	10	3	4	10
	5/25	30	16	28	21	7	29
	5/27	30	24	30	21	10	30
	5/29	30	20	29	18	6	29
	5/31	30	19	30	25	4	30

R1-57
UNITED STATES GOVERNMENT FISH AND WILDLIFE SERVICE

Memorandum

FAX TRANSMITTAL SHEET
Lower Columbia River Fish Health Center
MP 61.75R SR 14
Underwood, WA 98651
Phone: 509-493-3156
FAX: 509-493-2748
No. of Pages: _1__

TO : Assistant Regional Director - Fisheries and Federal Aid **DATE:** 5/18/94
Region 1, Portland Oregon

FROM : Project Leader, Lower Columbia River FHC
Underwood, WA

SUBJECT: Gas Bubble Disease

An update from this morning:

Training has been given at all dams. I completed McNary on 5/12 (3 people), John Day (3 people) and Bonneville (2 people) on 5/13. Eric completed Little Goose on 5/16 (4 people) and Lower Monumental on 5/17 (3 people). Today I'm going back to John Day and Bonneville to follow up.

One the 12th and 13th we did not see any gas bubbles in the fish. Eric reported that at Little goose 1 fish of four had bubbles in the lateral line. At Lower Monumental, all four fish examined had some minor signs: 2 in gills, 2 in lateral line, and 2 in kidney.

In talking with the Bonneville people today, their last sample of 15 fish produced 11 with lateral line bubbles, 2 with bubbles in the gills, 1 with a bubble in the kidney. At John Day they have found "minor" signs - gills in particular. Nobody has seen any external signs at the fish passage centers of the dams. But the John Day fish biologist says she talked to NMFS researchers at The Dalles dam, who report external and internal signs. They are apparently speaking directly with Earl Dawley about all this, so noone is sure if even the Fish Passage Center has heard of this.

Gas levels measured have been around 116%, 113% and 114%, I haven't heard any values of over 120%.

FISH PASSAGE CENTER

2501 S.W. FIRST AVE. • SUITE 230 • PORTLAND, OR 97201-4752
PHONE (503) 230-4099 • FAX (503) 230-7559

MEMORANDUM

DATE: May 19, 1994

TO: FPAC
Liaison Group
Donna Darm and Gary Smith, NMFS

FROM: Michele DeHart

RE: Gas Monitoring

Efforts are presently underway to coordinate and compile all of the dissolved gas related monitoring information to be disseminated to interested parties. These efforts are on-going and not yet completed. Therefore, we are distributing to you the Smolt Monitoring Program part of the gas monitoring initiative and the available dissolved gas information from the COE. We hope that this provides you with some understanding of the present data collected through the Smolt Monitoring Program. The data represent the presence of external symptoms and as you can see, all sites are reporting no symptoms of GBD or minor incidence.

1994 SNAKE RIVER SMP GAS BUBBLE SYMPTOMS

		LGR			LGS			LMN		
		# OBS	# SAM	% GBS	# OBS	# SAM	% GBS	# OBS	# SAM	% GBS
05/14	HCH1	0	28	0.0%	0	100	0.0%	4	5,822	0.1%
	WCH1	0	1	0.0%	0	18	0.0%	0	590	0.0%
	CHO	—	0	—	—	0	—	0	6	0.0%
	HST	0	30	0.0%	0	100	0.0%	0	1,832	0.0%
	WST	0	58	0.0%	0	12	0.0%	0	361	0.0%
	WSO	0	13	0.0%	0	2	0.0%	0	30	0.0%
	All Species	0	160	0.0%	0	232	0.0%	4	8,641	0.0%
05/15	HCH1	0	99	0.0%	0	100	0.0%	39	3,664	1.1%
	WCH1	0	1	0.0%	0	47	0.0%	0	261	0.0%
	CHO	—	0	—	—	0	—	0	6	0.0%
	HST	0	100	0.0%	0	100	0.0%	2	1,247	0.2%
	WST	0	31	0.0%	0	100	0.0%	1	358	0.3%
	WSO	0	13	0.0%	0	9	0.0%	1	14	7.1%
	All Species	0	244	0.0%	0	356	0.0%	43	5,550	0.8%
05/16	HCH1	0	97	0.0%	0	100	0.0%	5	5,772	0.1%
	WCH1	—	0	—	0	21	0.0%	0	434	0.0%
	CHO	0	0	—	—	0	—	0	8	0.0%
	HST	0	100	0.0%	0	103	0.0%	1	2,890	0.0%
	WST	0	43	0.0%	0	34	0.0%	0	426	0.0%
	WSO	0	16	0.0%	0	8	0.0%	0	14	0.0%
	All Species	0	256	0.0%	0	263	0.0%	6	9,544	0.1%
05/17	HCH1	0	100	0.0%	0	140	0.0%	0	175	0.0%
	WCH1	0	0	—	0	105	0.0%	0	15	0.0%
	CHO	0	0	—	0	2	0.0%	0	1	0.0%
	HST	0	100	0.0%	0	148	0.0%	0	153	0.0%
	WST	0	24	0.0%	0	102	0.0%	0	17	0.0%
	WSO	0	15	0.0%	0	21	0.0%	0	1	0.0%
	All Species	0	239	0.0%	0	518	0.0%	0	362	0.0%
05/18	HCH1	0	99	0.0%	0	95	0.0%	0	4,552	0.0%
	WCH1	0	1	0.0%	0	5	0.0%	0	293	0.0%
	CHO	0	0	—	0	0	—	0	15	0.0%
	HST	0	100	0.0%	0	100	0.0%	0	4,491	0.0%
	WST	0	52	0.0%	0	0	—	0	218	0.0%
	WSO	0	15	0.0%	0	0	—	0	13	0.0%
	All Species	0	267	0.0%	0	200	0.0%	0	9,582	0.0%

1994 LOWER COLUMBIA SMP GAS BUBBLE SYMPTOMS

		MCN			JDA			BON		
		# OBS	# SAM	% GBS	# OBS	# SAM	% GBS	# OBS	# SAM	% GBS
05/14	CH1	0	999	0.0%	0	222	0.0%	0	163	0.0%
	CHO	—	0	—	—	0	—	0	134	0.0%
	HST	0	146	0.0%	0	120	0.0%	0	113	0.0%
	WST	0	48	0.0%	0	97	0.0%	0	108	0.0%
	CO	0	356	0.0%	0	146	0.0%	0	353	0.0%
	HSO	—	0	—	0	5	0.0%	0	5	0.0%
	WSO	0	94	0.0%	0	105	0.0%	0	147	0.0%
	All Species	0	1,589	0.0%	0	695	0.0%	0	1,021	0.0%
05/15	CH1	0	[illegible]	0.0%	0	109	0.0%	0	175	0.0%
	CHO	0	16	0.0%	0	1	0.0%	0	122	0.0%
	HST	0	170	0.0%	0	109	0.0%	0	95	0.0%
	WST	0	44	0.0%	0	100	0.0%	1	94	1.1%
	CO	0	323	0.0%	0	134	0.0%	0	425	0.0%
	HSD	0	3	0.0%	0	15	0.0%	0	12	0.0%
	WSO	0	62	0.0%	0	127	0.0%	0	142	0.0%
	All Species	0	[illegible]	0.0%	0	539	0.0%	1	1,069	0.1%
05/16	CH1	0	1,068	0.0%	0	104	0.0%	0	107	0.0%
	CHO	0	8	0.0%	—	0	—	0	103	0.0%
	HST	0	93	0.0%	0	122	0.0%	0	101	0.0%
	WST	0	28	0.0%	0	68	0.0%	0	62	0.0%
	CO	0	168	0.0%	0	109	0.0%	0	104	0.0%
	HSO	0	2	0.0%	0	9	0.0%	0	4	0.0%
	WSO	0	72	0.0%	0	140	0.0%	0	115	0.0%
	All Species	[illegible]	1,439	0.0%	0	552	0.0%	0	[illegible]	0.0%
05/17	CH1	0	968	0.0%	0	109	0.0%	0	103	0.0%
	CHO	0	7	0.0%	—	0	—	0	127	0.0%
	HST	0	83	0.0%	0	101	0.0%	1	100	1.0%
	WST	0	19	0.0%	0	91	0.0%	4	101	4.0%
	CO	0	170	0.0%	0	151	0.0%	0	101	0.0%
	HSO	0	2	0.0%	0	12	0.0%	0	16	0.0%
	WSO	0	53	0.0%	0	68	0.0%	0	116	0.0%
	All Species	0	[illegible]	0.0%	0	512	0.0%	5	664	0.8%
05/18	CH1	0	1,856	0.0%	0	115	0.0%	0	111	0.0%
	CHO	0	12	0.0%	0	2	0.0%	0	102	0.0%
	HST	0	76	0.0%	0	124	0.0%	0	103	0.0%
	WST	0	21	0.0%	0	57	0.0%	1	102	1.0%
	CO	0	151	0.0%	0	126	0.0%	0	100	0.0%
	HSO	0	3	0.0%	0	10	0.0%	0	4	0.0%
	WSC	0	115	0.0%	0	129	0.0%	0	102	0.0%
	All Species	0	2,236	0.0%	0	563	0.0%	1	624	0.2%

Daily Average and Instantaneous High Total Dissolved Gas Saturation (%) at Upper and Middle Columbia Stations

	Boundary Waters		Grand Coulee		Chief Joseph		Wells		Rocky Reach		Rock Island		Wanapum		Below Wanapum (4 mi)		Priest Rapids (2.4 mi)		Below Priest Rapids	
Date	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High
05/05	111	118	106	107	104	105	106	107	105	106	109	110	107	109	—	—	119	125	115	119
05/06	112	118	106	107	104	106	107	108	107	107	113	114	108	110	120	127	120	126	115	119
05/07	113	117	106	108	105	106	109	111	107	107	109	111	113	117	122	128	122	127	116	119
05/08	110	117	106	107	106	107	109	111	107	107	110	111	113	116	121	128	122	126	115	118
05/09	114	120	106	108	106	107	109	110	107	108	111	112	114	115	121	128	120	122	115	117
05/10	115	119	106	107	105	106	109	109	107	108	110	111	112	114	120	128	—	—	114	118
05/11	114	119	106	107	105	105	108	109	108	108	110	111	112	113	119	127	—	—	115	119
05/12	117	119	107	108	105	106	109	109	107	107	110	112	112	113	117	126	118	120	112	117
05/13	117	121	106	107	105	105	108	109	105	106	109	111	109	111	115	125	114	120	110	113
05/14	117	122	106	107	—	—	107	109	105	106	108	110	109	110	114	125	115	121	109	110
05/15	116	121	107	108	—	—	108	109	108	109	108	109	110	112	118	124	117	121	110	113
05/16	114	120	107	108	—	—	108	108	109	110	109	110	110	112	117	127	115	119	109	112
05/17	116	120	107	108	107	108	108	109	—	—	—	—	109	111	117	126	115	121	110	113
05/18	115	120	105	107	106	107	108	108	109	111	109	111	106	109	116	125	115	120	109	114

Daily Average and Instantaneous High Total Dissolved Gas Saturation (%) at Snake Basin Stations

	Dworshak		Lower Granite		Lower Granite Tailrace		Almota (6 mi below LGR)		Little Goose		Little Goose Tailrace		Lower Monumental		Lower Monumental Tailrace		Ice Harbor		Below Ice Harbor (3.6 mi)		Below Ice Harbor (redundant)		Hood Park Bridge	
Date	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High
05/05	115	115	105	108	—	—	—	—	106	108	—	—	110	113	—	—	112	115	—	—	—	—	—	—
05/06	111	115	105	107	—	—	—	—	108	108	—	—	112	115	—	—	110	114	125	131	—	—	111	113
05/07	98	99	106	109	—	—	—	—	108	108	—	—	112	113	—	—	110	112	118	123	—	—	112	113
05/08	98	99	106	107	—	—	—	—	107	107	—	—	114	117	—	—	109	112	122	124	—	—	112	116
05/09	101	109	104	107	—	—	—	—	105	107	—	—	112	115	—	—	111	113	126	136	—	—	112	115
05/10	108	111	102	103	—	—	—	—	102	103	—	—	112	115	—	—	113	115	127	134	—	—	113	115
05/11	108	110	103	104	105	113	—	—	104	106	116	117	113	114	—	—	112	114	128	135	—	—	113	115
05/12	105	109	103	104	110	122	107	120	105	106	115	117	112	113	113	124	111	113	122	127	—	—	112	115
05/13	98	99	102	103	111	121	111	121	104	105	115	120	111	112	114	117	112	113	121	121	—	—	112	114
05/14	99	99	104	105	114	122	112	121	105	106	118	119	112	113	115	119	110	114	121	122	120	121	113	115
05/15	108	117	103	104	118	121	111	120	109	111	115	118	112	113	113	117	112	113	122	122	121	121	113	113
05/16	116	117	103	104	—	—	111	121	108	110	118	118	112	113	115	118	111	112	121	122	120	120	113	114
05/17	116	116	102	103	—	—	113	120	107	108	116	118	111	113	—	—	110	111	121	121	120	121	112	113
05/18	116	116	102	104	—	—	—	—	107	109	117	118	113	114	—	—	111	113	120	121	120	121	113	114

Daily Average and Instantaneous High Total Dissolved Gas Saturation (%) at Lower Columbia Stations

	McNary North		McNary South		McNary South (redundant)		McNary Tailrace		John Day		The Dalles		The Dalles (redundant)		Bonneville		Warrendale		Warrendale (redundant)		Skamania		Camas/Washougal		Kalama		Wauna Mill	
Date	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High	Avg	High
05/05	120	120	111	113	—	—	111	113	—	—	107	109	—	—	108	109	114	120	—	—	—	—	—	—	112	115	110	112
05/06	—	—	114	118	—	—	112	114	—	—	111	115	—	—	109	111	116	121	—	—	—	—	—	—	113	116	110	111
05/07	—	—	117	125	—	—	114	114	—	—	110	114	—	—	111	113	116	121	—	—	—	—	—	—	114	117	111	112
05/08	—	—	119	127	—	—	115	116	—	—	110	111	—	—	111	113	115	120	—	—	—	—	—	—	115	119	110	113
05/09	116	117	118	121	—	—	115	116	—	—	110	110	—	—	108	110	115	121	—	—	—	—	—	—	115	118	110	112
05/10	117	121	117	121	—	—	115	117	111	115	109	111	—	—	109	112	115	122	—	—	—	—	—	—	115	118	111	113
05/11	119	121	116	121	—	—	115	117	113	114	112	113	—	—	111	113	115	120	—	—	—	—	—	—	114	116	111	113
05/12	117	118	117	122	—	—	115	117	112	112	108	113	—	—	110	112	114	119	—	—	117	126	110	114	113	116	110	111
05/13	115	117	115	121	—	—	116	123	111	112	110	114	—	—	112	114	115	118	—	—	117	124	107	113	113	116	109	110
05/14	116	118	114	117	114	117	117	121	113	116	113	117	111	114	114	119	115	119	—	—	117	120	107	112	113	116	110	111
05/15	115	117	113	114	113	114	115	117	113	113	113	116	107	113	115	118	116	119	—	—	118	122	107	110	114	115	111	111
05/16	113	114	114	116	114	116	115	120	111	113	112	113	112	119	115	116	116	117	—	—	116	123	106	110	112	113	109	111
05/17	112	114	112	114	112	114	—	—	110	111	—	—	118	120	113	115	114	116	—	—	116	120	105	108	112	113	107	109
05/18	110	112	110	112	110	112	—	—	109	110	—	—	116	117	111	115	114	115	—	—	115	120	105	109	112	113	107	108

Data provided by the Corps of Engineers. Tailrace gauges are manually downloaded by Walla Walla District and forwarded through the Reservoir Control Center. Data from all other stations are collected via the GOES satellite network.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Northwest Region
7600 Sand Point Way, NE
BIN C15700 Bldg 1
Seattle, WA 98115

MAY 27 1994

Major General Ernest J. Harrell
U.S. Army Corps of Engineers
North Pacific Division
P.O. Box 2870
Portland, Oregon 97208

Dear General Harrell:

On May 5, 1994 the National Marine Fisheries Service requested the Corps to implement a spill program to improve survival of listed Snake River salmon juveniles. The program was instituted on May 11 and NMFS has been closely monitoring the biological impacts. To date we have seen a very low incidence (less than one percent) of gross external signs of gas bubble disease in smolts, and no incidence in adults. Microscopic bubbles have been observed, however, in lateral line and internal examinations.

As you may be aware, microscopic examinations have not been conducted in the past, so there is little information from which to judge the severity of these symptoms. As a precaution, we are requesting a reduction in spill levels at some projects until we can convene a panel of scientists to review the information to date and advise us on its interpretation. We also hope to have additional information available at that time on the incidence of these types of symptoms in smolts above Lower Granite Dam. We hope to convene this panel as early as next week.

This letter confirms the verbal request made to Colonel Bohn today to reduce spill by one third at all Snake and Columbia river mainstem dams, except Ice Harbor and The Dalles, beginning tonight. Discussions between our staffs indicate that if spill is reduced by one third at mainstem projects, it will reduce the recent dissolved gas levels seen in the rivers by approximately five percentage points.

We appreciate your cooperation on this matter.

Sincerely,

for J. Gary Smith
Acting Regional Director

Use of the FLUSH passage model in evaluating the NMFS emergency spill program

prepared May 25, 1994

by James J. Anderson
School of Fisheries and Center of Quantitative Science
University of Washington

The recent spill program implemented by the National Marine Fisheries Service (NMFS) as an emergency measure was, to a significant degree, based on model runs from the States' and Tribes' mainstem passage model FLUSH. No other models were used, nor was the FLUSH model, as used in the analysis, subjected to peer review. In light of the cost and controversy of the emergency spill program NMFS's exclusive use of FLUSH was inappropriate and contrary to the adaptive management of the Columbia River. What follows are comments concerning the problems in using FLUSH in this context. They also add to my declaration regarding the direct effects of gas bubble disease arising from the emergency spill.

To evaluate the effect of the NMFS spill program the FLUSH model was used with three different model assumptions on the efficacy of the transportation of juvenile fish through the hydrosystem. With one set of assumptions (designated transport model 2) FLUSH indicated that the NMFS spill program would have a negative impact on system survival. Under the other assumptions (designated models 3 and 4) the spill would benefit fish (Table 1). NMFS did not evaluate the spill program with the CRiSP1.4 model, which is the most developed mainstem passage model and is used by Bonneville Power Administration and the Army Corps of Engineers. An analysis using CRiSP1.4 indicated no benefit to the spill program[1]. Because of the significance of models in 3 and 4 in justifying the emergency spill it is important to understand their development and the uncertainties in them.

1. CRiSP1.4 and FLUSH model 2 both predicted system survival would decrease about 2% under the emergency spill program (See Table 1).

Table 1 System and transportation survivals from four model scenarios

Survival in	Spill plan	CRiSP[a]	FLUSH model 2	FLUSH model 3	FLUSH model 4
Total system passage	MOU[b]	50%	20.1%	9.4%	6.8%
	NMFS[c]	48%	17.7%	10.3%	8.2%
Transportation		80%	42.5%	21.2%	15.2%

a. Results from CRiSP 1.4 using a transportation survival of 80%
b. Memorandum Of Understanding on spill prior to emergency spill plan
c. NMFS emergency spill plan implemented in May 1994

History

I first encountered the FLUSH transportation models at the Model Comparison Workshops conducted in 1993 (Anonymous 1993). The purpose of the workshops was to compare the theory, general responses and sensitivities of the life cycle and passage models used by the various agencies in the Columbia River Region. The purpose was not to evaluate the *correctness* of the models or how well the models fit observed data.

Transportation models 2, 3 and 4 (referred to under different names then) were put forward by the States' and Tribes' modelers. Model 2 represented a middle of the road scenario on the level of survival in transporting fish[1]. Models 3 and 4 represented scenarios of *worse case conditions* or low transportation survival[2]. At no time were models 3 and 4 considered best representations of transportation survival. The transportation models next appeared in the analysis submitted by the States and Tribes to the Salmon Recovery Team[3]. The document (CBFWA et al. 1993) contains a more complete written description of the transportation models. The Recovery Team did not specifically address these transportation models in developing their recovery plan. Models 3 and 4 surfaced again as central assumptions in justifying the NMFS emergency spill plan. In brief, the transport models were developed in a model comparison framework as possible scenarios. Since then they have been applied to

1. Model 2 transportation survival was 42.5% in the comparison workshop report.
2. Transportation survivals were 21.2 and 15.2% respectively in models 3 and 4.
3. Model 2 transportation survival was changed to 66.4% in the report to the Recovery Team.

management decisions. At no time in development or application have models 2, 3 and 4 been reviewed[1].

The models

The FLUSH passage model contains three sub-models describing different assumptions on juvenile fish survival in transportation. Transport model 2 represents the standard model used for comparison purposes in the model Comparison Workshop. In model 2 transport survival is a constant over all flows. Models 3 and 4 assume low transport survival under average flows and further decrease survival with low flows. Models 3 and 4 were described in the model comparison workshop proceedings (Anonymous 1993) as follows:

> Model 3 and 4 reduce the survival for water travel times less than 15.7 days to the -survival associated with a TBR from LGO of 1.0:1 and 0.4:1 in 1986 respectively, and use a linear model to connect the survivals at 15.7 days to three times the observed survival from LGO in 1977

Models 3 and 4 imply that transportation does not benefit fish. This is contrary to the conclusions of the peer review of transportation by Mundy (1994). In that document he states, "It is more probable than not that transportation acts to improve survivals of certain kinds of salmon from the Snake River under certain combinations of dam operations and river flow conditions."

The three models are illustrated in Fig.1. The curve shapes were adjusted according to data and assumptions specific to 1977 and 1986. Information from 1986 was used to fix the flat part of the curves in Fig.1. In this year, the water travel time was specified in FLUSH as 15.7 days. Conditions for the year 1977, corresponding to a water travel time of 36.7 days, were used to specify the minimum transport survival. A linear relationship between the maximum and minimum survivals was assumed for both models 3 and 4. In effect, 3 and 4 are identical models except for the choice of maximum survival. Details on how the three models were developed follows.

1. The model peer review panel, charged with the task of reviewing all regional life cycle and passage models under the of coordination Oak Ridge Environmental Laboratory, has not reviewed transport models 2, 3 and 4 (Barnthouse, personal communication)

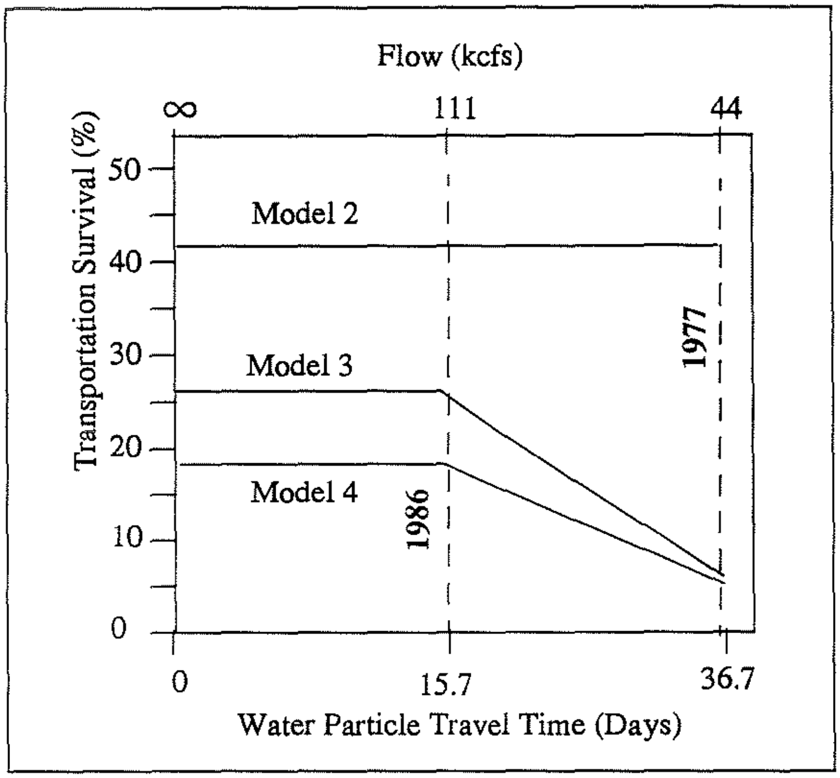

Fig.1 Three transportation survival models used in FLUSH showing relationships between survival and water particle travel time.

Generally speaking, transportation survival for any given year is estimated by the formula

$$S_{\text{transport}} = \text{TBR} \times S_{\text{river}} \tag{1}$$

where transport survival for a specific year, $S_{\text{transport}}$, is the product of the transport benefit ratio (TBR) for the year times the *in river* survival (S_{river}) for the year. The level of survival in model 2 was set with a more complete data set derived from studies of spring chinook transported from Lower Granite Dam in 1986. Model 3 and 4 used selected data from 1986 to define the flat section of the survival curves and assumptions on the conditions in 1977 to define the minimum survival point. The validity of the models rests entirely on the validity of using data from these years to represent survival in the current transportation system.

First consider the selection of TBR in the models. TBR is essentially the ratio of returning test and control adults tagged as juveniles at Lower Granite Dam. The test fish were placed in barges and transported to below Bonneville Dam, the lowest in the hydrosystem. The control fish were trucked to and released below Little Goose Dam, the dam immediately down river of Lower Granite. Since the adults were captured at different locations in their return different TBRs could be generated depending on which capture locations were selected. For model 2 only test and control fish captured at Lower Granite Dam were used to calculate the 1986 TBR. This gave a TBR of 1.6 to 1. Model 3 used a subset of the fish captured above Lower Granite dam. The resulting TBR was 1 to 1[1]. Model 4 used a further reduced subset of fish captured above Lower Granite Dam. The TBR was 0.4 to 1. The actual numbers of fish used to define these ratios were a small fraction (0.017%) of the fish tagged in the transportation study. As a result the TBRs in Table 2 contain significant uncertainty. The numbers for model 3 and 4 in Table 2 are approximate because the exact selection of data used is not available in any of the documents.

Table 2 Captures of test and control spring chinook from the 1986 transportation study. The numbers are used to estimate TBR ratios in models 2, 3 and 4 (Anonymous 1992). A total of 90,000 fish were tagged.

Model	Capture Location	Transport Recoveries	Control Recoveries	TBR
2	at LGR	74	47	1.6 to 1
3	above LGR	12	19	~ 1 to 1
4	selected sites	>9	> 15	~ 0.4 to 1

For models 3 and 4 a second estimate of TBR was required to identify the slope of the survival curve under low flow conditions. The States and Tribes choose 1977 as the low flow year. No fish returned from either test or control groups that year so no TBR is available. In spite of the extreme low flow conditions in 1977 and the documented poor conditions of fish arriving at Lower Granite Dam (Steward 1994) an intermediate TBR of 3 to 1 was chosen without clear justification. Using the maximum observed TBR, which was 8.5 and occurred in 1978 under a flow of 89 kcfs, transportation survival in low flows would be much higher than set in models 3 and 4.

1. The FLUSH modelers excluded the Rapid River hatchery collections. Had it been included the TBR would be 1.1 to 1.

A weakness of the FLUSH transportation models is that they selectively used transportation information from one year only, 1986. The eight transportation experiments conducted at Lower Granite since 1975 gave TBRs between 0.6 to 8.5 (Fisher 1993). Including these additional data yields a different result. Fisher (1993) analyzing all TBR data demonstrated a positive relationship between transportation survival and flow. Models 3 and 4 assume a negative relationship. To demonstrate a worse case scenario it is permissible to use selected data but for management purposes a model should consider all available data. Clearly models 3 and 4 were misused as the sole justification of the emergency spill plan.

The second element required to calculate transport survival is *in river* survival (S_{river}). Here also, the choice of values yields a low transportation survival. FLUSH uses a flow *in river* survival curve based on the Sims and Ossiander flow survival relationship generated from data collected in the 1970's and 1980's. A revaluation of this data set (Steward, 1994) indicated serious flaws in the analysis including; misreporting of results, problems in experimental design, and unusual hydrosystem operations in earlier years. Steward recommended that the Sims and Ossinder data *not be generalized to existing populations and passage conditions*. FLUSH uses this relationship at the exclusion of other, more recent results. The NMFS survival studies in the Snake River in 1993 and turbine survival studies in the mid Columbia support the contention that *in river* survival is higher than that estimated from the Sims and Ossinder data.[1]

Finally, the use of two transportation models (3 and 4) obscures the issues and falsely implies that additional evidence supports the low transport survival hypothesis. In fact, models 3 and 4 are the same model using different numbers, both equally supported or unsupported depending on ones point of view.

---

1. In calibrating CRiSP we are taking a more comprehensive approach that includes a variety of data sets. Our estimates of *in river* survival are higher than those used in FLUSH (Anderson et al. 1993). It is our belief that calibrations of the models for use in making management decisions should use all available data sets, not a single data set.

The bottom line

The benefits to system survival from the NMFS emergency spill plan rest solely on using the FLUSH passage model with transportation model 3 or 4. These models are the same with different parameters. They were developed to explore worst case scenarios of transportation in a Model Comparison Workshop and their use to evaluate the emergency spill plan to the exclusions of other models and scenarios is inappropriate. Models 3 and 4 are based in part on unsupported assumptions, selective use of the data, and data from studies that should not be generalized to current passage conditions.

In my opinion, NMFS's conclusion that the emergency spill improves system survival rests solely on questionable use of models and data. This action serves nobody well in the long run.

References

Anderson, J.J. et al. 1993. The CRiSP Users Manual. Version 1.4. Prepared by the University of Washington for the Bonneville Power Administration

Anonymous 1992. Review of Salmon and Steelhead Transportation Studies in the Columbia and Snake Rivers, 1984 to 1989. Prepared by the Ad Hoc Transportation Review Group. Submitted to the Columbia Basin Fish and Wildlife Authority.

Anonymous 1993. A comparison of several analytical models used to evaluate management strategies for Columbia River Salmon. Workshop proceedings prepared by Battelle Northwest.

CBFWA et al. 1993. Sensitivity Analysis of Juvenile Salmon Passage Models for Snake River Spring and Summer Survival Estimates: A Response to the NMFS Salmon Recovery Team, 1993

Fisher, T. R. 1993. Modeling Effects of Transportation Assumptions on the Population Trends of Snake River Chinook Salmon. BPA unpublished report.

Mundy, P. R. 1994. Juvenile Salmonid transportation from Hydroelectric Projects in the Columbia River Basin: An independent Peer Review. Final Report. U.S. Fish and Wildlife Service, 911 N.E. 11th Avenue, Portland Oregon 97323-4181

Steward, R. C. 1994. Assessment of the Flow-Survival Relationship Obtained by Sims and Ossiander (1981) for Snake River Spring/Summer Chinook Salmon Smolts. BPA report. April 1994.

WESLEY J. EBEL, Ph.D. & Associates
Fish and Wildlife Consultants
107 NW 185th Street
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May 26, 1994

Michael Llewelyn
Department of Ecology
300 Desmond Drive
Olympia, WA 98504-7600

Dear Mr. Llewelyn:

I have reviewed the National Marine Fisheries Services Final Gas Bubble Disease Monitoring and Management Plan dated May 20, 1994 and have the following comments.

In section 5.1, I note that NMFS has chosen to control the saturation levels by monitoring the forebay levels of saturation. They state that the forebay concentrations are "The most biologically relevant" because measurements of tailrace concentrations will be extremely variable depending on their location relevant to the powerhouse or spillway. This rationale may be correct for smolts but not for upstream migrating adults. The most biologically relevant concentrations for adults <u>are those in the tailraces</u>. Numerous studies have shown that adults passage problems at dams on the Columbia and Snake Rivers are usually caused by delays in fish finding the fishway entrances, entering and passing through the fishway systems. During these periods of delay, adults are searching in the tailraces of the dams on both the spillway and turbine sides of the dam for fishway entrances . Therefore high concentrations of dissolved gas in the tailraces could be critical to survival of adults during their upstream migration. The proposed level of spill required to reach the goal of 80% fish passage efficiency will result in high levels of dissolved gas (over 120%) on the spillway sides of most of the dams listed in the spill plan. Therefore, I believe the tailrace concentrations should be considered as well as the forebay concentrations in controlling the amount of spill; particularly at Ice harbor and Bonneville Dams where spilling will occur 24 hours a day. The tailrace concentrations of dissolved gas on the spillway side should be used to control the level of spill at these dams. The mixed value of dissolved gas measured in the forebay of McNary Dam has little relevance to adults attempting to pass Ice Harbor Dam.

I also note in section 5.2 that spilled water will be reduced if signs of GBD exceed 5% in juveniles and 2% in adults. My recollection of the recommendations of the Oregon Environmental Quality Commission on May 16, 1994 was that spilling would be reduced if any adults showed signs of GBD and that the dissolved gas measurements for controlling spill would be made in the areas where concentrations would be expected to be high (tailraces) of the dams.

In summary, I believe NMFS should carefully monitor dissolved gas levels of spillways at dams where concentrations are are known to get high, such as, Little Goose, Lower Monumental, Ice harbor, and John Day Dams and strive to hold saturation levels at or below 120% during times when adults are known to be present. In addition, dam counts of adults should be closely monitored throughout the adult migration for any indication of delay or loss at a particular dam so that corrective action can be taken.

Sincerely,

WESLEY J. EBEL, Ph.D.

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May 31, 1994

Mr. Fred Hansen, Director
Oregon Department of
Environmental Quality
811 S.W. Sixth Avenue
Portland, Oregon 97204

Re: Spill in the Lower Snake and Columbia Rivers

Dear Mr. Hansen:

Results of the biological monitoring for impacts of the current National Marine Fisheries Service's spill program are now becoming available. We enclose a copy of the Fish Passage Center's May 27 summary showing impacts on juvenile hatchery steelhead observed at monitoring points at five facilities. (Tab 1)

We are alarmed at the very high incidence of signs of Gas Bubble Disease (GBD) in these juveniles. Apparently, NMFS and the Corps of Engineers agreed on Friday, May 27, that the spill program had to be reduced immediately, by one-third, in order to respond to this data. This was in addition to reductions in spill made to comply with the Environmental Quality Commission's May 16 ruling.

The information we provided to the EQC in advance of its May 16 hearing, the submission by independent expert Dr. Gerald Bouck, and the testimony of our advisor Dr. Wesley Ebel, as well as Dr. Bouck, at the May 16 hearing all indicate how dangerous this spill program is.

The agencies that support the spill program attempt to justify it as a response to the collapse of the Columbia and Snake Rivers spring chinook runs, but this spill program is not a logical response to that development. Spill does not benefit upstream migrating adults. Instead, it harms them. Spill makes it harder for the adults to find fish ladders because it creates flow patterns in the tailraces of the dams that confuse adults and obscure attractant flows designed to lead adults to the fish ladders. At a minimum, this delays the adults' upstream migration.

Worse, as Dr. Ebel explained, when as a result of spill adults are delayed in the tailraces of the dams, they are subjected to very high concentrations of dissolved gas. This at least weakens the adults, and may be lethal if there is sufficient exposure. As Dr. Bouck advised the Commission, one should not expect to see external signs of gas bubble disease in adults. The absence of visible external signs in adults passing through fish counting facilities does not mean there have not been lethal or sub-lethal (but still seriously adverse) exposures. Internal signs are, we understand, certain to exist in adults when juveniles show the high incidence of internal and external signs that the Fish Passage Center and the monitoring agencies have observed.

The monitoring program that is in place does not hold any promise of disclosing the real incidence of GBD in adults because there is no plan to sacrifice the few that remain in order to conduct tests necessary to ascertain the existence of internal signs. Based on the testimony of the leading GBD experts, we believe it is irrational to assume, as it appears the Fish Passage Center and the Oregon Department of Fish & Wildlife do, that absence of external signs means affected fish will only suffer sub-lethal effects or that sub-lethal effects are not something to worry about. Adults will die and their carcasses will not likely be found in a river the size of the Columbia.

We asked Dr. Ebel, our gas saturation and GBD advisor, to review and comment on NMFS' monitoring program for this spill. Dr. Ebel's letter of May 26 (addressed to the Washington Department of Ecology for its May 31 hearing) is enclosed. (Tab 2)

To justify this spill program as a response to the collapse of adult runs is illogical. The spill cannot benefit the ESA listed adult salmon; it can only harm them. Not only that, as Dr. Bouck testified, it also harms many other organisms comprising the Columbia River biota, including steelhead runs that are subject to an ESA listing petition and other healthier runs of salmon.

The results of the biological monitoring on juveniles also shows the serious harm being inflicted on them by the spill program. The proponents of the spill concede that this season's population of downstream migrants is not weak. The juvenile runs do not need special assistance from increased spill.

The Fish Passage Center's seriously flawed critique of transport notwithstanding, a comparison with 1989 is in order. In that year, flow conditions closely paralleled those of 1994. Transport/control studies were conducted to assess the effectiveness of transport as compared to in-river passage. The results showed a 2.5 to 1 transport benefit ratio, meaning that transported fish experienced a 60% reduction in passage mortality, as compared to the control group. The choice this year to employ greatly increased spill, and thus to reduce the number of juveniles transported, was based on speculation, not on sound data and not on the basis of a crash in the juvenile population.

We recognize the DEQ staff and the EQC have been placed in the difficult position of <u>assuming</u> the scientific validity of a highly controversial policy decision to spill in this low flow year, rather than to fully implement the transport program. You asked the EQC and witnesses to focus on the effects of gas supersaturation at the May 16 hearing, but the proponents of spill spent much time justifying the proposal and criticizing the transport program. Taken as a whole, the spill proponents' effort was such as to cause two Commissioners to voice sharp criticism of the justifications offered for the spill.

We believe the EQC was misinformed when it heard only one side of the transport/spill debate. We asked Dr. Donald Chapman to provide us an analysis of the merits of this spill proposal, as compared to transport. We enclose a copy of his letter of May 13 and his resume. (<u>Tab 3</u>) Dr. Chapman advises that the best scientific information today favors transportation over in-river migration at low river flows, such as are occurring now. He also concludes that the risks of the proposed spill program in this low-flow year are too high to bear. The 80% FPE spill program, according to Dr. Chapman, risks killing an unacceptable number of ESA-listed smolts and adults.

Testimony before the EQC on May 16 also included statements by spill proponents that their computer model (FLUSH) supported the spill decision. You may recall that the Corps of Engineers' Mr. Athearn candidly suggested that the FLUSH model results were entirely dependent on the assumptions embedded in it. In fact, FLUSH was inappropriately used to justify the spill proposal. We enclose copies of a paper by modelling expert James J. Anderson (<u>Tab 4</u>) which describes the flaws in the use of FLUSH to support this spill. We also enclose an affidavit (and resume) of Prof. Anderson which explains how another model, CRiSP, is the only model which attempts to estimate the adverse effects of gas supersaturation caused by increased spill. (Tab 5) The CRiSP model predicts that increasing spill will increase mortality as a result of gas supersaturation.

This speculative spill exercise is all but certain to prove to have been a disastrous failure. The EQC can and should act to mitigate the harm this irresponsible experiment is causing. We urge you to bring before the Commission at the earliest possible time the question of abrogating the temporary rule that allowed gas supersaturation levels to peak at 120% and returning to the standard of 110%. This spill should be stopped now before it kills even more fish.

Very truly yours,

R. Erick Johnson
Attorney for
Pacific Northwest
Generating Cooperative

Gregory J. Miner
Attorney for
Public Power Council

Enclosures

cc (w/encl.): EQC Members

1994 Smolt Monitoring Program Gas Bubble Symptoms - Lateral Line and Internal Symptoms
Juvenile Hatchery Steelhead

Site	Date	# Sampled	Lateral Line External	Lateral Line Internal	Gill Filaments	Internal Symptoms	Total Affected
Little Goose Dam	5/18	30	0	0	7	1	7
	5/20	30	0	0	8	2	10
	5/22	30	0	0	11	2	12
	5/24	30	0	0	9	0	9
	5/26	15	0	0	5	2	6
Lower Monumental Dam	5/19	30	0	0	15	6	17
	5/21	30	0	0	7	7	11
	5/23	30	0	0	7	8	14
	5/25	30	0	0	11	7	16
McNary Dam	5/13	30	0	0	1	1	2
	5/15	30	0	0	0	0	0
	5/17	30	0	0	0	0	0
	5/19	30	0	0	0	1	1
	5/21	30	0	0	0	0	0
	5/23	30	0	0	0	0	0
	5/25	30	0	0	0	0	0
John Day Dam	5/17	30	n/a	6	9	0	
	5/19	30	0	1	10	2	13
	5/21	30	0	2	9	2	13
	5/23	30	2	7	13	7	19
	5/25	30	2	19	13	3	26
Bonneville Dam	5/17	15	0	10	2	1	
	5/19	30	22	30	13	8	
	5/21	22	11	19	5	2	
	5/23	12	5	10	3	4	
	5/25	30	16	28	21	7	

FROM:PNUCC 101 SW MAIN #810 TO:ERICK JOHNSON JUN 1, 1994 11:45AM #045 P.02

WESLEY J. EBEL, Ph.D. & Associates
Fish and Wildlife Consultants
107 NW 185th Street
Seattle, WA 98177
May 26, 1994

Michael Llewelyn
Department of Ecology
300 Desmond Drive
Olympia, WA 98504-7600

Dear Mr. Llewelyn:

I have reviewed the National Marine Fisheries Services Final Gas Bubble Disease Monitoring and Management Plan dated May 20, 1994 and have the following comments.

In section 5.1, I note that NMFS has chosen to control the saturation levels by monitoring the forebay levels of saturation. They state that the forebay concentrations are "The most biologically relevant" because measurements of tailrace concentrations will be extremely variable depending on their location relevant to the powerhouse or spillway. This rationale may be correct for smolts but not for upstream migrating adults. The most biologically relevant concentrations for adults are those in the tailraces. Numerous studies have shown that adults passage problems at dams on the Columbia and Snake Rivers are usually caused by delays in fish finding the fishway entrances, entering and passing through the fishway systems. During these periods of delay, adults are searching in the tailraces of the dams on both the spillway and turbine sides of the dam for fishway entrances. Therefore high concentrations of dissolved gas in the tailraces could be critical to survival of adults during their upstream migration. The proposed level of spill required to reach the goal of 80% fish passage efficiency will result in high levels of dissolved gas (over 120%) on the spillway sides of most of the dams listed in the spill plan. Therefore, I believe the tailrace concentrations should be considered as well as the forebay concentrations in controlling the amount of spill; particularly at Ice harbor and Bonneville Dams where spilling will occur 24 hours a day. The tailrace concentrations of dissolved gas on the spillway side should be used to control the level of spill at these dams. The mixed value of dissolved gas measured in the forebay of McNary Dam has little relevance to adults attempting to pass Ice Harbor Dam.

I also note in section 5.2 that spilled water will be reduced if signs of GBD exceed 5% in juveniles and 2% in adults. My recollection of the recommendations of the Oregon Environmental Quality Commission on May 16, 1994 was that spilling would be reduced if any adults showed signs of GBD and that the dissolved gas measurements for controlling spill would be made in the areas where concentrations would be expected to be high (tailraces) of the dams.

In summary, I believe NMFS should carefully monitor dissolved gas levels of spillways at dams where concentrations are are known to get high, such as, Little Goose, Lower Monumental, Ice harbor, and John Day Dams and strive to hold saturation levels at or below 120% during times when adults are known to be present. In addition, dam counts of adults should be closely monitored throughout the adult migration for any indication of delay or loss at a particular dam so that corrective action can be taken.

Sincerely,

WESLEY J. EBEL, Ph.D.

Don Chapman Consultants, Inc.

3653 Rickenbacker, Suite 200
Boise, Idaho 83705
(208) 383-3401 • FAX (208) 344-4861

Mr. Bill Masters
Bullivant, Houser and Bailey
300 Pioneer Tower
888 S.W. 5th Ave.
Portland, OR97204

13 May 1994

Dear Mr. Masters:

You asked me to evaluate the NMFS/FWS proposal to use spill in combination with transportation to provide 80% FPE (Fish Passage Efficiency)[1] for smolts in the Columbia River system. I respond in summary by stating that the risks entailed in the proposed spill program are unknown, hence unacceptable in comparison with full application of transportation. I conclude that the proposed program will kill more fish than would full reliance on transportation. I estimate that smolt survival in 1993 was very low in spite of high flows, extensive spill, and FPEs greater in the Snake River than those proposed for 1994. I estimate that the adult run of spring chinook in 1995 will be disastrously low, far lower than the 1994 adult run, indicating an ecological bottleneck downstream from Bonneville Dam in the smolt-to-adult stage. I urge that managers and researchers extend mitigation-oriented research beyond transport, flow, and travel time considerations. I recommend that NMFS declare at least the nearshore sea in Pacific Northwest waters as critical habitat.

I begin by examining how the 1995 run is likely to shape up after it enjoyed

[1] Percentage of fish that arrive at the upstream face of a dam and arrive in the tailrace or in transportation facilities.

excellent conditions for inriver migration from both the mid-Columbia and Snake rivers:

1. Over the past 10 years, according to FPC records,[2] the average count of spring chinook at Bonneville Dam through May 5 of each year was 70,502 adults, and the average jack count was 1,580. In 1993, the adult count was 88,537 and jacks totaled 503. In 1994, the adults totaled 15,936 and jacks 169 by May 5. As you know, jack numbers can be used to predict adult runs one year later.[3]

2. Over the past 10 years, the count by May 5 has amounted to 88% of the total spring chinook run at Bonneville. The jack count by May 5 has amounted to 39% of the total spring chinook jack count, showing that jacks tend to come in a bit later, on average, than adults. If I divide the 1994 jack count by 0.39, I get a total jack estimate of 433 for 1994. This estimate is 11% of the 10-year jack average for the spring chinook run. It suggests that the spring chinook run of 1995 will be disastrously low. A check on this calculation is that the 1993 jack total was 1,344, which would suggest that the 1994 adult run should be roughly 33% of the 10-year average, or about 26,800 adults. Latest estimated adult run for 1994 is about 22,000 fish. My calculations could certainly be refined with regression analysis, tweaking here and there, and by corrections for adult age distributions, but they suggest a 1995 run of less than 9,000 adults; a disaster by any account.[4] Even if I am off by 100%, and the run is 18,000 adults, it will still be a disaster.

3. Conditions in 1993 for the smolt migration in-river were very, very good, and generally accorded with long-term agency and tribe wishes, although the conditions resulted largely from a very wet spring, not human intervention. Nonetheless, we can use those conditions to examine the passage routing of smolts.

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[2] Fish Passage Center weekly report #94-8.

[3] Dammers, W. 1993. Run size forecast for Columbia River upriver adult spring chinook, 1994. WDF, Columbia River Lab. Prog. Rep. 93-27.

[4] I caution that my jack information only goes to May 5, 1994 for the 1994 jack run. It is possible, though not expected, that jack numbers could blossom late in May, making my calculations invalid.

a. Assuming an FGE (Fish Guidance Efficiency)[5] of 55% at Lower Granite Dam (LGR) turbine intake deflection screens between 26 March and 25 June, I used collections and spill fractions from FPC reports to estimate total Snake River smolt passage (spring and summer chinook combined in the Snake River). I estimated the passage at about 3.5 million. If I use an FGE of 44%, based on calculations from data in Iwamoto et al. (1994), the total passage would be about 4 million smolts. Thus, we can state that the smolt run did not fail.

b. Using proportions wild as recorded in FPC data for LGR (I used the Snake River trap data for the first week or so), I estimated a proportion wild as about 19% in the smolt run. This estimate may be slightly high, as a few hatchery smolts did not have the adipose removed. Wild fish would amount to about 670,000.

c. FPC reports show 1,692,270 smolts (combined spring/summer) transported from LGR, or about 48% of the estimated arrivals. About 1.39 million were transported by May 13, or about 82% of the total transported by late June. The fish that were bypassed or went via spill were exposed to high flows through the migration. I calculated that about 640,000 smolts reached the Lower Monumental Dam (LMO) tailrace, after adjusting for transport, bypass and project loss at 12% per project.[6]

d. If I very conservatively assume a TBR of 1.0,[7] transported fish would enjoy no survival advantage over in-river migrants. I would then apply a smolt-to-adult survival rate to the 3.19 million combined smolts that are transported and that migrate (from LMO tailrace) in the river. Adult returns for survivals of 0.5% and 1.0% 15,950 and 31,900.

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[5] The fraction of fish that enter turbine intakes and is deflected upward into gatewells in intakes equipped with submerged travelling screens.

[6] Most fish not transported passed LGR May 12-30 when spill and discharge averaged 45 kcfs and 157 kcfs, respectively. Project mortality estimates from PIT tag releases in 1993 were obtained at zero spill and discharges of 60-70 kcfs in late April. They equaled 10% in LGR from 30 km upstream from the dam to the tailrace, and 14% from LGR tailrace to LGO tailrace. Thus, a project mortality of 12% seems a reasonable assumption.

[7] TBR (the ratio of observed survival of transported test groups to observed survival of control groups that migrate inriver) in 1986 and 1989, the most recent years of transportation studies with controls, equaled 1.6 and 2.5, respectively. Flows in 1986 were about average for long-term conditions in the Snake River, while those in 1989 were well below average.

e. In (d) above, I dealt only with Snake River migrants, and combined spring/summer chinook. Fish classed as summer chinook in the Snake River amounted to about 20% of the combined spring/summer chinook adult count at Ice Harbor over the past 10 years. Thus, for spring chinook alone, I would expect spring chinook adult returns from 3.19 million spring/summer smolts to amount to 80% of the totals in (d), or 12,750 and 25,500 adults at the 0.5% and 1.0% survival rates.

f. Adult spring chinook counts (FPC adult passage data) at various dams in the Columbia River over the past 10 years have averaged:

Bonneville	81,341
The Dalles	55,545
John Day	44,924
McNary	42,228
Ice Harbor	21,197
Priest Rapids	14,261

g. Adult counts of spring chinook at Ice Harbor Dam (IHR) and Priest Rapids Dam (PRD) should be adjusted by interdam disappearance at about 5% per project,[8] thus divided by 0.81, or $(0.95)^4$, so the count at Bonneville for IHR and PRD would be:

	Adults	% of Bonneville adult count
Adjusted IHR	26,169	32.2
Adjusted PRD	17,606	21.6
Adjusted IHR+PRD	43,775	53.8

h. The run of spring chinook to the Snake River in 1995, given an adult run at Bonneville of 9,000 spring chinook (see #2 above), could thus be estimated as 2,898, if I use the adjusted 21.6% IHR contribution to the Bonneville count as in (g) above. This would represent a survival to Bonneville from Snake River smolt (0.8 x 3,190,000 combined spring/summer smolts = 2,552,000 spring chinook smolts) to adult of about 0.12% (see (d) above). Survival from smolt to IHR adult

[8] Chapman, D., A. Giorgi, M. Hill, A. Maule, S. McCutcheon, D. Park, W. Platts, K. Pratt, J. Seeb, L. Seeb, and F. Utter. 1991. Status of Snake River chinook salmon. Don Chapman Consultants, Inc., Report to PNUCC, February 19, 1991.

would be lower, about 0.10%.[9]

i. The agency performance standard for the Lower Snake River Compensation Plan is 0.8% survival from hatchery smolt to adult. Estimates of Petrosky (1992)[10] for survival of wild spring/summer chinook would predict an adult return of over 2.0% for a May discharge mean in 1993 of about 131,000 cfs. Even for June discharges in 1993, which were over 100 kcfs for most of the first three weeks of the month, Petrosky (1992) would predict 1.5-2.0% survival (for ready reference, see Figure 2 of Appendix B of the NMFS Biological Opinion for operations through 1999, as attached to letter from Schmitten to Hardy dated March 16, 1994).

5. The key point in the foregoing treatment is that with 1993 discharges much above average in the system, and with significant spill over most of the latter half of May in the Snake and Columbia rivers, estimated survival of Snake River smolts to adulthood will be very low. I recognize that some of the returning adults in 1995 will consist of 3-ocean fish that went to sea in 1992, but the very low run in 1994 indicates that 3-ocean fish will not be abundant in the 1995 run. The higher that fraction is, the lower will be the smolt-to-adult survival of 2-ocean fish, with my assumptions in the treatment in #1-#4 above.

6. A key question is "What were the Snake River FPEs in 1993?" I estimate them on the basis of total arrivals at LGR, or 3.5-4.0 million, in relation to combined numbers transported from all Snake River projects or arriving at LMO tailrace. With that combined approach for LGR arrivals of 4 million smolts, FPE was about 3.19 million divided by 4 million, or 80%. That equates to 93% per project for LMO, Little Goose Dam (LGO), and LGR. If I adjust the LMO tailrace survivors by IHR survival at 0.88 (using PIT tag reach survival in 1993 through LGO project as a

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[9] Calculations to this point are sensitive to FGE. If FGE is greater than 55%, the number of smolts that arrived at LGR is less than I estimate. If FGE is less than 55%, the number of arrivals is greater. The arrival estimate is also sensitive to the assumption that fish pass in spill in proportion to the volume spilled in relation to total river discharge. However, I used assumptions commonly used by agency and tribal biologists in modeling.

[10] Petrosky, C. 1992. Analysis of flow and velocity effects: smolt survival and adult returns of wild spring and summer chinook. Chinook Smolt Workshop Draft Summary. Idaho Department of Fish and Game, Boise, Idaho. 8 p.+figures.

surrogate for survival through IHR project), the FPE from the combined Snake River projects would equal (640,000 at LMO x 0.88 = 563,000 survivors at IHR tailrace, plus transported total of 2,550,000, divided by 4,000,000). This equates to FPE of 0.94 for the average Snake River project. This FPE would be equivalent in definition to, although greater than, the target FPE of 0.80 per project proposed for 1994.

7. If the foregoing materials are reasonably on track, it would appear that a survival problem beyond flows and FPEs exists for Snake River spring chinook. Possibilities, not mutually exclusive, that come to mind include:

a. The high proportion of hatchery fish in the Snake River system may depress survival of the smolt cohort, either because of inherent low viability or because of ecological interactions. This explanation seems less than reasonable for the sudden collapse of the 1994 and 1995 adult runs, at least as a major cause of the problem. This is not to say that excessive numbers of hatchery fish in the migration route have no influence on cohort survival.

b. Transportation seems an unlikely cause of the severely depressed survival that appears to be indicated for smolts in 1993 (see above analysis of jack counts for 1994), especially in light of the analysis of Matthews et al. (1993)[11], which indicated that the part of the smolt run in 1990 that consisted of a high proportion of wild fish survived at adult return percentages much higher than were enjoyed by parts of the smolt run with a high proportion of hatchery fish. Observed survivals to completion of observations in 1993 of two groups known to be constituted of mostly wild fish that were transported were 0.8% and 1.3%.[12] Actual survivals were considerably higher (over 2%) because only part of the adult arrivals at LGR were examined for marks. Transported groups that consisted mostly of hatchery smolts survived at observed rates of about 0.2%, or about 0.4% to 0.5% with an

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[11] Matthews, G., J. Harmon, D. Kamikawa, B. Sandford, N. Paasch, K. Thomas, and K. McIntyre. 1993. Evaluation of improved collection, handling, and transport techniques to increase survival of juvenile salmonids, 1993. Abstract of report of research funded by U.S. Army Corps of Engineers, Contract No. DACW68-84-H0034, Northwest Fisheries Science Center, National Marine Fisheries Service, Montlake, WA. 98112-2097.

[12] This analysis involved "index" groups transported. No control groups were involved, making moot the argument that control groups were transported to LGO, and that TBRs are unrepresentative of survival gains from transportation.

approximate adjustment of the observed fraction. Furthermore, the run collapse of 1994 and the predicted collapse of 1995 appear to involve spring chinook from areas where fish are not transported. If only the Snake River were involved, and in worst case all transported fish from the Snake River died, the runs at Bonneville Dam might go down by a maximum percentage of about 15% in 1995 (32% contribution of Snake River fish, with about half of the smolts transported in 1993) or up to 32% in 1994 (most smolts transported in 1991 and 1992). But the runs are down by 75% in 1994 and predicted to drop from the 10-year average by 89% in 1995 (see #2 and #3(f)). Transport is not the culprit.

c. Gas supersaturation may have affected inriver migrants in 1993, especially in the period in May when dissolved gas levels reached mean daily levels greater than 120% saturation (May 10-May 26, excluding 3 days slightly below 120% saturation) at LMO. Daily high gas saturations reached 138-141 for 3 days in mid-May. High mean gas saturation levels were frequent at McNary and other dams on the lower Columbia River. Gas problems would likely have affected in-river migrants more than transported smolts, partly because of the concentrated transport before spill began in early May, and partly because the smolts transported at the upper three Snake River Dams were not exposed to high gas levels before they were collected.[13] The adult run collapse of 1994 should not be related to gas levels, for they were relatively low during smolt migrations.

d. A bottleneck may exist downstream from the hydro system for the first few weeks of juvenile ocean life. It may consist of an exceedance of carrying capacity in the estuary and/or nearshore habitats as a result of too many hatchery coho, chinook, steelhead in a relatively small time window, too many shad, low upwelling of nutrients, changes caused by a reduced Columbia River plume in spring (Ebbesmeyer and Tangborn 1993)[14], or several other potential problems. Predation in the estuary and nearshore areas may be involved. Beamish and Buillon

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[13] This point leads one to suggest that the jack-based analysis means a survival bottleneck occurred downstream from the barge release point downstream from Bonneville Dam.

[14] Ebbesmeyer, C., and W. Tangborn. 1993. Great Pacific surface salinity trends caused by diverting the Columbia River between seasons. MS submitted to Nature, 17 September 1993, Evans-Hamilton, Inc., 731 N. Northlake Way, Seattle, WA 98103.

(1993)[15] warned of the potential risks of unabated hatchery output in periods of lowered ocean productivity. Evidence is scant as to the real cause of low survivals, but the fact that runs in rivers outside the Columbia River have declined in recent years leads me to believe that reduced ocean productivity is at least partly responsible (e.g., see trends in Central Valley chinook runs, Klamath inriver chinook runs, Rogue and Umpqua escapements, north-migrating Oregon coastal chinook, Olympic Peninsula chinook, since the late 1980s, in PFMC (1994)[16]). I think a collapse of carrying capacity of the nearshore ocean environment and density-dependent interactions there are likely candidates for an important part of the run depression.

8. Because chinook smolts and adults that swim deeper in the water column may hydrostatically adjust gas in tissues to some degree, it is difficult to predict precisely the effects of given gas supersaturation levels. Information on fish behavior in the presence of gas supersaturation is very limited. However, EPA (Environmental Protection Agency) and state standards specify a gas supersaturation level of 110%. Dawley and Ebel (1975)[17], as a result of studies of fish survival and sublethal stresses at various gas supersaturation levels, believed that the standard was justified. Risk attends spill that increases dissolved gases to more than 110% saturation. Managers must rationalize that risk in relation to possible benefits of spill for increasing survival "across the concrete." I am concerned about the high spill fractions and extended spills proposed at LGR, LGO, LMO, and IHR for 1994.

9. In low flow years, mortality in tailraces and reservoirs may offset gains produced by passage of smolts through spill. The reasons are two-fold. First, low-flow years tend to produce higher river temperatures earlier, in turn tending to

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[15] Beamish, R., and D. Bouillon. 1993. Pacific salmon production trends in relation to climate. Canadian J. of Fisheries and Aquat. Sci. 50:1002-1016.

[16] PFMC (Pacific Fishery Management Council). 1994. Review of 1993 ocean salmon fisheries. Pacific Fishery Management Council, 2000 SW First Ave., Ste 420, Portland, OR 97201-5344.

[17] Dawley, E., and W. Ebel. 1975. Effects of various concentrations of dissolved atmospheric gas on juvenile chinook salmon and steelhead trout. Fish. Bull. 73(4):787-796.

increase predator physiological activity and daily rations. Secondly, fish travel time tends to increase with lower discharge,[18] so that smolts may be exposed to predation for a longer period than would otherwise be the case. Spill is thought not to affect predation through the length of the reservoir. The agencies and tribes have repeatedly stressed dangers of extended travel time, and used NMFS data from the early 1970s to estimate low survivals in reservoir passage at low river discharge. The current NMFS/FWS action to force passage of more smolts at low discharge seems contrary to that history of position.

10. Biological monitoring as specified in the May 6, 1994 memo from NMFS/FWS does not specify how monitoring would be conducted. Does it include tissue sectioning and examination by pathologists, swimming performance, blood chemistry, body counts of dead fish in raceways, or other techniques? It is important to specify techniques, for they can lead to false impressions. For example, if fish collected in shallow, degassed raceways are used for monitoring, they might or might not display serious symptoms, and might or might not suffer greater mortality than fish that are free to swim deeper in the open river. Adults that must pass fishways may lose the option of deep swimming to adjust for gas-supersaturated water. How will adult condition and mortality be evaluated? It would be tragic if managers succeeded in "reducing risk of transportation" if the spills specified result in acute, chronic, or delayed mortality in adult salmon. As far as I can determine, the only places to evaluate adults would be for fish trapped at, say, Ice Harbor and perhaps LGR. By the time adults reach that point, we could have lost many and never be aware of it. I think the NMFS/FWS action is a gigantic and unprecedented gamble without knowledge of the odds.

11. Best scientific information today favors transportation over in-river migration at low river flows. Discharge this year certainly will be low, absent prompt torrential rains in May. River temperature in the Columbia River system will rise early and remain higher than average, favoring early predator activity.[19] Although some observers may criticize past transport study results, those data are the best that

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[18] Petrosky (1992), op cit.

[19] Air temperatures in Boise were well above normal in all the first 10 days of May. Precipitation is far below normal.

we have. A recent review by Mundy et al. (1994)[20] states: "It is more probable than not that transportation acts to improve the relative survivals of certain kinds of salmon from the Snake River under certain combination of dam operations and river flow conditions." "Certain kinds" here means steelhead and, "to a lesser degree, spring/summer chinook." "Certain ..... dam operations" here means low flow and low spill fractions. Mundy et al. (1994) also note: "Before a "spreading the risks" policy can be implemented, the risks need to be known." I submit that the low flow of 1994 should trigger full transportation, even if one relied only on the comments of Mundy et al. for support. It is important to proceed with great caution in encouraging in-river migration in the present river system, for the risks are **not** known for the mitigation scheme proposed in the NMFS/FWS letter of May 6, 1994.

12. Assuming that the wild smolt population in 1994 is close to that which arrived at LGR in 1993 (I estimated about 670,000 -- see #3(b)), I used the existing information from the 1989 TBRs (another low flow year, in which TBR was 2.5, meaning that 1.0 inriver migrants would survive to adulthood while 2.5 transported migrants would survive, or a ratio of 40%) to estimate that at LGR, spill to reach the 80% FPE will result in 0.80 minus 0.55 (based on FGE of 0.55), or 25% of the run lost to transport. That means, again based on the 1989 TBR, that the action by NMFS/FWS can be estimated to be responsible for loss of about 100,500 smolts, calculated as: (1.0-(1.0/2.5)(0.25)(670,000). At LGO, I would calculate loss from spill by estimating that about 167,500 wild smolts will pass LGR in spill. About 90% of them, or 150,000, will arrive at the upstream face of LGO. FPE for turbine routing would be about 60% (FGE=0.60), while FPE with spill would be 0.80. Thus, 20% of the arrivals, or 30,000 fish, that could have been transported will go over spill. They, too, based on TBRs in 1989, will survive about 40% as well as if they had been transported. Thus, the spill program will cause another 18,000 wild smolts to die. Finally, at LMO, about 27,000 fish spilled at LGO will survive to the upstream face. Spill to reach 80% FPE will deny 15% of the arrivals (assumes FGE of 65% in turbine intakes) the benefits of transport. I assume TBR

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[20] Mundy, P., D. Neeley, C. Steward, T. Quinn, B. Barton, R. Williams, D. Goodman, R. Whitney, and M. Erho, Jr. 1994. Juvenile salmonid transportation from hydroelectric projects in the Columbia River Basin, an independent peer review. Final Report, U.S. Fish and Wildlife Service, Portland, OR.

would go down somewhat at LMN with one less project to traverse, so I would use a TBR of about 2.0 for calculations. The loss would be (0.15)(27,000)(0.50) = 2,025 more smolts will die from spreading the risk. Total estimated kill of wild smolts, based on the 1989 TBR of 2.5 (but 2.0 at LMO) would equal 100,500 at LGR plus 18,000 at LGO plus 2,025 at LMO, or 120,525 fish. That is a loss of 18% of the wild smolt run that I estimated would arrive at LGR.

13. The estimates in #14 can be criticized, of course. But the main point is that they are based on the best scientific information available on transportation benefits. I consider the data that underlie the estimates to be greatly superior in quality to the data that one might use to estimate losses from in-river passage caused by gas supersaturation, for example.

14. I conclude that the risks of the proposed spill program in this low-flow year are too high to bear. The 80% FPE program of NMFS/FWS risks kill of an unacceptable number of ESA-listed smolts and adults.

15. Finally, I suggest that it is imperative for managers and researchers to look beyond flow, spill, and transportation.[21] We need to do all that is scientifically justified to improve smolt and adult survival during migrations through the Columbia River system, but I believe that the lower estuary and nearshore marine areas may constitute an ecological bottleneck. We may be witnessing a collapse of the carrying capacity of the nearshore sea. We may have to look also at declines in offshore productivity. We must quickly design research and management-level experimentation that will examine these factors.

16. I believe that NMFS should immediately declare the sea as critical habitat, at least including a region off the Pacific Northwest to the Canadian border. The collapse of Snake River spring chinook in the 1994 run and the predicted greater depression in 1995 mandate emergency action. At the very least, I hope NMFS and other agencies will seriously evaluate what I have said in this letter. I fervently hope I am wrong about the collapse in ocean productivity and the disastrously low

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[21] This paragraph is not meant to downplay the importance of tributary habitat husbandry. Although NMFS is addressing freshwater habitat issues as part of Section 7 consultations, we must act holistically, treating critical habitat as a seamless fabric.

run of 1995. I urge colleagues to demonstrate that I am in error. As a scientist I hope they can do so.

Signed: D. W. Chapman

Donald W. Chapman
Fisheries Scientist

EDUCATION

Ph.D., Fisheries, Oregon State University
M.S., Fisheries, Oregon State University
B.S., Forest Management, Oregon State University

HONORS AND AWARDS

Phi Sigma outstanding graduate student, 1957, Oregon State University.

Sigma Xi

Most significant paper of the year award, 1965, 1976, and 1988 volumes of Transactions of American Fisheries Society.

Award of Excellence, 1989, Idaho Chapter American Fisheries Society.

PRESENT ACTIVITIES

Catch and stock assessment, anadromous fish passage problems, population productivity in salmon and steelhead, habitat evaluation in salmon and steelhead spawning and rearing areas, fishery resource management, best management practices for land use, training and seminars and expert testimony.

PROFESSIONAL EXPERIENCE

Dr. Chapman founded Don Chapman Consultants, Inc. in 1978 and is the company President and principal scientist. The clients and projects Dr. Chapman has served include the following:

Idaho Power Company. Consultation on ecological studies of fall chinook.

Pacific Northwest Utilities Conference Committee. Completed status reports on five salmon species proposed by petitions for listing as rare and endangered. Current consultation on endangered and threatened salmon (Snake River) and recovery plans.

State of Montana. Expert witness on effects of heavy metals on fisheries in the Clark Fork, Montana.

Alaska Pipeline Defense Fund. Biological witness on proceedings for evaluating civil damage claims arising out of Exxon Valdez oil spill in Prince William Sound, Alaska. Primary emphasis was stock and recruitment effects on salmon.

Pacificorp. Potential of White Salmon River (Columbia River tributary) to produce anadromous fish.

Los Angeles Department of Water and Power. Fish habitat and ecology in the Mono and Owens basins, California.

Battelle Laboratories. Completed an evaluation of criteria for predicting effects of sediment (fines) on intragravel survival and on rearing and wintering of salmonids.

State of Idaho. Consultant in US v. Oregon case on harvest rates and escapement needs of steelhead trout in mixed stock salmon and steelhead fishery in the Columbia River.

State of Idaho. Retained as expert rebuttal witness against Southern Refrigerated Transport, Inc., on salmonid kill in the Little Salmon River, caused by Vitavax spill.

Stone Container Corporation. Retained to advise on ecological effects of pulp mill effluent on salmonids in the Clark Fork River, Montana.

Bechtel Corporation. Conducted environmental evaluations of anadromous fish habitat potential in Panther Creek, a Salmon River tributary.

Montgomery Engineers. Technical advisor on habitat reclamation in Bear Valley Creek, Middle Fork Salmon River.

Montana Power Company. Retained to advise on mitigation and compensation for Kerr Dam relicensing (Flathead River).

Eugene Water and Electric Board. Currently advising utility on ecological studies needed for relicensing McKenzie River hydro projects.

Native American Rights Fund. Retained to advise attorneys on water requirements for fish and wildlife on the Klamath Reservation.

Native American Rights Fund. Provided advice on sockeye salmon and chinook salmon management problems in Copper River, Alaska.

Envirocon, Ltd., Vancouver, B.C. Consulted in salmon and steelhead ecology for problems related to ALCAN developments in the Nechako River, an upper Fraser tributary, and in the Morice River, a Skeena tributary.

Chelan PUD. Conducted a 3-year study of microhabitat utilization by chinook salmon and steelhead in the Wenatchee River, Washington. Also conducted a 2-year study of genetic makeup of mid-Columbia River salmon and steelhead. Also completed a two year study on effects of a 3-ft pool raise in Rocky Reach Reservoir on fall chinook spawning.

Grant County PUD. Conducted a 5-year study of effects of peaking flows on fall chinook spawning below Priest Rapids Dam, Columbia River. Completed an analysis of effects of peaking on fish and invertebrates in the Hanford Reach. Currently retained on fish passage problems at Wanapum and Priest Rapids dams. Testified in FERC hearing re. fish passage facilities at two Grant County PUD dams on the Columbia River.

Chelan PUD. Currently retained for continuing consultation on fish passage problems in the mid-Columbia River.

Douglas County PUD. Conducted a study of sockeye salmon enhancement opportunities upstream from Wells Dam.

Montana Power Company. Advice on mitigation and compensation for effects of Kerr Dam on fisheries of the Flathead River.

Washington Water Power Company. Currently retained as witness in case involving Spokane Indian Tribe claims against the company.

Several small-scale hydro entrepreneurs. Conducted instream-flow studies on Billingsley, Cedar Draw, Orofino, Deadhorse, Goose, Mink and Fisher creeks in the Payette River, Patterson Creek, Carmen Creek, and West Fork Hood River. Prepared Exhibit E materials on fish, wildlife and botanical resources for projects at Auger Falls (Snake River), Fisher Creek, Goose Creek, and Elk Creek Falls. A California project, Rock Creek, resulted in a full scale FERC hearing.

Pacific Northwest Utilities Conference Committee. Completed an analysis of salmon and steelhead runs in the Columbia River as affected by hydro and other factors, associated with the Power Planning Council's 201 Section. With Drs. Mckenzie and Van Hyning, prepared a paper on alternative methods of assessing hydro-caused losses on the Columbia River. Estimated historical run sizes in the Columbia River. Recently completed a study of progress toward the Northwest Power Planning Council's doubling goal. Conducting a study of status of chinook salmon in the Snake River basin, and coho salmon in the Lower Columbia River.

Muckleshoot Indian Tribe. Worked for the Native American Rights Fund as witness against Puget Power. Conducted a study of environmental degradation from water diversion and dams on the White River near Seattle.

Bureau of Indian Affairs. Conducted a field study of effects of a dam on Kootenai Falls with regard to trout populations in the Kootenai River. Testified before FERC against Northern Lights, Inc.

Bureau of Indian Affairs. Conducted studies of instream flow and habitat in about 85 reaches in 14 rivers in the Pacific Northwest, to estimate habitat and fishery damages caused by various dams and water diversions. They included the Elwha, Baker, Sultan, Cedar, Green, Puyallup, Nisqually, Skokomish, North Fork Hoquiam, Walla and White salmon in Washington, Willow Creek and Klamath in Oregon, Clearwater in Idaho.

Bureau of Land Management. Prepared an EIS for effects of water withdrawals in the Snake River between Twin Falls and Brownlee pool.

Chelan PUD. Testified in FERC hearings in June/July 1985 as expert witness on river and ocean mortality rates, as well as mitigation and compensation requirements associated with smolts passing Rock Island Dam.

Food and Agriculture Organization (UN). Periodic missions in South America to provide advice on stock and catch assessment, including 1-2 month consultations in Colombia (1978), Peru (1979 and 1980) and Panama (1984).

Department of Justice. Effects of irrigation withdrawals on lahontan cutthroat and cui-ui suckers in the Truckee River. Completed.

Corps of Engineers, Walla Walla District. Investigated limnological effects of impoundment of North Fork Clearwater River.

Department of Defense. Critique of environmental impact statement prepared by Bureau of Reclamation on Mountain Home Project.

Thorne Ecological Foundation, Boulder, Colorado. Studies of effects of molybdenum mining in White Cloud Mountains with regard to fish and limnology.

Salmon Unlimited (now defunct). Evaluation of potential impoundments for production of coho salmon.

Hecla Mining Company. Habitat alteration by stream diversion in North Fork of Coeur d' Alene River.

1978-Present: Consulting Biologist and President, Don Chapman Consultants, Inc.

1980-Spring: Visiting professor at Montana State University.

Taught fishery management.

1976-1978: Inland fishery Biologist, Food and Agriculture Organization, United Nations, Cartagena, Colombia.

Developed catch assessment program and economic evaluations of fishery in Rio Magdelena system; trained counterpart personnel.

1973-1976: Stock assessment specialist, FAO, Kigoma, Tanzania.

Assessed population structure, abundance and fish behavior for pelagic species in Lake Tanganyika; trained counterpart personnel.

Fall, 1972: Visiting associate professor of limnology, University of Wisconsin, Madison.

Taught limnology and population dynamics, advised graduate students on research methods.

1964-1972: Leader, Idaho Cooperative Fishery Unit and Professor, University of Idaho.

Taught graduate and undergraduate students in population dynamics and fishery management; conducted personal research; supervised four staff members and up to 18 graduate students. Principal emphasis was salmon and steelhead ecology in fresh water.

1963-1964: Director of Research, Oregon Fish Commission.

Supervised research and management work of research division with 65 biologists charged with marine and freshwater food - fish management, with emphasis on Columbia River salmon, steelhead, and other anadromous stocks.

1962-1963: Associate Professor - Oregon State University.

Supervised and engaged in research, taught biometry and ecology.

1961-1964: Assistant and Associate Professor, Oregon State University; Coordinator of Alsea Watershed Study and Exec. Secretary of Water Resources Research Institute.

Supervised and engaged in research, taught biometry and ecology.

1959-1961: Assistant Professor, Oregon State University and Coordinator, Alsea Watershed Study.

Coordinated several research activities and engaged in research on effects of timber harvest on stream ecology, especially on coho salmon.

1957-1959: Coordinating Biologist, Governor's Commission on Natural Resources, Salem, Oregon.

Same duties as 1959-1961.

1955-1957: Graduate assistant, Oregon Cooperative Wildlife Research Unit, Corvallis, Oregon.

MS research on life history of steelhead trout.

MILITARY SERVICE

United States Army Reserve - Active duty July 1953 to May 1955. Honorable discharge as First Lieutenant, Infantry.

PROFESSIONAL ACTIVITIES

Member American Fisheries Society.

Associate Editor for American Fisheries Society for salmonids, 1981-1983.

Member of National Marine Fisheries Commission Endangered Species Act Technical Advisory Committee.

Member of National Academy of Science Committee on Conservation of Northwest Salmon.

Member NOAA Advisory Board on Oil Spill Effects.

FACULTY APPOINTMENT

Adjunct Professor, Idaho State University, Pocatello, 1984 -.

ADDITIONAL QUALIFICATIONS

Licensed as SCUBA diver.
Licensed as private pilot, instrument, multi-engine.

PUBLICATIONS

Chapman, D. W. 1957. Use of liquid latex to mark juvenile steelhead. Prog. Fish Cult. 19: 95-96.

____________. 1957. An improved portable tattooing device. Prog. Fish Cult. 19: 182-184.

__________. 1958. Life history of Alsea River steelhead. J. Wildl. Mgmt. 22: 123-134.

__________. 1961. Alsea Watershed Study - Summary Report. Oregon State Univ. Agric. Exper. Sta. Misc. Pap. 110: 52 p.

__________. 1962. Effects of logging upon fish resources of the West Coast. J. of Forestry. 60: 533-537.

__________. 1962. Aggressive behavior in juvenile coho salmon as a cause of emigration. J. Fish. Res. Bd. Can. 19: 1047-1080.

Chapman, D. W., and R. L. Demory. 1963. Seasonal changes in the food ingested by aquatic insect larvae and nymphs in two Oregon streams. Ecology 44: 140-146.

Chapman, D. W. 1965. Net production of juvenile coho salmon in three Oregon streams. Trans. Amer. Fish Soc. 94: 40-52.

__________. 1966. The relative contributions of aquatic and terrestrial primary producers to the trophic relations of stream organisms. Pymatuning Laboratory Symposia in Ecology, Univ. of Pittsburgh., Spec. Publ. 4: 116-130.

__________. 1966. Food and space as regulators of salmonid populations in streams. Amer. Natur. 100: 345-357.

Chapman, D. W., H. J. Campbell, and J. D. Fortune, Jr. 1967. Summer distribution and food of kokanee and trout in Elk Lake, Oregon. Trans. Amer. Fish. Soc. 96: 308-312.

Chapman, D. W. 1967. Production. IN: Biological basis of freshwater fish production, S. D. Gerking, Editor. Blackwell Sci. Publ., Oxford.

__________. 1968. Production. IN: Methods for assessment of fish production in fresh waters, W. E. Ricker, Editor. International Biological Program Handbook No. 3, Blackwell Sci. Publ., Oxford.

Edmundson, E., F. H. Everest, and D. W. Chapman. 1968. Permanence of station in juvenile chinook salmon and steelhead trout. J. Fish. Res. Bd. Can. 25: 1453-1464.

Chapman, D. W., and T. C. Bjornn. 1969. Distribution of salmonids in streams, with special reference to food and feeding. IN: Symposium on salmon and trout in streams. H.R. MacMillan Lect. in Fish., Univ. of British Col.: 153-176.

Chapman, D. W., C. M. Falter, and F. Rabe. 1971. Water quality implications of clearing Dworshak pool below 1440 elevation. IN: Design Memo. 19, Reservoir Clearing, Supp. No. 1, Dworshak Proj., No. Fk. Clearwater River, Idaho. U.S. Army Engineer District, Walla, Walla.

Raleigh, R. F., and D. W. Chapman. 1971. Genetic control in lakeward migrations of cutthroat trout fry. Trans. Amer. Fish. Soc. 71: 33-40.

Chapman, D. W., W. H. Miller, R. G. Dudley, and R. J. Scully. 1971. Ecology of fishes in the Kafue River. Tech. Rept. 2, FAO FI:SF/ZAM 11. pp. 1-66.

Chapman, D. W. 1971. Scientific communications via meetings. Trans. Amer. Fish. Soc. 100: 400-402.

Everest, F. H., and D. W. Chapman. 1972. Habitat selection and spacial interaction of juvenile chinook salmon and steelhead trout in two Idaho streams. J. Fish. Res. Bd. Can. 29: 91-100.

Chapman, D. W., and H. Gibson. 1972. Effects of Zectran insecticide on aquatic organisms in Bear Valley Creek, Idaho. Trans. Amer. Fish. Soc. 101: 330-344.

Gordon, D., D. W. Chapman, and T. Bjornn. 1973. Economic evaluations of sport fisheries - what do they mean? Trans. Amer. Fish. Soc. 102: 293-311.

Chapman, D. W. 1976. Acoustic estimates of pelagic ichthyomass in Lake Tanganyika with an inexpensive echo sounder. Trans. Amer. Fish. Soc. 105: 581-587.

____________. 1976. Assessing the skipper factor - fishing sense for ring-net skippers on Lake Tanganyika. World Fishing, Sept. 76: 65-67.

Chapman, D. W., and P. Van Well. 1977. Observations on the biology of Luciolates stappersii in Lake Tanganyika. Trans. Amer. Fish. Soc. 107: 567-573.

Chapman, D. W., and P. Van Well. 1977. Growth and mortality of Stolothrissa tanganicae. Trans. Amer. Fish. Soc. 107: 26-35.

Chapman, D. W. 1977. Production. pp. 5-25, chapter in "Ecology of fresh water fish production," S.D. Gerking, Editor, Blackwell Sci. Publ., Oxford. 520 p.

______________. 1977. Methods for assessment of fish production. Pp. 199-214, chapter in "Methods for assessment of fish production in fresh waters": IBP Handbook No. 3; T. Bagenal, Editor, Blackwell Sci. Publ., Oxford. 348 p.

Chapman, D. W., J. Escobar, P. Arias, M. Zarate, M. Valderrama, and Y.C. Lara. 1977. La pescaria, captura y ingreso le los pescadores en el Rio Magdalena y el plano inundable. FAO Tech. Rept.

Chapman, D. W., and E. Knudsen. 1980. Channelization and livestock impacts on salmonid habitat and biomass in Western Washington. Trans. Amer. Fish Soc. 109: 357-363.

Chapman, D. W. 1980. Practical fisheries assessment in a tropical floodplain. Fisheries 6 (3): 2-6.

______________. 1980. Evaluacion de capturas en el Lago Titicaca y en el Rio Amazonas en Peru. p. 49-108 IN: Informe No.81, Instituto del Mar del Peru, FAO: Proyecto PNUD/FAO-PER/76/011, Callao, Peru. 303 p.

Chapman, D., J. Van Hyning, and D. McKenzie. 1982. Alternative approaches to base run and compensation goals for Columbia River salmon and steelhead resources. Battelle Pac. N.W. Labs. Contr. No. 2311204080.

Chapman, D. W., D. E. Weitkamp, T. L. Welsh, and J. H. Schadt. 1983. Effects of minimum flow regimes on fall chinook spawning at Vernita Bar 1978-82. Final Rept. to Grant Co. PUD by Don Chapman Consultants, Inc., and Parametrix, Inc. 123 p.

McKenzie, D., D. Weitkamp, T. Schadt, D. Carlile, and D. Chapman. 1983. 1982 Systems mortality study. Prepared for Chelan, Grant, and Douglas County P.U.D.'s. Battelle Pacific Northwest Laboratories.

Chapman, D. W., and B. May. 1984. Downstream movement of rainbow trout (Salmo gairdneri) past Kootenai Falls, Montana. N. Amer. J. Fish. Mgmt. 6: 47-51.

Chapman, D. W., D. E. Weitkamp, T. L. Welsh, T. H. Schadt, and M. B. Dell. 1985. Effects of river flow on the distribution of fall chinook salmon redds. Trans. Amer. Fish. Soc. 115 (4): 537-547.

Chapman, D. W. 1985. Salmon and steelhead abundance in the Columbia River in the nineteenth century. Trans. Amer. Fish. Soc. 115: 662-670.

Chapman, D. W., K. P. McLeod. 1987. Development of criteria for sediment in the Northern Rockies Ecoregion. Final Report to Battelle Columbus Laboratories - Work Assignment 2-73. EPA Contract No. 68-01-6986. 279 p.

Carlson, C. D., S. Achord, G. M. Matthews, D. E. Weitkamp, R. P. Whitman, R. Raleigh, and D. Chapman. 1988. Fish transportation studies, Priest Rapids Dam 1987. Joint report of Grant Public Utility District, National Marine Fisheries Service (CZES), Parametrix, Inc., and Don Chapman Consultants, Inc.

Chapman, D. W. 1988. Critical review of variables used to define effects of fines in redds of large salmonids. Trans. Amer. Fish. Soc. 117: 1-21.

Pratt, K. L., and D. W. Chapman, 1989. Progress toward the doubling goal of the Northwest Power Planning Council. Don Chapman Consultants, Inc. Report to the Pacific Northwest Utilities Conference Committee.

Chapman, D. W. 1989. "Visiting hours only", or, catch and release revisited. Wild Trout IV., Yellowstone National Park.

Chapman, D. W., W. S. Platts, D. Park, and M. Hill. 1990. Status of Snake River sockeye salmon. Don Chapman Consultants, Inc., Final Report to Pacific Northwest Utilities Conference Committee, Portland, Oregon.

Chapman, D., A. Giorgi, A. Maule, S. McCutcheon, D. Park, W. Platts, K. Pratt, J. Seeb, L. Seeb, and F. Utter. 1991. Status of Snake River chinook salmon. Don Chapman Consultants, Inc., Report to Pacific Northwest Utilities Conference Committee, Portland, Oregon.

Book Reviews

1972. Environment, resources, pollution and society (William W. Murdock, Ed.). For - Trans. Amer. Fish. Soc. 101: p. 137.

1972. Introduction to the fishery sciences (Wm. F Royce). For - Trans. Amer. Fish. Soc. 101: p. 760.

1972. Economic growth and environmental decay; the solution becomes the problem (P.W. Barkly and D.W. Seckler). For - Trans. Amer. Fish. Soc. 101: p. 760.

1975. Fish communities in tropical fresh waters (Margaret Lowe-McConnell). For - Copeia.

1978. Economic evaluation of sport and commercial fisheries (EIFAC). For - Trans. Amer. Fish. Soc.

1982. Man and Fisheries on an Amazon Frontier (M. Goulding). For - Dr. W. Junk Publishers.

Use of the FLUSH passage model in evaluating the NMFS emergency spill program

prepared May 25, 1994

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The recent spill program implemented by the National Marine Fisheries Service (NMFS) as an emergency measure was, to a significant degree, based on model runs from the States' and Tribes' mainstem passage model FLUSH. No other models were used, nor was the FLUSH model, as used in the analysis, subjected to peer review. In light of the cost and controversy of the emergency spill program NMFS's exclusive use of FLUSH was inappropriate and contrary to the adaptive management of the Columbia River. What follows are comments concerning the problems in using FLUSH in this context. They also add to my declaration regarding the direct effects of gas bubble disease arising from the emergency spill.

To evaluate the effect of the NMFS spill program the FLUSH model was used with three different model assumptions on the efficacy of the transportation of juvenile fish through the hydrosystem. With one set of assumptions (designated transport model 2) FLUSH indicated that the NMFS spill program would have a negative impact on system survival. Under the other assumptions (designated models 3 and 4) the spill would benefit fish (Table 1). NMFS did not evaluate the spill program with the CRiSP1.4 model, which is the most developed mainstem passage model and is used by Bonneville Power Administration and the Army Corps of Engineers. An analysis using CRiSP1.4 indicated no benefit to the spill program[1]. Because of the significance of models in 3 and 4 in justifying the emergency spill it is important to understand their development and the uncertainties in them.

1. CRiSP1.4 and FLUSH model 2 both predicted system survival would decrease about 2% under the emergency spill program (See Table 1).

Table 1 System and transportation survivals from four model scenarios

Survival in	Spill plan	CRiSP[a]	FLUSH model 2	FLUSH model 3	FLUSH model 4
Total system passage	MOU[b]	50%	20.1%	9.4%	6.8%
	NMFS[c]	48%	17.7%	10.3%	8.2%
Transportation		80%	42.5%	21.2%	15.2%

a. Results from CRiSP 1.4 using a transportation survival of 80%
b. Memorandum Of Understanding on spill prior to emergency spill plan
c. NMFS emergency spill plan implemented in May 1994

History

I first encountered the FLUSH transportation models at the Model Comparison Workshops conducted in 1993 (Anonymous 1993). The purpose of the workshops was to compare the theory, general responses and sensitivities of the life cycle and passage models used by the various agencies in the Columbia River Region. The purpose was not to evaluate the *correctness* of the models or how well the models fit observed data.

Transportation models 2, 3 and 4 (referred to under different names then) were put forward by the States' and Tribes' modelers. Model 2 represented a middle of the road scenario on the level of survival in transporting fish[1]. Models 3 and 4 represented scenarios of *worse case conditions* or low transportation survival[2]. At no time were models 3 and 4 considered best representations of transportation survival. The transportation models next appeared in the analysis submitted by the States and Tribes to the Salmon Recovery Team[3]. The document (CBFWA et al. 1993) contains a more complete written description of the transportation models. The Recovery Team did not specifically address these transportation models in developing their recovery plan. Models 3 and 4 surfaced again as central assumptions in justifying the NMFS emergency spill plan. In brief, the transport models were developed in a model comparison framework as possible scenarios. Since then they have been applied to

1. Model 2 transportation survival was 42.5% in the comparison workshop report.
2. Transportation survivals were 21.2 and 15.2% respectively in models 3 and 4.
3. Model 2 transportation survival was changed to 66.4% in the report to the Recovery Team.

management decisions. At no time in development or application have models 2, 3 and 4 been reviewed[1].

The models

The FLUSH passage model contains three sub-models describing different assumptions on juvenile fish survival in transportation. Transport model 2 represents the standard model used for comparison purposes in the model Comparison Workshop. In model 2 transport survival is a constant over all flows. Models 3 and 4 assume low transport survival under average flows and further decrease survival with low flows. Models 3 and 4 were described in the model comparison workshop proceedings (Anonymous 1993) as follows:

> Model 3 and 4 reduce the survival for water travel times less than 15.7 days to the -survival associated with a TBR from LGO of 1.0:1 and 0.4:1 in 1986 respectively, and use a linear model to connect the survivals at 15.7 days to three times the observed survival from LGO in 1977

Models 3 and 4 imply that transportation does not benefit fish. This is contrary to the conclusions of the peer review of transportation by Mundy (1994). In that document he states, "It is more probable than not that transportation acts to improve survivals of certain kinds of salmon from the Snake River under certain combinations of dam operations and river flow conditions."

The three models are illustrated in Fig.1. The curve shapes were adjusted according to data and assumptions specific to 1977 and 1986. Information from 1986 was used to fix the flat part of the curves in Fig.1. In this year, the water travel time was specified in FLUSH as 15.7 days. Conditions for the year 1977, corresponding to a water travel time of 36.7 days, were used to specify the minimum transport survival. A linear relationship between the maximum and minimum survivals was assumed for both models 3 and 4. In effect, 3 and 4 are identical models except for the choice of maximum survival. Details on how the three models were developed follows.

1. The model peer review panel, charged with the task of reviewing all regional life cycle and passage models under the of coordination Oak Ridge Environmental Laboratory, has not reviewed transport models 2, 3 and 4 (Barnthouse, personal communication)

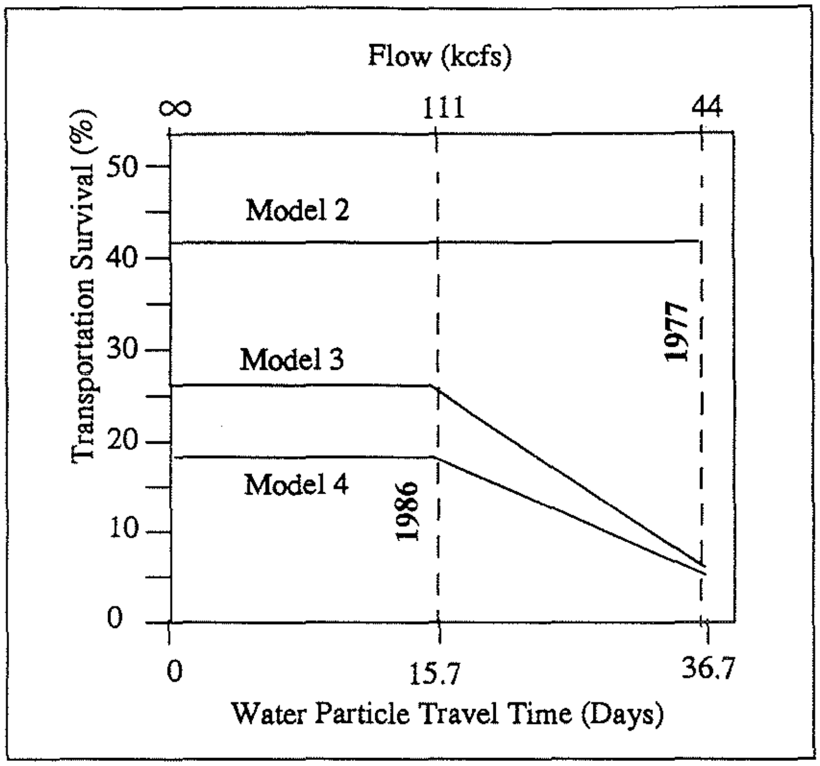

Fig.1 Three transportation survival models used in FLUSH showing relationships between survival and water particle travel time.

Generally speaking, transportation survival for any given year is estimated by the formula

$$S_{transport} = \text{TBR} \times S_{river} \tag{1}$$

where transport survival for a specific year, $S_{transport}$, is the product of the transport benefit ratio (TBR) for the year times the *in river* survival (S_{river}) for the year. The level of survival in model 2 was set with a more complete data set derived from studies of spring chinook transported from Lower Granite Dam in 1986. Model 3 and 4 used selected data from 1986 to define the flat section of the survival curves and assumptions on the conditions in 1977 to define the minimum survival point. The validity of the models rests entirely on the validity of using data from these years to represent survival in the current transportation system.

First consider the selection of TBR in the models. TBR is essentially the ratio of returning test and control adults tagged as juveniles at Lower Granite Dam. The test fish were placed in barges and transported to below Bonneville Dam, the lowest in the hydrosystem. The control fish were trucked to and released below Little Goose Dam, the dam immediately down river of Lower Granite. Since the adults were captured at different locations in their return different TBRs could be generated depending on which capture locations were selected. For model 2 only test and control fish captured at Lower Granite Dam were used to calculate the 1986 TBR. This gave a TBR of 1.6 to 1. Model 3 used a subset of the fish captured above Lower Granite dam. The resulting TBR was 1 to 1[1]. Model 4 used a further reduced subset of fish captured above Lower Granite Dam. The TBR was 0.4 to 1. The actual numbers of fish used to define these ratios were a small fraction (0.017%) of the fish tagged in the transportation study. As a result the TBRs in Table 2 contain significant uncertainty. The numbers for model 3 and 4 in Table 2 are approximate because the exact selection of data used is not available in any of the documents.

Table 2 Captures of test and control spring chinook from the 1986 transportation study. The numbers are used to estimate TBR ratios in models 2, 3 and 4 (Anonymous 1992). A total of 90,000 fish were tagged.

Model	Capture Location	Transport Recoveries	Control Recoveries	TBR
2	at LGR	74	47	1.6 to 1
3	above LGR	12	19	~ 1 to 1
4	selected sites	> 9	> 15	~ 0.4 to 1

For models 3 and 4 a second estimate of TBR was required to identify the slope of the survival curve under low flow conditions. The States and Tribes choose 1977 as the low flow year. No fish returned from either test or control groups that year so no TBR is available. In spite of the extreme low flow conditions in 1977 and the documented poor conditions of fish arriving at Lower Granite Dam (Steward 1994) an intermediate TBR of 3 to 1 was chosen without clear justification. Using the maximum observed TBR, which was 8.5 and occurred in 1978 under a flow of 89 kcfs, transportation survival in low flows would be much higher than set in models 3 and 4.

1. The FLUSH modelers excluded the Rapid River hatchery collections. Had it been included the TBR would be 1.1 to 1.

A weakness of the FLUSH transportation models is that they selectively used transportation information from one year only, 1986. The eight transportation experiments conducted at Lower Granite since 1975 gave TBRs between 0.6 to 8.5 (Fisher 1993). Including these additional data yields a different result. Fisher (1993) analyzing all TBR data demonstrated a positive relationship between transportation survival and flow. Models 3 and 4 assume a negative relationship. To demonstrate a worse case scenario it is permissible to use selected data but for management purposes a model should consider all available data. Clearly models 3 and 4 were misused as the sole justification of the emergency spill plan.

The second element required to calculate transport survival is *in river* survival (S_{river}). Here also, the choice of values yields a low transportation survival. FLUSH uses a flow *in river* survival curve based on the Sims and Ossiander flow survival relationship generated from data collected in the 1970's and 1980's. A revaluation of this data set (Steward, 1994) indicated serious flaws in the analysis including; misreporting of results, problems in experimental design, and unusual hydrosystem operations in earlier years. Steward recommended that the Sims and Ossinder data *not be generalized to existing populations and passage conditions.* FLUSH uses this relationship at the exclusion of other, more recent results. The NMFS survival studies in the Snake River in 1993 and turbine survival studies in the mid Columbia support the contention that *in river* survival is higher than that estimated from the Sims and Ossinder data.[1]

Finally, the use of two transportation models (3 and 4) obscures the issues and falsely implies that additional evidence supports the low transport survival hypothesis. In fact, models 3 and 4 are the same model using different numbers, both equally supported or unsupported depending on ones point of view.

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1. In calibrating CRiSP we are taking a more comprehensive approach that includes a variety of data sets. Our estimates of *in river* survival are higher than those used in FLUSH (Anderson et al. 1993). It is our belief that calibrations of the models for use in making management decisions should use all available data sets, not a single data set.

The bottom line

The benefits to system survival from the NMFS emergency spill plan rest solely on using the FLUSH passage model with transportation model 3 or 4. These models are the same with different parameters. They were developed to explore worst case scenarios of transportation in a Model Comparison Workshop and their use to evaluate the emergency spill plan to the exclusions of other models and scenarios is inappropriate. Models 3 and 4 are based in part on unsupported assumptions, selective use of the data, and data from studies that should not be generalized to current passage conditions.

In my opinion, NMFS's conclusion that the emergency spill improves system survival rests solely on questionable use of models and data. This action serves nobody well in the long run.

References

Anderson, J.J. et al. 1993. The CRiSP Users Manual. Version 1.4. Prepared by the University of Washington for the Bonneville Power Administration

Anonymous 1992. Review of Salmon and Steelhead Transportation Studies in the Columbia and Snake Rivers, 1984 to 1989. Prepared by the Ad Hoc Transportation Review Group. Submitted to the Columbia Basin Fish and Wildlife Authority.

Anonymous 1993. A comparison of several analytical models used to evaluate management strategies for Columbia River Salmon. Workshop proceedings prepared by Battelle Northwest.

CBFWA et al. 1993. Sensitivity Analysis of Juvenile Salmon Passage Models for Snake River Spring and Summer Survival Estimates: A Response to the NMFS Salmon Recovery Team, 1993

Fisher, T. R. 1993. Modeling Effects of Transportation Assumptions on the Population Trends of Snake River Chinook Salmon. BPA unpublished report.

Mundy, P. R. 1994. Juvenile Salmonid transportation from Hydroelectric Projects in the Columbia River Basin: An independent Peer Review. Final Report. U.S. Fish and Wildlife Service, 911 N.E. 11th Avenue, Portland Oregon 97323-4181

Steward, R. C. 1994. Assessment of the Flow-Survival Relationship Obtained by Sims and Ossiander (1981) for Snake River Spring/Summer Chinook Salmon Smolts. BPA report. April 1994.

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IN THE UNITED STATES DISTRICT COURT

FOR THE DISTRICT OF OREGON

IDAHO DEPARTMENT OF FISH AND GAME, Plaintiff, v. NATIONAL MARINE FISHERIES SERVICE, *et al.*, Defendants.	Civil No. 92-973-MA (Lead Case) 93-1420-MA 93-1603-MA (Consolidated Cases) DECLARATION OF JAMES JAY ANDERSON

JAMES JAY ANDERSON declares:

1. I am an Associate Professor at the Fisheries Research Institute and Center for Quantitative Science in Forestry, Fisheries and Wildlife in the College of Ocean and Fisheries Science at the University of Washington. A copy of my curriculum vitae is attached as Exhibit 1. I am generally familiar with several computer models used to estimate the effects of the Federal Columbia River Power System on salmon. I am most familiar with, and was the architect and principal investigator for the

development of the CRiSP model used to model juvenile passage survival. I make this affidavit to demonstrate the effects of a planned increase in the amount of spill at the eight mainstem dams along the Columbia and Snake Rivers.

2. The CRiSP model contains parameters which attribute mortality to each of the three principal means by which juvenile salmon may pass a dam while migrating downriver: through a spillway, through a bypass system, or through the electric turbines. The CRiSP model also contains parameters which model the effects of transporting juvenile salmon around the dams. The CRiSP model is thus capable of predicting the net change in mortality to juvenile salmon arising from a change in operations that increases the percentage of water passing through spillways and decreases the percentage of water passing through turbines.

3. Although mortality to salmon passing through spillways is generally regarded as lower than mortality to salmon passing through turbines, increased spill tends to increase the percentage of dissolved gases present in water. This phenomenon, called gas supersaturation, has long been recognized to be a problem arising from the dams, because high levels of gas supersaturation are lethal to both juvenile and adult salmon.

4. The CRiSP model is the only computer model in existence which attempts to estimate the adverse effects of gas supersaturation caused by increasing spill at the hydroelectric projects along the Columbia and Snake Rivers. Thus the CRiSP model

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is the only model that can provide an estimate of the balance between advantages to increasing spill and the disadvantage of increasing gas supersaturation. The model predicts effects from gas supersaturation based on the work of Dawley <u>et al.</u> (1976), using the relationships between gas supersaturation and survival developed through experiments in deep tanks.

5. I have been unable to obtain definitive documentation of the program to increase spills. It is unusual to have a program of this magnitude developed in haste, and implemented without any public review or scrutiny. As best I can determine, the U.S. Army Corps of Engineers, at the urging of the National Marine Fisheries Service (NMFS) and other parties, will change previously-planned operations to:

(a) spill at The Dalles Dam to 40 percent 24 hours a day;

(b) spill 25,000 cubic feet per second (25 kcfs) of water at Ice Harbor Dam 24 hours a day;

(c) operate the remaining six dams to spill during the 12 nighttime hours (and 24 hours at Bonneville Dam) at the lesser of (1) the quantity of spill needed to meet 80% fish passage efficiency and (2) the quantity of spill producing a maximum 12 hour average dissolved gas concentration of 120% measured at the next downstream project; and

(d) increase spill to meet 80% fish passage efficiency to the extent that there are no observed adverse biological effects of dissolved gas over and above 120% in increments of 2.5%.

I also understand that the Bonneville Power Administration has estimated the increase in spill at the eight mainstem projects to achieve 80% fish passage efficiency as follows:

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	Current Spill	Increased Spill
Lower Granite	40% 12 hrs	78% 12 hrs
Little Goose	30% 12 hrs	48% 12 hrs
Lower Monumental	none	54% 12 hrs
Ice Harbor	25 kcfs 24 hrs	100% 12 hrs
McNary	none	48% 12 hrs
John Day	none	33% 12 hrs
The Dalles	30% 8 hrs	40% 24 hrs
Bonneville	180 kcfs 8 hrs 75 kcfs 15 hrs	same

6. I have run the CRiSP 1.4.5 model to compare current and the NMFS 80% FPE spill plans. Total system survival is 50% for current spill conditions and 37% under the NMFS plan. These estimates include survival of both fish that are transported to below Bonneville Dam and fish that migrated through the river system.

7. The survival of fish traveling in river is also adversely affected in the NMFS spill program. The total passage survival of in river fish decreased from 34% under current conditions to 17% under the NMFS plan. This is a decrease in fish survival of 50%.

8. The decreases with the NMFS plan are the result of decreased transportation and the high level of nitrogen supersaturation. In the current plan saturation is below 114% but it reaches to 139% under the NMFS plan. The percent of fish transported is also decreased under the NMFS plan. Current transport is 50%. Under the NMFS plan 37% of the fish are transported.

9. Attached as Exhibit 2 is a very brief report providing details of these analyses.

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10. These results will tend to underestimate the adverse effects of the NMFS spill program for at least three reasons. First, the CRiSP model does not calculate adverse effects to salmon until the dissolved gas concentrations exceed 114%. Generally recognized water quality standards call for avoiding levels higher than 110% to protect fish; some research suggests that significant adverse effects begin at even lower levels. Second, the CRiSP model works with average gas supersaturation levels and does not take account of localized areas of much higher gas supersaturation levels associated with high average supersaturation rates. Third, the CRiSP model does not take account of adverse effects on returning adults, which tend to concentrate below dams where localized gas supersaturation levels are highest. The loss of returning adult salmon from gas supersaturation may have much greater consequences for the population of endangered and threatened salmon stocks than the loss of juvenile.

11. I understand that NMFS bases its rationale for the increases in spill at least in part on certain computer modeling results provided by the states and tribes. I have not seen these results. However, assuming that they are generated with the FLUSH model generally used by the states and tribes, they would not show the negative effects of gas supersaturation at all because the FLUSH model does not take account of the negative effects of gas supersaturation.

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12. I declare under penalty of perjury that the foregoing is true and correct.

Executed on May 13, 1994

James Jay Anderson

BALL, JANIK & NOVACK
Attorneys at Law
101 S.W. Main Street

April 1 1994

Curriculum Vitae for James Jay Anderson

Appointment

Associate Professor (WOT)
Fisheries Research Institute and Center for Quantitative Science in Forestry, Fisheries and Wildlife
College of Ocean and Fisheries Sciences
University of Washington. Seattle Washington 98195

Phone number

(206) 543-4772, 543-7848

e-mail

jim@fish.washington.edu

Social security number

537-44-4818

Previous appointments

Oceanographer. Dept. of Oceanography, University of Washington (1969-1979)
Principal Oceanographer. Fisheries Research Institute, UW (1979-80)
Adjunct Assistant Professor, Marine Sciences Research Center, State Univ. of New York (1977-1980)
Visiting Scientist, Institute of Oceanographic Sciences, Wormley England (1980)
Visiting Scientist, National Institute of Oceanology, Ambon Indonesia (seven visits between 1980-1983)
Visiting Scientist, Dept. of Biophysics, University of Kyoto Japan (1981)
Research Associate, College of Ocean and Fishery Sciences, UW ((1981-1982)
Research Assistant Professor, College of Ocean and Fishery Sciences, UW (1983-87)
Research Associate Professor, College of Ocean and Fishery Sciences, UW (1987-91)

Research Interest

Biomathematics, ecology, fisheries, oceanography, toxicology, fish protection at power plants, animal and human behavior, decision processes, ecosystem modeling.

Professional Activities

Journal activities

Associate Editor to The North American Journal of Fisheries Management (1988-1989)

Proposal Reviews

EPA Environmental Biology Review Panel
NSF Biological Oceanography, Physiological Processes
U.S. Geological Survey
Natural Environmental Research Council, Great Britain
EPA Cooperative research programs
NSF Psychobiology
Research and Evaluation Associates, Inc.
Bonneville Power Administration to technical work group
NSF Physiological Process section
NOAA Northwest Fisheries Center

EXHIBIT 1

Journal reviews

Journal of Marine Research
Limnology and Oceanography
Deep-Sea Research
Continental Shelf Research
American Naturalist
Mahasagar, the quarterly journal in Oceanography
International Symposium and Educational Workshop on Fish-Marking Techniques
North American Journal of Fisheries Management
Transaction of the American Fisheries Society
Canadian Journal of Fisheries and Aquatic Sciences
Northwest Environmental Journal (Illahee)

Consulting Activities

1975 NOAA, report on underway sampling systems
1983, 1984 Technical Arts Corporation, mathematical modeling
1984 Exxon Company, impact of off shore drilling
1985 Chelan Public Utility, expert witness on fish mortality at hydroelectric plants
1986 Coastal Climate Corporation, computer programming
1987, 1988 Bonneville Power Administration, consultant to technical work groups
1989 Great Saltbay Experimental Station, fish behavior literature review
1989 Envirex, Inc. fish diversion and protection
1989-1990 Montana Dept. of Fish Wildlife and Parks, ecosystem modeling
1989-1991 Bonneville Power Administration, consultant to develop fisheries research agenda
1990 City Council of Kennewick (WA), affects of bridge removl on salmon runs
1991/2 Army Corps, modeling fish behavior at dams
1993/4 Harza Northwest Consulting Engineers, Salmon passage modeling
1993/4 Pacific Northwest Project, Salmon passage modeling
1994 Chapman Consulting, Salmon passage modeling

Professional memberships

Sigma XI
Western Society of Naturalists
Association of the Study of Animal Behavior
American Society of Limnology and Oceanography
American Association for the Advancement of Science
American Fisheries Society
Resource Modeling Association

Workshop and conference organization activities

Session chairperson at the Saanich Inlet workshop, Feb 1983

Coordinator for Ecological Risk Assessment Workshop University of Washington, Jul 1987

Session chairperson at the Conference on Fish Protection at Stream and Hydro-Power Plants Sponsored by Electric Power Research Institute, Oct 1987

Coordinator of the Bonneville Power Administration Survival Workshop, Friday Harbor Laboratories, Feb 1989

Organization committee for the Bonneville Power Administration Predator/Prey Workshop, Friday Harbor Laboratories, May 1989

Public service

Puget Sound water quality planning committee, ad hoc committee on nutrient studies, Mar 1987

University of Washington Saturday Alumni Lectures, Autumn 1989

Associate Editor North American Journal of Fisheries Management, 1989-1990

University Task Force on Salmon and the Columbia River System - represent the UW in a group of faculty from the University of Idaho, Oregon State University, Washington State University and University of Washington with interests and expertise relating to the Columbia River system.

Ravenna Creek Feasibility Study - joined with representatives of neighborhoods adjacent to Ravenna Creek and members of the Department of Landscape Architecture to consider the possibility of daylighting the creek from it's source to Portage Bay and possible restoration of it's salmon run.

Provide analysis and advice to the Snake River Endangered Species Recovery Team

Expert witness certified

Federal Energy Regulatory Commission Court - certified as a fisheries expert on issues of fish migration and dam passage

1989 Anderson, J., D. Dauble, and D. Neitzel. Proceedings of the Smolt survival workshop. Pacific Northwest Laboratory Publication, in press.

1989 Morison, R. and J.J. Anderson. Risk assessment-risk management: The need for a synthesis. R. Morison and J.J.Anderson presented at the Annual Meeting of the Society for Risk Analysis. San Francisco, CA. Oct. 30, 1989.

1990 Anderson, J.J. Assessment of the risk of pile driving to juvenile fish. Presented at the 15th annual members meeting and seminar of the Deep Foundations Institute. October 10-12, 1990, Seattle Washington.

1990 Ostrander, G.K., J.J. Anderson, J. P. Fisher, M. L. Landolt and R. M. Kocan. Decreased performance of rainbow trout emergence behaviors following exposure to benzo(a)pyrene. Fishery Bull. 88:51-55.

1990 Anderson, J. J. Mathematical models for fish bypass systems. Report to the Portland District of the Army Corps of Engineers.

1991 Anderson, J.J. Fish Bypass System Mathematical Models. WATERPOWER 91, Proceedings of the International Conference on Hydropower. July 24-26 1991 in Denver, Colorado.

1991 Feist, B. E., and J.J. Anderson. Review of Behavior Relevant to Fish Guidance Systems. Fisheries Research Institute, University of Washington. FRI-UW-9102.

1992 Anderson, J.J. A vitality based stocnastic model for organism survival. In Individual-Based Models and Approaches in Ecology: Populations, Communities and Ecosystems. Editors DeAngelis and Gross, Chapman Hall, New York. p 256-277.

1993 Anderson., J.J. et al. Columbia River Salmon Passage Model CRiSP.1: Documentation for version 4, Release Date March 1993

1993 Nemeth R. and J.J. Anderson Response of juvenile salmon to light. In North American Journal of Fisheries Management. 12:684-692.

1993 Anderson. J.J. July Report to the Snake River Salmon Recovery Team on an Analysis of Spring and Fall Chinook Survivals using the CRiSP Mainstem Passage Model.

Invited Lectures and Seminars

1978 Water masses of the eastern tropical North Pacific. Dept. of Oceanography, Oregon State University.

1982 NSF/Indonesia Seminar on Marine Science, Jakarta Indonesia.

1982 A stochastic model for the size of fish schools. Dept. of Biophysics, Kyoto University

1983 Saanich Inlet Conference, Institute of Ocean Sciences Sydney, British Columbia.

1984 Probability distributions in biology. Fisheries Class 507, winter quarter.

1984 Probability models. Marine Sciences Research Center, State University of New York at Stony Brook

1984 A look at why and how animals form groups. Littorial Society of New York.

1984 Fish Schooling, New York City Sea Gypsies.

1984 The limitations and uses of microcomputers. Psychiatry Grand Rounds. St. Vincents Hospital, New York.

1885 A fish feeding model based on game and catastrophe theories. CQS/Biomath 597, Seminar Center for Quantitative Science, University of Washington.

1985 Model of fish feeding behavior. Marine Sciences Research Center, State University of New York, Stony Brook, N.Y. February 5

1985 Mathematical model of fish feeding behavior. Behavioral Ecology seminar, Simon Fraser University, March 6.

1985 Seasonal distributions of nutrients and chlorophyll in Puget Sound. University of Washington, Chemical Oceanography Lunch seminar.

1985 NITROP-85 Workshop. Bigelow Laboratory for Ocean Sciences. Booth Bay Maine, July 8-11.

1986 Ecological Risk Assessment Colloquium. Environmental Effects branch of the U.S. Environmental Protection Agency, Baltimore. Nov 10-14.

1987 Risk Assessment: Its context, theory and application. Fish Habitat Short Course. Colorado State University. Nov. 18.

1987 Presentation to Pacific Northwest Power Planning Council: Strategies for a five year work plan on reservoir mortality and water budget effectiveness evaluation. December.

1988 Panel member for discussion on uncertainty at ecological modeling in a regulatory framework, sponsored by the International Society for Ecological Modeling, U. of California at Davis. August.

1989 Fish Reservoir Interactions. North American Lake Management Society, Seattle, Sept.

1989 Rebuilding Fish Populations on the Columbia River. UW Alumni Seminar. Oct 14 1989.

1990 Symposium/workshop populations, community, and ecosystem: an individual perspective. Knoxville, Tennessee, May 16-19

1990 Assessment of the risk of pile driving to juvenile fish. Presented at the 15th annual members meeting and seminar of the Deep Foundations Institute. October 10-12, 1990. Seattle WA.

1990 Design criteria of behavioral fish guidance systems. Corps of Engineers Fish Passage Development and Evaluations Program. 1990 Annual Review. Portland OR. Oct. 19.

1990 Fish behavior considerations in fish diversion systems. Lecture for the U.S. Fish and Wildlife Service. Short course on Fish diversion Systems. Portland OR. October 22

1991 Computer Models and Columbia River Management: An exercise in Fact or Fantasy? Presented at the American Institute of Fishery Research Biologist, Northwest Meeting, January

1991 The History and Restoration of Columbia River Salmon: The Problem of an Endangered Species. Presented at Earth Day '91 Workshops, Center House Seattle Center

1991 Anderson, J.J. . *Computer Models and Columbia River Management: An Exercise in Fact or Fantasy?* Presented at the American Institute of Fishery Research Biologist Northwest Meeting, January

1991. The History and Restoration of Columbia River Salmon: The Problem of an Endangered Species. Presented at Earth Day '91 Workshops Center House Seattle Center, MayBPA .

1992. What we know and don't know about reservoir survival of juvenile salmonids. Presented at Chinook Smolt Survival Workshop. University of Idaho, Moscow, Idaho. February 26-28, 1992.

1992. Observations and models of the behavior of fish to sound. Acoustic workshop sponsored by Army Corps of Engineers and the Bureau of Reclamation, Sacramento California March 17

1992 A vitality based model for organism survival. Pacific Northwest workshop on Mathematical Biology. University of WaShington April 4.

1992. History and status of Columbia River Fisheries Models. Oregon Graduate Institute. April 14.

1992. Fish behavior considerations in fish diversion systems. Lecture for the U.S. Fish and Wildlife Service Short course on Fish diversion Systems. Yakima, WA. April.

1992 Bonneville Power Administration Projects Review. Mainstem pasage models presentation in Vancouver WA.

1993 Center For Streamside Studies' seminar *Integration of Salmon Life Cycle Models - Habitat to Harvest*

1993 Software for Sustainability: A Columbia River Example. Lecture in the Institute for Envirnmental Studies Seminar Attaining a sustainable Society.

1994 Fist Nations Conference ot Fisheries. Vancouver BC January 1994

1994 Lampery Barrier Reserch Workshop. In minnessota Feb 1994

1994 Ecosystem Management in Wester Interior Forests. May 1994. spokane Washingotn. Science Team leader in session on Stratagies for Resolving Major Ecosystem Issues.

Published Abstracts

1976 A model for the chlorophyll maximum. Joint Oceanography Assembly, Edinburgh.

1983 An underway water sampling system (with A. Copping), American Society of Limnology and Oceanography Meeting, San Francisco.

1984 Mathematical models for zooplankton swarms: Their formation and maintenance (with A. Okubo), Ocean Science meeting, New Orleans.

1984 Zooplankton probability distributions: Everything coming up gamma (with A. Okubo), Ocean Science meeting, New Orleans.

1984 Temporal patterns of chlorophyll and nitrogen species in a Puget Sound intertidal zone. American Society of Limnology and Oceanography Meeting, University of British Columbia.

1984 A relationship between attitude change and groups size. 17th annual Mathematical Psychology meeting at the University of Chicago, August.

1984 A predator-prey behavior model based on catastrophe and game theories. GUTSHOP'84, Fourth workshop on fish food habits at Pacific Grove, California. Dec 2-6.

1987 A mathematical model for startle response in fish. International Ethology Conference XX, University of Wisconsin, August

1987 Graphical representation of model uncertainty for risk assessment (with R. Morison), Workshop on theoretical ecology: Ecodynamics. Oct 19-20 1987, Julich, Germany.

1987 Mortality and survivorship based on a stochastic model of organism health. Workshop on theoretical ecology: Ecodynamics, Oct 19-20, Julich, Germany.

1987 A dose-response model based on a stochastic equation of organism health. Environmetrics 87, Washington D.C., November.

1987 Is uncertainty in risk assessment predictable? (with R. Morison), Environmetrics 87, Washington D.C., November.

1988 The relationship of uncertainty and probability in ecological risk analysis models (with R. Morison), Ecological Modeling in a Regulatory Framework, sponsored by the International Society for Ecological Modeling, University of California at Davis, August.

Evaluation of NMFS Spill recommendation

prepared May 11, 1994

by James J. Anderson, University of Washington

Introduction

This report describes an analysis of the proposed May/June 1994 spill program for the Snake River. The analysis uses the CRISP1.4.5 model with the most up to date calibrations including the NMFS survival study in 1993 and model parameters used in the System Operation Review.

The model runs used flows and temperatures from 1990, a year similar to observed and projected flows for 1994. The 1990 flows may be below the 1994 flows so in this respect the model runs underestimate nitrogen mortality affects.

Results specific to spring chinook are given in tables below which compare a base case using the current spill schedules, the NMFS proposed spill levels to achieve a 80% fish passage efficiency (FPE), a spills to meet exactly 80 FPE, and spills that limit nitrogen level to 120%. Table 1 gives total system survival and transportation percentages under the four scenarios. Table 2 through Table 5 give in river conditions including flow at dams, percent instantaneous spill at dams (spill was set at 12 hr per day except at Ice Harbor which spilled for 24 hr to a maximum of 25 kcfs), percent nitrogen saturation levels in pools behind dams, FPE at dams, and percent in river survival of fish to each dam.

The total system survival under transportation (Table 1) assumes transport survival of 80%. A document is in preparation detailing the calibration of transportation survival estimates (Anderson et al. in preparation). System survival is taken as the percent of fish released at the top of Lower Granite Reservoir that survive to the estuary.

Table 1 System survival and transportation percents under four plans

Scenario	system survival	percent transported
Current	50%	49%
NMFS plan	37%	34%
FPE = 80%	33%	16%
N_2 < 120%	48%	40%

EXHIBIT 2

Table 2 Current conditions projected for May 20.

River segment or project	Flow (kcfs)	Spill % (hr)	Nitrogen in pool	FPE	In river survival
Estuary		-	112		36
Bonneville	232	50	107	70	39
The Dalles	216	30 (8)	105	52	42
John Day	212	0	106	72	46
McNary	208	0	107	70	51
Ice Harbor	61	25[a]	114	58	56
Lower Monumental	61	0	113	65	62
Little Goose	61	30 (12)	105	65	70
Lower Granite	61	40 (12)	105	67	82

a. 25 kcfs achieved under 24 hr spill

Table 3 Conditions under 80% FPE for May 20

River segment or project	Flow (kcfs)	Spill %	Nitrogen in pool	FPE	In river survival
Estuary		-	113		17
Bonneville	232	50	116	64	20
The Dalles	216	40	113	74	22
John Day	212	33	110	78	23
McNary	208	48	110	80	26
Ice Harbor	61	25[a]	139	84	33
Lower Monumental	61	54	125	83	62
Little Goose	61	48	112	75	72
Lower Granite	61	78	100	82	84

a. 25 kcfs achieved under 24 hr spill

Table 4 Conditions under exactly 80% FPE for May 20

River segment or project	Flow (kcfs)	Spill %	Nitrogen in pool	FPE	In river survival
Estuary		-	113		15
Bonneville	232	90	118	80	16
The Dalles	216	48	113	80	17
John Day	212	36	110	80	19
McNary	208	48	110	80	21
Ice Harbor	61	40[a]	140	80	27
Lower Monumental	61	47	129	80	58
Little Goose	61	60	111	80	72
Lower Granite	61	71	100	80	84

a. 25 kcfs achieved under 24 hr spill

Table 5 Conditions for keeping nitrogen below 120% and maximizing FPE up to 80% for May 20

River segment or project	Flow (kcfs)	Spill %	Nitrogen in pool	FPE	In river survival
Estuary		-	113		38
Bonneville	232	90	118	80	40
The Dalles	216	48	113	80	40
John Day	212	36	110	80	44
McNary	208	48	110	80	52
Ice Harbor Tailrace			121		56
Ice Harbor	61	25[a]	120	64	56
Lower Monumental	61	5	120	68	63
Little Goose	61	30	111	69	71
Lower Granite	61	71	100	80	84

a. 45 kcfs achieved under 24 hr spill