Volume 2
Appendices

IDAHO's ANADROMOUS FISH STOCKS:

Their Status and Recovery Options

Report to the Director

Idaho Department of Fish and Game
600 S. Walnut
Boise, ID 83707

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LIST OF APPENDICES

Appendix 1.1

Fisheries Management Plan
1996-2000

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7. Continue Emphasis on Protection and Enhancement of Salmon and Steelhead

The range (Figure 4) and abundance of anadromous salmon and steelhead in Idaho are reduced from historic conditions. About 62% of Idaho's historic spawning and rearing habitat for spring and summer chinook salmon remains available. A similar amount of steelhead habitat remains. Approximately 25% of the historical surface area of sockeye salmon nursery lakes in Idaho remains accessible. The greatest loss of production habitat has occurred for Snake River fall chinook salmon, for which only 17% of the historic habitat is currently accessible. Approximately 30% of Idaho's streams inhabited by salmon and steelhead are located within areas designated as wilderness or waterways classified as wild and scenic rivers.

The reduction in abundance of fish has been severe for salmon (Figure 5). A primary factor in the decline of Idaho's once productive anadromous stocks has been development of the Snake and Columbia rivers' hydroelectric system. Mortalities to migrating juveniles are incurred either because of adverse migration conditions or physical damage as they pass through dams. Habitat degradation and mixed-stock fisheries have also contributed to the decline. Drought and poor ocean rearing conditions during the early 1990s exacerbated the mortality problems for anadromous salmon and steelhead. Sockeye salmon were listed as endangered under the Federal Endangered Species Act (ESA) in 1991. In 1992, spring, summer, and fall chinook salmon in the Snake River Basin were listed as threatened under the ESA, excluding spring and summer chinook salmon in the Clearwater Basin. The National Marine Fisheries Service (NMFS) became the federal authority in charge of Snake River salmon as a listed species. Historic low returns of adult spring and summer chinook salmon occurred during 1994-95, leading to a proposal by NMFS to reclassify all three runs of chinook as endangered. The result of federal listings is that actions to protect or enhance Idaho's salmon must be consistent with the federal recovery plan and standards. In addition, NMFS began a status review to consider listing Idaho steelhead under the ESA in 1994.

Appendix 1.1 cont'd.

As a result of historically low runs of salmon, the Department has increased emphasis on preserving the numerous subpopulations of native salmon that are genetically and ecologically adapted to return, spawn, and rear in Idaho. In 1991, the Department began a captive breeding program to perpetuate the few Snake River sockeye in existence at Redfish Lake near Stanley. Juvenile fish were reared to sexual maturity, bypassing the major mortality phase of migration to the ocean. The program is considered an emergency preservation effort that is experimental. Due to lack of spring and summer chinook adult returns in 1994-95, captive techniques will likely be necessary for some of the chinook populations in the Salmon River drainage during 1996-2000. Juvenile chinook salmon were collected from the Selway River beginning in 1992 and from the Yankee Fork, Lemhi River, and East Fork of the Salmon River in 1995 for experimental rearing to maturity. Captive programs for listed salmon will be guided by a Snake River Salmon Recovery Plan, currently in development by NMFS.

Efforts to achieve improved survival of Snake River salmon and steelhead will remain an important management activity. Improvement in migration survival provides our best avenue of success for enhancement of all salmon and steelhead populations, wild or hatchery, in Idaho. Priorities will be directed at improving juvenile migration and resulting adult salmon and steelhead returns through the federal hydroelectric system. The Department's goal is to preserve Idaho's salmon runs and to recover them to provide benefits to all users.

Other opportunities for enhancement of salmon populations will be limited due to low abundance of adult sockeye and chinook. Work will continue on priorities from the previous fish management plan, such as improvement of hatchery fish health and smolt quality factors most likely associated with early migration mortality; maintaining wild salmon and steelhead management program; managing for natural production; and implementation of fisheries safeguarding naturally-produced salmon and steelhead while providing fishing opportunity for surplus hatchery fish in Idaho.

Hatchery facilities to produce a total of about 20 million salmon and steelhead smolts are in operation as partial mitigation for losses to Idaho runs attributed to hydroelectric dams. However, low smolt-to-adult survival (less than 0.2%) of spring and summer chinook salmon smolts produced by these facilities have not returned enough adults to meet program goals. Mitigation planning expected returns three to four times better for both hatchery and naturally-produced fish than those occurring. By 1997, chinook salmon hatcheries will only release about 8% of their smolt capacity, but smolt releases should increase during 1998-99. Wild chinook salmon, such as in the Middle Fork Salmon River, have also experienced low smolt-to-adult return. We project only 66,000 wild smolts will migrate in 1997, returning less than 300 adults during 1999-2000.

The hatchery steelhead program was slightly modified beginning in 1993 to reduce potential ecological effects to listed salmon. Modifications included altering release sites and numbers (Table 2), but steelhead harvest should remain within the range of the last five years. Further modification will be implemented during 1996-2000 with the addition of acclimation/release ponds for steelhead smolts to reduce residualism. These ponds should benefit both steelhead and resident fish anglers.

The Department will seek to ensure sufficient returns of anadromous fish to Idaho waters to perpetuate both naturally- and hatchery-produced runs and to allow angler harvest through negotiation or legal means. Efforts will be continued to ensure a fair allocation of the available harvest of anadromous fish among the various Idaho user groups when a surplus is available. The Department will work with Idaho Indian Tribes to develop ceremonial harvest opportunities in years when surplus fish for treaty harvest are not available.

Steelhead and Salmon (Anadromous) Management

The Snake River above Lewiston historically produced an estimated 55% of the summer steelhead trout, 40% of the spring chinook salmon, and 45% of the summer chinook salmon in the Columbia River. Lesser numbers of sockeye salmon, coho salmon, and fall chinook salmon inhabited the Snake River drainage.

Snake River coho are extinct. As discussed under "Program Direction," all other runs of salmon and wild steelhead into Idaho are now at a low level. The only stocks not seriously threatened are hatchery-produced steelhead trout. The strategies and management actions for this planning period are conservation-oriented because of low fish abundance.

The long-range goals of the anadromous fish program are to (1) maintain genetic diversity and integrity of both naturally- and hatchery-produced fish; (2) rebuild naturally-producing populations of anadromous fish to utilize existing and potential habitat at an optimal level; (3) achieve equitable mitigation benefits for losses of anadromous fish caused by development of the hydroelectric dam system on the Snake and Columbia rivers; (4) secure adequate migration conditions to increase smolt and adult survival; (5) allow consumptive harvest by sport and treaty fishers; and (6) coordinate regional management with Idaho anadromous management to ensure achievement of Idaho escapement and other goals.

To meet fishery goals, Idaho's anadromous fish management utilizes both natural and hatchery production. Natural production recruits and sustains populations by spawning and rearing in the natural habitat with no human intervention, regardless of the parentage of the spawners. Hatchery production recruits and sustains fish populations in a controlled artificial spawning and rearing environment. Fish managers classify three groups of salmon and steelhead based on definition of production and broodstock history: wild, natural, and hatchery fish.

Wild/Natural

Wild fish are native fish which have no history of hatchery or nonnative fish outplanting or a limited amount unlikely to have had genetic impact. Natural fish also result from natural spawning, but are either not of native broodstock, or have had opportunity to breed with introduced hatchery fish. "Preservation" describes the fishery management applied to wild/natural salmon and steelhead (see drainage management plans). This is a management program which prohibits harvest and/or angling in order to preserve salmon and steelhead populations. For salmon listed under the ESA, preservation management is consistent with federal rules and recovery activities.

The Department will emphasize maintaining remaining runs of wild, native stocks of salmon and steelhead where they occur. Examples include wild steelhead in the Selway River and the South Fork Salmon River drainages, or wild salmon and steelhead in the Middle Fork Salmon River drainage and the Salmon Canyon tributaries. Maintaining genetic integrity of the native stocks is essential to continued production (hatchery and natural) of quality anadromous fish, as well as being the only practical means of utilizing the production capability of wilderness streams.

A variety of actions will be employed to manage wild and natural fish populations. Artificial production will be limited or curtailed in areas to be managed for natural production. Releases of hatchery-produced fish will be managed to minimize straying of those fish as juveniles or adults into wild fish streams. Fisheries programs will not reduce population status to a level reducing genetic integrity. Population abundance will be increased by improving survival of juveniles and adults with priority on major mortality factors related to migration through the hydroelectric system and regional fisheries. Naturally reproducing populations will be enhanced by setting fishing regulations to concentrate angler harvest on hatchery fish, continuing efforts to preserve and restore spawning and rearing habitat, and improving survival of downstream migrants.

Wide-scale outplanting of hatchery fish to increase natural production was curtailed during the last planning period. Supplementation of natural stocks with hatchery fish has not yielded desired results and rebuilding. Poor contribution of supplemented populations is likely caused by the same low smolt-to-adult survival as wild fish experience. While survival bottlenecks exist, rebuilding through supplementation or other production mechanisms is unlikely. Supplementation of natural fish populations will be limited to regionally coordinated and Department-approved evaluation studies.

Experimental and emergency use of wild anadromous fish stocks in captive rearing programs will be undertaken in this planning period. Bringing wild fish into captivity will be considered only if essential for long-term preservation. Careful monitoring of wild/natural salmon and steelhead populations will be necessary for future preservation and recovery management decisions.

Appendix 1.2

Commission Salmon Policy
April 18, 1996

Fish and Game Commission Policy Paper
Salmon and Steelhead Recovery

ISSUE

Snake River Salmon and Steelhead Recovery

BENEFITS

Sustainable salmon and steelhead fisheries in Idaho provide an important recreational, cultural and financial benefit to the citizens of the State.

Sustainable wild/natural populations of native salmon and steelhead in Idaho provide the foundation for present and future fishery opportunities.

Idaho's spring/summer chinook salmon and summer steelhead are the ecological cornerstone for these races of salmon and steelhead throughout the entire Columbia River basin.

CONCERNS

Although a regional solution will be required to recover Idaho's salmon and steelhead, these fish are first and foremost the heritage of the citizens and tribes within Idaho. We will not abrogate our responsibility toward this heritage, even if federal agencies and other interests continue to do so.

Recovery efforts over the past 20 years have been inadequate to reverse the decline of Idaho's wild salmon and steelhead. The abundance and stock structure of these fish have been eroded to the point that extinction is an imminent threat unless dramatic improvements occur.

Idaho has not had a general chinook fishery since 1978; hatchery programs implemented to mitigate for hydropower impacts have not been able to offset excessive mortality associated with smolt migration through the hydroelectric system. Steelhead fisheries are variable and sometimes fall short of mitigation goals. Hatchery supported fisheries are overly dependent on multi-generation hatchery broodstocks; the lack of wild fish to infuse into these broodstocks puts the sustainability of these fisheries at risk.

Idaho's chinook hatchery programs were federally mandated and implemented to mitigate for lost fisheries due to hydropower development. This mitigation debt has not been paid to the citizens of Idaho. These mitigation programs have recently been modified to focus on preservation of the few salmon left in Idaho, backsliding further from the promised mitigation of fisheries.

Processes to develop and implement recovery actions have not focused enough on the primary 'man-caused" factors limiting survival of Idaho's salmon and steelhead. These processes occur primarily under federal authority and oversight and do not adequately solicit or embrace input from state and tribal professional fishery managers and scientists.

Appendix 1.2 contd.

BACKGROUND

As recent as the late 1960s, the Snake River supported wild runs exceeding 120,000 adult spring/summer chinook salmon and summer steelhead (approximately 60,000 each). These runs supported popular fisheries that generated significant financial and recreational benefits to local and regional communities.

Adult returns of chinook and steelhead in the Snake River basin began declining dramatically in the 1970s, concurrent with completion of the final three dams on the lower Snake River.

The Northwest Power Planning Act of 1980 formed the Northwest Power Planning Council to oversee recovery and mitigation of lost fisheries due to federal hydropower development. This Act mandated equal consideration of fish and wildlife with power in the operation of the federal Columbia River hydroelectric system. Anticipated benefits of this effort helped avoid listing salmon in the early 1980s for protection under the federal Endangered Species Act (ESA).

Hatchery programs were implemented under the Lower Snake River Compensation Plan and Idaho Power Settlement Agreement to help mitigate for fisheries impacted from hydropower development.

Continued decline of Snake River salmon stocks resulted in listing for ESA protection in 1991 and 1992; declining Snake River wild steelhead stocks were petitioned for ESA protection in 1994.

RESPONSE

The Commission reaffirms its commitment to recover sustainable salmon and steelhead fisheries in Idaho. The Commission is not interested in museum-piece management of Idaho's salmon and steelhead. Short- and long-term recovery actions must lead to a level of recovery which provides consistent, harvestable surpluses. Losing our fish is not acceptable.

Success must be measured by wild/natural populations recovered in their native habitats without further loss of native stock characteristics. Wild/natural populations provide both the ecological diversity for sustainable natural production and the genetic material needed for long-term hatchery mitigation programs.

The Commission recognizes that successful recovery is dependent on regional and local support and ownership in recovery actions and outcomes. A well informed public and political leadership is vital to this objective.

The Commission recognizes the controversy surrounding how best to recover Idaho's salmon and steelhead, and advocates strong emphasis on effective monitoring and research to resolve priority questions impeding implementation of recovery measures. The Commission believes new research must focus on the primary "manageable" factors limiting survival of Idaho's salmon and steelhead, which is mortality associated with juvenile migration through the lower Snake and Columbia rivers.

The Commission strongly advocates an adaptive management approach that does not defer decisions simply because of uncertainty and controversy. Maintaining the status quo until all uncertainties are resolved is not acceptable. Idaho's salmon and steelhead cannot afford delay. Managing under uncertainty requires decision makers to err on the side of the natural state. The Department is directed to advocate changes it feels likely to have net beneficial effects.

Appendix 1.2 contd.

The Commission supports an adaptive approach that focuses on preservation of wild fish in the near-term and hastened efforts to develop appropriate long-term actions. The interim approach will not provide recovery; long-term solutions must be agreed to and implemented by the turn of the century if Idaho is to retain its salmon and steelhead heritage. These long-term solutions must reflect the goal of recovering sustainable salmon and steelhead fisheries to Idaho.

The Commission recognizes that promised mitigation of salmon fisheries may not be possible in the short-term. As escapement to hatcheries allow, top priority shall be to restore salmon fisheries and maintain steelhead fisheries. If escapements do not allow harvestable surpluses, the Department is directed to seek interim alternative mitigation programs which provide public benefits in the form of consumptive fisheries in Idaho.

The Commission supports short-term strategies that reflect the following guidelines:

> *Migration Corridor:* Efforts should strive to recreate, as closely as possible, the natural migration conditions under which salmon and steelhead evolved. Short-term actions include: 1) a spread-the-risk strategy that provides balance between smolts allowed to migrate in the river and smolts transported; 2) improve in-river migration conditions by promoting spillway passage, at least 80% fish passage efficiency, mainstem reservoirs at minimum operating pool, and prioritizing limited stored-water supplies to benefit mainstem reservoir passage of springtime juvenile migrants (spring/summer chinook, steelhead, sockeye); and 3) research to address transport vs. in-river dam passage, flow-survival relationships, and overall survival needed to achieve recovery. Results should be measured by the success of returning adults to their stream of origin.
>
> *Hatcheries:* Short-term chinook hatchery strategies should focus on preservation of Idaho's spring/summer chinook stock structure until migration corridor improvements are implemented. These efforts should first focus on refining preservation hatchery techniques, and strive to provide an ecologically sound safety net for populations at imminent risk of extinction. Steelhead hatchery programs should focus on maintaining viable fisheries without adverse effects on wild salmon and steelhead populations. Implementation should remain conservative and include adequate monitoring and research to evaluate the programs and adapt accordingly.
>
> *Harvest:* Harvestable surpluses are clearly our long-term goal. Harvest must be limited to those fish not essential to future production. The Commission recognizes the need to not overly constrain ocean and lower-river fisheries, but maintains that escapement and genetic diversity within and between populations is a mandatory conservation requirement. We oppose mixed stock harvest on the basis that it does not allow appropriate escapement of weak stocks. Similarly, the United States v. Oregon settlement negotiations did not provide for adequate escapement of Idaho stocks. Idaho will continue to seek reform to known stock fisheries driven by escapement, not mixed stock harvest driven by commercial fishery allocations.
>
> *Habitat:* Spawning and rearing habitat in Idaho is not currently prohibiting salmon recovery. Salmon and steelhead are declining in both pristine wilderness and extensively developed areas. However, with the precarious state of Idaho's populations, we must strive to optimize survival of every spawning pair. The Commission is committed to maintaining the multiple use of Idaho's lands, but doing so in a manner which does not impair the success of naturally spawning fish populations. The protection of remaining high-quality habitat is top priority. Restoration of degraded habitats, including water quality and flows, in wild/natural areas is also a high priority.

Appendix 1.3

ANADROMOUS FISH RECOVERY: 1999 DECISION POINT

IDAHO FISH & GAME COMMISSION POSITION STATEMENT
August 15, 1997

The legal mandate for the Commission is to preserve, protect, and perpetuate Idaho's wildlife for use by its citizens. The Commission believes a normative river is clearly the best biological route to meet that mandate, recover salmon and steelhead, and restore fisheries in Idaho. The Commission is not interested in museum-piece management of native salmon and steelhead runs.

While the biological choice is clear, the Commission recognizes that the State cannot support dramatic changes to the lower Snake River until the economic and social ramifications are clearly understood and society is supportive of the changes. Regional decisions that fail to focus on Idaho fish or Idaho societal needs are unacceptable.

A proactive strategy is needed to determine how best to balance long-term fish recovery with other societal interests. Development of a successful strategy requires effort on three major fronts: biological, economic and social. This effort should focus on measures that meet the long-term biological needs of the fish and determine the best options for maintaining social and economic benefits. The strategy should include local community involvement in helping find ways to keep economic sectors whole (e.g., alternative ways to get barged commodities to market) if recovery measures impact those economies.

These activities must be given top priority to ensure the 1999 decision is not deferred or made without the benefit of an honest and open debate of the relevant issues. Neither the fish nor the region can afford to delay implementation of an effective strategy to restore the runs to Idaho. The Commission directs staff to assist the region in making a timely decision by developing and implementing a Department plan to provide relevant information to agencies, decision-makers, and the public concerning the biological, economic and social ramifications of salmon and steelhead recovery proposals.

The criteria for recovery of fisheries lost due to construction and operation of mainstem dams must pivot on smolt-to-adult survival in the 2-6% range for Idaho wild salmon and steelhead. Delay of the decision is also unacceptable because delay defaults operations to continued collection and transportation, which cannot provide return rates necessary for wild fish recovery. Continuance of the status quo will lead to functional, if not complete extinction of the runs. It is therefore the Commission's position that smolt collection and barging should be phased-out in favor of a comprehensive program to increase the survival of in-river migrants to levels necessary for recovery.

Appendix 1.4

F&G Commission and the Natural River Option

Idaho Statesman - Guest Opinion Editorial

by
Stephen P. Mealey, Director
Idaho Department of Fish and Game

January 13, 1998

The Idaho Statesman recently printed the headline "F&G Favors Breaching Dams". This headline implies the Fish and Game Commission has taken an official position on breaching dams; it has not. To be productive all discussions on this important issue must be accurate and fair.

Idaho's wild salmon and steelhead are imperiled and decisions about their survival must be made soon. We advocate an honest and open debate of all the biological, social and economic issues before society makes informed decisions about the future of these precious fish. I'd like to clarify the Commission's and Department's position on conserving our salmon and steelhead.

As a result of successful litigation by the Department against the Federal Government in 1993, the National Marine Fisheries Service [NMFS] has until 1999 to decide on a long-term salmon recovery strategy. The strategy will be developed after considering three basic options: (1) current smolt transportation and flow augmentation; (2) "new and improved" smolt transportation and flow augmentation (more barges, surface collectors, and perhaps more Idaho water); and 3) restoration of a natural river in the lower Snake River between Lewiston and Pasco, by removing the earthen portion of four dams (little or no flow augmentation from Idaho).

The Department's and Commission's statutory responsibility and authority is to determine what is best for Idaho's salmon and steelhead in order to preserve, protect, perpetuate and manage them for Idahoans. In August 1997, the Commission adopted a position advocating a more "normative" river and phasing out smolt transportation. This position, aimed at the 1999 Decision Point includes: "...a normative river is clearly the best biological route ..." "...ensure the 1999 decision is not deferred or made without the benefit of an honest and open debate of the relevant issues." "... collection and transportation ... cannot provide return rates necessary for wild fish recovery." "... smolt collection and barging should be phased-out ...". While this position does not translate into support for any of the options to be considered by NMFS, the Department and Commission will continue to work with the involving science and data, to be ready for the 1999 Decision Point in the spirit of the "normative river" concept. Department scientists are confident the "normative" river concept will provide recovery to healthy, fishable levels.

Although the "normative" river concept appears best for the fish, this is only one piece of the recovery puzzle. Society and regional decision makers must also look at social and economic factors before drawing conclusions. Our piece of the puzzle is biology, and if biology was the only consideration, the choice would be clear: the "normative" river approach is best. Even the NMFS recognizes this, as is evidenced by its recent statement, "Natural river drawdown is the long term recovery option with the greatest degree of scientific certainty."

Appendix 1.4 cont'd.

Physical changes in the dams or the lower Snake water course may not occur soon or at all. Our legal mandate is to do everything we can to preserve these fish under what every condition or circumstances prevail. The Department takes this responsibility very seriously. We are actively fighting to reduce downriver harvest of Idaho's wild steelhead and improve smolt and adult migration conditions within the current constraints of the hydrosystem.

We have also taken drastic actions in Idaho. Harvest of wild salmon and steelhead has been precluded for nearly 20 years. Hatchery programs are doing their best to provide limited fishing opportunities and help keep wild fish from going extinct. We are active partners with public and private land managers to provide optimal spawning and rearing habitat in Idaho.

These activities will help slow the decline of Idaho's wild salmon and steelhead, but they cannot recover the fish. The 1999 Decision Point is vital to recovery. The Department will continue to do all it can to preserve Idaho's wild salmon and steelhead, and will be a good partner in helping society decide on the long term solution.

We fear that the decline of our wild salmon and steelhead will be irreversible if the 1999 Decision Point is allowed to slide or be set back. I encourage you to help us make certain that this does not happen.

Appendix 1.5

OFFICE OF THE GOVERNOR
P.O. BOX 83720
BOISE 83720-0034

PHILIP E. BATT
GOVERNOR

(208) 334-2100

April 3, 1998

Mr. William Stelle, Jr.
Regional Administrator
National Marine Fisheries Service
7600 Sand Point Way NE
Bin C15700 Building #1
Seattle, WA 98115-0070

Dear Mr. Stelle:

Please accept the enclosed comments from the State of Idaho on the Draft Supplemental Biological Opinion for Operation of the Federal Columbia River Power System. We appreciate the opportunity to comment and also request consideration of earlier comments submitted January 3, 1997, regarding the proposed listing of Snake River steelhead. Please contact Jim Yost (208-334-2100) or Ed Bowles (208-334-3791) if any clarification is needed.

I am confident Idaho's input will be carefully considered as you develop the final Supplemental Biological Opinion. I also request a formal response from the National Marine Fisheries Service on any concerns raised in the enclosed comments that are not embraced in the final Supplemental Biological Opinion.

Very truly yours,

Philip E. Batt

Governor Philip E. Batt

PEB:jy

Appendix 1.5 contd.

STATE OF IDAHO COMMENTS: DRAFT SUPPLEMENTAL BIOLOGICAL OPINION OF THE FEDERAL COLUMBIA RIVER POWER SYSTEM

State of Idaho
Office of the Governor
Capitol Building
Boise, Idaho

April 3, 1998

The State of Idaho (Idaho) appreciates the opportunity to comment on the National Marine Fisheries Service (NMFS) *Draft Supplemental Biological Opinion of the Federal Columbia River Power System (FCRPS) Including the Smolt Monitoring Program and the Juvenile Fish Transportation Program, During 1998 and Future Years* (Supplemental BiOp). Idaho believes this draft reflects significant improvement over the Biological Assessment submitted by the operating agencies. Idaho also has some significant concerns with portions of the draft Supplemental BiOp which are outlined in these comments. Idaho expects NMFS' consideration of these and earlier comments (State of Idaho 1997) in development of a final Supplemental BiOp.

Idaho's goal is to recover wild Snake River salmon and steelhead populations and restore productive salmon and steelhead fisheries. It is clear that neither the current smolt transportation program nor current in-river migration conditions will provide recovery. As a result of litigation by Idaho Department of Fish and Game (IDFG) and others, the 1995 hydrosystem BiOp recognized this fact and required a decision by the end of 1999 on a long term recovery strategy (NMFS 1995). This process is known as the 1999 Decision Point. The Supplemental BiOp should not undermine the integrity of the 1999 Decision Point. The Supplemental BiOp should more clearly reaffirm a commitment to make this decision on time using the best available information. This commitment should be clarified in the Background, Proposed Action, Framework Coordination and Conclusions sections of the Supplemental BiOp, and clearly describe that a "no jeopardy" finding is explicitly linked to the 1999 Decision Point and implementation of long-term recovery measures. Idaho supports NMFS' conclusion in the draft Supplemental BiOp that long-term recovery options being analyzed for salmon are likely to provide similar responses for steelhead.

To provide recovery, Idaho believes long term direction must improve in-river conditions enough to provide sustainable 2-6% smolt-to-adult survival. This survival "yard-stick" was developed by PATH for spring/summer chinook (Marmorek et al. 1996); the survival standard may be slightly higher for steelhead, as identified in the Supplemental BiOp. Idaho also believes the smolt transportation program should be phased out as river conditions improve. This approach is consistent with the Independent Scientific Group's (now called the Independent Scientific Advisory Board (Science Board)) assessment that a "normative'" river is the only scientifically credible route to recovery

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[1] Normative is defined by the Independent Scientific Group as "... an ecosystem where specific functional norms or standards that are essential to maintain diverse and productive populations are provided." (Williams et al. 1996). Idaho does not view the normative approach as a specific set of recommendations, but as a guiding premise from which to develop, assess and prioritize potential recovery actions. For example, large scale flow augmentation and smolt transportation are actions inconsistent with the normative approach, whereas efforts to recreate a natural hydrograph would be an action consistent with the normative approach.

(Williams et al. 1996, 1998). The Science Board, sanctioned by the Northwest Power Planning Council and NMFS, indicates that transporting smolts in barges is inconsistent with the "normative" approach and should not be considered a long term recovery option. Preliminary analyses from PATH for spring/summer chinook also indicate smolt transportation is unlikely to provide recovery (Marmorek and Peters 1998). Idaho requests NMFS to state this science-based long term direction more clearly in their Supplemental BiOp.

Until long term recovery actions are implemented, we all must remain committed to doing everything we can to preserve Idaho's imperiled salmon and steelhead. These interim measures should be the primary focus of the Supplemental BiOp. The *interim* status of the Supplemental BiOp should be clearly stated, particularly since its draft title includes "....1998 and Future Years°. Idaho requests the Supplemental BiOp extend for 1998 and 1999 only; it should not be considered a long term operational plan. If for some reason long term recovery decisions are not made in 1999, a new hydrosystem BiOp should be developed. This is necessary because all input into the existing 1995 BiOp and Supplemental BiOp are made under the assumption that long term recovery decisions will be made in 1999. Additionally, if a long term decision is not made in 1999, this would be in violation of the BiOp and therefore require reinitiation of consultation.

Interim measures in the Supplemental BiOp should build on the "normative" approach wherever possible, without prejudice to the 1999 Decision Point. The Supplemental BiOp should also fully embrace the Science Board's recent report on smolt transportation (Williams et al. 1998). Consistent with this scientific direction, the Supplemental BiOp's interim objective should be to: a) provide as high quality in-river conditions as possible given existing dam configurations, water availability and a balanced resource approach; and b) spread the risk accordingly between transport and in-river migration based on these river conditions, erring on the side of in-river migration when conditions, such as flow and spill, are favorable and on transportation when conditions are unfavorable. The draft Supplemental BiOp alludes to this objective when describing the ISAB report, but does not explicitly state this objective for the Supplemental BiOp. Idaho requests that this objective be clearly stated in the Proposed Action section as the basis for interim FCRPS operations.

The first component of this objective is to optimize in-river migration conditions. This requires getting fish safely through the reservoirs and past the dams. The Supplemental BiOp should be structured to clearly show how FCRPS operations will meet this objective.

Idaho's salmon and steelhead prospered for thousands of years by utilizing headwater tributaries for spawning and nursery areas and then sending their young to the ocean on the wave of snowmelt each spring. The ecosystem that nurtured this process as recent as 30 years ago remains largely intact except for the fact that the wave of snowmelt now slows to a crawl as it leaves Idaho at Lewiston. The remaining 400 miles to the ocean includes a series of eight dams and reservoirs in the lower Snake and Columbia rivers. This impounded reach has lost many of the ecosystem components required for successful migration (Williams et al. 1996). This altered environment results in slower migration, increased stress, direct mortality and greater exposure to predators.

Flow augmentation is not a long-term solution to this dilemma. It is both unrealistic and unacceptable to use storage reservoirs in the Snake and Clearwater basins to try to reverse the fundamental effects that the four federal dams on the lower Snake River have had on the Snake River ecosystem. Historical water velocities cannot be attained through the current mainstem reservoirs even if all reservoir storage in the basin were used (IDFG and IDWR 1993). Simply adding more water to the system is inconsistent with the normative river approach because flow and water velocity are only two components of the complex ecosystem requirements for successful migration (Williams et al. 1996). Flow augmentation will not recover the fish and it places large burdens on vital state interests. To reduce conflicting demands on Idaho water, the region must accept this fact and focus recovery on measures that provide more normative conditions in the lower Snake and Columbia rivers.

During the interim, Idaho recognizes that flow augmentation is a major component of the 1995 BiOp, and likely provides some benefits to migrating salmon and steelhead under current dam configuration on the lower Snake and Columbia rivers. The Supplemental BiOp should clarify that the amount of water available to aid migration must be determined annually based on snowpack and be consistent with state water law. This includes clearly stating that upper Snake River contributions cannot exceed 427 kaf.

Once water available to aid fish migration is determined each year, it should be prioritized for springtime migrants. These include spring/summer chinook, steelhead and sockeye, all of which are listed as threatened or endangered under the federal ESA. The Supplemental BiOp takes the opposite approach by prioritizing water for summer migrants, which is primarily limited to fall chinook. The Supplemental BiOp even digresses from the 1995 BiOp by removing management flexibility for spring vs. summer water allocations. Idaho strongly objects to this digression and questions how NMFS can rationalize putting an even higher priority on summer migrants when the basis for the Supplemental BiOp is the recent listing of steelhead, which are springtime migrants.

Although all Snake River salmon and steelhead stocks are vital to the evolutionary legacy of these species, the ecological significance and relative imperilment of springtime migrants exceeds that of summer migrants. The Snake River historically produced approximately 50% of the total spring/summer chinook and summer steelhead for the entire Columbia River basin (Bjornn 1960; Mallet 1974). As a result of habitat degradation and loss in other states, Idaho and northeast Oregon currently have over 70% of the natural production potential for these fish in the Columbia River basin (StreamNet database). Idaho has a less significant ecological role for fall chinook in the Columbia River basin. Historically, Idaho fall chinook comprised only 5-10% of the Columbia basin total (Bjomn 1960; Mallet 1974). Idaho's relatively low contribution is accentuated because Swan Falls Dam and the Hell's Canyon complex of dams removed approximately 83% of Idaho's fall chinook habitat from production (Hassemer et al., 1997). Presently, the primary contribution of naturally produced fall chinook in the Columbia River basin is from the mid Columbia River (e.g., Hanford Reach) (CBFWA 1991).

The status of Snake River fall chinook is also not as alarming as spring/summer chinook, sockeye and steelhead when examined at the population level. For example, the population size of fall chinook is not at as critical a level as spring'summer chinook, which averaged less than 50 adults per population in 1994 and 1995; the fall chinook population exceeded 350 fish during these same two years. Recent trend in the number of naturally produced adult fall chinook returning to Idaho is also not as steep as the decline experienced by Idaho's natural spring\summer chinook (WDFW and ODFW 1996). Since 1975, individual populations of spring/summer chinook have been more variable, and dropped to critically low levels more frequently, than the Snake River fall chinook population (STFA 1995).

Appendix 1.5 cont'd.

In addition to being biologically indefensible, NMFS' approach of increasing summer flows at the expense of springtime flows is inconsistent with the normative river approach and does not recognize the limited availability of water. Available water should be prioritized consistent with the natural hydrograph, not used to maintain an unnaturally high summer hydrograph.

Inflow and storage available to aid fish migration at Brownlee and Dworshak reservoirs should be prioritized to help "fill in the holes" from spring snowmelt. This operation should strive to help keep flows at Lower Granite Dam from dropping below 100 kcfs from mid-April through May when spring migrants are present. To aid this effort, the Corps of Engineers should manage flood control to ensure the highest possible reservoir levels by early April and to shift as much of the flood control drafting as possible to coincide with smolt migration. The inability of NMFS and the operating agencies to embrace and implement this concept has resulted in avoidable low flow conditions mid to late April the past several years. The Supplemental BiOp should clearly identify the actions NMFS and the operating agencies are going to take to remedy this chronic deficiency.

Idaho supports keeping mainstem reservoir levels at minimum operating pool during the spring migration period and operating John Day Reservoir at minimum irrigation pool. The Supplemental BiOp should include a more clearly defined process to determine the social, economic and biological costs and benefits of operating John Day at reduced levels. This process should allow informed decisions on John Day to be made as soon as possible, and should not impede the 1999 Decision Point.

The second part of improving in-river conditions requires getting smolts past the dams. The Supplemental BiOp should include: 1) spill to the maximum allowable by state water quality agencies at all dams on the lower Snake and Columbia rivers when spring migrants are present; 2) minimize multiple bypass passage in the lower Snake River for in-river migrants; and 3) operate turbines within 1% of peak efficiency when smolts are present. Idaho Department of Fish and Game recommends that Washington and Oregon allow gas variances to 120/125% in the lower Snake and Columbia rivers. Idaho is willing to discuss annual adjustments to these recommended spill levels to accommodate priority research needs or for adaptive management based on new information.

Idaho appreciates the improvements NMFS made regarding spill in the draft Supplemental BiOp. Maximizing spillway passage within the constraints of state water quality standards, regardless of bypass screen efficiency, is progressive. The draft Supplemental BiOp also made progress regarding flow-induced spill "triggers". The 1995 BiOp included a unique spill trigger of 100 kcfs at Lower Granite Dam to increase smolt transportation. The Supplemental BiOp reduced this trigger to 85 kcfs in recognition of the state, tribal and Science Board recommendation that transport operations should not be allowed to erode in-river conditions. Idaho appreciates this progress but recommends a complete decoupling of flow and spill to allow the flexibility to optimize spillway passage regardless of flow. The science is clear that spillway passage is the best way to get in-river migrants past the dams (NMFS 1995, 1998; Williams et al. 1998), therefore managers must retain the flexibility for spill whenever in-river migrants are present, regardless of flow. If river conditions degrade to the point that state, tribal and federal salmon managers (Salmon Managers) believe more smolts need to be transported, then spill levels could be adjusted accordingly inseason.

Once migration conditions are optimized each year, the next step is to determine an appropriate balance between smolt transportation and in-river migration. The Supplemental BiOp should require an interim "spread the risk" approach toward transportation during the spring migration period until long term solutions are implemented. This approach should strive for a sensible balance, based on river conditions, between the number of fish transported and those allowed to migrate in the river. This approach is consistent with the Science Board's recent report on transportation and is consistent with existing and emerging scientific information. The draft Supplemental BiOp partially embraces this concept, but does not go far enough in meeting recommendations from Idaho and the Science Board regarding transportation.

Idaho believes river conditions that can be provided in 1998, and in 1999 unless a drought occurs, warrant a spread-the-risk strategy that errs toward allowing the majority of smolts to migrate in-river during spring. Once again, this is consistent with the Science Board's recommendation for ensuring that the majority of smolts are not transported from any one stock during 1998. Idaho recognizes that there may not be any operational scenarios that allow this to occur without pulling turbine screens or having multiple bypass in the lower Snake River, both of which are not currently recommended by Idaho. But there are scientifically-supportable operations available that would reduce transportation more than allowed for in the draft Supplemental BiOp.

Idaho recommends the following operations for the spring migration period in order to best meet Science Board recommendations and achieve our spread-the-risk policy without multiple bypass in the lower Snake River.

> Spill to the maximum allowable by state water quality agencies at all collector projects throughout the spring migration period. This should be maintained at all but the lowest flows, based on the discretion of the Salmon Managers.
>
> Transport from two dams only during the spring migration period. Existing PIT tag data on survival of bypassed and transported smolts support Idaho's preference for transporting all smolts collected at Lower Granite and Little Goose dams, and returning all bypassed fish to the river at Lower Monumental and McNary dams.
>
> Do not use trucks to transport any smolts.

All of these operations are consistent with the Science Board report on transportation Williams et al. 1998) and improve on the draft Supplemental BiOp by providing better "spread-the-risk" and ensuring transport operations do not undermine in-river conditions. This operation will likely fall short of Idaho's and the Science Board's preference to best spread-the-risk during this interim period. The region should investigate options to spread the risk more equitably without increasing risk to in-river migrants. The goal of dam operations should be to create river conditions that allow the highest possible proportion of smolts to safely migrate in the river, given recognized constraints. Smolt transport operations should not be allowed to undermine management for optimal in-river migration conditions.

The Supplemental BiOp should allow the federal, state and tribal salmon management agencies to collectively determine the specific transportation measures for each year. This is a vital component of the Adaptive Management Process (AMP). Maintaining annual flexibility to adjust the transportation program is particularly important because PIT tag returns from wild spring/summer chinook in 1998 may shed substantial light on the controversy regarding transport vs. in-river migration success and bypass systems. The draft Supplemental BiOp appears to remove smolt transportation from the AMP. This digression is unsupportable and is inconsistent with the existing 1995 Hydrosystem BiOp and ongoing discussions regarding river governance. Idaho strongly recommends that this annual management flexibility be reincorporated into the final Supplemental BiOp.

Idaho also has some general and specific comments on the discussion of jeopardy standards in the draft Supplemental BiOp. The draft emphasizes recent and historic smolt-to-adult-return rates (SARs) of Snake River and upper Columbia River steelhead to evaluate jeopardy status. Steelhead SARs are compared with spring/summer chinook SARs to determine qualitatively whether ESA jeopardy standards would be met by long-term actions and the reasonable and prudent actions (RPA) of the BiOp. In general, this is a good approach given the available information, but could be refined in certain areas.

The draft Supplemental BiOp emphasizes SAR to the upper dam (defined here as SAR1) and downplays the value of SAR based on total returns to the mainstem fishery plus escapement (defined here as SAR2). However, both SAR measurements are extremely valuable and should be used in the BiOp on FCRPS operation. SAR2 is most relevant to evaluate the effects of FCRPS development and operation, has historical precedence, and best parallels the PATH spawner and recruit analyses for spring/summer chinook that compare total mortality of upriver and downriver stocks. Reduction in direct and delayed mortality due to the hydropower system should be gauged primarily by SAR2. SAR measured as escapement (SARI) seems the more relevant for the ESA survival and recovery standards which address all mortality sources, including harvest.

The Snake River wild steelhead SARI measure should be disaggregated into A-run and B-run components since the two runs experience different mainstem harvest policies and rates. Methods to evaluate spawner-to-spawner population responses also should be explored. A more thorough discussion of this issue within the context of steelhead stock structure and harvest rates is included in Idaho's comments on the proposed listing of Snake River steelhead (State of Idaho 1997). These previous comments should be considered by NMFS in developing the final Supplemental BiOp.

Appendix 1.5 cont'd.

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Williams et al. 1996. Return to the river: restoration of salmonid fishes in the Columbia River ecosystem (prepublication copy). Northwest Power Planning Council, Columbia River Basin Fish and Wildlife Program. Northwest Power Planning Council, Portland, Oregon. 580 p.

Williams et al. 1998. Response to the questions of the Implementation Team regarding juvenile salmon transportation in the 1998 season. ISAB Report 98-2. February 27, 1998. Independent Scientific Advisory Board, Northwest Power Planning Council and National Marine Fisheries Service, Portland, Oregon. 21 p.

Appendix 1.6

April 6, 1998

The Honorable Philip E. Batt
Governor of Idaho
Statehouse
Boise, ID 83720

RE: Social and economic concerns surrounding 1999 Decision Point

Dear Governor Batt:

The Idaho Fish and Game Commission (Commission) appreciates your continued leadership on salmon and steelhead issues. Since taking office, you have been very successful in bringing together diverse interest groups to develop the State's annual recommendations for interim migration strategies. This annual state-wide effort is unparalleled in the Northwest and has benefitted Idaho's salmon and steelhead within a balanced resource approach. The Commission requests your continued leadership to help the state and region decide on a long-term course of action regarding salmon and steelhead recovery.

The National Marine Fisheries Service (NMFS) is scheduled to decide on a long-term recovery strategy by the end of 1999, known as the 1999 Decision Point. This commitment is a requirement of their 1995 Biological Opinion (BiOp) on operations of the Federal Columbia River Power System. The Commission has joined the State of Idaho in requesting that the 1999 Decision Point not be deferred, and that the decision be made with the best available information.

Recovery options being assessed for the 1999 Decision Point fall into three basic categories:

1) Status quo smolt barging and flow augmentation (full smolt transportation, Dworshak and Brownlee drawdown plus 427 kaf flow augmentation from upper Snake River).

2) New and improved smolt barging and flow augmentation (surface collectors, reduced spill, more barges, greater proportion of fish barged, Dworshak and Brownlee drawdown plus existing or 1-3 maf additional flow augmentation from upper Snake River).

3) Natural river option (natural river in lower Snake River between Lewiston and Pasco; perhaps John Day to spillway crest or natural river; Dworshak, Brownlee and upper Snake River flow augmentation at existing levels or reduced to zero).

These options were arrived at by the states, tribes, and federal government within the regional forum. Expected biological consequences of these options are being analyzed by a group of scientists from NMFS, Corps of Engineers, BPA, and the states and tribes. This scientific process is known as PATH (Plan for Analyzing and Testing Hypotheses). The economic consequences of the recovery options (excluding John Day) are being analyzed by the Corps through their Environmental Impact Statement on the 1999 Decision Point.

It is becoming increasingly clear that the natural river option may be the best, and perhaps only, way to restore Idaho's wild salmon and steelhead. The Commission has not officially advocated the natural river option, or any other option, at this time. The Commission has joined the State of Idaho in advocating a long-term solution that embraces the "normative" river and phases out smolt transportation. As the 1999 Decision Point nears, the Commission is likely to endorse one of the three recovery options as the best biological choice based on available scientific information. The Commission recognizes that meeting the biological needs of the fish is only one piece of the recovery puzzle. Social and economic concerns are equally important if the recovery decision is to be successful. Without societal understanding, it is unlikely a biological solution will be politically feasible or sustainable. It is in this spirit that the Commission requests your leadership in helping ensure an honest and open discussion of social and economic issues among the citizens of Idaho and their decision makers.

The Commission understands your criteria for major changes to mainstem dams to include five essential points.

1) Must have a clear understanding of biological, social and economic effects.

2) Must have a high likelihood of biological success.

3) Must have broad-based social acceptance.

4) Adverse impacts to Idaho interests must be mitigated.

5) Funding for mitigation must be secured.

These are thoughtful and rational criteria. The biological components of these criteria are being aggressively addressed in-state by the Idaho Department of Fish and Game and regionally by the PATH process. The Commission is concerned that the social and economic components of these criteria are primarily being addressed by the federal government without direct Idaho perspective or insight.

The Commission requests your leadership in establishing an in-state public forum to begin addressing the social and economic issues surrounding the 1999 Decision Point. This effort would not attempt to duplicate the economic analyses generated by the federal process or the Northwest Power Planning Council, but would look at this and other information from an Idaho perspective. This proactive approach would hopefully allow the State to better influence long-term recovery decisions and ensure Idaho interests are benefitted as best possible, regardless of the final decision.

Appendix 1.6 cont'd.

We believe your approach to the energy deregulation issue provides a useful method to address the 1999 Decision Point. This approach does not require choosing a side on the issue. It simply recognizes that the decision is coming and that whatever the decision is, it will have significant consequences to Idaho. Local focus groups and publics can then sort out the available information to determine the best course of action.

The Commission appreciates your consideration of this request, and looks forward to our continued partnership in helping restore Idaho's salmon and steelhead.

Sincerely,

Frederick L. Wood, III, MD
Chairman
Idaho Fish and Game Commission

Appendix 2.0 Summarization of Reports Related to Salmon and Steelhead Options

Appendix 2.1 Summary: Return to the River Restoration of Columbia River Ecosystem. Development of an Alternative Conceptual Foundation and Review of Science Underlying the Columbia River Basin Fish and Wildlife Program of the Northwest Power Planning Council. The Independent Scientific Group. September 10, 1996

Appendix 2.2 Summary: Decision Analysis - Lower Snake River Feasibility Study. Final Report and US Army Corps of Engineers, Walla Walla District. Submitted by Harza Northwest, Inc. October 4,1996

Appendix 2.3 Summary: PATH - Plan for Analyzing and Testing Hypothesis: Conclusions of FY96 Retrospective Analysis. D. Marmorek and C.Peters, ESSA (Editors). December 10, 1996

Appendix 2.4 Summary: Plan for Analyzing and Testing Hypothesis (PATH): Preliminary Decision Analysis Report on Snake River Spring/Summer Chinook. Draft Report compiled and edited by D. Marmorek and C.Peters, ESSA Technologies Ltd. March 1998

Appendix 2.1

Summary: RETURN TO THE RIVER:
RESTORATION OF SALMONID FISHES IN THE COLUMBIA RIVER ECOSYSTEM

Report of the Independent Scientific Group to the Northwest Power Planning Council
September 18, 1996

Who is the ISG?

The Independent Scientific Group (ISG) was the science arm of the Northwest Power Planning Council. They were and still continue to be considered by the region to be impartial experts. There were 10 original members of the ISG made up of mostly academic types from throughout the northwest. The ISG has evolved into 13 members now called the Independent Scientific Advisory Board (ISAB) that supports both the Council's and National Marine Fisheries Service's impartial science needs.

What is the Report?

In the 1994 amendments to the Council's Fish and Wildlife Program the Council called on BPA to fund the Independent Scientific Group (ISG) to conduct a biennial review of the science underlying salmon and steelhead recovery efforts in the Columbia River ecosystem.

The report is a compilation of information that could form the basis of salmon recovery measures and policies in the future. A group of independent scientists produced the report after reviewing more than 4,000 scientific documents. It is in essence a review of the pertinent literature related to the needs of Columbia River salmon.

Why did the Council ask for the report?

Under of the Northwest Power Act of 1980, the Council is responsible for preparing The plan to protect, mitigate and enhance fish and wildlife and related spawning grounds and habitat of the Columbia River Basin that have been affected by the hydropower system. Under the Act the Council must utilize measures from the Council's Fish and Wildlife Program based on the best available scientific knowledge.

The Council's objective was to provide the region, to the best extent possible, a clear and authoritative analysis conducted by impartial experts.

Normative Ecosystem

The report develops the concept of a "normative ecosystem" approach to salmon recovery and management in the Columbia Basin. There are three key characteristics of the "normative ecosystem" process identified in the report:

1. Restoration of the Columbia River salmon must address the entire natural and cultural ecosystem.

Appendix 2.1 cont'd.

2. Sustained salmon production requires a network of complex and interconnected habitats from freshwater spawning and rearing grounds to the ocean that are created, altered and maintained by natural physical processes.

3. Life history diversity, genetic diversity and metapopulation organization (collection of core populations) contribute to the ability of salmon to cope with environmental variation.

Constructive Criticisms of the Current Council's Fish and Wildlife Program by the ISG

The current Fish and Wildlife Program appears to be based on the fundamental assumption that ecological processes that result in healthy salmon populations can be circumvented, simplified and controlled by humans. These actions represent "technological substitutes for ecological processes ... rather than actions that look at the broader context of salmon life history, behavior and habitat."

The ISG suggested that the fish and wildlife managers:

1. Adopt an integrated approach to salmon recovery that incorporates a comprehensive understanding of salmon life cycles, rather than a technological approach.

2. Recognize that salmon exist naturally as collections of populations (metapopulations) and that they should be protected. The Hanford Reach of the Columbia should be the model for this approach.

3. Reduce the sources of fish mortality throughout the ecosystem including the ocean and estuary.

4. Align future management decisions with the "normative ecosystem" concept and evaluate recovery actions against that concept.

In this *Conclusion and Implication,* the ISU states, "We conclude ... the dominant paradigm that has governed fisheries management . . . says that we can engineer an alternative system that works as well as the natural ecosystem." "This ... we find . . . to be fundamentally flawed." "We find the concept that we can engineer our way out of the present crises to be at odds with the prevailing scientific knowledge. This is not to say that technological solutions to particular problems will have no part in a successful recovery strategy or that the only solution is a return to natural conditions. On the contrary, we conclude that the social context of the Columbia River mandates the use of technology. However, to be successful, that technology must work with the natural physical and biological processes of the salmonid-bearing ecosystem rather than attempting to circumvent it."

"Although many measures may show positive incremental results, in total, they have failed to stem the decline of salmon and steelhead."

Conclusions and Implications, Chapter 11, p 507.

Appendix 2.1 cont'd.

Transportation

The Independent Scientists were asked for input on the issue of fish transportation in the 1998 Biological Opinion for steelhead. Using the Return to the River, ISAB/ISG concluded:

1. Application of the ISG's conceptual foundation to available information on transportation causes us to question whether any system of juvenile transport can be made compatible with the life history requirements of all migratory fish species and life history types native to the Snake River Basin.

2. Comparisons of transported and river-run fish should be evaluated by returns to the spawning grounds of individual stocks where the effects of transport on survival and spawning success may be measured for the full diversity of populations under management.

Appendix 2.2. Summary

Salmon Decision Analysis - Final Report to COE
By Harza Northwest, Inc. October 4, 1996

Background:

This report was contracted by COE for use in their preparation of the _Interim Status Report of the Lower Snake River Juvenile Salmon Migration Feasibility Study. November 1996 that responded to specific issues in the 1995 NMFS BiOp. The COE gave HARZA...significant *independence in developing this report. As such their (HARZA) content and conclusions do not reflect the policies of the COE. (Cover letter.)*

This reports brings the information on the two competing recovery options together and reviews them in a systematic manner against survival criteria that they set at 1.5% smolt to adult survival (SAR). They also find unless you can get a 30% increase in survival, extinction is likely to occur.

Purpose: *Lay out the options for improving the hydropower system to help save salmon*

Goal: *Provide biological criteria for each (option) path;* including
How much it will help salmon
How long it will be
How much it might cost

Three different options with up to 15 various actions applied to each option, (p.1-1)

Option 1: Transportation with and without additional structures(surface collectors);

Option 2: In-River: drawdown with natural river a) permanent or b) seasonal;

Option 3: Mixed-combine both Transportation and In-River. (Figure 1-1)

Options 1&2 are the major options. Options were evaluated in terms of *biological analysis* first, *benefits, costs, and risks* second.

To select a major option two questions must be answered:

1. *Do juveniles belong in the river or barges* (based on SAR criteria)?

2. *Regardless of how much better one OPTION maybe compared to the others, does it return enough adult salmon to reverse population declines* (based on SAR criteria)?

... *Answers to these questions are determined by comparing SAR for each option. If Option 1 or 2 provides 30% more adults, it is the option of choice. If less than 30%, then Option 3 - mixed, is picked, we establish a minimum SAR of 1.5% for wild spring/summer chinook for all options as the criteria for reversing declines. (p.1-3)*

Appendix 2.2 cont'd.

Given assumption of report:

- 1.5% SAR *returns enough adult salmon to reverse population decline* (p.1-3)
- maximum increase in juvenile survival with dams in place for In-River fish is 3% per dam from 46% to 56% (or *30%* increase in survival)
- SARs .9% to 1.2% require one to two dam removal
- SARs below .7% require four dam removal
- SARs below .7% cannot be improved to 1.5% in hydrosystem (p.1-6)

Findings:

- transportation gives smallest survival benefits - 10% improvement over existing
- •four pool drawdown gives largest survival benefit - 96% improvement

(p.1-7, Fig 1-4)

- *Habitat, harvest, and hatchery modifications are unlikely to improve survival with any certainty by 1999 compared to hydropower changes*

- *Permanent natural river has several benefits:*
  1 *All Snake River hydropower impacts are removed*
  2. *Provides maximum survival benefits*
  3. *Simplest to design and construct*
  4. *Restores . . . spawning and rearing habitat*
  5. *Accomplished in about five years*
  6. *Ten times less costly and three times faster to construct then seasonal drawdown.*

Spillway crest drawdowns are undesirable because.. they retain reservoirs and dams and with no guarantee of comparable fish benefits.

Seasonal full pool drawdowns are undesirable because engineering is complex..., construction costly and long (15 years), does little for adults... (p.1-9)

Conclusions:

1. *Do juveniles belong in the river or barges?*

Based on survival criteria salmon belong in the river. Transportation (barging in various forms) does not provide sufficient survival improvement for recovery. (Figure 4-1)

The In-River 4 pool permanent drawdown provides the most benefit and greatest certainty of recovery.

2. *Regardless of how much better one OPTION may be compared to the others, does it return enough adult salmon to reverse population declines?*

Appendix 2.2 cont'd.

Yes, several do. Only drawdown in various iterations i.e. seasonal with 2 or 4 dam drawdown or permanent drawdown (removal) met established survival *criteria.* (Figure 4-1)

KEY POINTS OF THE REPORT

... *recommends the elimination of further study of seasonal and/or partial drawdowns, Permanent dam removal is the only "drawdown" option that is worthy of further study.*

Partial drawdowns offer limited and uncertain biological benefits to fish.
(Item 1, p.1-15)

Quite simply, dam removal is the biological option of choice if salmon and ecosystem restoration is the primary goal. (Item 4, p.1.16)

...a *criterion is established . . . to avoid extinction... for wild fish of 1.5%... (SAR). Historic populations of Snake River salmon returned at the rates greater than 2.0%, so 1.5% is conservative.* (Item 8, p.1-17)

The potential to increase adult return rates...exists... by <u>*hoping*</u> *ocean productivity will improve. The ocean is uncontrollable but can have more influence on population changes than changes at the dams.* (Item 8, p.1-17)

In conclusion... The data cannot predict future ocean conditions. The data... cannot eliminate all risk and uncertainty. Although availing ourselves to as much data as possible, is a wise and prudent path in itself, sooner or later choices will come down to value judgment about our knowledge .. .
(p.1-18)

Delay in itself in deciding which path to choose is also a risk, action is needed to prevent extinction.
(p.2-7)

Appendix 2.3

SUMMARY: PATH - PLAN FOR ANALYZING AND TESTING HYPOTHESES

CONCLUSIONS OF FY96 RETROSPECTIVE ANALYSIS

December 10, 1996

Objectives of PATH (Page 1)

PATH is an interactive process of defining and testing logical framework of hypotheses relating to the Columbia River anadromous salmon ecosystem, while moving toward stock recovery and rebuilding**.**

PATH's objectives are to:

1. Determine the level of support for key hypotheses and provide guidance to management agencies on the implications of these analyses.

2. Assess the effects of alternative future management actions on salmon stocks. Advise various institutions on the consequences of alternative future management actions.

Question 1 (Page 2)

The first question, "Do all stocks show a similar pattern of recent change in stock indicators?" is important for understanding whether the trends in recent decades in endangered salmon stocks are affected by region-wide forces (e.g. climate) or stresses specific to those stocks.

Conclusions (Page 5)

1.1 "Although all stocks have declined somewhat since the late 1950's, we conclude with high confidence that all stocks do not all have the same long-term trends in number of spawners or recruits."

1.2 "We conclude with reasonable confidence that stocks originating from the Salmon River sub-basin and from the Upper-Columbia sub-basin show steeper pattens of decline since the late 1950s than do stocks originating from the lower Columbia sub-basin."

1.3 "We conclude with reasonable confidence that year-to-year fluctuations about the trends are strongly similar within the Salmon River, Oregon tributaries of the Snake River, and Upper Columbia River sub-basins."

- - -"long-term declines were more likely associated with factors affecting stocks which originate in those sub-basins, rather than some common factor affecting all monitored stocks within the Columbia Basin. Year-to-year changes about these trends, however, showed some similarities among both upper and lower river stocks, suggesting that some common environmental forces may have been operating."

Appendix 2.3 contd.

Question 2 (Page 2)
The second question focuses on the nature of difference among stocks.

1. Have productivity and survival rates of spring chinook changed and, if so, when? (Q2a)

   (Page 7)

   "We conclude with a high degree of confidence that the stock productivity and survival rate of the aggregate of spring chinook stocks have decreased over time, especially between the pre-1970 and post-1974 periods."

2. Is the difference between productivity indices in pre-1970 and post-1974 periods the same for upstream and downstream stocks? (Q2b)

   (Page 7)

   "We conclude with a reasonable degree of confidence that the stock productivity decreased between the pre-1970 and post-1974 periods more in upstream than in the downstream stocks."

   "We conclude with a high degree of confidence that the survival rate index decreased more between the pre-1970 and post-1974 period in the upstream than in the downstream stocks."

The third set of questions are on Page 4.

A. What do retrospective analyses indicate about the contribution of each of five factors (hydro, habitat, hatchery, harvest, and climate)?

HYDRO-SYSTEM (Page 9)

> "We are highly confident that the differences in stream-type chinook indicators of productivity and survival rates between upstream (Snake River sub-basins) and downstream (Lower Columbia sub-basin) stocks are coincident in space and time with development of the hydrosystem."
>
> "We are reasonably confident that the aggregate effects of the hydro system have contributed to reduced survival rates of Snake River stocks during the post-1974 period, as compared to the pre-1970 period."

(Page 10)

> "We are reasonably confident that the hydro system has contributed to decreased juvenile survival in the downstream corridor for Snake River stocks in the post-1974 period."

Appendix 2.4 contd.

FLUSH model about the effectiveness of transportation in mitigating the effects of the hydropower system.

Results

FLUSH Model:

The natural river option for the Snake River (A3) met the 100-year survival standard (Fig. 5.3-2) and the 48-year recovery standard (Fig. 5.3-3) under all assumptions using the State and Tribal Fishery Agencies' passage model (FLUSH). This is indicated by the distribution to the right of the 0.7 vertical line on Fig. 5.3-2 and to the right of the 0.5 vertical line on Fig. 5.3-3. The short-term survival standard was not met consistently (about half the simulations were to right of the 0.7 line; Fig. 5.3-1). This result reflects both the current high risk to spring/summer chinook populations and a sensitivity to the length of the pre-°removal° period: the longer the delay, the less likelihood of meeting the standard.

Neither the status quo (Al) or maximum transportation option (A2) met any of the standards using FLUSH (Figs. 5.3-1, 5.3-2, 5.3-3).

Only the natural river option in the Snake River (A3) consistently achieved future smolt-to-adult return rates (SAR) in the 2%-6% range, using the FLUSH model (Fig. B.5-2). Simulated median SARs ranged from about 1.5% to 3.5% for status quo; 1.5% to 3.1% for maximum transportation; and 3.0% to 7.0% for natural river options. Only those simulations exceeding about 2% SAR met the 100-yr survival standard (those to the right of the vertical line at 0.7 probability), which is consistent with the interim 2%-6% SAR goal established previously in PATH. Projected SARs for A3 were also similar to those reported by Raymond (1988) for Snake River spring/summer chinook during the 1960s.

CRISP Model:

None of the options meets or exceeds any of the jeopardy standards using the BPA/UW passage model (CRiSP) (Figs. 5.3-1, 5.3-2, 5.3-3). The natural river option (A3) performed slightly worse than Al and A2. This is expected since transportation provides better survival than the natural river in the CRiSP model.

Using CRISP, none of the options consistently achieved future SARs in the 2%-6% range (Fig. B.5-2). Like the FLUSH simulations, the only CRiSP simulations that met the 100-yr survival standard had 2% or higher SAR. However, with CRISP, none of the simulations exceeded 4.5% SAR. These median SARs ranged lower for all options than those estimated by Raymond (1988) during the 1960s.

Appendix 2.4

Summary: PATH Preliminary Decision Analysis Report Results on Snake River Spring/Summer Chinook

The PATH Preliminary Decision Analysis Report on Snake River Spring/Summer Chinook (Marmorek and Peters 1998) has the following five objectives for reporting results (p. v):

1. Explore ways to summarize complex analyses and results
2. Provide preliminary insights into performance (ability to meet NMFS jeopardy standards) of alternative actions
3. Identify key uncertainties or hypotheses
4. Test sensitivity of decisions to weights placed on key uncertainties or hypotheses
5. Summarize results for other important performance measures (harvest rates, smolt-to-adult return rates)

The preliminary report provides predicted outcomes for three alternative management actions for a range of hypotheses and assumptions. Actions are:

A1–status quo or BiOp actions
A2–maximum smolt transportation
A3–Snake River natural river with BiOp flow augmentation

Primary performance measures (p. 10-11) reported reflect the ability of the different actions to meet three NMFS jeopardy standards. Two survival standards address the need to maintain a minimum number of spawners to help ensure persistence over the short-term (24 years) and long-term (100 years). The recovery standard addresses delisting by reporting the average numbers of spawners projected at the end of a 48-year period.[1]

The preliminary report does not attempt to identify which hypotheses or assumptions are most likely correct based on empirical evidence and the Retrospective Analyses. The PATH group is currently developing an approach to weighting the evidence for spring/summer chinook, to be completed in fall 1998. Other selected management actions will also be modeled for spring/summer chinook during summer 1998. Final reports for spring/summer chinook, fall chinook and steelhead are scheduled to be completed in time for the 1999 Decision under the 1995 BiOp.

Results are presented separately by passage model, FLUSH (State and Tribal Fishery Agencies) and CRiSP (BPA/UW), because the two models represent different ways of estimating direct mortality through hydropower system, and because they are each associated with different interpretations about the relative survival of transported and non-transported fish after they leave the hydropower system. That is, the CRiSP model uses a more optimistic assumption than the

---

[1] The 24-year survival standard, as modeled, means that 80% of the populations (6 out of 7 modeled) must have a high probability (0.7) of the simulated number of spawners exceeding a threshold number (150 or 300), for 24 years into the future (starting with the 1995 BiOp). The 100-year survival standard has the same criteria, except for the longer time frame. The recovery standard is the fraction of simulations for which the average spawner level over the last 8 years of a 48-year period is greater than a specified level; the specified level is 60% of that observed before 1971. A high proportion (6 of 7) of the populations must have a moderate probability (0.5) of exceeding the recovery level.

Appendix 2.3 cont'd.

3. Can a combination of transportation under some conditions and in-river passage under other conditions compensate for the effect of the hydro systems? (p23)

 a combination of transportation and in-river passage measures is unlikely to increase survival rates to target levels,..."

4. Can drawdowns to spillway crest or natural river level compensate for the effect of the hydro systems? (p24)

"Drawdown of 3-4 Snake River dams to natural river level should compensate for hydro effects through that reach and yield overall juvenile survival from Lower Granite to Bonneville of 50-70%. However, we have not yet evaluated whether resultant smolt-to-adult rates would attain our target of 2-6%."

"Snake River spillway crest drawdown was not analyzed because it no longer appears to be a management option being considered by the region. It appears to be too risky a venture because it requires major structural reconfiguration of juvenile and adult passage facilities. The efficiency and safety of the new devices cannot be guaranteed."

Appendix 2.3 contd.

HABITAT CHANGES (Page 12)

> "We conclude with reasonable confidence that habitat degradation affected many Columbia River salmon stocks before 1975. Such past changes may still be affecting some stocks, though the habitat of other index stocks remains in high quality condition."
>
> "Though changes in the quantity and quality of freshwater spawning and rearing and pre-spawning habitat may have contributed to production declines in some index streams, we conclude with reasonable confidence that changes in adult-to-smolt survival do not appear to be of a great enough magnitude alone to explain the post-1974 decline in spring and summer chinook index stocks."

ARTIFICIAL PROPAGATION (Page 13)

> "Preliminary results suggest that artificial propagation of spring/summer chinook has not significantly contributed to declines in wild populations of spring/summer chinook in upstream areas (Snake and Upper Columbia River) between pre-1970 and post-1974

HARVEST (Page 14)

> "—an interim conclusion with a reasonable degree of confidence that harvest has not significantly contributed to declines in index upstream (Snake and Upper Columbia Rivers) stream-type chinook stocks between the pre-1970 and post-1974 periods."

OCEAN CONDITIONS AND TERRESTRIAL CLIMATE (Page 5)

> "We conclude with reasonable confidence that stocks differ in their degree of statistical association with selected indicators of ocean conditions and terrestrial climate, but there are no consistent differences in response between upstream/downstream stocks."
>
> "We conclude with reasonable confidence that climatic conditions have contributed to observed differences in stock indicators between the pre-1970 and post-1974 periods."

To what extent can management actions under consideration within each of these factors compensate for past impacts?

1. Can transportation of fish to below Bonneville Dam compensate for the effect of the hydrosystem on juvenile survival rates? (p18)

   "...Available information and analyses are presently insufficient to answer this question."

2. Can modifications to in-river passage, other than drawdown, compensate for the effect of the hydro system on juvenile survival rates? (p22)

   "It is unlikely that current and proposed in-river passage measures will achieve the interim smolt passage survival goal of 50-70%..."

Appendix 2.4 cont'd.

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Appendix 3. Issue Papers

Idaho's Anadromous Fish Stocks

Their Status and Recovery Options

Report to the Director

Idaho Department of Fish and Game

May 1, 1998
IDFG 98-13
Second Printing

Appendix 3. Issue Papers

Overview

To better understand the two major hypotheses, Issue Papers were developed to respond to common questions about smolt transportation and normative river assumptions. We used the following logic to develop these questions:

If smolt transportation has compensated for the dams, then why aren't the fish runs recovering? If the lack of adults is due to ocean and estuary conditions, then why are similar downriver stocks surviving two to five times better than upriver stocks? Why did this discrepancy only become evident after the dams were completed?

If upriver stocks are performing worse than similar downriver stocks because they enter the estuary at a different time or go to a worse place in the ocean, then why does existing data indicate similar migration timing and ocean distribution among these upriver and downriver stocks? Why did this phenomena begin at the same time the dams were completed? Why is this phenomena less apparent for years when migration conditions (flow and spill) in the lower Snake and Columbia rivers are relatively good?

If upriver stocks are performing worse than similar downriver stocks because of poor genetics or elevated disease, then why have upriver stocks shown the ability to rebound when migration conditions are favorable? Why does genetic monitoring indicate genetic integrity is still strong? Why doesn't pathogen monitoring indicate significant differences in disease history, prevalence and infection level between these upriver and downriver stocks?

If dams are removed there will be sediment release? Will there be lethal levels of sediment? How long will the effects last?

Appendix 3.1

Issue Paper: Sediment Considerations and Dam Breach on the Lower Snake River
Fisheries Bureau, IDFG, May 1, 1998

Will removal of dams create sediment that will harm fish?

Introduction

The following information is provided to give a sense of the types of considerations and possibilities when fish, flowing water, and sediment interact. Because potential impacts are dependent upon a myriad of factors (e.g., sediment type, fish species, fish size, water temperature, and others), extrapolation from one situation to another is problematic at best. Clearly, sediment can effect fish, given the variables and unknowns; however, probably the most productive considerations relate to how to manage sediment and its potential impacts. Lastly, from an ecosystem perspective the sediment that will travel downstream following dam breach on the lower Snake River should be considered episodic in nature; a large-scale event whose detrimental effects will be transient. Restoration of Idaho's salmon and steelhead resources is long-term in nature, and like other anadromous populations in the Northwest have survived past episodic perturbations.

Definitions and Units

Suspended sediment (SS) is typically measured in milligrams per liter (mg/L). Turbidity is an optical quality and can be measured in a number of different units, but generally these units relate the amount of light that can be passed or refracted from a suspension or the distance through which something can be seen. The relationship between SS and turbidity changes depending upon the size, shape, and type of sediment in suspension. A turbidity measured at one concentration of SS in one stream could be achieved at a lower or higher concentration of SS in another stream, depending upon the type of sediment in suspension. Jackson turbidity units (JTUs) are a measure of turbidity and relate the distance a light can be seen through a suspension.

Direct Impacts of Suspended Sediment on Fish

Direct impacts on fish include lethal and sublethal responses. These effects are related to a number of factors and among these factors some generalities can be made.

> Dose–dose is defined as the concentration of SS multiplied by the duration of exposure. SS concentration alone without duration factored in does not correlate with effects on fish nearly as well as dose does. As a result, when considering potential impacts of SS on fish, duration should be considered. The higher the dose, the greater the impact.
>
> Particle size and shape—The larger the particle (up to a point) and the more angular, the greater the impact.
>
> Water temperature—For salmonids, the higher. the temperature, the greater the impact.
>
> Fish size and lifestage—The smaller the fish, the greater the impact. This is believed to be related to the fish's ability to physically expel particles that enter the mouth.

Appendix 3.1 contd.

> Presence of other stressors—The greater the stress the fish is under prior to exposure, the greater the impact.
>
> Species—Some species are affected by SS differently than others. This may be due to size and behavioral differences. From laboratory experiments, it appears that chinook and steelhead may be more resistant to SS than coho or sockeye.

Lethal Impacts, Examples from the Laboratory

Recalling that sediment type affects impacts on fish, none of the studies below necessarily occurred with sediment similar to that behind the lower Snake River dams. Nonetheless, differential impacts under different conditions does provide some insight into the principles governing potential impacts to fish from SS.

At a concentration of Fraser River sediment in suspension at 2,100 mg/L for 96 hours, sockeye salmon experienced no mortality. As the concentration increased to 3,148 mg/L, trauma to gill tissues was evident. In one trial, 50 % mortality occurred at 17,650 mg/L while in another trial 90% mortality occurred at 13,000 mg/L. Coho salmon were used in a subsequent experiment by the same researchers using the same Fraser River sediment, and the fish never experienced more than 50% mortality even at 22,700 mg/L for 96 hours. Unfortunately, chinook and steelhead were not tested in either of these experiments.

In other experiments with a different sediment type, using coho and steelhead of similar size and under similar conditions (5,471 mg/L, 96 hours, 18.7C), coho experienced 10% mortality, but no mortality occurred in steelhead. In another experiment, it took almost twice the concentration of SS to elicit the same mortality rate in chinook as in sockeye.

In addition to different responses between species, differences also occur between different size fish of the same species. In one experiment with coho, 50% of the test fish died at a concentration of 8,200 mg/L for 96 hours. After these fish grew an additional 6mm and weight increased 40%, the concentration required to kill 50% of them over 96 hours increased to 22,700 mg/L.

Sub-lethal Impacts

Sub-lethal responses can occur at doses of SS cited above and less. The sub-lethal responses of fish observed in the laboratory include: elevated plasma cortisol and hematocrit levels (indicating stress), changed feeding patterns and reactive distances, decreased growth rates, decreased disease resistance, and use of turbidity for predator avoidance (a beneficial impact). Some of these responses were measured under conditions more favorable than those observed in the wild where wild populations not only persist, but thrive.

Appendix 3.1 cont'd.

Suspended Sediment Impacts at the Population Level

From the examples above, it is clear that sediment can affect fish on an individual basis when they cannot seek refuge. On a population level those effects and the ramifications are unclear; at least partly because suspended sediment and turbidity are factors fish have evolved with. Indeed, some of the largest producers of salmon on the west coast of North America are quite turbid and regularly carry a significant SS load. For instance, the Taku River (mean turbidity range 240-400 JTUs) and the Fraser River (>100 JTUs and up to 1,050 mg/L) in Southeastern Alaska. In the case of the Fraser River, the high level of SS also corresponds with the peak of smolt emigration.

Chinook have been observed rearing for extended periods in rivers with SS concentrations up to 61 mg/L. Estuaries which are generally turbid, typically have SS concentrations of >15 mg/L. A survey published in 1959 reported that peak values of SS in northwest streams were in excess of 10,000 mg/L. Another survey conducted in Oregon coastal streams reported that SS seldom exceeded 500 mg/L but at times could go as high as 7000 mg/L.

Sediment flushing from the Spencer Dam on the Niobrara River in Nebraska resulted in a SS concentration up to almost 22,000 mg/L. Over a period of five years these flushing activities resulted in mortality of at least 22,471 fish. However, the fish impacted were primarily resident, bottom-dwelling species, not migrating salmon and steelhead. When the Harpster Dam on the South Fork Clearwater River and the Lewiston Dam on the mainstem Clearwater River were breached, no dead fish were observed by IDFG personnel.

Generally, the main concern with sediment effects on salmonids in the Northwest is the detrimental effects on spawning and rearing areas and in impacting egg-to-parr survival. From an ecosystem perspective, in the case of the lower Snake River, rearing habitat could only be improved by breach. Spawning activity in the pools of the dams is negligible relative to what could potentially occur in a free-flowing Snake River and tributaries following breach. In 1993, an estimated 10 redds were constructed in the pools formed by the lower four Snake River dams, in 1994, 9 redds, and an abbreviated survey in 1995 found 0 redds.

Breach Options Being Considered for the Lower Snake River Dams

Options for breach under consideration by the U.S. Army Corps of Engineers, Walla Walla (the Corps), include different combinations of the number of dams breached at once. The two options being looked at most seriously at this time are breach of all four dams in one year and breaching two dams each year over two successive years. Due to administrative policies, the latter option would likely result in work beginning one year earlier than the former option. Removal of all four dams at once would return the river to a natural state sooner, decrease construction duration, and more work could be done out of the water under low flow conditions. Work would begin around August 1 and finish in December or January. The earthen portion of all four dams could be removed in six months at a cost of about $207 million dollars. Adult steelhead and chinook are in the river during the late summer and fall and fish ladders could remain operational. It's expected that under this scenario, significant amounts of sediment wouldn't begin moving downstream until the November – December time frame.

Appendix 3.1 cont'd.

Sediment Behind the Lower Snake River Dams

An estimated 100-150 million cubic yards of sediment reside in the pools behind the lower Snake River dams. In Lower Granite pool, this sediment is believed to be primarily silt with a smaller component of sand. From 47% to 95% of the particle sizes moving as bedload during the 1992 drawdown were less than 0.5mm in size, depending upon location and date, relative to peak drawdown. All of this material was less than 16 mm in diameter.

Removal of sediment from the bankfull channel of the Snake River through erosion is expected to take no longer than 5 years. At least 50% of this sediment is expected to be moved downstream within 2 years, depending upon conditions. This time frame is similar to that estimated on the Elwha River following removal of the Glines Canyon and Elwha dams and the Condit Dam on the White Salmon River. About 95% of the fine silt is expected to be removed in the first year following removal of the Condit Dam.

During the 1992 drawdown, suspended sediment increased from a background level of 9.5 mg/L to a high of 1,928 mg/L. Most measurements were substantially less than 510 mg/L, the next highest reading. The 1992 drawdown occurred during March and peak drawdown lasted 2 weeks. Inflow into Lower Granite pool during the drawdown averaged 30,100 cfs, which was 54% of the 18-year average. During the duration of the 1992 drawdown, the Snake River and tributaries eroded down to their original channels.

Based on observations during the 1992 drawdown, the Corps believes that there will be little opportunity to stabilize accumulated sediment and use it in the riparian reclamation process. Rather, due to the incised nature of the landscape and instability of the sediment, most of the sediment will be eroded and moved downstream. The ultimate fate of this sediment is uncertain, but a substantial portion will likely settle out in McNary pool

Snake River Channel Stabilization and Fall Chinook Use

The amount of time for the river channel and stream banks to stabilize are not known at this time, but the Corps is in the process of developing a model to answer these questions. The Elwha River is expected to remain unstable for 6-10 years following removal of the Glines Canyon and Elwha dams. Much of the 15 million cubic yards of sediment behind these dams is fine-grained silt and clay; potentially similar in size to the sediment behind the lower Snake River dams. As the gravel and sandbars of the Elwha River are restored following dam removal, it is estimated that the streambed will elevate 1-5 feet.

The amount of spawning habitat that would become available to fall chinook following breach in the lower Snake River is being addressed by the USFWS and USGS cooperatively, but that work will not be completed until June. However, based on maps from the mid 1930s, the Snake River, under what is now Lower Granite pool, contained 13 rapids, 46 pools, and 23 riffles. The average size of the riffles was 1,600,000 square feet, ranging in size from 94,000 square feet to 4,900,000 square feet.

Considering the short amount of time it took in for the Snake River to erode down to its original channel in 1992, it's possible that recolonization of the lower Snake could conceivably begin in a relatively short time frame, although time will be required to achieve streambed stability and a clearing of the gravels.

Productivity of rearing areas will require some time to re-establish as a flowing-water aquatic community fills in the newly created habitat. A model to examine productivity following breach is being built, but results are not yet available. It is likely that short-term losses in productivity immediately following breach will be minor compared to the long-term gain.

Managing Sediment Impacts

Sediment can affect fish individually and, under the right circumstances, on a population basis. Resolution of exactly what the sediment impacts following dam breach will be, will remain elusive; however, due to the absence of projects similar in size and scope. Perhaps the best question when considering breach of the lower four Snake River dams, and the sediment behind them, is how best to manage the sediment and minimize its impact.

Timing is probably the best method available for minimizing impacts. Within any given year, breach should occur consistent with timing that considers both the number of native species affected and species particularly susceptible to extirpation. Between year timing will also be critical. Questions of whether to protect strong brood years or weak ones will have to be addressed as well as which species warrant the highest level of protection. An additional management action for consideration is augmentation of spring flows with storage water following breach, to decrease the concentration of SS and thereby potentially reduce any impacts.

Appendix 3.1 cont'd.

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Appendix 3.2

Issue Paper: The Ocean Influence

Fisheries Bureau, IDFG May 1, 1998

Why *would the ocean be selectively bad for Snake River salmon and steelhead?*

Conclusion: Ocean conditions influence smolt-to-adult survival of salmon and steelhead. However, there have been no hypotheses advanced or evidence presented to explain why the estuary or ocean would be selectively bad for Snake River fish.

The following material is adapted from Schaller et al. (1996).

The conclusion by Schaller et al. (1996) that hydropower was a primary cause of productivity and survival rate declines of Snake River and upper Columbia River stocks was conditioned on evidence that the estuary and early ocean conditions do not have a systematically different effect on survival for interior Columbia River basin stream-type chinook stocks. This is reasonable in view of the similarity of these stocks, the overlap in time and space of these stocks during their early ocean residence (and beyond), and the broad-scale nature of climatic influences described in the literature.

There are several lines of evidence suggesting that the interior Columbia Basin stocks are exposed to similar estuary and ocean conditions, particularly during the critical first year. Beamish and Bouillon (1993) and others provided evidence that indices of climate over the north Pacific Ocean may play an important role in production of different species of salmon originating over a wide geographic range. Deriso et al. (1996) found evidence of a common year effect for these index stocks of stream-type chinook from the Snake River and lower Columbia River regions. Of the lower Columbia River stocks in this analysis, at least the John Day River and Warm Springs River spring chinook smolt timing appears very similar to that of Snake River spring and summer chinook. Smolts of these lower Columbia River, Snake River and upper Columbia River stocks migrate through the mainstem to the estuary primarily in late April and May (Lindsay et al. 1986, 1989; Raymond 1979; Hymer et al. 1992; Mains and Smith 1964). Current hypotheses regarding ocean survival of Pacific salmon generally focus on the juveniles' critical first months at sea (Pearcy 1988, 1992; Lichatowich 1993), where juveniles of these index stocks are most likely to overlap in time and space. Year class strength for these spring and summer chinook is established, for the most part, within the first year in the ocean, as evidenced by the ability of fishery managers to predict subsequent adult escapements from jack counts (e.g., Fryer and Schwartzberg 1993).

Since it appears that Columbia Basin stream-type chinook share a common estuary and nearshore ocean environment and a more common ocean distribution than stocks evaluated by Beamish and Bouillon (1993), it is very unlikely that differential estuary and ocean conditions could explain systematic differences in stock survival. The ocean recoveries of coded wire tagged (CWT) stream-type chinook were infrequent (Berkson 1991). The few recaptures (62 recoveries from 8 release years) from hatchery stocks in both the Snake River (21 recoveries) and lower Columbia River (41 recoveries) were widely scattered from California to Alaska ocean fisheries (Pacific States Marine Fisheries Commission unpublished data). The average annual proportion of CWT recoveries from

Appendix 3.2 cont'd.

ocean fisheries north and south of the Columbia River mouth appears similar between the Snake and lower Columbia hatcheries (Fig. 1).

It is noteworthy that even the lower Columbia stocks have been affected by hydropower, and that a portion of their recent decline may be hydropower related, rather than environmental. John Day River stocks, in particular, were likely subjected to a higher smolt passage mortality at John Day Dam relative to other stocks passing the dam between 1968 and 1984 (Lindsay et al. 1986). Development of the Canadian storage projects in the upper Columbia River in the mid-1970s, and hydrosystem regulation have reduced flows during the spring smolt migration for all stream-type chinook (Raymond 1988). Since Columbia Basin stream type chinook share a common lower river migratory corridor and estuary, changes that may have occurred due to the development of storage projects in the mid-1970s are unlikely to account for the differential decline in productivity and survival rates between the upriver and downriver index stocks.

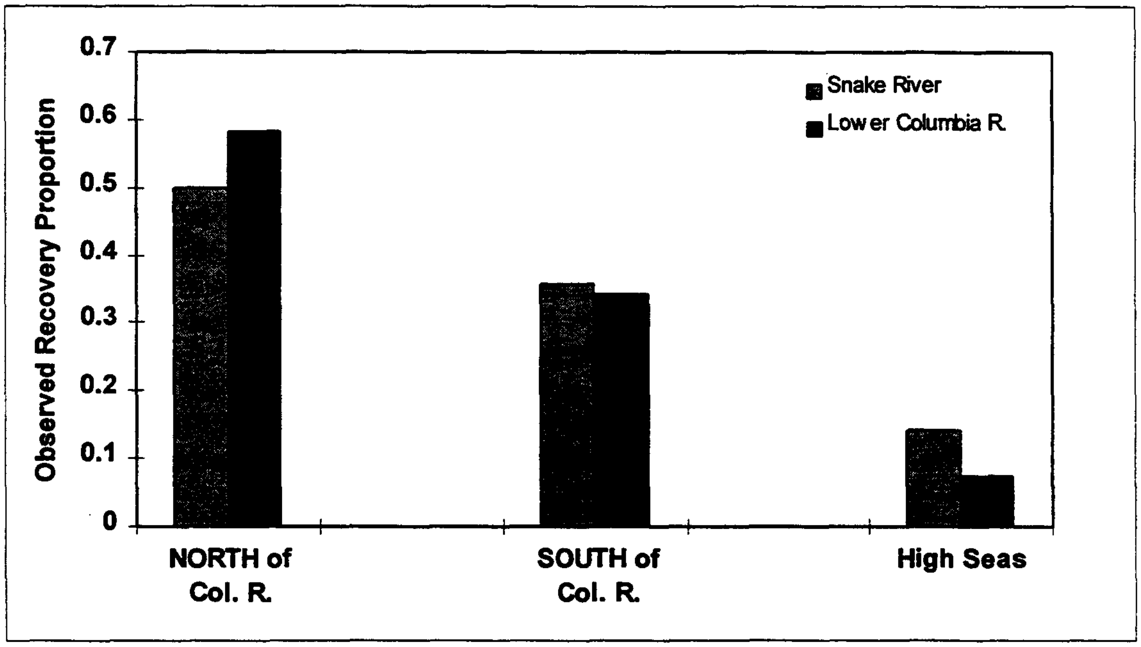

Figure 1. Observed coded wire tag ocean recoveries of Snake River and lower Columbia River `1983 through 1990.

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Appendix 3.3

Issue Paper: Fish Health and Stress Related to Transportation

Fisheries Bureau, IDFG, May 1, 1998

Does fish health suffer from the stress related to transportation?

CONCLUSION: Collection and barging through the upper Snake and Columbia River corridor represents the largest fish health danger to upper Snake River stocks of anadromous fish by exposing chinook to overwhelming stress and to horizontal transmission of etiologic agents, particularly *Renibacterium salmoninarum (RS),* Bacterial Kidney Disease (BKD).

Several aspects of fish health and stress issues are related to transportation. These are dealt within the context of the differences and similarities of spring/summer chinook stocks which PATH identified as being Snake River drainage, Upper Columbia River drainage, and Lower Columbia River drainages as follows:

- Snake River Stocks:
  - Upper Salmon River-Lemhi, Salmon River upstream of Yankee Fork
  - Upper Middle Fork-Marsh Creek/Cape Horn Creek
  - South Fork-Poverty Flats and Johnson Creek
  - Minam River of NE Oregon
  - Lostine River of NE Oregon

- Upper Columbia River Stocks:
  - Entiat River
  - Methow River
  - Wenatchee River

- Lower Columbia River Stocks:
  - Deschutes River
  - John Day River
  - Klickitat River
  - White Salmon and Wind Rivers

Data on fish health status of hatchery and wild, juvenile and adult spring/summer chinook was sought from ODFW, WDFW, and USFWS. The fish health database of the Eagle Fish Health Lab was also queried for the same information. The primary salmonid disease issue related to transportation, identified by NMFS and the Independent Scientific Review Group, has been BKD caused by RS. Consequently, our primary focus was to collect data on juvenile and adult chinook related to RS and BKD. Excellent cooperation was obtained from all the agencies. Most of the agencies provided detection data from enzyme-linked immunosorbent assay (ELISA) analyses conducted since 1991 when the application of ELISA became standard in the Columbia River Basin.

Appendix 3.3 cont'd.

FISH HEALTH ASPECTS OF COLLECTION AND TRANSPORTATION

There are several premises which relate to this issue: BKD has been implicated to be the cause of delayed mortality following release of transported chinook; BKD occurs in Snake River Basin hatchery chinook at a greater rate and level (prevalence and intensity of infection) than in chinook stocks from the two other locations identified by PATH; BKD is a problem of hatchery chinook and not of wild chinook; that IDFG has not taken steps to control BKD in its chinook hatchery programs; and that diseases other than BKD need to be addressed.

It is very important to emphasize the difference between detection of the pathogen (RS) which causes BKD and the clinical disease itself. This was the subject of a symposium sponsored by the Pacific Northwest Fish Health Protection Committee (PNFHPC, 1997). This point is often lost in discussions of this nature, but is the cornerstone of fish health. There is ample data indicating that detection of the disease agent does not always constitute disease. All managing agencies differentiate between detection and disease. Clinical BKD (the disease state) is associated with ELISA values greater than an optical density (OD) value of 1.0 and correlates well with observing RS from kidney smears by optical methods as well as the progression to the death of the host (Pascho et al. 1993). Environmental factors are key to whether the disease agent becomes problematic. These environmental factors include both those external and internal to the fish host. Most factors are stressors and some will be identified in the section on Stress to follow.

Premise: BKD CAUSES DELAYED MORTALITY

Bacterial kidney disease is a chronic, debilitating disease, meaning it causes mortality within a population over a long period of time following a protracted incubation period, which is inversely related to water temperature (Sanders et al. 1978). Post-challenge incubation periods usually exceed 100 days at water temperatures experienced during transportation and in the Columbia River estuary (Murray et at. 1992). Infections with RS have been shown to inhibit smoltification and delay salt water entry. Consequently, the mortality rate is exacerbated in salt water compared with freshwater (Banner et at. 1983). Therefore, BKD has been implicated to be a cause of delayed mortality. Infection rates in hatchery and wild chinook smolts captured at Jones Beach in the Columbia River estuary have been about 25% (Sanders et al. 1992).

Exceptions to this "rule" have been seen with Idaho and Oregon wild chinook taken as parr and reared in either fresh or salt water in the captive propagation programs. Mortality attributed to BKD has been more severe in freshwater than in salt water. Chinook demonstrated to be infected with RS were able to resolve the infection when reared under optimal conditions in salt water (Thorarinsson et al. 1994; Elliott et al. 1995). This provides a link between culture conditions, stress, and mortality to BKD (Congleton et at. 1984). These exceptions indicated that only those fish which had relatively high ELISA values subsequently succumbed to the infection and that those with low values were able to cope with and resolve the infection.

Appendix 3.3 contd.

CONCLUSION: BKD can be the cause of delayed mortality which may be amplified after entry into salt water particularly when initial infection rates are high and when environmental conditions which are not optimal.

Premise: BKD IS A HATCHERY DISEASE

Research by Pascho and Elliott (1991) on the effect of BKD and the transportation process examined ELISA values of wild and hatchery chinook captured at Lower Granite Dam. They concluded that both wild and hatchery chinook from the Snake River had detectable levels of RS by ELISA. Some years, the prevalence of RS in wild chinook exceeded that of hatchery fish. However, ELISA optical density values were generally low in wild fish. ELISA values of hatchery and wild chinook collected from the three sections of the Columbia River Basin considered by the PATH process will follow. A topic for which there is not much data is the correlation of ELISA value at collection with the subsequent mortality. This mortality data must be partitioned between those fish which were initially infected from those subsequently infected by cohabitation during the holding period.

Observations from IDFG's captive propagation programs which originate from collections of wild parr and smolt sockeye and chinook from three river systems illustrate that BKD was present in a small percentage of the wild fish. Mortality attributed to BKD which occurred within the first five months following collection was low indicating that these wild fish may have had RS in the carrier state but that progression to the disease state was rare. For Redfish Lake sockeye and Salmon River chinook, it appears that about 0.2% of over 1,000 sockeye smolts and 0.7% of the chinook parr carried RS. These rates of infection are similar to those found as "highs" within the Snake and Columbia River Basin areas shown in Table 1.

CONCLUSION: Both wild and hatchery chinook of the Snake River have detectable, but low intensity levels of RS.

Premise: INFECTION RATES ARE MUCH HIGHER IN SNAKE RIVER CHINOOK COMPARED TO RATES OBSERVED IN CHINOOK FROM THE UPPER COLUMBIA AND LOWER COLUMBIA RIVER AREAS

Survey data for juvenile and adult chinook from the areas of the Columbia River Basin areas identified by PATH are summarized in Table 1. Most of these data are from hatchery populations except for the ID/NE OR area. Some of these data originate from transportation studies on wild and hatchery chinook of the Snake River by Pascho and Elliott (1991). They demonstrated that RS could be detected in water of the post-collection holding raceways and barge holds and that brook trout contracted BKD when exposed to these environments. RS was not in sufficient quantity to be detected in waters of the Snake River outside of the barge hold. They also determined that chinook with ELISA values exceeding 2.0 (very high level) were those shown to shed RS into the water.

Chinook of all three areas have been demonstrated to harbor antigens of RS regardless of which area of the Snake River and Columbia River they originated from. Both the prevalence and intensity of infection of those originating from the Snake River Basin were

Appendix 3.3 contd.

frequently lower than those of either the Upper and Lower Columbia River Basin area. Detections of smolts with clinical BKD by ELISA are rare. These data illustrate the need to avoid the crowded conditions, such as barging, where horizontal transmission from the few "highs" could occur. The actual transmission of BKD from hatchery to wild chinook (or vise versa) through smolt collection and subsequent barging has not been demonstrated (Steward and Bjomn 1990).

Table 1. Comparison of adult and juvenile spring/summer chinook BKD ELISA categories for Snake River, Upper Columbia River, and Lower Columbia River for the years 1991-1997.

Idaho/Northeast Oregon					
	Number	BL	L	M	H
Adult	10,450	48%	29%	14%	9%
Juvenile	1987	66%	30%	3%	1%

Upper/Mid Columbia River					
	Number	BL	L	M	H
Adult	74521905	43%	41%	7%	9%
Juvenile		60%	29%	2%	9%

Lower Columbia River					
	Number	BL	L	M	H
Adult	5132	58%	18%	6%	18%
Juvenile	1330	52%	32%	8%	8%

Legend of ELISA Cut-off Categories:

BL = Below Low, ELISA OD <0.1
L= Low, ELISA OD 0.1 to 0.2
M= Moderate, ELISA OD 0.2 to 0.45
H= High, ELISA OD > 0.45

Appendix 3.3 cont'd.

CONCLUSION: BKD is no more prevalent in Snake River systems than elsewhere and infectious diseases would not constrain recovery of these stocks if migration conditions in the mainstem are corrected.

Premise: IDFG HAS NOT TAKEN MEASURES TO CONTROL BKD WITHIN ITS HATCHERIES

The evolution of fish culture methods for successful control of BKD in chinook has emphasized injection of returning adults with Erythromycin (Klontz. 1982), feeding the same antibiotic to juveniles (Moffitt and Schreck. 1988), and segregation rearing (with or without culling) of progeny from females demonstrated to be clinically infected with BKD (Pascho et al. 1991). IDFG has been proactive in the application of these practices over the last two decades. Application of the most effective combination of these practices has resulted in marked reduction in the occur^{r}ence of clinical BKD at IDFG facilities (Figure 1; Munson 1998). These improvements have been observed by reduced detection of clinically infected chinook at collection facilities of the dams on the lower Snake River (Maule et al. 1996; VanderKooi and Maule. in press).

CONCLUSION: Dramatic reduction in clinical BKD has occurred at IDFG facilities over the last decade.

Premise: DISEASES OTHER THAN BKD NEED TO BE ADDRESSED

Myxobolus cerebralis, the myxozoan parasite which can cause whirling disease was demonstrated to infect chinook at Sawtooth and Pahsimeroi Hatcheries in 1987. Facility management actions were implemented to limit exposure of small fish to the infective river water at both sites. This action has been demonstrated to be effective in Europe and has limited infections to the asymptomatic carrier state. Approximately 4.6% of wild chinook parr collected for the chinook captive propagation program have been shown to be infected with *M. cerebralis,* but whirling disease has not caused any mortality after 2.5 years of rearing. Infections of returning adults have also been at the carrier level. It is doubtful that this parasite exerts a limiting effect on chinook populations in the Salmon River.

Erythrocytic Inclusion Body Syndrome (EIBS) occurs at a higher rate in hatchery chinook (70%) than those produced naturally (50%) in the Snake River Basin (PNFHPC 1997). This viral condition, deemed "fuzzy-tail," has been shown to be debilitating to chinook at Rapid River Hatchery. It was especially prevalent in the late 1980's but has diminished dramatically once BKD was controlled with Erythromycin therapy (Munson 1998).

Appendix 3.3 contd.

STRESS ASPECTS OF COLLECTION AND TRANSPORTATION

A variety of biological, physical, and chemical factors are capable of challenging the physiological systems of fish, forcing the fish to adapt to survive. Selye (1950) described stress and the general adaptation syndrome (GAS) which states that if an animal is stressed long enough, the physiologic systems will adapt to accommodate the stress to maintain or reestablish a normal metabolism. Once the accommodating systems are exhausted, the animal will die. It is well established that acute and chronic stress that approaches physiological tolerance limits of fish will impair reproductive success, growth, resistance to infectious disease, and survival (Wedemeyer et al. 1990). The cumulative effects of stress may reduce recruitment to successive life stages and eventually cause populations to decline (Vaughn et al. 1984; Adams et al. 1985).

Several authors have described the stressors and the cascade of events that follow stress-related events during collection, barging and release of anadromous fish (Congleton 1984; Bjomn 1984, 1986, and 1987; Wedemeyer 1985; Pascho and Elliott 1993; Schreck 1998). Taken individually, these stressors may not be directly lethal, but the cumulative effect does change a group of individual stressors into a deadly gauntlet which poses the overwhelming threat at any life stage to wild and hatchery anadromous fish.

Location/actions which appear to be most stressful in the collection and transportation process vary in fish response. The separation step and loading the barges were found to be high point sources of stress for chinook. Lesser reactions were noticed during holding the fish in raceways (exposed to direct sunlight) and unloading the barges during these studies. Trucking fish exacted more stress from chinook than barging, because recovery from stress was achieved during barging. Transporting chinook with steelhead was more stressful to chinook than if chinook were transported without steelhead. Barge loads at near maximum densities created higher levels of stress than loads well below maximum density. Decreased adult return rates have been demonstrated from chinook with elevated stress levels during transportation. Stress and delayed mortality are related topics especially when dealing with BKD (Schreck, 1998; Pascho & Elliott, 1993). Cohabitation of high titer RS individual fish with low titer fish, exacerbates horizontal transmission, with the prolonged time of infection to death (up to 104 days). Thus, most deaths would occur in the salt water stage. Chinook which are disoriented, diseased, and/or with diminished smoltification are predisposed to predation after release from the barges and passage through dams (Schreck, 1998).

Smoltification and migration of chinook are normal, but chronically stressful events (Steward and Bjomn 1990). The success of regional anadromous fish restoration efforts rests on immediate improvements in the quality of the mainstem corridor (Bisbal 1998). Linkage of Idaho spawning habitats (and hatcheries) to the ocean is crucial to Idaho anadromous stocks. Mainstem alterations have slowed migration, supersaturated the water with nitrogen, and provided a beneficial habitat for predators (squawfish). Collection and barging have been implemented to circumvent these adverse migration conditions but are themselves inherently stressful. These additional acute and chronic stressors diminish and drain the anadromous populations' ability to survive. The cumulative effects of all factors natural and manmade, need to be considered. The unnecessary stressors should be eliminated from this process. IDFG feels that the choice of a normative river is the best way to achieve this result.

CONCLUSION: Collection and barging through the Snake River and Columbia River corridor represents the largest fish health danger to upper Snake River stocks of anadromous fish by exposing chinook to overwhelming stress and to horizontal transmission of etiologic agents, particularly *Renibacterium.*

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Appendix 3.4

Issue Paper: A Genetics Perspective to Fitness of Snake River Spring/Summer Chinook Salmon.

Fisheries Bureau, IDFG, May 1, 1998

Abstract

Snake River spring/summer chinook salmon persisted through an apparent bottleneck (period of low abundance) in the 1980s and again in the 1990s. Genetic analysis of samples collected from 1989 through 1994 revealed no changes in within or between population variability that could have resulted from the bottlenecks. Thus there is no evidence of genetic change occurring that would impact growth, survival, and reproduction in the population and preclude the population from rebounding should conditions change.

Introductory Concepts

Fitness of fishes can be quantified at either the individual level or the population level. Fitness of an individual fish is typically described as its ability to successfully reproduce, and is influenced by fitness-related traits such as growth and survival rates (Kapuscinski and Jacobsen 1987). The fitness of a population is a function of the fitness of individuals within the population.

The fitness of fish populations has been linked to the genetic variation measured in individuals or populations. Genetic variation is necessary for adaptation to changing environments and the ability to persist through environmental changes. Conversely, loss of genetic variation increases the chance of extinction in the long-term. At one extreme end of the spectrum, a population with no genetic variation possesses no adaptive or evolutionary potential, and in the long-term is not likely to persist. If individuals are unable to adapt to new environmental conditions, their survival and growth would tend to be reduced, hence a reduction in fitness.

Mechanisms owing to the loss population genetic variation are inbreeding, genetic drift, migration (gene flow), and selection (Kapuscinski and Jacobsen 1987). The greatest concern to managers at this time is the decade-long low abundance of Snake River spring/summer chinook salmon and the potential loss of genetic variation at these low abundances. At low population sizes (population bottlenecks) inbreeding and genetic drift are the primary causes of loss of genetic variation. The rate of loss of genetic variation due to inbreeding is inversely related to the population size, and is often expressed as F (the per generation rate of loss) = $1/2N_e$, where N_e is the effective size of the breeding population (e.g. Crow and Kimura 1970, Nunney 1992, Ryman and Laikre 1991). Robertson (1955) noted that inbreeding had its greatest effect on "fitness characters" related to reproduction. Genetic drift is a random process that leads to loss of genetic variation; its effects are also more pronounced at low population sizes.

Also of concern for many stocks of Pacific Salmon are genetic interactions between wild and hatchery stocks that may have negative genetic impacts on the wild populations (Waples 1991). The hybridization of wild and hatchery stocks may result in reduced interpopulation genetic diversity. If non-native stocks are allowed to interbreed with wild endemic stocks, a reduction in fitness may occur through outbreeding depression. Research is currently being conducted in the Snake River basin to measure the effects of hatchery outplanting on wild populations' genetic characteristics (Waples 1991, 1993)

Measuring Genetic Variation

The most commonly used technique in fisheries literature for measuring genetic variation is allele frequency data of selectively neutral alleles. Because selectively neutral alleles are examined, different genotypes that are revealed have no adaptive or fitness differences (Currens et al. 1986). This allele frequency information is used primarily to discern genetic differences between or among populations. Typically the geneticist is interested in identifying a unique species or distinct population segment(s) within a species. Metrics commonly reported in the literature to express the amount of genetic variation are proportion of all loci examined that are polymorphic (genetically variable) and the total amount of genetic variation (heterozygosity) observed in the samples. The total heterozygosity can be partitioned into the proportion due to variation within populations and the proportion due to variation between populations.

Fishery managers must be cautious in trying to infer future fitness information about populations from such genetic data. Currens et al. (1996) noted that there is both empirical and theoretical evidence that genetic variation is important for adaptation and long-term persistence, but neither of these can be predicted from allozyme [allele frequency] data. It is important to remember that although fitness levels cannot be predicted from genetic data, numerous studies have demonstrated reduced fitness owing to mechanisms that can reduce genetic variation (e.g. Kincaid 1976, Leary et al. 1985, Young 1995).

Snake River Spring/Summer Chinook Salmon

The recovery potential of Snake River spring/summer chinook salmon is dependent on the fitness of the population. We can not <u>predict</u> the future fitness (or adaptive or recovery potential) of Snake River Spring/summer chinook salmon. However, we can infer from genetic data whether recent reductions in population abundance (or fishery management actions such as hatchery releases) may have resulted in reduced population genetic variation that may lead to reduced fitness. If a temporal reduction in genetic variation can be demonstrated, we should conclude that some adaptive potential in the population has been lost. This does not proscribe the population to extinction or preclude the ability of the population to increase (e.g. Caro and Laurenson 1994).

Genetic analysis of Snake River chinook salmon populations has been conducted by Waples et al. (1993) beginning with collections made in 1989 and 1990. Marshall (1992, 1993, 1996) analyzed samples collected in Idaho from 1991 through 1994.

The findings of Waples et at. (1993) are summarized below.

> Snake River spring/summer chinook salmon are a genetically diverse group, and that more than 96% of the variation in allozyme loci surveyed exits as individual

> heterozygosity. (The authors further noted that Gyllensten (1985) noted a similar pattern of individual variation for other anadromous species.)
>
> "... population structure of in Snake River spring/summer chinook salmon occurs primarily at the level of differences between individual populations or groups of geographically proximate populations."
>
> ... it also seems unlikely that these populations are currently experiencing serious short-term problems associated with inbreeding." (The authors conditioned this statement on the assumption that their estimates of the effective numbers of breeders per year are accurate.)
>
> Results of tests comparing heterozygosity and indices of asymmetry "provide little evidence for a relationship between heterozygosity and asymmetry in any population."
>
> " ... the greatly reduced abundance of Snake River spring/summer chinook salmon has not been severe enough or protracted enough to substantially reduce levels of genetic variability in local populations."

Marshall (1996) provided a combined analysis of four years of Snake River spring/summer chinook salmon samples. Her conclusion was that despite the recent declining abundance of fish, genetic variation and diversity had persisted in the populations examined.

Summary

Some of the within population variability may have been maintained over time by the age-structured nature of spawning populations, where several age classes contribute to spawning in any one year. Marshall (1996) noted that between year variation in allele frequency was high in samples that could be temporally compared, and that this temporal variation was greater than that detected in large wild and hatchery populations in Washington. When multiple age classes spawn together, between year genetic variation is converted to within population variation. Although loss of genetic variation in Snake River spring/summer chinook salmon can not be demonstrated, the future potential loss should be a concern of fishery managers. Genetic impacts resulting from low population sizes are cumulative over time if a population bottleneck persists over two or more generations. Snake River spring/summer chinook salmon are at risk of loss of genetic variation and adaptive potential because of current low population sizes that may persist over several years.

Appendix 3.4 cont'd.

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Appendix 3.5

Issue Paper: Headwater Nutrient Loss

Fisheries Bureau IDFG May 1, 1998

Can a loss of headwater nutrients due to fewer carcasses explain the decline in survival rate of Snake River spring/summer chinook?

Conclusion: Headwater nutrients do not appear to be a dominant factor in accounting for declines in adult-to-adult returns to Idaho.

Loss of headwater nutrients due to fewer adult carcasses could potentially decrease stock productivity at small escapements through a reduction in survival rate or growth rate of juveniles. This mechanism would theoretically operate as depensation, wherein survival rate decreases (rather than increases) as population levels decrease. We have no indication that loss of headwater nutrients, or depensation in general, is currently limiting survival rate of Snake River spring/summer chinook. Several observations suggest that it has not strongly influenced the decline to date. However, maintaining adequate numbers of spawners throughout the species range is an important safeguard against potential depensatory mechanisms.

The Biological Requirements Work Group (BRWG 1994) reviewed available information on depensation, during development of recommended population threshold levels for ESA jeopardy standards. BRWG (1994) concluded that while the concept of depensation is widely accepted in the fisheries literature and forms the basis for recruitment overfishing, empirical evidence is difficult to obtain. Because of population theory and limited evidence, they assumed that depensation could be important for the Snake River spring/summer chinook populations.

The estimated numbers of smolts per spawner for aggregate Snake River spring/summer chinook from the 1975-1993 brood years have not shown a strong depensatory response (Petrosky and Schaller 1996). However, they cautioned that stronger populations tend to dominate recruitment patterns based on aggregate stock data, and those populations most likely experiencing depensation would be underrepresented in the aggregate. Thus the aggregate would be a relatively insensitive measure to detect whether a depensatory response, such as loss of headwater nutrients, was occurring.

If nutrient loss were a strong controlling factor in recent survival patterns of Snake River salmon, one might expect to see a less of a population decline in streams with high natural fertility. This is based on an assumption that nutrient inflow would be less important to parr and smolt survival rate or growth rate in more fertile streams such as the Lemhi River. The Lemhi River is one of the most productive Snake River spawning/rearing tributaries in terms of water chemistry (136 ppm total alkalinity; 8.1 pH and 300 ppm total dissolved solids; Bjornn 1966). Examination of patterns of progeny:parent ratios [In(spawner/spawner)]for brood years 1974-1992 (Figure 1) does not suggest a stronger recruitment pattern for Lemhi River spring chinook relative to other stocks in the Snake River Basin.

Appendix 3.5 cont'd.

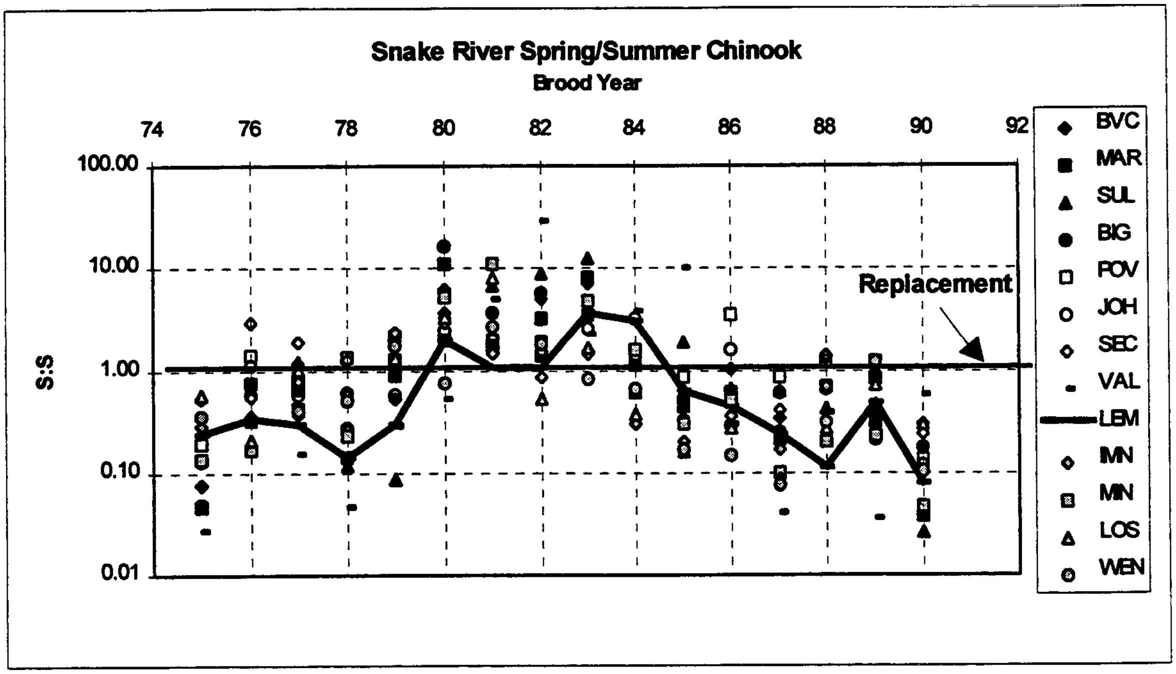

Figure 1. Spawner to spawner ratios (natural log scale) of 13 index stocks of Snake River spring/summer chinook, brood years 1975-1990. Stocks are: BVC—Bear Valley Cr., MAR—Marsh Cr., SUL—Sulphur Cr. and BIG—upper Big Cr. from Middle Fork Salmon River (ID); POV—Poverty Flat, JOH—Johnson Cr. and SEC—Secesh R. from South Fork Salmon River (ID); VAL—upper Valley Cr. and LEM—Lemhi R. from Salmon River (ID); IMN—Imnaha R. mainstem (OR); MIN—Minam R., LOS-Lostine R. and WEN—Wenaha R. from Grande Ronde River (OR). Data from Beamesederfer et al. (1997) and IDFG (unpublished).

If depensation (including limited nutrients from too few carcasses) were the primary mechanism depressing Snake River stocks, a decrease in spawner:spawner ratios would be expected at low spawner abundance. However, the only years in which Snake River index stocks consistently met replacement were the 1980-1983 brood years (Figure 1), which at that time included the lowest spawner numbers on record (Beamesderfer et al. 1997). The data show synchronous behavior between the populations which suggests factors outside the spawning/rearing tributaries have greater influence.

A plot of spawner:spawner ratios versus spawner numbers did not reveal a dominant depensatory pattern (Figure 2). In Figure 2, the data from Figure 1 were rearranged, and spawner numbers were normalized to the average during brood years 1975-1990. Spawner:spawner ratios tended to increase with decreasing spawner numbers (Figure 2). The patterns in Figures 1 and 2 suggest that depensation has not been strongly influencing recruitment patterns in the recent past, relative to other factors. However, data variability is high, and the possibility of depensatory response in the recent past cannot be completely ruled out.

Appendix 3.5 cont'd.

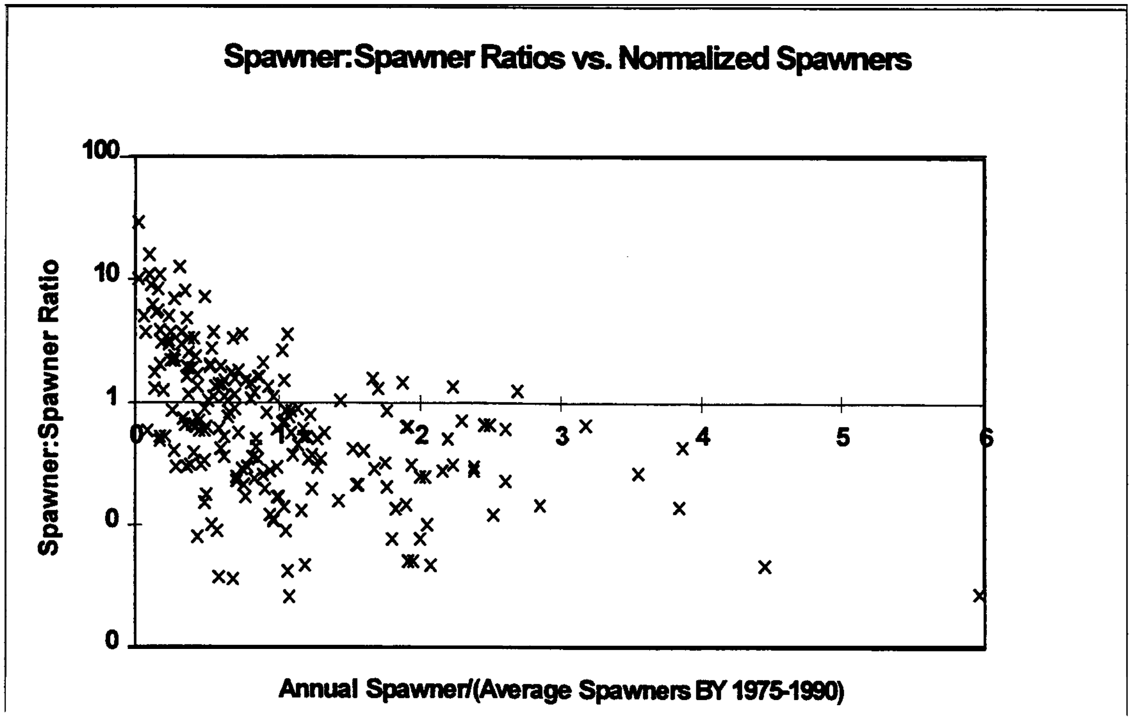

Figure 2. Spawner to spawner ratios (natural log scale) versus normalized spawners for 13 index stocks of Snake River spring/summer chinook, brood years 1975-1990. Normalized spawner numbers calculated as spawners/(average spawners brood years 1975-1990).

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Appendix 3.6

Issue Paper: Hypotheses for Delayed or Extra Mortality of Snake River Spring/Summer Chinook

Fisheries Bureau, IDFG May 1, 1998

Why has barging not worked to recover salmon?

The PATH Preliminary Decision Analysis Report on Snake River Spring/Summer Chinook (Marmorek and Peters 1998; Appendix A, p. 94) defines delayed or extra mortality as any mortality occurring outside the juvenile migration corridor that is not accounted for by:

1. underlying spawner-recruit relationships;
2. estimates of *direct* mortality within the migration corridor; or
3. common year effects affecting both Snake River and downriver stocks (delta model only).

A central issue of the competing hypotheses is whether smolt transportation has mitigated the effects of the hydropower system. The following three points are critical to understanding the issue: 1) survival rates of Snake River spring/summer chinook stocks *decreased more* after the hydropower system was completed than did survival rates of downriver stocks (above 1-3 dams); 2) most Snake River smolts have been transported for the past two decades; and 3) a relatively small proportion of smolts die directly during barge or truck transportation.

The "hydro" hypothesis attributes most of the differential decline in Snake River salmon survival to increased direct and delayed mortality of juvenile migrants due to the hydropower system (p. 38; Table 4.1-2; Appendix A, p. 95-99).

Both the "BKD" or "stock viability" hypothesis and the "regime shift" hypothesis attribute most the differential decline of Snake River salmon survival to factors other than the hydropower system (p. 39; and Table 4.1-2; Appendix A, p. 105-109). It follows that if delayed mortality due to the hydropower system is low, then the "non-hydro" factors must have had a systematically worse effect on Snake River salmon since the dams were constructed (Table 4.1-2).

These three alternative hypotheses considered in the Preliminary Decision Analysis (p. 38-39) were:

a) Hydro-related

The completion of the Federal Columbia River Power System in the late 1960s through the mid-1970s and it subsequent operation, have increased the direct and delayed mortality of juvenile migrants, resulting in considerably sharper declines in survival rates of Snake River spring and summer chinook stocks (over the same time period), than of similar stocks which migrate past fewer dams and are not transported. This hypothesis follows from Conclusion 3a.2 of the PATH FY96 Conclusions Document:

> *We are reasonably confident that the aggregate effects of the hydrosystem have contributed to reduced survival rates of Snake River stocks (from spawners to adults returning to the mouth of the Columbia River), during the post-1974 period, as compared to the pre-1970 period. Hydrosystem effects include both direct (e.g., turbine mortality) and indirect effects (e.g., delayed mortality, due to such mechanisms as changes in estuary arrival times).*

b) "BKD" or Stock Viability Hypothesis

The hypothesis proposes that 1) the viability of Snake River stocks declined as a direct or indirect result of the hydrosystem construction in the 1970s; 2) current extra mortality is not related to either the hydrosystem or climate conditions; and 3) extra mortality is here to stay, even if hydrosystem direct mortality is reduced and/or the climate improves. One hypothesis to account for decreased stock viability is that hatchery programs implemented after construction of the Snake River dams increased either the incidence in the level of bacterial kidney disease (BKD) within the wild population or its severity. In both cases, mortality increased in juvenile fish after they exited the hydropower system as compared to earlier years (or as compared to downstream stocks for the same time period). Under this hypothesis, it is unlikely that the increased rate of mortality from BKD would change back to a more favorable condition in the near future. Another stock viability hypothesis is that low stock sizes have led to increased predation rates on juveniles and insufficient nutrients from returning adults' carcasses to support growth of parr.

BKD is one possible means by which stock viability may have been reduced. Occasional changes in underlying stock viability may cause some or all of the delayed mortality to remain, even if direct mortality is reduced. The consequence of falling into this category (i.e., "delayed mortality is here to stay") is that it is unknown when or if the impacts will switch back to a [more] benign state. For modeling purposes, we consider this the worst case, which is that these factors will stay in the present less favorable state.

c) "Regime shift" Hypothesis

Extra mortality is not related to the hydropower system, but is due instead to an interaction with a long term cyclical climate regime shift with a period of 60 years. This regime is believed to have shifted from good to poor during brood year 1975, and is expected to return to above average conditions in 2005. The signatures of a recurring pattern of interdecadal climate variability are widespread and detectable in a variety of Pacific basin climate and ecological systems. These cyclical changes affect ocean temperatures and currents which affect distributions of predators and prey; and broad scale weather patterns over land masses which then affect temperatures, rainfall, snowpacks, and subsequent flows. The changes in conditions could affect various stocks to different degrees with the effect on Snake Rimer stocks being systematically different from lower river stocks. There is nothing we can do to change these patterns, but they are expected over time to provide more favorable and less favorable conditions to species located in different areas.

Appendix 3.6 cont'd.

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Appendix 3.7

Issue Paper: 1950s and 1960s Productivity

Fisheries Bureau, IDFG May 1, 1998

Were the 1950s and 1960s unusually productive years for Snake River spring and summer chinook?

Conclusion: The 1950s and 1960s may have been somewhat more productive than recent years, but we have no evidence that they were unusually productive to the extent that they explain declines in Snake River chinook.

Schaller et al. (1996) assessed historical patterns of productivity and survival rates for the aggregate upriver Columbia River wild spring chinook, 1939-1990 brood years. The upriver aggregate is all interior Columbia Basin spring chinook populations originating upstream of Bonneville Dam. This aggregate was dominated by Snake River and upper Columbia River populations prior to the major impacts of dam construction and operation (Fulton 1968; Hassemer et al. 1997); the downriver populations historically were a relatively small component. Therefore, the aggregate patterns, in large part, reflect the effect of hydropower system development on productivity and survival rates.

Schaller et al. (1996) concluded that spawner and recruit data of the aggregate upriver run of wild spring chinook for brood years 1939-1990 provided little or no evidence of a long-term, gradual decline in productivity and survival rate. Rather, the analyses provided support for the hypothesis that the productivity and survival rate of upriver spring chinook remained fairly stable from early hydropower development (1939) until the era of major hydropower development (about 1970), when major declines began. The same conclusions were reached by PATH in the 1996 Retrospective Analysis Conclusions document (Marmorek and Peters 1996). Productivity is defined in these studies as the number of recruits per spawner in the absence of density dependent mortality; survival rate is defined as the residuals about the fitted spawner-recruitment relationship. The following discussion is adapted from Schaller et al. (1996).

Analysis of covariance and least square means tests in Schaller et al. (1996) found no differences in productivity estimates between the periods 1939-1949, 1950-1959 and 1960-1969. Productivity estimates from the periods 1970-1979 and 1980-1990 were significantly less than any of the early periods. This aggregate provides a longer time series of R/S data than any of the index stocks. The indices of climate change over the Pacific Ocean, which Beamish et al. (1997) linked to sockeye salmon (O. *nerka)* production, varied widely from 1939 to 1970. Interestingly, the productivity of the aggregate remained fairly stable (relative to post-1970) through these decades and then decreased coincident with the period of major hydropower development and operation.

Plots of survival rate indices for the aggregate upriver run (Schaller et al. 1996) also indicated the major declines in survival rate began about 1970 (Fig. 1). In the period 1939-1949, annual survival rates ranged from about 40% to 200% of the 1939-1969 average. Annual survival rates in the 1950s and 1960s ranged from about 60% to 200% of the 1939-1969 average. After 1970, survival rates have ranged from less than 10% to 70% of the 1939-1969 average.

In addition, Deriso, et al. (1996) estimated a common year effect between Snake River spring/summer chinook and downriver spring chinook populations for the 1960-1990 brood years (Fig. 2). Downriver populations were from the John Day, Warm Springs, Klickitat and Wind rivers, above one to three dams. Examination of the common year effects indicates that the 1950s and 1960s had generally better survival (presumably in the ocean phase), than the 1970s and 1980s, but that both periods had good and poor years.

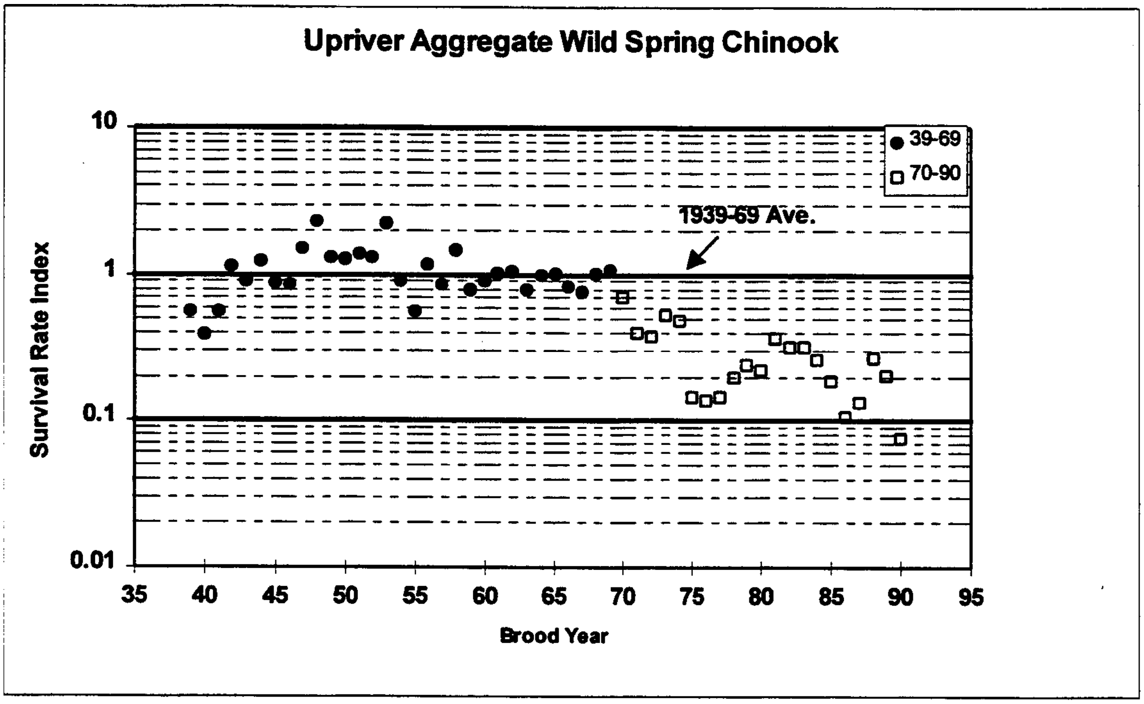

Figure 1. Survival rate indices [$(R/S_{obs})/(R/S_{pre\text{-}1970})$] for upriver aggregate wild spring chinook, 1939-1990 brood years. Upriver aggregate is all spring chinook upstream of Bonneville Dam. Sequence of dams (year of initial service) were: Bonneville-1938; McNary-1953; The Dalles-1957; Ice Harbor-1961; John Day-1968; Lower Monumental-1969; Little Goose-1970; and Lower Granite-1975.

Appendix 3.7 cont'd.

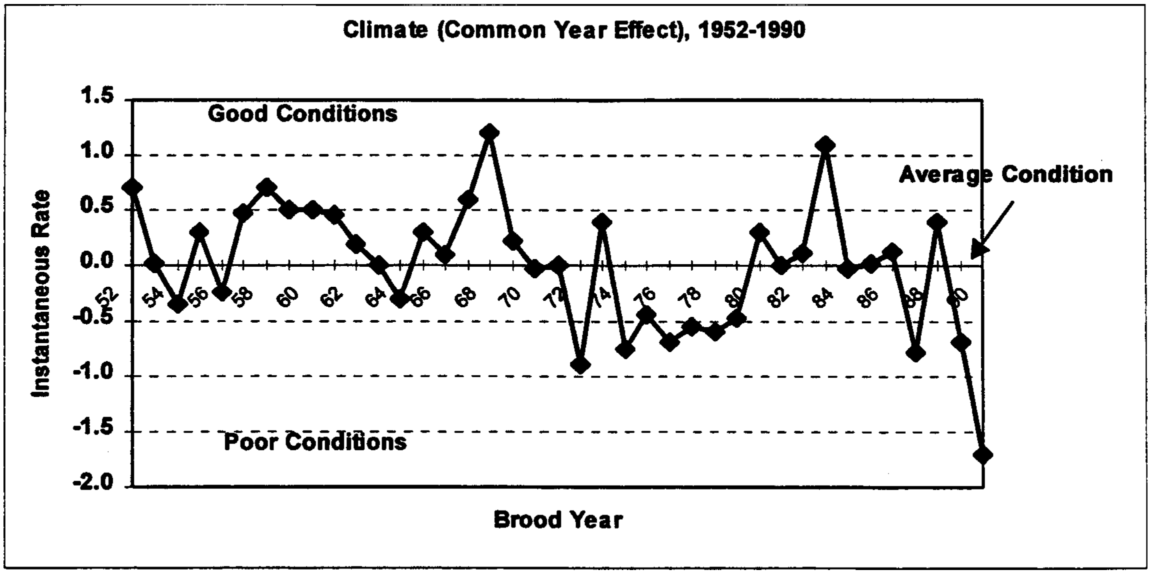

Figure 2. Common year effects estimated by Deriso et al. (1996) between Snake River and downriver stocks of spring/summer chinook. Values above and below the 0 line indicate that survival of both stock groupings was better than average, and worse than average, respectively. (adapted from Deriso et al. 1996; Fig. 5-1, S-R Model with VVTT).

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Appendix 3.8

Issue Paper: Surface Bypass and Collection System Options For Lower Snake River Dams

Fisheries Bureau, IDFG, May 1, 1998

Will surface bypass technology allow for recovery of Snake River salmon?

Conclusion: We do not know. At this time, the supposed benefits attributable to surface collection implementation are speculative at best.

Present juvenile fish collection systems at the four Lower Snake River Dams utilize mechanical turbine intake screens, developed around existing powerhouse intake structures. These systems, have limited effectiveness in diverting and collecting large numbers of migrating, juvenile salmonids. They subject migrants to very turbulent flows, high velocity and violent pressure changes. We now strongly suspect these conditions stress and injure fish.

In an attempt to improve smolt survival through their mainstem dams, the Corps of Engineers (COE) and others are developing a new type of juvenile fish bypass system called a surface flow bypass (SFB). This new bypass is modeled after the successful smolt bypass at the Wells Dam on the Mid-Columbia River. A SFB uses intake baffles to increase forebay water velocities to attract migrating salmonids into a safe passage route through the dam. It is hoped that a SFB in the forebay will take advantage of the behavioral tendency of juvenile fish to swim in the upper water levels of the reservoirs. Besides reducing injury and stress levels, a SFB system may also reduce the time that smolts spend in the forebay area close to the dam structure as they attempt to find the entrances to the turbine intakes. A major leap in pursuing this new technology, is the assumption that the COE's Snake River projects (side-by-side powerhouse and spillway) can be modified with forebay installed surface collection systems (SBC) to effectively simulate the "hydro-combine" type of construction use at Wells Dam.

The SFB strategy at Wells, referred to as hydrocombine spill, has demonstrated very high fish passage efficiency. Testing has repeatedly born out FPE at approximately 90% for spring and summer migrants (Skalski, et al. 1997). It should be pointed out, that SFB at Wells Dam is a completely developed, *full* powerhouse system that has several characteristics worth considering with respect to SFB/SBC development elsewhere. There are five vertical slot entrances passing approximately 11,000cfs (5-7% total project discharge). Well's SFB entrances are *uniformly* spaced across the entire powerhouse. Fish have no other alternative passage route because of the hydrocombine structure. At other dams, smolts typically have multiple passage routes horizontally, especially during spill. The Wells system works as *a system* and extending this to prototype SFB/SBC work at other locations may not be straightforward.

Based on the success of the Wells SFB system, the National Marine Fisheries Service (NMFS) called for immediate testing of a similar system at COE dams on the Snake and Columbia rivers (1995 Biological Opinion). The COE initiated an investigation on the engineering feasibility of installing a prototype surface bypass collector at Lower Granite

Dam in 1996. Test results from 1996 and 1997 were similar, and SBC efficiency relative to the turbine units it covered (Units 4-6) was only 37% to 42% (Johnson et al. 1998). Regional salmon managers have repeatedly indicated that a minimum standard for SBC efficiency should be 80%. The COE has interpreted the results somewhat differently, claiming that evaluation results have established a "proof of concept", and are proceeding with further testing in 1998.

Surface bypass system testing at Lower Granite in 1998 calls for a spring migration test. The existing prototype was extensively modified since the last test. The SBC now has a Simulated Wells In-sert (SWI) attached to the lower end of the structure (Figure 1). In effect, the device now has a false ceiling that aligns with the turbine intake ceilings at turbine 4-6. Model test results indicated that adding the SWI would flatten flow lines into the turbines beneath the SBC and reduce the downward component of flow in the intermediate zone (0-30m) in front of the collector. In addition, a behavior guidance structure (BGS) was constructed and will be attached to the end of the SBC between turbines 3 and 4. The BGS is a steel curtain, 335m long, extending form the SBC upstream to the south shoreline of the forebay (Figure 2). The curtain is 24m deep where it intersects with the SBC and tapers to 17m at its upstream end. The BGS addition is an attempt to improve fish guidance by changing the horizontal distribution of smolts approaching turbines 1-3 and guide them towards units 4-6 and the SBC device.

The salmon managers have strongly urged the COE to make the 1998 SBC/BGS evaluations the "decision-point" for the future of the surface flow collection program. The future of SFB systems has been made more complicated due to the number of SBC system options the COE has chosen to consider for installing a production system at Lower Granite. The Walla Walla District has released a report under their Lower Snake River Feasibility Study calling for 10 different SBC options to be analyzed in their final attempt to select an alternative to improve downstream migration survival of smolts at Lower Granite Dam (Sverdrup Engineering, 1998). A brief description of each of the options and the estimated costs is attached. Also included is a short SBC Combinations Summary for all four lower Snake River projects, which the COE provided (Bruce Collison, personal communication). From where the Department sits, it would appear that final selections for not only Lower Granite, but for the other dams as well, will require years of further testing, delaying the recovery decision point.

The pursuit of SFB systems is not only time consuming, but also costly. To date, the COE has spent $45.4 million (including 1999 requests) in its evaluation of the Granite prototype. Plans in place (beginning 1998) to evaluate SFB systems at Bonneville and John Day Dams will practically "bankrupt" the COE's annual appropriations under the Fish Mitigation Program. It has been the Department's position that surface bypass evaluation at other COE projects should be delayed until the results of the Granite prototype are fully analyzed, and its use proven as a fish survival improvement measure.

It is obvious that the action agencies of the FCRPS are counting on assumed and unverified benefits from production SFB systems to significantly improve juvenile fish survival. Therefore, surface collectors are an important part of the "improved transport" recovery option being considered for the 1999 Decision Point.

At present the Lower Granite prototype SBC is diverting all migrants entering the device over the project's spillway. In order for SFB to become an operational component to juvenile transport, the COE must also design, test, and evaluate a dewatering system that will demand technology and facilities that are beyond any typical application in use currently. By their own admission, the COE points out that screens required to dewater volumes in the range of 2,000 to 4,000 cfs, stretches existing technology to their limits. Not only is the overall area of screening large, but the depth of the screens below the water surface is well beyond where standard screen cleaning technology exist. The design, testing and eventual installation of these new dewatering systems, necessary for SBC diverted smolts to be transported, is a decade away. Currently the COE , is somewhat more optimistic, and feels that a production SBC could be coupled to the Lower Granite bypass/transport system by 2004 to 2005 (Mike Mason, personal communication). This estimate assumes that congressional funding would not be major hurdle once appropriations are requested.

At this time, the supposed benefits attributable to surface collection implementation are speculative at best. PATH has not modeled any recovery options using a range of assumed survival benefits associated with retrofitting the dams with SFB systems. Whether increased survival rates for juvenile salmonids collected/transported with surface collections systems can place transport SARs into the "recovery" range is also unknown. What is known, is that many of Idaho's listed stocks will not wait for options that may not be in place until the end of the next decade.

Would additional flow augmentation be necessary with surface bypass?

Surface bypass options have not been fully defined or modeled, but such an option would likely include additional flow augmentation. Under a surface bypass option, transportation from Snake River projects would not be operating; smolts would be bypassed back into the reservoirs. Alternative A6 is described as follows (Marmorek and Peters 1998; Appendix C):

> This alternative represents Federal system operation in the future without drawdown but reflect operational changes brought about by installation of various fish passage improvements such as surface bypass collectors, gas abatement facilities, etc. Flow augmentation is sized to match with the available facilities and appropriate fish passage routes. [Operating requirements have not yet been determined for this alternative]

No modeling of this alternative has been completed, nor the quantity of additional flow augmentation defined. In addition to estimating effects of flow on inriver survival the modeling analysis will need to consider the range of possible scenarios for dam passage, including guidance efficiency into the bypass collectors and direct and indirect bypass mortality.

Available information suggests that additional flow augmentation would increase reservoir survival of spring/summer chinook under this alternative. Both the State and Tribal Fishery Agency (FLUSH) and BPA/UW (CRiSP) passage models indicate survival through reservoirs decreases with delayed smolt migration. In turn, speed of the smolt migration through full reservoirs depends on flow. The effect of fish travel time on reservoir survival is more pronounced in FLUSH than in CRISP; thus flow augmentation would have relatively more effect in the State and Tribal Fishery Agencies' passage model.

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Appendix 3.9

Issue Paper: Ocean and Estuarine Predators

Fisheries Bureau, IDFG, May 1, 1998

Do predators control the recovery of Idaho's salmon and steelhead?

Conclusion: Although birds, fish, and mammals consume salmon in the ocean and estuary, there is no evidence that predators select for, caused the decline of, or are preventing recovery of Idaho salmon and steelhead. Nevertheless, dramatic increases in bird predation at the Columbia River mouth since 1990 appear to be a problem that should be addressed to increase survival of all stocks.

BIRD PREDATION

Caspian terns and cormorants nesting on man-made islands may take 20 to 40 percent of the salmon and steelhead smolts that arrive at the Columbia River estuary between mid-April and mid-July (Pollard 1998). Tern nesting in the estuary increased from none prior to 1984, to more than 8,000. pairs after dredge spoils were used to create islands. Cormorant nesting increased from 200 pairs prior to 1987, to 6,000 pairs after portions of the islands were protected from erosion with large rock. Most of the increase of 30,000 large fish-eating birds has occurred since 1990. Consumption estimates do not include unknown numbers of gulls, which also feed on smolts in the estuary. Bird feeding activity is intense where smolts are concentrated by wing piling and dredge islands to a 600-foot wide navigation channel. There is no evidence that this predation is selective for Idaho stocks, or caused their decline, although highly stressed fish are known to be more vulnerable to predators. Bird colonies in the estuary consume many more smolts than the 5.5 million °saved" by transportation around the dams in 1997. The NMFS, USFWS, and USACOE have discussed alteration of man-made islands to discourage bird nesting in the Columbia River estuary. IDFG strongly supports immediate implementation of measures to return bird predation to low levels.

FISH PREDATION

In some years predators such as pacific mackerel may deplete juvenile salmon in near-shore areas before they move to the open ocean (Chapman 1997). These impacts increase when concentrations of predators move north during ocean warming cycles. Steelhead and sockeye salmon may be somewhat less vulnerable than chinook and coho because they move offshore as soon as they leave the estuary. Idaho spring-summer chinook and similar downriver stocks are vulnerable as they move north along the coast enroute to feeding areas off the Aleutian Islands. Fall chinook could be affected even more because they remain inshore longer, disperse north and south of the Columbia River, and are smaller that spring-summer chinook and steelhead when they enter the ocean. Snake River fall chinook returns have been relatively stable since 1975, however.

Appendix 3.9 cont'd.

MARINE MAMMAL PREDATION

California sea lions on the West Coast have increased at more than five percent annually to about 170,000 animals following passage of the Marine Mammal Protection Act in 1972 (NMFS 1997). The more common pacific harbor seal has shown similar increases. Relatively small numbers of seals and sea lions become a problem primarily in areas where salmonids concentrate or are caught in fishing gear. In other areas seals and sea lions generally feed on other fish; consequently this source of mortality has little significance for most stocks. Peak numbers of 3,000 seals and 300-500 sea lions consume salmon, steelhead, and other fish in the lower Columbia River from the estuary to Bonneville Dam, primarily during the winter months. Much of this time salmon and steelhead do not comprise the majority of their diet however. Salmonid predation that does occur is not likely to select Idaho fish over other stocks present in the area.

Distinct populations of killer whales that inhabit the inside passages of British Columbia feed almost exclusively on salmon. They prey primarily on salmon stocks resident in, or returning to those waters. Idaho steelhead pass through these areas on their return to the Columbia River, however killer whale predation is not known to be a factor limiting salmon and steelhead populations in general.

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Appendix 3.10

Issue Paper: Ocean and In-river Harvest

Fisheries Bureau, IDFG May 1, 1998

Does harvest keep Idaho's salmon and steelhead from recovery?

Conclusion: Harvest has not caused the decline leading to listing of wild Snake River salmon and steelhead. Idaho spring-summer chinook undergo little fishing mortality in the ocean. Spring-summer chinook harvest rates are also low in tribal ceremonial and subsistence fisheries in the Columbia River basin; commercial harvest is closed. There is no known harvest of Snake River sockeye. Incidental wild salmon and steelhead mortalities in sport fisheries for marked hatchery fish have been estimated to be minimal, and are closely monitored to ensure they do not constrain recovery efforts.

Some Idaho runs are harvested at rates inconsistent with ESA protection. Spawning escapements of large Group B wild steelhead, which return only to Idaho, are perilously low. In addition to poor mainstem migration conditions, wild B steelhead escapements are further reduced by harvest rates of 30 percent in Columbia River fisheries for fall chinook and steelhead. Harvest rates in the ocean and Columbia River also reduce spawning escapements of threatened Snake River fall chinook.

OCEAN HARVEST

The ocean harvest of Snake River fall chinook has been estimated at 35 to 40 percent of the stock in recent years (NMFS 1996a). By comparison, releases of several million coded-wire tagged spring-summer chinook from Idaho hatcheries between 1976 and 1987 resulted in only 32 recoveries in the ocean. While this is partially due to dramatic reductions in survival of these fish, Idaho spring chinook in particular seem to spend most of their time offshore of major fisheries. Sockeye and steelhead also are distributed offshore and not targeted by ocean fisheries. Summer steelhead show up in local fisheries as they return to the Columbia River along the Pacific coast, however the numbers are insignificant. The Japanese high seas drift net was eliminated by international treaty in 1992. Drift net fisheries on the high seas formerly took less than three percent of the Pacific Northwest steelhead stock (NMFS 1996b).

COLUMBIA RIVER HARVEST

Treaty rights held by the Columbia River tribes account for most of the limited harvest of salmon and steelhead that still occurs in the mainstem Columbia River. All mainstem harvest and incidental mortality of spring-summer chinook has averaged seven percent of the run since 1978 (Figure 1). Harvest losses have totaled 4.5 percent of the Columbia River sockeye run since 1989 (TAC 1997a). The chance of Idaho sockeye entering the harvest is considered remote because estimated numbers at the mouth of the Columbia River have averaged only five fish since 1989. Snake River fall chinook have been harvested at 25 to 30 percent in recent years (TAC 1998); this fishery, combined with ocean harvest, limits spawning escapements. Approximately 30 percent of the wild B steelhead run has been harvested in the Zone 6 tribal fishery in the fall. This also reduces escapement to the spawning grounds (TAG 1997b). Sport harvest of wild steelhead has been prohibited in the Columbia River since 1986. Incidental mortality estimates are not available for most sport fisheries, but probably are similar to Idaho estimates of two percent at the population level (IDFG 1997).

TRIBUTARY HARVEST

Tribal fisheries in Idaho have harvested relatively few fish in recent years (TAC 1997c). Sport fisheries for marked hatchery spring-summer chinook occur infrequently and are closely regulated based on catch-and-release estimates for wild fish. Incidental mortality of wild steelhead in hatchery fisheries is estimated to have been 1.6 to 3.6 percent from 1990 to 1996 (IDFG 1997). No harvest or incidental mortality of sockeye salmon is known to have occurred in Idaho since sockeye fishing was closed in 1965.

Salmon and steelhead rearing areas statewide are managed with special regulations to minimize or eliminate sport harvest of juvenile anadromous fish.

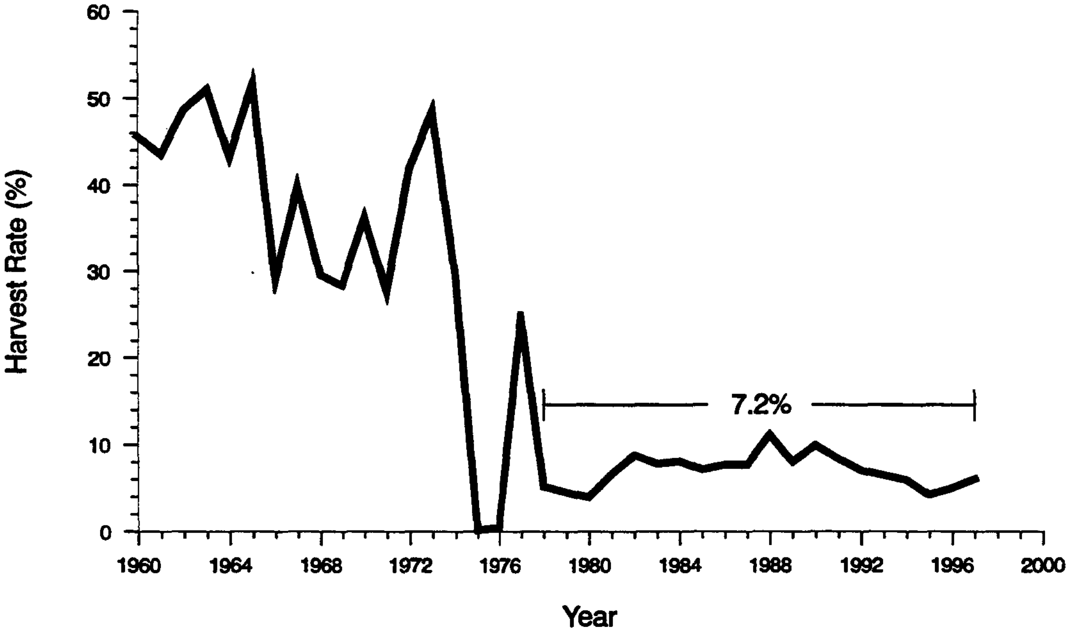

Figure 1. **Harvest rates for upriver spring-summer chinook salmon in 1960-97 mainstem Columbia River fisheries.**

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Appendix 3.11

Issue Paper: Transportation and Delayed Mortality

Fisheries Bureau, IDFG May 1, 1998

How do the FLUSH and CRISP juvenile passage models compare to spawner and recruitment information of upriver and downriver spring/summer chinook populations?

Conclusion: Passage models which assumed a low delayed mortality after transportation did not explain the spawner and recruitment information for upriver and downriver stocks. This assumption of low delayed mortality has generally been used in CRiSP model runs. Both FLUSH and CRiSP models fit the population data when assuming substantial delayed mortality of transported smolts.

Because most Snake River spring/summer chinook smolts have been transported for the last two decades, the modeled effect of delayed mortality after barging or trucking is critical to the analyses. The largest differences between the FLUSH and CRiSP passage models are in the interpretation of effectiveness of transportation in reducing total mortality of juvenile spring/summer chinook.

In the PATH 1996 Retrospective Analysis, passage models which assumed a high, constant transport survival over the complete life cycle showed the poorest fits to the empirical stock-recruitment data (Deriso et al. 1996; Marmorek and Peters 1996). The parameter "mu" from Deriso et al. (1996) described the differential mortality between Snake River and downriver stocks

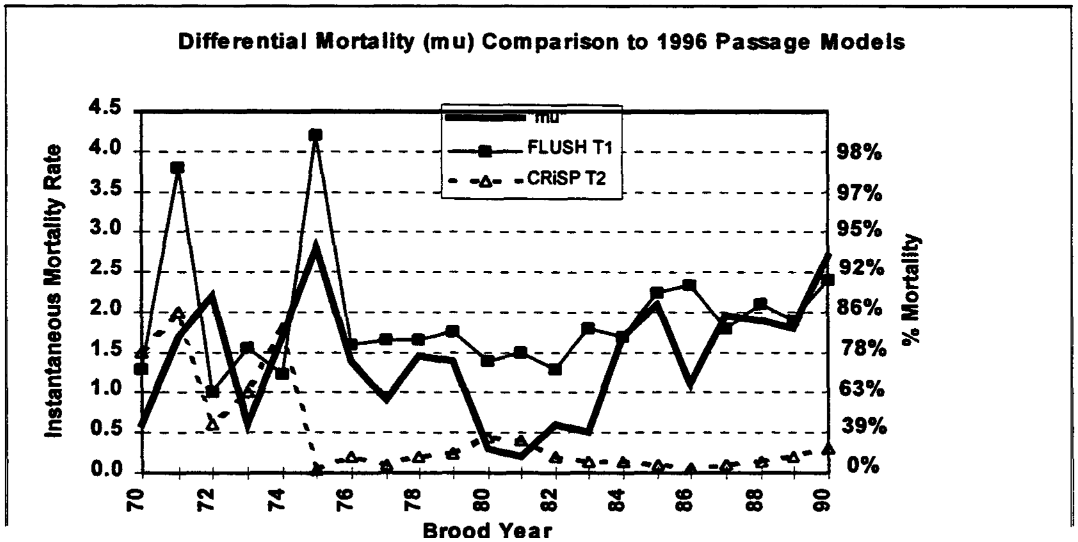

Figure 1. Comparison of estimates of differential instantaneous mortality rate (mu) with estimates from CRiSP and FLUSH passage models with different assumptions about delayed mortality of transported fish. FLUSH T1 assumes variable post-transport survival from 2% at low flows to 19% at moderate-high flows; CRiSP T2 assumes constant, high post-transport survival. (Adapted from Fig. 5-5 of Deriso et al. 1996)

from the stock recruitment data of Schaller et al. (1996). Deriso et al. (1996) estimated that Snake River stocks survived on average about 1/3 as well as downriver stocks from spawner to adult, since the hydropower system was completed (i.e., mu = 1.15; and $e^{-1.15} = 0.32$). When a high, constant transportation survival (74%) was assumed in the CRiSP model, the passage model output did not match the stock recruitment mortality patterns (Figure 1, compare CRiSP T2 and mu). In Figure 1, the CRISP T2 model consistently underestimated mortality of Snake River stocks since mass transportation began in 1977 (brood year 1975). On the other hand, the FLUSH T1 model with a variable transport survival (2% to 19%) assumption provided a better fit through this time period (Figure 1; compare FLUSH T1 and mu).

In contrast, when variable transport survival assumptions were applied to both CRiSP (21% to 48%) and FLUSH (2% to 19%), the passage model estimates bracketed the estimates of mu (Figure 2). The "best" passage model would appear to be somewhere between FLUSH T1 and CRiSP T1, but an essential ingredient is that there is substantial delayed mortality of transported smolts, and that delayed mortality is highest in years of poor flow or low water velocity during the smolt migration. Both passage models have been recalibrated since the 1996 Retrospective Analysis, but the concepts still apply: assumptions of little delayed mortality of transported fish require some other systematic mortality factor to fit the empirical population data.

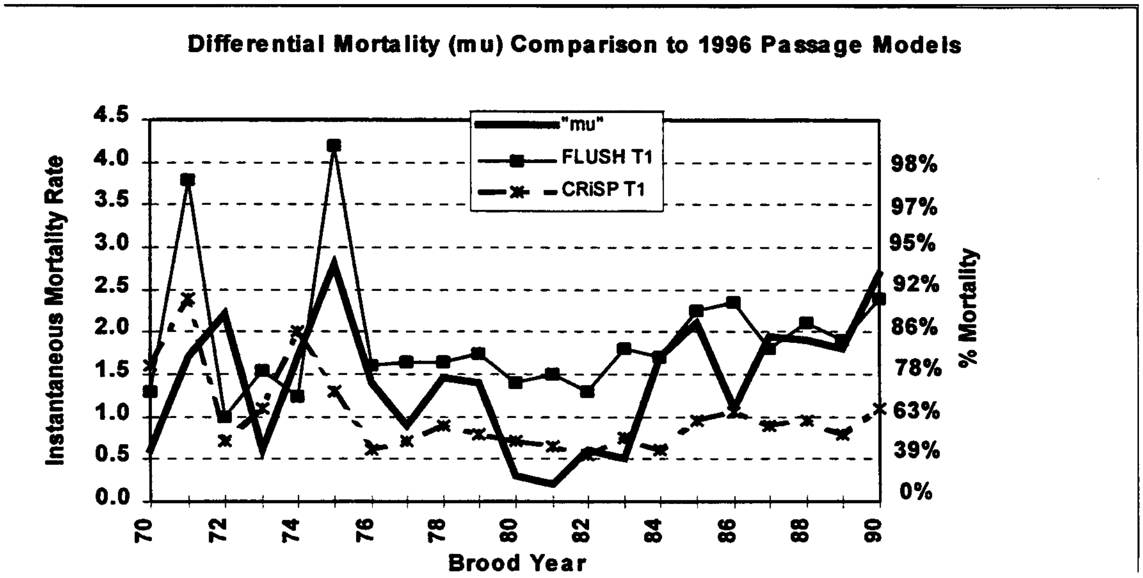

Figure 2. Comparison of estimates of differential instantaneous mortality rate (mu) with estimates from CRiSP and FLUSH passage models with different assumptions about delayed mortality of transported fish. FLUSH T1 assumes variable post-transport survival from 2% at low flows to 19% at moderate-high flows; CRiSP T1 assumes variable post-transport survival from 21% at low flows to 48% at moderate-high flows. (adapted from Fig. 5-5 of Deriso et al. 1996)

Appendix 3.11 cont'd.

Differences in transportation effectiveness are likely the most important (but not the only) differences between CRiSP and FLUSH. The FLUSH model has a steeper flow-survival relationship than CRiSP; and FLUSH also estimates lower survival rates of inriver migrants than does the CRiSP model (Marmorek and Peters 1998; Appendix A). However, the real driver appears to be the relative amount of delayed mortality of transported smolts. This delayed mortality factor has been algebraically described as D in the PATH preliminary decision analysis report (Marmorek and Peters 1998).

The only way for a transport survival model such as CRiSP T2 to be consistent with the differential total mortality between Snake River and downriver stocks, is to hypothesize that some other factor is systematically affecting Snake River stocks. That is, if smolts are not suffering delayed mortality from transportation and inriver passage, some other factor must be selecting against Snake River fish. No specific hypotheses have been submitted in PATH process to explain such a selective mortality factor.

The prospective analysis model runs using CRiSP indicate a small probability of stock survival and recovery for Snake River spring/summer chinook under the natural river option (A3) in the Snake River (Marmorek and Peters 1998). In the CRiSP model framework, this aggregate hypothesis implies that smolt transportation has mitigated the effects of the hydropower system; and that some [unidentified] factor is selecting against Snake River fish.

In contrast, prospective analysis model runs using the State and Tribal model indicates a high probability of stock survival and recovery for Snake River spring/summer chinook under the natural river option (A3) in the Snake River (Marmorek and Peters 1998). This aggregate hypothesis appears more consistent with the total mortality patterns observed in spring/summer chinook stocks from the Snake River and from downriver stocks above 1-3 dams.

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Appendix 3.12

Issue Paper: Role of Habitat in Idaho Salmon Decline and Recovery

Fisheries Bureau, IDFG, May 1, 1998

Did habitat changes in Idaho cause the decline of chinook salmon that led to listing? Is Idaho habitat limiting recovery?

The Idaho Department of Fish and Game (Department) compiled technical information in 1992 (Idaho Department of Fish and Game 1992a) clarifying the role of Idaho spawning and rearing habitat relative to salmon decline and recovery. Key findings included:

1) Absence of productive salmon populations in pristine or good habitat implies factors other than habitat degradation is limiting naturally produced salmon abundance;

2) Juvenile salmon production is low, irrespective of habitat quality, due to lack of adults returning to spawn and produce smolts in available habitat;

3) Although smolt capacity and egg-to-smolt survival has decreased in Idaho habitat compared to predevelopment conditions, neither of these parameters is currently the primary limitation of overall salmon production;

4) Changes in habitat over the last fifteen years have not led to the rapid and continued decline of salmon populations.

Since 1992, Department staff has developed additional information that continues to illustrate these key findings with updated information.

1) Figure 1 demonstrates the similarity in production trend between managed and unmanaged watersheds for Idaho spring and summer chinook salmon. If habitat degradation were a primary factor in the recent and rapid decline of Idaho salmon, the trendlines would not be so similar among drainages. Salmon populations are declining in unmanaged wilderness as well as managed, and more degraded, watersheds. This reiterates our key finding that factors other than the quality of Idaho spawning and rearing habitat is limiting naturally produced salmon abundance.

   Idaho Department of Fish and Game (1992a) also referenced Platts (1997) who noted in 1968 that the sediment content of Bear Valley study areas was far above what could cause fishery resource destruction. He documented movement of bedload sediment in his upper study area moving during low flows and blanketing newly formed salmon redds. Yet, for the period 1970-1982, Bear Valley/Elk creeks still contributed about 50% of the index redds for spring chinook counted in the Middle Fork Salmon River (MFSR) drainage, which induded significant wilderness areas in the index redd counts. However, the annual, average count in the MFSR during this period was only 563 redds, a 64% decline from the 1957-69 period. That Bear Valley/Elk creeks continued to contribute about half of the spring chinook redds counted in the MFSR, even as the numbers of redds substantially declined, illustrates that redds declined throughout the Middle Fork, not just in degraded areas. Even for the period 1983-1995, Bear

Valley/Elk creeks contributed 55% of the annual average of 293 spring chinook redds counted in the MFSR (an 81% decline from 1957-69).

More recently, Quigley and Arbelbide (1997) as editors of an assessment of ecosystem components of the interior Columbia Basin conducted by the U.S. Forest Service, noted that strong populations of steelhead and chinook were rare or absent even in relatively undisturbed habitats in the Central Idaho Mountains, suggesting that factors outside the area strongly influence status of salmon and steelhead.

2, 3) Idaho currently has about 3,676 miles of spawning and/or rearing habitat for spring and summer chinook. This represents about 62% of predevelopment condition (Hassemer et al. 1997). Thirty percent of this habitat is within boundaries of designated wilderness or wild and scenic river corridors (State of Idaho, 1991). Idaho's current habitat, with its mosaic of excellent to badly degraded habitat, could produce several million smolts (IDFG 1992b). As recently as 1995, an estimated 1.7 million naturally produced spring/summer chinook smolts migrated from the spawning and rearing habitats upstream of Lower Granite Dam from an adult return to the uppermost Snake River dam that was only 25% of the 1964-78 average. The Department annually counts juvenile chinook (parr) in habitats that vary substantially in quality. Parr densities are critically low regardless of habitat quality, generally mirroring the redd counts (Hall-Griswold and Petrosky 1996). The empirical information demonstrates sufficient habitat exists to support far greater smolt production than currently occurs from the low number of adults returning over the last 20 years; there is no valid argument against this point.

Petrosky and Schaller (1996) further investigated the possibility that decreases in egg-to-smolt survival, presumably due to habitat degradation, has caused the decline towards extinction (Attachment 1). They concluded that the data provided no evidence for a major shift in spawner-to-smolt productivity and survival rates that would explain much of the precipitous decline in productivity and survival rate of Snake River spring and summer chinook since completion of the Federal Columbia River Power System (FCRPS). This expanded analysis corroborates our key finding #3 from 1992.

4) There is no question that the quality of Idaho spawning and rearing habitat has generally declined from predevelopment conditions. However, the Department and other scientists have noted that change in Idaho's spawning and rearing habitat quality has not occurred of a magnitude proportionate to the change in salmon populations during the last thirty years. Not coincidentally, the lower Snake River underwent extremely radical change during this same period. In fact, there is indication that Idaho spawning and rearing habitat is as good or even better than for lower river spring chinook stocks, which are performing consistently better than Idaho's (discussed elsewhere in this document). Information compiled during an assessment of ecosystem components of the interior Columbia Basin conducted by the U.S. Forest Service (Quigley and Arbelbide 1997), and used for salmon production retrospective analysis (Marmorek et al. 1996) designated Idaho habitat as having the largest amount of habitat rated as "low" for road density for reviewed stocks in the Columbia Basin. It also had the largest amount of Forest Service wilderness habitat. Quigley and

Arbelbide (1997) noted that habitat change due to land use is pervasive and at times dramatic, but impacts are not evenly distributed across the landscape. However, as illustrated in Figure 1 and elsewhere in this document, decline in naturally producing chinook populations has occurred in all populations, i.e. across the Idaho landscape. The only major change affecting all spring and summer chinook populations across the Idaho landscape that corresponds to the timeline of decline (Figure 1) is development of the lower Snake River into the FCRPS.

A conclusion of the interior Columbia Basin assessment (Quigley and Arbelbide 1997) was that the declines of chinook salmon stocks in the Snake River Basin could be attributed primarily to mainstem dams. However, the assessment scientists also suggested that the rapidly declining numbers of chinook salmon during and after construction of the federal dams in the lower Snake did not permit an adequate test of the hypothesis that habitat conditions changed during the same period. They suggested conducting such a test would require a return to historical levels of spawning adults that predate the dams. Nevertheless, the assessment (Quigley and Arbelbide 1997) documented that although much of the native ecosystem has been altered, core areas remain for rebuilding and maintaining functional native aquatic systems such as within the Central Idaho Mountains. This region can still provide highly productive habitat for multiple aquatic species. Current habitat could support many more adult and juvenile chinook salmon than it is. Similar to information presented previously by the Department (IDFG 1992a), the assessment found that maintaining quality and diversity in remaining habitats is critical to resiliency and persistence of remaining chinook stocks until passage problems are resolved.

As soon as the FCRPS was completed, it was noted during a production study in the Lemhi River (a rather degraded watershed) that "Mortality related to the dams in the Columbia and Snake Rivers has placed the runs of wild chinook salmon and steelhead trout in jeopardy" (Bjomn 1978). The conclusion is still valid and substantiated 20 years later.

Attachments:

Figure 1: Idaho Salmon Trends.

Attachment 1: Spawning and Rearing Habitat

Appendix 3.12 cont'd.

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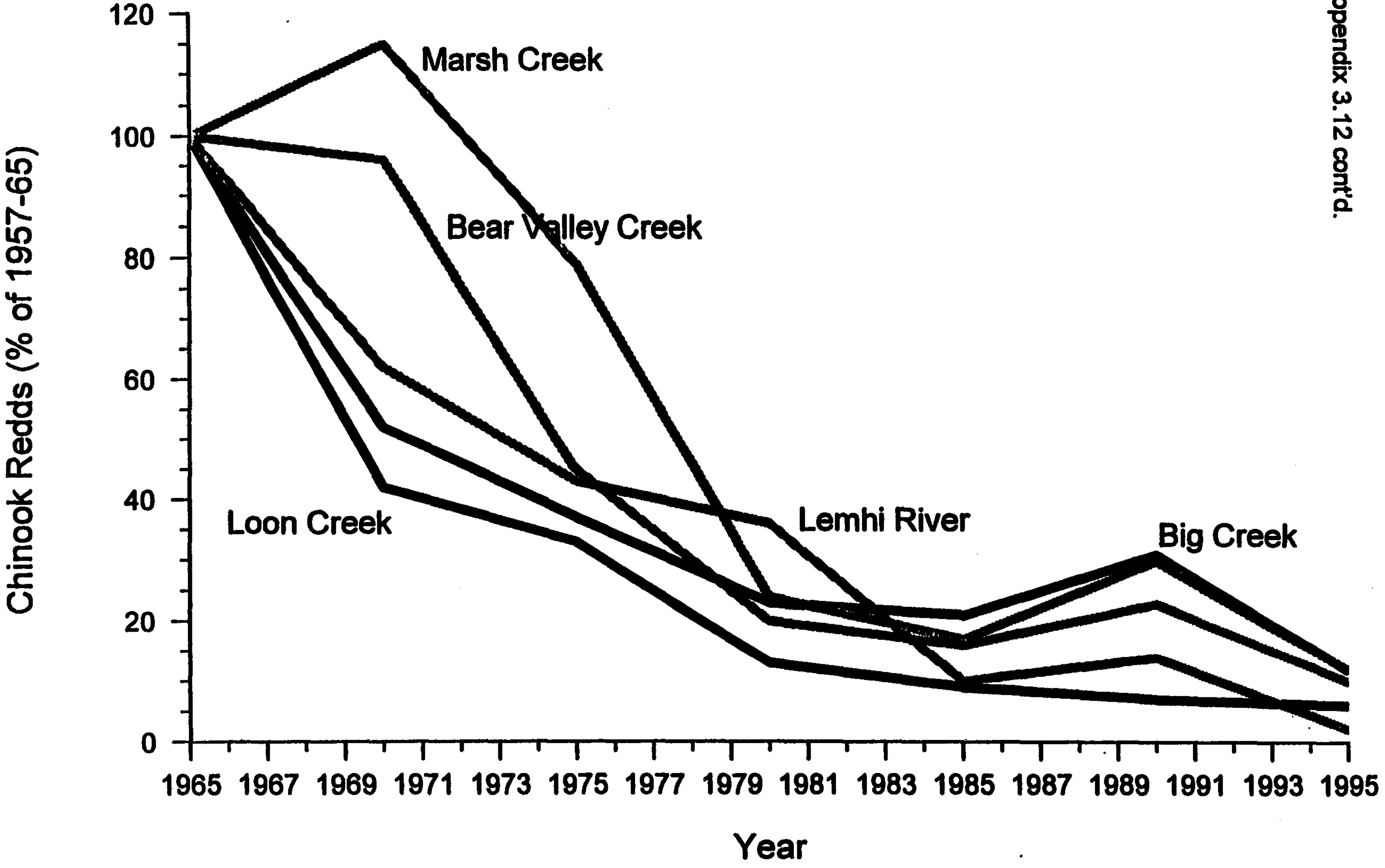

Figure 1. Trend counts of 1965-95 spring-summer chinook redds indexed as a percentage of the 1957-65 average. Big and Loon creeks are wilderness watersheds. The Lemhi River, Bear Valley and Marsh creeks are managed watersheds.

Attachment 1 of Appendix 3.12

Issue *Investigation:* *Can the decline in Snake River spring/summer chinook be explained by a decline in spawner to smolt survival rate?*

Issue Conclusion: *Decline in freshwater survival of eggs and juveniles was not a major factor in decline of adult to adult survival.*

Petrosky and Schaller (1996) assessed whether there has been a net decrease in productivity and survival rate during the freshwater spawning and rearing (FSR) stage for Snake River spring/summer chinook since completion of the Federal Columbia River Power System (FCRPS) that could explain the decline in adult recruitment, productivity, and survival rate. The following material has been adapted from their paper.

Petrosky and Schaller (1996) found no evidence of a marked decline in FSR productivity and survival rate since completion of the FCRPS of the magnitude observed by Schaller et al. (1996). The same conclusion was reached by PATH in the 1996 Retrospective Analysis Conclusions Document (Marmorek and Peters 1996). The numbers of spawners declined significantly from the first to second period (1962-1974 and 1975-1993 brood years, respectively). Productivity as measured by smolts per spawner or ln(smolts/spawner) increased as the population declined following FCRPS development. This increase is consistent with density dependence as expressed in production functions (Ricker 1975). The recent year estimates for smolts per spawner versus spawner generally agreed with those predicted from the two historic periods, regardless of the spawner index or FGE assumption (Fig. 1).

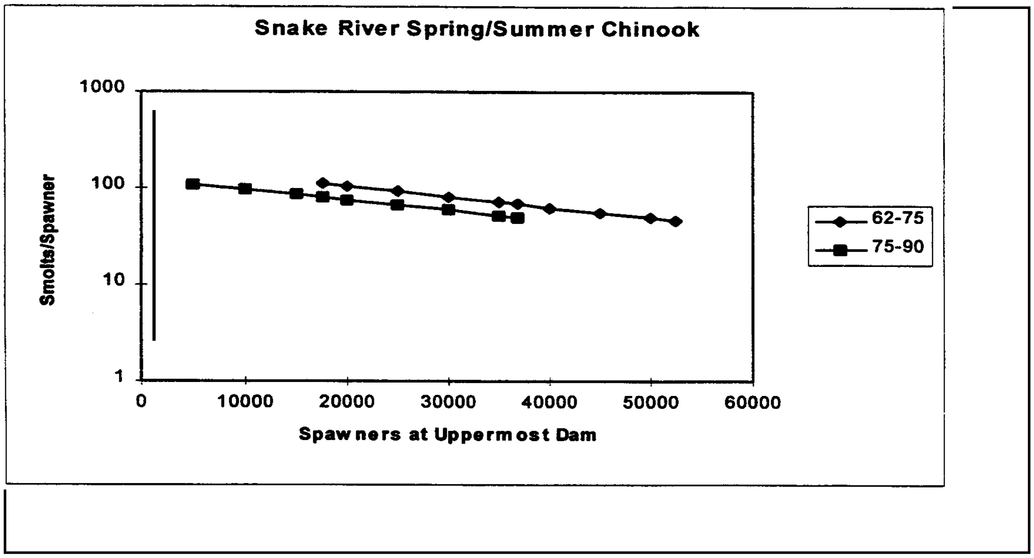

Figure 1. Relationship of smolts/spawner versus spawner for aggregate wild Snake River spring and summer chinook, 1962-1993 brood years. Plotted from Petrosky and Schaller (1996), using SP1 and 0.56 FGE assumptions.

The Petrosky and Schaller (1996) analyses do not rule out comparatively minor decreases in FSR productivity and survival rate since FCRPS completion. The index of density independent FSR survival rate, as measured by residual, showed no significant decline from the first to second period for four combinations of spawner index and fish guidance efficiency (FGE) assumptions. However, the residual pattern and comparison of variance between the two periods indicate greater variability in the later period. In addition, ANCOVA showed a significant decrease in density independent productivity from the first to second period for one of the four combinations of spawner and juvenile indices. Adverse environmental conditions, such as below average runoff, may have reduced FSR survival rate in some years. The Snake and Columbia River basins experienced prolonged drought from 1987 through 1994. When drought years were removed from the data set, ANCOVA showed no significant decrease in productivity from the first to second period for any of the four combinations.

The tests performed had limited power to support a conclusion that no decline or change occurred in FSR survival rate in the recent period, but did have sufficient power to support the conclusion that a decline in FSR survival rate was not a major factor in the observed declines in adult to adult survival rate of Snake River spring and summer chinook. The most sensitive tests for between period change in FSR survival rate, had minimum detectable differences in the range of -0.26 to 0.28. Thus, had recent FSR survival rates decreased to 76% ($e\text{-}^{02}$) of the rate before 1975, there would be an 80% probability of detecting the change. Point estimates of change in FSR survival rates ranged from -0.11 to -0.14, much less than minimum detectable limits. The power to detect change of this magnitude was poor, 45% or less. In contrast, adult-to-adult survival rate for Snake River index stocks following FCRPS completion declined by -1.15 more than similar stocks which migrated past fewer dams and reservoirs (Schaller et al. 1996). Therefore, the power of the smolt and spawner indices to detect change in FSR survival rates would be adequate (>99%) to detect a change of the magnitude estimated in adult-to-adult survival rates.

Because both spawners and smolts were indexed at the uppermost dam, spawner-to-smolt productivity and survival rate estimates include life stages in addition to the FSR, specifically the prespawning and early smolt migration stages through free-flowing river, and passage through the first reservoir. Throughout the time series, the spawner-to-smolt estimates consistently contained the effects of passage through one reservoir, which presumably had similar impacts on survival rate given a similar suite of runoff conditions (e.g., flow volume and timing, turbidity, temperature). Any comparison of smolt/spawner estimates reported here with those from other systems, or within the Snake River Basin, would need to take into account differences in the stage at which smolts and spawners are indexed (e.g., tributary smolt indices generally include migrating and rearing juveniles). Preliminary analyses for the PATH process found no evidence for a decreasing trend in prespawning survival rate indices of Snake River wild spring/summer chinook from 1953-1994 (Petrosky 1995).

The proportion of hatchery fish spawning and contributing to wild smolts increased during recent years. If reproductive success was lower for hatchery fish spawning in streams than for wild spawners (e.g., Chilcote et al. 1986), then in theory, aggregate FSR productivity and survival rate would exhibit an apparent decline. The two spawner indices in the analyses bracketed a range of potential spawners at the uppermost dam. Use of the SP1 index implicitly assumed hatchery spawners are completely ineffective, while use of SP2 assumed hatchery spawners are equally effective as wild spawners. If SP1 were true, no significant decreases in FSR productivity and survival rate were detected. If SP2 were true, FSR productivity decreased significantly in a single case. If hatchery spawners were somewhat less effective than wild spawners, only weak or nonsignificant decreases might be expected from these results.

Appendix 3.12 contd.

The trends and patterns in FSR productivity and survival rate observed for aggregate populations may not extend to individual populations within the Snake River Basin. Although poorly quantified, dynamics of individual spawning populations at the FSR life-stage can be expected to respond to habitat conditions at the local and basin scales. A broad mix of land use influences, from relatively pristine to management for irrigated agriculture, livestock grazing, logging and mining, existed throughout the time series (Fulton 1968; Beamesderfer et al. 1996). Negative trends in habitat condition (quality pools) are evident in several managed watersheds, whereas wilderness or unroaded watersheds have shown greater stability, over half-century time scales (McIntosh et al. 1994). Reductions in sediment deposition have also been documented in the heavily-degraded South Fork Salmon River since the mid-1960s (Platts et al. 1989), and major fish screening programs were completed by the late 1960s in the upper Salmon and Grand Ronde rivers. While FSR survival of individual populations would be expected to track with these localized trends, the aggregate data provide no evidence for a major shift in spawner-to-smolt productivity and survival rate that would explain much of the precipitous decline in productivity and survival rate of Snake River spring and summer chinook since completion of the FCRPS (Schaller et al. 1996). However, this analysis did not address whether there was a significant decline in FSR survival prior to the completion of the hydrosystem, because the smolt and spawner data were not collected prior to the 1960s.

Aggregate population data should be used with caution to infer the strength of depensatory mechanisms for Snake River spring and summer chinook. Stronger populations tend to dominate recruitment patterns within the aggregate (Ricker 1975); those populations most likely experiencing depensation would be underrepresented in the aggregate. As pointed out in BRWG (1994), classic production functions of the form used in this analysis, inevitably overestimate production at low escapements. This is because, in these functions, productivity increases to a maximum value at one spawner, well below levels postulated to be influenced by demographic (uneven sex ratio, Allee effects, etc.), genetic or environmental factors. A function, which diminishes productivity from that predicted by a Ricker function when escapement is below a minimum escapement threshold (Dennis 1989), would appear reasonable for individual spawning populations. Recently, most of the individual Snake River populations have experienced extremely low escapements. Aggregate escapements for brood years 1994 and 1995 were substantially lower (1,100-1,700) than those used in these analyses (5,000-52,700). Thus, it is reasonable to expect a drop in estimated productivity in upcoming smolt migration years (brood years 1994-1995) relative to Ricker functions fitted to the aggregate Snake River populations. Future estimates of smolts/spawner from these brood years may provide additional insight into the relative strength of depensatory mechanisms in Snake River spring and summer chinook. Ensuring survival and recovery of these populations will be more difficult, the more that productivity declines at low escapements

Appendix 3.12 cont'd.

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Appendix 3.13

Issue Paper: Smolt Transportation

Fisheries Bureau, IDFG May 1, 1998

Has smolt transportation compensated for effects of dams?

Conclusion: Transportation alone does not appear sufficient to overcome the negative effects on survival of salmon caused by development and operation of the hydroelectric system.

The Independent Scientific Group (Williams et al. 1996) concluded that the "concept that we can engineer our way out of the present crisis [is] at odds with the prevailing scientific thought." "Furthermore, transportation alone does not appear sufficient to overcome the negative effects on survival of salmon caused by development and operation of the hydroelectric system."

Transported smolts are released alive, but survive poorly to return as adults. Delayed mortality of transported smolts appears to be related to conditions within the hydropower system (Mundy et al. 1994). Several possible mechanisms have been identified from the literature that may explain delayed mortality of smolts that are transported (as well as those that migrate through the hydropower system). These include: altered saltwater entry timing which is poorly synchronized with the physiological state of the smolts (CBFWA 1991; Fagurlund et al. 1995); stress from crowding and injury (including descaling–Basham and Garrett 1996; Williams and Matthews 1995) during bypass, collection, holding and transport (Mundy et al. 1994); increased vulnerability to disease outbreak (e.g., BKD and fungal infection) due to stress and injury (Mundy et al. 1994); Raymond 1988; Williams 1989); and increased vulnerability to other stressors in the environment or to predation, particularly northern squawfish (Mundy et al. 1994).

Smolt-to-adult return rates (SAR) of transported wild spring/summer chinook smolts have been consistently less than the 2% to 6% interim goal defined in PATH (Toole, et al. 1996; Marmorek and Peters 1996, 1998). The SARs of transported wild smolts have shown no evidence of an increasing trend over the past two decades (Figure 1).

Not only have SARs remained extremely low, there is no indication that the gap has narrowed between performance of Snake River stocks and lower river stocks, as might be expected if transportation and hydrosystem improvements were merely masked by generally poor ocean conditions for all stocks (Figure 2). In the 1996 Retrospective Analysis, Deriso et al. (1996) estimated the differential instantaneous mortality rate ("mu") between Snake River and similar downriver populations. The differential mortality between upriver and downriver stocks did not decrease over time; the geometric mean of mu by period was 1.3, 1.3, 0.6, 1.3 and 2.0 for 1972-1974, 1975-1980, 1980-1984, 1985-1989 and 1990-1992, respectively. The differential mortality increased significantly as water velocities decreased during the smolt migration. Examination of the data in Fig. 2 does not support a hypothesis that migration conditions (including transportation) were continually improving for Snake River stocks compared to lower river stocks.

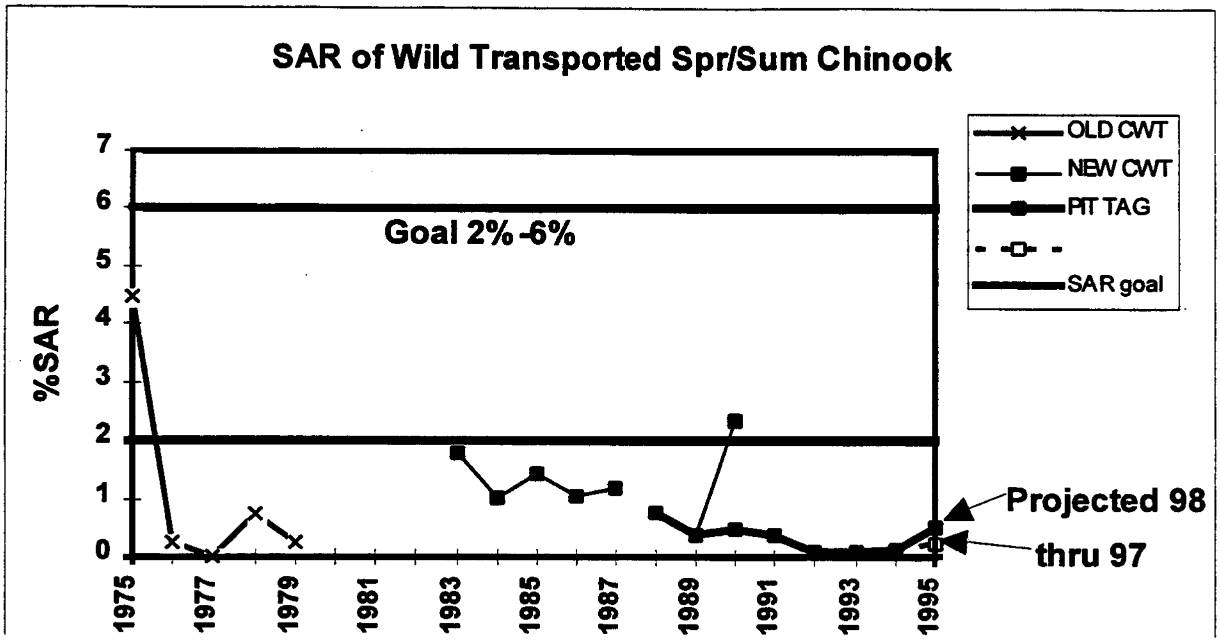

Figure 1. Smolt-to-adult return rates (SAR) of transported wild Snake River spring/summer chinook, 1975-1995 smolt migration years. Return from 1995 incomplete; projected SAR for 1998 returns based on average proportion age 5 from 13 index stocks. Adapted from Marmorek and Peters (1998; Appendix A, Figure A.3.3.1-1).

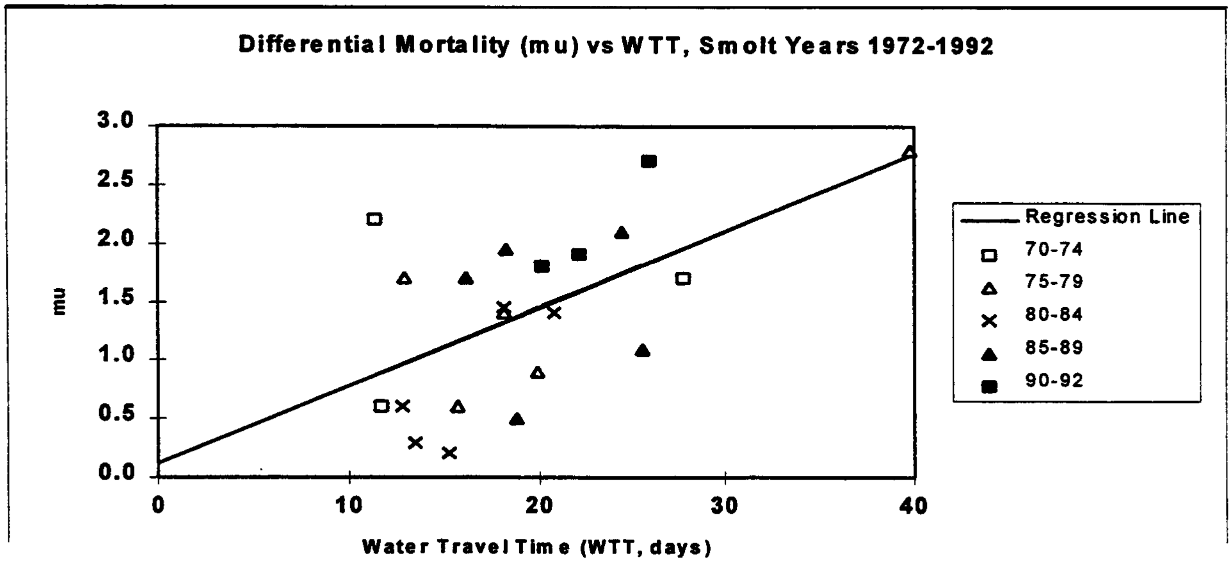

Figure 2. Differential instantaneous mortality rates (mu) of Snake River and downriver stocks compared to water travel time experienced during the smolt migrations, 1972-1992. Regression line was fit through all years of data. (Adapted from Deriso et al. 1996; Fig. 5-6).

Hypotheses and models that suggest transportation has effectively reduced hydrosystem mortality must point to some other factor that selectively causes mortality for Snake River fish beyond that affecting lower river stocks. This is because passage models which assume low delayed mortality of transported fish do not match the spawner and recruit patterns of both Snake River and downriver populations after the hydropower system was completed (e.g., 1996 Retrospective Analysis; Deriso et at. 1996; Marmorek and Peters 1996). Some additional explanation is then needed to resolve this discrepancy. These hypotheses have pointed at some factor (independent of effects of the hydropower system), such as BKD, genetic viability, or some unidentified climate factor, being selectively worse for Snake River fish than for downriver stocks since the hydropower system was completed. Biological mechanisms to support these alternative hypotheses have not been postulated.

There may be relative benefits to transportation compared to allowing smolts to migrate through the hydroelectric system, but these are not conclusive. Regarding relative benefits of transportation, Mundy et at (1994) concluded that while transportation appears to improve the relative survivals of certain salmon and steelhead from the Snake River Basin under certain combinations of dam operations and river flow conditions, it removes only part of the mortalities attendant to passage through the hydroelectric system. Recent studies have raised further questions about even these relative benefits.

Emerging PIT tag data for wild spring/summer chinook smolts raise questions about the perceived *relative* benefits of transportation (IDFG 1998). Typically, transportation has been justified primarily because smolts avoid some of the direct mortality due to the dams, and based on NMFS studies indicating that adult return rates have been higher for transported smolts than for smolts that migrate through the hydropower system. In past transportation studies, smolts were bypassed, collected, held in raceways, tagged and assigned into "transport" and "control" study groups. The "controls" pass through mechanical bypass systems an average of two and one half times during their migration through the four lower Snake dams. Mechanical bypass systems are used at the dams to collect smolts for barging and can be quite stressful. Emerging PIT tag data suggest that the more times smolts are bypassed the poorer the adult return. Transported smolts returning as adults in 1997 did not do any better than smolts migrating in the reservoirs in 1995 which passed the dams via the spillways or turbines. The estimated survival of these true inriver migrants (0.38%) was actually higher in 1997 than that of transported fish (0.26%), although the difference was not statistically significant.

In 1998, the Independent Scientific Advisory Board (ISAB) was asked by the Implementation Team to evaluate transportation as a management option for the 1998 smolt migration season. The ISAB (1998) recommended a spread-the-risk approach involving barges, spill and other measures intended to enhance downstream passage survivals throughout the entire spectrum of the salmon and steelhead emigration.

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Appendix 3.14 Summaries of Alternatives to be Modeled by Path

State of Idaho
Department of Fish and Game

October 29, 1997

To: Jim Yost and Mike Field
From: Ed Bowles
SUBJECT: PATH/IT Meeting Summary

As promised, this memo summarizes some of the highlights of the recent PATH/IT meeting and lists most of the alternatives to be modeled by PATH and DREW. There are four alternatives that are being modeled first to provide an initial starting point. These include:

A1: Base case using BiOp operations;
A2a: New improved transport (no spill at collector projects, flip lips, surface collectors, more barges, bigger barge orifices) with current BiOp flow;
A3: Lower Snake River drawdown to natural river with current BiOp flows;
B1: Lower Snake River and John Day drawdown to natural river with current BiOp flows.

You will note that all these alternatives include existing BiOp flows for the Snake and Columbia rivers. These alternatives will be modeled by the end of the year to give some sideboards on expected benefits to the fish. PATH will then model variation on these alternatives. Additional alternatives that have a high priority for modeling include:

A2b: New improved transport with additional flows (additional 1 to 3 maf from Snake, additional 1+ maf from Columbia).
A6: New improved in-river with additional flows and the dams in place (surface bypass, gas abatement, temperature control, adult passage improvement, spill, additional 1 to 3 maf from Snake and 1+ maf from the Columbia).
A5: Lower Snake River drawdown to natural river with no flow augmentation from Snake and current BiOp flows from Columbia.
B2: Lower Snake River and John Day drawdown to natural river with no flow augmentation from the Snake or Columbia rivers.
C1: Lower Snake to natural river and John Day to spillway crest with current BiOp flows.
C2: Lower Snake to natural river and John Day to spillway crest with no flow augmentation from the Snake or Columbia rivers.

The alternatives with additional flow augmentation volumes were recommended by the downriver tribes (CRITFC; see attached memo). Brian Brown stated that NMFS also supported looking at alternatives that included additional flows beyond BiOp volumes. These alternatives will be modeled by PATH early next year. Other variations listed below have also been identified for modeling, but are currently tabled until results from the above alternatives are available.

A4a: Lower Snake to natural river with no flow augmentation in Snake or Columbia.
A4b: Lower Snake to natural river with no flow augmentation in Snake and BiOp flows in Columbia.
B3a: Lower Snake and John Day to natural river with no flow augmentation from the Snake and BiOp flows from the Columbia.

There is still some confusion as to what exactly is the complete list of alternatives and who is the official "keeper of the list" I am not quite sure what DREW 's schedule is for assessing social/economical impacts of the various alternatives, but the goal is to have that group proceed concurrent with the PATH modeling.

Let me know if additional information is needed.