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November 22, 2006

Derek I. Sandison
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RE: Columbia River Water Management Program Draft Programmatic EIS

Dear Mr. Sandison:

The Columbia River Inter-Tribal Fish Commission (CRITFC)[1] appreciates the opportunity to provide comments to Ecology on the Draft Programmatic EIS (DEIS) for the Columbia River Water Management Program and Ecology's willingness to allow us two extra days to file comments.

5-1 CRITFC's member tribes have a direct interest in the waters of the Columbia River Basin, as is appropriately noted in the DEIS (at 3-82). All of the CRITFC member tribes have ceded territories that encompass entire large watersheds within the Columbia River Basin, e.g. the Yakima Basin. Each of these tribes exercise treaty rights to take fish from the Columbia River and its tributaries. As supported by a significant body of case law, these treaty rights include off-reservation instream water rights with priority dates that are senior to all other users and that are the necessary to protect the biological functions of fish and their habitat.[2] Adequate instream flow with water of high quality is essential to sustaining healthy and viable salmonid populations, and preserving tribal culture, religion and economies.

The direction that the State of Washington is taking toward growth management is inimical to salmon resource upon which the tribes have depended for millenia. Instead of

[1] In 1977, the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, the Nez Perce Tribe, and the Yakama Nation created the Columbia River Inter-Tribal Fish Commission (CRITFC or "Commission"). These four tribes have 1855 treaty rights to take fish that pass their usual and accustomed fishing places. Consequently, it is of critical importance to the tribes to protect and conserve the habitat and life cycle of the fisheries. The Commission functions to protect, promote, and enhance the Columbia River Basin's anadromous fish resources consistent with the treaty-secured interests of its member tribes by formulating a broad, general fisheries program, and providing technical and legal support.

[2] *See, e.g., United States v. Winans, 198 U.S. 371 (1905); Colville Confederated Tribes v. Walton, 647 F.2d 42 (9th Cir. 1981); United States v. Adair, 723 F.2d 1394 (9th Cir. 1984); Ecology v. Yakima Reservation Irr. Dist., 850 P.2d 1306 (Wash. 1993).*

implementing actions that require water conservation as a prerequisite to growth and development, it appears that there are no State mechanisms to begin to control growth that threatens to diminish water and salmon resources in tribal ceded areas to the point of extinction.

5-1 While there is a need to reexamine State water resources, the burden of reduced water resources must not fall upon the salmon and other anadromous fish such as sturgeon and Pacific lamprey. It is not as easy to quantify the water needs down to the last cubic foot per second for salmon as it is for new water right consumers. Salmon need ecologically functioning rivers, and flow plays many important roles in this regard. Many of these roles are imperfectly understood due to data limitations. Nevertheless, the greatest danger to salmon and other anadromous fish productivity in the long-term is the constant and cumulative loss of water resources, permit by permit.

5-2 CRITFC has participated in Washington states' processes for several years in order to aid its member tribes in protecting their interests. We incorporate by reference the comments of the Yakama Nation (YN) and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and rather than repeat their comments, we hope to add additional observations. We also incorporate by reference our previous comments on Ecology's Columbia Basin Water Supply Inventory (dated November 8, 2006), as well as the attached economic report. Gustanski, et al. 2006.

5-3 Attached you will find more general and specific comments on the DEIS. We attempted to organize our comments to address major issues in the DEIS. However, the document is incredibly awkward in its content and organization. The DEIS tries to do too much for one SEPA document. On the one hand it is supposed to be a "Programmatic" EIS for the CRWMP program, yet, on the other hand, the DEIS only substantively analyzes the three "Early Actions" (the CSRIA VRA, the proposed Lake Roosevelt drawdown and the supplemental feed routes). The scope of this EIS should be narrowed to the scope of the actual substantive analysis which is set forth. Separate SEPA reviews on other actions should be undertaken to focus analysis on the actions described in this DEIS, rather than tying them up in a confusing bundle.

5-4 We thank you for the opportunity to submit these comments and to participate in this process. If you have any questions about our comments, we would be happy to set up a meeting with you to discuss them. Please feel free to contact Julie Carter or Robert Heinith at 503-238-0667.

Sincerely,

Olney Patt, Jr.

Olney Patt, Jr.
Executive Director
Columbia River Inter-Tribal Fish Commission

GENERAL COMMENTS
OF THE COLUMBIA RIVER INTER-TRIBAL FISH COMMISSION

The DEIS does not appropriately address the issue of flow.

5-5 The CRWMP must address the issue of water flow in order to handle the most basic and fundamental elements of the program, such as defining "no negative impact" (p.2-18). Instead, the DEIS simply notes that "the relationship between flow levels in the Columbia River and salmon survival is not clear." (p. S-10). We believe that there is far, far more clarity about the relationship than the DEIS gives credit. While the relationship is definitely complex, there is a clear flow-velocity- survival relationship, for yearling chinook, steelhead and subyearling chinook that demonstrates that without adequate flow,[3] fish will suffer harm through a variety of impacts and survival and stock productivity will be reduced (See Figures 1-4). In addition, September is a critical month for juvenile salmon passage. Most of the basin's adult salmon are also migrating during this month. The DEIS, and indeed, the CRWMP, fails to identify the importance of providing flows in September.

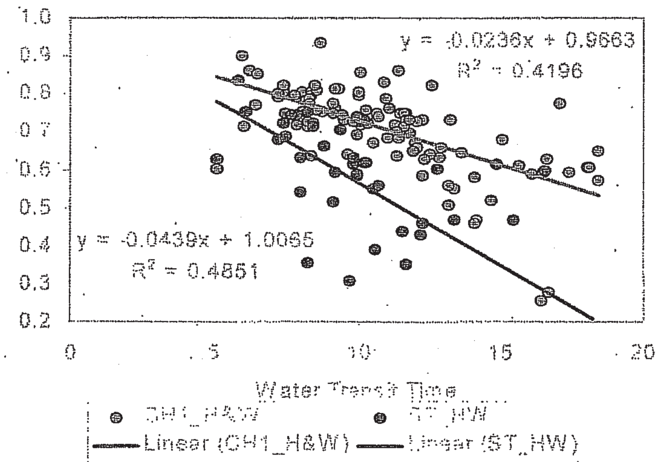

Figure 1. Yearling Chinook and Steelhead – Travel Time versus WTT LGR to McN 1998 to 2005 (Fish Passage Center).

[3] "Flow" refers to a volume or quantity of water moving in a stream per unit of time. A common unit of measure for flow is thousand cubic feet of water per second (kcfs). "Velocity" is the distance of a unit of wate travels per unit time. Common units are feet per second (fps:ft/sec) or kilometers per day (km/da). From NMFS (1995).

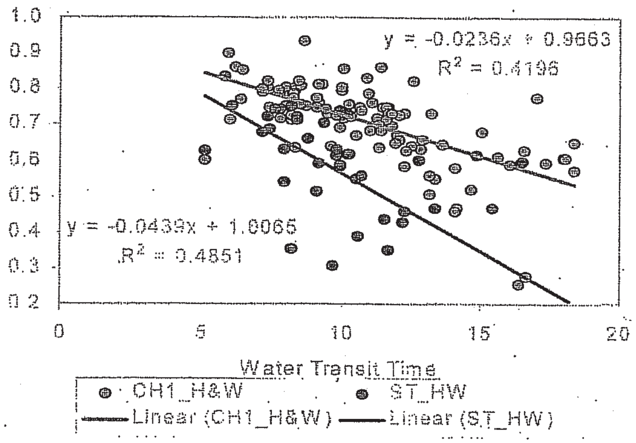

Figure 2. Yearling Chinook and Steelhead – Survival versus WTT LGR to McN 1998 to 2005 (Fish Passage Center).

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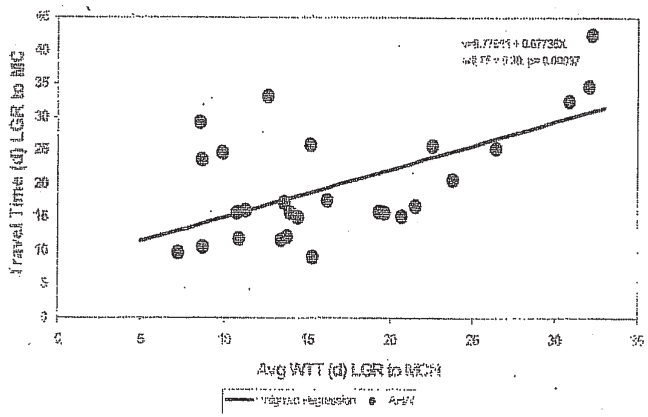

Figure 3. Subyearling Chinook – Travel Time versus WTT Lower Granite Dam to McNary Dam (Fish Passage Center).

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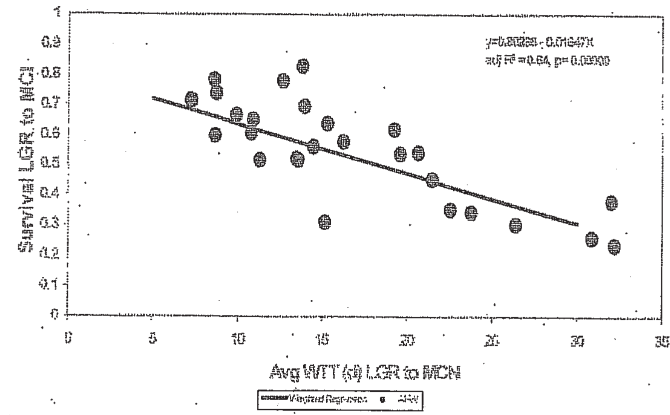

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Figure 4. Subyearling Chinook – Survival versus WTT Lower Granite to McNary Dam (Fish Passage Center).

The current "target flows" under the NMFS 2000 and 2004 Biological Opinions for the Federal Columbia River Power System (hereafter, "2000 BiOp" and "2004 BiOp", respectively) are not adequate to protect anadromous fish spawning, rearing and migratory critical habitat in the mainstem Columbia River. Even these inadequate target flows have not been met since the BiOps were issued. Additional withdrawals from the mainstem Columbia will further reduce critical habitat, lower the probability that the "target flows" will be met, and move the region further from increasing flows from the NMFS target levels that are already inadequate.[4] We support the comments and technical review of the Fish Passage Center and include their comments by reference with respect to further issues surrounding the impacts of the proposed water withdrawals to anadromous fish populations.

The DEIS fails to note that in March, 2000, the Washington Department of Fish & Wildlife's concern about additional water withdrawals led them to send a letter to Ecology recommending:

[4] In the 1995-8 NMFS Biological Opinion for the Federal Columbia River Power System, NMFS attached an analysis, *Basis for flow objectives for operation of the federal Columbia River Power System*. In this attachment, NMFS stated that the flow objectives were "…. Low estimates of flow that is likely to avoid high mortality ". In the CRITFC tribes' *Spirit of the Salmon* restoration plan calls for short (5 years) flow objectives to meet the NWPPC's 1994 *Strategy for Salmon* sliding scale flows of 300-220 kcfs depending on the runoff year and measured at The Dalles. Long term CRITFC flow objectives (25 years) are directed to meet the 50% exceedence levels at The Dalles and other key points. At The Dalles this is 480 kcfs.

- no additional withdrawals occur during the salmon outmigration season
- cumulative effects analyses be performed before any new water rights are granted
- minimum flows for salmon must be established before water rights are approved

A number of aquatic scientists have considered the benefits of managing stored water and flows in highly regulated large rivers such as in the Columbia Basin to produce a more natural river hydrograph, one that has a high flow peak in the late spring with gradually declining flows (NAS 2004; NRC 2002). In the context of the Columbia River, this flow pattern is intended to at least partially mimic the natural river flows in which salmon and other biota evolved and provides an ecological context for salmon productivity [5] (ISG 1996). The importance of providing such a flow pulse has been addressed in several reports and studies (Bunn and Arthington 2002; Power et al. 1996; ISG 1996; Junk et al. 1989; Sherwood et al. 1990). Providing a naturally peaking hydrograph is important to increase the quality and quantity of riverine, estuarine and near shore marine habitat (ISG 1996; Bottom and Jones 2002).

Increasing the flow regime would increase the velocity of the river through the slack water reservoirs that have increased the cross-sectional area of the river. This would have the effect of reducing water particle travel time and correspondingly, juvenile fish migration time to the estuary. Longer juvenile migration times delay saltwater entry, increase exposure to predation and disease, increase energy expenditure (Congleton et al. 2002) and increase residualization in reservoirs (ISG 1996; Bennett 1992). NMFS has noted that only a small proportion of residualized PIT-tagged steelhead survived to successfully migrate the following
5-5 year (Schiewe 2001).

Reduction of fish travel time to the estuary is an important consideration to increasing spring and summer juvenile survival and adult returns (Marmorek et al. 2004; NOAA 2005; Berggren and Filardo 1993; Cada 1994; Schluchter and Lichatowich 1977; Connor et al. 2003). For example, Counihan et al. (2002) found increased survival probabilities for radio-tagged steelhead with increased discharge at John Day Dam. Plumb et al. (2001) found that yearling chinook and steelhead in the Lower Snake River had a higher frequency of traveling upriver than downriver in 2001 (a low flow year) than in other higher flow years.

Increasing river velocities increases turbidity that has been linked to increased salmon survival and productivity, likely through masking of juvenile salmon from predators (Junge and Oakely 1966; Williams et al. 2005; Plumb et al. 2001). As noted by Ward and Stanford (1989) and Vannote et al. (1980), increased sediment transport also replenishes the organic food base necessary for primary production that is critical for salmonid growth and survival.

The loss of a significant freshwater plume of the Columbia River into the nearshore marine environment from the loss of a peaking hydrograph is likely related to reduced juvenile salmon estuarine and early ocean survival (Sherwood et al. 1990). The historical plume likely provided a source of nutrients for important primary and secondary productivity necessary for

[5] The ISG (1996) concluded that the establishment of a new hydrograph to more closely match historical hydrographs to which the fish were adapted was an assumption for which there was solid, peer-reviewed empirical evidence.

salmon growth and also provided cover from predators (Brodeur et al. 1992). Increasing juvenile survival in the estuary and the first year at sea has been considered by NMFS as an important objective to reverse current population declines of Snake River spring and summer chinook salmon (Kareiva et al. 2000). A peaking hydrograph would contribute to improving habitat conditions in the river, estuary and near ocean environment for juvenile and adult salmon.

In addition, there is substantial evidence that increased travel times due to reduce flows and increased temperatures increases delayed mortality mechanisms that affect juvenile salmon after they leave the Columbia River (Budy et al. 2002; Marmorek et al. 2004; Petrosky et al. 2006). Figure 5 illustrates the modeled relationship between flows represented by the NMFS seasonal targets, reduced travel time, smolt to adult survival rates (SARs) and three ocean conditions.[6] While ocean conditions are important to anadromous fish recovery, river flows are also highly influential. In the face of ocean conditions that cannot be controlled, it is critical to provide improved flow regimes. The DEIS fails to consider these issues.

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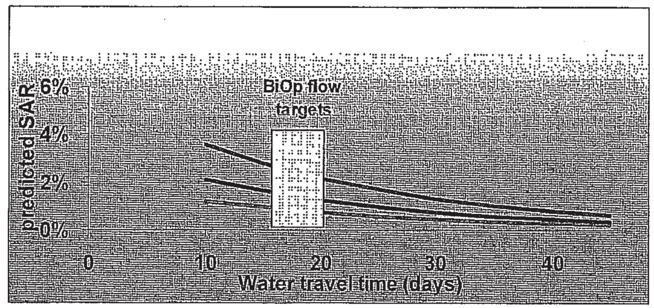

Figure 5. **Influence of Water Travel Time and Ocean Effect on Spring/Summer Chinook SAR. The blue line signifies good ocean conditions, the black line average ocean conditions and the red line poor ocean conditions (predicted). (Fish Passage Center)**

The State of Washington and Ecology, in particular, must consider the Endangered Species Act, its own state policies regarding threatened, depressed and endangered species and the potential detrimental effects of instream flow reduction on the survival of these species. To our knowledge, no analysis of these impacts has yet to be performed by the State, either in this DEIS or elsewhere.

The 1995-1998 NMFS BiOp stated that the Opinion's seasonal target flows were the *minimum* to prevent jeopardy, and that more flows were important and should be obtained. This

[6] The Northwest Power Conservation Council and an panel of regional and independent scientists determined that a SAR of 2-6 % was necessary to recover ESA listed populations. The Council adopted this goal in their 2000 Fish and Wildlife Program. Current survival rates for listed stocks are well below 2%.

position was carried over into the 2000 and 2004 BiOps (NMFS 1995). In reality, seasonal target flows are not being met in many instances, including this past year. Figure 6 shows the probability of target flows being met for any given year of the historical flow record under current operations. If minimum target flows are considered on a weekly basis, they are missed every year for considerable time periods. Additional mainstem water withdrawals are continuous and occur whether the runoff year is good or bad. Figure 6 indicates that target flows are missed during many periods outside of the July-August period, which are the only months considered critical for salmon in the DEIS. The paradigm of the DEIS where flows during other portions of the year are removed from the Columbia and Snake Rivers for potential storage project or other out of river uses would only exacerbate the ability to meet the minimum target flows, thus preventing survival and recovery of these stocks.

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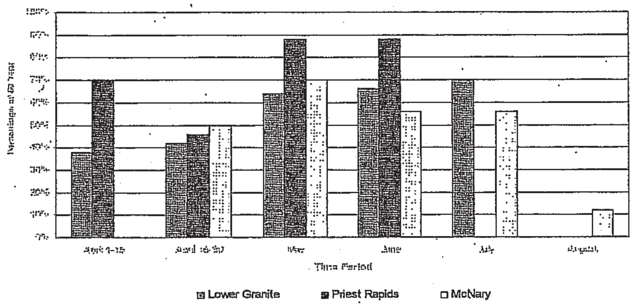

Figure 6. Likelihood of meeting BiOp target flows under current operational conditions. (Fish Passage Center)

The DEIS tends to focus on developing more consumptive water rights, rather than focusing on improving conditions for aquatic resources.

The status of the Basin's ESA-listed salmonid resources must be the focus for SEPA review. The ESA places the survival and recovery of listed species among the Nation's highest priorities. The ESA should effectively shift priorities to improving the status of the affected resources. This priority starts with a scientifically sound understanding of salmon resource needs
5-6 and the effects that water resources management has had on individual populations. The DEIS is wholly inadequate in this regard.

As noted above, increases in flow which in turn increase river velocities, turbidity and mainstem habitat and reduce temperatures are critical to salmon and other anadromous fish. The DEIS failed to define the extant precarious state of these fish populations. It is clear that additional flows are necessary to increase fish productivity necessary to meet ESA recovery standards.

The Interior Columbia Technical Review Team (TRT) filed an Interim Gaps Report on May 17, 2006. They described the abundance and productivity "gaps" for listed ESUs including Snake River spring and summer chinook, steelhead and fall chinook. They also described viable salmon population parameters beside abundance and productivity which includes spatial structure and diversity. The TRT estimated that the change in survival projected required to achieve a 95% chance and a 99% of meeting recovery goals of 3000 naturally producing Snake
5-6 River fall Chinook adults was between 38-47% and 38-69% respectively (ICTRT 2006).

Of equal concern in the TRT gaps for listed Upper Columbia Spring Chinook. The TRT estimated that the change in productivity projected required to achieve a 95% chance and a 99% of meeting recovery goals of 2000 naturally producing Upper Columbia Spring Chinook adults was between 98-135% and 178-233% respectively (ICTRT 2006). Of even more concern are the TRT estimated changes in productivity projected required to achieve a 95% chance and a 99% of meeting recovery goals of 3000 naturally producing Upper Columbia Steelhead adults between 372-566% and 463-791% respectively (ICTRT 2006).

For Pacific lamprey, a special species of concern both in the States of Washington and Oregon and already petitioned for listing under the ESA, abundance levels are at an all time low
5-7 in the historical record, basinwide. Only 35 and 21 adults passed Lower Granite Dam and Wells Dam respectively in 2006. The peak mainstem migration for lamprey occurs in June and early July. These are periods outside the DEIS consideration for flow augmentation. The DEIS fails to consider the impact of water withdrawals on Pacific Lamprey.

It is important for Ecology to realize that the tribal recovery goals for sustainable, harvestable populations significantly exceed those of NOAA Fisheries under the ESA (Nez Perce
5-8 et al. 1995). These include, among other things: 1) halting the declining trends in salmon, sturgeon and lamprey populations upstream of Bonneville Dam within 7 years, 2) within 25 years increase total annual salmon returns to Bonneville Dam to 4 million in a mater that provides for sustainable, natural production and tribal ceremonial, subsistence and commercial harvests.

The CRWMP should analyze all options, including storage, in light of what is biologically best for fish and for improving instream water.

With storage opportunities, it is imperative that Ecology consider and address the impacts and benefits to fish populations and instream water uses. Building new in-channel dams, even for storage purposes, raises a host of issues that ultimately could be detrimental to aquatic life. Off-channel storage, during the time when mainstem water withdrawals are conducted to create
5-9 the storage, will impact anadromous fish flows during the period when fish are in the mainstem and estuary, which is at all times during the year (Bottom et al. 2002). Listed Snake River fall Chinook recently were discovered to have a "holdover," or reservoir, juvenile life history so that these fish do not leave the Columbia and Snake River until early spring. ESA-listed Snake River and Upper Columbia and Lower Columbia juvenile steelhead often spend one to several years in mainstem reservoirs. Adult steelhead are repeat spawners and need migration flows during the early spring to successfully survive their mainstem migrations back to the ocean.

5-10 As CRITFC has repeatedly stated to Ecology, there is ample existing storage in the Columbia River Basin (over 30 MAF). What is key that is not examined in the DEIS is modifying current, overly conservative flood control management that flushes significant portions of water in the winter from storage reservoirs. This eliminates the possibility of use of this storage during the spring and summer months. Improvements to flood control and use of storage are being examined in the BiOp Remand process. An addendum to the DEIS should be established following the conclusions of the Remand process to incorporate flood control modifications.

5-11 With respect to tributary flow enhancement, we support the efforts of the CTUIR in their work to restore flows to the Walla Walla River and believe it will ultimately benefit fish in the region. We encourage Ecology and the state of Washington to continue working closely with the tribe to develop attainable options to further the project. Such an approach has been used to successfully restore anadromous fish populations in the Umatilla River.

5-12 <u>The CSRIA-Proposed Voluntary Regional Agreement Needs Closer Evaluation.</u>

The Voluntary Regional Agreement (VRA) program is a new idea in the world of water law and needs further scrutiny. While it is generally useful to set up a "test case" (as it were) to try out a new idea, we are not convinced that the VRA proposed by the Columbia Snake River Irrigators Association (CSRIA) is appropriate at this time. We believe it is premature and needs closer scrutiny, especially in light of the fact that the VRA will be used as a way for those with "interruptible" rights subject to the Washington 1980 instream flow (the "fishes' water right") to acquire rights that are not interruptible. The VRA is comprised of a series of conservation measures (through best management practices) that are supposed to result in real "wet" water to supply to new (and uninterruptible) water rights. The logistics and legal ramifications of this have not been adequately examined to assure that it is workable. Furthermore, there is not enough review of its impacts to fish and instream flow. Instead the VRA is all about protecting water users and creating more consumptive water rights, not about protecting aquatic beneficial uses of the river, and certainly not heeding the advice of the National Research Council to avoid withdrawing water during times of low flow.

5-13 Of significance, the CSRIA-Proposed VRA contemplates a water mitigation program whereby members within the VRA "commit to pay $10 per acre-foot annually for the full amount of water used under the permit in the previous year." This "mitigation program" was devised under a settlement agreement that Ecology entered into with the CSRIA. We do not agree that this settlement agreement should be a part of this VRA. The mitigation program was never publicly examined or commented upon, nor was it formally assessed by economists.

5-14 Because VRA mitigation option seemingly appeared out of nowhere and did not reflect the real market value of water resources, the tribes and CRITFC contracted with Resource Dimensions, LLP, to examine the program.

5-14 We are attaching the report (as Attachment A), Gustanski, Julie Ann, PhD.; E. Ariel Bergmann, PhD., Eva Gibson-Weaver, M.S., *Economic Analysis of the Columbia River Basin Water Mitigation Program* (Draft Sept. 2006). We ask Ecology to consider the report as part of its evaluation of the VRA. For purposes of the report, Resource Dimensions examined the question: "Is the fee level proposed for new water diversions within the Columbia River basin sufficient to assure that adequate mitigation funds will be available to protect instream requirements during a dry year at any given point in the future?" The report looks as several different alternative mitigation options, basing its analysis on the availability of replacement water, an important detail that is often overlooked when devising the mitigation component of these water rights permits. The report reflects that the proposed $10 per acre-foot does not adequately meet the actual cost of providing the mitigation, especially when the mitigation is needed for years of low flow.

The report acknowledges some other primary risks and uncertainties that Ecology *must* address in public forum before it proceeds further with a mitigation proposal and a VRA. Some of the primary risks and uncertainties noted in the report are: the length of time that the mitigation fund will need to accumulate enough money to purchase mitigation water; duration and intensity of future droughts; availability of wet water for acquisition; and management of the fund. While the report does not fully answer these problems, it offers some options for Ecology, the Tribes and other stakeholders to consider for future VRAs.

5-15 The DEIS notes that "implementation of some conservation projects [for the VRA] may require additional environmental review." Therefore we recommend that Ecology take the "No Action Alternative" for this Action at this time and not process the VRA until the mitigation option is reviewed and the plan is further considered.

5-16 <u>Early Action: Lake Roosevelt Drawdown.</u>

As we stated in our comments on the CR Water Inventory Report, a foot and a half of Lake Roosevelt will only provide about 130,000 acre feet of water. Current discussions in the Remand Process are considering 4-8 feet of storage for Lake Roosevelt, and an additional 5 feet of storage from Banks Lake for flow augmentation. The DEIS has failed to examine these additional storage volumes for anadromous fish flows.

SPECIFIC COMMENTS

Summary § S.3.1.6 (p. S-8).

Mitigation measures would be developed in coordination with state and federal fish and wildlife agencies, the state Department of Archeology and Historic Preservation, and affected tribes.

5-17 In the past, Washington law has instructed Ecology to consult with "appropriate" tribes, rather than "affected." Is there a difference in application here? Should the scope be broadened to "appropriate"?

Chap. 2, § 2.2.8 (p. 2-18).

5-18 The DEIS contemplates defining certain terms found in the legislation. For the term: "No Negative Impact," the definition cannot simply state "same pool" or "same major reach" because these definitions do not capture the reality of providing *no negative impact*. The definition must be considered in light of benefits to salmon and other fish population. Meeting a no net negative impact standard will not recover anadromous salmon populations, because they are at a baseline that is already headed toward extinction. A no net negative impact standard will only at best, retain the currently baseline, which is unacceptable to CRITFC and its member tribes.

Chap. 2, § 2.5.1.2

5-19 The DEIS claims that there would not be a drawdown of Lake Roosevelt under the No Action Alternative. This may be the case with respect to the CRWMP, but it is not necessarily the case under other processes such as ESA and the Clean Water Act. As stated elsewhere in these comments, additional drawdowns of Lake Roosevelt are being contemplated as alternatives to increase listed salmon survival in the BiOp remand process in most water years. In addition, thorough a collaborative process led by EPA which includes Ecology, the Bureau of Reclamation has finished a selective withdrawal modeling study to determine if Lake Roosevelt could be used to reduce mainstem temperatures in the upper and mid-Columbia Rivers (BOR 2003) in order to better meet Washington State water quality standards. It may be necessary to drawdown Lake Roosevelt in order to meet temperature standards. A supplemental DEIS should describe these differences and explore these related issues.

Chap. 3, § 3.6.1.4 (p. 3-44).

This reserved right will prevent any new, upstream consumptive diversion that would leave insufficient flows in the river to maintain the fishery protected by the reservation. As such, this reservation could be a significant constraint on new diversions upstream of the Hanford Reach.

5-20 It is true that the 2000 federal designation of this site created federal water rights for the Reach, but the DEIS failed to also note that the Reach – the last free-flowing stretch of the Columbia River, is the spawning, incubation and rearing grounds for Hanford fall Chinook – the primary fish stock harvested by the Columbia River treaty tribes to fulfill their treaty rights. herefore, it is likely that there are significant tribal treaty instream water rights to the Reach that

5-20 are priority date of time immemorial. From a harvest perspective, the Hanford Brights are also an important stock coastwide from Alaska to Oregon. Flow fluctuations impact this stock, as will millions of juveniles estimated to be lost from these fluctuations and spawning habitat also reduced (Anglin et al. 2006). Reductions in flows during from October to May during the spawning, incubation and rearing life histories of this stock would likely impact productivity.

5-21 The DEIS describes the Hanford fall Chinook and sturgeon stocks as "healthy" but fails to provide any information or justification for this term. Actually, Hanford fall Chinook abundance has been in decline since the 2001 drought, when millions of juveniles were estimated to be lost due to flow fluctuation aggravating already low flows which were further reduced by Ecology's decision not to interrupt irrigation flows (Anglin et al. 2006). Hanford Reach sturgeon have failed to provide consistent recruitment because of the lack of high flows and are in a state of decline, as with other sturgeon stocks in the basin, particularly those located above McNary Dam. Only 1 population of sturgeon of 25 basin populations is considered to be stable and abundant (Miller 1995 in Parsley and Kappenman 2000).

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Delayed Mortality of Columbia River Salmon

Exploring evidence concerning delayed hydrosystem mortality for Snake River spring/summer Chinook

A draft technical document developed for the Framework/Policy Work Groups Federal Columbia River Power System Salmon Biological Opinion Remand

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May 31, 2006

Executive Summary:

The hypothesis that a portion of the mortality that occurs in the estuary and ocean life stage is due to cumulative impacts of the Federal Columbia River Power System (FCRPS) is examined and the rationale described. Multiple analytical approaches are presented addressing this delayed or latent mortality for Snake River spring/summer Chinook. Water travel time and ocean/climatic conditions are considered in describing the variation in survival rates. In all results water travel time proved to be a significant factor in explaining the variation in survival. The FCRPS has delayed migration of in-river fish; with later arriving components of the population exhibiting lower SARs. The results of these multiple analyses provide compelling evidence that passage through the FCRPS strongly influences levels of delayed mortality of in-river migrants for these populations.

- The paper summarizes the hypothesis of delayed (latent) mortality relative to development and operation of the FCRPS, the mechanisms and the lines of evidence for this hypothesis, and variants of this main hypothesis.
- Past analyses are updated and expanded addressing upriver and downriver population comparisons and the development and operation of the FCRPS as a key factor in delayed mortality of Snake River spring/summer Chinook.
- New analyses are presented on survival of Snake River stocks alone that do not rely on upriver and downriver population comparisons.
- The analysis of Snake River populations alone included ocean/climatic variables, and water travel time relative to spawner-recruit residuals, smolt-to-adult return rates (SARs) and survival during the first year of ocean residence. Water travel time increased as the FCRPS was developed, and populations experienced a wide range of ocean/climatic conditions during the study period.
- Evaluation of the spawner-recruit residuals, SARs and early ocean survival showed that survival was related to water travel time, providing supporting evidence that there is a significant component of the survival during early ocean residence that is accounted for by delayed mortality, and related to construction and operation of the FCRPS. These analyses compliment the results from the upriver/downriver population performance model and did not rely on an assumption that downriver populations can serve as controls for Snake River populations.
- There is a delayed mortality component to survival during early ocean residence that is related to construction and operation of the FCRPS; however survival rates are also strongly related to the PDO and upwelling indices (measures of oceanic climatic conditions). The magnitude of delayed mortality may be modified by ocean conditions.
- Additional support for delayed mortality associated with passage through the FCRPS is provided by within-season patterns of SARs for in-river migrants, SARs of bypassed vs. true in-river migrants, and the relatively higher SARs of John Day wild Chinook when they experience the same arrival timing at Bonneville Dam as Snake River wild Chinook.
- Some delayed mortality of transported fish is well established by D-values less than 1.0, indicating ocean survival of transported smolts is less than that of in-river fish, which also experience delayed mortality.

I. Introduction

The Federal Columbia River Power System (FCRPS) Biological Opinion Remand Policy Work Group (PWG) provided direction in early May 2006 to the Framework Group participants to clarify issues related to delayed hydrosystem mortality for in-river migrants of Snake River spring/summer Chinook salmon. The PWG directed the Framework Group participants to develop clear statements of the differing hypotheses related to delayed mortality, and provide supporting rationale and evidence by May 31. Due to the short time-frame for this assignment, the draft document has not received complete agency or Framework Group review.

This technical draft document describes one hypothesis implemented in the Framework process that indicates substantial delayed (latent) mortality of juvenile salmon in the estuary or early ocean as a consequence of the hydrosystem experience. We also explored a variation on this hypothesis that delayed hydrosystem mortality may be influenced by ocean and climatic conditions. The rationale for the delayed mortality hypothesis is briefly described, and evidence from a number of existing and new analyses is presented.

II. Definition and Background for delayed mortality of Columbia River salmon

Development of the FCRPS from 1968 through 1975 resulted in a doubling of the number of dams, from four to eight, through which Snake River salmon migrate. This development was accompanied by severe declines in all Snake River anadromous salmon and their listing under the Endangered Species Act (ESA) in 1992.

A key remaining uncertainty for evaluating recovery options for upper basin salmon populations relates to the source of mortality that fish experience while in the estuary and early ocean. Sources of estuary and early ocean mortality include not only elements of the natural ocean environment, but also delayed effects of earlier-life-stage experiences. One hypothesis for this delayed (or latent) mortality is that although this mortality occurs in the estuary and early ocean, it may be related to a fish's earlier experience through the hydrosystem. Because this mortality may be caused by the cumulative impacts of the hydrosystem during downstream migration as juveniles, a portion of the mortality that occurs in this life stage is called delayed mortality. In the case of Snake River salmon, fish may die in the estuary or ocean after exiting the hydrosystem, but as a result of the cumulative impacts from negotiating up to eight hydroelectric dams. Hereafter, in order to synthesize the terminology and emphasize its anthropogenic source, we refer to this type of mortality as delayed hydrosystem mortality. Identifying the magnitude of delayed hydrosystem mortality of Snake River salmon populations is crucial to estimate the distribution of mortality among the Hs and the predicted the outcome of recovery scenarios. The relative utility of different recovery actions for Snake River stream-type Chinook salmon hinges in part on whether post-Bonneville smolt-to-adult survival rate is influenced by hydrosystem experience during seaward migration. Previous analytical assessments (2000 BiOp, Peters and Marmorek 2001; Karieva et al. 2000; Wilson 2003) evaluated management options for halting the decline of these populations. Investigators found that model results of management actions are sensitive to assumptions about the degree to which mortality that takes place in the estuary and ocean is related to earlier hydrosystem experience during downstream migration.

To standardize the discussion, we introduce the following notation (Figure 1) in use by the COMPASS modeling group. First, we designate survival terms using S and mortality terms using $L = 1 - S$. Terms for in-river migrants are denoted by the subscript I and terms for transported fish by the subscript T. We partition survival and mortality into the following life stages: downstream migration through the hydropower system (subscript *ds*), estuary/ocean (subscript *e/o*), and upstream migration through the hydropower system (subscript *us*). We further partition the estuary/ocean stage to reflect mortality that would occur independent of the hydropower system ($1\text{-}S_{e/o}$), and hydropower system-related delayed (latent) mortality (L), which applies to both transported fish and in-river migrants. This partitioning of estuary/ocean survival reflects an assumption that for in-river fish, delayed mortality is essentially entirely expressed in the estuary/ocean stage. In previous studies, latent mortality (L) was

termed delayed hydrosystem mortality and denoted as 1-λn (Peters and Marmorek 2001). We use this earlier terminology when discussing updated estimates of delayed mortality.

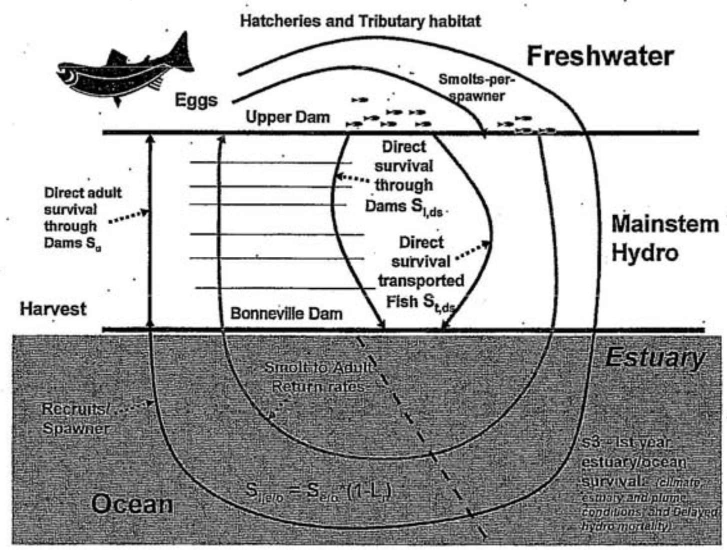


Figure 1. Survival and mortality terms used by the COMPASS work group for migration through the hydrosystem, and estuary/ocean survival partitioned into natural survival and hydrosystem latent mortality (L) components. Survival (S) and mortality (L) affecting Snake River anadromous salmonids migrating in-river (denoted by subscript I) at various life stages. The life stages are downstream migration through the hydropower system (*ds*), estuary/ocean (*e/o*), and upstream migration through the hydropower system (*us*). The estuary/ocean survival is partitioned into survival that would occur in the absence of the hydropower system ($s_{e/o}$) and latent mortality associated with the passage through the hydropower system (L_I). Transported fish (denoted by subscript T) are affected by the same survival and mortality processes and are represented by changing the subscript I to T. In previous literature, L = 1-λn.

III. Rationale for delayed mortality and mechanisms:

Because, by definition, delayed mortality is expressed after fish pass through the hydrosystem, it is impossible to measure directly. Delayed mortality associated with the FCRPS might result from changes in migration timing; injuries or stress incurred during migration through juvenile bypass systems, turbines, or spill at dams that does not cause direct mortality; disease transmission or stress resulting from the artificial concentration of fish in bypass systems or barges (Williams 2001, Williams et al. 2005, Budy et al. 2002; Schreck et al. 2006); depletion of energy reserves from prolonged migration (Congleton et al. 2004); altered conditions in the estuary and plume as a result of FCRPS construction or operation; or disrupted homing mechanisms. Nevertheless, changes in the hydrosystem over time were concurrent with changes in ocean conditions, hatchery smolt releases, and etc., making direct inference about relative influence of different factors in elevating mortality difficult. However, a number of reviews have found evidence in various forms linking the delayed mortality to the construction and operation of the FCRPS (Budy et al. 2002; Marmorek et al. 2004).

a. *Stress and injury at the dams*: Problems associated with collection and mechanical bypass systems at the dams include: 1) delay of fish in the forebay; 2) a large pressure change experienced by fish going through the collection and bypass system; 3) mechanical injury during collection and bypass; and 4) concentration of fish at the bypass outflow where predators tend to congregate. Fish that pass via turbines are also delayed in forebays and are exposed to similar extreme pressure changes and mechanical injuries while going through the turbines (Long et al. 1968; Mathur et al. 1996; Navarro et al. 1996; Ferguson et al. 2006; *see review by* Bickford and Skalski 2000).

b. *Stress and delayed mortality*: In addition to the stress smolts experience at the dam, the reservoirs behind the dams may also create stressful conditions. Water velocity has been greatly reduced as a result of the dams, and thus the time and energy expended to get through the reservoirs has increased over that

experienced in the free flowing conditions for which these fish evolved (Williams and Mathews 1995). The concept of increased vulnerability to predators as a result of acute or chronic stress is ubiquitous in ecology (see Budy et al. 2002).

c. *Delayed mortality and arrival timing to the estuary*: During their seaward migration smolts are undergoing physiological changes in order to make the transition to saltwater. The increased freshwater residence time may result in premature physiological changes for saltwater that are not optimally suited for the freshwater environment. Also, the delay in reaching the estuary may result in arriving during a period of suboptimal conditions for survival. The combination of disrupting the timing of physiological readiness and arrival to the estuary during suboptimal conditions could cause increases in delayed mortality levels. The decrease in water velocity has also resulted in an increase in the residence time of the water, stressing fish energetically and allowing water temperatures to increase to higher than optimal levels for these cool water species (Raymond 1979; Budy et al. 2002; Congelton et al. 2004).

IV. Hypothesis: *Passage of seaward migrating juvenile fish through and around the FCRPS causes delayed mortality to salmon populations that may not be expressed until the estuary and ocean life-stage.*

a. *Evidence*

Delta model results from updated spawner-recruit (SR) analysis indicates that differential mortality between upriver and downriver populations increased during development of the FCRPS and remained high after completion of the FCRPS (Deriso et al. 2001; Marmorek et al. 2004; Schaller and Petrosky *in review*). In addition, delayed mortality estimates (using the methods of Peters and Marmorek 2001) also increased during development of the FCRPS and remained high after completion of the FCRPS.

i. Differential mortality between upriver and downriver populations.

Differential mortality is an estimate of the difference in the instantaneous mortality rate between Snake River and downriver (John Day River) population groups, accounting for common ocean climatic influence on both groups. Retrospective life-cycle analysis provided evidence of increases in mortality in Snake River spring/summer Chinook coincident with the development of the FCRPS (Schaller et al. 1999; Deriso et al. 2001; Marmorek et al. 2004; Schaller and Petrosky *in review*). The declines in survival rate of Snake River stocks were considerably sharper than those of downriver stocks over the same time period. Further, most Snake River survival rate declines were in the smolt-to-adult life stage, rather than the spawner-to-smolt stage (Petrosky et al. 2001). Differential mortality (μ), using model 1 from Deriso et al. (2001), has averaged about 1.47 since hydrosystem completion (Fig. 2). An alternative SR method compares Ricker residuals from Snake River and downriver stocks, which results in differential mortality estimates of about 1.15 (Fig. 3; Schaller et al. 1999; Schaller and Petrosky *in review*). Thus, life cycle survival rates ($e^{-\mu}$) of Snake River population averaged only ¼ to 1/3 those of downriver populations since FCRPS completion.

PIT-tagged fish provide an independent measure of survival rates from smolt to adult stage, which incorporates variation in hydrosystem experiences and environmental conditions in the estuary and (early) ocean. Spatial and temporal contrasts of survival rates from different life stages (adult-to-adult, adult-to-smolt, and smolt-to-adult) provide valuable information to diagnose where mortality rates have increased in the salmon life-cycle, and allow indirect inferences about alternative causes. The Comparative Survival Study (CSS; Berggren at al. 2005) started a consistent time series of PIT-tag SARs for Snake River and downriver wild spring/summer Chinook (John Day River) beginning in smolt year 2000. SAR estimates of differential mortality

generally agree with those from spawner and recruit information (Fig. 2, 3), and indicate Snake River stocks survived 1/3 as well as downriver stocks during smolt years 2000-2002 (Berggren et al. 2005). The close correspondence of the SAR and SR estimates of differential mortality provides additional evidence that the relative survival difference occurred during the smolt- to-adult life stage. Lastly, this SAR analysis of differential mortality provides a measure that is independent of μ estimated from SR data.

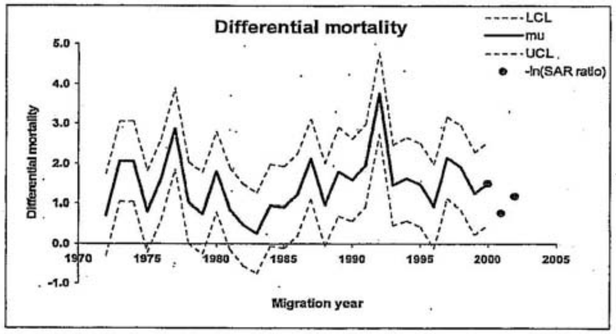


Figure 2. Differential mortality estimates (mu) from the Deriso et al. (2001) model updated through smolt year 2000 (Marmorek et al. 2004; Schaller and Petrosky *in review*) compared to estimates based on SARs of wild Snake River and John Day River spring/summer Chinook (-ln(SAR ratio)), smolt years 2000-2002 (Berggren et al. 2005).

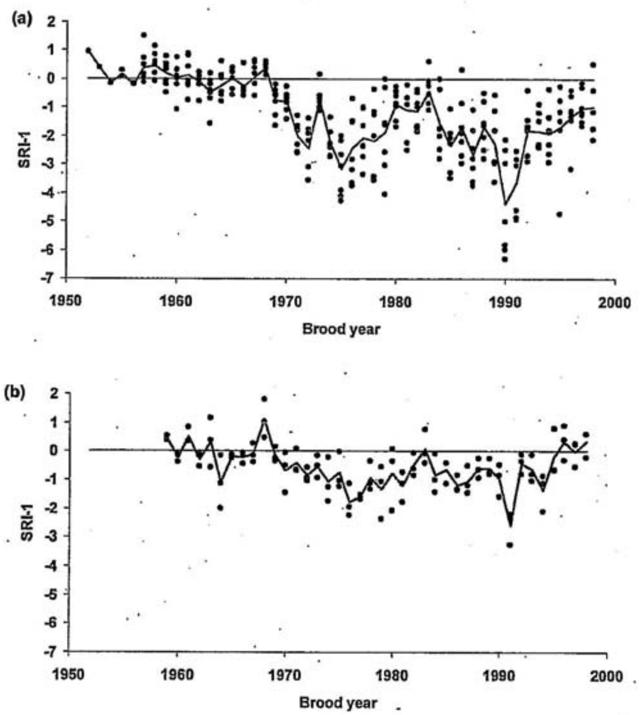


Figure 3. Deviations of ln[(observed R/S)/(predicted R/S)] from ANCOVA fit to the pre-1970 period (SRI-1) for the (a) Snake, and (b) downriver regions, brood years 1952-1998 (Schaller and Petrosky *in review*). Average SRI-1 values represented by solid line.

ii. <u>Estimating delayed mortality</u>. The magnitude of delayed mortality is estimated by partitioning direct juvenile passage survival and the differential delayed transportation mortality factor, *D*, from the estimated total mortality (m) of the Snake River populations (Peters and Marmorek 2001; see Fig. 1). Total mortality (m) is estimated by spawner-recruit methods described in Deriso et al. (2001; model 1). Tagging studies (Williams et al. 2005; Berggren et al. 2005, Zabel et al. 2006) and retrospective juvenile passage modeling (Peters and Marmorek 2001) can be used to generate historical estimates of the juvenile passage survival, direct hydrosystem mortality (M) and *D*.

Delayed mortality is estimated as 1-λn ("lambda_n" in Table 1; Peters and Marmorek 2001). Estimates of delayed mortality averaged 0.59 for smolt migration years 1977-1993 (Peters and Marmorek 2001; Fig. 4), using passage model in-river survival estimates and an average D = 0.53 (Table 1). Updated estimates of delayed mortality, using PIT-tag estimates of in-river survival and D, averaged 0.67 for smolt years 1994-2000 (Marmorek et al.2004, Schaller and Petrosky *in review*; Fig. 4).

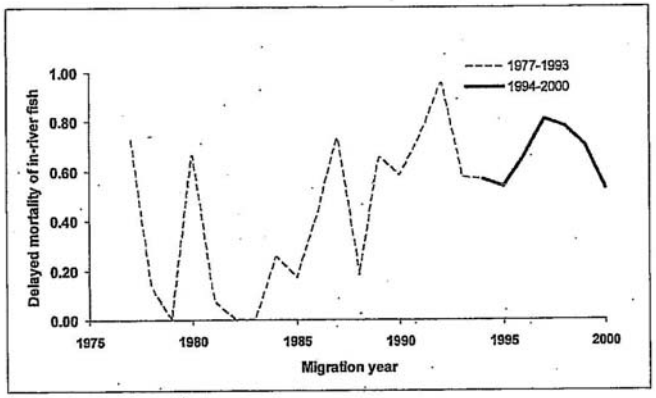


Figure 4. Delayed mortality estimates for smolt migration years 1977-2000 (Schaller and Petrosky *in review*).

Table 1. Estimates of instantaneous mortality rates, and survival rates attributed to delayed hydrosystem mortality for Snake River spring/summer Chinook, post FCRPS completion. Estimated parameters from Peters and Marmorek (2001), updated through brood year 1998 (Marmorek et al. 2004). Differential mortality estimates for 1999 from SARs of Snake River and John Day River spring Chinook (Berggren et al. 2005). Estimates of D before brood year 1992 sampled from 1993-2003 distribution (Berggren et al. 2005), except brood year 1999 value of D (2001 smolt year) applied to other low flow years (brood year 1975).

Brood year	M	Pbt	D	m	Delta_m	Sem	Lambda n	Delta	Mu
1975	1.252	0.984	2.20	3.176	1.924	0.146	0.07	-0.196	2.860
1976	0.632	0.900	0.48	1.327	0.695	0.499	0.94	-1.137	1.011
1977	0.514	0.936	0.47	1.060	0.546	0.580	1.00	-1.046	0.744
1978	0.427	0.939	0.47	2.104	1.678	0.187	0.37	-0.341	1.789
1979	0.511	0.938	0.47	1.169	0.658	0.518	1.00	-0.727	0.853
1980	0.616	0.732	0.49	0.767	0.150	0.860	1.00	-0.100	0.451
1981	0.738	0.703	0.49	0.569	-0.169	1.000	1.00	-0.523	0.254
1982	0.542	0.746	0.48	1.266	0.724	0.485	0.79	0.151	0.950
1983	0.466	0.922	0.48	1.220	0.754	0.470	0.90	0.800	0.905
1984	0.444	0.880	0.49	1.527	1.083	0.339	0.62	-0.157	1.211
1985	0.492	0.958	0.48	2.425	1.933	0.145	0.29	0.027	2.109
1986	0.470	0.969	0.48	1.278	0.807	0.446	0.90	-0.573	0.981
1987	0.497	0.892	0.49	2.106	1.609	0.200	0.37	-0.842	1.790
1988	0.430	0.957	0.48	1.893	1.463	0.231	0.46	-0.105	1.577
1989	0.339	0.942	0.48	2.274	1.935	0.144	0.29	0.008	1.958
1990	0.322	0.979	0.48	4.072	3.750	0.024	0.05	-0.337	3.756
1991	0.320	0.943	0.48	1.759	1.439	0.237	0.47	-1.892	1.443
1992	0.210	0.973	0.32	1.925	1.716	0.180	0.53	0.128	1.609
1993	0.159	0.939	0.40	1.775	1.618	0.199	0.46	-0.186	1.460
1994	0.180	0.674	0.86	1.244	1.063	0.345	0.39	-0.733	0.928
1995	0.198	0.882	0.39	2.450	2.251	0.105	0.22	0.581	2.134
1996	0.178	0.882	0.54	2.210	2.032	0.131	0.22	0.901	1.894
1997	0.121	0.912	0.74	1.555	1.433	0.239	0.31	0.585	1.239
1998	0.218	0.859	0.38	1.808	1.590	0.204	0.45	1.025	1.492
1999	0.027	0.990	2.20	0.947	0.919	0.389	0.18		0.756
							0.44 geomean lambda n (BY78-98)		

M = direct mortality of Snake stocks
m= total annual mortality of Snake stocks
Delta_m = m - M
Sem = exp(-Delta_m)
Lambda_n = Sem/(D*Pbt+1-Pbt)

Lambda_n is survival rate attributed to delayed hydrosystem mortality of in-river migrants

Delayed mortality = 1 - Lambda_n

D = differential delayed mortality of transported smolts
Pbt = proportion of migrants below Bonneville Dam that were transported
Delta = common year effect (common mortality patterns between Snake and downriver populations)
Mu = differential mortality (difference in mortality between Snake and downriver populations)

Average Mu = 1.47, i.e., Snake River populations survived 23% as well as downriver populations

M, m, Delta and Mu are defined in Deriso et al. (2001)
Delta_m, D, Pbt and Lambda_n are defined in Peters and Marmorek (2001)

iii. <u>Common year effect.</u> In the Delta model, differential mortality is estimated with an assumption of a common climatic influence on the different population groups (Deriso et al. 2001); the best fit empirical models included an estimate of a common year effect (δ). The estimated common year effect ranged from -1.89 to 1.49 for smolt years 1954-2000 (Fig. 5; Marmorek et al. 2004; Schaller and Petrosky *in review*). This range of mortality equates to relative annual changes (e^{δ}) from 15% to 444% of the long-term average survival rate.

The relevance of upriver/downriver population comparisons to infer common climatic influences and to estimate hydrosystem impacts, including delayed mortality, was questioned by Zabel and Williams (2000), Levin and Tolimieri (2001) and Williams et al. (2005). A primary criticism was that the two stock complexes may have considerable genetic differences and would not respond identically to estuary and ocean conditions. Arguments in support of such a framework appeared in Schaller et al. (1999, 2000), Marmorek et al. 1998, Deriso et al. (2001) and Schaller and Petrosky *in review*. These papers stressed that the stock differences would need to explain the systematic change in relative stock performance coincident with, but unrelated to, the development and operation of the hydrosystem.

The common year effect, δ, appears to be a reasonable description of co-variation between upriver and downriver stream-type Chinook salmon in the Columbia River. Snake River and John Day River stream-type Chinook have similar smolt migration timing and share common estuary conditions (Schaller et al. 1999; Berggren et al. 2005). Elsewhere, co-variation in survival rates within and between species has been described at regional scales up to 500 km from the point of ocean entry (e.g., Pyper et al. 2005). The variation in δ and SR residuals for the downriver stream-type Chinook populations fell within a range similar to that observed for pink, chum, sockeye and coho salmon from other regions, and Columbia River ocean-type Chinook (Fig. 6a,b; Schaller

and Petrosky *in review*). In contrast, the variance in Snake River SR residuals significantly exceeded that in 36 out of 40 other salmon population groups (Fig. 6c). This larger variation in Snake River SR residuals relative to other salmon population groups is consistent with the Schaller et al. (1999) and Deriso et al. (2001) hypotheses of large mortality impacts due to hydrosystem development and operation, which is in addition to environmental variation (captured by the common year effect).

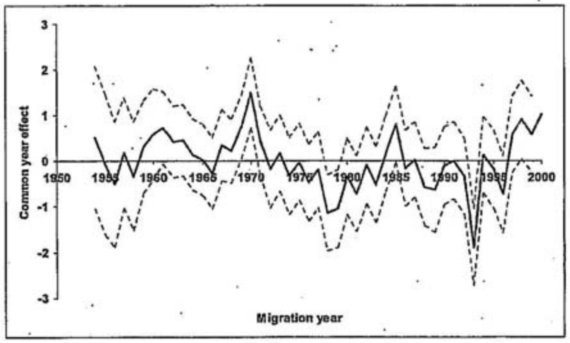


Figure 5. Common year effect estimates from the Deriso et al. (2001) model updated through smolt year 2000 (Marmorek et al. 2004; Berggren et al. 2005).

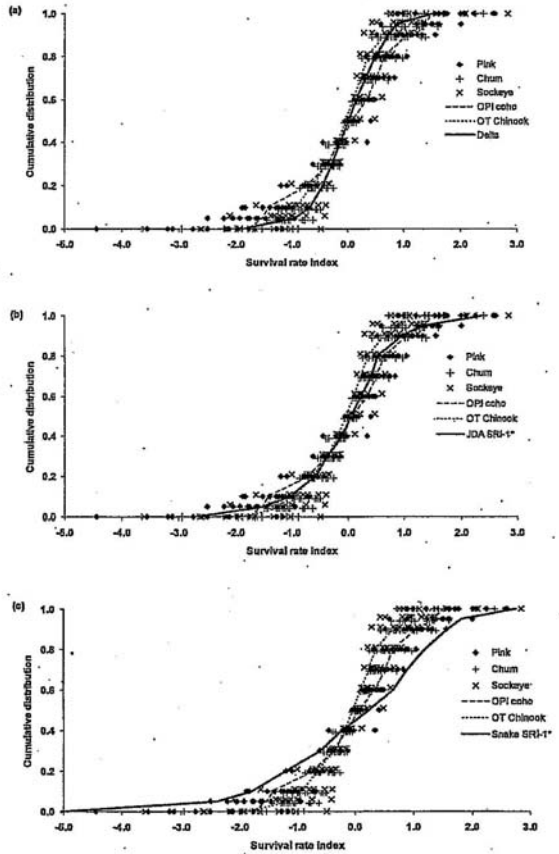


Figure 6. Distribution of δ (a), SR residuals for John Day River populations (b) and SR residuals for Snake River populations (c) of stream-type Chinook compared with SR residuals for other salmon population groups (Schaller and Petrosky *in review*).

iv. <u>Analyses excluding downriver stocks.</u> The preceding delayed mortality analyses relied on upriver/downriver population performance to determine annual mortality differences between population groups, and then partitioned this annual mortality by the measured (or model estimated) direct passage mortality and *D*.

Other analytical methods, which rely only on the Snake River population response, also point to large mortality impacts from the FCRPS in the SAR life-stage. First, Wilson's (2003) matrix modeling analysis also concluded that a sharp decline in estuarine and ocean survival, associated with dam construction and operation, was the primary reason for the population declines. We explored alternative approaches, using just the Snake River populations, including multiple regression of the SR residuals (Schaller et al. 1999; Schaller and Petrosky *in review*), the SARs and the 1st year ocean survival (s3 - Zabel et al. 2006) against environmental conditions experienced during the smolt migration and in the ocean (Petrosky and Schaller *in prep.*).

Linear multiple regression was used to relate SR residuals (an index of survival) for Snake River spring/summer Chinook populations (Schaller et al. 1999; Schaller and Petrosky *in review*) to water travel time (WTT) during the smolt migration and ocean climatic variables experienced during the first year at sea. WTT is a measure of the average number of days for water particles to travel from the confluence of Clearwater and Snake Rivers to Bonneville Dam (April 15-May 31 flow). Ocean climatic variables investigated included: Pacific Decadal Oscillation Index (PDO), Sea Surface Temperatures (SST) and wind induced coastal upwelling index (Mantua et al. 1997, Pacific Fisheries Environmental Laboratory 2006). WTT increased substantially as the number of dams increased, and varied as a function of flow (Fig. 7). WTT was about 2 days during pristine conditions and increased to an average 19 days (range 10-40 days) with 8 dams. WTT was a significant independent variable in the top regression models (Table 2), suggesting some of the life cycle survival variation was associated with the juvenile migration conditions. The best 3 variable model included WTT, April Upwelling and September PDO. The expected response for (R/S) to changes in WTT (holding ocean climatic variables constant) is shown in Fig. 8. For average climate conditions the expected ln(R/S) residual was 0 at 2.8 days WTT, decreasing to -1.79 at 19 days WTT. In other words, with increased WTT survival (recruits/spawner residuals) would decrease to 17% ($e^{-1.79}$) of survival expected under historic WTT conditions. For the good and poor climate conditions considered here (Sep PDO -1 or +1, April Upwelling +40 or -40), the expected recruits/spawner was 2 fold higher or lower, respectively (Fig. 8). The increase in instantaneous mortality after FCRPS completion predicted by the WTT regression (1.79) corresponded closely with the Delta model estimates of annual instantaneous mortality (average m = 1.75; Table 1). In other words, both methods (upstream/downstream comparison and Snake River population performance only) estimate that, on average, current survival has decreased to 17% of the average historic level.

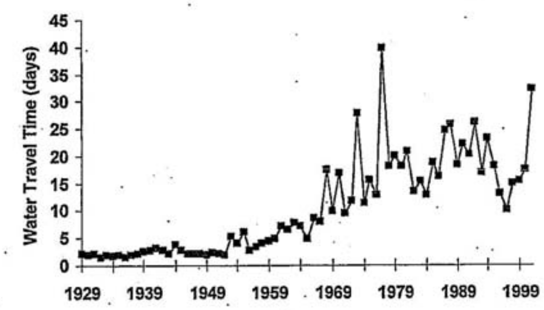


Figure 7. Water Travel Time (days for water particles to travel from the confluence of Clearwater and Snake Rivers to Bonneville Dam), 1929-2001. FCRPS dams were constructed in 1938 (BON), 1953 (MCN), 1957 (TDD), IHR (1961), JDA (1968), 1969 (LMN), 1970 (LGS), and 1975 (LGR).

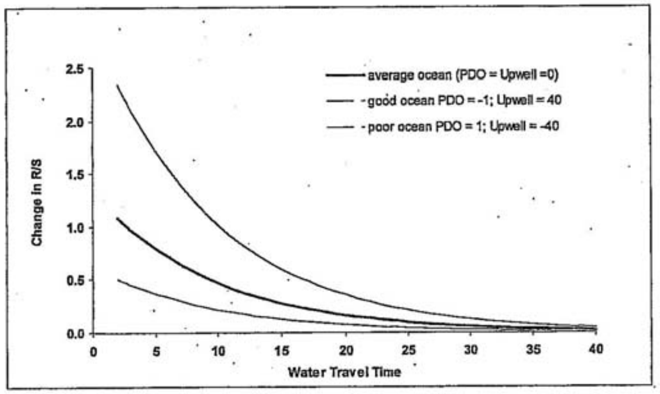


Figure 8. Expected change in Recruit/Spawner vs. Water Travel Time (WTT) for average ocean conditions (Sep PDO = 0; April Upwelling = 0), good ocean conditions (Sep PDO = -1; April Upwelling = 40), and poor ocean conditions (Sep PDO = 1, April Upwelling = -40). Historic WTT was 2 days, recent average (range) with 8 dams is 19 days (10-40 days).

Table 2. Regression model results (selected) for SR residuals of Snake River spring/summer Chinook versus environmental variables, Water Travel Time (days), PDO, Upwelling and Sea Surface Temperature (selected months), smolt migration years 1954-2000.

Number in model	Adjusted R^2	R^2	AIC	BIC	Variables in model	Comments
8	0.733	0.760	-37.46	-30.37	WTT, May PDO, JunPDO, AprUP, OctUP, MarPDO, AugPDO,SepPDO	highest R^2_{adj}
4	0.721	0.745	-38.62	-35.48	WTT, AprUP, OctUP, SepPDO	best AIC, BIC
3	0.695	0.715	-35.36	-33.37	WTT, AprUP, SepPDO	best 3 variable model
3	0.689	0.709	-34.39	-32.56	WTT, AprUP, AugPDO	
3	0.688	0.708	-34.32	-32.50	WTT, OctUP, SepPDO	
3	0.687	0.707	-34.10	-32.32	WTT, OctUP, AugPDO	
2	0.668	0.682	-32.30	-30.94	WTT, AugPDO	best 2 variable model
1	0.540	0.550	-17.93	-17.67	WTT	
3	0.524	0.555	-14.44	-15.58	WTT, MarSST, MarPDO	lowest R^2_{adj} including WTT
4	0.464	0.511	-7.99	-10.62	MayPDO, JunPDO, OctUP, AugUP	highest R^2_{adj} excluding WTT

Parameter estimates SR residuals = WTT, AprUP, OctUP, SepPDO

Variable	Estimate	Pr > [t]
Intercept	0.0600	0.7909
WTT	-0.0974	<0.0001
AprUP	0.0106	0.0183
OctUP	-0.0111	0.0311
SepPDO	-0.3147	0.0019

Parameter estimates SR residuals = WTT, AprUP, SepPDO

Variable	Estimate	Pr > [t]
Intercept	0.2916	0.1691
WTT	-0.1051	<0.0001
AprUP	0.0109	0.0201
SepPDO	-0.3368	0.0014

Linear multiple regression was also used to relate SARs for Snake River spring/summer Chinook populations to water travel time and the above ocean climatic variables (PDO, SST, upwelling index). SARs were transformed into mortality rates (-ln(SAR)) for the analysis. Two time series of SAR estimates were investigated, one using the estimates reported in Zabel et al. (2006) for all years (SARnmfs), and the other using the same estimates for the early years and PIT tag estimates (Berggren et al. 2005) for smolt years 1994-2001 (SARpit). Smolt years 1985-1991 were excluded from the SAR analyses because no estimates of wild smolts were available (Petrosky et al. 2001). WTT was a significant independent variable in the best fit regression models for both data series (Tables 3 and 4), suggesting ocean survival was also influenced by the juvenile migration conditions. The expected response of SARpit to changes in WTT (holding ocean climatic variables constant) is shown in Fig. 9. The regression suggests that at current average WTT (19 days), SARpit survival rate would decline to 35% of the value predicted from historic WTT (2 days).

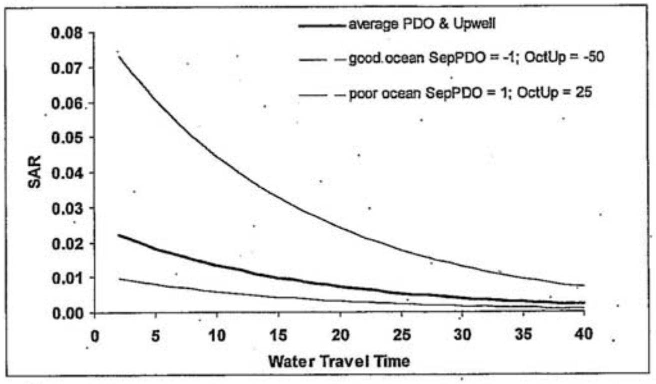


Figure 9. Expected SAR vs. Water Travel Time (WTT) for average ocean conditions (Sep PDO = 0; Oct Upwelling = 0), good ocean conditions ((Sep PDO = -1; Oct Upwelling = -50), and poor ocean conditions (Sep PDO = 1, Oct Upwelling = 25). Historic WTT was 2 days, recent average (range) with 8 dams is 19 days (10-40 days).

Table 3. Regression model results for SARs of Snake River spring/summer Chinook versus environmental variables, Water Travel Time (days), PDO, Upwelling and Sea Surface Temperature (selected months), smolt migration years 1966-1984, 1992-2001. SARs (SARnmfs) are from Zabel et al. (2006) based on run reconstruction from Williams et al. (2005).

Number in model	Adjusted R^2	R^2	AIC	BIC	Variables in model	Comments
5	0.706	0.755	-39.11	-33.46	WTT, SepPDO, OctUP, AugSST, AprUP	highest R^2_{adj}, best AIC
4	0.680	0.723	-37.29	-33.67	WTT, SepPDO, AugSST, AprUP	best model from BIC
3	0.633	0.670	-33.85	-32.01	WTT, SepPDO, AugSST	best 3 variable model
4	0.577	0.633	-28.59	-27.80	MayPDO, SepPDO, OctUP, AugSST	highest R^2_{adj} excluding WTT
2	0.514	0.547	-26.03	-25.91	WTT, SepPDO	best 2 variable model

Parameter estimates -ln(SARnmfs) = WTT, SepPDO, OctUP, AugSST, AprUP

Variable	Estimate	Pr > [t]
Intercept	7.3010	<0.0001
WTT	0.0529	0.0003
SepPDO	0.5138	<0.0001
OctUP	0.0089	0.0823
AugSST	-0.2387	0.0099
AprUP	-0.0079	0.0554

Table 4. Regression model results for SARs of Snake River spring/summer Chinook versus environmental variables, Water Travel Time (days), PDO, Upwelling and Sea Surface Temperature (selected months), smolt migration years 1966-1984, 1992-2001. SARs (SARpit) through 1993 are from Zabel et al. 2006; SARs for 1994-2001 are from PIT tag estimates (Berggren et al. 2005).

Number in model	Adjusted R^2	R^2	AIC	BIC	Variables in model	Comments
6	0.690	0.752	-38.44	-31.84	WTT, SepPDO, OctUP, AprSST, AugSST, AprUP	highest R^2_{adj}
5	0.688	0.740	-39.00	-33.74	WTT, SepPDO, OctPDO, AugSST, AprUP	best model from AIC
4	0.665	0.709	-37.55	-34.10	WTT, SepPDO, OctUP, AugSST	best model from BIC
3	0.618	0.655	-34.32	-32.55	WTT, SepPDO, OctUP	best 3 variable model
4	0.536	0.598	-27.49	-27.24	MayPDO, SepPDO, OctUP, AugSST	highest R^2_{adj} excluding WTT
2	0.516	0.549	-27.91	-27.61	WTT, SepPDO	best 2 variable model

Parameter estimates -ln(SARpit) = WTT, SepPDO, OctUP, AugSST, AprUP

Variable	Estimate	Pr > [t]
Intercept	4.6836	0.0342
WTT	0.0562	0.0002
SepPDO	0.4452	0.0005
OctUP	0.0112	0.0316
AprSST	0.1599	0.2953
AugSST	-0.1709	0.0581
AprUP	-0.0058	0.1807

Parameter estimates -ln(SARpit) = WTT, SepPDO, OctUP

Variable	Estimate	Pr > [t]
Intercept	3.6911	<0.0001
WTT	0.0617	0.0002
SepPDO	0.4434	0.0002
OctUP	0.0151	0.0073

The time series of 1st year ocean survival (3rd year survival, s3) was estimated by methods similar to Zabel et al. (2006) from SARs of aggregate Snake River spring/summer Chinook for smolt years 1966-2001. Smolt years 1985-1991 were excluded from the s3 analyses[1] because no estimates of wild smolts were available (Petrosky et al. 2001). Estimates of s3 were derived by partitioning the SARs for each smolt migration year by estimates of direct passage survival and *D*, assuming the survival during the 2nd and 3rd ocean years is fixed at 0.8 (Zabel et al. 2006). This approach contains any latent or delayed hydrosystem mortality in the s3 estimate, rather than attempting to estimate the magnitude of delayed mortality as described above for the Peters and Marmorek (2001) method.

Linear multiple regression was used to relate s3 to water travel time (WTT), and several ocean climatic variables (PDO, SST, upwelling index). First year ocean survival was transformed to a mortality rate (-ln(s3)) for the analysis. WTT was a significant independent variable in the top s3 regression models (Table 5), suggesting some of the 1st year ocean survival was associated with the juvenile migration conditions. The simplest best fit model (best BIC score) selected the independent variables WTT, September PDO, and April Upwelling.

The expected response of s3 to changes in WTT (holding ocean climatic variables constant) is shown in Fig. 10. Under average ocean conditions (Sep PDO = 0, April Upwelling = 0), predicted s3 was 20.5% at 2 days WTT and 4.1% at 19 days WTT. Under good ocean conditions (assumed Sep PDO = -1, April Upwelling = 40), predicted s3 was 55.7% at 2 days WTT and 11.1% at 19 days WTT. Under poor ocean conditions (assumed

[1] Regression analyses using assumptions to generate wild smolts for 1985-1991 resulted in the same primary variables with similar coefficients.

Sep PDO = 1, April Upwelling = -40), predicted s3 was 7.6% at 2 days WTT and 1.5% at 19 days WTT.

The level of mortality for Snake River spring/summer Chinook populations, during their 1st year of ocean residence that can be attributed to the FCRPS configuration and operation is characterized by the s3 response to the change in WTT from average historic levels (2 days) to average present levels (19 days). Thus, under the current FCRPS configuration, 1st year ocean survival was expected to average only 20% of historic based on WTT change (2 to 19 days). The magnitude of delayed hydrosystem impact suggested by the s3 regression analysis is consistent with, and slightly greater than, the delayed mortality estimates (Table 1; $\lambda n = 0.33$) derived using upriver and downriver population performance.

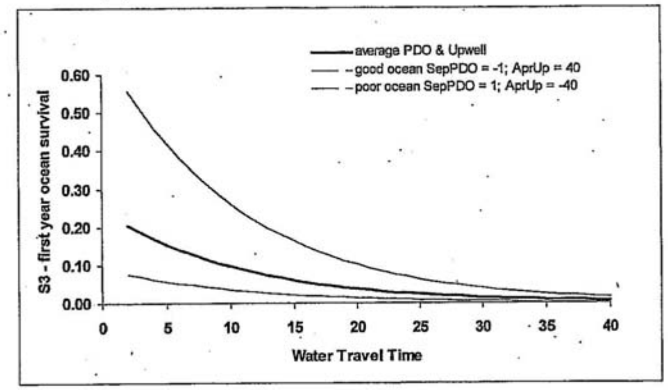


Figure 10. Expected 1st year ocean survival (s3) vs. Water Travel Time (WTT) for average ocean conditions (Sep PDO = 0; April Upwelling = 0), good ocean conditions ((Sep PDO = -1; April Upwelling = 40), and poor ocean conditions (Sep PDO = 1, April Upwelling = -40). Historic WTT was 2 days, average (range) with 8 dams is 19 days (10-40 days).

Table 5. Regression model results for 1st year ocean survival (s3) of Snake River spring/summer Chinook versus environmental variables, Water Travel Time (days), PDO, Upwelling and Sea Surface Temperature (selected months), smolt migration years 1966-1984, 1992-2001.

Number in model	Adjusted R^2	R^2	AIC	BIC	Variables in model	Comments
4	0.728	0.765	-33.99	-29.03	WTT, MayPDO, SepPDO, AprUP	highest R^2_{adj} best AIC
5	0.725	0.774	-33.08	-26.95	WTT, MayPDO, SepPDO, AugSST, AprUP	
3	0.712	0.743	-33.36	-29.82	WTT, SepPDO, AprUP	best 3 variable model, best BIC
3	0.705	0.737	-32.64	-29.31	WTT, MayPDO, AprUP	
2	0.655	0.680	-29.00	-27.21	WTT, AprUP	best 2 variable model
4	0.420	0.503	-12.23	-14.30	MayPDO, AprSST, AugSST, AprUP	highest R^2_{adj} excluding WTT

Parameter estimates S3 mortality (-ln(s3))= WTT, MayPDO, SepPDO, AprUP

Variable	Estimate	Pr > [t]
Intercept	1.4648	<0.0001
WTT	0.0665	<0.0001
MayPDO	0.1730	0.1437
SepPDO	0.2052	0.0988
AprUP	-0.0144	0.0088

Parameter estimates S3 mortality (-ln(s3)) = WTT, SepPDO, AprUP

Variable	Estimate	Pr > [t]
Intercept	1.3934	<0.0001
WTT	0.0947	<0.0001
SepPDO	0.2777	0.0204
AprUP	-0.0180	0.0006

Evaluation of the time series of SR residuals, SARs, and s3 showed that survival was related to water travel time – providing supporting evidence that there is a significant component of the survival during early ocean residence that is delayed mortality, and related to construction and operation of the FCRPS. These analyses compliment the results from the upriver/downriver population performance model, and did not rely on an assumption that downriver populations can serve as controls for Snake River population response.

V. Modified delayed mortality hypothesis: ***Passage of seaward migrating juvenile fish through and around the FCRPS causes delayed mortality to salmon populations that may not be expressed until the estuary and ocean life-stage. The magnitude of delayed effects related to the FCRPS may vary due to ocean/climate conditions.***

a. Evidence

The hypothesis that the magnitude of delayed mortality is modified by ocean conditions is plausible, because fish condition can be compromised by the effects of the hydrosystem and therefore the 1st year ocean survival moderated by ocean/climate conditions.

Williams et al. (2005) hypothesized that delayed mortality of Snake River spring/summer Chinook became negligible in the late 1990s as ocean conditions improved. Schaller and Petrosky (*in review*) found evidence that delayed hydrosystem mortality remained high even as climatic conditions improved (Figure 4).

Evaluation of the time series of s3 (early ocean survival), SARs, and SR residuals show that survival is related to water travel time – providing supporting evidence that there is a delayed mortality component to survival during early ocean residence that is related to construction and operation of the FCRPS. However, the survival rates are also strongly related to the PDO and upwelling indices (measures of ocean/climate conditions).

Figures 8-10 show the response of SR residuals, SARs and s3 from the multiple regression models to water travel time (WTT) for average, good and poor PDO and upwelling conditions. For a fixed WTT, the predicted survival rates vary widely across the ocean climatic conditions. The environmental variables that demonstrated a significant relation to these survival indices included Water Travel Time, April and October upwelling, May and September PDO, and on occasion August sea surface temperatures. These findings for the oceanographic indices were generally consistent with the work of Scheuerell and Williams (2005), Zabel et al. (2006), and Nickelson (1986). However, in addition we identified that survival rates have been strongly influenced by water travel time through the Columbia River mainstem projects and reservoirs.

b. *Sub Hypothesis: There is a differential delayed mortality for transported fish from those fish that migrate through the FCRPS inriver.*

   i. D refers to the ratio of smolt-adult survival (measured from below Bonneville Dam as juveniles to Lower Granite Dam as adults) of transported fish relative to that of in-river migrants. Using our earlier notation, the corresponding SARs are

$$SAR_{T,BON\rightarrow LGR} = S_{e/o}(1-L_T)S_{T,ur} \text{ , and}$$

$$SAR_{I,BON\rightarrow LGR} = S_{e/o}(1-L_I)S_{I,ur} .$$

Therefore, D is simply

$$D = \frac{SAR_{T,BON\rightarrow LGR}}{SAR_{I,BON\rightarrow LGR}} = \frac{(1-L_T)S_{T,ur}}{(1-L_I)S_{I,ur}}$$

Note that we assume the same natural estuary/ocean survival ($S_{e/o}$) for both in-river and transported fish.

   ii. D is typically below 1.0 for Snake River spring-summer Chinook salmon and steelhead, providing one measure of latent mortality for transported fish, but not an absolute measure--it is only relative to in-river fish. This latent mortality may result from stress experienced on the barge, disruption of timing to the estuary, or increased straying or fallback of adult migrants. While we cannot identify specific mechanisms that lead to $D < 1.0$, we can directly estimate D, because it relates to the juvenile survival and SAR for in-river migrants. Estimates of D for wild spring/summer Chinook are presented in the following table:

Migration year	NMFS (Williams et al. 2005)	CSS (Berggren et al. (2005)
1994	0.68	0.36
1995	0.46	0.42
1996	1.08	0.92
1997	0.50	0.40
1998	0.43	0.55
1999	0.64	0.72
2000	0.34	0.32
2001		2.16
2002		0.44
2003		0.69

D is not an absolute measure of the latent mortality of transported fish, because the overall amount of delayed mortality for transported fish is a consequence of both *D* and the level of hydropower-related delayed mortality of in-river migrants.

c. *Sub Hypothesis: Passage of seaward migrating juvenile fish through (inriver) and around (transportation) the FCRPS causes delayed mortality to salmon populations by delaying or accelerating arrival of smolts to the estuary.*

i. Evidence

1. Seasonal Trends in SARs: Previous analysis suggests that there may be seasonal trends in transport-inriver ratios (TIR) of SARs and D values for hatchery and wild yearling migrant Chinook. These analyses have suggested that TIR (and D) tends to increase over the migration season (e.g. see Figure C2 in Marmorek et al. (2004). Such a pattern may reveal one mechanism by which hydrosystem experience can affect survival below Bonneville dam, and it can have implications for transportation strategy. Patterns for steelhead are not as pronounced and average TIRs have tended to be above 1 across the migration season.

Data from PIT-tagged wild spring/summer Chinook were used (Fish Passage Center unpublished data) to investigate the consistency of seasonal trend between years, from migration years 1998-2003. The method used to explore within-season variation was adapted from the method used in the Collaborative Systemwide Monitoring and Evaluation Project (CSMEP) Hydro Group Data Quality Objectives process (Porter et al. 2005) and in the post-Bonneville mortality work group for the NMFS COMPASS modeling process (P. Wilson). The method uses an assumption of binomial sampling error in the SAR estimates to remove measurement error variance from total variance to estimate inter-annual process error (environmental) variance. Instead of using data from each migration year in the aggregate to estimate environmental variance in

SARs and TIRs, here the data from each of three periods within the migration season is treated separately. The resulting distributions can then be used to derive estimates of, for instance, the frequency with which true TIR would be greater than one for each of the time periods. In this analysis, Lower Granite Dam (LGR) is the only transport project investigated (though the exercise could be performed for other projects). Unlike the CSMEP and post-Bonneville hypothesis analyses submitted to the post-Bonnneville group, the in-river fish used are "C1" fish—PIT-tagged fish detected at LGR dam. The "true control" (C0) fish used in previous applications of this method cannot be used to estimate season trends in SAR and TIR; since a C0 smolt is not detected at LGR (or any of the collector projects), a date of LGR passage cannot be accurately assigned to it. Because the C1 group has typically shown lower annual SARs than the "true controls" (Berggren et al. 2005) the seasonal TIRs calculated here likely have some positive bias.

Each migration year, the season was broken into three periods based on detection date at LGR: Before April 26, April 26 to May 10, and after May 10. This resulted in approximately equal total numbers of PIT-tagged fish in each group, over the six year period. Summary information from the resulting TIR distributions is presented in the table below. It appears that TIR (and consequently, D) increases substantially over the season.

Period	T smolts	C1 smolts	Median TIR	Prob TIR > 1
Before 4/26	4059	15380	0.36	15%
4/26 – 5/10	2366	19568	1.29	59%
After 5/10	3022	15348	2.30	91%

Inspecting the distributions of transport and in-river SARs suggests that although transport SAR is modestly higher late in the season than earlier (Fig. 11a), the primary reason for the increasing trend in TIRs is that in-river (C1) SARs decline dramatically in the middle and end of the season

(Fig. 11b). The decline in SAR of in-river (C1) fish as the season progresses is consistent with the hypothesis that the protracted migration and late arrival in the estuary is in part responsible for elevated levels of post-Bonneville mortality as a consequence of the hydrosystem experience.

The seasonal TIRs contain some positive bias because the true controls (C0), which migrate through spill and turbine routes at collector dams, have shown higher SARs than fish bypassed at one or more of the collector dams (Berggren et al. 2005). The SAR distributions for true controls (C0) and smolts detected and returned to the river at LGR dam (C1) using the same method are shown in Figure 12. If in-river survivals are similar for C1 and C0 groups, as generally assumed, the differential SAR is evidence of delayed mortality for bypassed fish (see Budy et al. 2002). It is also possible that the trend in increasing TIRs may not be as pronounced for C0 fish as seen for C1 fish (Figure 11), particularly in years when the spill program is implemented.

A number of mechanisms may explain the temporal patterns of SARs. In-river migrants face migration delays through the FCRPS, which may have different consequences depending on seasonal timing. For example, later in-river migrants may:

- face increased exposure to elevated temperatures, contributing to poorer condition upon estuary arrival
- be further along in the smoltification process and be more vulnerable to migration delay
- miss the optimal window of estuary and early ocean environmental conditions
- face increased predation rates in the lower Columbia River mainstem, estuary and ocean

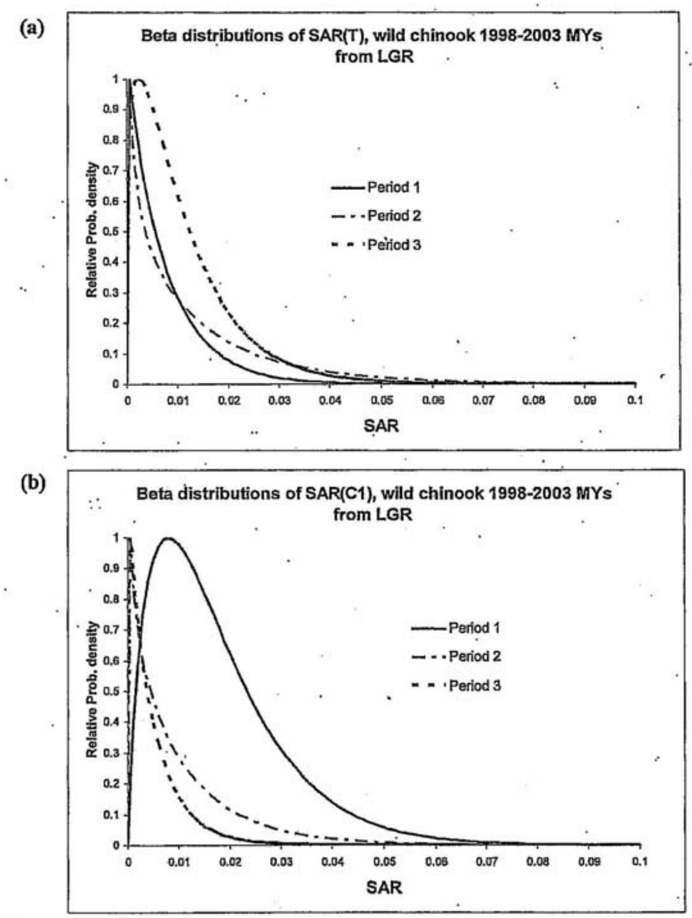


Figure 11. Distributions of SAR for smolts detected at Lower Granite and transported (a) or returned to the river (b), for the three migration periods.

Probability density functions of C0 and C1 SARs of wild chinook for migration years 1994-2002

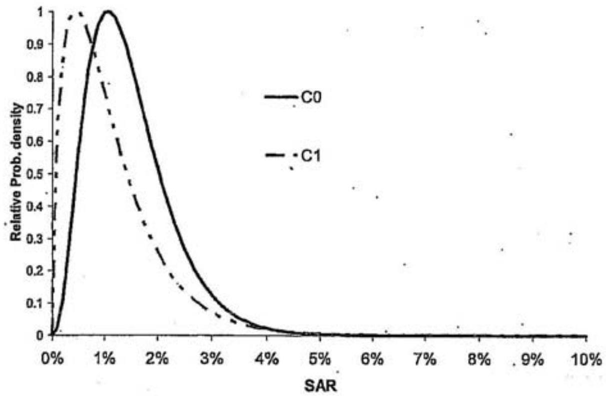


Figure 12. Distributions of SAR for true controls (C0) and smolts detected at Lower Granite and returned to the river (C1), 1994-2002 migration years.

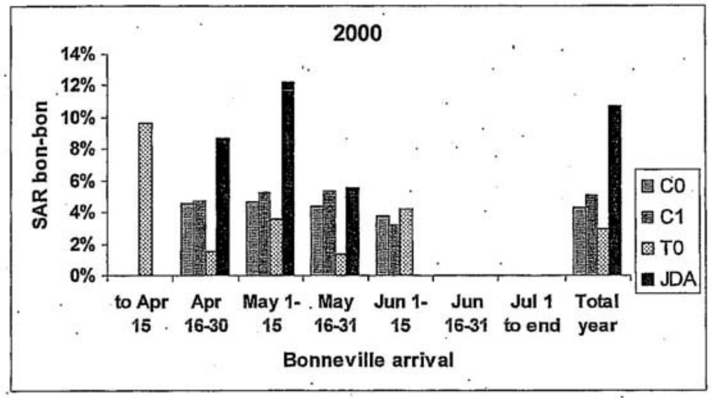
2. <u>SARs by Bonneville Arrival Timing:</u> The numbers of Snake River wild spring/summer Chinook PIT-tagged smolts and returning adults from the CSS study groups T0, C0, and C1 were summarized for smolt arrival timing based on their detection at Bonneville Dam, at John Day Dam or trawl samples below Bonneville Dam (T. Berggren, pers. comm.), 2000-2003 migration years. Bonneville arrival dates for smolts detected only at John Day Dam or in the trawl were corrected for median travel times to or from the Bonneville detector. Numbers of PIT-tagged wild John Day River spring Chinook smolts and adults for the same arrival periods and years were included in the summary. SARs in this case represent smolts from Bonneville dam to adult returns to Bonneville dam.

The arrival timing of John Day wild smolts was primarily late April through May all years (similar to Snake River wild smolt timing at Lower Granite Dam). A combination of delayed migration of in-river smolts and transportation has altered the arrival timing of Snake River migrants to the lower Columbia River estuary. All groups of Snake River wild Chinook consistently experienced lower SARs (Bonneville to Bonneville) than John Day wild Chinook within the same arrival time period and for the season (Fig. 13, 14). In 2000 and 2001, SARs for the earliest transport Snake River groups apparently approached 10% (Fig. 13), but these were based on small sample sizes (n<70) and the pattern did not continue in subsequent years[2].

The disparity between SARs for John Day River and Snake River wild Chinook, when they arrive to the lower Columbia River at the same time, provides additional support for the hypothesis of delayed hydrosystem mortality, and may shed light on likely mechanisms. The Comparative

[2] No adults returned from the earliest period from 68 transported smolts in 2002; and 1 returned from 661 transported smolts in 2003.

Survival Study analysts plan to more formally investigate the SAR patterns based on arrival timing and other factors in future years.



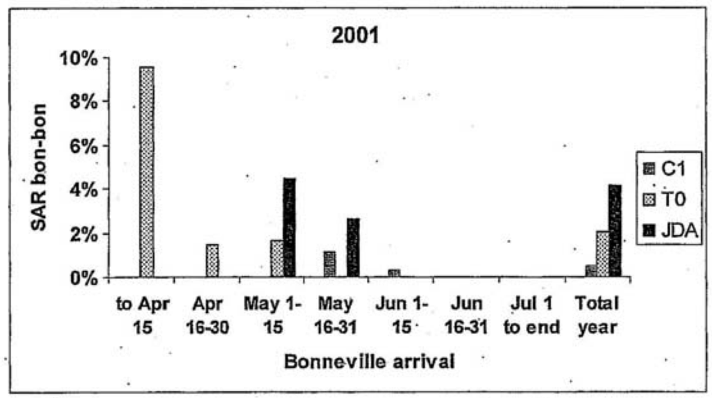
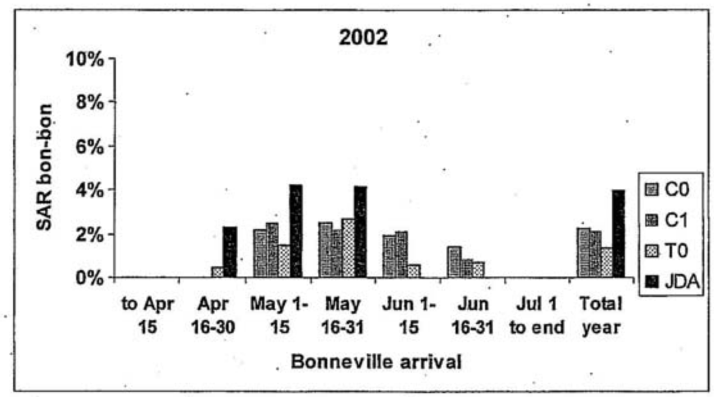


Figure 13. SAR by Bonneville arrival date and group for Snake River wild spring/summer Chinook (T0, C0, and C1) and John Day wild spring Chinook, 2000-2001. SARs calculated for all smolt groups > 50.



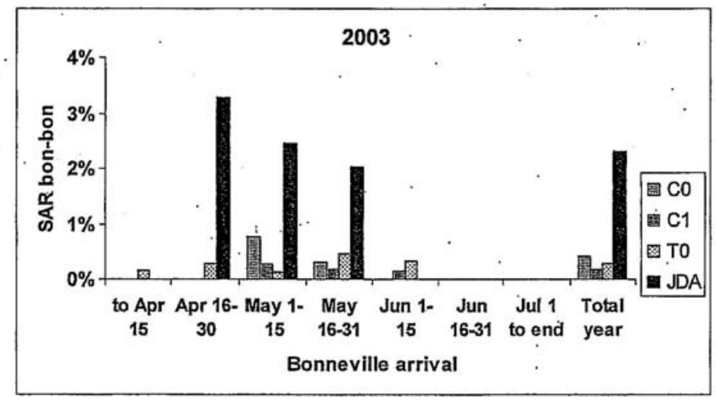


Figure 14. SAR by Bonneville arrival date and group for Snake River wild spring/summer Chinook (T0, C0, and C1) and John Day wild spring Chinook, 2002-2003. SARs calculated for all smolt groups > 50. Adult returns from 2003 complete only through 2-ocean returns.

VI. Summary and Conclusions

Based on our findings from multiple analyses, the hypothesis that a portion of the mortality that occurs in the estuary and ocean life stage is due to cumulative impacts of the FCRPS appears highly plausible. We explicitly described this hypothesis of delayed mortality relative to development and operation of the FCRPS and variants of this main hypothesis. We provided a summary, from the literature, for the mechanisms and the lines of evidence supporting this hypothesis.

We presented multiple analytical approaches addressing this delayed mortality for Snake River spring/summer Chinook. Results from updated and expanded analyses comparing upriver and downriver population performance continued to show that development and operation of the FCRPS was a key factor influencing levels of delayed mortality of Snake River spring/summer Chinook.

We developed new analyses relating survival rates for Snake River spring/summer Chinook to FRCPS and ocean/climate conditions, which did not rely on comparing upriver and downriver population performance. The analysis of Snake River populations alone included ocean/climatic variables, and water travel time relative to spawner-recruit residuals, smolt-to-adult return rates (SARs) and survival during the first year of ocean residence. Water travel time increased as the FCRPS was developed, and populations experienced a wide range of ocean/climatic conditions during the study period. Evaluation of the spawner-recruit residuals, SARs and early ocean survival showed that survival was related to water travel time, providing supporting evidence that there is a significant component of the survival during early ocean residence that is accounted for by delayed mortality, and related to construction and operation of the FCRPS. These analyses compliment the results from the upriver/downriver population performance model.

From this information there appears to be a delayed mortality component to survival during early ocean residence that is related to construction and operation of the FCRPS;

however survival rates are also strongly related to the PDO and upwelling indices (measures of oceanic climatic conditions). The magnitude of delayed hydrosystem mortality may be modified by ocean conditions.

The FCRPS has delayed migration of in-river fish; with later arriving components of the population exhibiting lower SARs. Additional support for delayed mortality associated with passage through the FCRPS is provided by within-season patterns of SARs for in-river migrants, SARs of bypassed vs. true in-river migrants, and the relatively higher SARs of John Day wild Chinook when they experience the same arrival timing at Bonneville Dam as Snake River wild Chinook.

The results of these multiple analyses provide compelling evidence that passage through the FCRPS strongly influences levels of delayed mortality of in-river migrants for these populations.

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Comment Letter No. 5 – Columbia River Inter-Tribal Fish Commission

5-1. Comment noted. Ecology is in agreement that continued salmon productivity is a vital component of water resource management. The Columbia River Water Management Act includes the development of water supplies to meet instream flow needs for fish.

5-2. Comment noted. See the responses to Comment Letters 1 and 2 for responses to the comments of the Confederated Tribes of the Umatilla Indian Reservation and Yakama Nation. Receipt of the economic report is acknowledged.

5-3. See the Master Responses regarding a Programmatic EIS and future project specific review.

5-4. Comment noted.

5-5. The information you provided on stream flows is noted. Ecology does not dispute that there is a relationship between stream flows and salmonid survival. It is known that “when river flows become critically low or when water temperatures are excessively high, there are pronounced changes in salmon migratory behavior and lower survival rates are expected” (National Research Council, 2004). This relationship is documented by the Fish Passage Center information cited in your comment and in the document by Petrosky et al. that you provided (Fish Passage Center, 2006, Petrosky et al. 2006). However, as concluded by the National Research Council and presented in Section 1.3.1.3, the exact nature of that relationship, the quantity of flow and survival specific to flow, is not certain.

One of the purposes of the Management Program is to provide additional flows for fish. Ecology will pursue a full range of options for augmenting instream flows. See the revised Section 2.1.2.4 in the Final EIS for a description of Ecology’s program for developing water supplies for instream flows. Also, see the Master Response to the July/August mitigation issue regarding Ecology’s proposal to provide stream flows during critical periods for fish. As stated in the response to Comment 1-30, Ecology’s approach to implementing the Management Program will be an incremental one.

Implementing the Management Program is not in itself expected to significantly reduce or eliminate existing threats to ESA-listed species, but modest improvements in conditions could occur. Ecology will continue to coordinate with resource managers throughout the Columbia River Basin to ensure that conditions for ESA-listed species are maintained and/or improved through a variety of management approaches, including the protection and augmentation of stream flows.

5-6. The Columbia River Management Act established two goals for the Management Program—developing new water supplies to meet economic and community development needs and to meet instream flow needs for fish. The Management Program includes projects to meet both goals. Additional information on Ecology’s program for improving instream flows has been added to Section 2.1.2.4 of the Final EIS.

5-7. An enhanced discussion of the effects of water withdrawals on Pacific lamprey has been added to the Final EIS.

5-8. Comment noted.

5-9. The EIS acknowledges that storage options have the potential to negatively affect fish. Section 4.1.1.6 includes a discussion of these potential impacts. Ecology will consider a wide range of factors, including potential impacts to fish, when considering specific projects for implementation of the Management Program. Impacts to fish populations and instream water users will be evaluated during project specific environmental review.

5-10. See the response to Comment 1-10 regarding revisions to flood control management. Ecology will review the legal findings regarding the BiOp Remand Process when they become available and incorporate those findings as appropriate into the Management Program.

5-11. Comment noted. As noted in response to Comment Letter 1, Ecology will continue to coordinate with the Confederated Tribes of the Umatilla Reservation.

5-12. See the response to Comment 2-27.

5-13. Comment noted. A 60-day consultation period and a 30-day public comment period will be held on the CSRIA VRA. See also the response to Comment 5-14 regarding the mitigation fee.

5-14. Comment noted. Ecology has reviewed the referenced report. The report evaluates mitigation funding methods and their associated risks for strategies like the draft mitigation plan prepared by Ecology and the Washington Department of Fish and Wildlife in 2002 for several Columbia River proposed permits and the mitigation scenarios presented to the National Research Council. The 2002 draft mitigation plan provided in-kind and potential out-of-kind mitigation actions that differ significantly from the draft VRA proposed by CSRIA and were to be funded by a $10 per acre-foot annual fee. Permits issued based on the draft CSRIA VRA would be based on mitigation already in the Trust Water Rights Program. The concern about vulnerability in early years is valid for the 2002 mitigation plan, however, permits issued pursuant to RCW 90.90 will rely on water rights acquired and placed into the trust water rights program. In-kind mitigation required to meet the VRA mitigation standard would be in place before the authorization to use water is given. See the response to Comment 1-48.

5-15. Comment noted.

5-16. Comment noted. Additional information and analysis on drawdown amounts will be provided in the Supplemental EIS that Ecology will be preparing on the Lake Roosevelt drawdown.

5-17. SEPA Rules (WAC 197-11) use the term “affected tribes”.

5-18. See the response to Comment 1-30 regarding Ecology’s incremental approach to stream flow improvements. Ecology has worked with the Columbia River Policy Advisory Group and others to refine the "no negative impact" criteria. The preferred alternative is presented in Section 6.1.9.

5-19. The No Action Alternative described in Section 2.5.1.2 is specific to the Lake Roosevelt drawdown proposed by Ecology and Reclamation. It does not preclude other proposals for drawdowns of the reservoir, which would be evaluated under separate environmental review. Text clarifying the No Action Alternative for Lake Roosevelt has been added to Section 2.5.1.2. Ecology will prepare a Supplemental EIS on the Lake Roosevelt drawdown project that will include additional evaluation of water quality impacts.

5-20. Comment noted. The discussion in Section 3.6.1.4 is intended to explain federal reserved water rights that are additional to the tribal federal reserved water rights discussed in Section 3.6.1.3 and Appendix D.

5-21. The EIS does not specifically mention Hanford fall Chinook or sturgeon stocks. The information provided about the health of the stocks is noted.

5-22. The inclusion of these references is acknowledged.