FISH PASSAGE CENTER

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MEMORANDUM

To John Stein, PhD
Salmon Science Coordinator
Northwest Fisheries Science Center

From Michele DeHart

Date January 30, 2004

Subject Comments on NMFS white paper entitled "Passage of Juvenile and Adult Salmonids at Columbia and Snake River Dams"

Thank you for the opportunity to comment on the White Paper entitled "Passage of Juvenile and Adult Salmonids at Columbia and Snake River Dams" NOAA Technical Memorandum December 2003. We are submitting these comments on January 30, 2004 to meet the February 1, 2004 comment deadline date established in the December 22, 2003 NOAA correspondence to the state and tribal co-managers from Usha Varanasi. The Fish Passage Center, as technical staff for the state and tribal co-managers was requested to review this manuscript and provide comments. We hope these comments will be useful in finalizing the document. Our review might have been more extensive had NOAA provided additional review time.

The purpose of the white paper, as stated in the introduction "This report summarizes the information pertinent to the FCRPS as it is currently configured for each route of passage and life history, and discusses uncertainties associated with the existing database." Overall, we found serious deficiencies in the document, which raise serious questions regarding its adequacy as a basis for development of a Biological Opinion on the operation of the FCRPS. In addition we were discouraged to find that NOAA fisheries ignored several specific technical memorandums that were previously provided to NOAA fisheries regarding specific project passage issues. Specifically:

- It is lacking in breadth of data reviewed, thoroughness of review and consistency and often lacks meaningful syntheses of those data reviewed.
- The list of key uncertainties is incomplete and seems in some ways unrelated to the reviewed data. Also, it is unclear how they were chosen, and whether NOAA is suggesting that these areas are hopelessly too difficult to study, such as performance measures for individual stocks within the hydro-system.

- We could find only five conclusions identified, as such, in the document. These conclusions are related to turbine passage issues. There are no concluding sections on Spill Passage, Mechanical Bypass, Surface Bypass, Adult Passage.
- Several sections fail to synthesize the available information in any concise way.
- The document is poorly organized and inconsistent in approach. Section by section the format of the review is quite different, with some sections reviewed much more thoroughly, such as “Adult Passage”, while others lack meaningful syntheses, such as “Spill Passage” and others contain outdated discussion such as “Surface Bypass”.
- The spill and bypass sections have no conclusions, while the turbine section has several bulleted conclusions. In the “Spillway Passage” section very little summary data is available, little mention of how the data are to be used or have been used in previous biological opinions is evident.
- Tables appear to show data from many different studies without indicating the relative merit of the data from different studies. Not all studies could have equal merit. It is impossible to tell whether NOAA technical staff have considered the quality of studies reviewed. Other review such as Coutant and Whitney 2000 (cited in the white paper) discussed the relative merits of data used. NOAA inconsistently indicates poor study designs, good studies, or whether data could be useful and in what capacity.

We suggest that a thorough rewrite of this document might include a more careful and thorough synthesis of data (including updating many sections with current research results), identify appropriate use of data listed in tables, provide solid conclusions that show how NOAA intends to use these data in their Biological Opinion and address specific concerns outlined below.

Specific comments follow and are organized by section and headings within those sections.

Comments on spill section “**JUVENILE PASSAGE THROUGH SPILLWAYS**”.

This section is poorly written and consequently hard to follow. NOAA does not consistently identify those research results that stand out as being most reliable, repeatable and useful. Consequently it is impossible to tell what NOAA intends to do with this data. NOAA should indicate which studies are of high quality, showing which are most applicable and rigorous. For example, problems were identified with hose release studies at Ice Harbor Dam. Fish were shown not to be passing at the depth of hose releases, which could seriously bias results let alone interpretation of those results. Yet NOAA treats these data in context of the larger issues of depth of deflector submergence and overall spillway survival just as any other study results. Further, freeze brand studies are listed in same table and presumably given equal weight in terms of applicability and rigor as PIT survival studies. Studies from more recent years should be added.

“**Spill Efficiency and Effectiveness**”

A standardized notation for efficiency and effectiveness should be developed. The fifth paragraph of the section defines the parameters for equation 1 from a PATH analysis as:

“P_f is the proportion of fish passing over the spillway (spill effectiveness)
P_w is the proportion of total river flow passing over the spillway
Spill efficiency is defined as $P_f \div P_w$ “.

The final paragraph of the section states the opposite :
“…(note: definitions for spill efficiency and effectiveness have changed recently where efficiency = P_f and effectiveness = P_f / P_w)…” and then uses this new definition for discussing the final paragraph. This is truly confusing.

NOAA makes no conclusions about the data presented. There appear to be gaps in information such as information at McNary Dam. Changes in configuration and operations at Lower Granite Dam should be included. Such as information on the RSW and it’s effects on FPE and survival. There is no clarifying statements regarding the relative importance of spill efficiency and effectiveness in meeting performance standards such as 80% FPE or survival standards.

NOAA should demonstrate how well the equations presented in this section match the radio-telemetry data. Also provide correlation coefficients. NOAA should clarify whether they are recommending their use or not.

Regarding spill efficiency at 3 lower Snake projects NOAA states; “Spill efficiency at Lower Granite, Little Goose, and Lower Monumental Dams can be estimated based on radiotelemetry observations for yearling chinook salmon at Lower Granite Dam (Wilson et al. 1991), because of the similarity of the three projects.”
The above quote does not make sense. While those projects were similar in 1991, Lower Granite is not like Little Goose and Lower Monumental dams due to the presence of the RSW, BGS, and SBC at Granite.

The review mentions sensitivity analyses using estimates of efficiency of 1.0 to 2.0, however NOAA is unclear regarding their determination of the appropriateness of that standard. NOAA does not identify whether or not that criterion is utilized by NOAA in the conducting its own sensitivity analysis.

NOAA reviews radio-telemetry studies, as well as hydroacoustic studies in detail with some reservations about mixed species. The section is so disorganized that reviewing it is difficult. For example, discussion of hydroacoustic study results occurs in paragraph 2 on page 8, while further discussion of “sampling assumptions and error” occurs two paragraphs lower in a paragraph that begins discussing (presumably) steelhead spill effectiveness from radio-telemetry studies.

“Seasonal Spill Timing”

This is an important section and is fully covered in two paragraphs. NOAA should provide information, to the best of their knowledge on the migration patterns of various listed stocks of fish. And compare run timing to planning dates. This may warrant status as a key uncertainty if little or no data is available. One potential way to improve knowledge of the timing of wild stocks would be to improve marking (such as adipose clips or coded wire tagging) of hatchery stocks, whether listed or not to be able to discern Snake River wild steelhead, yearling chinook or subyearing chinook timing from hatchery fish. Further efforts in PIT-tag marking wild fish would also be necessary to improve timing information on wild specific wild stocks. NOAA should provide some discussion of the reasons why timing data is not used as a substitute for planning dates such as the calculated 95% passage date that had been proposed by some.

“**Daily Spill Timing**”

NOAA seem to be concluding that 24 hour spill is better than night-time only spill because it decreases delay. This is based on a discussion of data from studies at 3 sites in the Lower Columbia. Other data are available to support this conclusion. NOAA should clarify their recommendations by providing a summary of conclusions in a separate section. A discussion of the trade-offs are involved in 24h v 12h spill such as impacts on spill effectiveness, adult delay, gas production.

“**Forebay Predation**”

NOAA should further elaborate on forebay populations of predatory fish. If there are substantial numbers of predators, provide some evidence of the impacts of predation on the population of juvenile migrant salmonids. Contrast this with impacts of avian predation. Perhaps there is enough uncertainty to include this as key uncertainty also.

“**Tailrace Passage**”

Again, there is little data on this issue, despite some hypotheses that have been proposed as mechanisms for improving egress, this issue is largely not determined. A more rigorous approach, that carefully identifies hypotheses related to tailrace egress, weighs evidence to support the hypotheses and then concludes what the evidence suggests or identifies data needs should be done. Data gaps could be included as a key uncertainty.

“**Spill Survival**”

In this section a large number of study results are presented, but NOAA provides no interpretation of qualitative or quantitative differences either between tag types (such as the difference between freeze brand estimates and PIT-tag survival estimates). Which method best estimates survival through the spillway. Confidence intervals associated with the estimates in table 2 should be provided.

Comments on Section entitled “**JUVENILE PASSAGE THROUGH MECHANICAL SCREEN BYPASS SYSTEMS”**

Comments on Section entitled “**JUVENILE PASSAGE THROUGH SURFACE BYPASS SYSTEMS AND SLUICEWAYS”**

Parts of this section need updating. There are whole paragraphs that seem to be out of date. For example paragraph 4 on page 81 beginning “Tests in 2000 will…” does not reflect an entirely different approach at Bonneville 1.

Also out of date is the section on Bonneville Second Powerhouse Sluice Chute on page 82 – This is in need of updating since the Corner Collector has been installed and is being operated in 2004.

Paragraph on page 85 beginning “Lower Granite spillbay…” needs to be updated. The RSW has been installed, operated and tested.

The section beginning in 2^{nd} Paragraph on page 86 beginning “Lower Granite Dam behavioral…” needs to be updated. It is outdated.

Comments on Section entitled “**JUVENILE PASSAGE THROUGH TURBINES”**

Comments on NOAA conclusions regarding turbine passage on page 98

Bullet number 2 states “(comparing)…direct (balloon) estimates to direct and indirect estimates (PIT and radiotelemetry)…, a significant component of …(mortality)…is related to passage through the tailrace.”

We strongly disagree with NOAAs reliance on the use of balloon tag estimates for this type of estimation comparison and interpretation. Balloon tags may be useful for identifying relative problems in passage via a specific route, but comparisons to PIT-tag and radio-telemetry estimates is stretching the application of this method beyond its due. We have several concerns regarding the balloon tag methodology that we believe raise serious concern about that methodology (see attached Joint Technical Staff Memorandum). We have attached specific comments regarding the use of balloon tags, (appendix A). that lists several sources of bias within the methodology that we believe bring the methodology in to question. Any use of balloon tags, especially for turbine survival should only be done once uncertainty about the method can be shown to be unlikely to cause bias in results. Furthermore, we question the validity of previous studies especially those summarized by Skalski et al 2002 for questioning the relationship between turbine peak efficiency and peak survival. These concerns regarding the application of balloon tags have been discussed in regional forum meetings such as the System Configuration Team. We are discouraged that NOAA did not address or include any of these concerns of the co-managers in this “white paper”.

Concluding bullet number 3 states "A statistical relationship between fish survival and Kaplan turbine efficiency for Snake and Columbia River dams does not exist." This statement is misleading. It suggests that operation outside the peak 1% would not result in decreased survival, but that is not likely the case, and would require careful testing (as is suggested in bullet 5) to justify operation outside 1%. But this statement seems to be based largely on a discussion earlier in the text of the Skalski et al 2002 review that NOAA termed "…the most rigorous review to date of the relationship between salmon survival and turbine operating efficiency." The use of the Skalski et al paper as primary source is troubling since fisheries agencies review found many serious flaws. However, even in the concluding section of that review, Skalski et al stated that the zone of peak operating efficiency was wide and that it "will probably also encompass the maximum turbine passage survival". They went on to say that peak ±1% "…in the broadest sense, is a useful guide for managing turbine operating conditions for the benefit of smolt survival". In fact Skalski et al (2002) provides a basis for maintaining the 1% turbine efficiency. NOAA fisheries was advised of the agencies and tribes technical position and review in a letter dated May 29, 2003 from the joint agencies and tribes technical staffs. That letter is attached. Another review by Coutant and Whitney 2000 (cited by NOAA in this report) summarized the turbine studies they reviewed by stating "Fish survival appeared to follow roughly the efficiency curve of Kaplan turbines, with the highest survival occurring at about the highest efficiency…". Given recent efforts by BPA to operate turbines outside the ±1% of peak efficiency, NOAA should provide a stronger defense of the peak 1% range of operation which is most protective of endangered fish and should require rigorously designed studies that provide a scientifically defensible justification for operating outside this zone. This bullet should include language that qualifies the "statistical relationship" statement recognizing that operations within 1% of peak are likely to provide the highest turbine survival.

Comments on Section entitled " **KEY UNCERTAINTIES RELATED TO JUVENILE PASSAGE"**

Performance measures on a stock specific basis could be more easily accomplished in the hydro-system if NOAA required a more thorough marking program designed to identify hatchery fish distinctly from wild. For example, Snake River wild steelhead could be identified at population trends measured at SMP sites if all hatchery fish were marked in unique ways. This could tell us whether passage timing of run-at-large steelhead is similar to overall run and whether planning dates truly encompass that run. Similar information could be obtained for wild yearling chinook with a comprehensive hatchery marking program.

There is uncertainty as to the level of selective pressures caused by hydrosystem passage, but NOAA could make some hypotheses to encompass the uncertainty, similar to the approach taken in developing the Surface Bypass Premises that lead to Design Criteria on pages 77 and 78. For example the hydro-system likely alters estuary entry timing, due to passage delays. The hydrosystem also alters the riverine environment in several ways such as decreased velocity, increased temperature, changes in ecosystem species composition all likely to lead to changes selective pressures on juvenile fish.

Transportation also is likely to lead to changes in selective pressures on juvenile fish. Other factors that could alter selective pressures could include altered hydrograph, and emphasis upon protection of middle of the run. By operating juvenile bypass systems and providing spill for fish passage from April to August, alternative life-history strategies such as winter migration, are selected against. A more thorough treatment of this key uncertainty may lead to a better understanding of the long-term effects of the hydrosystem by providing hypotheses to test, which may in turn lead to changes in fall and winter operations, for example to benefit diverse life-history strategies.

NOAA should explain why lamprey passage is a key uncertainty for juvenile salmonid passage.

Appendix A

Potential Sources of Bias in Turbine Survival Estimates Using Balloon Tags via Hose Release

The use of balloon tags to determine survival has become fairly common and while several fisheries agencies have objected to their use in survival studies (see attached memo) their use persists as do reviews, which cite balloon tag results for determining relationships between survival and turbine operating efficiency (Skalski et al 2002, Ferguson et al 2003). Balloon-tag studies have been criticized because they do not take into account any indirect effects of turbine passage because the tags inflate and fish are removed from the system shortly after turbine passage so that any effects that may increase predation vulnerability, disease intolerance or other longer term effects are not measured. However, there are likely unmeasured effects of the methodology that affect even the estimation of direct mortality. We term those potentially biasing effects critical uncertainties.

These critical uncertainties should be addressed prior to further use of balloon tags in estimating survival through turbines. It is important that the methodology used to measure turbine survival is representative of conditions actively migrating fish would experience when passing the turbine.

The basic methodology of Balloon Tag studies is well known in the Columbia Basin, since the tag has been used extensively in estimating survival via various routes (Heisey et al 1992). Fish are tagged with the balloon tag and released via hoses into turbines or other passage routes to be evaluated. Our critical uncertainties are related mainly to the evaluation of turbine survival but some aspects may apply, more generally to other types of evaluations as well.

Critical Uncertainties of Balloon Tag Methodology for Estimating Turbine Survival

The Critical Uncertainties are those potential sources of bias in estimation of turbine survival in comparison to the survival of untagged active migrant fish.

Release Location acclimation pressure – Balloon Tagged fish are released from a holding tank at surface and delivered to turbine depth via a hose or pipe. Generally fish are held near atmospheric pressure (1.01 kPa) in shallow water prior to release. This pressure is likely quite different than the pressures to which actively migrating fish would be acclimated, that are destined for turbine passage. Generally, for active migrants, those nearest the surface would encounter the screens and diverted away from the turbines, while those fish deepest in the water, would be entrained in the turbines. Those deep water migrants would be acclimated to hydrostatic pressures in the range of 2 to 3 kPa. Cada et al 1997 cite studies (Harvey 1963, Turnpenny et al 1992, and Muir 1959) in which mortality of salmonids exposed to pressure changes was reported. Cada et al concluded that change from acclimation pressure to exposure pressure (in our case from acclimation to sub-atmospheric pressures in turbine passage) was directly related to mortality rate. In other words, fish acclimated at greater depth (high pressure of 2 to 3 kPa) experienced much higher mortality than those fish acclimated at surface (lower pressures 1 kPa) after both groups were exposed to sub-atmospheric pressures in simulated or direct turbine passage. The use of surface acclimated fish in turbine survival studies probably reduces both direct and indirect affects of turbine mortality due to the smaller change in pressure experienced by experimental fish compared to that of active migrants.

Release location fish orientation to turbine intake —Experimentally released fish that were acclimated to surface pressure would likely swim toward the surface to compensate for pressure difference if given the opportunity and assuming they had the ability to do so. For example, in the balloon tag study conducted at McNary Dam in 2002 (Normandeau et al 2003), fish were released directly below and behind vertical barrier screens in front of turbine intakes some 50 feet or more in front of the stay vanes of the turbines. These fish would likely have attempted to swim upward as they were swept toward the turbines. This would result in net distribution toward the upper portion of the water column in relation to the stay vane (if one assumes the balloon tagged fish can swim). If fish are distributed higher in the water column they would be more likely to pass near the hub of the turbine and these fish have been shown by other tests (Skalski et al 2002) to experience higher survival than those passing mid depth (mid-blade) or deep (blade tip release).

Release location fish orientation to turbine blades – It is unlikely however, that balloon tagged fish can swim with anything approaching normal ability. This has to do with both tagging procedures and release location as well as the center of buoyancy of the fish. In general fish center of buoyancy is below their center of gravity (Cada et al 1997) resulting in fish needing to continually maintain their dorso-ventral orientation in the water. If fish are stunned (as in electrofishing induced tetany), they immediately lose buoyancy control and flip over ventral surface up. The relatively large size of the balloon tag likely accentuates this dorso-ventral imbalance. The deflated balloons would also change the hydro-dynamic profile of the fish, not only increasing drag, but increasing it mainly on the dorsal portion of the fish. This combination of changes probably results in a fish that swims very poorly, that may also struggle to maintain proper dorso-ventral orientation in the water.

Given their delivery through a hose, and their likely difficulty in maintaining orientation, it is likely that balloon tagged fish enter the turbine, and encounter the turbine blades at random orientations. While, it is unknown what the environment within the turbine does to the orientation of actively migrating fish, it is probable that those fish encountering the entraining flows of the turbine intakes, would orient head upstream, or in some cases head downstream (depending on species and smoltification). But in either case body orientation would be parallel to flow net. If these fish maintain this orientation into the turbine it would result in maximum surface area perpendicular to the path of the turbine blade and a higher likelihood of turbine blade strike, than for fish that were randomly oriented in the water (i.e. balloon tag test fish). Fish randomly oriented in the water column would, on average have a smaller profile perpendicular to the turbine blade path, which reduces the likelihood of turbine strike.

Balloon tag effects on drag and inertia—The deflated balloon tags would substantially increase drag in the experimental fish compared to an untagged fish. This would alter the inertia of the fish as related to an untagged fish of the same size, and decrease the likelihood of turbine blade strike. Turbine blades have a pressure wave in front of them as they spine through the water. Small fish, such as fry, having small mass and volume, would likely be pushed away from the blade by this pressure wave, while large fish, such as adult salmon, have much higher inertia based on their mass and would not be moved nearly as much by such a pressure wave and would have a much greater likelihood of being struck by a turbine blade as result (assuming other factors such as orientation, rate of movement etc were equal and also realizing that other factors affect the likelihood of a larger fish being struck by a turbine blade such as total size). However, a balloon tagged fish, of the same size as untagged fish, as a result of its increased drag, would be more likely to be swept around a turbine blade by the preceding pressure wave, than would an untagged fish of the same size. The large external tag decreases the inertia of the tagged fish compared to an untagged fish decreasing the likelihood of turbine strike.

Balloon Tag effects on Draft Tube Passage – In addition to changes in turbine strike probability, the effects of the balloon tag on swim ability may affect fish response to turbulence in the draft tube after passing the turbine. Cada et al 1997 stated that “a turbine imparts a … rotational component” (to the draft tube), and that “fish may sense this whirl as a natural vortex and orient to it in ways that move them rapidly toward the periphery.” In other words actively swimming fish may collide with the draft tube wall attempting to avoid turbulence in the draft tube. This type of behavior would likely increase injuries to these fish, while balloon tagged fish would not be able to orient in similar fashion and would not show a similar effect when passing through the draft tube.

These critical uncertainties may not, individually, greatly change the probability of injury and mortality of tagged versus untagged fish, but in combination, may cause significant bias in the direct survival estimate. it is important that serious consideration be given to these

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State, Federal and Tribal Fishery Agencies Joint Technical Staff

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May 29, 2003

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Dear Mr. Brown, Ms. Kalamaz, Ms. Fodrea and Mr. Peters:

The Bonneville Power Administration has developed and distributed a proposal to the Corps of Engineers Study Review Work Group (SWRG) to discontinue the 1% peak turbine efficiency turbine operating limits included in the NMFS Biological Opinion. We understand and support the ongoing process of evaluating hydrosystem operations and how they relate to fish survival. However, we find that the available evidence strongly suggests that operations outside the 1% of peak efficiency would be detrimental to fish. Therefore we cannot support the draft proposal submitted by BPA to discontinue operations within the 1% of peak efficiency in all mainstem federal projects. We support the implementation of the Biological Opinion (BiOp) measures requiring that turbines operate within 1% of their efficiency range.

State and tribal co-managers have reviewed the proposal and have summarized their comments and concerns below which are presented in detail in the following discussion. In addition we have attached our comments on a specific study proposal presented to the SRWG to study the 1% turbine efficiency operating criteria at McNary Dam in 2003.

- Our review of historic and recent data only finds evidence that supports maintaining the 1% peak efficiency limits included in the NOAA Biological Opinion.
- The BPA proposal shifts the burden of proof of risks to the fishery resource in favor of apparently more certain economic benefits for the hydropower system.
- The BPA proposal abandons the precautionary approach to hypothesis testing which is warranted in an endangered species context.
- The BPA proposal reflects a management priority, which is inconsistent with the fishery management priorities of the state, tribal and federal fishery managers submitting these comments. The BPA proposal to expend effort and limited funds to test fish survival relative to turbine efficiency ranges above levels that are safer for fish is establishing a federal operator priority for increasing hydropower revenue rather than fish protection. A priority established for fish protection would direct expenditures at keeping fish out of turbines and providing alternative passage routes rather than increasing passage of fish in turbines and operating turbines at levels that reduce fish survival. Expenditure of fish mitigation funds for this study is unacceptable to the natural resource managers.
- The BPA proposal does not address the deterioration of conditions in the gatewells and on the vertical barrier screens that will result from higher turbine flows. Gatewell and vertical barrier screen and orifice conditions will deteriorate and result in significantly increased fish injury, stress and mortality.

Our review of historic and recent data only finds evidence that supports maintaining the 1% peak efficiency limits for turbines included in the NOAA Fisheries Biological Opinion.

The NOAA Fisheries 2000 Biological Opinion (BiOp) includes the requirement that turbine operations be limited to within 1% of peak efficiency based upon evidence (both empirical data and expert opinion) suggesting that smolt survival was higher within these limits compared to operations beyond them. In an effort to re-evaluate this BiOp requirement, Bonneville Power Administration (BPA) has submitted a draft proposal (dated May 19, 2003) to discontinue these turbine operating limits. However, in our review of this proposal, historic data, and recent data, we only find evidence that supports maintaining the 1% of peak efficiency limits, and therefore do not support the BPA proposal on turbine operations. Our basis for this conclusion is outlined below.

<u>Milo Bell Compendiums</u>

Bell et al. (1967) and Bell et al. (1981) provided the first basis for the 1% of peak efficiency limits. These reports present published and unpublished data on survival of small fish passing through Kaplan- and Francis-type turbines. The Bell Compendiums provide compelling evidence that fish survival is generally higher when turbines are operated within the 1% limits than when they are operated beyond these limits. In addition, survival appears to decrease linearly as turbines are operated beyond peak efficiency.

These results make sense from a mechanistic perspective as well. Mechanistically, when turbines are operated beyond peak efficiency, flow fields in the turbines are disrupted, resulting in cavitation and damage to the metal surfaces in contact with the water. Clearly, this is an undesirable condition for fish, and therefore operations that create these conditions (i.e., operations beyond the 1% of peak efficiency limits) are expected to reduce survival. The data provided by the Bell Compendiums clearly support this expectation.

Eicher and Associates (1987)

In a comprehensive review of fish mortality through turbines, Eicher and Associates for EPRI (1987) reported the conclusions of a panel of experts that the maximum survival of fish coincides with the greatest turbine efficiency. Further they noted that turbine efficiency is determined by wicket gate openings and resulting flow qualities and design head in relationship to operation head, and that efficiency falls off after reaching a peak of 60-80% maximum flow into a unit. Eicher and Associates also note that the hydraulic character of the backroll of the turbine discharge into the tailrace is a function of overall flow into the turbine unit. They note as was described by NMFS in Bonneville Dam survival studies (Gilbreath et al. 1993) that the backroll carries fish into heavy predation zones. Eicher and Associates concluded by noting that diverting fish from turbines is probably the most cost-effective way of reducing fish mortality.

Skalski et al. (2002)

The data evaluated in Skalski et al. (2002) provide a second basis for maintaining the 1% efficiency limits. While their analysis was primarily focused on evaluating the academic question of whether peak survival coincides with peak efficiency, they do provide a useful summary of more recent data on the relevant operational question of maintaining the 1% of peak efficiency limits. Based on the data provided in Skalski et al. (2002, Table A.1), mean survival is reduced by 1.13% (for Columbia/Snake River projects) to 1.64% (for all projects) when Kaplan-type turbines are operated beyond the 1% of peak efficiency limits (Figures 1 and 2). In addition, survival decreases linearly as turbines are operated beyond peak efficiency for Columbia/Snake River projects (Figure 3).

Normandeau et al. (2003)

The presence of several study design flaws severely limits the utility of the 2002 McNary turbine survival study results summarized by Normandeau et al. (2003) for evaluating the BiOp turbine efficiency requirement. These flaws stem from both how the study was conducted and how the results can be interpreted given the greater context of fish passage at dams. We condense some of these issues into five main points, below.

First, operations beyond peak efficiency increase turbulence and flow within the gatewells, resulting in screen and orifice clogging, increased current velocities, and fish mortality along the intake and vertical barrier screens. During times of high debris loading, this problem is especially severe. Because fish were released within the gatewells in the 2002 McNary study, the survival estimates do not reflect this known problem. Furthermore, the estimates do not incorporate the changes in fish guidance efficiency that would occur with operations beyond the BiOp regulations.

Second, the sole use of large chinook salmon smolts prevents the application of study results to other species and size classes. As found in Skalski et al. (2002), turbine survival is significantly related to fish size, with smaller fish showing lower survival rates. Species that are more sensitive to turbine passage or are smaller than the large chinook smolts used in the 2002 McNary study will show reduced survival compared with results presented in Normandeau et al. (2003). Therefore using the 2002 McNary study results to overturn the BiOp turbine efficiency operating requirements, which in nature apply to all species and size classes, is inappropriate.

Third, spill operations and sample sizes were not consistent across the treatments in the 2002 McNary study. Treatments outside of the 1% limits (i.e., the 14 kcfs and 16.4 kcfs operations) had no spill during 6 of the 7 study days, whereas the treatments inside of the 1% limits had no spill for 4 of the 9 study days. This inconsistency in spill operations creates the question of whether the differences in survival estimates are the result of differences in turbine operations or of differences in spill. The number of fish released also differed among the treatments. Between 350 and 390 fish were released for 5 of the 6 treatments, but only 270 fish were released for the 14 kcfs treatment. The fact that this treatment also showed the highest survival is curious. Further, based on the results from previous studies, we expect survival to decline linearly as turbines are pushed beyond peak efficiency. Because the survival estimate at the 14 kcfs treatment is well above an interpolation between the 11.2 kcfs and 16.4 kcfs treatment estimates, this casts additional doubt upon the validity of the 14 kcfs survival estimate.

Fourth, we question the use of 48 h survival rates for evaluating delayed turbine mortality. Studies have shown that delayed mortality associated with turbine passage can be significant, and often is not manifested until several days following passage (Kostecki et al. 1987). Without holding the fish for longer periods, we cannot ensure that operations outside the BiOp limits will not jeopardize the long term survival of smolts. Further, forebay and tailrace mortality must be evaluated. Extended holding to assess delayed mortality presents other biases that make this approach difficult experimentally. These delayed and indirect effects may only be understood through studies that evaluate effects on smolt-to-adult survival rates.

Fifth, the efficiency levels chosen for the 2002 McNary study are not informative for comparing fish survival inside and outside of the 1% of peak efficiency operations. The 8 kcfs and 11.2 kcfs treatments lie at the boundary of the 1% limits and the other two treatments are beyond the limits. To evaluate whether operations outside the 1% limits do not negatively impact fish, data must be collected well inside of the 1% limits. Studies operating at the limits and beyond (e.g., the 2002 McNary study) do not provide information on the effects of turbine efficiency on survival because estimates are only collected at operations beyond the efficiency limits. Furthermore it is important to note the fact that Normandeau et al. (2003) report the planned discharges (8, 11.2, 14 and 16.4 kcfs) rather than the actual discharges (7.7, 12, 13.4, and 16.6 kcfs) throughout the document. This was misleading, as was the practice of claiming that the 11.2 kcfs treatment was near peak efficiency when in fact it was at the 1% boundary. We encourage proper and accurate documentation of study outcomes and request the authors of Normandeau et al. (2003) in the future refrain from reporting misleading and inaccurate treatment data and results.

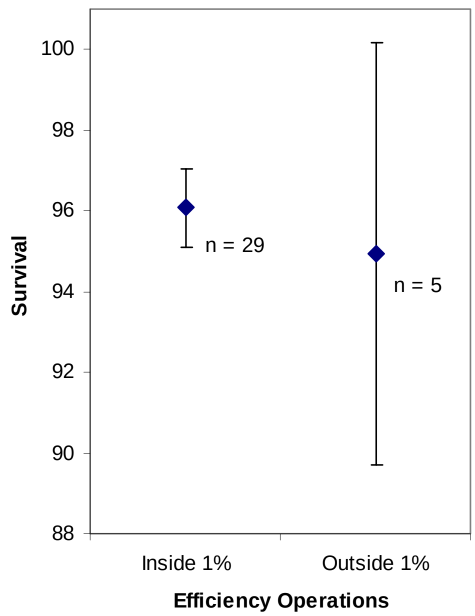

Figure 1. Mean survival and 95% confidence intervals for Kaplan-type turbines operated inside and outside of the 1% of peak efficiency bounds for Columbia/Snake River projects [Data from Skalski et al. (2002, Table A.1)].

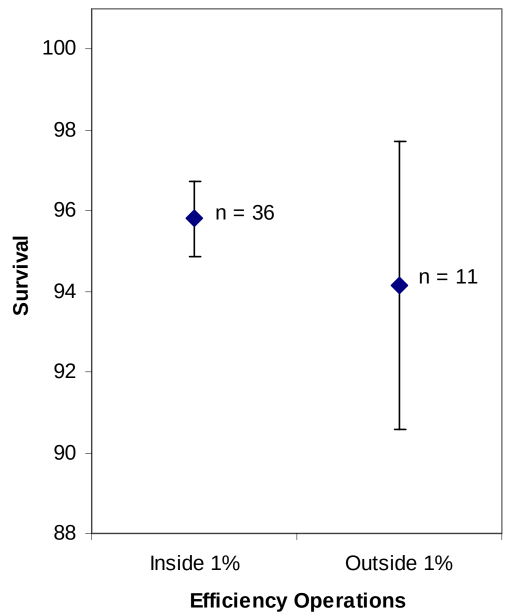

Figure 2. Mean survival and 95% confidence intervals for Kaplan-type turbines operated inside and outside of the 1% of peak efficiency bounds for all projects [Data from Skalski et al. (2002, Table A.1)].

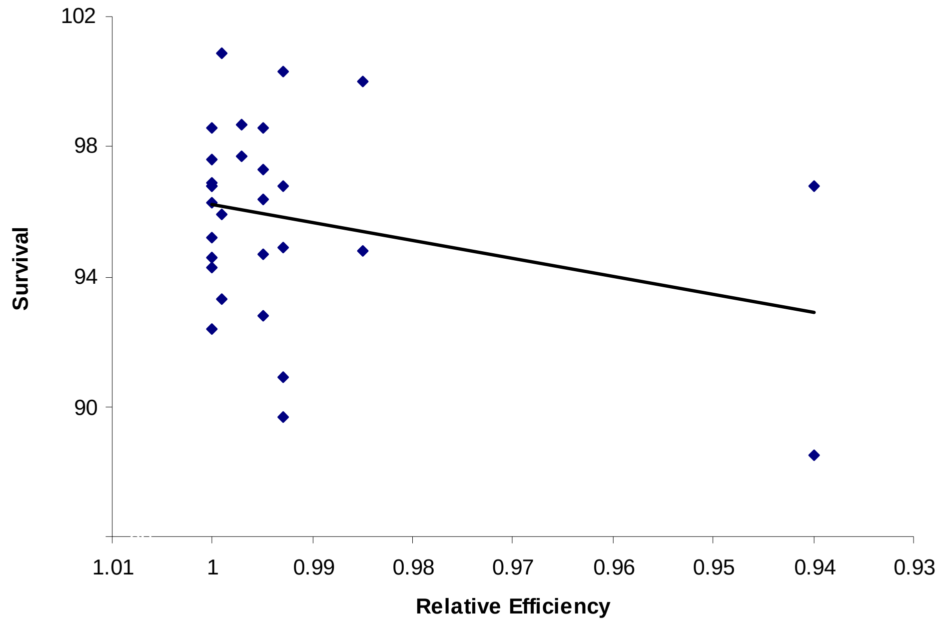

Figure 3. Relationship between survival and relative efficiency of Kaplan-type turbines for Columbia/Snake River projects [Data from Skalski et al. (2002, Table A.1)].

With respect to risks, the BPA proposal shifts the burden of proof to the fishery resource in favor of apparently more certain economic benefits for the hydropower system. The BPA proposal abandons the precautionary approach to hypothesis testing which is warranted in an endangered species context.

The BPA proposal is based upon BPA's decision to place the burden of proof for protection upon the ESA listed salmon, and other anadromous fish resources in favor of anticipated economic benefits to BPA.

The choice of a significance level determines the relative frequency of two kinds of mistakes, either rejecting the H_0 when it is correct making a Type I error, or failing to detect the truth of H_A when it is correct making a Type II error (Snedecor &Cochran, 1989) The failure rate β of not rejecting the null hypothesis when the alternative is "true" is termed the "Type II error" and the failure rate α of rejecting the null hypothesis when the null hypothesis is "true" is termed the "Type I error". In ecological studies, it is often desirable to balance these errors by applying the same failure rates to each type of error or even setting the failure rate such that $\beta < \alpha$.The proposal indicates that BPA is more willing to accept a Type II error than a Type I error. However, there are reasons why a more precautionary approach to hypothesis testing is warranted in endangered species contexts (Peterman 1990, Dayton 1998). Steidl and Thomas (2001) cite investigators who have suggested that Type II errors be considered paramount when monitoring endangered species; or at least that Type I and Type II errors be balanced based on their relative costs. In endangered species recovery activities, if a Type II error is committed, a population could be on its way to extinction before the decline is detected and preventative action is taken. Conversely, if the population is monitored after initiating recovery actions (such as implementing turbine efficiency limitations), and the population is actually increasing, a Type II error would lead to the mistaken inference that the actions are not having the desired effect, perhaps jeopardizing continuance of those actions. The limitations of empirical data and ability to determine small differences in survival should not result in placing listed stocks at additional risk. If the data and methods do not allow differentiation of small differences a precautionary approach to management of endangered species require adoption of the measures that provide conservation and protection of the species.

Proper consideration of the possible detrimental effects of failing to meet turbine efficiency requirements requires acknowledging the limitations inherent in the available empirical data on turbine efficiency and survival. It should be kept in mind, for instance, that it's difficult to accurately characterize exact turbine conditions experienced by individual release groups in the turbine survival studies. The most relevant question we can ask in light of these limitations of data is not whether we can tease out effects on highly variable survival estimates from small variations in turbine operations within a season. Many factors affecting turbine survival probability will always remain outside of management influence. A more relevant question is, over a longer time series, given a representative range of uncontrolled variation in factors affecting survival, are turbine operations within their efficiency ranges associated with higher survival rates?

The BPA proposal does not address the deterioration of conditions in the gatewells, on the vertical barrier screens, and in the tailrace which would result from higher turbine flows. Gatewell and vertical barrier screen conditions would deteriorate and result in fish injury, stress, and direct and delayed mortality.

During 1997 and 1998 studies were conducted (Brege et al. 1998, Brege et al. 2001) to evaluate the vertical barrier screens and outlet flow control devices at McNary Dam. In those studies turbines in the test units were operated at low load 60 MW and high load 80 and 75 MW. Those tests with spring migrants showed that there was significantly higher levels of descaling under high turbine load operations. Under high load conditions descaling averaged 17 % versus 6.7% at low loads.

Present studies indicate that delayed mortality is an important factor in return of adult transported salmon and steelhead. Smolt to adult return data (CSS status report 2001) indicates that smolt to adult return rates for bypassed smolts are lower than spill passage. The BPA proposal to operate turbines at higher loads, given the results of gatewell vertical barrier screen descaling data, will potentially exacerbate and add to delayed morality for transported smolts and reduced survival of bypassed smolts.

The current proposal outlines BPA's justification for operating turbines, specifically at McNary Dam, outside the current 1% efficiency guidelines. The 1% operation was implemented based upon previous research that showed a relationship between peak efficiency of the turbine and maximum survival. BPA has outlined their rationale for believing that this data may not be accurate. Regardless of the debate over operating ranges and juvenile survival through the turbines, operating the turbines outside of 1% percent to increase generation will divert more flow through the turbines. This will likely increase the number of juveniles using this route of passage. As flow through a route increases so does the number of juveniles that use the specific route. This has been shown through countless passage evaluations. Thus, more juveniles will pass via the turbines; only the percent increase is uncertain. Current estimates for passage through the turbines are 86% and 87% from the radio tagged fish evaluation in the 2002 survival study conducted at McNary dam to test the 11.2 and 16.4 kcfs flow rates through the turbines. The project goal is to attain project survival in the high to upper 90’s, ideally a route specific survival would be 98%. By increasing the number of juveniles using the turbines, project survival is going in the wrong direction, making it more difficult to attain the goals set out in the 2000 BiOp.

While gatewell releases during the April 2002 evaluation showed no difference in fish condition or survival, the gatewells were clean and operating at an ideal condition. During this time of year, there is little debris and no temperature problems; hence, this evaluation did not test a worst-case situation. By increasing flow through the turbines, more flow will be directed up the gatewell. Peak debris loads normally occur during the spring freshets and during the late summer. As debris and grasses are guided up into the gatewells with the migrating fish, increased head differentials across the barrier screens become evident and normally fish quality/condition problems start to manifest itself at the project. Not only is this hard on the screen mesh and other associated equipment in the gatewells, but fish that are guided into the slots can be injured or worse yet killed as hot spots (increased velocities) along the screen mesh develop. In past years and at present, to best counteract this problem, the project biologists would advise the project to reduce turbine loading to minimum operating levels and where warranted the unit would be taken down and the barrier screens cleaned. Increasing megawatts at McNary for example would only exasperate a “known” condition that currently exists at the project and is counter to improved fish survival goals stated in the 2002 BiOp.

Furthermore, the 2002 spring evaluation measured a much reduced residence time for fish released into the gatewell at 16.4 kcfs. Reductions in gatewell residence have been noted in the past when gatewell conditions become more turbulent and more aggressive hydraulically, which make it more difficult for juveniles to avoid the orifices. Under these condtions the juveniles are more similar to buoyant particles than active swimmers. This situation can be very injurious to fish, even under medium debris loads. This would also likely lead to reduced survival for fish using the bypass system, which would again drive project survival in the opposite direction of the survival goals for McNary as outlined in the 2002 BiOp.

The BPA proposal states that the SIMPASS model showed no difference in project survival. Notably the evaluation is missing the summer component. The evaluation used in the proposal used spring conditions. However the current operation under region discussion will continue through the summer. Current operations at McNary involve daytime involuntary spill. By increasing turbine flow, more fish will be passed via the powerhouse and turbine units as daytime involuntary spill is reduced. Because of the limited powerhouse capacity at McNary, involuntary spill was included in the biological effects analysis during the ESA consultation in 2000. By reducing the involuntary spill, project survival will be decreased and once again the separation between current conditions and the survival targets in the BiOp will be increased.

Table 3 in the BPA proposal, on page 27 describes the SIMPASS assumptions, has questionable values for turbine survival. BPA used balloon tag survival estimates for turbine survival. Balloon tag survival is not an appropriate technique to get a route specific survival due to the interaction of the tag and test animal. Balloon tags only estimate direct survival at best, and do not look at indirect survival post passage. Balloon tags are commonly used to identify areas of concern for passage, not to estimate route specific survival. A radio tag survival study was conducted along with the balloon tag study in 2002. Estimates for survival between the two turbine levels where 86% versus 87% as opposed to the 95% and 93% survival used by BPA in the SIMPASS model. Furthermore, BPA did not model any changes in FGE or FPE as more flow was passed by the turbines, which is questionable when doing a sensitivity analysis for turbine and project survival.

We understand that Bonneville Power Administration's objective is to enhance hydropower production without reducing fish survival. However, the proposal eliminate the 1% turbine efficiency operating criteria included in the NOAA Biological Opinion does not accomplish that objective.

BPAs proposal for operations and study does not represent a prudent expenditure of funds or assignment of priorities from a fish protection standpoint or a Biological Opinion progress check in dates. The BPA proposal is counter to BPA's historical position that turbines should run at peak efficiency during fish migration season. The primary objective of the BPA proposal is to increase hydrosystem revenue.

However, running turbine units outside of 1% peak efficiency will cause cavitation and poor operational conditions that would require more frequent shutdowns of units to repair cavitation damage (Shelton and Loupin 1995). In Europe, turbine units are never operated outside peak efficiency criteria because the costs of shutdowns and repairs are prohibitive. Increased repair costs and unit shutdowns for repairs may actually reduce overall FCRPS hydro revenues, or simply shift anticipated revenue gains to BPA with repairs costs to the Corps.

Precautionary management as anticipated by ESA would place the highest priority on increasing fish survival at the projects which would place the highest priority for expenditure of funds on actions that would reduce injury through the bypass, reduce fish passage through the turbines and provide alternatives to turbine passage. Fish survival is lowest through turbines than any other passage route even within the most efficient turbine operating range, , the BPA proposal will increase the proportion of fish passing through the most lethal project route.

Study design
Studies conducted to date have not shown that survival is improved or unchanged under high load turbine operations. The precision of the balloon tag studies does not support a management decision to eliminate the turbine efficiency requirements of the NMFS Biological Opinion. Please refer to our specific comments (attached) on the BPA,COE proposal to study the 1% turbine efficiency criteria at McNary Dam in 2003.

Conclusions

- Historical and present data does not support the BPA proposal to eliminate turbine efficiency requirements of the BIOP.
- The BPA proposal inappropriately shifts the burden of proof to the fishery resource, placing a higher level of risk on listed and non-listed fish stocks.
- The BPA proposal if implemented is likely to exacerbate issues of delayed mortality on transported fish, and reduced survival of bypassed fish and turbine passed fish due to increased stress, injury and descaling in the gatewells and degraded tailrace conditions.
- Studies of survival relative to turbine operations are turbine operations are a low funding priority in comparison to funding alternatives to turbine passage.
- Funds intended for current fish mitigation programs should not be expended on these proposed studies.
- A proposal to increase fish passage through turbines is counter to the aggressive, non-breach all-H recovery plan that BPA to this point has supported.

Sincerely,

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Steve Pettit, IDFG

Ron Boyce, ODFW

Tom Lorz, CRITFC

Keith Kutchins, SBT

Shane Scott, WDFW

Bob Heinith, CRITFC