FISH PASSAGE CENTER

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MEMORANDUM

TO: Pat Poe, BPA

Michele DeHart

FROM: Michele DeHart

DATE: February 28, 2002

RE: Comments on the NMFS/UW Draft report entitled, "Survival Estimates for the Passage of Spring-Migrating Juvenile Salmonids Through Snake and Columbia River Dams and Reservoirs, 2001".

Attached are our comments on the subject NMFS draft report. We have provided the comments directly to NMFS, the state and tribal salmon management agencies and, as requested by the NWPPC, posted them on the FPC web site. In our earlier discussions of comments on the Comparative Survival Study review draft, BPA requested and we agreed to append review comments and our response to the final report. We are requesting that the attached comments plus the NMFS response, as well as other comments and responses be appended to the final report. Thanks

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February 27, 2002

Rich Zabel
National Marine Fisheries Service
7600 Sand Point Way NE
Seattle, Washington 98115-0070

Dear Rich:

The Fish Passage Center (FPC) staff has reviewed the NMFS draft report entitled, "Survival Estimates for the Passage of Spring-Migrating Juvenile Salmonids Through Snake and Columbia River Dams and Reservoirs, 2001". We appreciate your agreement to extend the deadline date for receipt of comments from January 31 to March 1 to allow us to complete our review comments. We offer the following comments for your consideration in completing the final report. We request that, as is required by other Bonneville Power funded studies, that these comments and an explanation of how they were addressed be appended to the final report.

The findings of the NMFS draft report were presented to the Implementation Team on February 13, 2002 and the Northwest Power Planning Council on February 5, 2002. This document includes comments on NMFS Draft Annual Report and comments on the NMFS presentation to IT and the NWPPC. While much of what was provided in the NMFS Annual Report was included in the NMFS presentations, the presentation also covered a good deal of material not included in the Annual Report and contradicted it on key issues. While we do disagree with some of the conclusions contained in the Annual Report, we found the presentations particularly troubling since many of slides were undocumented, and statements made went far beyond the Annual Report in interpretations as well as conclusions. The primary points of our review are summarized below followed by specific discussion.

- We agree with the NMFS overall finding that the lowest survivals and slowest travel times for smolts resulted from the lowest flow and spill that has occurred in recent years.
- The calculated per-project survival estimates are average rates of survival and not appropriate to assess the effect of the flow variable.
- The per-project survival data set is of limited use because each data point is not directly comparable to other data points. Each point represents averages over different reaches and different projects.
- When the calculated average (per project) rate of survival based upon upper reaches is used to extrapolate for survival through lower reaches, the trend is to overestimate survival for the extended length reach.
- The freeze brand data estimates of survival and the recent PIT tag data should not be combined into a single data set and do not support a combined analysis.

- The survival estimation methodology simply produces model-based estimates of survival and collection efficiency, and how various environmental and project operational factors may ultimately influence the "true" survival and collection efficiency being estimated must be investigated indirectly through "correlative" deduction.
- There was a survival benefit to the limited amount of spill for fish passage provided in 2001.
- Increasing flow and spill in past years could account for the temporal increase in survival observed in past years.
- The 2001 data indicates that the temporal trend in survival without spill was downward for both chinook and steelhead throughout the spring migration. This trend indicates that the increases in survival observed at John Day with the implementation of spill were probably due to spill not other temporal effects.

<u>John Day Spill Benefit</u>

NMFS analysis of John Day spill effects in 2001 obscured the benefits of those operations by using narrowly defined statistical tests. In their conclusion to the Annual Report they state that "Thus, the decrease in spill alone may explain much of the lower survival observed for chinook salmon during the 2001 migration." While NMFS states that there may be a detriment to lack of spill in the Snake River, they are extremely reluctant to demonstrate a benefit from spill such as FPC showed for data collected at John Day in 2001. (See attached document entitled John Day Spill Analysis 2001 by FPC.)

The FPC analysis of spill uses all the fish detected or released at McNary Dam during specified time intervals related to spill at John Day Dam. The FPC analysis divides the groups into pre-spill and spill groups. NMFS analysis of the benefit of John Day spill is problematic. The NMFS analysis divides the groups into temporal blocks representing pre-spill, spill and post-spill conditions. The greatest differences in survivals were found post-spill when sample sizes were too low for reliable estimates. The post-spill group only represents 8% of the migration based on passage indices at McNary Dam. Therefore, we question the appropriateness of attempting to create a post-spill temporal block for purpose of survival estimation.

Before conducting a series of hypothesis tests, NMFS split the yearling spring/summer chinook data into four distinct groups by regional stock designations. These groups included Snake River spring/summer stocks, Yakima spring stocks, Upper Columbia spring stocks, and Upper Columbia summer stocks (although they show the latter group having yearling fall chinook also, but no yearling fall fish were released in the Upper Columbia River in 2001). Survival estimates from McNary Dam tailrace to John Day Dam tailrace were obtained for each regional stock group separately for three temporal periods, pre-spill, spill, and post-spill. NMFS observed a pattern of the highest survival estimates during the spill period, followed by lower survival in the pre-spill and the lowest survival in the post-spill period. This same pattern occurred across the four regional stock groups. This similarity in pattern across groups supports the FPC's use of an aggregate of all yearling chinook detected at McNary Dam in their estimation of reach survival from McNary Dam tailrace to John Day Dam tailrace in 2001. NMFS conducted their analysis only at the level of the individual regional stock groups, but given the common pattern across groups, it would be beneficial for NMFS to also conduct their analysis at the level of the combined stock aggregation. This would increase sample sizes, reduce variances within blocks, and thereby improve our power of detecting significant differences among temporal periods if they do exist within the underlying data.

In conducting their hypothesis tests, NMFS utilizes the capabilities of the SURPH computer software to compute likelihood ratio tests between a model and a simpler (parameter reduced) version of that model. For example, the "full" model would allow for a different parameter of survival in each temporal block, whereas a "reduced" model could assume a common survival across the three blocks, and thereby a single survival parameter. Let the subscript j denote the temporal block, where 1 = pre-spill, 2 = spill, and 3 = post-spill. This gives a null hypothesis of $S_1 = S_2 = S_3 = S$ and alternative hypothesis of S_j's not all equal. This is what NMFS is testing in their Hypothesis H_{10} although they label the null hypothesis as $S_{spill} = S_{no\text{-}spill}$. In the second hypothesis, NMFS is testing a null hypothesis of $S_1 = S_3$ versus the alternative hypothesis of $S_1 \neq S_3$. If we put this in the context of an experimental design, we would have for a given regional stock group with three temporal periods, a main effects test of "between periods" with 2 degrees of freedom. If we split these 2 degrees of freedom into a pair of orthogonal contrasts, we would have for the first contrast the test of spill versus average of no-spill, *i.e*., $S_2 = ½(S_1 + S_3)$, and for the second contrast the test of pre-spill versus post-spill, *i.e*., $S_1 = S_3$. This is the proper set-up for orthogonal contrasts. It appears that NMFS is attempting to perform a similar set of orthogonal contrasts through the use of the SURPH program. However, the first hypothesis being tested by NMFS is simply the main effects test of "between periods." In this situation, the second hypothesis is not an orthogonal contrast relative to the first hypothesis. NMFS could have just as easily run the null hypothesis of $S_1 = S_2$ and $S_2 = S_3$ against each of their respective alternatives, which is akin to inspecting all differences between pairs of means, rather than running a set of planned comparisons. With the planned comparison, only the first orthogonal contrast is really of interest regarding the statistical significance of survival in Period 2 versus the other two periods. With the approach used by NMFS, the two sets of hypothesis still do not address the question of statistical significance of survival in Period 2 versus the other two periods, rather the *a-posteriori* comparisons of mean survivals between each pair of periods is more appropriate.

NMFS inappropriately concluded that their hypothesis testing showed that no statistical significance could be ascribed to the estimated higher survival of Period 2 (spill period). However, the survival estimates obtained by NMFS for Period 2 were consistently higher across the four regional stocks in 2001, and across the recent past years. If NMFS had directly tested the periods of pre-spill vs spill and spill vs post-spill, they would have come to a different conclusion. This test would have been accomplished in SURPH as the likelihood ratio test of "reduced" model divided by "full" model for each pair of periods being compared (*e.g*., null hypothesis of $S_1 = S_2$ versus alternative hypothesis of $S_1 \neq S_2$ and null hypothesis of $S_2 = S_3$ versus alternative hypothesis of $S_2 \neq S_3$). In these test, all that will result is that Period 2 survivals were greater than either Period 1 or Period 3 survivals. One still has to make the inference to what mechanism was contributing to the higher survival in Period 2. We contend that when one looks at 2001 and the other recent years that there is a clear link to higher spill volumes occurring during Period 2 in each year, so even in years where the proportion of spill doesn't change much, the typical increasing flows in the latter half of May will result in increased volume of water spilled. During these periods of increased flows, the turbidity level of the water also increases, and the duration of passage of fish through the reservoirs decreases, thus contributing to lower predation levels. It is the combination of all these factors that influences the improved survival observed in each year during Period 2. But in 2001, with constantly low flows, very clear water, and slow travel time from McNary Dam tailrace to John Day Dam tailrace, it is the presence versus absence of spill at John Day Dam that occurred between periods. From this set of circumstances, it appears that a link to spill improving survival can be made. Otherwise, one could argue that because we can only make “correlative,” not “causative” comparison between smolt survival levels and associated environmental and project operational factors in the hydro system, we in essence should abandon the futile endeavor of analyzing reach survival estimates against these factors.

NMFS recognizes that there is a measurable change in collection efficiency at John Day Dam after the initiation of spill. However, NMFS does not relate this change to a change in survival nor to the operations at the project. Given that nearly every study NMFS conducted shows spill has a significantly lower rate of mortality than any other passage route, it seems this alone could be used to biologically explain the change in the survival estimate observed. At the very least it demonstrates an alternate hypothesis that questions the “temporal trend” theory as the explanation.

Also, for 2001 we looked at the proportion of Mid-Columbia, and Snake River origin yearling chinook passing during the period May 1 to June 10. We found the proportions that contributed to FPC survival estimates were similar for each of these groups over the entire season. Consequently, we concluded that it was unlikely there was a stock dependent temporal effect on survival estimates as suggested by NMFS in their presentation to the NWPPC and IT.

<u>McNary Dam Spill Benefit Analysis</u>

There was very limited spill at McNary Dam in 2001. Spill occurred every other day and was limited to an instantaneous average of 30 kcfs. NMFS found no survival benefit to spill at McNary in 2001. In fact they found survival significantly lower during spill than pre-spill. It is likely that the extremely low spill levels resulted in a negligible spill benefit at McNary this season. The detection efficiency for yearling chinook at McNary did not change appreciably between mid-May prior to spill and through the spill period. This suggests that spill did not improve overall fish passage efficiency enough, (especially when occurring every other day) to improve passage conditions at McNary Dam. Also, the survivals for the reach LGR to MCN showed a downward trend throughout the season, so that NMFS finding a lower survival during spill which was toward the end of period for which they could estimate survivals is consistent with that seasonal trend, and probably was not related to spill.

<u>Reach and System Survival</u>

NMFS uses per project survival plotted against a flow index as a means of comparing annual system survival to flow conditions (Figure 13 page 91 Annual Report). They regressed per project survival by flow index and found no significant relation. However, this type of plot and analysis may be very misleading. Annual per project values are derived from differing length reaches in different years. For example, yearling chinook data incorporates one project (LGR to LGS) in 1993, two projects (LGR to LMN) in 1994, four projects (LGR to MCN) in 1995 through 1998, and eight projects (LGR down to BON) from 1999 to 2001.

Using short reach estimates to characterize a season can significantly misrepresent what occurs over the longer reach. For example, if we used the 2001 LGR to LGS reach survival (0.939) for yearling chinook to represent 2001 survival (as NMFS used for 1993 in figure 13 page 91 Annual Report), then 2001 would appear as a very favorable migration year. Expanding this ‘per project’ survival to a system survival for 2001 would yield 0.68 LGR to BON survival for yearling chinook. This is nearly three times the NMFS reported survival of 0.27 for this reach. The same holds true for LGR to LMN survivals (as NMFS used to represent 1994 in Figure 13). If the 2001 LGR to LMN survival was averaged per project it would yield a per project survival of 0.877. Expanding this to the LGR to BON reach would yield a system survival of 0.45. Nearly twice as high as the NMFS 2001 estimate. A final example, using 2001 steelhead survival for LGR to LGS (0.801) and expanding this to a system survival would yield 0.26. Comparing the resulting value to NMFS reported system survival of 0.04 shows how misrepresentative the expansion of short reach survivals can be for characterizing an entire season.

As the above comparison shows the assumption that per project survival is constant throughout the system oversimplifies both the biology of migrant fish and the physical characteristics of the hydrosystem. Juvenile salmon migrating in-river would be expected to show increasing mortality over time in a year like 2001, when no spill occurred in the Snake River forcing migrant population to pass through multiple dams via turbines or bypasses. Also, comparing survival over short reaches in the Snake River (LGR to LGS or LGR to LMN) to longer reaches (LGR to MCN) could fail to capture the differences between these very different sections of river.

The freeze brand survival estimates from the 1970’s should not be directly compared with the 1990’s PIT-tag estimates without a great deal of caution. These data were collected in a very different fashion and likely the precision of the freeze brand estimates would be much lower. It is possible that the magnitude of low survivals during the 1970’s is meaningful to compare, however, plotting both types of data in the same graph gives the impression that these are comparable data sets. Clearly, this is not the case. In their NWPPC presentation NMFS presented survivals in the 1990’s as much better than even the best survivals during the 1970’s. While it is likely that physical improvements in the hydrosystem and improved operation strategies have combined to improve survival, the quality of the data sets is very different. Also, even with improved survivals, none are high enough to insure recovery of endangered species especially those seen in 2001.

NMFS found no significant relationship between flow and survival when they regressed their flow index versus seasonal per project survival. But the per project survival rate compresses data points between 0.9 and 0.98. This probably makes it very difficult to find any significant relationship from this sort of presentation of the data.

An alternate means of comparing survival among years may include observations for the longest reaches over which survivals have been estimated for all years, compared to seasonal flow conditions. In this analysis the flow index was average discharge during the period that the BiOp sets spring targets for flow and spill at the Snake Projects. Flow is compared to seasonal survivals for the years 1995 to 2001 for the reach LGR to MCN, and for the years 1999 to 2001 for the reach from LGR to JDA. (These are the only years for which PIT-tag survival estimates were calculated for these entire reaches.) As can be seen in Figure 1, the LGR to MCN survivals of yearling chinook remain above 65% for the years 1995 to 2000, when flows are at or above the BiOp flow target of 85 kcfs during the BiOp spill season, but fall to 57% in 2001. For steelhead, the LGR to MCN reach survivals also remain above 65% when flow targets were met and plummet to 16% in 2001, when target flows were well below the BiOp target spill levels (Figure 2). For the years 1999 to 2001 there was sufficient data available for the longer reach LGR to JDA. Plots comparing those years (Figures 3 and 4) do show a similar trend to the shorter reach; survival in 2001 was considerably lower than 1999 and 2000.

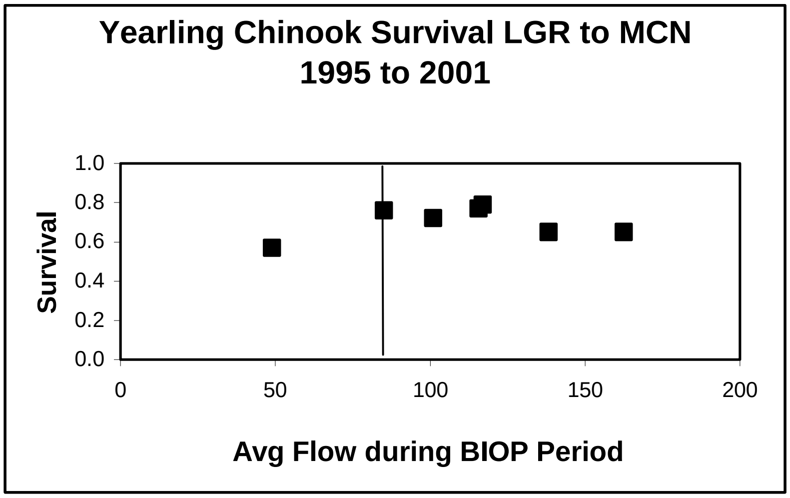

Figure 1. NMFS season survival estimates Lower Granite Dam tailrace to McNary Dam tailrace for yearling chinook from 1995 to 2001 plotted with average flows during BiOp flow period in Snake River.

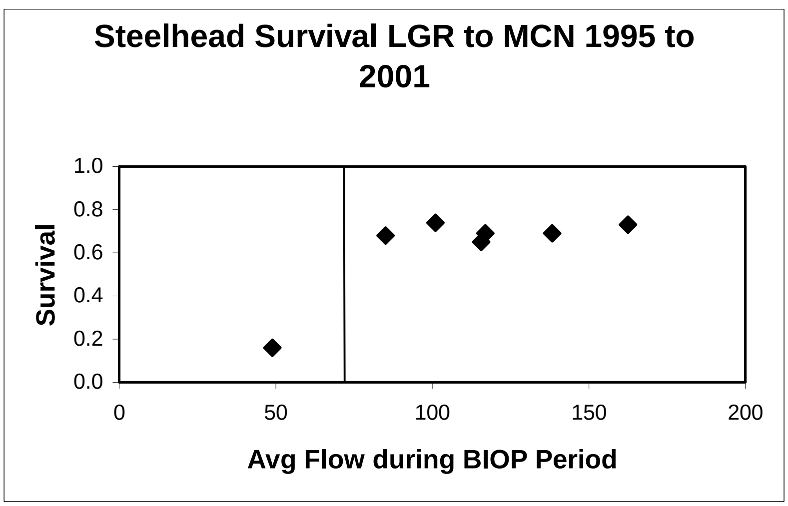

Figure 2. NMFS season survival estimates Lower Granite Dam tailrace to McNary Dam tailrace for steelhead from 1995 to 2001 plotted with average flows during BiOp flow period in Snake River.

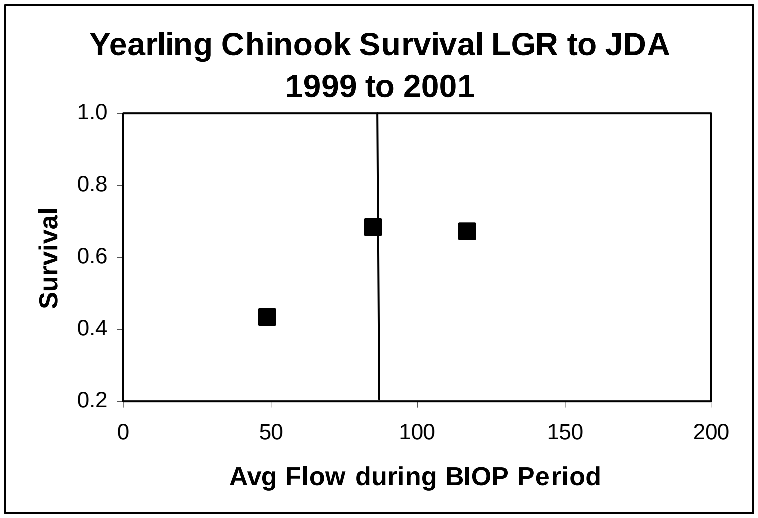

Figure 3. NMFS season survival estimates Lower Granite Dam tailrace to John Day Dam tailrace for yearling chinook from 1999 to 2001 plotted with average flows during BiOp flow period in Snake River.

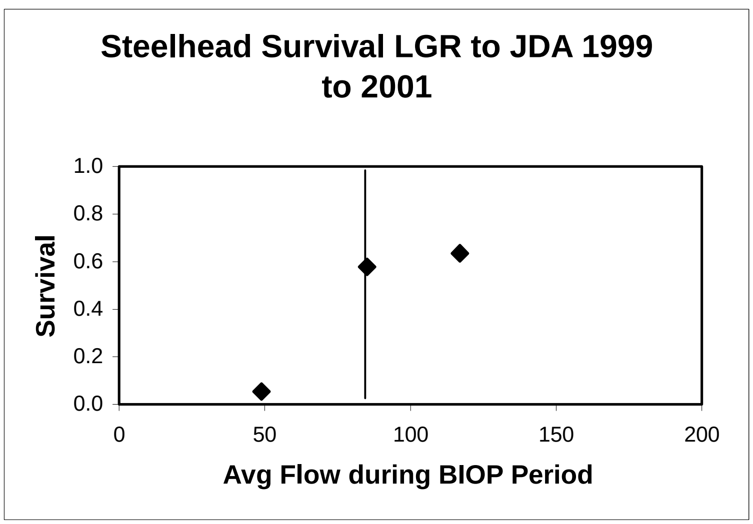

Figure 4. NMFS season survival estimates Lower Granite Dam tailrace to John Day Dam tailrace for steelhead from 1999 to 2001 plotted with average flows during BiOp flow period in Snake River.

NMFS presents a relatively short-time series of survival vs. flow data (1993-2001). With the exception of 1994 and 2001 the average flow exceeded the Biological Opinion flow targets. The Biological Opinion flow targets were specifically chosen based on data that showed little change in survival with flow above the targets. Consequently, rather than showing a no flow/survival relation, the data are validating those upon which the flow targets were based. In Figures 3 and 4, NMFS season survival estimates Lower Granite Dam tailrace to John Day Dam tailrace for yearling chinook and steelhead respectively from 1999 to 2001 are plotted with average flows during BiOp flow period in Snake River.

NMFS PRESENTATION TO THE IMPLEMENTATION TEAM AND THE NORTHWEST POWER PLANNING COUNCIL

In their presentation to the NWPPC and IT, NMFS did not rely on the multiple hypothesis testing included in their annual report to argue against a spill benefit. Instead they used comparisons of temporal changes in survival between 2001 and earlier years to make the argument that the pattern of survival in 2001 was repeated annually, and was therefore impossible to attribute to spill. They presented data from 1998, and 1999 showing similar trends in survival for chinook salmon (mid-season highest survival, early season middle range survival, late season lowest survival). NMFS did not present the data for 2000, however; it did not seem to fit their hypothesis. They argue that the trends in survival are repeating temporal and may possibly have been due to differential survival of various stocks passing John Day at different times. While a pattern of high survivals in mid-May to early June does occur each of these years, these higher survivals each year can be related to the highest flows and/or proportion spill occurring during that time period.

A temporal effect cannot be demonstrated unless flow and spill remain relatively stable over that period each season. Flows and spill did not remain constant during these time periods. In fact, using the time periods NMFS blocked for their presentation to NWPPC we found the highest survivals occurred during the periods of the highest flows and spill proportions in 1998 and 2001 (Figures 5 a,b,c). In 1999, the differences in survival were the smallest among the three periods. In that year spill was manipulated in blocks of low and high daily spill during early May and was more consistent during the second time period (May 18 to June 6) and decreasing in the

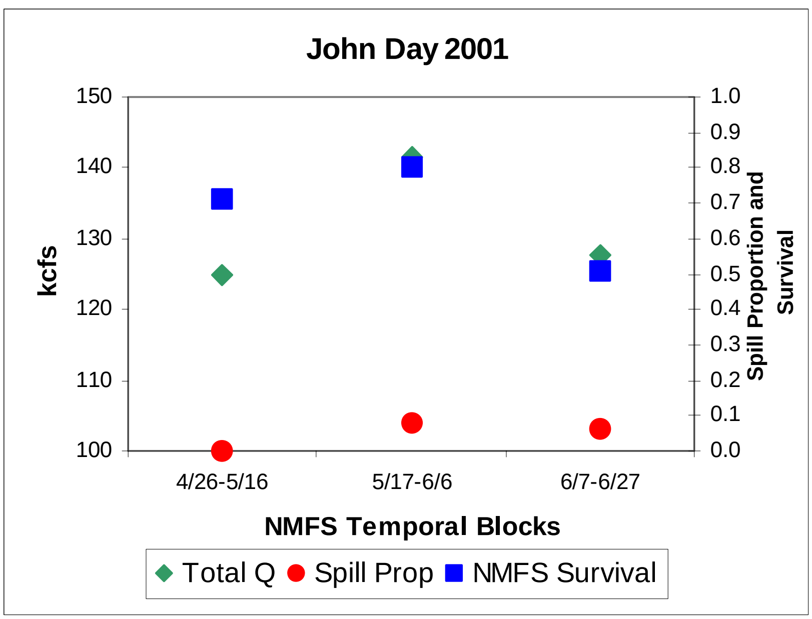

Figure 5a. Yearling Chinook Survivals MCN to JDA tailwater, Spill proportion at JDA, and Average Total Discharge at John Day during pre-spill, spill and post-spill blocks at JDA 2001.

third block. Also, flows increased over the three blocks while proportion spilled decreased. So that some positive effects of high flows and higher spill proportion might counterbalance each other, resulting in more moderate differences in survivals throughout the season. The historical data presented by NMFS could be considered an indication that temporal patterns of survival might be attributed in part to an increase in flow and spill proportions through the passage season. Neither the NMFS presentation nor their annual report recognized this possibility. These findings support the assertion that high flows and spill improve survival.

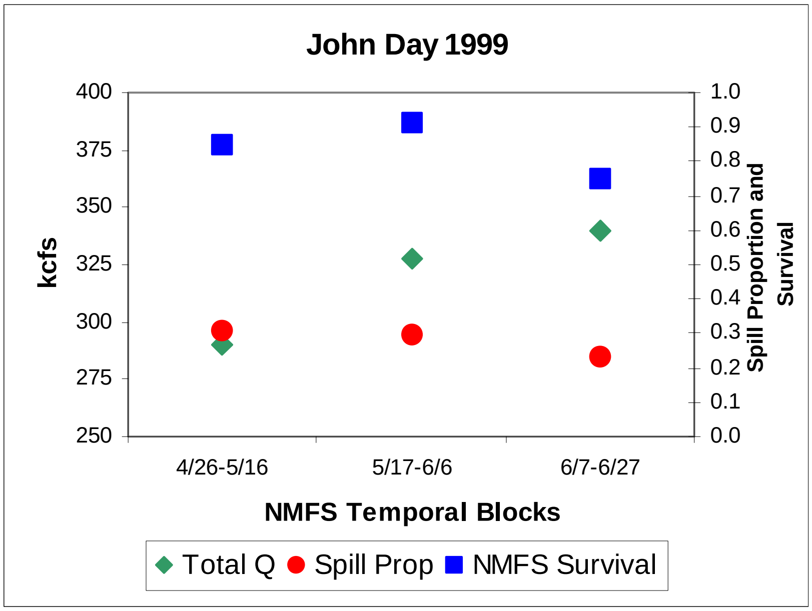

Figure 5b. Yearling Chinook Survivals MCN to JDA tailwater, Spill proportion at JDA, and Average Total Discharge at John Day during pre-spill, spill and post-spill blocks at JDA 1999.

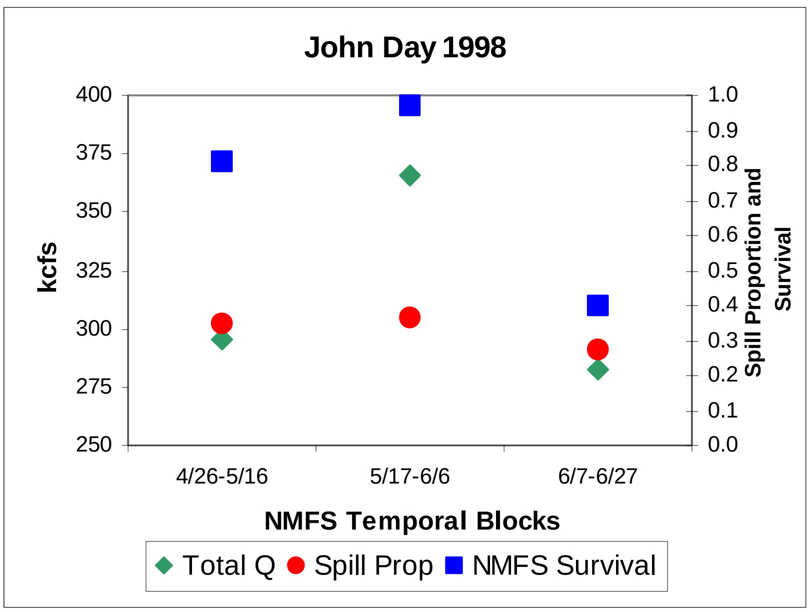

Figure 5c. Yearling Chinook Survivals MCN to JDA tailwater, Spill proportion at JDA, and Average Total Discharge at John Day during pre-spill, spill and post-spill blocks at JDA 1998.

Spill provides a parsimonious explanation for the improved survival seen at John Day Dam both in 2001 and other years. Spill provides the most benign route of passage at John Day Dam. The benefits of spill can be seen both in improved survival and decreased collection efficiency during spill (i.e. more fish passing through spill and less through turbines or bypass).

Role of Birds in Survival

NMFS, in their presentation to the NWPPC and IT, attributed the increased mortality observed in 2001 to increased avian (tern and pelican) predation. In their presentation they suggested that the increased mortality was due to greater water clarity making fish more vulnerable to predation.

NMFS focused on bird predation as the cause of poor survival in the Lower Snake, but in their annual report state, "The extended travel times experienced in 2001 may have contributed to poor survival of juvenile salmonids by lengthening their exposure time to predators and by extending their residence in reservoirs into periods with higher temperatures when predators are more active." In other words they link low flows to increased predation vulnerability or lower survival. Low flows result in lower turbidity, exposure to increased temperatures and increased travel time, essentiality increasing the predation vulnerability of migrant fish. NMFS provides the link between flow and poor survival in their annual report, but in their presentation fail to link the increased vulnerability to the flow. Fish don't die from traveling slow, they die from increased predation, disease, residualism or exposure to high temperatures for prolonged periods, or as a result of injury in passing through turbines or the cumulative effects of multiple bypass/turbine passage. Again NMFS neglects to explain the limitation of the survival estimation technique to allocating specific increments of mortality to any particular variable. NMFS infers that all of the variables that consolidate to result in a survival index are interdependent and that flow, travel time and predation do not interact.

SAR versus in-river survival comparison

In their presentation NMFS presents a 2.5% SAR for 1999 spring chinook outmigrants. It is unclear how this number was developed. The highest reported SAR value number previously reported by NMFS was under 2%. NMFS finds no relationship between in-river survival and SARs. They attribute increasing trend in returns over the last several years to improving ocean conditions. While adult returns are the highest observed in recent years during a time period of very favorable ocean conditions, based on recoveries of PIT-tagged groups the number of returns is still not sufficiently high ensure recovery of endangered species according to NMFS' calculations.

Research has shown considerable interaction between flow and survival in the estuary. Despite the high proportion of Snake River fish transported from the 2001 out-migration it is unlikely that significant numbers of adults will return from this migration year because of the estuarine conditions. Yet, NMFS stated in their presentation that, since over 90% of fish were transported in the Snake River, it will offset poor river conditions. This emphasis downplays the importance of conditions for in-river migrants, especially those from the Umatilla, Walla Walla, and John Day and other lower river stocks.

CONCLUSIONS

- All of the data collected in 2001 validates the need for and the benefits of implementation of the biological opinion flow and spill measures even in low run-off years. The preponderance of data indicates that the low flow and low spill levels resulted in extremely poor migration conditions and very poor survivals.
- NMFS inability to reach a definitive conclusion regarding the benefits of spill in 2001 is the result of their chosen statistical approach. Their own data shows an increase in survival with spill in 2001, NMFS chose not to discuss or address this point. NMFS ignored or neglected to address other tests, which indicate a benefit of spill. NMFS analysis does not disprove the conclusion that spill at John Day was beneficial.
- The NMFS "per-project survival approach" to evaluate the effect of flow and spill across years is not valid. It clearly overestimates survival. In addition historical freeze brand data is not directly comparable to present PIT tag data.
- NMFS own survival estimates show that survival was lower in 2001 than all recent years that PIT tag data is available.
- The survival estimation methodology does not allow the incremental allocation of survival to specific environmental variables.
- The source of the 2.5% smolt to adult return rate presented by NMFS is not presented.
- NMFS infers that the large proportion of fish transported will counteract the poor in-river survivals. This will await adult returns, however, available data to date indicates that transportation returns may not meet recovery goals for listed stocks.

Sincerely,

Michele DeHart

Michele DeHart
Fish Passage Center Manager