Review of the Bonneville Power Administration's analysis of the biological impacts of alternative summer spill operations

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Executive Summary

The Bonneville Power Administration is considering reducing or eliminating the summer spill program at the lower Columbia River dams, currently used to aid the migration of subyearling chinook. This consideration is based on an evaluation that uses a juvenile migration model, SIMPAS, as a means to assess the number of juvenile fish that are lost as spill levels decrease below levels prescribed in the Reasonable and Prudent Alternative (RPA) of the 2000 Biological Opinion on the Operation of the Federal Columbia River Power System (FCRPS). Upon review of the BPA spill analysis, I find that the proposal to reduce or eliminate the summer spill program is based upon inappropriate methods resulting in highly suspect results. The BPA analysis takes a dangerous approach by using a simple juvenile passage model to estimate the difference in the number of adults under different management scenarios. Adult numbers are compared against potential revenue gain to justify a management strategy. No context is given for the value of an adult fall chinook relative to the fall chinook populations or to management. This approach suggests that the rarer a species becomes the less mitigation strategies should be applied to ensure its survival. The uncertainties inherent in this analysis (e.g. survival estimates, smolt-to-adult return rates, benefits of offset mitigation, etc.) are not considered, thus the risks to the populations in question are not assessed placing the burden of proof once again on species in need of protection. The following observations of the BPA analysis are worth noting:

- **The use of SIMPAS model in the BPA analysis ignores the caveats providing by NOAAF who developed this tool.** The BPA approach is inappropriate because; the model cannot predict the likelihood of adult returns much less the absolute difference in the number of adult returns under subtle differences in management options; does not include sources of uncertainty, which are extremely large for subyealing chinook and thus no evaluation of risk is possible; the model is based on seasonal averages and thus does not include a time or seasonal component and cannot evaluate seasonal change in spill patterns as attempted in the analysis; the model is not mechanistic and cannot evaluate direct and indirect mortality by different routes of passage such as delay in the forebay, increased forebay predation and stress, and increased delayed mortality.
- **Results are highly dependent on stating juvenile numbers and smolt-to-adult return rates, which are likely too low.** This dependence is in large part due to the metric of choice to measure the benefits of an action (i.e. difference in absolute adult numbers). If juvenile numbers and SARs are based on recent or historic information (i.e. since the mid-1980s), then the benefits of spill are based on empirical information from a population before such a strategy was implemented. In essences this assumes no benefits exist to the prescribed mitigation efforts. This analysis assumes an estuary to Lower Granite SAR, but appears to use a Lower Granite to Lower Granite SAR. Review of past information suggests that a 4% estuary to Lower Granite SAR is at best moderate for a severely depressed stock (brood years 1985-1994). The 2%-6% Lower Granite to Lower Granite SAR goal described in the Mainstem amendments equates to a nearly 7%-20% estuary to Lower Granite SAR. An estuary to Lower Granite SAR of at least 10% appears more appropriate for this analysis.

- **The SIMPAS model does not include a D-value for mid-Columbia stocks transported from McNary Dam.** This assumes D is equal to 1.0. Based 1995 and 1996 coded wire tag studies, D is more likely around 0.5. This value needs to be included into SIMPAS when evaluating trade-offs between spill and transportation for mid-Columbia stocks.
- **The SIMPAS model suggests that ceasing transportation and providing a spring-like spill program in the summer provides large increases in adult numbers over current BiOp and no spill scenarios.** Using SIMPAS in the same manner as in the BPA analysis (but including a mid-Columbia River D value of 0.5) in this no transport/spring-like spill scenario suggests an increase of over 3,000 (or 6 times the 1985-1994 average) in Snake River fall chinook over the current BiOp RPA. For all stocks, the model predicts an increase of 44,000 and 139,000 adults over the BiOp and no spill scenarios, respectively. This increase benefit under a no transport scenario occurs because T/I ratios are less than 1.0 for subyearling chinook. Consistent with a spread-the-risk approach and RPA action 51, this argues for a spring-like spill program during the summer migration.
- **Benefits to offset mitigation are highly uncertain, optimistic, and untested.** The benefits to the predator removal programs applied when evaluating the RPA of the BiOp (NMFS 2000b) were likely much too high. These benefits are likely inflated because the maximum impact of the predator removal program occurred in 1996-1997 with a reduction and leveling off of 15% in later years, is implicitly included in the 1995-1999 PIT-tag survival estimates used in SIMPAS. The RPA then assumes an additional 10% predator mortality reduction on top of this maximum reduction. The assumed benefits to the predator removal program in the BiOp is likely greater than the combined gains estimated from the offset measures. BPA proposes to add additional gains to this inflated benefit. Also, (all) predator removal benefits fail to consider compensation from growth rates, and numeric and functional response by the predator community. Trading spill mitigation measures for even more uncertain and untested mitigation measures, places the burden of proof on populations already in need of further protection.

Introduction

The Bonneville Power Administration is considering reducing or eliminating the summer spill program at the lower Columbia River dams, currently used to aid the migration of subyearling chinook. This consideration is based on an evaluation that uses a juvenile migration model, SIMPAS, as a means to assess the number of juvenile fish that are lost as spill levels decrease below levels prescribed in the Reasonable and Prudent Alternative (RPA) management action of the 2000 Biological Opinion on the Operation of the Federal Columbia River Power System (FCRPS). The spreadsheet model used in this analysis is posted on the Technical Management Team website (www.nwd-wc.usace.army.mil/tmt/agendas/2004/0204.html). The number of juvenile fish that are lost under reduced or no spill scenarios are converted to the number of adults lost under a fixed smolt-to-adult survival rate and compared to the amount of revenue that could potentially be generated if the summer spill program were ceased. Alternative mitigation efforts are described as potential offsets to the losses expected based on the model exercise.

Benefits of spill

Spill has long been considered the safest and least stressful route of passage past a dam (NMFS 2000a, NMFS 2000b, Giorgi et al., 2002). Studies estimating survival through different routes of passage at a hydroproject indicate that the direct mortality is lowest through the spillways (NMFS 2000a, Giorgi et al., 2002). In addition, review of smolt-to-adult return rates (SARs) by different routes of passage suggests that a smolt's experience at a dam can affect the probability of surviving below the hydrosystem (Budy et al. 2003). For example, after correcting for direct mortality by the different routes of passages, estimates of SARs have been demonstrated to be higher for smolts that did not pass the dams through bypass/collection facilities, suggesting that the lower survival of the bypassed fish must have occurred after but as a result of their experience at the dam (Bouwes et al. 1999, Budy et al. 2003). The National Oceanic and Atmospheric Administration Fisheries (NOAAF) presents recent evidence to suggest that this pattern no longer exists (Williams et al. 2004), however this analysis fails to consider direct mortality differences by route of passage that can obscure the delayed mortality impacts. When these direct mortality impacts are accounted for, delayed mortality of fish not detected in the bypass systems appears greater than for smolts not detected (Petrosky personal communication). Non-detected smolts are comprised of smolts passing a dam through a combination of spillways and turbines. Because passage through the turbines has been demonstrated to be the passage route with the highest mortality, it stands to reason that spill survival is not only the route of passage with the least direct mortality but also the least delayed mortality.

Several mechanisms can explain these empirical survival benefits of passing a dam through the spillways over other passage routes. Hydroacoustic studies have demonstrated that in the absence of spill, juvenile salmonids are found milling in the forebays of dams (Giorgi et al. 1985, Sheer et al. 1997), particularly for subyearling chinook (Vendetti and Kraut 1999). When spill was provided, forebay delays were reduced. Predators have exploited this holding area for migrating juveniles, making the forebay one of highest areas of smolt losses to predation (Poe et al. 1991, Beamesderfer and Rieman 1991). During the summer months forebay temperatures can exceed lethal levels introducing greater stress and mortality in these areas for subyearling smolts (Coutant 1983). In addition, forebay delays can affect estuary arrival timing, resulting in delayed saltwater entry after physiological changes to deal with the saline environment have occurred. This introduces a whole host of problems for migrating smolts such as increases in susceptibility to predation and pathogens in the estuary (for review see Budy et al. 2002).

Adults, in addition to smolts may also realize the survival benefits through a spill program at the hydroprojects. Survival of adults has been shown to be higher for returning fall chinook during times of spill. These increases in survival are presumably a result of fallback occurring at the spillways rather than through the turbines where mechanical injury and mortality are much higher (NMFS 2000a). Based on this information and reasoning, the RPA of the 2000 FCRPS Biological Opinion (BiOp) calls for spring and summer spill programs to help provide the benefits to listed stocks needed to avoid jeopardy.

SIMPAS

SIMPAS is a spreadsheet model developed by the NOAAF used to describe the impact of the FCRPS on juvenile salmon and steelhead. The model is an effective tool for summarizing empirical information regarding the general impacts of the different routes of passage through the FCRPS on juvenile survival. The different routes of passage at a hydroproject include bypass/collections systems, spillways, and turbines. Smolts are divided into those migrating through the reservoirs and dams (in-river), and those placed in barges and trucks at collector project, transported and released below Bonneville Dam (transport). Passage survival rates are based on passage route specific studies where possible, and in-river survival estimates through the reservoirs and dams are based on PIT tag studies. The model is deterministic and does not include measures of uncertainty for parameter estimates. The model is also not mechanistic such that impacts of changes is environmental conditions are not possible.

All models have limitations, due to an attempt in balancing the qualities of a simple understandable approach with the adequate detail to evaluate goals. In the BiOp (Appendix D), NOAAF acknowledges the limitations of SIMPAS and offers the following ‘important’ caveats:

1. The juvenile survival rates … are based on juvenile passage studies only and cannot be used to infer the likelihood of adult returns.
2. The juvenile survival rates shown, as well as the input passage parameters, are point estimates, i.e., confidence intervals are not calculated or implied.
3. The model does not contain a time-step function, so both inputs and outputs are scaled to seasonal averages.

4. The model does not account for the potential effects of various fish passage options on forebay passage in terms of reducing delay, residence time, or predation.
5. Best professional judgment was used to develop some of the passage parameters, e.g., in some cases, fish passage data gathered at one dam during a single passage season were applied to several other similar hydrosystem projects.

BPA spill evaluation

BPA attempts to use the SIMPAS model to predict the changes, in some cases subtle changes, in the summer spill program on adult return numbers of fall Chinook in the Snake and Columbia River. The BPA analysis is an extension of the spill analysis conducted by the Northwest Power Planning Council (NPPC). I reviewed the BPA spill analysis spreadsheet provided on the TMT website. Because this spreadsheet only included values rather than formulas for the SIMPAS results, I also reviewed the SIMPAS spreadsheet analysis, which included model formulas, conducted by the NPPC. The BPA analysis used more recent estimates of survival rates over different routes of passage. A simple copy of the these modified inputs from BPA spreadsheet pasted into the NPPC spreadsheet, allowed for an exact replication of the SIMPAS survival rates produced in the BPA analysis. Other worksheets in the BPA spreadsheet evaluated changes in adult numbers over a greater complement of stocks then the NPPC analysis. The results of the NPPC spreadsheet could be pasted into the SIMPAS results worksheet of the BPA spreadsheet to estimate the changes to this larger complement of stocks to evaluate modifications to BPA analysis if needed.

After thorough review of the analysis provided BPA, I find the conclusions, which will presumably be used in the decision in the implementation of the spill program, to be highly questionable for several reasons.

The BPA analysis ignores NOAAF caveats of the SIMPAS model

Many of the deficiencies of the BPA analysis can be organized into the caveats provided in the BiOp of the SIMPAS model. The first caveat is extremely important in that the static juvenile model “cannot be used to infer the likelihood of adult returns” much less precise point estimates in the difference of return numbers expected under multiple scenarios of changes in spill timing and volume, as it used in the BPA analysis. The BPA analysis adds even greater uncertainties to the model by inputting an estimated number of subyearlings produced in the Columbia River Basin above Bonneville Dam (BON) and converting this number into adults over an assumed range of SARs.

There are several problems with using the SIMPAS model to estimate differences in adult returns. First, because the model is specific to the smolt life-stage the impacts to following life-stages cannot be evaluated. For example, spill can provide safer passage to adults by allowing fallback to occur over the spillway rather than through the turbines (NMFS 2000a). This could substantially change the value of spill but is not considered in this analysis because the same SAR is applied to all scenarios. Second, the experience of the smolt life-stage on subsequent survival can also not be addressed in the life-stage specific approach (see above description on delayed mortality). If delayed mortality is reduced by going through the spillway, as appears to be the case, then exclusion of this mechanism will result in an underestimate of the benefits of spill.

Third, using the number of returning adults is a highly suspect metric to determine the success of a recovery program because it does not provide a relative sense of what this means to decision making or to population persistence. Because this analysis compares potential loss of profit to the number of expected adults, a dollars per adult metric is advocated in this analysis. What is the dollars per adult threshold needed to make a decision about the spill program? Based on the highly negative relationship between of mitigation costs to adult returns in the Columbia Basin (Figure 1), it is clear the value of a fish is not constant and thus a context relevant to decision making is warranted. A reproductive adult of an endangered stock is worth considerably more than an adult of an abundant one. Is the production of 30,000 adult salmon from a non-listed population such as the Hanford stock, worth more than 100 adult salmon produced for the listed Snake River stock?

If a loss of 100 adult salmon was observed after removal of the spill program to the Snake River population, this could be significant given that population has been averaging about 500 adult spawners since the mid-1980s (Peters et al. 1999). However, a loss of 1,000 from a population averaging over 40,000 over the same time frame may not have a much of impact on the population persistence of the Hanford stock. To provide a context, this analysis should evaluate the benefits relative to population specific recovery goals, population growth rates, and/or probability of extinction.

In addition, the adult return metric is highly dependent on the assumed starting numbers of juveniles and the SARs used to convert these numbers to adults. These assumptions may be the most sensitive component of this analysis. The SAR assumed in this analysis will produce a proportional difference in the returning adult costs of alternative management actions. This analysis assumed a range of SARs, but these were considered constant for all alternatives. The 0.5%-4% range of SARs considered appears much too low. Because survival to salt water is estimated in SIMPAS, this analysis must apply an estuary-to-LGR SAR to convert juveniles into adults. Estuary-to-LGR SARs for Snake River fall chinook even between 1985-1994, during a time of severely depressed stock status, averaged around 2.7% and were as high of 6.5% (Peters et al. 1999). The NPPC interim objective of 2%-6% LGR-LGR SAR for Chinook and steelhead has been established in the Mainstem amendments. Assuming stocks achieve these goals an expected estuary-LGR SAR from the mitigation strategies outlined in the BiOp can be estimated. By applying a very optimistic assumption that survival from LGR to estuary will be doubled under the current BiOp, an estuary-LGR SARs of approximately 6.5%-20% for Snake River stocks would be expected. I cannot determine from where the values used in the BPA analysis were derived. If they were based on historic SARs, then I believe there is serious flaw in the logic applied to this analysis. Estimating the benefits of the current mitigation strategy by applying historic empirical information from a population before such a strategy has been realized or implemented, assumes no benefits exists. A range of 4% to 20% estuary-LGR SARs seems like a more reasonable assumption on which to base this analysis.

The same logic needs to be applied to the estimated number of juveniles produced. It is not clear if the number of juveniles used in the BPA analysis is assumed to have come from a depressed, current, or recovered population. If, for example, Snake River chinook were recovered based on the intent of the action agencies, we might expect to have greater than 2,500 returning adults (Peters et al. 1999), which will produce a much higher number of juveniles and therefore adults than a population that has been averaging around 500. A higher number of juveniles will produce a greater loss of adults under the no spill option relative to the BiOp spill program.

The second caveat, stating that SIMPAS inputs are only point estimates with no measure of uncertainty, is also germane to this analysis. This is even more problematic with fall chinook that have received relatively little research attention. Several of the input variables have not been estimated but rather are based on studies done at other project or on other species. For example, PATH assumed 90% turbine survival at many of the projects. While BPA has incorporated the latest point estimates, which generally has demonstrated that these PATH turbines survival estimates were optimistic, not all project and passage specific survival rates have been evaluated. Reach survival estimates based on PIT-tags are highly variable suggesting that complex interactions between release groups and their environments may not be captured in a highly simplistic model.

The D value, a critical uncertainty, used for the Snake River stock in this analysis is based on PATH estimates, which were highly variable (note: no D value was applied to mid-Columbia stocks transported from MCN, which assumes D=1.0). The D values derived in PATH using information specific to Snake River stocks were D=0.24 based on PIT-tags (the valued used in this analysis) and D=0.02 to 0.05 based on spawner/recruit data (Peters et al. 1999). This lower D value could have profound implications on model results as the benefits of transportation will be much lower. Because the uncertainty in these and other variable values has not been considered, the risks involved with the various strategies are not evaluated in this analysis. Even more problematic are that uncertainties in the largely untested offsets actions. A sensible first step to this problem would be to conduct a sensitivity analysis based on the range of values observed in the empirical information. Weighting the different scenarios based on evidence and theory would help describe the inherent risks of alternative management actions. In addition, studies, such as estimating the benefits of alternative management strategies, should be conducted before altering a mitigation strategy with demonstrated gains, else this puts the burden of proof on the species in question.

The third caveat explains that SIMPAS is not a seasonally dynamic model. This analysis attempts to evaluate the impacts of turning off spill over different portions of the season using seasonal average values. This could be quite problematic as this analysis makes no attempt to describe the possible mechanisms producing intra-seasonal differences. For example, non-spill options may be more detrimental to smolts later in the season as temperature problems in the forebay become more pronounced. As stated above, spill reduces time in the forebay and therefore exposure to higher temperatures that increases the energetic demand for both smolts and their predators. This may also result in more stressful conditions for transported smolts reducing the effectiveness of the transportation program.

The forth caveat as with the third further warns that this model is not mechanistic and therefore cannot handle indirect effects associated with different routes of passage. The mechanisms of why spill has direct and indirect benefits are discussed above. These ecological considerations are often given as rationalization for providing spill (NMFS 2000a, 2000b), yet this reasoning is largely ignored in this analysis.

The fifth caveat indicates that definitive research has not been conducted for several aspects of the model. This is particularly problematic for fall chinook due the relatively little research conducted on these stocks. These potential problems were discussed under the second caveat.

<u>Specific comments on the BPA spreadsheet analysis</u>

I reviewed the model structure and equations used to evaluate survival rates under the different routes of passage. Below is a list of the potential errors and problems I have noted.

-- There appears to be a mistake in the estimate of the Total to Salt Survival that includes an estimate of D (SIMPAS results page, column O). The cumulative survival of the proportion transported is based on a 3 collector project scenario (LGR, LGS, LMN) whereas the in-river proportional survival is based on a 4 collector project scenario where McNary dam is included. This mistake was made in the NPPC SIMPAS spreadsheet as well. Correction of this problem has a small impact on the results of the BPA analysis.

-- No D value is applied to mid-Columbia smolts transported from MCN. By default this assumes D = 1.0. Based on presentations by Bill Muir and Steve Smith to the ISAB, and on information in the recent white papers (figures 20 and 21 in Williams et al. 2003), the most relevant (under the 1995 BiOp conditions) and best estimates of transport SARs to in-river SARs (T/I) on mid-Columbia fall chinook transported at MCN, are derived from coded wire tag studies conducted in 1995 and 1996. In 1995 and 1996, 133, 663 and 146,658 transport fish and 166,266 and 182,289, inriver fish, respectively, were tagged and released above MCN. Results from this study suggest that in 1995 T/I = 0.9 and in 1996 T/I = 1.21, producing a geometric mean of both years of 1.04. SIMPAS was used to estimate survival from MCN pool to BON tailrace where $V_C = 0.47$, $V_T = 0.98$ so that $D = T/I * V_C/V_T$ or $D = 1.04 * 0.47/0.98 = 0.50$.

Given the low D estimates for the Snake River stocks, this result is not too surprising. The benefits from transportation at MCN are expected to be lower because the smolts are only circumventing 4 dams rather than 8 dams, as in the case of Snake River fish. One might expect a D value less than 0.24, however mid-Columbia stocks experience different environmental conditions making this comparison difficult. A D value of 0.50 was added to the SIMPAS model for mid-Columbia smolts arriving at MCN.

-- As discussed above the 0.5% - 4% range in SARs (2% appears to be the value the main conclusions were drawn from) used in the BPA analysis appears low for a estuary-LGR SAR based on past data and current goals. I cannot determine from where the values used in the BPA analysis were derived. Even during a time of severely depressed stock status the average estuary-LGR SARs for Snake River fall chinook between 1985-1994 was around 2.7% and was as high 6.5% (Peters et al. 1999). However, this analysis should not assess the benefit of a mitigation strategy based on information before such a strategy was in place. The NPPC interim objective of 2%-6% LGR-LGR SAR for chinook and steelhead has been established in the Mainstem amendments. By applying a very optimistic assumption that survival from LGR to estuary will be doubled under the current BiOp, an estuary-LGR SAR of approximately 6.5%-20% for Snake River stocks would be expected. Therefore, in addition to the modest 0.5%-4% evaluated by BPA, I included a 10% estuary to the furthest upstream dam SAR as a modest upper bound.

Alternative scenario

Using the above modifications to the SIMPAS model (the addition of a mid-Columbia D value and a corrected estimate of Total to Salt Survival), I estimated the benefits from one more alternative scenario not evaluated in the BPA analysis. Using the SIMPAS model, I evaluated a scenario in which the BiOp spring spill program was applied to the summer. Nighttime spills were modified at LGR, LGS, LMN, MCN, JDA so that spill was 31, 31, 31, 135, 111 kcfs, respectively. Daytime spill was modified at LMN to 31 kcfs. All other spills volumes were left as described in the BiOp spill scenario in the BPA analysis spreadsheet located on the TMT website. In addition, I assumed all transportation was discontinued at all collector projects (i.e. total survival is equal to the cumulative in-river survival to saltwater). Difference in juvenile numbers between the BiOp and no spill (BPA analysis) and no transportation (alternative scenario) scenarios were converted to adult numbers using SARs of 2%, 4%, and 10%. The results are displayed in Table 2.

The basic result of the analysis suggests that there is a large benefit of ceasing all transportation and increasing spill in the summer time. Model results suggest an increase of more than 3,000 listed Snake River adults over the current BiOp (under a more reasonable assumption of 10% SAR) will occur under this management alternative (Table 2). Considering this increase alone is over 6 times the early 1990 adult return and meets or exceeds the lower recovery goal of this population, the benefits of this scenario are tremendous. The no spill option resulted in a systemwide loss of nearly 38,000 and 95,000 adults under 4% and 10% SARs, respectively, as compared to the BiOp spill program. The total return under the no transport option is nearly 44,000 and 139,000 adults **greater** than the BiOp and no spill scenarios, respectively, under a 10% SAR (Table 2).

This increased benefit under the no transport option occurs because the survival through transportation as described by SIMPAS equals survival to the collector project * survival to the barge * D, which is lower than survival if smolts migrated through all projects. In other words, the T/I for both Snake River and mid-Columbia fall chinook is less than 1.0. T/Is of approximately 1.0 are now observed without the benefits of increased spill so this result is not unexpected. In the recent white papers, Willams et al. (2003) state results are uncertain but so far suggest that "…transportation of fall chinook neither greatly harms nor helps the fish, and thus transportation is consistent with a 'spread the risk' strategy." Actually, current operations are not consistent with the 'spread the risk' type of strategy applied to yearling chinook in the spring, because spill at the Snake River collector projects does not occur during the summer migration, therefore maximizing transportation.

Action 51 of the RPA described in the BiOp states "If results of Snake River studies indicate that survival of juvenile salmon and steelhead collected and transported during any segment of the juvenile migration (i.e., before May 1) is no better than the survival of juvenile salmon that migrate inriver, the Corps and BPA, in coordination with NMFS through the annual planning process, shall identify and implement appropriate measures to optimize inriver passage at the collector dams during those periods." BPA is actually suggesting a strategy in an opposite direction of this action based on their SIMPAS analysis. Results from the alternative scenario, more consistent with this action, suggest much could be gained through implementation of a no transport approach.

I do not place much faith in these SIMPAS analyses for the reasons I described above. Results are based on highly uncertain inputs. The SIMPAS model does suggest, as do the limited studies, that transportation may provide no benefit to migrating in-river. This also appears to be the case for spring migrants (Sandford and Smith 2002, Berggern 2003), which has lead to a spread-the-risk approach. Because these results are even more uncertain for fall chinook, the spread-the-risk approach applied to spring migrants appears equally or more applicable to fall migrants.

Offset mitigation

BPA offers alternative mitigations strategies, although hardly novel, to offset the loss of expected adult returns by reducing summer spill. Most of these strategies have not been tested and are therefore highly uncertain. Trading spill mitigation measures for even more uncertain and untested mitigation measures, places the burden of proof on populations already in need of further protection. A true adaptive management approach should be applied, by implementing these offset actions in conjunction with the spill program, and if it can be demonstrated that the necessary benefits to lead to recovery has occurred as a result of these offsets then, relax spill and evaluate the impacts.

BPA suggests that added survival benefits can be expected by increasing the removal efforts of northern pikeminnows, the major predator of migrating smolts. BPA indicates that by increasing bounties a decrease in pikeminnow predation on subyearlings resulting in increased adult fall chinook returns is expected. Previous predator reductions were estimated by ODFW and were based on detailed tagging studies to provide exploitation rates by size class. These exploitation rates were used in the Plan for Analyzing and Testing Hypotheses (PATH) and are reported in Peters et al. (1999). The BPA analysis simply assumes these exploitation rates can be increased without thorough analyses like those conducted by ODFW. The exploitation rates of pikeminnows from the removal program peaked in 1996 and 1997, then decreased and were projected to level off at approximately 15% mortality associated with these predators (Figure 2; note: review of the Friesen and Ward analyses by Schaller and Ward during the PATH revealed a miscalculation producing the 25% reduction in mortality, this is why NMFS used the estimates reported in PATH for the BiOp rather than Friesen and Ward). The leveling off in exploitation rates may partially be explained by the fact that a majority of the pikeminnows were removed by a very small percentage of the individuals participating in the program as it became less novel. Therefore, more experts, not just participants, have to be recruited into this program.

The PIT-tag estimates used to describe survival in the SIMPAS model were estimated during this peak time of the predator exploitation rates. Thus, the maximum benefits expected by BPA of the predator removal program are already included in SIMPAS. The BiOp then assumes a 10% additional decrease in the predator mortality, even though the SIMPAS analysis already implicitly included the maximum benefits expected from the predator removal program. Thus, the BiOp has double counted for the benefits of the predator removal program. This is a flaw in the BiOp that overestimates the expected survival improvements from the RPA, which is likely inadequate to achieve recovery of Snake River fall chinook (Table 1). This double counting of the improvements to predator removal program in the BiOp is likely greater the combined impact of all strategies proposed as offset mitigation in the BPA analysis. Thus, not only is BPA proposing a mitigation effort already in place, the assumed benefits are greatly overestimated.

An alternative of 0% predator reduction was explored in PATH because compensation in growth rates, numeric, and functional responses of pikeminnows and other predators may occur, as is commonly witnessed in other systems. For example, Peterson et al. (1999) found that proportion of salmonids found in the stomach of smallmouth bass in the Hanford reach was greater than the proportion found in Snake River smallmouth bass stomachs, where smallmouth bass were more common. They attributed this to the greater availability of prey per predator in the Hanford reach. This suggests that compensation in predation rates as prey per predator increases may result in much smaller benefits to predator reductions. This uncertainty is not explored in the BPA analysis, but applies to all the predator reduction programs included in the offset mitigation strategies.

The greatest concern I have with the offsite mitigation measures is that they are largely untested and are simply assumed to occur. I defer to comments provided by the USFWS on changes in Hanford stranding strategies and changes in exploitation rates in the BPA analysis since they capture my main and further concerns. These offset measures are offered as mitigation due to loss of adults expected from reducing spill, which is already a mitigation effort imposed to help offset the losses due to operation of the hydrosystem. The current hydrosystem mitigation efforts are not enough to compensate for survival improvements needed to prevent the hydrosystem from jeopardizing the survival and recovery of certain fall chinook stocks. Thus, these offset mitigation strategies should be put forth as additional measures rather than exchange for current strategies to ensure the recovery of listed stocks and the conservation of remaining stocks.

Table 7. Fraction of survival increase needed to achieve recovery target that is expected from the proposed action, the Hydro component of the RPA, and the offsite mitigation component of the RPA (from Peters et al. 2001).

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
ESU	**% Survival Improvement Required to Achieve Recovery**	**% Survival improvement expected from**			**% Survival Improvement required from Non-Hydro RPA**	**Fraction of Required Survival Improvement**		
		Proposed Action (PA)	**Hydro RPA**	**PA+ Hydro**		**PA**	**Hydro RPA**	**Non-Hydro RPA**
Lowest estimate of survival improvement required from Non-Hydro RPA								
Snake River fall chinook	72	63	23	86	0	0.88	0.32	0.00
Highest estimate of survival improvement required from Non-Hydro RPA								
Snake River fall chinook	114	31	18	49	65	0.27	0.16	0.57

Column Notes:

A. % increase in base period survival rate required to achieve 48-year recovery standard (for stocks with defined recovery escapement thresholds) or lambda=1.0 (for stocks without recovery thresholds). Values are from BiOp Table A.4 and A.6.

B. Values are from BiOp Tables 6.3-1 to 6.3-11.

C. expected survival improvements from the Hydro RPA were not provided separately in the BiOp, so we calculated these values as Column D – Column B.

D. Values are taken from BiOp Tables 9.7-6 to 9.7-16.

Table 2: Difference in numbers of adults produced under different scenarios relative to the BiOp spill program estimated from a BPA type analysis using the SIMPAS passage model. The scenarios include the BiOp spill and no summer spill scenarios of the BPA analysis, and an alternative no transport/spring-like spill during the summer scenario.

	BiOp spill	no spill (July- August)	no transport (spring-like spill)	Difference between no transport and no spill
Listed Snake River Stocks				
# of juveniles difference from BiOp spill	0	-1287	30,037	31,324
difference converted to adults with 2% SAR	0	-26	601	626
difference converted to adults with 4% SAR	0	-51	1201	1,253
difference converted to adults with 10% SAR	0	-129	3,004	3,132
All stocks				
# of juveniles difference from BiOp spill	0	-948623	437,589	1,386,211
difference converted to adults with 2% SAR	0	-18972	8,752	27,724
difference converted to adults with 4% SAR	0	-37945	17,504	55,448
difference converted to adults with 10% SAR	0	-94862	43,759	138,621

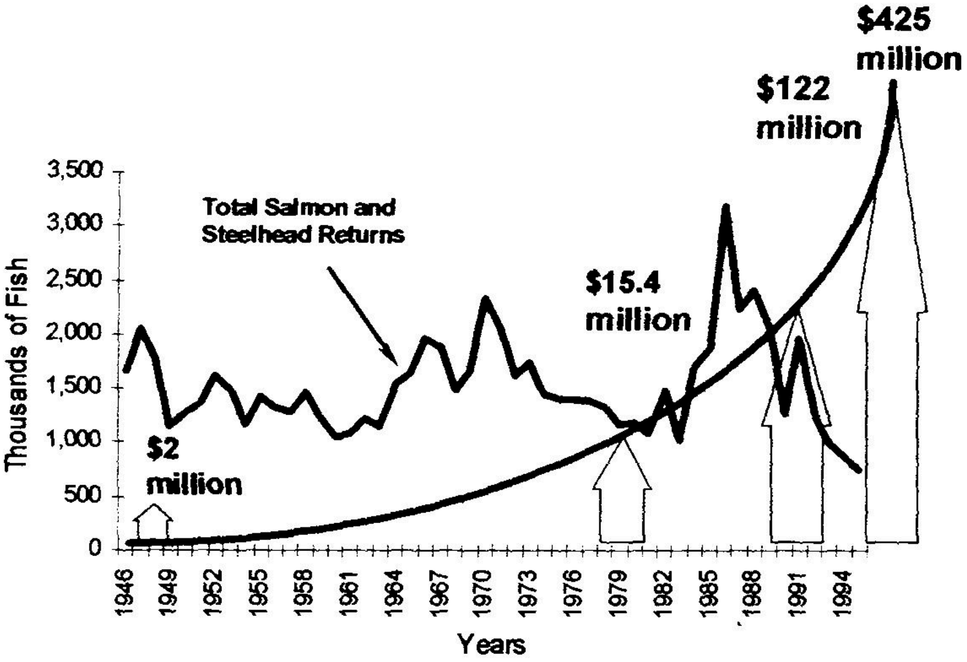

Figure 1: The estimated amount of money spent on mitigation and the estimated number of returning hatchery and wild salmon and steelhead in the Columbia River Basin (from Licatowich 1999).

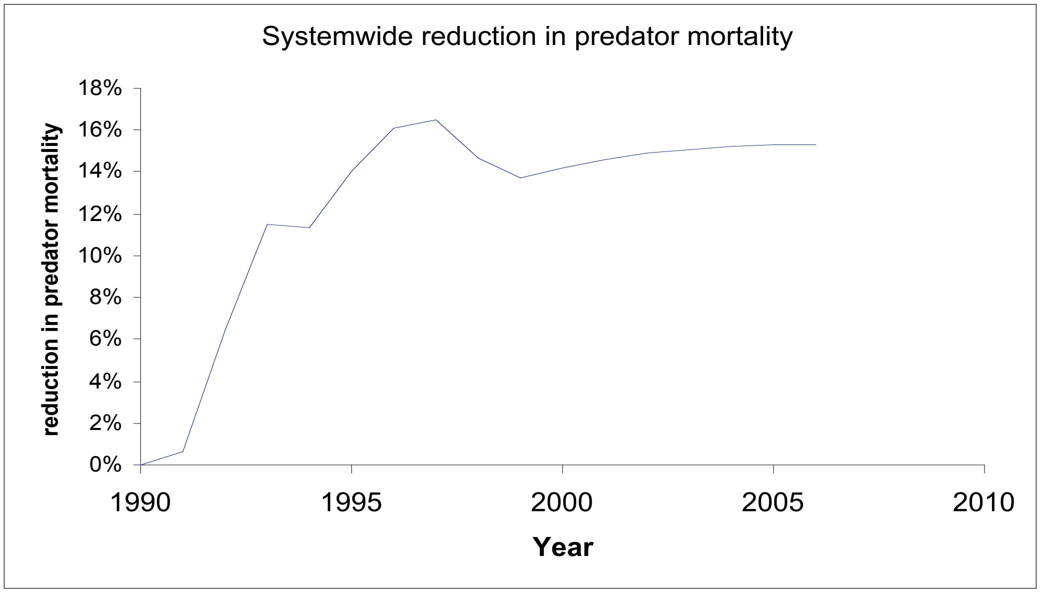

Figure 2: Estimated reduction (reduction relative to pre-1991 levels) in predator mortality due to the Northern Pikeminnow harvest management program. Predation is estimated for age 5-16 year old pikeminnow. The mortality reduction estimates are for the mean total pikeminnow exploitation rate estimates (reproduced from Peters et al. 1999).

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