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ADF&G response to peer reviewer comments on the December 26, 2012 draft of "Run reconstruction, spawner-recruit analysis, and escapement goal recommendation for late-run Chinook salmon in the Kenai River" by S. J. Fleischman and T. R. McKinley.

The draft report was provided to five fisheries professionals, two from within ADF&G who were not part of the escapement goal review for this stock and three external to ADF&G. We received peer review comments from both ADF&G reviewers and one of the external reviewers. The two external reviewers who provided no comments stated during initial contact they were extremely busy, but willing to review the report. They were ultimately unable to review the report within the timeline given.

Reviewer 1, Comment 1: The recommended goal range (15,000-30,000) is strikingly low relative to the estimated historical escapements. The lower bound is lower than any estimated previous escapement, while the midpoint itself is lower than anything seen before 2009. Even the upper bound of the goal range is below more than half of the estimated escapements. This assessment implies that the stock has been greatly under harvested in the past.

The recommended goal appears to be an interim measure, awaiting an improved and longer time series of DIDSON-based counts of escapement. Reflecting this interim quality, the goal range is termed an SEG. Other qualitative methods for setting SEGs exist, often based on maintaining escapements in the (usually) upper end of historical values. They would be problematic to apply, as indices of escapement are either short or unreliable.

However, examining the two short indices also suggests that the recommended goal range is below historical averages. As current DIDSON counts miss Chinook by a factor of 1.3, the recommended goal range translates to DIDSON counts of 11,500 to 23,000, with a median of 17,300. This is well below the counts of 19,000, 21,000, and 22,000 recorded in the last three years. In addition, the short time series of mark-recapture estimates were below average in this same period, suggesting that if DIDSON had been deployed prior to 2010 counts would have been even higher.

This discrepancy between the recommended goal range and historical escapements needs to be explained. Either the stock has been routinely under harvested, or there are issues (methodological or data-related) with the assessment. This is the "elephant in the room".

Discussion of these issues is scattered throughout. A couple of statements caught my attention. The lower bound of the recommended escapement goal range was set above what a straightforward interpretation of the assessment might suggest, an ad hoc adjustment to increase stock safety (p. 16). The rationale for the adjustment and the size of the adjustment should be given. The discussion also notes that the lower bound is below the lowest escapement ever seen, reducing the likelihood that fisheries would be restricted (p. 16). However, the same could be said for a lower bound of zero. The discussion should be refocused on the credibility of the assessment methodology and other evidence that historical escapements were unnecessarily high.

If the assessment is trustworthy, there are allocative issues involved in a large reduction of the escapement goal that are squarely in the purview of the Board of Fisheries. The lower goals would most likely result in less frequent restrictions on commercial fisheries, but reduce the catch rate in in-river sport fisheries. This is likely to be a contentious decision, and it would be quite helpful if any doubts about the reliability of the BEG implied by the assessment were settled first, as they are likely to get muddled with the policy arguments.

ADF&G Response: In the final version of the report (Fleischman and McKinley 2013, herein referred to as the final report), we attempted to bolster the corroboration of reconstructed estimates of run size by running the model with different assumptions relative to the run size indices and independent estimates of abundance. Modeled run sizes were relatively insensitive to the assumptions we made, so we concluded that the modeled abundances were robust estimates of run size that could be used in the stock-recruitment analysis (SRA). We added and clarified text in the final report, devoting a section of the discussion section to remaining uncertainties, pointing out the need to continue to estimate run size independently of the DIDSON to evaluate the proportion of fish missed by the DIDSON at the RM 9 site. While the recommended interim escapement goal (15,000 – 30,000 fish) appears numerically lower than the current escapement goal for this stock (17,800 – 35,700 fish), the recommendation is consistent with the Policy for the Management of Sustainable Salmon Fisheries (Title 5 of the Alaska Administrative Code, Chapter 39.222) in that it attempts to include escapements that have a high probability of producing maximum sustained yield (MSY). In the final report we also attempted to clarify the rationale for the recommended interim escapement goal in terms of probabilities of producing MSY, as well as probabilities of avoiding overfishing with respect to achieving MSY (Figure 8 of the final report). Although the reconstructed stock is "under harvested" with respect to producing MSY, realized harvest rates average nearly 40%, indicating a moderately exploited stock that has not been overfished. We agree that the Board of Fisheries is responsible for addressing the allocative impacts to fisheries that might occur due to implementation of the interim escapement goal recommendation.

Reviewer 1, Comment 2: There are no obvious problems with the assessment methodology; in fact, it contains several advanced assessment features that sensibly incorporate uncertainty. ADF&G biometricians have been updating their methodologies in the last few years. These new methods account for many of the problematic features of stock-recruitment data sets, including time series bias, evolution of the productivity of the stock, etc. In addition, this particular analysis deals sensibly with incorporating several imperfect indices of return size, neither ignoring them nor treating them as absolutely reliable. Sensitivity to a couple of key assumptions is assessed. The analysis also includes a methodology to incorporate the unavoidable uncertainty in the estimate of the stock-recruitment relationship. An algorithm is used to pick escapement goals that are robust to the range of plausible stock-recruitment relationships.

However, related Bayesian methods have been found problematic, particularly in the translation of the Bayesian posterior into policy recommendations. For instance, using expected yield as the objective results in unrealistically high escapement goal recommendations. On the surface, using a high probability of achieving near-MSY harvests seems sensible, but unforeseen complications are a possibility.

The performance of this procedure, both the creation of the posterior distribution from the data, and the %MSY criterion for translating the posterior into a goal range, should be tested. A management strategy evaluation would be a first step to determine how the methodology works in principle, using noisy but unbiased simulated stock-recruitment data. Next, issues with data quality could be incorporated into the evaluation, to test the robustness of the procedure. The particular situation of the data available to Kenai Chinook could be explored.

To make these simulations most applicable to decision makers, it would be helpful to include other performance measures in the simulations in addition to MSY. The expected frequency of restrictions on the various user groups would be particularly useful.

These new assessment procedures should be documented in a peer-reviewed scientific journal; they definitely merit it. The biometricians' work should be acknowledged to a wider audience, and the process of external peer review would serve to validate these new methodologies.

ADF&G Response: We agree that a management strategy evaluation (MSE) approach (Jones and Volk 2011) is a sensible next step for the Kenai River late-run Chinook salmon stock. The MSE would provide the ability to evaluate harvest policy performance with respect to yield, frequency of fishery restrictions, and other objectives. The current analysis is a necessary pre-cursor to this work, because it supplies information on stock productivity and capacity directly into the MSE simulations.

Although progress in science always involves "unforeseen complications", our Bayesian state-space formulation of SRA is not "brand new". It was first developed in 2003 and has now been applied to more than a dozen Alaska salmon stocks. We recognize that the methodology is more complex and thus more difficult to explain and to understand. However, for every application (including this one), it has been found to provide sensible results compared to more traditional methods of SRA. A partial list of other related analyses is referenced on pages 10 and 11 of the final report. On pages 18 and 19 of the final report we compare the recommended goal with those from 5 other Chinook salmon stocks.

A peer-reviewed journal article (Fleischman et al. in press) has been accepted and currently appears on the "Just-in" page of the Canadian Journal of Fisheries and Aquatic Science website (subscriber-only access at http://www.nrcresearchpress.com/toc/cjfas/0/ja). The CJFAS article was reviewed by Dr. Randall Peterman of Simon Fraser University, as well as 2 anonymous referees. The advantages of our analysis method are fully discussed in the article, and are also summarized on page 10 of the final report.

Reviewer 1, Comment 3: To proceed with this recommendation, ADF&G needs to be able to confidently assert that prior escapements have been higher than necessary and that harvest rates have been lower than the stock could have supported. It would be very helpful to see support for such assertions outside of the evidence from the modeling of escapement and total return data. For example, are the densities of Chinook on their spawning grounds unusually high? How would the goal of 22,500 fish in a watershed the size of the Kenai compare with spawner densities implied by goals for other Chinook stocks?

ADF&G Response: We are confident that the run reconstruction in the final report has more accurately portrayed the time series of runs sizes and realized escapements than the previous assessments based on target-strength based methods. Relative to all other indicators of run size based directly on observations of Chinook salmon abundance (e.g., netting catch rates, recreational fishery catch rates, capture-recapture estimates of run size), the target-strength based assessment tended to significantly underestimate large runs (1992, 1998, 2001-2006). This resulted in very little contrast in apparent escapements (see McKinley and Fleischman 2010, Figure 11), under representing the underlying variation in escapements relative to the current escapement goal of 17,800 – 35,700 fish.

Reviewer 1, Comment 4: The department's methodology for estimating a BEG is probably the best that could be done given the limitations of the data. The escapement and total return data available for assessing the Chinook escapement goals have undergone a major revision recently. Prior estimates have been found to be problematic, and the newer more reliable DIDSON counts span only three years. In the near future DIDSON technology and genetic assessments of the harvests will result in a rapid accumulation of reliable stock and recruitment data. It is probably due to the data quality issues that the results of the current assessment are termed an SEG rather than a BEG.

A higher SEG could be justified based on the criteria of maintaining escapements at historical levels, which have resulted in a sustainable fishery. An SEG could be based on the few available DIDSON counts and mark-recapture estimates, or the estimated time series of historical escapements from the new assessment, or some combination of the available historical data. Because high quality data are currently sparse and this situation is rapidly improving, this might be a better alternative in the short term.

ADF&G Response: We agree that the methodology used in the final report to develop the recommended interim escapement goal is the best available in terms of incorporating uncertainty in run reconstruction into the escapement goal analysis. We investigated using the DIDSON-based assessments from 2010 onward to develop an SEG, but abandoned this approach in favor of the methods used in the final report. We also investigated the sensitivity of the results of the SRA to use of only the 2002-2012 brood years, where all indices of abundance are available (see Table 5, alternate configuration 5) and this tended to lower estimates of the management parameters, not increase them. The method used in the final report is the preferred approach for developing an escapement goal. This method utilizes knowledge of the production capabilities of the stock, rather than utilizing *ad hoc* approaches that maintain an arbitrary level of observed escapements independent of the production capability of the stock. The interim escapement goal recommendation is based on production data from the reconstructed runs and represents our best attempt to develop an escapement goal based on high probabilities of achieving the fishery objective of MSY.

Reviewer 2, Comment 1: In the abstract, the meat of your results is very clear; the escapement goal and how it will be evaluated. The correction factor for undetected fish behind the sonar is explicitly stated as a 1.31 expansion, but it's hard to figure out where this key value came from. It is mentioned again on page 15 and I assume it comes from a comparison of in-river M/R estimates to pMR (the two paired estimates in Table 3), but it's not really clear how we got there. Given that this is a key metric for evaluating escapement goal performance, I think we should clearly explain its origin and our confidence in the estimate.

ADF&G Response: We agree that it was unclear how the correction factor was estimated and have provided clarifying text on estimation of the expansion factor and it's use on pages 9 and 14 of the final report.

Reviewer 2, Comment 2: Along the same lines, sport harvests and catch/release mortality would be subtracted from the expanded sonar estimate. But, what is the source of catch and release mortality data that is used to estimate this for sport fish harvests above the sonar? I see from Table 1 that the numbers are not typically large, and perhaps a footnote reference here would help, along with a quick sentence to say something about how those mortalities were determined. I know that estimation of catch and release mortality is potentially tricky business. And if we are estimating C/R mortality upstream of RM 9, what about that below the sonar? There may be an obvious explanation but perhaps we should say what it is.

ADF&G Response: We included text on page 5 of the final report that details how catch-and-release mortality was estimated and applied to the assessment.

Reviewer 2, Comment 3: There is a single sentence suggesting, based on experience, that the model is insensitive to the choice of CV for harvests below RM 9, yet the point is made at the outset in methods that this is a necessary piece of information for the analysis. This is not necessarily a contradiction but it may be worthwhile to explain this a bit more. It's hard to know exactly what this means and where the choice of CV does become an issue.

ADF&G Response: We clarified the use of an assumed coefficient of variation (CV) of 0.15 for harvests below RM 9 on page 5 of the final report. We also conducted sensitivity analyses (Table 5, alternate configuration 3), using a CV of 0.10 and 0.20 for harvests below RM 9. We believe these values of CV are realistic given our knowledge of measuring harvest in the various fisheries. These sensitivity analyses did not materially affect the recommended interim escapement goal. We also conducted sensitivity analyses (Table 5, alternate configuration 4), ranging the contributions of minor fisheries (commercial drift, marine recreational) from zero to 100% to the Kenai River late-run stock. These sensitivity analyses did not materially affect the recommended interim escapement goal.

Reviewer 2, Comment 4: Marine sport and commercial drift harvest is clearly not the largest part of marine harvest but it sometimes represents 50% and frequently exceeds 20% (Table 1). Based on results of the ESSN genetics study and the proximity at least of the marine sport fishery, what is the impact of the assumption that all of this harvest is late run Kenai? It seems to me that the genetics results for ESSN are important prior information that could be used to make a more reasonable assumption of composition for the sport fishery. I am wondering what impact that assumption may have on the analysis. I think we should at least address the issue and consider whether ESSN results could reasonably inform the marine harvest data. Also note that the hatch mark legends for figure 1 do not correspond well with the ellipses in the figure.

ADF&G Response: We corrected the graphics in Figure 1 of the final report. As indicated earlier, we conducted sensitivity analyses (Table 5, alternate configuration 4), ranging the contributions of minor fisheries (commercial drift, marine recreational) from zero to 100% to the Kenai River late-run stock. These sensitivity analyses did not materially affect the recommended interim escapement goal.

Reviewer 2, Comment 5: It is never really made clear (in the introduction I would think) why we are creating an interim escapement goal based on DIDSON at RM 9 in 2013, knowing that the sonar site will be moved and the goal re-evaluated. Lots of improvements to stock assessment at the sonar site have been made since 2002, and the escapement goal type was changed in 2011 because TS based estimates were found to be inaccurate, something suspected since Burwen et al, 1998. But we are still left with a stock assessment site with major problems in terms of fish migrating outside the ensonified area and it's not clear how much we know about that issue. Our best estimate is that we may be missing 30% of the fish. I think we should try to be clear about why we are pursuing this specific goal and how our stock assessment capabilities mesh with that.

ADF&G Response: We attempted to clarify the immediate need for an interim escapement goal in the final report. We clarified and added text in the Introduction section of the final report to better describe the problems at the RM 9 site and steps to remedy the problems.

Reviewer 2, Comment 6: I am curious about the elimination of age 3 fish from the analysis. The only additional information offered is that they represent a very small proportion of total run. But, this appears equally true for age 7 fish, just scanning table 1. Personally, I think there is some wisdom in crafting King salmon escapement goals based on larger fish like SEAK does. Does the elimination of age 3 fish in this analysis imply that we have a goal based on older (larger) fish? Sorry if that's an ignorant question, but I suspect others will have it and we should make mention of this analysis approach which is dismissed pretty quickly.

ADF&G Response: We agree that we needed to be clearer about what was done with age 3 fish in the draft analysis as this confused others on what ages were included in our analysis. We did include numbers of age 3 fish in the draft analysis, but did not use the age composition data from age 3 fish in constructing the brood table. This was an oversight on our part. In the final report we included numbers and age composition of all fish (age 3 and older) in the analysis. The recommended interim escapement goal is for all fish, regardless of age.

Reviewer 2, Comment 7: The DIDSON estimates over three years are viewed as preliminary and it is noted in the table that they could change. The reference for the preliminary data is in preparation. The only thing to recognize here from readers' standpoint is that a critical anchoring data source for the goal may change at some unknown time. Can we provide some confidence that we are simply waiting for this and the genetics results to be published and we don't expect big changes?

ADF&G Response: We indicated in the final report that the analyses of DIDSON counts and genetics-based capture-recapture (CRGEN) estimates are preliminary with respect to their status prior to publication, but will likely not change materially at publication. We also added an appendix in the final report (Appendix D) that describes the CRGEN estimation methods.

Reviewer 2, Comment 8: A critical assumption in the analysis is that telemetry and genetic M/R estimates are unbiased and the comment is made that while they are probably biased, authors don't believe they are biased much. The justification for this is that the seven measures are more or less in agreement and generally consistent with limited pMR (page 14, Miller et al in prep). I am having trouble with this. I believe the data for this would be in Table 3. I see the seven M/R estimates, but how is it that seven estimates done in different years can be judged to be mainly in agreement? What am I missing? Also, there are only two years when we can evaluate consistency with pMR from table 3 (2010 and 2011). In one case they are spot on; in another the M/R is 50% higher. I apologize if I am missing something fairly basic here, but this justification will not add up to the average reader I think.

ADF&G Response: In the final report, we acknowledged and clarified that the CRGEN and CRTLM estimates may contain some systematic bias, but that the bias, high or low, is likely not consistent from year to year. Since the draft report, we also added the 2012 DIDSON and CRGEN data to the run reconstruction. The three years (2010-2012) of comparison of DIDSON with CRGEN indicate that average pMR during the three years is consistent with the overall estimate of pMR from the run reconstruction.

Reviewer 3, Comment 1: What was the stock composition apportionment (if any) for commercial drift gillnet fisheries harvests and the Cook Inlet marine recreational fishery? It would be good to explain how stock composition was/was not handled for these fisheries. If assumed to be 100% Kenai fish, explain why that assumption may be considered to be appropriate.

ADF&G Response: As indicated earlier, we conducted sensitivity analyses (Table 5, alternate configuration 4), ranging the contributions of minor fisheries (commercial drift, marine recreational) from zero to 100% to the Kenai River late-run stock. These sensitivity analyses did not materially affect the recommended interim escapement goal.

Reviewer 3, Comment 2: In regards to the statement "For the state-space model, CVs for the total harvests below rm 9 were assumed to be 0.10. Previous experience leads us to believe that the results are not sensitive to choice of this number." Is this because the harvest is a small component and therefore uncertainty in it has little influence overall? This might need some further explanation.

ADF&G Response: We clarified the use of assumed of a CV of 0.15 for harvests below RM 9 on page 5 of the final report. We also conducted sensitivity analyses (Table 5, alternate configuration 3), using a CV of 0.10 and 0.20 for harvests below RM 9. We believe these values of CV are realistic given our knowledge of measuring harvest in the various fisheries. These sensitivity analyses did not materially affect the recommended interim escapement goal. We also conducted sensitivity analyses (Table 5, alternate configuration 4), ranging the contributions of minor fisheries (commercial drift, marine recreational) from zero to 100% to the Kenai River late-run stock. These sensitivity analyses did not materially affect the recommended interim escapement goal.

Reviewer 3, Comment 3: In regards to the statement "Age composition of the inriver run at rm 9 was estimated from fish sampled (ny >> 100) at the rm-9 inriver gillnetting project." Uncertainty associated with these two sources of age composition? Uncertainty has been addressed for the sources of harvest above so for consistency, it should be mentioned here as well.

ADF&G Response: Uncertainty in these two sources (inriver run and commercial setnet harvest) of age composition are expressed by the effective sample size (assumed to be 100, but varied from 50 to 200 in the sensitivity analyses) and are modeled hierarchically as age-at-maturity vectors drawn from a *Dirichlet* distribution as described on page 8 of the final report.

Reviewer 3, Comment 4: It might be helpful to add explanation as to what a higher vs lower value of D means as far as consistency of age-at-maturity among brood years because this parameter is listed in results tables 5 and 6 and it would help the reader interpret what the relative differences in these values mean. For example in Table 6 the estimated value of D for N.E = 50 is 87, which is higher than the other values for D in the table, which is indicative of the reduced effective sample size and results in reduced consistency of age-at-maturity among brood years.

ADF&G Response: In the final report, we clarified the meaning of the D parameter and its use relative to the model sensitivity to the effective sample size for age composition data. We also tested the sensitivity of the model to a wide range of effective sample size (Table 5, alternative configuration 2), with the expected effect to the D parameter.

Reviewer 3, Comment 5: I would suggest adding more comments to codes so that it is accessible to a wider variety of readers (e.g. those without specific WinBUGS/OpenBUGS programming experience, but with some technical knowledge).

Indicating prior and sampling distributions by color is fine, but it I think it might be helpful to add the information in comments in case report is printed in black and white.

It is indicated in caption that not all notation corresponds directly to text of report - comments in code would help to clarify these differences in notation making it easier for the reader to follow between the text and the code. Perhaps indicating the corresponding eqn # in report (where appropriate) would be useful?

ADF&G Response: We have added clarifying comments to the BUGS code in Appendix A of the final report, but kept the differential coloring of prior and sampling distributions.

Reviewer 3, Comment 6: In reference to Appendix A2. Would be useful to add comments specifying what each of these datasets are. Which index is which abundance index? One can figure this out by looking at table 3, but why make them do that?

Add comment explaining what these data represent. It is not clear that these are number/percentage of fish in each age class (4-7) for the 28 years in the analysis that provides the age comp data with an effective sample size of 100 fish each (calendar) year. Should they be colored blue like other data above?

ADF&G Response: We clarified the meaning of variable names in Appendix A of the final report.

References

Fleischman, S. J. and T. R. McKinley. 2013. Run reconstruction, spawner-recruit analysis, and escapement goal recommendation for late-run Chinook salmon in the Kenai River. Alaska Department of Fish and Game, Fishery Manuscript No. 13-02, Anchorage.

Fleischman, S. J., M. J. Catalano, R. A. Clark, and D. R. Bernard. In press. An age-structured state-space stock recruit model for Pacific salmon *Oncorhynchus* spp. Canadian Journal of Fisheries and Aquatic Sciences. Subscriber-only access at http://www.nrcresearchpress.com/toc/cjfas/0/ja

Jones, M. and E. Volk. 2011. Management strategies for AYK salmon stocks: accounting for uncertainty. Final report of an expert panel submitted to Arctic Yukon Kuskokwim Sustainable Salmon Initiative. Available from http://www.aykssi.org/project/escapement-goal-setting-to-ensuresustainable-fisheries/.

McKinley, T. R. and S. J. Fleischman. 2010. Stock assessment of late-run Chinook salmon in the Kenai River, 1999-2006. Alaska Department of Fish and Game, Fishery Data Series No. 10-96, Anchorage.