SALMON TECHNICAL TEAM COMMENTS
METHODOLOGY REVIEW – MODIFICATION OF CHINOOK FRAM

On October 15, 2002, the Salmon Technical Team (STT) met jointly with the Scientific & Statistical Committee's (SSC) Salmon Subcommittee to review modifications to chinook FRAM which are proposed for implementation beginning with the 2003 season. These modifications were undertaken pursuant to a WDFW-tribal agreement and work plan for the purpose of enabling chinook FRAM to generate estimates of impacts of mark selective fisheries (MSF).

The STT applauds the care and diligence that has been devoted to these modifications and appreciates the thoughtful efforts of agency staff to prepare materials for review. However, at the time of the STT's review, modifications were not complete. Additional work was still required to finalize reporting formats and to complete integration of terminal area management modules (TAMMs) to estimate terminal run sizes, escapements, and exploitation rates for Puget Sound stocks (in addition to incorporating marked and unmarked fish components into calculations, modification of the methods used to compute exploitation rates for South Puget Sound stocks is in progress).

The modifications to chinook FRAM reviewed by the STT generally involved splitting each modeled stock into two components to represent marked and unmarked fish with identical base period exploitation patterns and maturation rates. Parameters for drop off, release mortality, mark recognition error, and unmarked retention error are incorporated per recommendations of the Pacific Salmon Commission's (PSC) Selective Fishery Evaluation Committee, along with a special report formatted to present estimates of selective fisheries impacts on individual stocks. Modifications also include the addition of the White River hatchery yearling stock to the model.

The structural modifications to chinook FRAM are analogous to those employed for coho. For both models, MSFs will increase the uncertainty surrounding estimates of mortalities of unmarked fish due to the heightened significance of various parameters in chinook FRAM, such as drop off and release mortalities, unmarked retention error, and mark recognition error. The values of these parameters are not known with a high degree of certainty and it will not be possible to directly observe mortalities of unmarked fish on stocks of concern. For both models, new methods will be required for future calibrations if there is a need to develop new estimates of exploitation rates based on CWT data collected during time periods affected by MSFs.

However, despite these similarities, there are significant and important differences between the two models that result in greater uncertainties with chinook FRAM than with coho FRAM. These uncertainties could significantly affect the utility of the modified version of chinook FRAM and its acceptability as a means to estimate mortalities of unmarked fish in MSFs. These differences are summarized in Table 1.

Table 1. Summary of differences between chinook and coho FRAM modified for evaluation of mark selective fisheries.

Coho FRAM	Chinook FRAM	Significance
Fish are harvested predominantly as three year olds and escapement accrues in the same year	Fish are harvested at multiple ages and stages of maturity. Some of the fish not harvested in one year accrue to escapements in the same year while others become available for harvest in subsequent years or are lost to natural mortality.	Impacts of a MSF in preterminal areas can have residual effects that last for years after the fishery occurs. These effects become more complex as additional MSFs are implemented in subsequent years.
Monthly time step	Multi-month time step	The longer time step raises at least two issues: (a) Procedures to estimate impacts of inconsistent regulations within a time step will likely be necessary (e.g., a fishery may operate as a retention fishery for part of a time step, a non-retention fishery during another part, and a MSF during yet another part). While it may be possible to address the estimation problem externally, procedures and methods to address this problem have not been presented for STT review; and (b) Computation of sub-legal mortalities depends upon stock-specific growth functions and *"base period sub legal encounter rates."* Long time steps suggest that growth during a time step could be a more significant factor in estimation of both catch and non-catch fishing mortality on unmarked chinook than for coho.
Size limits are not considered as a factor for estimating shaker encounters	Shaker encounters are based on stock-specific growth functions and stock-age-fishery specific "base period encounter rates"	For Chinook, MSFs will exacerbate the problems of estimating incidental mortalities of sublegal fish because of multiple age class and growth considerations. The STT has not reviewed the technical basis for parameter values used for *"base period encounter rates."*
Single release mortality rate	Single release mortality rate directed primarily at sub-legal mortalities	Since legal sized unmarked fish would not be retained regardless of size, there may be a need to further modify Chinook FRAM to incorporate different release mortality rates for sublegal and legal-sized fish.
Includes all major stocks coastwide	Limited to a subset of stocks that contribute primarily to fisheries off the Washington coast and in Puget Sound.	Chinook FRAM does not represent all the stocks that are expected to be encountered in a fishery. Consequently, when catch quotas are modeled, stock-specific impacts are estimated relative to the proportion of the catch comprised of the stocks included in the model during the base period, i.e., the proportion of unmodeled stocks relative to the modeled stocks remains constant. When quotas of marked fish are evaluated in MSFs, this assumption implies that the unrepresented stocks are marked at the same rate as the stocks that are included in the model; the validity of this assumption seems highly improbable. Mark rates of unrepresented fish are likely to be lower than for the populations targeted by MSFs. Unless additional parameters and algorithms are incorporated into the model to reflect differences in anticipated mark rates of marked and unmarked fish from unrepresented stocks, the model will likely generate biased estimates of impacts of MSFs on both marked and unmarked fish.

Conclusions and Recommendations:

1. Review of model structure insufficient. The modified chinook FRAM is proposed as a tool for generating estimates of mortalities of unmarked stocks in Council and inside fisheries. The principal objectives of the Council's management of ocean salmon fisheries is directed at constraining impacts on natural stocks, which are of course unmarked. The STT cannot adequately evaluate the performance of the proposed modification of chinook FRAM in abstract terms. The STT review was extremely limited in scope, being focused primarily on structural modifications. While this type of review can identify potential issues and concerns, it is not sufficient to enable the STT to evaluate the model's utility as a tool to estimate impacts of MSFs on chinook salmon. **The significance of modeling issues must be examined within the context of specific proposals for MSFs and their potential impacts on individual natural stocks of interest to the Council.**

2. Mortalities of unmarked fish likely underestimated. The structure of Chinook FRAM would probably generate underestimates of mortalities of unmarked fish in MSFs. The magnitude and significance of such bias would be dependent upon the location of the MSF; it is clear, however, that the bias would be expected to increase exponentially as MSF harvest rates on marked fish increase. **The STT's review has identified several factors that lead it to conclude that the proposed modifications to chinook FRAM would likely underestimate mortalities of unmarked fish in MSFs.** Some of the key factors are summarized as follows:

> Catch Algorithms. The algorithms employed to estimate fishing mortality do not reflect the potential impacts of increasing the proportion of unmarked fish in the exploited population as MSFs are conducted over time. Since the chinook FRAM computes mortalities as if they occur instantaneously and independently for each fishery at the beginning of a time period, estimates of mortalities of unmarked fish are likely to be underestimated. The catch algorithms do not account for mortalities due to potential multiple encounters, that is fish that survive after being released in a MSF would be expected to become available for recapture. This issue is related to the duration and intensity of MSFs – see summary in Table 1 regarding time step differences.
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> The proportion of the catch represented by model stocks. Mark rates of unrepresented fish are likely to be lower than for the populations targeted by MSFs. As a result, the model will likely generate biased estimates of impacts of MSFs on both marked and unmarked fish. See summary regarding stock representation in Table 1.

3. Management buffers should be considered. It is clear that MSFs would introduce bias and increase the uncertainty in estimates of mortalities of unmarked fish. If the modified Chinook FRAM is adopted as a means to estimate impacts of MSFs, the Council should interpret results in light of these likely effects. **The STT recommends that the Council consider incorporating an explicit methodology to establish buffers for management targets (e.g., reduce model targets for exploitation rates below ESA jeopardy standards) to compensate for increased bias and uncertainty.** The magnitude of the required buffers is likely to depend on the stocks and MSFs involved so the procedures to determine the appropriate buffer size could become quite complex.

4. Spill over (domino effects). *(a) Interactions with other models and management processes.* Chinook FRAM depends upon the PSC chinook model to generate parameter values required to estimate the impacts of Council and inside fisheries on stocks of concern. Depending on the location and magnitude of MSFs, the **abundance and exploitation rates of marked and unmarked fish from the same cohort could change differentially over time.** If this occurs, significant changes to the PSC chinook model would be required and, more importantly, substantive multi-jurisdictional policy issues that could alter the basis for chinook salmon management in Aggregate Abundance Based Management regimes will eventually have to be addressed by the PSC; *(b) Preseason Abundance Forecasts.* Since chinook FRAM is a single year model, procedures external to the model will be required to track differences in abundance and mortalities of marked and unmarked fish across years. Many preseason abundance forecasts are based on sibling relationships of hatchery fish. Because hatchery fish are likely to be marked, and subject to different patterns of exploitation rates than associated unmarked populations, **separate forecasts may be required for marked and unmarked population components,** depending upon where the MSF occurs and the magnitude of mortality differences in exploitation rates between marked and unmarked fish. Consequently,

adjustments to preseason forecasting methodologies may be a necessary part of the application environment for using the chinook FRAM. A new report summarizing pre-terminal exploitation rates and escapements by age for individual stocks should be developed to support this process.

5. Model Documentation. **The STT strongly recommends that a high priority be placed on updating model documentation** At the very least, documentation of the original chinook FRAM should be redistributed to the STT and SSC, along with a summary of key equations and the sequence of computations, and a description of procedures employed to generate estimates of exploitation rate patterns for stocks lacking CWT data during the model base period. The membership of the STT and SSC has changed since Chinook FRAM was initially reviewed several years ago. Further, changes to model calibration procedures and data, as well as structural modifications to address MSFs have not been formally documented. This creates a situation where the details of the model and its data requirements are largely retained within the personal memories of only a few individuals. Under such circumstances, model maintenance can become problematic. Further, the model itself becomes more vulnerable to criticism as a mysterious "black box." Because the preseason planning processes that support Council decisions depend so heavily upon models, it is important for fishery managers and those affected by Council decisions to have as much confidence as possible in those models. Improved documentation is a key component in facilitating understanding of the inner workings of the models relied upon by the Council.

6. Additional Review. The STT is also concerned that the model is not yet fully integrated into external systems that support its application. For example, (a) the model interface with TAMMs, which are vital to the development of fishing plans and evaluation of regimes in light of ESA consultation standards for Puget Sound stocks, has not yet been completed; and (b) procedures have not been developed to address implications of multi-year impacts of MSFs, such as effects of differences in fishery exploitation and escapement rates of marked and unmarked population components on preseason abundance forecasts. **The STT recommends that an additional technical review be conducted before March 2003, after the interface with the TAMMs is completed.**

7. Model Implementation for Non-Mark Selective Fisheries. The materials provided for STT review indicate that the modified chinook FRAM is capable of replicating results of the previous version of the model in the absence of MSFs.

8. Model Implementation for Mark Selective Fisheries. The STT is not confident that the modified version of chinook FRAM will generate reliable estimates of mortalities of unmarked fish in MSFs. Potential implications of biases and errors that would be introduced into the STT's assessments by the proposed model become more significant as the intensities (as reflected by the proportion of marked fish subjected to the fishery which is removed) of MSFs increase.

9. Model Use for 2003 Chinook Fisheries. **The STT recommends that the modified version of chinook FRAM be adopted for evaluation of non-mark selective fisheries, provided that the functionality of the TAMM interfaces required to assess impacts on Puget Sound stocks is verified. At this time, the STT recommends that the modified chinook FRAM not be adopted as standard methodology to evaluate MSFs that would significantly impact stocks of concern to the Council. The STT recommends that an additional technical review of the capacity of the modified version of chinook FRAM to adequately evaluate MSFs be conducted in March 2003.** The timing of this review would allow the STT to examine specific MSFs that are under consideration within the context of 2003 preseason abundance forecasts. Upon completion of its review, the STT would provide its recommendations regarding the use of the modified version of chinook FRAM for evaluation of 2003 MSFs that may impacts stocks of concern to the Council.

10. 2003 Methodology Review. **The STT recommends that the modified chinook FRAM be reevaluated in depth during the 2003 methodology review cycle.** This would provide adequate time to analyze and address the concerns noted above, and the model could then be adopted as standard methodology.

11. Model Evaluation Workgroup. **The STT again strongly recommends that a multiagency team, similar to the 'Model Evaluation Subgroup' that existed in the late 1990s, be formed.** Many of the concerns expressed above, especially in relation to model documentation, management buffers, and model calibration and maintenance could be addressed through such a group.