FISHERY REGULATION ASSESSMENT MODEL

(FRAM)

- An Overview for Coho and Chinook - v 3.0

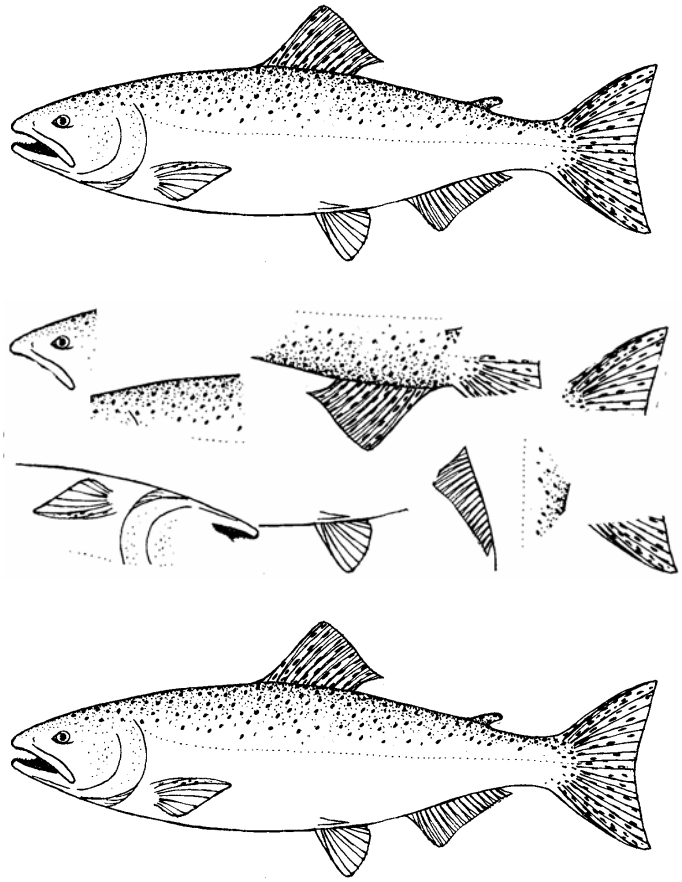

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

The Fishery Regulation Assessment Model (FRAM) is currently used by the Pacific Fishery Management Council (PFMC) to annually estimate impacts of proposed ocean and terminal fisheries on Chinook and coho salmon stocks. FRAM is a single-season modeling tool with separate processing code for Chinook and coho salmon. The Chinook version evaluates impacts on most stock groups originating from the California Central Valley (Sacramento River), north-central Oregon coast, Columbia River, Willapa Bay, north Washington coast, Puget Sound, and Southern British Columbia. The coho version evaluates impacts on a comprehensive set of stocks originating from Central California to Southeast Alaska and is considered to represent total West Coast production. The FRAM produces a variety of output reports that are used to examine the impacts of proposed fisheries for compliance with management objectives, allocation arrangements, Endangered Species Act (ESA) compliance, and domestic and international legal obligations. Until recently FRAM was not used for assessing compliance with Chinook or coho agreements in international fisheries management forums. However, the U.S. and Canada have developed a common coho base period data set of fisheries and stocks allowing FRAM to be used as the first version of a bilateral regional planning tool for coho salmon management. The intent is to have a single common tool that can support both domestic and international fishery planning processes using a common set of data and assumptions.

1.1 Background

The need for a tool to project the impact of proposed salmon fisheries at the stock-specific level became apparent in the mid-1970s with treaty fishery rights litigation and the associated legal obligation for the states of Washington and Oregon to provide treaty tribes with the opportunity to harvest specific shares of individual runs. Other legal issues such as the Magnuson-Stevens Fishery Conservation and Management Act and the Law of the Seas convention contributed to the need for developing better assessment tools. These legal issues in conjunction with the information available from the coast wide coded-wire-tag (CWT) program provided the impetus for developing the early salmon fishery assessment models.

In the late 1970s, the Washington Department of Fisheries (WDF) and U.S. National Bureau of Standards (NBS) developed a model for evaluating alternative fishery regulatory packages. The WDF/NBS Model could be configured for either Chinook or coho by using different input data files. This model was coded in FORTRAN and ran on a mainframe computer at the University of Washington. Model runs were usually processed over night and results were painstakingly extracted from large volumes of printed output reports. The WDF/NBS model was not extensively used by the PFMC because it proved costly to operate and its results were difficult to obtain in a timely manner. Morishima and Henry (2000) provide a more in-depth history of Pacific Northwest salmon management and fishery modeling.

In the early 1980s, the development of personal computers permitted the WDF/NBS model to be converted into simple spreadsheet models. This transformation improved accessibility to the model during the PFMC pre-season planning processes. The first spreadsheet model for Chinook used by the PFMC was developed in the mid-1980s to model Columbia River “tule” fall Chinook. The Coho Assessment Model (CAM) was the corresponding spreadsheet model for coho and covered stocks from the Columbia River, Puget Sound, and Washington and Oregon coastal areas. The CAM was revised over time, principally to improve report generation capabilities and provide more detailed information on management of terminal area fisheries in Puget Sound through the use of Terminal Area Management Modules (TAMMs). The CAM was used as the primary model for evaluating coho impacts for proposed PFMC fisheries until the mid-1990s.

The increased complexity of proposed fishery regulation regimes and the need for increased time and area resolution for the impact projections soon surpassed the capability of the spreadsheet models. In the mid-

1990s, CAM was programmed in QUICK BASIC and was renamed FRAM. The recognition that common algorithms underlie both the coho and Chinook spreadsheet models led to the effort to develop the QUICK BASIC version of FRAM for both species. The FRAM code could be used to evaluate proposed fishery regulation regimes for either Chinook or coho by using different input file configurations. In 1998, FRAM was converted to VISUAL BASIC to take advantage of the improved user interface available through the MS-WINDOWS operating system. A multi-agency Model Evaluation Subgroup periodically reviewed model performance and parameter estimation methods and coordinated revisions to the model during this period (1998-2000).

2. MODEL OVERVIEW

The FRAM is a discrete, time-step, age-structured, deterministic computer model used to predict the impacts from a variety of proposed fishery regulation mechanisms for a single management year. It produces point estimates of fishery impacts by stock for specific time periods and age classes. The FRAM performs bookkeeping functions to track the progress of individual stock groups as the fisheries in each time step exploit them. Individual stock-age groups are exploited as a single pool, that is, in each time step all pre-terminal fisheries operate on the entire cohort simultaneously and all terminal fisheries operate on the mature run.

2.1 Stocks

Currently, 123 stock groups are represented in Coho FRAM and 3833 stock groups are represented in Chinook FRAM (see Appendices 1 and 2 for lists of the stocks). Each of these groups have both marked and unmarked components to permit assessment of mark-selective fishery regulations. For most wild stocks and hatchery stocks without marking or tagging programs, the cohort size of the marked component is zero; therefore, the current version of FRAM has a virtual total of 246 stock groups for coho and 76 for Chinook. Stocks or stock-aggregates represented in the FRAM were chosen based on the level of management interest, their contribution rate to PFMC fisheries, and the availability of representative CWT recoveries in the historical CWT database.

2.2 Fisheries

The FRAM includes pre-terminal and terminal fisheries in southeast Alaska, Canada, Puget Sound, and off the coasts of Washington, Oregon, and California. There are 73 fisheries in Chinook FRAM and 198 fisheries in Coho FRAM. The intent is to encompass all fishery impacts to modeled Chinook and coho stocks in order to account for all fishing-related impacts and thereby improve model accuracy. Terminal fisheries in Chinook FRAM are aggregations of gears and management areas. Terminal fisheries in Coho FRAM are modeled with finer resolution, most notably by including individual freshwater fisheries. Fishery number and fishery name for each of the FRAM fisheries are listed in Appendix 3 for Chinook and Appendix 4 for coho.

2.3 Time Steps

The time step structure used in FRAM represents a compromise level of resolution that corresponds to management planning fishery seasons and species-specific migration and maturation schedules. The FRAM consists of five time periods for coho and four periods for Chinook (Appendix Table 5-1). At each time step a cohort is subjected to natural mortality, pre-terminal fisheries, and also potentially to maturation (Chinook only), and terminal fisheries.

The recovery data available in the CWT database limit the time-step resolution of the model. Increasing the time-step resolution of the model usually decreases the number of CWT recoveries for a stock within a time period. Since estimation of fishery impacts, like exploitation rates, is dependent on CWT recovery information, decreasing the number of CWT recoveries in time/area strata increases the variance of the

estimated exploitation rates in those strata. In recognition of these data limitations, efforts were made to restrict the level of time-step resolution to that necessary for fishery management purposes.

2.4 Assumptions and Limitations

Major assumptions and limitations of the model are briefly described below.

1. CWT fish accurately represent the modeled stock. Many "model" stocks are aggregates of stocks that are represented by CWTs from only one production type, usually hatchery origin. For example, in nearly all cases wild stocks are aggregated with hatchery stocks and both are represented by the hatchery stock's CWT data. Therefore, for each modeled stock aggregate, it is assumed that the CWT data accurately represent the exploitation rate and distribution pattern of all the untagged fish in the modeled stock.

2. Length at age of Chinook is stock specific and is constant from year to year. Von Bertalanffy growth functions are used for Chinook in determining the proportion of the age class that is of legal size in size-limit fisheries. Parameters for the growth curves were estimated from data collected over a number of years. It is assumed that growth in the year to be modeled is similar to that in the years used to estimate the parameters.

3. Natural mortality is constant from year to year. Natural mortality is assumed to be constant across months--but not necessarily time steps--for all stocks. Rates for Chinook are age specific and yield the same annual rate as used in the Pacific Salmon Commission (PSC) Chinook model.

4. Stock distribution and migration is constant from year to year and is represented by the average distribution of CWT recoveries during the base period. We currently lack data on the annual variability in distribution and migration patterns of Chinook and coho salmon stocks. In the absence of such estimates, fishery-specific exploitation rates are computed relative to the entire cohort. Differences between the distribution and migration pattern of stocks during the base period and the year being modeled will decrease the accuracy of the estimates of stock composition and stock-specific exploitation rates for a modeled fishery.

5. There are not multiple encounters with the gear by the fish in a specific time/area/fishery stratum. Within each time/area/fishery stratum, fish are assumed to be vulnerable to the gear only once. The catch equations used in the model are discrete and not instantaneous. Potential bias in the estimates may increase with large selective fisheries or longer time intervals, both of which increase the likelihood that fish will encounter a gear more than once.

While it is difficult to directly test the validity of these assumptions, results of validation exercises provide one assessment of how well these assumptions are met and the sensitivity of the model to the assumptions.

3. BASE PERIOD DATA

The Chinook FRAM is calibrated using escapement, catch, and CWT recovery data from 1974-1979 brood year CWT releases. During the late 1970s and early 1980s fisheries were conducted across an extensive geographic area and were typically of longer duration than current fisheries. The CWT recovery data from this period provides a very good representation of the distribution and migration timing of many stocks. Not all stocks currently represented in the Chinook FRAM have CWT recovery data available from the 1974-1979 brood years in the base period (e.g., Snake River fall Chinook); these stocks are categorized as "Out-of-Base" stocks. Available CWT data for the "Out-of-Base" stocks are translated to equivalent base period recovery and escapement data using known fishing effort and harvest

relationships between recovery years. See MEW (2006b) for a more detailed description of the development of the Chinook base period data. Appendix 1 lists the brood years used to develop each Chinook stock's base period.

Model base period data for the Coho FRAM is derived from fishery and escapement recoveries of CWTs and terminal area run size estimates for the return years 1986-1992. See MEW (2006c) for a more detailed description of the development of the coho base period data.

Chinook and coho base period data are used to estimate base period stock abundances and age-specific, time/area fishery exploitation rates, and maturation rates for modeled stocks. These estimates are derived through species-specific cohort analysis procedures. Cohort analysis is a series of procedures that use CWT recoveries and base period catch and escapement data to "back-calculate" or reconstruct a pre-fishing cohort size for each stock and age group using assumed natural mortality and incidental mortality rates (see Glossary). See MEW (2006b, 2006c) for a more detailed description of the cohort analysis procedures for Chinook and coho.

4. GENERAL INPUT TYPES

There are five general types of input that are used by FRAM. The first three types are defined annually to reflect projected stock abundances and proposed fishery regulations for the current model year. The last two types of input are specifications for different sources of fishery-related mortalities. While these values can change as more information becomes available from additional data collection and new studies, they typically do not change on an annual basis.

1. **Cohort Abundance:** For each stock or stock aggregate, an annual forecast of abundance is obtained from a source that is independent of the model. For pre-season modeling, these forecasts of stock abundance are used to estimate initial cohort size. For Chinook, initial stock abundance estimates are needed by age class, from age-2 to age-5 year old fish. For coho, only one age class (age-3) is assumed vulnerable to fisheries and abundances are input to the model as January age-3 abundance. Chinook and coho abundance estimates are further segregated by mark status ("marked" or "unmarked").

2. **Size Limits:** For Chinook, minimum size limits are specified by fishery where appropriate. For coho, age-3 fish are assumed fully vulnerable and age-2 fish are assumed fully invulnerable to modeled fisheries.

3. **Fishery Landed Catch:** The model provides four options for setting the catch in a fishery: a quota, an exploitation rate scalar, a ceiling, and harvest rate (for Puget Sound terminal fisheries only).
   a) Quota. Catch in the fishery is set equal to a value input by the user.
   b) Exploitation rate scalar. The exploitation rate in the fishery is scaled, relative to the effort observed during the base period, using a scalar input by the user.
   c) Ceiling. Catch is first calculated based on an exploitation rate scalar and then compared to a ceiling; if the estimated catch exceeds the ceiling, then the catch is truncated at the ceiling value.
   d) Harvest rate. Using the Puget Sound TAMMs, a terminal area harvest rate can be applied to either all fish present in the terminal area (coho or Chinook) or to the number of local-origin stock only (coho only).

   The FRAM inputs for quota, exploitation rate scalar, or ceiling can be flagged as a mark-selective fishery and modeled accordingly. This initiates additional calculations to estimate catches, encounters, and mortalities for marked and unmarked groups.

4. **Release Mortality:** This is the mortality associated with the release of landed fish from hook-and-line and other gears. Release mortality rates assumed for coho are shown in Appendix Table 5-2 and for Chinook in Appendix Table 5-3. Hook-and-release mortality is assessed when coho or Chinook are not allowed to be retained (so-called "Chinook/coho non-retention" or CNR fisheries), when size limits apply, or in mark-selective fisheries. Release mortality has been estimated by a number of studies of hook-and-line fisheries, and release mortality rates for troll and recreational fisheries in the ocean have been formally adopted by the PFMC. Release mortality in net fisheries with coho or Chinook non-retention is estimated externally to FRAM and input into the model as either "landed catch" or as CNR mortality.

   Mark-selective fisheries have two additional variations of "release" mortality that are described as either the inappropriate retention of an unmarked fish or the release of a marked fish which consequently endures some release mortality. The failure to release an unmarked fish is a user input to the model called "Unmarked Retention Error" (or Retention Error Rate) and is the proportion of the unmarked fish encountered that are retained. The release of marked fish that subsequently die due to release is a user input to the model called "Marked Recognition Error" and is the proportion of the marked fish encountered that are released. These rates are identified in Appendix Table 5-4.

5. **Other Non-landed Mortality:** This includes fishing-induced mortality not associated with direct handling (or landing) of the fish (see Appendix Tables 5-2 and 5-3 for coho and Chinook, respectively). "Drop-off" mortality refers to sport and troll hook-and-line fisheries (fish that drop off the hook before they are brought to the vessel but die from hook injuries) and "drop-out" mortality refers to commercial net fisheries (fish which are not brought on board but die from injury as a result of being netted). Net drop-out mortality rates vary depending on species, net type, or terminal versus pre-terminal nature of the fishery. In general, a 5% drop-off mortality rate is applied to the landed catch to account for "other non-landed mortalities" in hook-and-line fisheries.

5. OUTPUT REPORTS AND MODEL USE

Model results are available as either standard FRAM output reports or in Excel spreadsheets that have a summary of FRAM results/reports. The TAMM spreadsheets (coho and Chinook versions) provide comprehensive summaries of fishery mortalities, exploitation rates, run sizes, and escapements for key Puget Sound stocks in the PFMC and North of Falcon annual salmon season setting processes. The coho TAMM spreadsheet reports fishery impacts for all coho stocks of management interest while Chinook TAMM spreadsheet reports are limited to Puget Sound stocks. Other model results not shown in the spreadsheets can be generated directly from FRAM. These reports include summaries of projected catch by fishery, catch by stock, catch by age, and escapement/run size reports. A new report has been created for FRAM to provide more detailed information relative to mark-selective fisheries for coho and Chinook. For a full scope of FRAM report generating functions, refer to "User Manual - Fishery Regulation Assessment Model for Chinook and Coho" (MEW 2006d). Appendix Tables 5-10 and 5-11 summarize the reports commonly used in negotiations during PFMC and North of Falcon meetings to define fishery regulations, seasons, and other management options for salmon management in a year.

6. COMPUTATIONAL STRUCTURE

For each time step and fishery, FRAM simulates fishery regulations following the sequence of computations depicted for coho (Figure 1) and Chinook (Figure 2). The first step for both coho and Chinook is to scale the predicted cohort size for the current year to the base period: this is done by stock for the January age-3 cohort for coho and for the age-2 through age-5 cohorts for Chinook. Each stock's cohort is then processed through a time step loop defined for the species (five time steps for coho and four time steps for Chinook).

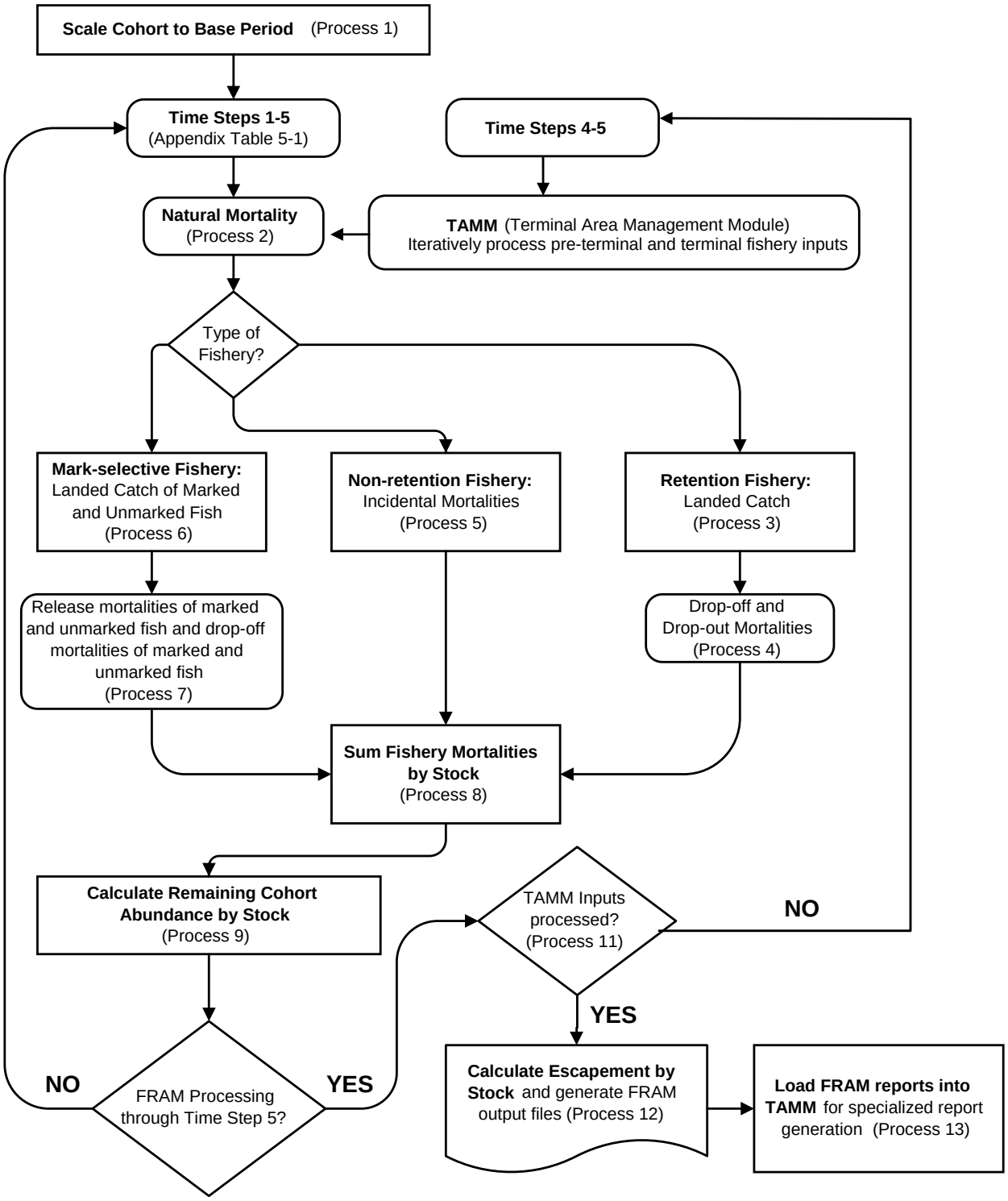

Figure 1. Flow chart for Coho FRAM model.

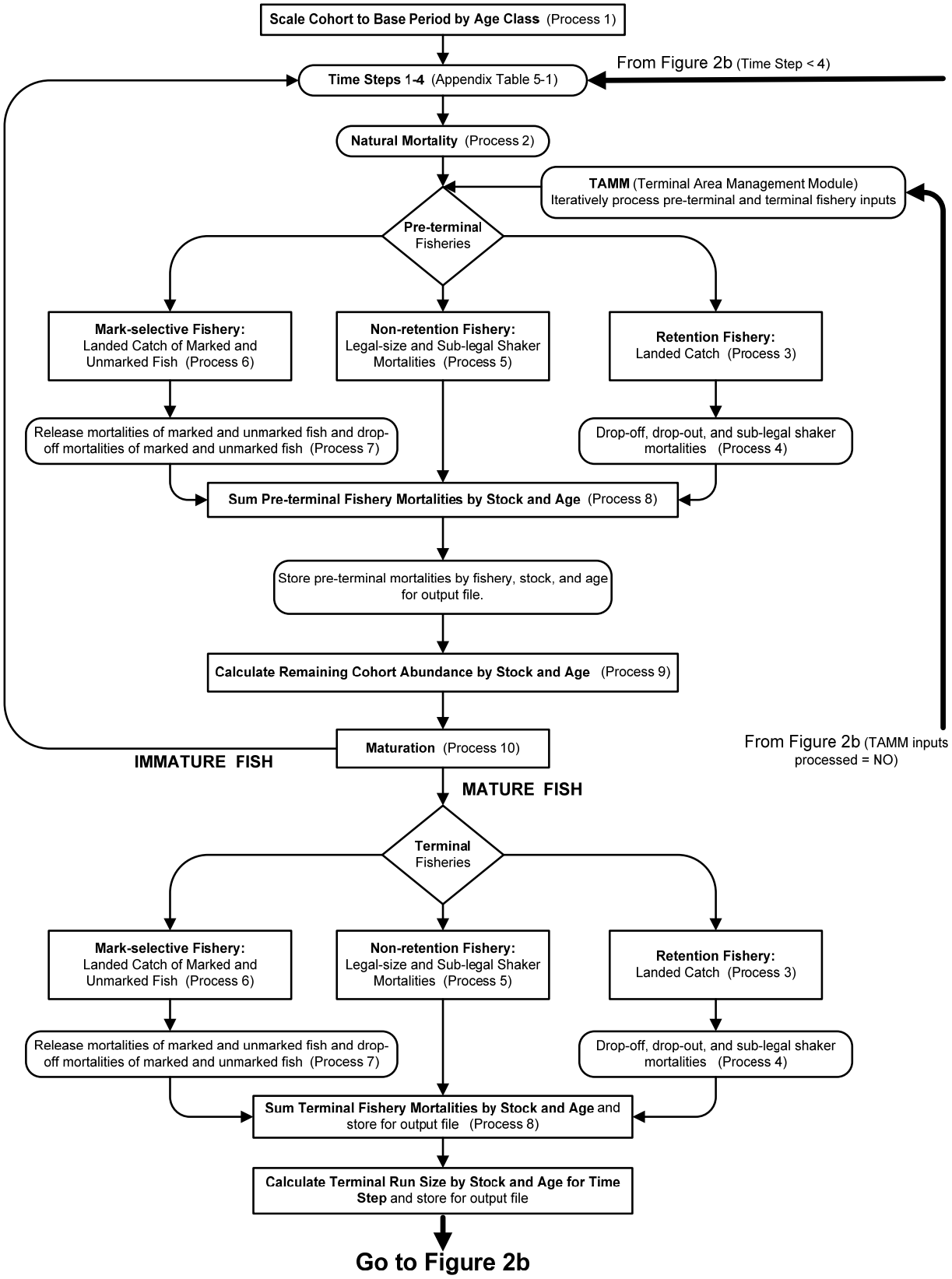

Figure 2a. Flow chart for Chinook FRAM model (continued on next page).

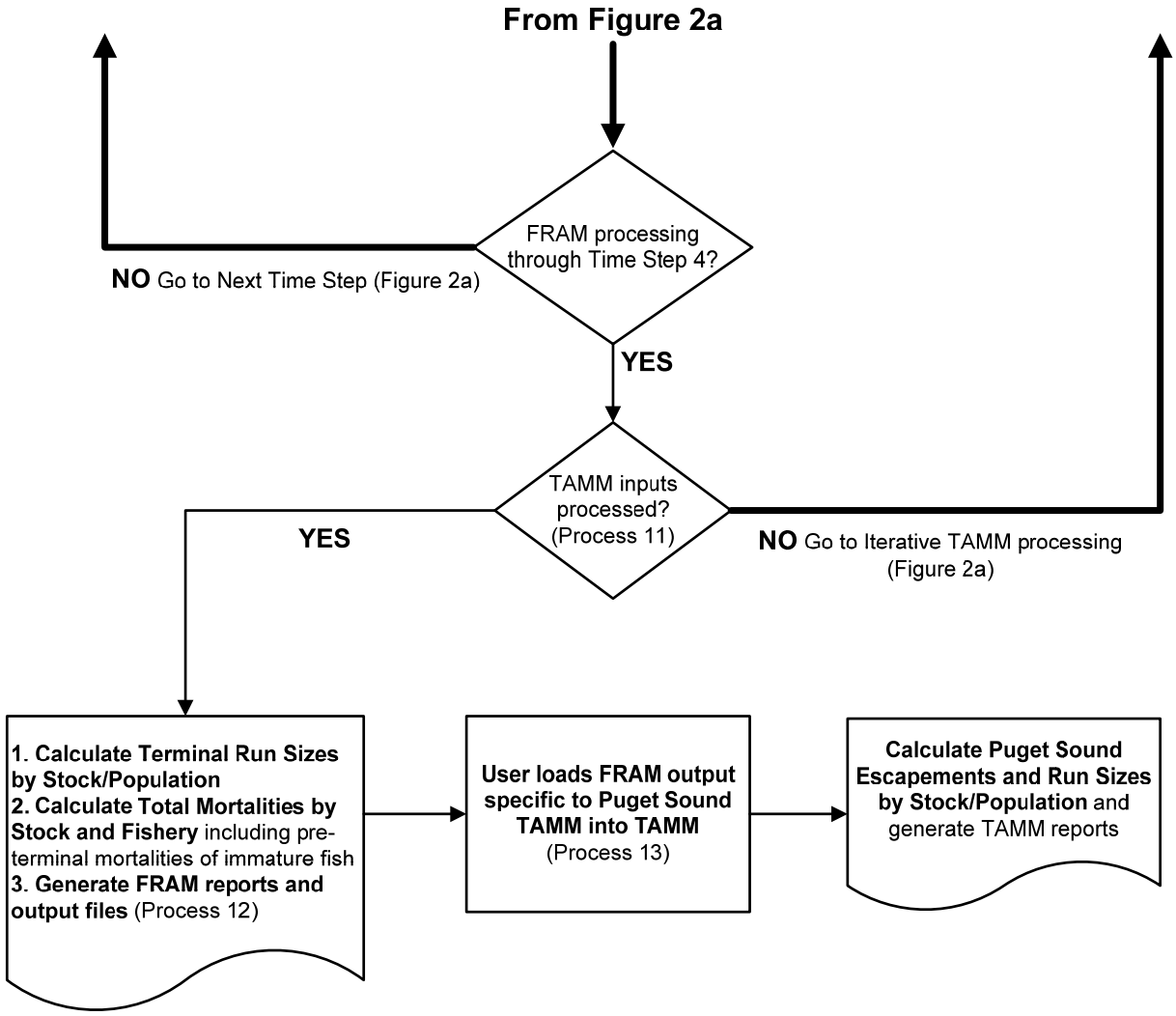

Figure 2b. Flow chart for Chinook FRAM model (continued from previous page).

6.1 Explanation of Flow Charts

This section briefly describes the flow charts which explain FRAM for coho (Figure 1) and Chinook (Figures 2a and 2b). See MEW (2006a, 2006b, 2006c) for a more detailed description of all input data, processes, and algorithms used in FRAM.

Scale Cohort to Base Period (Process 1)

The starting cohort size for each stock in the model is expressed as a product of the average cohort size for stock *s* at age *a* during the base period ($BPCohort_{s,a}$) and an age-specific stock scalar ($StockScalar_{s,a}$). $StockScalar_{s,a}$ is estimated externally to the model and is an annual input to the model.

(Process 1) $Cohort_{s,a,1} = BPCohort_{s,a} \ x \ StockScalar_{s,a}$

For coho, the starting cohort size is the projected number of age-3 fish in January of the fishing year for each stock. For Chinook, separate cohort sizes for the first time step (October to April) preceding the beginning of the fishery year are required for age-2, age-3, age-4, and age-5 fish in each stock.

Time Step Loop

During each time step, the stock (coho) or stock-age (Chinook) cohort size at the start of the time step is decreased to account for natural mortality:

(Process 2) $Cohort_{s,a,t} = Cohort_{s,a,t} \ x \ \left(1 - M_{a,t}\right)$.

where $M_{a,t}$ is the natural mortality rate for age *a* fish during time step *t* (see Appendix Table 5-5 for specific rates used for coho and Chinook).

The remaining cohort is then subjected to removals by proposed fisheries; both landed catch and non-landed mortalities associated with each proposed fishery are calculated. FRAM simulates fishery mortalities using different processes depending upon the type of fishery: retention fishery, species non-retention fishery, or mark-selective fishery.

If all fish can be retained regardless of mark status, the following general equation is used:

(Process 3) $Catch_{s,a,f,t} = Cohort_{s,a,t} \ x \ BPER_{s,a,f,t} \ x \ Scalar_{f,t}$.

where $BPER_{s,a,f,t}$ is the average base period exploitation rate for stock *s*, at age *a*, in fishery *f*, during time step *t* and $Scalar_{f,t}$ relates expected catch (or effort) in the model year back to average catch (or effort) during the base period[1].

(Process 4) Drop-out mortalities (in commercial net fisheries) and drop-off mortalities (in recreational and commercial hook-and-line fisheries) are estimated by simply multiplying the calculated landed catch for a retention fishery by a user-specified mortality rate (see "Other" Mortality column in Appendix Tables 5-2 and 5-3). Sub-legal shaker mortalities are not estimated for coho since most minimum size limits - if they exist - apply to age-2 fish that are not represented in the coho FRAM. Chinook FRAM calculates sub-legal sized shaker mortalities based upon the minimum size limit for the fishery and von Bertalanffy growth equations for stocks that contribute to the fishery. The procedure constructs a normalized length distribution for the stock at each time step based upon the parameters of the von

[1] The parameter $Scalar_{f,t}$ is the foundation for FRAM's fishery simulation algorithms. FRAM can evaluate two general types of fisheries: catch-based or effort-based. For catch-based fisheries, $Scalar_{f,t}$ is computed automatically to obtain a user-specified catch level. For effort-based fisheries, the parameter $Scalar_{f,t}$ is specified by the user to reflect expected effort during the model year relative to the average effort observed during the base period.

Bertalanffy growth equation[2]. The number of sub-legal encounters is then calculated by comparing the projected length distribution to the minimum size limit. Chinook non-retention mortalities are then calculated with management approved "shaker" and "adult" release mortality rates (Appendix Table 5-3).

(Process 5) There is one method for calculating mortalities in species non-retention fisheries (CNR fisheries) for coho and three different methods for Chinook. The method for coho is simply an external-to-the-model estimate of total coho mortalities in a fishery based upon historical observations. Chinook non-retention mortalities are model estimates from inputs that are based upon either: the level of open versus non-retention effort within each time step; external to the model estimates of legal and sub-legal encounters; or external to the model estimates of total encounters. Chinook non-retention mortalities are calculated using "shaker" and release mortality rates (Appendix Table 5-3) and external-to-the model estimates of adult encounters (with some adjustments).

(Process 6) Mark-selective fishery regulations require additional computations to calculate both the landed catch of marked fish and the mortalities due to the release of unmarked fish. Landed catch is calculated using an equation similar to that specified in Process 3 except that there is an additional term in the equation used to calculate the landed catch. For <u>marked</u> fish, the additional term accounts for mark-recognition error (the release of a marked fish) and is fishery specific (mre_f):

$$Catch_{s,a,f,t} = Cohort_{s,a,t} \; x \; BPER_{s,a,f,t} \; x \; Scalar_{f,t} \; x \; (1 - mre_f).$$

For <u>unmarked fish</u>, the additional term accounts for unmarked retention error (retaining an unmarked fish in a selective fishery) and is fishery specific (ure_f):

$$Catch_{s,a,f,t} = Cohort_{s,a,t} \; x \; BPER_{s,a,f,t} \; x \; Scalar_{f,t} \; x \; ure_f.$$

(Process 7) Similarly, the equations used to calculate release mortalities in mark-selective fisheries must account for marked recognition and unmarked retention error. Computations for Chinook mark-selective fisheries must also account for sub-legal mortality, which does not differ between marked and unmarked components. Drop-off mortalities in mark-selective fisheries are calculated with the methods similar to those used for retention fisheries (Process 4).

(Process 8) All fishery mortalities for a cohort (stock) are totaled (*TotMort*) and the size of the cohort is reduced accordingly. For coho, all fisheries are assumed to operate on the mature cohort and the summing of fishery mortalities occurs only once in each time step. For Chinook, because there are pre-terminal fisheries operating on the immature cohort and terminal fisheries operating on the mature portion of the remaining cohort, the summing of fisheries mortalities potentially occurs twice (Figure 2a) in each time step.

$$TotMort_{s,a,t} = \sum_f (Catch_{s,a,f,t} + Dropoff_{s,a,f,t} + Dropout_{s,a,f,t} + Shakers_{s,a,f,t} + LegalShakers_{s,a,f,t} + CNR_{s,a,f,t})$$

Shaker mortalities are not calculated for coho.

The remaining cohort (after fishery mortalities) is then calculated as:

(Process 9) $Cohort_{s,a,t+1}$ *(for coho) or* $Cohort_{s,a,t}$ *(for Chinook)* $= Cohort_{s,a,t} - TotMort_{s,a,t}$.

<u>Coho:</u> If the time step is less than 5, $Cohort_{s,a,t+1}$ is passed to the beginning of the time step loop and the next time step begun. After FRAM has processed all steps in the time step loop (time step = 5), the program checks for the presence of an optional Terminal Area Management Module (TAMM). If the model user has not specified a TAMM input file for additional processing, computations are complete and final escapements are calculated. If a TAMM has been specified, then FRAM will begin an iterative

[2] The von Bertalanffy growth parameters are estimated during the model calibration process from stock-specific CWT recovery data.

procedure to process the terminal fishery inputs and repeat the time step loops before calculating final escapements. Section 7 of this report provides additional details on the TAMM process.

Chinook: Because of the multiple age groups for Chinook, and the presence of both immature and mature fish, the process for Chinook involves additional steps and processes. The total harvest by pre-terminal fisheries of immature fish is calculated first following processes 3 to 9 similar to coho. Then a stock, age, and time step specific maturation rate that is calculated from the base period data is applied to the cohort remaining after the pre-terminal fishery removals **(Process 10)**. The mature portion of the cohort is then available to those fisheries, during the same time step, that have been designated as harvesting only mature fish (terminal fisheries) while the immature portion of the cohort is used to initiate the next time step.

If the time step is not the last step for a species (5 for coho or 4 for Chinook), the next step in the time step loop is initiated with updated cohort sizes for each stock (and stock-age group for Chinook). If the last time step had been completed, FRAM checks to see if there are TAMM inputs and whether or not they have been processed. If the TAMM inputs have not been processed, an iterative procedure (**Process 11**) is begun which loops back through the fishery procedures (processes 3 to 9) to make adjustments to terminal area catches and provide final estimates of escapements (coho) and terminal run sizes.

(Process 12) For coho, FRAM creates output files with the escapement by stock and total mortalities by fishery, stock, and time step. Escapement is defined as any fish from the mature cohort that do not die from fishery-related mortality in the terminal-area fisheries and is assumed to equal spawning escapement ("pre-spawning" mortality after the last fishery has been prosecuted is assumed negligible). For Chinook, FRAM creates output files with the terminal run size by stock and age and total mortalities by fishery, stock, age, and time step. Chinook fisheries in FRAM are designated as pre-terminal or terminal in the base period data. The terminal fisheries only harvest fish from the mature cohort thus simulating a migration pattern from the pre-terminal mixed stock areas.

(Process 13) For coho, the user loads the appropriate FRAM output files and reports into TAMM to produce additional TAMM reports commonly used during the pre-season fishery planning process. Similarly for Puget Sound Chinook stocks, the user loads the appropriate FRAM output files and reports into TAMM to produce additional TAMM reports for examining Puget Sound stocks and fisheries at a higher level of resolution than provided by FRAM. See the FRAM user manual (MEW 2006d) for more details on reports.

7. TERMINAL AREA MANAGEMENT MODULE (TAMM)

The FRAM program interacts with two species-specific (Chinook and coho) EXCEL spreadsheets that allow users to specify terminal fishery impacts on a finer time-area level of resolution than FRAM provides. The TAMM spreadsheets began with separate sections for each of the six Puget Sound terminal areas (Table 7-1) that are defined in the Puget Sound Salmon Management Plan (1985) for the State of Washington and the Treaty Tribes of Puget Sound. This structure has supported development of unique regional management goals and allows managers the flexibility to analyze and report FRAM model output according to their needs. The Chinook TAMM contains the original Puget Sound sections, while the coho TAMM has been expanded to allow report generation for many non-Puget Sound stock groups.

Table 7-1. Puget Sound terminal management regions.

Nooksack-Samish	Skagit
Stillaguamish-Snohomish	South Sound
Hood Canal	Strait of Juan de Fuca

Historically, managers used TAMMs to analyze fishery impacts on individual stock components of the larger FRAM stock groupings. The relatively new 1986-1991 base period for coho now includes individual Puget Sound populations (61 stocks) at the management level of resolution. Similarly, the current set of coho fisheries defined for Puget Sound in Coho FRAM are comprehensive; thus coho TAMMs now serve more as recipients of FRAM output for customized report generation.

In contrast, Chinook TAMM remains a critical element of pre-season modeling for Puget Sound stocks as many populations of management focus need to be "extracted" from the aggregated FRAM stock groupings. The current Chinook base period data aggregates terminal area fisheries for FRAM modeling at a higher level than is needed by management. The Chinook TAMM provides the ability to model individual marine and freshwater net fisheries in Puget Sound by the smaller time intervals associated with fisheries directed at Chinook, pink, coho, chum, or steelhead. In addition, test fisheries and fisheries in sub-areas can be specified. Similarly, the Chinook TAMM allows individual freshwater sport fisheries in Puget Sound to be modeled. The abundance of every hatchery and natural population of Chinook in Puget Sound is entered into the TAMM, as are harvest impacts from all Puget Sound fisheries, to allow fishery-specific impact analyses on all the populations of interest. The appropriate Chinook TAMM fishery impacts are summed into the terminal fishery definitions used by FRAM to calculate the FRAM fishery scalar inputs.

An iterative FRAM process for TAMM fishery inputs was developed to solve the problem of a stock being harvested in more than one terminal area during a time step. This often results in large differences between the impacts to a stock specified in a TAMM compared to those projected by FRAM during its initial pre-TAMM calculations. The FRAM program re-runs the terminal fishery time steps until the difference between the TAMM-specified expected fishery impacts and FRAM estimates (calculated from base period exploitation rates) are within ±0.1% of the expected value or the difference is less than four fish. During each iteration, the FRAM fishery scalars are adjusted by a proportion that is calculated as the expected value divided by the FRAM estimate for each terminal fishery. See MEW (2006a) for a more detailed description of the FRAM/TAMM iterative process.

8. PRE-SEASON MODEL INPUT DEVELOPMENT

The process for developing the FRAM model inputs used to assess upcoming fishing season options begins with the forecasting of hatchery and wild stock abundances and the proportions of each that are marked with an adipose fin clip. Fishery inputs for FRAM are generally developed later in the pre-season process beginning with the PFMC meeting in early March. Fishery-related mortality parameters such as release mortality rates, drop-off, drop-out, and mark-selective fishery parameters are reviewed and confirmed at the start of annual management cycle. Many of these rates do not change from year to year; some are the result of manager agreements made in previous years based on research study results. In the cases where research study results may be lacking such as marked recognition error in mark-selective fisheries, *ad hoc* values are established following technical staff discussions and manager agreement.

8.1 Stock Abundance

A variety of methods are used to forecast abundances of coho and Chinook. These forecasts are usually developed by local/regional technical staff during one or more technical meetings where relevant forecasting information is exchanged. The abundance forecasts vary in units of measure. For example, there are forecasts of salmon returning to a terminal area (which implies some accounting for pre-terminal fishery levels), forecasts of ocean abundance (which is commonly landed catch plus escapement), and forecasts of abundances prior to any fishing impacts (which includes natural mortality and non-landed fishery related mortality). The forecasts that are based on expectations of fish returning to the terminal area need to account for pre-terminal fishing impacts or impacts that occurred in previous seasons in the case of Chinook. Each of these different types of forecasts need to be converted to the "unit of measure" used by FRAM, which is the abundance at age of each stock prior to fishing vulnerability and natural mortality. For both coho and Chinook, the FRAM stock abundances are input as a scalar where the forecasted number of fish prior to fishing is divided by the FRAM base period average abundance for each stock at each age.

8.1.1 Coho

The coho forecasts supplied by the local/regional technical staff vary in methods and units of measure (Appendix Table 5-6). Common forecasting methods include jack-to-adult relationships using the previous year's jack returns (age-2 fish) to estimate age-3 adult return (e.g., Oregon Production Index) or smolt production estimates for hatchery or wild-origin fish expanded by an average marine survival rate. Forecasts can be in terms of ocean abundance (i.e., all catch and escapement), return to a terminal area, or production index relative to the 1986-91 base period from a representative population within a region. These too must be converted to FRAM units of measure, which for coho is the number of age-3 fish in January of the fishing year. Most of the coho forecasts are now produced in terms of ocean abundance that is expanded by 1.232 to account for natural mortality and provide an estimate of the abundance of age-3 fish in January of the fishing year. Any non-landed fishery related mortality that occurs is ignored in this ocean abundance-to-total abundance FRAM conversion step.

8.1.2 Chinook

The methods used to convert the forecasts made by the local/regional technical staff to FRAM inputs vary depending on the type of forecast (Appendix Table 5-7). Forecasts for Columbia River stocks are usually in terms of age-specific returns to the river mouth using brood year sibling relationships with the number of age-specific Chinook that returned the previous season. Puget Sound stock forecasts are commonly recent year averages of Chinook returning to terminal net fisheries and escapement areas east of the western end of the Strait of Juan de Fuca (called "4B" run size). The Puget Sound forecasts are a mixture of age-specific forecasts and forecasts that assume all fish caught are four-years old (e.g., South Puget Sound Hatchery fall Chinook yearlings). Forecasts of Snohomish, Stillaguamish, and Tulalip Hatchery Chinook are made in terms of age-specific abundances prior to fishing that can be directly converted to FRAM abundance scalars.

8.2 Fisheries

Fisheries are modeled using FRAM input methods that usually do not vary between yearly pre-season model runs. Generally, Council managed fisheries North of Cape Falcon are modeled as landed catch quotas and fisheries South of Cape Falcon are modeled as landed catch quotas (coho) or exploitation rate scalars (Chinook). Fisheries outside of Council jurisdiction are modeled using a variety of the FRAM methods available except "ceiling", which has not been used in recent years.

8.2.1 Coho

Council-managed coho retention fisheries are modeled as landed fish quotas (Appendix Table 5-8). Inside fisheries are modeled as quotas managed as a landed catch expectation, as catch (or occasionally effort) scalars, or as terminal area harvest rates used during TAMM processing.

Council-managed coho non-retention fisheries are modeled using external estimates of mortalities generated from historical coho to Chinook ratios of landings when retention of both species was allowed. In some fisheries, like the troll fisheries South of Cape Falcon, these external mortality estimates are adjusted downward to account for shifts in effort away from the species that cannot be retained.

8.2.2 Chinook

Input methods used for Chinook retention fisheries during recent year's pre-season runs are shown in Appendix Table 5-9. Generally, effort or exploitation rate scalars are used for those fisheries that have relatively low Chinook stock representation in FRAM, such as in Alaska, Northern Canada, Central Oregon, and California. For fisheries with a high proportion of catches from FRAM stocks, any of the FRAM input methods can be used. Input type can depend on the management regime such as for PFMC fisheries North of Cape Falcon which are managed for a Total Allowable Catch (i.e., quota). Chinook FRAM relies on exploitation rate scalars derived from the PSC Chinook model as inputs for Alaskan and most Canadian fisheries. The PSC model has better stock representation in these northern fisheries and consequently is assumed to provide a better representation of fishing effort changes relative to the base period, which is common to both models. Usually fishery inputs for the PSC model for the current year are not available until late in the Council management cycle. Until the new inputs are available, very preliminary values or values from the previous year must be used which creates greater uncertainty during the annual assessment process.

For Council managed fisheries South of Cape Falcon, exploitation rate scalars calculated from fishing effort data are used for inputs to the model. Effort scalars are calculated from the expected number of vessel fishing days for troll fisheries and the angler-trips for sport fisheries divided by 1979-81 base period average effort levels.

For "inside" fisheries that are not Council managed, including those in Puget Sound and in freshwater fisheries, FRAM fishery input methods for retention fisheries include quota (as a fixed catch), effort scalars (e.g., Puget Sound marine sport) or as terminal fishery harvest rates used during TAMM processing (e.g., Puget Sound terminal net).

Chinook non-retention fishery mortalities are primarily modeled using estimates of sub-legal and legal size encounters.

9. POSTSEASON MODEL USAGE

Although FRAM is primarily used for preseason fishery impact assessment, FRAM is also used in a "postseason" mode. These postseason model runs can be used for two purposes; as a tool to validate/evaluate the model's performance by comparing model estimates to independently derived estimates and to evaluate the performance of the fishery management system towards meeting conservation objectives for key stocks.

Postseason FRAM runs contain actual catches (or effort scalars) and estimates of actual stock abundances. The postseason estimates of total abundances of each stock are the most difficult to derive. In most cases, this estimate of the number of fish available prior to any fishing are derived from expanding the number of fish returning to a terminal area by preterminal fishery expansion factors. These

preterminal fishery expansion factors are estimated from fishing-year CWT recovery data and/or from effort scalars derived from comparing effort during the base period to effort during the fishing year for each FRAM fishery strata. For Chinook FRAM, the postseason model runs, which are called "validation" runs, are developed during the model calibration process (See Chinook FRAM Base Data Development for details). For Coho FRAM, a "Backwards" FRAM subroutine was developed that uses iterations of FRAM to derive initial stock abundances. Basically, the procedure involves estimation of the set of stock abundance scalars that best explains observed escapements and reported catches through an iterative process involving modification of stock abundance scalars specified in a FRAM command file The Backwards FRAM subroutine can also be used to derive hypothetical CWT recoveries for FRAM stock units that were not tagged for specific fishing year (See Section 13 in Coho FRAM Base Data Development for details).

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11. GLOSSARY

Adult Equivalent (AEQ) - The potential for a fish of a given age to contribute to the mature run (spawning escapement) in the absence of fishing. Because of natural mortality and unaccounted losses, not all unharvested fish contribute to spawning escapement. For example, a two-year-old Chinook has a lower probability of surviving to spawn, in the absence of fishing, than does a five-year-old, and these two age classes have different "adult equivalents".

Base Period - A set of brood years from which CWT data are used to estimate exploitation rates, maturation rates, and stock abundances. The years used for the base period differ by species and stock. Brood years are chosen based on consistent coded-wire tagging of stocks, consistent CWT sampling of fisheries, and the relatively consistent execution of fisheries during the return years. Some Chinook stocks in the model were not tagged during the base period; recoveries of these stocks (called "out-of-base" stocks) are adjusted to account for changes in exploitation rates relative to the base period.

Catch Ceiling - A fishery catch limitation expressed in numbers of fish. A ceiling fishery is managed so as not to exceed the ceiling; actual catch is expected to fall somewhere below the ceiling.

Catch Quota - A fishery catch allocation expressed in numbers of fish. A quota fishery is managed to catch the quota; actual catch is expected to be slightly above or below the quota.

Chinook/Coho Non-retention (CNR) - Time periods when salmon fishing is allowed, but the retention of Chinook (or coho) salmon is prohibited.

Cohort Analysis - A sequential population analysis technique that is used during model calibration to reconstruct the exploited life history of coded-wire tag groups.

Cohort Size (initial) - The total number of fish of a given age and stock at the beginning of the fishing season.

Coded-Wire-Tag (CWT) - Coded micro-wire tags that are implanted in juvenile salmon prior to release. Historically, a tagged fish usually had the adipose fin removed to signal tag presence. Fisheries and escapements are sampled for tagged fish. When recovered, the binary code on the tag provides specific information about the tag group (e.g., location and timing of release, special hatchery treatments, etc.).

Drop-off Mortality - Mortality of salmon that "drop-off" sport or troll fishing gear before they are landed and die from their injuries prior to harvest or spawning.

Drop-out Mortality - Mortality of salmon that die in a fishing net and "drop-out" prior to harvest or salmon that disentangle from a net while it is in the water and die from their injuries prior to harvest or spawning.

Exploitation Rate (ER) - Total fishing mortality rate in a fishery expressed as the sum of all fishery-related mortalities divided by that sum plus escapement.

Exploitation Rate Scalar - A multiplier, typically based on expected effort relative to base period effort, used to estimate fishery impacts by adjusting the base period exploitation rates. Exploitation rate scalars can be stock and fishery specific, but generally they are applied to all stocks in a fishery.

FRAM - The Fishery Regulation Assessment Model is a simulation model developed for fishery management and used to estimate the impacts of proposed Pacific Coast salmon fisheries on Chinook and coho stocks of interest to fishery managers.

Harvest Rate (HR) - Catch or total fishing mortality in a fishery expressed as a proportion of the total fish abundance available in a given fishing area at the start of a time period.

Hooking Mortality - Mortality of salmon that are caught and released by sport or troll hook-and-line gear and die from their injuries prior to harvest or spawning.

Marked Recognition Error - The probability that a marked fish will be inadvertently released.

Model Calibration - Model process involving base period data which (1) scales the coded-wire tag recoveries to represent a stock, (2) allocates non-landed catch mortality to stocks, and (3) reconstructs the cohort in order to compute exploitation rates, maturation rates, and stock abundance.

Model Simulation - Use of the model to vary the calibrated fish population abundance and fishing rates to portray the effects, on the stocks and fisheries, of different sets of proposed sport and commercial fishery regulations.

Non-landed Mortality - This category of fishery-related mortality includes hook-and-line drop-off, net gear drop-out, and hook-and-release mortality.

Non-treaty Fisheries - Fisheries conducted by fishers who are not members of the twenty-four Belloni or Boldt Case Area Tribes.

Pre-terminal - In FRAM, a "pre-terminal" fishery is one that operates on immature fish.

Shaker Mortality – "Shakers" - This term is synonymous with hooking mortality and represents fish that are released from recreational and troll hook-and-line fisheries, either because they are outside of the regulatory size limits or because the species is not allowed to be kept.

Terminal - In FRAM, a "terminal" fishery is one that operates only on mature fish. These fisheries tend to be adjacent to a stock's stream of origin and harvest returning adult fish.

Terminal Area Management Modules (TAMM) - Spreadsheets external to but integrated with FRAM that are used to: (1) provide input for FRAM simulations regarding projected Puget Sound terminal area catches or stock-specific impacts; (2) compute mortality and escapements of individual stock components of the larger Puget Sound FRAM stock aggregates; and (3) create output reports that summarize simulated regulations, stock exploitation rates, allocation accounting, and escapement estimates.

Treaty Fisheries - Fisheries conducted by members of the twenty-four Belloni or Boldt Case Area Tribes.

Unmarked Retention Error (or Retention Error Rate) - The probability that an unmarked fish will be retained inappropriately in a selective fishery (e.g., the fisher fails to identify the mark or the fisher fails to comply with release requirement).

Validation - An evaluation of how well the model predicts variables of interest (e.g., terminal runs, catch by stock, and stock composition) when post-season estimates of stock abundance and fishery catches are used as input data. Validation is intended to evaluate performance of the model. In other words, does the model yield correct stock-specific impacts using, as inputs, actual stock size and fishery catch information.

12. APPENDICES

Appendix 1. Coho FRAM stocks.

Production Region	Unmarked Stock #	Abbreviated Name	Coho Stock Name
NOOKSM	1	nkskrw	Nooksack River Wild
NOOKSM	3	kendlh	Kendall Creek Hatchery
NOOKSM	5	skokmh	Skookum Creek Hatchery
NOOKSM	7	lumpdh	Lummi Ponds Hatchery
NOOKSM	9	bhambh	Bellingham Bay Net Pens
NOOKSM	11	samshw	Samish River Wild
NOOKSM	13	ar77aw	Area 7/7A Independent Wild
NOOKSM	15	whatch	Whatcom Creek Hatchery
SKAGIT	17	skagtw	Skagit River Wild
SKAGIT	19	skagth	Skagit River Hatchery
SKAGIT	21	skgbkh	Baker (Skagit) Hatchery
SKAGIT	23	skgbkw	Baker (Skagit) Wild
SKAGIT	25	swinch	Swinomish Channel Hatchery
SKAGIT	27	oakhbh	Oak Harbor Net Pens
STILSN	29	stillw	Stillaguamish River Wild
STILSN	31	stillh	Stillaguamish River Hatchery
STILSN	33	tuliph	Tulalip Hatchery
STILSN	35	snohow	Snohomish River Wild
STILSN	37	snohoh	Snohomish River Hatchery
STILSN	39	ar8anh	Area 8A Net Pens
HOODCL	41	ptgamh	Port Gamble Net Pens
HOODCL	43	ptgamw	Port Gamble Bay Wild
HOODCL	45	ar12bw	Area 12/12B Wild
HOODCL	47	qlcnbh	Quilcene Hatchery
HOODCL	49	qlcenh	Quilcene Bay Net Pens
HOODCL	51	ar12aw	Area 12A Wild
HOODCL	53	hoodsh	Hoodsport Hatchery
HOODCL	55	ar12dw	Area 12C/12D Wild
HOODCL	57	gadamh	George Adams Hatchery
HOODCL	59	skokrw	Skokomish River Wild
SPGSND	61	ar13bw	Area 13B Misc. Wild
SPGSND	63	deschw	Deschutes R. (WA) Wild
SPGSND	65	ssdnph	South Puget Sound Net Pens
SPGSND	67	nisqlh	Nisqually River Hatchery
SPGSND	69	nisqlw	Nisqually River Wild
SPGSND	71	foxish	Fox Island Net Pens
SPGSND	73	mintch	Minter Creek Hatchery

Appendix 1. Coho FRAM stocks (continued).

Production Region	Unmarked Stock #	Abbreviated Name	Coho Stock Name
SPGSND	75	ar13mw	Area 13 Miscellaneous Wild
SPGSND	77	chambh	Chambers Creek Hatchery
SPGSND	79	ar13mh	Area 13 Misc. Hatchery
SPGSND	81	ar13aw	Area 13A Miscellaneous Wild
SPGSND	83	puyalh	Puyallup River Hatchery
SPGSND	85	puyalw	Puyallup River Wild
SPGSND	87	are11h	Area 11 Hatchery
SPGSND	89	ar11mw	Area 11 Miscellaneous Wild
SPGSND	91	ar10eh	Area 10E Hatchery
SPGSND	93	ar10ew	Area 10E Miscellaneous Wild
SPGSND	95	greenh	Green River Hatchery
SPGSND	97	greenw	Green River Wild
SPGSND	99	lakwah	Lake Washington Hatchery
SPGSND	101	lakwaw	Lake Washington Wild
SPGSND	103	are10h	Area 10 H inc. Ebay,SeaAq NP
SPGSND	105	ar10mw	Area 10 Miscellaneous Wild
SJDFCA	107	dungew	Dungeness River Wild
SJDFCA	109	dungeh	Dungeness Hatchery
SJDFCA	111	elwhaw	Elwha River Wild
SJDFCA	113	elwhah	Elwha Hatchery
SJDFCA	115	ejdfmw	East JDF Miscellaneous Wild
SJDFCA	117	wjdfmw	West JDF Miscellaneous Wild
SJDFCA	119	ptangh	Port Angeles Net Pens
SJDFCA	121	area9w	Area 9 Miscellaneous Wild
MAKAHC	123	makahw	Makah Coastal Wild
MAKAHC	125	makahh	Makah Coastal Hatchery
QUILUT	127	quilsw	Quillayute R Summer Natural
QUILUT	129	quilsh	Quillayute R Summer Hatchery
QUILUT	131	quilfw	Quillayute River Fall Natural
QUILUT	133	quilfh	Quillayute River Fall Hatchery
HOHRIV	135	hohrvw	Hoh River Wild
HOHRIV	137	hohrvh	Hoh River Hatchery
QUEETS	139	quetfw	Queets River Fall Natural
QUEETS	141	quetfh	Queets River Fall Hatchery
QUEETS	143	quetph	Queets R Supplemental Hat.
QUINLT	145	quinfw	Quinault River Fall Natural
QUINLT	147	quinfh	Quinault River Fall Hatchery

Appendix 1. Coho FRAM stocks (continued).

Production Region	Unmarked Stock #	Abbreviated Name	Coho Stock Name
GRAYHB	149	chehlw	Chehalis River Wild
GRAYHB	151	chehlh	Chehalis River (Bingham) Hat.
GRAYHB	153	humptw	Humptulips River Wild
GRAYHB	155	humpth	Humptulips River Hatchery
GRAYHB	157	gryhmw	Grays Harbor Misc. Wild
GRAYHB	159	gryhbh	Grays Harbor Net Pens
WILLAPA	161	willaw	Willapa Bay Natural
WILLAPA	163	willah	Willapa Bay Hatchery
COLRIV	165	colreh	Columbia River Early Hatchery
COLRIV	167	youngh	Youngs Bay Hatchery
COLRIV	169	crorew	Lower Col Oregon Wild
COLRIV	171	washew	Washington Early Wild
COLRIV	173	washlw	Washington LateLate Wild
COLRIV	175	colrlh	Columbia River Late Hatchery
OREGON	177	orenoh	Oregon North Coastal Hat.
OREGON	179	orenow	Oregon North Coastal Wild
OREGON	181	orenmh	Oregon No. Mid Coastal Hat.
OREGON	183	orenmw	Oregon No. Mid Coastal Wild
OREGON	185	oresmh	Oregon So. Mid Coastal Hat.
OREGON	187	oresmw	Oregon So. Mid Coastal Wild
OREGON	189	oranah	Oregon Anadromous Hatchery
OREGON	191	oraqah	Oregon Aqua-Foods Hatchery
ORECAL	193	oresoh	Oregon South Coastal Hat.
ORECAL	195	oresow	Oregon South Coastal Wild
ORECAL	197	calnoh	California North Coastal Hatch
ORECAL	199	calnow	California North Coastal Wild
ORECAL	201	calcnh	California Central Coastal Hat.
ORECAL	203	calcnw	California Central Coastal Wild
GSMLND	205	gsmndh	Georgia Strait Mainland Hat.
GSMLND	207	gsmndw	Georgia Strait Mainland Wild
GSVNCI	209	gsvcih	Georgia Strait Vanc. Is. Hat.
GSVNCI	211	gsvciw	Georgia Strait Vanc. Is. Wild
JNSTRT	213	jnstrh	Johnstone Strait Hatchery
JNSTRT	215	jnstrw	Johnstone Strait Wild
SWVNCI	217	swvcih	SW Vancouver Island Hat.
SWVNCI	219	swvciw	SW Vancouver Island Wild
NWVNCI	221	nwvcih	NW Vancouver Island Hatchery

Appendix 1. Coho FRAM stocks (continued).

Production Region	Unmarked Stock #	Abbreviated Name	Coho Stock Name
NWVNCI	223	nwvciw	NW Vancouver Island Wild
FRSLOW	225	frslwh	Lower Fraser River Hatchery
FRSLOW	227	frslww	Lower Fraser River Wild
FRSUPP	229	frsuph	Upper Fraser River Hatchery
FRSUPP	231	frsupw	Upper Fraser River Wild
BCCNTL	233	bccnhw	BC Central Coast Hat./Wild
BCNCST	235	bcnchw	BC North Coast Hatchery/Wild
TRANAC	237	tranhw	Trans Boundary Hatchery/Wild
NIASKA	239	niakhw	Alaska No. Inside Hat./Wild
NOASKA	241	noakhw	Alaska No. Outside Hat./Wild
SIASKA	243	siakhw	Alaska So. Inside Hat./Wild
SOASKA	245	soakhw	Alaska So. Outside Hat./Wild

Appendix 2. Chinook FRAM stocks and CWT brood years used for base period data sets.

Unmarked Stock #	Stock Name	Abbreviated Name	CWT Broods Included*
1	Nooksack-Samish summer/fall	NkSm FlFi	77, 79
3	North Fork Nooksack early (spring)	NFNK Sprg	OOB - 84, 88 (N. Fk.)
5	South Fork Nooksack early (spring)	SFNK Sprg	OOB - 84, 88 (N. Fk.)
7	Skagit summer/fall fingerling	Skag FlFi	76, 77
9	Skagit summer/fall yearling	Skag FlYr	76
11	Skagit spring yearling	Skag SpYr	OOB - 85, 86, 87, 90
13	Snohomish summer/fall fingerling	Snoh FlFi	OOB - 86, 87, 88
15	Snohomish summer/fall yearling	Snoh FlYr	76
17	Stillaguamish summer/fall fingerling	Stil FlFi	OOB - 86, 87, 88-90
19	Tulalip summer/fall fingerling	Tula FlFi	OOB - 86, 87, 88
21	Mid S. Puget Sound fall fingerling	USPS FlFi	78,79
23	UW Accelerated fall fingerling	UW-A FlFi	77-79
25	Deep S. Puget Sound fall fingerling	DSPS FlFi	78,79
27	South Puget Sound fall yearling	SPSo FlYr	78,79
29	White River spring fingerling	Whte SpFi	OOB – 91-93
31	Hood Canal fall fingerling	HdCl FlFi	78,79
33	Hood Canal fall yearling	HdCl FlYr	78,79
35	Juan de Fuca Tribs. fall fingerling	SJDF FlFi	78,79
37	Oregon Lower Columbia River Hatchery	Oregn LRH	78,79
39	Wash. Lower Columbia River Hatchery	Washn LRH	77,79
41	Lower Columbia River Wild	Low CR Wi	77-78
43	Bonneville Pool Hatchery tule	BP H Tule	76-79
45	Columbia Upriver summer	Upp CR Su	76,77
47	Columbia Upriver bright	Col R Brt	75-77
49	Washington Lower River spring	WaLR Sprg	77
51	Willamette spring	Will Sprg	76-78
53	Snake River fall	SnakeR Fl	OOB - 84, 85, 86
55	Oregon North Migrating fall	Ore No Fl	76-78
57	West Coast Vancouver Island Total	WCVI Totl	74-77
59	Fraser Late	Fraser Lt	OOB - 81, 82, 83
61	Fraser Early	Fraser Er	78,79, OOB -, 86
63	Lower Georgia Strait fall	Lwr Geo St	77, 78
65	White River spring yearling	Whte SpYr	OOB – 91-93
67	Lower Columbia Natural Tule	LwrColN	77-79
69	Central Valley-Sacramento River	CtrVal	OOB - 98-99
71	Washington North Coast	WA N Cst	77-78
73	Willapa Bay	Wilpa	OOB – 83-85
75	Hoko	Hoko	OOB – 85-87

*OOB = Out-of-base stock.

Appendix 3. Coho FRAM fisheries.

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
No Cal Trm	1	North California Coast Terminal Catch
Cn Cal Trm	2	Central California Coast Terminal Catch
Ft Brg Spt	3	Fort Bragg Sport
Ft Brg Trl	4	Fort Bragg Troll
Ca KMZ Spt	5	KMZ Sport (Klamath Management Zone)
Ca KMZ Trl	6	KMZ Troll (Klamath Management Zone)
So Cal Spt	7	Southern California Sport
So Cal Trl	8	Southern California Troll
So Ore Trm	9	South Oregon Coast Terminal Catch
Or Prv Trm	10	Oregon Private Hatchery Terminal Catch
SMi Or Trm	11	South-Mid Oregon Coast Terminal Catch
NMi Or Trm	12	North-Mid Oregon Coast Terminal Catch
No Ore Trm	13	North Oregon Coast Terminal Catch
Or Cst Trm	14	Mid-North Oregon Coast Terminal Catch
Brkngs Spt	15	Brookings Sport
Brkngs Trl	16	Brookings Troll
Newprt Spt	17	Newport Sport
Newprt Trl	18	Newport Troll
Coos B Spt	19	Coos Bay Sport
Coos B Trl	20	Coos Bay Troll
Tillmk Spt	21	Tillamook Sport
Tillmk Trl	22	Tillamook Troll
Buoy10 Spt	23	Buoy 10 Sport (Columbia River Estuary)
L ColR Spt	24	Lower Columbia River Mainstem Sport
L ColR Net	25	Lower Columbia River Net (Excl Youngs Bay)
Yngs B Net	26	Youngs Bay Net
LCROrT Spt	27	Below Bonneville Oregon Tributary Sport
Clackm Spt	28	Clackamas River Sport
SandyR Spt	29	Sandy River Sport
LCRWaT Spt	30	Below Bonneville Washington Tributary Sport
UpColR Spt	31	Above Bonneville Sport
UpColR Net	32	Above Bonneville Net
A1-Ast Spt	33	Area 1 (Illwaco) & Astoria Sport
A1-Ast Trl	34	Area 1 (Illwaco) & Astoria Troll
Area2TrlNT	35	Area 2 Troll Non-treaty (Westport)
Area2TrlTR	36	Area 2 Troll Treaty (Westport)

Appendix 3. Coho FRAM fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
Area 2 Spt	37	Area 2 Sport (Westport)
Area3TrlNT	38	Area 3 Troll Non-treaty (LaPush)
Area3TrlTR	39	Area 3 Troll Treaty (LaPush)
Area 3 Spt	40	Area 3 Sport (LaPush)
Area 4 Spt	41	Area 4 Sport (Neah Bay)
A4/4BTrlNT	42	Area 4/4B (Neah Bay PFMC Regs) Troll Non-treaty
A4/4BTrlTR	43	Area 4/4B (Neah Bay PFMC Regs) Troll Treaty
A 5-6C Trl	44	Area 5, 6, 6C Troll (Strait of Juan de Fuca)
Willpa Spt	45	Willapa Bay (Area 2.1) Sport
Wlp Tb Spt	46	Willapa Tributary Sport
WlpaBT Net	47	Willapa Bay & FW Trib Net
GryHbr Spt	48	Grays Harbor (Area 2.2) Sport
SGryHb Spt	49	South Grays Harbor Sport (Westport Boat Basin)
GryHbr Net	50	Grays Harbor Estuary Net
Hump R Spt	51	Humptulips River Sport
LwCheh Net	52	Lower Chehalis River Net
Hump R C&S	53	Humptulips River Ceremonial & Subsistence
Chehal Spt	54	Chehalis River Sport
Hump R Net	55	Humptulips River Net
UpCheh Net	56	Upper Chehalis River Net
Chehal C&S	57	Chehalis River Ceremonial & Subsistence
Wynoch Spt	58	Wynochee River Sport
Hoquam Spt	59	Hoquiam River Sport
Wishkh Spt	60	Wishkah River Sport
Satsop Spt	61	Satsop River Sport
Quin R Spt	62	Quinault River Sport
Quin R Net	63	Quinault River Net
Quin R C&S	64	Quinault River Ceremonial & Subsistence
Queets Spt	65	Queets River Sport
Clrwtr Spt	66	Clearwater River Sport
Salm R Spt	67	Salmon River (Queets) Sport
Queets Net	68	Queets River Net
Queets C&S	69	Queets River Ceremonial & Subsistence
Quilly Spt	70	Quillayute River Sport
Quilly Net	71	Quillayute River Net
Quilly C&S	72	Quillayute River Ceremonial & Subsistence
Hoh R Spt	73	Hoh River Sport
Hoh R Net	74	Hoh River Net
Hoh R C&S	75	Hoh River Ceremonial & Subsistence

Appendix 3. Coho FRAM fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
Mak FW Spt	76	Makah Tributary Sport
Mak FW Net	77	Makah Freshwater Net
Makah C&S	78	Makah Ceremonial & Subsistence
A 4-4A Net	79	Area 4, 4A Net (Neah Bay)
A4B6CNetNT	80	Area 4B, 5, 6C Net Nontreaty (Strait of JDF)
A4B6CNetTR	81	Area 4B, 5, 6C Net Treaty (Strait of JDF)
Ar6D NetNT	82	Area 6D Dungeness Bay/River Net Nontreaty
Ar6D NetTR	83	Area 6D Dungeness Bay/River Net Treaty
Elwha Net	84	Elwha River Net
WJDF T Net	85	West JDF Straits Tributary Net
EJDF T Net	86	East JDF Straits Tributary Net
A6-7ANetNT	87	Area 7, 7A Net Nontreaty (San Juan Islands)
A6-7ANetTR	88	Area 7, 7A Net Treaty (San Juan Islands)
EJDF FWSpt	89	East JDF Straits Tributary Sport
WJDF FWSpt	90	West JDF Straits Tributary Sport
Area 5 Spt	91	Area 5 Marine Sport (Sekiu)
Area 6 Spt	92	Area 6 Marine Sport (Port Angeles)
Area 7 Spt	93	Area 7 Marine Sport (San Juan Islands)
Dung R Spt	94	Dungeness River Sport
ElwhaR Spt	95	Elwha River Sport
A7BCDNetNT	96	Area 7B-7C-7D Net Nontreaty (Bellingham Bay)
A7BCDNetTR	97	Area 7B-7C-7D Net Treaty (Bellingham Bay)
Nook R Net	98	Nooksack River Net
Nook R Spt	99	Nooksack River Sport
Samh R Spt	100	Samish River Sport
Ar 8 NetNT	101	Area 8 Skagit Marine Net Nontreaty
Ar 8 NetTR	102	Area 8 Skagit Marine Net Treaty
Skag R Net	103	Skagit River Net
SkgR TsNet	104	Skagit River Test Net
SwinCh Net	105	Swinomish Channel Net
Ar 8-1 Spt	106	Area 8.1 Marine Sport
Area 9 Spt	107	Area 9 Marine Sport (Admiralty Inlet)
Skag R Spt	108	Skagit River Sport
Ar8A NetNT	109	Area 8A Stillaguamish/Snohomish Net Nontreaty
Ar8A NetTR	110	Area 8A Stillaguamish/Snohomish Net Treaty
Ar8D NetNT	111	Area 8D Tulalip Bay Net Nontreaty
Ar8D NetTR	112	Area 8D Tulalip Bay Net Treaty
Stil R Net	113	Stillaguamish River Net
Snoh R Net	114	Snohomish River Net

Appendix 3. Coho FRAM fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
Ar 8-2 Spt	115	Area 8.2 Marine Sport
Stil R Spt	116	Stillaguamish River Sport
Snoh R Spt	117	Snohomish River Sport
Ar 10 Spt	118	Area 10 Marine Sport (Seattle)
Ar10 NetNT	119	Area 10 Net Nontreaty (Seattle)
Ar10 NetTR	120	Area 10 Net Treaty (Seattle)
Ar10ANetNT	121	Area 10A Net Nontreaty (Elliott Bay)
Ar10ANetTR	122	Area 10A Net Treaty (Elliott Bay)
Ar10ENetNT	123	Area 10E Net Nontreaty (East Kitsap)
Ar10EnetTR	124	Area 10E Net Treaty (East Kitsap)
10F-G Net	125	Area 10F-G Ship Canal/Lake Washington Net Treaty
Duwm R Net	126	Green/Duwamish River Net
Duwm R Spt	127	Green/Duwamish River Sport
L WaSm Spt	128	Lake Washington-Lake Sammamish Tributary Sport
Ar 11 Spt	129	Area 11 Marine Sport (Tacoma)
Ar11 NetNT	130	Area 11 Net Nontreaty (Tacoma)
Ar11 NetTR	131	Area 11 Net Treaty (Tacoma)
Ar11ANetNT	132	Area 11A Net Nontreaty (Commencement Bay)
Ar11ANetTR	133	Area 11A Net Treaty (Commencement Bay)
Puyl R Net	134	Puyallup River Net
Puyl R Spt	135	Puyallup River Sport
Ar 13 Spt	136	Area 13 Marine Sport (South Puget Sound)
Ar13 NetNT	137	Area 13 Net Nontreaty (South Puget Sound)
Ar13 NetTR	138	Area 13 Net Treaty (South Puget Sound)
Ar13CNetNT	139	Area 13C Net Nontreaty (Chambers Bay)
Ar13CNetTR	140	Area 13C Net Treaty (Chambers Bay)
Ar13ANetNT	141	Area 13A Net Nontreaty (Carr Inlet)
Ar13ANetTR	142	Area 13A Net Treaty (Carr Inlet)
Ar13DNetNT	143	Area 13D Net Nontreaty (South Puget Sound)
Ar13DNetTR	144	Area 13D Net Treaty (South Puget Sound)
A13FKNetNT	145	Area 13F-13K Net Nontreaty (South PS Inlets)
A13FKNetTR	146	Area 13F-13K Net Treaty (South PS Inlets)
Nisq R Net	147	Nisqually River Net
McAlls Net	148	McAllister Creek Net
13D-K TSpt	149	13D-13K Tributary Sport (South PS Inlets)
Nisq R Spt	150	Nisqually River Sport
Desc R Spt	151	Deschutes River Sport (Olympia)
Ar 12 Spt	152	Area 12 Marine Sport (Hood Canal)
1212BNetNT	153	Area 12-12B Net Nontreaty (Upper Hood Canal)

Appendix 3. Coho FRAM fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
1212BNetTR	154	Area 12-12B Net Treaty (Upper Hood Canal)
Ar9A NetNT	155	Area 9A Net Nontreaty (Port Gamble)
Ar9A NetTR	156	Area 9-9A Net Treaty (Port Gamble/On Reservation)
Ar12ANetNT	157	12A Net Nontreaty (Quilcene Bay)
Ar12ANetTR	158	12A Net Treaty (Quilcene Bay)
A12CDNetNT	159	12C-12D Net Nontreaty (Lower Hood Canal)
A12CDNetTR	160	12C-12D Net Treaty (Lower Hood Canal)
Skok R Net	161	Skokomish River Net
Quilcn Net	162	Quilcene River Net
1212B TSpt	163	12-12B Tributary FW Sport
Quilcn Spt	164	12A Tributary FW Sport (Quilcene River)
12C-D TSpt	165	12C-12D Tributary FW Sport
Skok R Spt	166	Skokomish River Sport
FRSLOW Trm	167	Lower Fraser River Stock Terminal Catch
FRSUPP Trm	168	Upper Fraser River Stock Terminal Catch
Fraser Spt	169	Fraser River/Estuary Sport
JStrBC Trl	170	Johnstone Straits Troll
No BC Trl	171	Northern British Columbia Troll
NoC BC Trl	172	North Central British Columbia Troll
SoC BC Trl	173	South Central British Columbia Troll
NW VI Trl	174	NW Vancouver Island Troll
SW VI Trl	175	SW Vancouver Island Troll
GeoStr Trl	176	Georgia Straits Troll
BC JDF Trl	177	British Columbia Juan de Fuca Troll
No BC Net	178	Northern British Columbia Net
Cen BC Net	179	Central British Columbia Net
NW VI Net	180	NW Vancouver Island Net
SW VI Net	181	SW Vancouver Island Net
Johnst Net	182	Johnstone Straits Net
GeoStr Net	183	Georgia Straits Net
Fraser Net	184	Fraser River Gill Net
BC JDF Net	185	British Columbia Juan de Fuca Net
JStrBC Spt	186	Johstone Strait Sport
No BC Spt	187	Northern British Columbia Sport
Cen BC Spt	188	Central British Columbia Sport
BC JDF Spt	189	British Columbia Juan de Fuca Sport
WC VI Spt	190	West Coast Vancouver Island Sport
NGaStr Spt	191	North Georgia Straits Sport
SGaStr Spt	192	South Georgia Straits Sport

Appendix 3. Coho FRAM fisheries (continued).

Albern Spt	193	Alberni Canal Sport
SW AK Trl	194	Southwest Alaska Troll
SE AK Trl	195	Southeast Alaska Troll
NW AK Trl	196	Northwest Alaska Troll
NE AK Trl	197	Northeast Alaska Troll
Alaska Net	198	Alaska Net (Areas 182:183:185:192)

Appendix 4. Chinook FRAM fisheries and the proportion of catch attributed to FRAM modeled Chinook stocks from 2007 calibration.

Fishery #	Fishery Name	FRAM Stock Portion Of Modeled Catch
1	Southeast Alaska Troll	0.5790
2	Southeast Alaska Net	0.2410
3	Southeast Alaska Sport	0.2720
4	North/Central British Columbia Net	0.5856
5	West Coast Vancouver Island Net	0.5489
6	Strait of Georgia Net	0.6611
7	Canada Juan de Fuca Net (Area 20)	0.9178
8	North/Central British Columbia Sport	0.8454
9	North/Central British Columbia Troll	0.6355
10	West Coast Vancouver Island Troll	0.9201
11	West Coast Vancouver Island Sport	1.0000
12	Strait of Georgia Troll	0.5319
13	North Strait of Georgia Sport	1.0000
14	South Strait of Georgia Sport	1.0000
15	BC Juan de Fuca Sport	0.9967
16	NT Cape Flattery-Quillayute Troll (Area 3-4)	0.9909
17	T Cape Flattery-Quillayute Troll (Area 3-4)	0.9618
18	Cape Flattery-Quillayute Sport (Area 3-4)	1.0000
19	Cape Flattery-Quillayute Net (Area 3-4)	1.0000
20	NT Grays Harbor Troll (Area 2)	1.0000
21	T Grays Harbor Troll (Area 2)	0.6776
22	Grays Harbor Sport (Area 2)	0.8352
23	NT Grays Harbor Net	0.1759
24	T Grays Harbor Net	0.0418
25	Willapa Net	0.5572
26	NT Columbia River Troll (Area 1)	1.0000
27	Columbia River Sport (Area 1)	0.8842
28	Columbia River Net	2.1063
29	Buoy 10 Sport	1.0000
30	Orford Reef-Cape Falcon Troll (Central OR)	0.9289
31	Orford Reef-Cape Falcon Sport (Central OR)	0.9129
32	Horse Mountain-Orford Reef Troll (KMZ)	0.7365
33	Horse Mountain-Orford Reef Sport (KMZ)	1.0000
34	Southern California Troll	0.9847
35	Southern California Sport	1.0000
36	Area 7 Sport	1.0000
37	NT San Juan Net (Area 6A,7,7A)	1.0000
38	T San Juan Net (Area 6A,7,7A)	1.0000
39	NT Nooksack-Samish Net	1.0000

Appendix 4. Chinook FRAM fisheries and the proportion of catch attributed to FRAM modeled Chinook stocks from 2007 calibration (continued).

Fishery #	Fishery Name	FRAM Stock Portion Of Modeled Catch
40	T Nooksack-Samish Net	1.0000
41	T Juan de Fuca Troll (Area 5,6,7)	1.0000
42	Area 5/6 Sport	1.0000
43	NT Juan de Fuca Net (Area 4B,5,6,6C)	1.0000
44	T Juan de Fuca Net (Area 4B,5,6,6C)	1.0000
45	Area 8 Sport [a]	1.0000
46	NT Skagit Net (Area 8)	1.0000
47	T Skagit Net (Area 8)	1.0000
48	Area 8D Sport	1.0000
49	NT Stilly-Snohomish Net (Area 8A)	1.0000
50	T Stilly-Snohomish Net (Area 8A)	1.0000
51	NT Tulalip Bay Net (Area 8D)	1.0000
52	T Tulalip Bay Net (Area 8D)	1.0000
53	Area 9 Sport	1.0000
54	NT Area 6B/9 Net	1.0000
55	T Area 6B/9 Net	1.0000
56	Area 10 Sport	1.0000
57	Area 11 Sport	1.0000
58	NT Area 10/11 Net	1.0000
59	T Area 10/11 Net	1.0000
60	NT Area 10A Net	1.0000
61	T Area 10A Net	1.0000
62	NT Area 10E Net	1.0000
63	T Area 10E Net	1.0000
64	Area 12 Sport	1.0000
65	NT Hood Canal Net (Area 12,12B,12C)	1.0000
66	T Hood Canal Net (Area 12,12B,12C)	1.0000
67	Area 13 Sport	1.0000
68	NT Deep S. Puget Sound Net (13,13D-K)	1.0000
69	T Deep S. Puget Sound Net (13,13D-K)	1.0000
70	NT Area 13A Net	1.0000
71	T Area 13A Net	1.0000
72	Freshwater Sport	1.0000
73	Freshwater Net	1.0000

Notes: * (T = Treaty; NT = Non-treaty)

[a] Sport areas 8-1 and 8-2 were combined and input into Fishery 45.

Appendix 5. Tables of model inputs and methods used to develop model inputs for Coho and Chinook FRAM

Appendix Table 5-1. FRAM time steps for coho and Chinook.

Coho		Chinook	
Period	Months	Period	Months
Time 1	January-June	Time 1	Preceding October-April
Time 2	July	Time 2	May-June
Time 3	August	Time 3	July-September
Time 4	September	Time 4	October-April
Time 5	October - December		

Appendix Table 5-2. FRAM/TAMM fishery-related mortality rates for coho salmon used for Southern U.S. fisheries in 2008.

Fishery: (designated by area, user group, and/or gear type)	**Fishery Type**	**Comments**	**Release Mortality**	**"Other" Mortality**[a]
PFMC Ocean Recreational[d]	MSF	barbless	14.0%	5.0%
	Non-Retention	N. Pt. Arena	14.0% [b]	5.0% [b]
	Non-Retention	S. Pt. Arena	23.0% [b]	5.0% [b]
PFMC Ocean T-Troll	Retention		n.a.[c]	5.0%
	Non-Retention		26.0% [b]	5.0% [b]
PFMC Ocean NT-Troll	MSF	barbless	26.0%	5.0%
Area 5, 6C Troll	Retention		n.a.	5.0%
ıget Sound Recreational[e]	Retention		n.a.	5.0%
	MSF	barbless	7.0%	5.0%
WA Coastal Recreational	Retention		n.a.	5.0%
Buoy 10 Recreational	MSF	barbed	16.0%	5.0%
Gillnet and Setnet			n.a.	2.0%
PS Purse Seine			26.0% [b]	2.0%
PS Reef Net, Beach Seine, Round Haul			n.a.	2.0%
Freshwater Net			n.a.	2.0%
Freshwater Recreational	Retention		n.a.	5.0%
	Non-Retention		10.0% [b]	5.0% [b]

[a] The "other" mortality rates (which include drop-out and drop-off) are applied to landed fish (retention fisheries), thus FRAM does not assess "drop-off" in non-retention fisheries. Drop-off (and release mortality) associated with CNR fisheries are estimated outside the model and used as inputs to the model. For mark-selective fisheries (MSF), "other" mortality rates are applied to encounters of marked and unmarked fish.

[b] Rate assessed externally to FRAM.

[c] None assessed.

[d] Source: Salmon Technical Team (2000).

[e] Source: WDF et al. (1993).

Appendix Table 5-3. FRAM/TAMM fishery-related mortality rates for Chinook salmon used for Southern U.S. fisheries in 2008.

Fishery: (designated by area, user group, and/or gear type)	**Fishery Type**	**Comments**	**"Shaker" Release Mortality**	**"Adult" Release Mortality**	**"Other" Mortality**[a]
PFMC Ocean Recreational[e]	Retention	N Point Arena	14.0%	n.a.[c]	5.0%
	Retention	S Point Arena	23.0%	n.a.	5.0%
PFMC Ocean Troll	Retention	barbless	25.5%	n.a.	5.0%
Area 5,6,7 T-Troll	Retention	barbless	25.5%	n.a.	5.0%
Puget Sound (PS) Recreational[f]	Retention	barbless	20.0%	n.a.	5.0%
	MSF	barbless	20.0%	10.0%	5.0%
	Non-Retention	barbless	20.0%	10.0% [b]	5.0% [b]
Buoy 10 Recreational	not modeled within FRAM		n.a.	n.a.	n.a.
Commercial Net					
PS Areas 4B,5,6,6C	PT[d] GN, SN		n.a.	n.a.	3.0%
WA Coastal & Col R. Net	PT[d] GN, SN		n.a.	n.a.	3.0%
PS Areas 6A,7,7A	PT[d] GN, SN, Purse S		n.a.	n.a.	1.0%
NT PS Areas: 6B,9,12,12B,12C	PT[d] GN, SN, Purse S		n.a.	n.a.	1.0%
T PS Areas:7B,7C,7D	PT[d] GN, SN, Purse S		n.a.	n.a.	1.0%
All other PS marine net	Terminal GN, SN		n.a.	n.a.	2.0%
PS Purse Seine	Non-Retention	immature	n.a.	45.0% [b]	0.0%
	Non-Retention	mature	n.a.	33.0% [b]	0.0%
PS Reef Net, Beach Seine	Non-Retention		n.a.	n.a.	n.a.
Freshwater Net			n.a.	n.a.	n.a.
Freshwater Recreational	Retention		n.a.	n.a.	n.a.
	MSF	TAMM	n.a.	10.0% [b]	n.a.
	Non-Retention	TAMM	n.a.	10.0% [b]	n.a.

[a] The "other" mortality rates (which include drop-out and drop-off) are applied to landed fish (retention fisheries), thus FRAM does not assess "drop-off" in non-retention fisheries. Drop-off (and release mortality) associated with CNR fisheries are estimated outside the model and used as inputs to the model. For mark-selective fisheries (MSF), "other" mortality rates are applied to legal sized encounters of marked and unmarked fish.
[b] Rate assessed externally to FRAM.
[c] None assessed.
[d] PT = Pre-terminal.
[e] Source: Salmon Technical Team (2000).
[f] Source: WDF et al. (1993).

Appendix Table 5-4. Mark-selective fishery input values for Southern U.S. fisheries.

Fishery and Years Used	Unmarked Retention Error Rate (% of unmarked fish retained)	Mark Recognition Error Rate (% of marked fish released)
NOF troll, sport	2%	6%
SOF sport	2%	6%
Area 5,6 sport—2001 coho	2%	34%
Area 5,6 sport—2002-07 coho	2%	38%
Area 5,6 sport—2003-07Chinook	8%	6%
Area 5,6 sport—2008	6%	6%
Area 7 sport—2001 coho	5%	6%
Area 7 sport—2002-07 coho	8%	9%
Area 7 sport—2007-08 Chinook	8%	6%
Area 8-1,2 sport—2005-07 Chinook	8%	6%
Area 8-1,2—2008 Chinook	7%	10%
Area 9 sport—2007 Chinook	8%	6%
Area 9 sport—2008 Chinook	6%	6%
Area 10 sport—2007 Chinook	8%	6%
Area 10 sport—2008 Chinook	6%	6%
Area 13 sport—2007-08 Chinook	8%	6%

Appendix Table 5-5. Time period and age-specific rates used by FRAM to simulate Chinook and coho natural mortality.

Chinook Ages	Time Steps			
	1. Oct. to April	2. May to June	3. July to Sept.	4. Oct. to April
2	0.2577	0.0816	0.1199	0.2577
3	0.1878	0.0577	0.0853	0.1878
4	0.1221	0.0365	0.0543	0.1221
5	0.0596	0.0174	0.0260	0.0596

Coho Age	Time Steps				
	1. Jan. to June	2. July	3. August	4. Sept.	5. Oct. to Dec.
3	0.117504	0.020618	0.020618	0.020618	0.020618

Appendix Table 5-6. FRAM input abundance scalar development methods for coho abundance forecasts.

Production Region	Forecast Method	Forecast Type	FRAM Input *StockScalar* Development Method
Canada	Production Scalar X Surv Rt Scalar	Outlook Scalar from Base	Scalar as is
	Production X Surv Rt	Ocean Abundance	Ocean Abundance X 1.232
Washington Coast	Smolt X Ave. Marine Surv Rate	Ocean Abundance	Ocean Abundance X 1.232
	Ave. Term Run X Ave. PreTerm ER	Ocean Abundance	Ocean Abundance X 1.232
Puget Sound	Ave. Return/Spawner	Ocean Abundance	Ocean Abundance X 1.232
	Smolt X Ave. Marine Surv Rt	Ocean Abundance	Ocean Abundance X 1.232
	Ave. Return	Ocean Abundance	Ocean Abundance X 1.232
Columbia River	Oregon Production Index (OPI)	Ocean Abundance	Ocean Abundance X 1.232
Oregon Coast	Oregon Production Index (OPI)	Ocean Abundance	Ocean Abundance X 1.232
CA/SoOR Coast	Rogue/Kalmath Hatchery x Surv Rt	Ocean Abundance	Ocean Abundance X 1.232

Appendix Table 5-7. FRAM input abundance scalar development methods for Chinook abundance forecasts.

Production Region	Forecast Method	Forecast Type	FRAM Input *StockScalar* Development Method
Canada	Brood Year-Sibling	Terminal Run	Method 3
Puget Sound	Ave. Return/Spawner	Terminal Run	Method 2 or 3
	Ave. Return/Smolt Rel	Terminal Run	Method 2 or 3
	Ave. Return	Terminal Run	Method 2 or 3
	Cohort/Spawner	Prefishing cohort	Method 1
Columbia River	Brood Year-Sibling	Terminal Run	Method 3
Oregon Coast	Ave. Return	Terminal Run	Method 3

Appendix Table 5-8. FRAM input methods for coho retention fisheries.

Fishery Region	Fishery Input Type	Fishery Input Origin
Alaska	Scalar[a] or Quota	PFMC-STT/No.Falcon Staff
Canada		
Troll	Scalar or Quota	PFMC-STT/No.Falcon Staff
Net	Scalar or Quota	PFMC-STT/No.Falcon Staff
Sport	Scalar or Quota	PFMC-STT/No.Falcon Staff
PFMC North of Cape Falcon	Quota	PFMC-STT/No.Falcon Staff
PFMC South of Cape Falcon	Quota	PFMC/STT
Puget Sound		
Troll	Quota	No. Falcon Staff
Net	Pre-Terminal: Quota, Terminal: Quota, Scalar or Harvest Rate	No. Falcon Staff
Sport	Scalar or Quota	No. Falcon Staff
WA Coast/Columbia R	Scalar or Quota	No. Falcon Staff

[a] Scalars are typically based on catch but may occasionally be based on effort.

Appendix Table 5-9. FRAM input methods for Chinook retention fisheries.

Fishery Region	Fishery Input Type	Fishery Input Origin
Alaska	Scalar	PSC Chinook Model
Canada		
Troll	Scalar	PSC Chinook Model
Net	Scalar	PSC Chinook Model
Sport	Effort North; Quota-South	PSC Chinook Model; PFMC-STT/No. Falcon Staff
PFMC North of Cape Falcon	Quota	PFMC-STT/No. Falcon Staff
PFMC South of Cape Falcon	Scalar	PFMC-STT (KOHM)
Puget Sound		
Troll	Quota	No. Falcon Staff
Net	Pre-Terminal: Quota, Terminal: Quota, Scalar or Harvest Rate	No. Falcon Staff
Sport	Quota or Scalar	No. Falcon Staff
WA Coast/Columbia R	Quota or Scalar	No. Falcon Staff

[a] Scalars are typically based on catch but may occasionally be based on effort.

Appendix Table 5-10. Important FRAM model output reports produced for the PFMC's Preseason Reports II and III during the salmon fishery planning process.

Table Name	Stocks or Fisheries Referenced	FRAM Report Name or Statistic Source
Table 5. Projected key stock escapements (thousands of fish) or management criteria adopted by the Council for ocean fishery options.		
	Stock specific (Chinook) projected ocean escapement	Terminal Run Size Report
	Columbia Lower River Natural Tules (E.R. from Coweeman.xls, combining FRAM output and freshwater impacts)	Terminal Run Size Report Stock Catch by Fishery Report
	Snake River Fall Chinook Index (SRFI) for all ocean fisheries (Index calculated in SRFI.xls spreadsheet, combining PSC model and FRAM model outputs)	Exploitation Rate Comparison Report
	Key coho stocks: ocean escapement or various E.R. estimates (see Appendix Table 5-11 for table names within coho TAMM)	FRAM output reports as summarized within coho TAMM
Table 6. Preliminary projections of chinook and coho harvest impacts for ocean salmon fishery management measures adopted by the Council.		
	Regional ocean fisheries aggregates	Fishery Summary Report
Table 7. Expected coastwide lower Columbia natural (LCN) coho, Oregon coastal natural (OCN), Rogue/Klamath (RK) coho, and lower Columbia River (LCR) natural tule Chinook exploitation rates by fishery for ocean fisheries management measures adopted by the Council. (see Appendix Table 5-11 for table names within coho TAMM)		
	Regional ocean fisheries aggregates	FRAM output reports as summarized within coho TAMM Coweeman.xls spreadsheet for LCR tule stock E.R.
Table 8. Projected coho mark rates for fisheries under base period fishing patterns (% marked)		
	Regional fisheries from Canada, Puget Sound, Washington, and Oregon	Stock Catch by Fishery Report as summarized in MarkRateTable.xls.

Appendix Table 5-11. Primary model output summary reports referenced by the NOF Co-Managers during the PFMC pre-season salmon fishery planning process.

Report Name	Stocks or Fisheries Referenced	Evaluation Statistic	Report Production
Coho Reports:			
Table 1: Description of Fishery Regulations and Summary of Coho Catch Targets.			
	Total mortality for pre-terminal fishery aggregates and for Puget Sound fisheries	# of fish	TAMM report
Table 2s: Coho Fishery Impact Summary Highlights (management criteria, total ER[a], spawner escapement).			
	Puget Sound and WA coastal stock specific mortality by fishery	# of fish	TAMM report
Table 4: Summary of Coho Exploitation Rates by Fishery Aggregate.			
	Puget Sound stocks (total ER), and WA coastal stocks (pre-terminal ER)	Regional ERs	TAMM report
Table 7: Coho Run Sizes for Salmon Technical Team Reference.			
	Ocean escapement of Southern U.S. coho stock aggregates	# of fish	TAMM report
Table C: Columbia River Coho Fishery Impact Summary (catch by fishery aggregates, ocean escapement, marine ERs).			
	Columbia River Early and Columbia River Late coho stocks	# of fish	TAMM report
Table OR: Total Mortality and Exploitation Rates for OCN and Rogue/Klamath (statistics by fishery aggregates).			
	Oregon Coastal Natural and unmarked Rogue/Klamath	# of fish & ERs	TAMM report
Table T: Thompson and Upper Fraser Coho Fishery Impact Summary (statistics by fishery aggregates).			
	Ocean escapement and marine ERs for Canadian Upper Fraser wild coho	# of fish & ERs	TAMM report
Chinook Reports:			
Table 1: Description of Fishery Regulations and Summary of Chinook Catch Targets.			
	Total mortality for pre-terminal fishery aggregates and for Puget Sound fisheries	# of fish	TAMM report
Table 2: Exploitation Rates and Natural Escapement of Selected Puget Sound Chinook Stocks (MSF[b] compatible).			
	ESA listed Puget Sound stock unit model prediction and management criteria	ERs & escapement	TAMM report
Snake River Fall Chinook Index (SRFI) for all ocean fisheries.			
	From PSC and PFMC fisheries: total predicted ER divided by base period ER	Impact ratio	SRFI.xls
Total mortality adult equivalent exploitation rates (catch/catch + ocean escapement) and Terminal Run Size.			
	Columbia River stocks with focus upon Coweeman (Lower Columbia River wild tules)	Total ER	Coweeman.xls

[a] ER = exploitation rate.

[b] MSF = mark-selective fishery.