Agenda Item G.1
Situation Summary
June 2006

FISHERY REGULATION ASSESSMENT MODEL (FRAM)

The Model Evaluation Workgroup (MEW) was assigned the task of providing detailed documentation of the Chinook and Coho FRAM in 2003. An overview of the FRAM was produced in 2004 and accepted by the Council. The first draft of the detailed documentation was reviewed by the Scientific and Statistical Committee (SSC) and Salmon Technical Team (STT) at the November 2005 Council meeting, and several recommendations to improve the documents were made. The detailed documentation has now been completed and is ready for a final review by the Scientific and Statistical Committee. The core FRAM documents are: FRAM Overview, FRAM Technical Documentation, Chinook FRAM Base Data Development, and Coho FRAM Base Data Development (Agenda Items G.1.a, Attachments 1-4, available on the June 2006 Briefing Book CD). A FRAM Users Guide is also near completion and should be available as supplemental material at the June Council meeting.

This set of reports constitutes the final draft of the Council assignment to the MEW for developing FRAM documentation. The SSC and STT will review the reports over the summer and provide recommendations for finalizing the documentation during the 2006 methodology review process.

Council Action:

1. **Consider status of FRAM documentation and provide guidance for modifications and additions.**
2. **Provide direction for future MEW assignments.**

Reference Materials (available on the June 2006 Briefing book CD):

1. Agenda Item G.1.a, Attachment 1: Fishery Regulation Assessment Model (FRAM) – An Overview for Chinook and Coho.
2. Agenda Item G.1.a, Attachment 2: Fishery Regulation Assessment Model (FRAM) – Technical Documentation for Chinook and Coho.
3. Agenda Item G.1.a, Attachment 3: Chinook FRAM Base Data Development.
4. Agenda Item G.1.a, Attachment 4: Coho FRAM Base Period Development.

Agenda Order:

a. Agenda Item Overview — Chuck Tracy
b. Report of the Model Evaluation Workgroup (MEW) — Larrie LaVoy
c. Reports and Comments of Advisory Bodies
d. Public Comment
e. **Council Action**: Consider Status of FRAM Updates and Recommendations of the MEW on Further Efforts

PFMC
05/24/06

Agenda Item G.1.a
Attachment 1
June 2006

FISHERY REGULATION ASSESSMENT MODEL (FRAM)

- An OVERVIEW for CHINOOK and COHO -

MODEL EVALUATION WORKGROUP[1]

May 2006

[1]MEW Members: Henry Yuen (USFWS); Andy Rankis (NWIFC); Larrie LaVoy (WDFW); Jim Packer (WDFW); Curt Melcher (ODFW); Ethan Clemons (ODFW); Robert Conrad (NWIFC); C. Dell Simmons (NMFS); Rishi Sharma (CRITFC); Allen Grover (CDFG).

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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 north-central Oregon coast, Columbia River, 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, 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, 33 stock groups are represented in Chinook FRAM and 123 stock groups are represented in Coho 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 66 stock groups for Chinook and 246 for coho. 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 four time periods for Chinook and five periods for coho (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. <u>CWT fish accurately represent the modeled stock.</u> 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. <u>Length at age of Chinook is stock specific and is constant from year to year.</u> 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. <u>Stock distribution and migration is constant from year to year and is represented by the average distribution of CWT recoveries during the base period.</u> 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.

4. <u>There are not multiple encounters with the gear by the fish in a specific time/area/fishery stratum.</u> 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 1986-1991. 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% mortality rate is applied to the landed catch to account for "other non-landed mortalities" in hook-and-line fisheries. "Shaker" mortality is a type of drop-off mortality that is applied only to the sub-legal size component of a cohort in a hook-and-line fishery.

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).

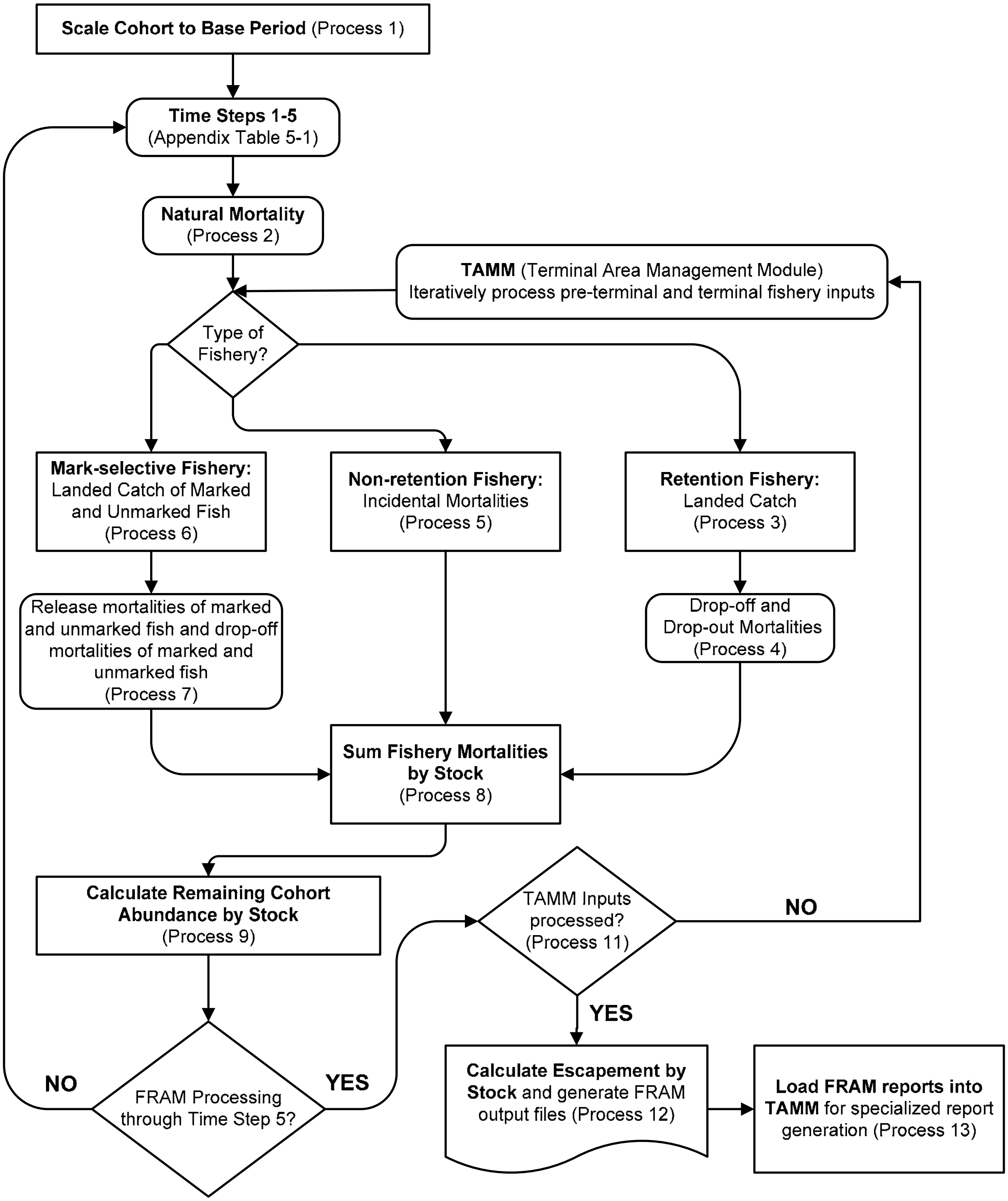

Figure 1. Flow chart for coho FRAM model.

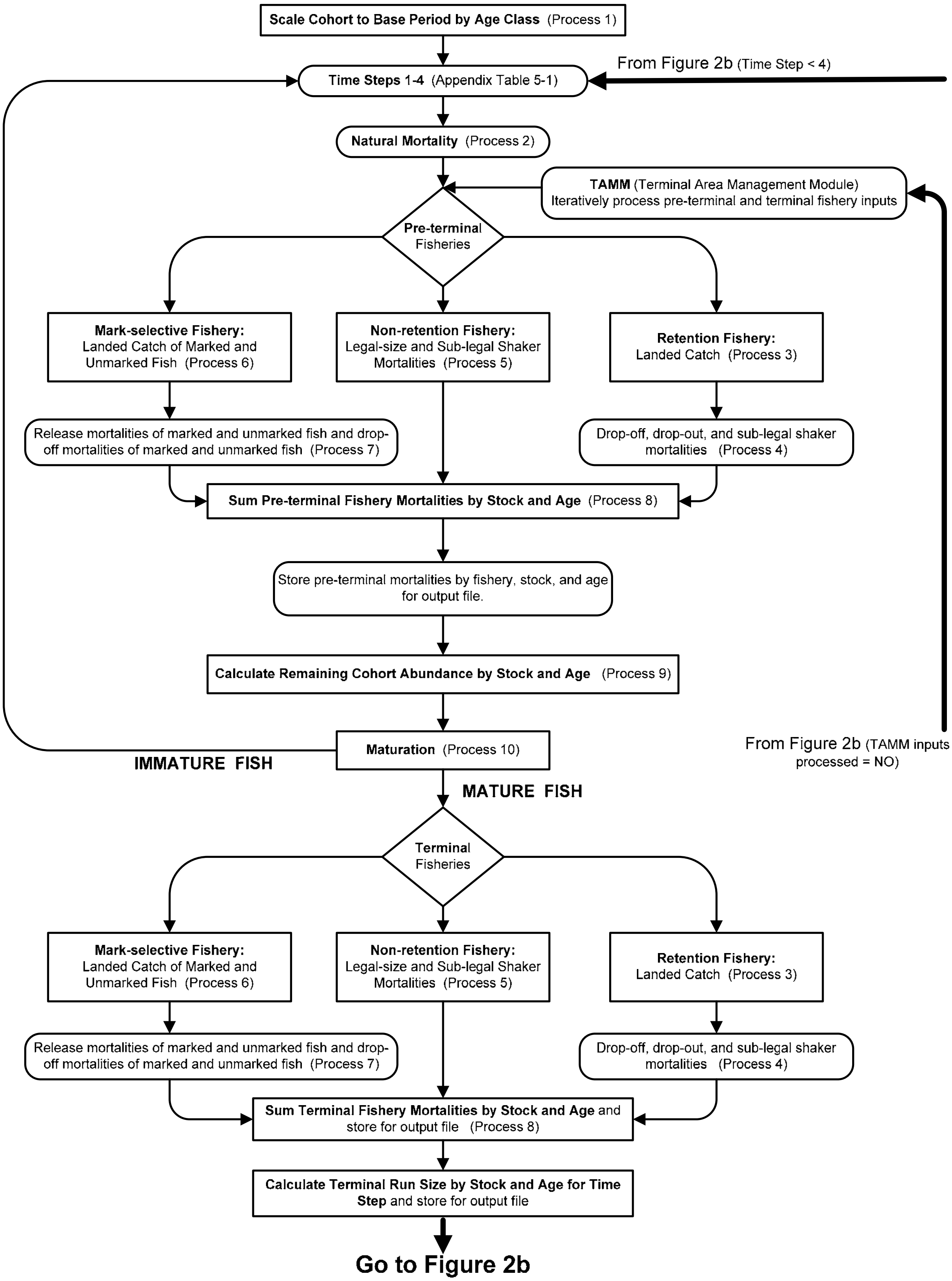

Figure 2a. Flow chart for chinook FRAM model (continued on next page).

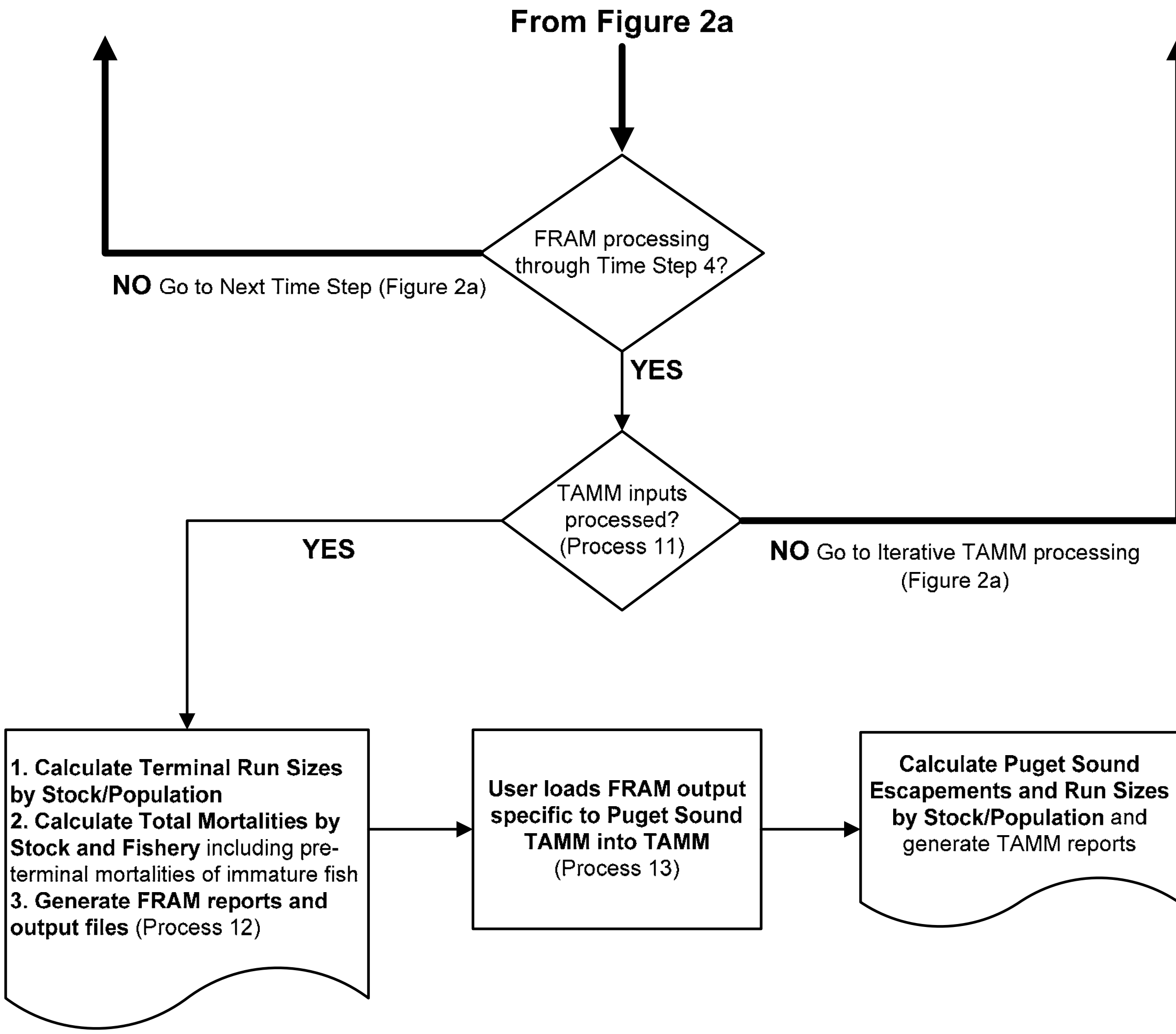

Figure 2b. Flow chart for chinook FRAM model (continued from previous page).

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:

(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

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

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 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) - Process 13

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 Pacific Salmon Commission (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.

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10. 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.

APPENDICES

Appendix 1. 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

*OOB = Out-of-base stock.

Appendix 2. 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 2. 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 2. 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	sandew	Sandy Early Wild
COLRIV	171	clakew	Clakamas Early Wild
COLRIV	173	claklw	Clakamas Late 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 2. 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 3. Chinook FRAM fisheries and the proportion of catch attributed to FRAM modeled Chinook stocks from 2005 calibration.

Fishery #	Fishery Name	FRAM Stock Portion Of Modeled Catch
1	Southeast Alaska Troll	0.5537
2	Southeast Alaska Net	0.2157
3	Southeast Alaska Sport	0.3118
4	North/Central British Columbia Net	0.5583
5	West Coast Vancouver Island Net	0.5461
6	Strait of Georgia Net	0.6812
7	Canada Juan de Fuca Net (Area 20)	0.9305
8	North/Central British Columbia Sport	0.8479
9	North/Central British Columbia Troll	0.5627
10	West Coast Vancouver Island Troll	0.8278
11	West Coast Vancouver Island Sport	1.0000
12	Strait of Georgia Troll	0.6265
13	North Strait of Georgia Sport	1.0000
14	South Strait of Georgia Sport	1.0000
15	BC Juan de Fuca Sport	0.8653
16	NT Cape Flattery-Quillayute Troll (Area 3-4)	0.8999
17	T Cape Flattery-Quillayute Troll (Area 3-4)	0.8256
18	Cape Flattery-Quillayute Sport (Area 3-4)	0.8404
19	Cape Flattery-Quillayute Net (Area 3-4)	1.0000
20	NT Grays Harbor Troll (Area 2)	0.8945
21	T Grays Harbor Troll (Area 2)	0.5510
22	Grays Harbor Sport (Area 2)	0.6984
23	NT Grays Harbor Net	0.1338
24	T Grays Harbor Net	0.0001
25	Willapa Net	0.1645
26	NT Columbia River Troll (Area 1)	1.0000
27	Columbia River Sport (Area 1)	0.6855
28	Columbia River Net	2.0605
29	Buoy 10 Sport	1.0000
30	Orford Reef-Cape Falcon Troll (Central OR)	0.1612
31	Orford Reef-Cape Falcon Sport (Central OR)	0.2154
32	Horse Mountain-Orford Reef Troll (KMZ)	0.0059
33	Horse Mountain-Orford Reef Sport (KMZ)	0.0756
34	Southern California Troll	0.0006
35	Southern California Sport	0.0001
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
40	T Nooksack-Samish Net	1.0000
41	T Juan de Fuca Troll (Area 5,6,7)	1.0000
42	Area 5/6 Sport	0.8906

Appendix 3. Chinook FRAM fisheries and the proportion of catch attributed to FRAM modeled Chinook stocks from 2005 calibration (continued).

Fishery #	Fishery Name	FRAM Stock Portion Of Modeled Catch
43	NT Juan de Fuca Net (Area 4B,5,6,6C)	0.8087
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 4. 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)
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)

Appendix 4. Coho FRAM fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
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
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)

Appendix 4. Coho FRAM fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
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
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)

Appendix 4. Coho FRAM fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
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)
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)

Appendix 4. Coho FRAM fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
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
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 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 2005.

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%
Puget 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 2005.

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.
<u>Commercial Net</u>					
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 SOF sport	2% 2%	6% 6%
Area 5,6 sport - 2001 coho Area 5,6 sport - 2002, 2003, 2004, 2005 coho	2% 2%	34% 38%
Area 5,6 sport – 2003, 2004, 2005 Chinook	8%	6%
Area 7 sport - 2001 coho Area 7 sport - 2002, 2003, 2004, 2005 coho	5% 8%	6% 9%
Area 13 sport - 2002, 2003, 2004, 2005 coho	27%	18%
Other PS marine sport	8%	9%

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

Chinook	Time Steps			
Ages	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	Time Steps				
Age	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[a] 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 collated by the STT for ocean fishery options.		
	Stock specific (Chinook) projected ocean escapement	Terminal Run Size Report
	Columbia Lower River Natural Tules	Terminal Run Size Report
	(including Coweeman Index as calculated in Coweeman.xls spreadsheet)	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 ER[b] estimates (see Appendix Table 5-nB for coho TAMM report names)	FRAM output reports as summarized within coho TAMM
Table 6. Preliminary projections of chinook and coho harvest impacts adopted by the Council for ocean salmon fishery management options.		
		Fishery Summary Report
Table 7. Expected coast-wide Oregon coastal natural (OCN) and Rogue/Klamaath (RK) coho exploitation rates by fishery adopted by the Council for ocean fisheries management options. (see Appendix Table 5-11 for coho TAMM report name).		
		FRAM output reports as summarized within coho TAMM
Table 8. Projected coho mark rates for XXXX fisheries under base period fishing patterns (%marked).		
	Regional fisheries from Canada, Puget Sound, Washington, and Oregon	Stock Catch by Fishery Report as summarized within MarkRateTable.xls
Table A-3. STT preliminary analysis of impacts of tentatively-adopted management measures on Endangered Species Act (ESA) listed Evolutionarily Significant Units (ESUs) Table A-3 not in Preseason Report II.*[c]		
	Puget Sound chinook stocks	FRAM output as modeled through TAMM

[a] Preseason Report II Analysis of Proposed Regulatory Options for XXXX Ocean Salmon Fisheries and Preseason Report III Analysis of Council Adopted Management Measures for XXX Ocean Salmon Fisheries, where XXXX = management year (e.g., 2006).

[b] ER = exploitation rate.

[c] In Preseason Report III only.

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.

FISHERY REGULATION ASSESSMENT MODEL (FRAM)

- Technical Documentation for Coho and Chinook

MODEL EVALUATION WORKGROUP[1]

May, 2006

[1] MEW Members: Andy Rankis, Chair (NWIFC); Larrie LaVoy, Vice-Chair (WDFW); Jim Packer (WDFW); Ethan Clemons (ODFW); Robert Conrad (NWIFC); C. Dell Simmons (NMFS); Rishi Sharma (CRITFC), Allen Grover, CDFG; Henry Yuen (USFWS)

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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 coho and Chinook salmon stocks. FRAM is a single season modeling tool with separate processing code for coho and Chinook salmon. The coho version evaluates impacts on a comprehensive set of stocks originating from Central California to Southeast Alaska and represents total West Coast production. The Chinook version evaluates impacts on most stock groups originating from the north-central Oregon coast, Columbia River, Puget Sound, and Southern British Columbia. The FRAM produces a variety of output reports that are used to examine fishery impacts for compliance with management objectives, allocation arrangements, ESA compliance, and domestic and international legal obligations. Until recently FRAM was not used for assessing compliance with coho or Chinook agreements in international fisheries management forums. However, the U.S. and Canada have agreed to develop a bilateral regional coho planning tool. FRAM will be used for the development of the first version of this regional model. 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 salmon fishery assessment tools at the stock-specific level became apparent beginning 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 Fishery Conservation 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 coho or Chinook 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 preseason 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 through the use of Terminal Area Management Modules (TAMMs). The CAM was used as the primary model for evaluating coho impacts for PFMC fisheries until the mid 1990s.

Increasing demands for information soon outstripped the capacity of these spreadsheet models to evaluate the fishery regimes under consideration by the PFMC. 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 fishery regimes for either coho or Chinook by using different input file configurations. In 1998, FRAM was converted to VISUAL BASIC to take advantage of improved user interfaces 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 model capabilities during this period (1998-2000).

2. MODEL OVERVIEW

The FRAM is a discrete, time-oriented, age-structured, deterministic computer model intended 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 and all terminal fisheries operate on the mature run.

2.1 Stocks

Currently, 123 stock groups are represented in Coho FRAM and 33 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. Therefore the current version of FRAM has a virtual total of 246 stock groups for coho and 66 for Chinook. For most wild stocks and for hatchery stocks without marking or tagging programs, the cohort size of the marked component is zero. 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 fisheries.

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 198 fisheries in Coho FRAM and 73 fisheries in Chinook FRAM. The intent is to encompass all fishery impacts to modeled coho and Chinook stocks in order to account for all fishing-related impacts and thereby improve model accuracy. Terminal fisheries in Coho FRAM are modeled with finer resolution than Chinook FRAM, most notably by including individual freshwater fisheries. Terminal fisheries in Chinook FRAM are aggregations of gears and management areas. Fishery number and fishery name for each of the FRAM fisheries are listed in Appendix 3 for coho and Appendix 4 for Chinook.

2.3 Time Steps

The time step structure used in FRAM represents a compromise level of resolution that corresponds to fishing season planning and species-specific migration and maturation schedules.

The FRAM consists of five time periods for coho and four periods for Chinook (Table 2-1). At each time step a cohort is subjected to natural mortality, pre-terminal fisheries, and also potentially to maturation (Chinook only), and terminal fisheries.

Table 2-1. 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		

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 described briefly below.

1. <u>CWT fish accurately represent the modeled stock.</u> 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 recovery data from non mark selective fisheries accurately depict the exploitation and distribution of all the untagged fish in the modeled stock.

2. <u>Length at age of Chinook is stock specific and is constant from year to year.</u> Growth functions (von Bertalanffy; see Section 6.4.2) are used for Chinook in determining the proportion of the age class that is 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 (Appendix 5). Rates for Chinook are age specific and yield the same annual rate as used in PSC Chinook model.

4. Stock distribution and migration is constant from year to year and estimated as the average distribution in the base period data. We currently lack data on the annual variability in distribution and migration patterns of coho and Chinook salmon stocks. In the absence of such estimates, fishery-specific exploitation rates are computed relative to the entire cohort. Changes in the distribution and migration of stocks from the base period will result in poor estimates of stock composition and stock-specific exploitation rates.

5. Fish do not encounter gear multiple times 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 the gear more than once.

While it is difficult to directly test the validity of these assumptions, results of validation exercises could provide one assessment of how well these assumptions are met and the sensitivity of the model to the assumptions. Currently, there is little effort directed at model validation.

3. BASE PERIOD DATA

Coho and Chinook CWT recovery data for abundances and stocks during a "base period" 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 steps and processes that uses 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 MEW (2006a, 2006b) for a more detailed description of the cohort analysis procedures for coho and Chinook.

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 1986-1991. See MEW (2006a) for a more detailed description of the development of the coho 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 being conducted across an extensive geographic area and over an extended period of time, thus giving the best available representation of CWT stock distribution. Not all stocks represented in the Chinook FRAM have CWT recovery data available from the 1974-1979 brood year base period (e.g., Snake River fall Chinook); these stocks are categorized as "Out-of-Base" stocks. Available CWT data for these 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 2 lists brood years used to develop each stock's base period.

4 GENERAL INPUT TYPES

The five general types of input values used by FRAM are:

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

2. Size Limits: For coho, age-3 fish are assumed fully vulnerable and age-2 fish are assumed not vulnerable to modeled fisheries. For Chinook, minimum size limits are specified by fishery where appropriate.

3. Fishery Catch Mortality: The model provides five options for estimating mortality in a fishery: a quota, an exploitation rate scalar, a ceiling, "selective", and harvest rate (for Puget Sound terminal fisheries only).
   a) Quota: Total 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 base period, using a scalar input by the user. Most common scaling mechanism used is fishing effort (e.g. vessel-days, angler-trips) relative to the level during the base period.
   c) Ceiling: A ceiling catch for the fishery is input by the user. Fishery 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) Selective: Identified as either a quota or exploitation rate scalar controlled fishery with additional calculations to cover catches and encounters for marked and unmarked groups.
   e) Harvest rate: A terminal area harvest rate is applied to either all fish present in the terminal area or to the 'local-origin stocks only.

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 Table 4-1a and for Chinook in Table 4-1b. Hook-and-release mortality is assessed when coho or Chinook are not allowed to be retained (so-called "Coho/Chinook non-retention", or CNR fisheries), when size limits apply, or in mark-selective fisheries. Release mortality has been estimated in 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 following analysis by Salmon Technical Team (2000). Release mortality in net fisheries for coho or Chinook non-retention is estimated external to FRAM and input into the model as either additional "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 Table 4-2.

5. Other Non-landed Mortality: This category includes fishing-induced mortality not associated with direct handling (or landing) of the fish (see Table 4-1a for coho and Table 4-1b for Chinook). Included in this category are sport and commercial troll “drop-off” (fish that drop off from the hook before they are brought to vessel but die from hook injuries), and net gear “drop-out” (fish which are not brought on board but die from injury as a result of being netted). In general, a 5% mortality rate is applied to the landed catch to account for “other non-landed mortality” in hook-and-line fisheries. Net drop-out mortality rates vary depending on species, net type, or terminal versus pre-terminal nature of the fishery.

Table 4-1a. FRAM/TAMM fishery-related mortality rates for coho salmon used for Southern U.S. fisheries in 2005.

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%
Puget 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).

Table 4-1b. FRAM/TAMM fishery-related mortality rates for Chinook salmon used for Southern U.S. fisheries in 2005.

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).

Table 4-2. Mark-selective fishery input values for Southern U.S. fisheries.

Fishery	Unmarked Retention Error (% of unmarked fish retained)	Mark Recognition Error (% of marked fish released)
NOF troll, sport SOF sport	2% 2%	6% 6%
Area 5,6 sport—2001 coho Area 5,6 sport—2002 coho Area 5,6 sport—2003-06 coho	2% 2% 2%	34% 38% 38%
Area 5,6 sport—2003-06 Chinook	8%	6%
Area 7 sport—2001 coho Area 7 sport—2002 coho Area 7 sport—2003-06 coho	5% 8% 8%	6% 9% 9%
Area 13 sport—2002 coho Area 13 sport—2003-06 coho	27% 27%	18% 18%
Other PS marine sport	8%	9%

5. OUTPUT REPORTS AND MODEL USE

Model results are available as either standard FRAM printed output reports or in Excel spreadsheets that are linked to FRAM results/reports. The Terminal Area Management Module (TAMM) spreadsheets provide comprehensive summaries of fishery mortalities, exploitation rates, run sizes, and escapements for key stocks in the PFMC and North of Falcon annual salmon season setting processes. Early versions of these spreadsheets focused on finer resolution of stocks and fisheries for Puget Sound terminal areas. The TAMM spreadsheets have now broadened in scope and contain information for both pre-terminal and terminal fisheries as well as FRAM fishery inputs for terminal fisheries in coastal Washington (coho) and in Puget Sound (both species). Other model results not shown in the spreadsheets can be generated directly from FRAM. These reports include summaries of catch by fishery, stock, and 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 "Users Manual for the Fishery Regulation Assessment Models (FRAM) for Coho and Chinook" (MEW 2000c). Summaries of important FRAM and TAMM output reports used during PFMC and NOF management processes are shown in Appendix 7-1, 7-2.

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 for Chinook). Within the time step loop: (1) natural mortality is applied to the beginning cohort size at age; (2) the procedures to calculate projected catches for all fisheries operating in the time step are executed; and (3) all fishery mortalities for the cohort (stock) are totaled and the remaining abundance of the stock at age is calculated.

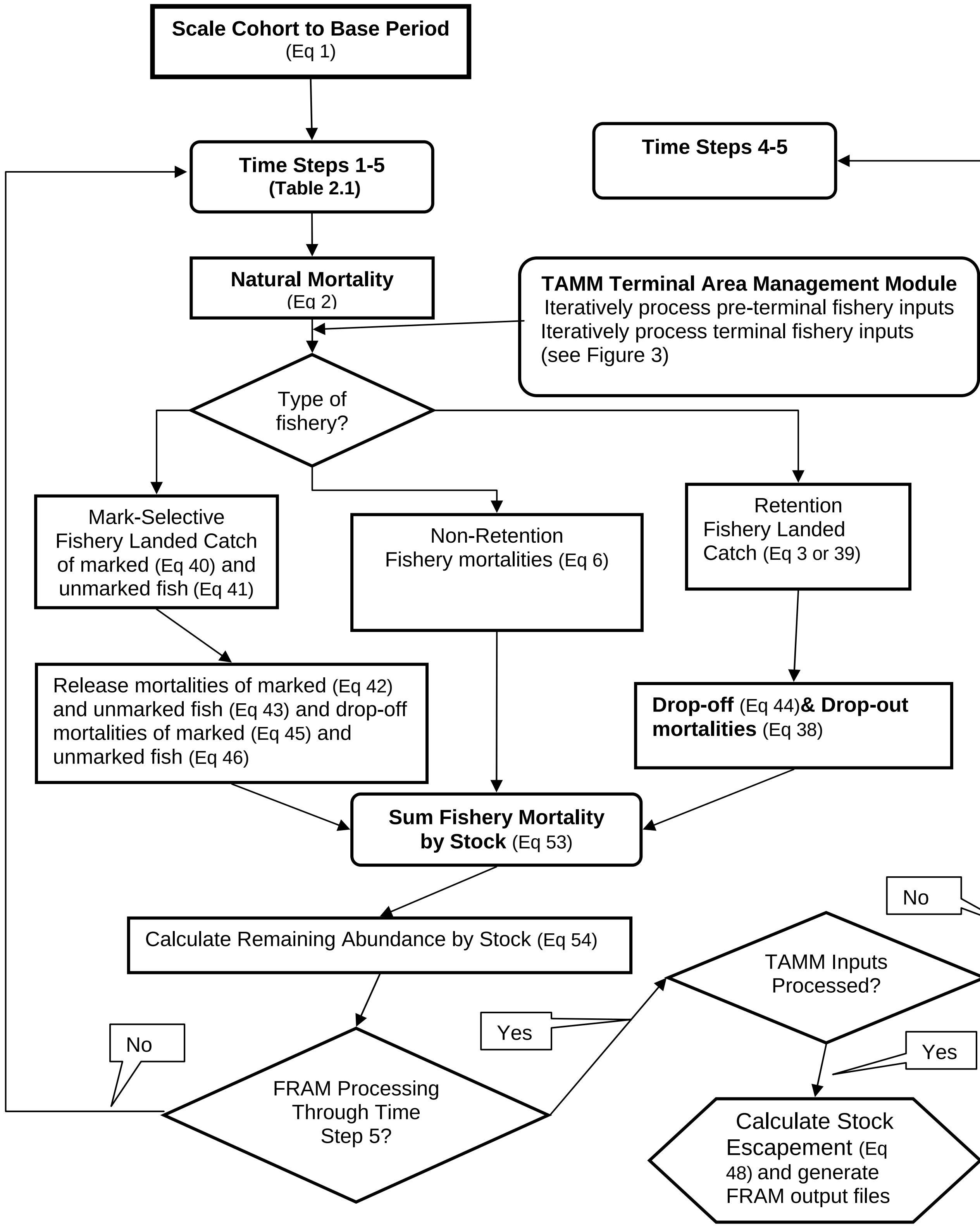

Figure 1. Flow chart for FRAM coho model

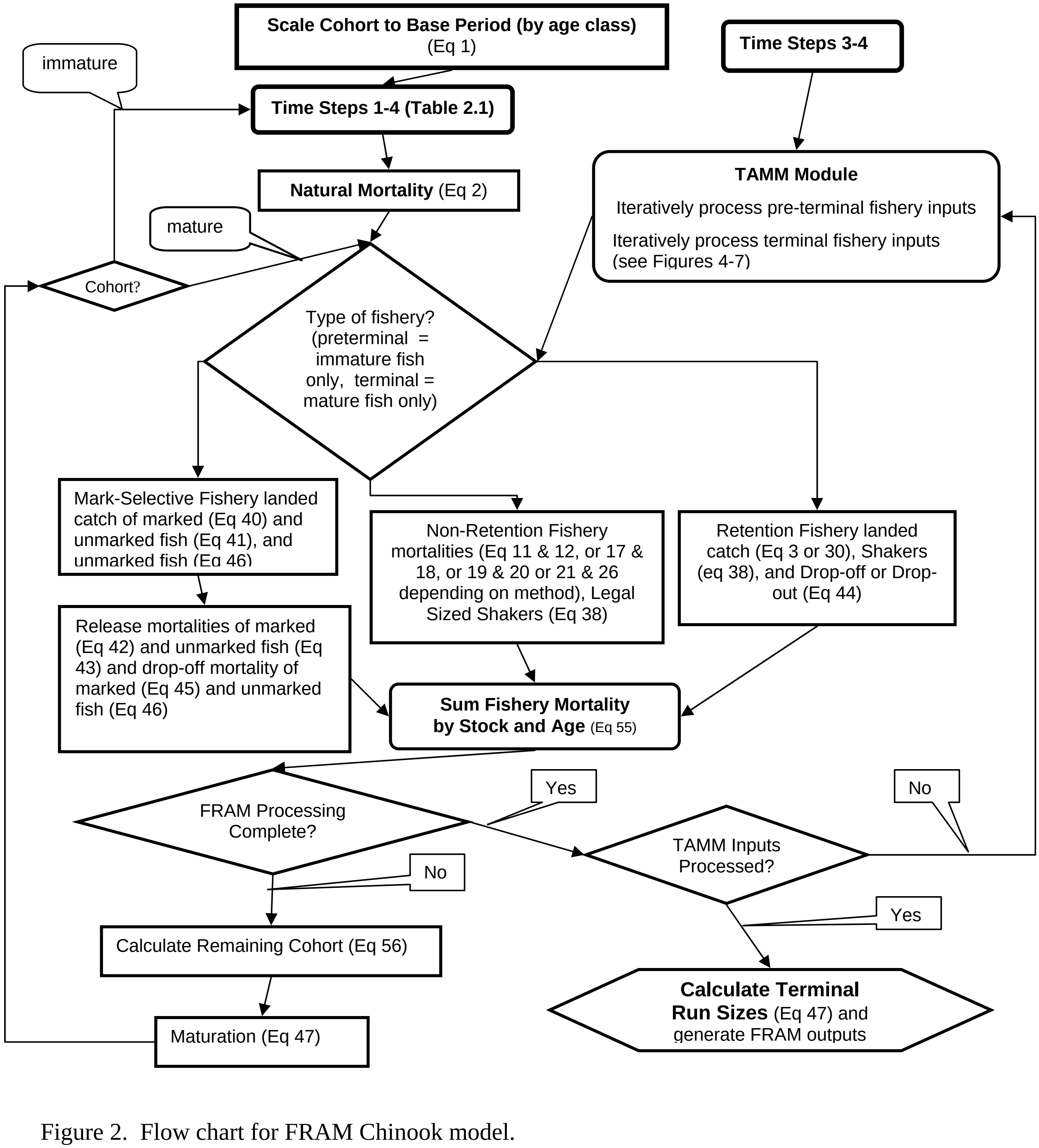

Figure 2. Flow chart for FRAM Chinook model.

After FRAM has processed all steps in the time step loop the program checks for the presence of an optional TAMM. If the model user has not specified a TAMM input file for additional modeling, FRAM processing is complete and final terminal run sizes (Chinook) or escapements (coho) are calculated. If a

TAMM has been specified, then FRAM will repeat processing through the specified fisheries and time step loops. Although TAMMs are focused upon terminal area fisheries, some of the TAMM fisheries are in mixed-stock areas and may impact both mature and immature Chinook. Thus an iterative FRAM/TAMM process is used to obtain the final tabulations of fishery mortalities and stock escapements (see Section 7 for further TAMM explanation).

6.1 Scale Cohort to Base Period

The equation below establishes the starting cohort size for all stocks as a product of two parameters: the cohort size during the base period for stock *s* at age *a* in the first time period ($BPCohort_{s,a}$) and a stock and age specific scalar ($StockScalar_{s,a}$). $StockScalar_{s,a}$ is estimated externally to the model and is an annual input to the model (see Section 8.1 for more *StockScalar* detail).

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

6.2 Natural Mortality

At the beginning of each time step *t*, each cohort is decreased to account for projected natural mortality using the following equation:

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

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

6.3 Catch

The FRAM simulates fisheries through the use of linear equations. Different types of computations are used depending upon whether or not a fishery operates under mark-retention restrictions. If all fish can be retained regardless of mark status, the following general formula is used (mark-selective fisheries are described in Section 6.5):

$$(3)\ Catch_{s,a,f,t} = BPER_{s,a,f,t}\ \ x\ Cohort_{s,a,t}\ \ x\ PV_{s,a,t}\ \ x\ FishScalar_{f,t}\ \ x\ SHRS_{s,f,t}$$

where:

$Catch_{s,a,f,t}$	=	Catch of stock *s*, age *a*, in fishery *f*, at time step *t;*
$BPER_{s,a,f,t}$	=	Base Period Exploitation Rate (harvest rate for terminal fisheries) for stock *s*, age *a*, in fishery *f*, at time step *t* (*BPER* is derived from cohort analysis using CWT release and recovery data);
$Cohort_{s,a,t}$	=	Number of fish in cohort (Chinook are expressed as both immature and mature cohorts) for stock *s* at age *a* in time step *t*;
$PV_{s,a,f,t}$	=	Proportion of cohort for stock *s*, age *a*, vulnerable to the gear at time step *t* (for coho *PV* is always = 1.0; for Chinook *PV* is a function of a Von Bertalanffy growth curve);

$FishScalar_{f,t}$	=	Impact scalar for fishery f at time step t relative to the base period; and
$SHRS_{s,f,t}$	=	Stock-specific exploitation rate scalar for stock s, in fishery f, at time step t (the default value of 1.0 is rarely changed).

The parameter $FishScalar_{f,t}$ is the foundation for the model's fishery simulation algorithms. FRAM can evaluate two general types of fisheries: (1) effort-based or (2) catch-based. For effort-based fisheries, the parameter $FishScalar_{f,t}$ is specified by the modeler to reflect expected effort relative to the average effort observed during the model's base period. For catch-based fisheries, $FishScalar_{f,t}$ is computed automatically so as to attain a specified catch level. In addition, FRAM can model input catches as either quotas or ceilings. In a quota fishery, the input catch is always achieved. In a ceiling fishery, the input value is a catch cap, which may or may not be reached by the fishery. If the catch level is to be modeled as a quota, then $FishScalar_{f,t}$ is computed as:

$$(4)\ FishScalar_{f,t} = \frac{QuotaLevel_{f,t}}{\sum_s \sum_a Catch_{s,a,f,t}\ \ x\ \ (1/PropModelStock_f)}$$

where $\sum_s \sum_a Catch_{s,a,f,t}$ is computed with $FishScalar_{f,t}$ = 1.0 and $PropModelStock_f$ is the proportion of model stocks in the catch relative to the total catch in fishery f for the base period ($PropModelStock_f$ is used for Chinook only, it is always set to 1.0 for coho).

If the catch level is to be modeled as a ceiling, both an effort scalar and quota are specified. A catch estimate is made during a first iteration of FRAM using the effort scalar. If the effort scalar computes a catch level that is less than the catch ceiling, then the final catch estimate is this effort-based catch. If the initial effort scalar results in a catch level that exceeds the ceiling, then the final catch estimate is the ceiling. In the case of a ceiling-type fishery, the final $FishScalar_{f,t}$ will be calculated based on the lower of the two types of catch estimates (effort scalar or quota).

6.4 Incidental Mortality

Several types of incidental mortality can be accounted for in FRAM either through external calculations of mortality or through internal FRAM processing. Incidental mortality associated with hook-and-line drop-off and net drop-out is expressed as a fraction of retained catch or as a fraction of encounters in the case of mark-selective fisheries. Incidental mortality in mark-selective fisheries is discussed in the next section.

6.4.1 Mortality Calculations for Salmon Non-Retention Fisheries

Mortalities in coho non-retention fisheries (CNR) are derived using estimates calculated outside of the FRAM using historical landing information (Method 1). Chinook non-retention mortalities are modeled using inputs of legal and sub-legal encounters (Method 2), from total encounters (Method 3) or from the levels of open versus non-retention effort within each time step (Methods 4 and 5). The methods were developed to fit observations available from various fisheries. Methods 4 and 5, which have not been used in recent years, were developed for Canadian and Alaskan fisheries which had both open and non-retention regulation periods in the same season and had changes in the gear or fishing patterns to avoid Chinook encounters.

METHOD 1 (Coho) – Computed from external estimates of nonretention mortalities

(5) $$PropCatch_{s,f,t} = \frac{BPER_{s,f,t} \ x \ Cohort_{s,t} \ x \ SHRS_{s,f,t}}{\sum_{s} BPER_{s,f,t} \ x \ Cohort_{s,t} \ x \ SHRS_{s,f,t}}$$

(6) $$CNR_{s,f,t} = EstCNRMorts_{f,t} \ x \ PropCatch_{s,f,t}$$

METHOD 2 (Chinook) – Computed from external estimates of legal and sub-legal sized encounters

(7) $$LegalPropCatch_{s,a,f,t} = Catch_{s,a,f,t} \big/ TotCatch_{f,t}$$

(8) $$SubLegPop_{s,a,t} = Cohort_{s,a,t} \ x \ (1 - PV_{s,a,t})$$

(9) $$SubLegNR_{s,a,f,t} = SubLegPop_{s,a,t} \ x \ SubER_{s,a,f,t} \ x \ RelRate_{f,t}$$

(10) $$SubLegPropEnc_{s,a,f,t} = SubLegNR_{s,a,f,t} \Big/ \sum_{s} \sum_{a} SubLegNR_{s,a,f,t}$$

(11) $$CNRLegal_{s,a,f,t} = LegalPropCatch_{s,a,f,t} \ x \ LegalEnc_{f,t} \ x \ RelRate_{f,t} \ x \ PropModelStock_{f}$$

(12) $$CNRSub_{s,a,f,t} = SubLegPropEnc_{s,a,f,t} \ x \ SubLegEnc_{f,t} \ x \ RelRate_{f,t} \ x \ PropModelStock_{f}$$

METHOD 3 (Chinook) – Computed from external estimate of total encounters

(13) $$LegalPropCatch_{s,a,f,t} = Catch_{s,a,f,t} \big/ TotCatch_{f,t}$$

(14) $$LegalEnc_{s,a,f,t} = BPER_{s,a,f,t} \ x \ Cohort_{s,a,t} \ x \ PV_{s,a,t} \ x \ SHRS_{s,f,t} \ x \ LegalPropCatch_{s,a,f,t}$$

(15) $$SubLegEnc_{s,a,f,t} = SubER_{s,a,f,t} \ x \ SubLegPop_{s,a,t}$$

(16) $$CNRScaler_{f,t} = \frac{TotalEstCNR_{f,t}}{\sum_{s}\sum_{a} LegalEnc_{s,a,f,t} + \sum_{s}\sum_{a} SubLegEnc_{s,a,f,t}}$$

(17) $$CNRLegal_{s,a,f,t} = LegalEnc_{s,a,f,t} \ x \ CNRScaler_{f,t} \ x \ RelRate_{f,t}$$

(18) $$CNRSub_{s,a,f,t} = SubLegEnc_{s,a,f,t} \ x \ CNRScaler_{f,t} \ x \ RelRate_{f,t}$$

METHOD 4 (Chinook) – Computed from ratio of non-retention to retention days

(19) $$CNRLegal_{s,a,f,t} = Catch_{s,a,f,t} \ x \ (CNRDays_{f,t} \big/ RetentDays_{f,t}) \ x \ RelRate_{f,t} \ x \ LegalSelRate_{f,t}$$

(20) $$CNRSub_{s,a,f,t} = Shakers_{s,a,f,t} \ x \ (CNRDays_{f,t} \big/ RetentDays_{f,t}) \ x \ SubSelRate_{f,t}$$

METHOD 5 (Chinook) – Computed from relative effort of non-retention to retention period mortality

(21) $$CNRLegal_{s,a,f,t} = Catch_{s,a,f,t} \ x \ \frac{1 - FishScalar_{f,t}}{FishScalar_{f,t}} \ x \ RelRate_{f,t} \ x \ LegalSelRate_{f,t}$$

(22) $$TotalLegPop_{f,t} = \sum_s \sum_a (Cohort_{s,a,t} \ x \ PV_{s,a,t}) \quad \text{for stocks with catch in fishery } f$$

(23) $$TotalSubLegPop_{f,t} = \sum_s \sum_a (Cohort_{s,a,t} \ x \ (1 - PV_{s,a,t})) \quad \text{for stocks with catch in fishery } f$$

(24) $$EncRate_{f,t} = TotalSubLegPop_{f,t} / TotalLegPop_{f,t}$$

(25) $$TotCatch_{f,t} = \sum_s \sum_a Catch_{s,a,f,t} \ x \ (1 / PropModelStock_f)$$

(26)
$$CNRSub_{s,a,f,t} = TotCatch_{f,t} \ x \ EncRate_{f,t} \ x \ \frac{1 - FishScalar_{f,t}}{FishScalar_{f,t}} \ x \ RelRate_{f,t} \ x \ SubSelRate_{f,t} \ x \ PropSubPop_{s,a,f,t}$$

where (for method 1 to 5): $Cohort_{s,a,t}$, $Catch_{s,a,f,t}$, $FishScalar_{f,t}$, $PV_{s,a,t}$, $PropModelStock_f$, $BPER_{s,a,f,t}$, and $SHRS_{s,f,t}$, are previously defined and:

$PropCatch_{s,f,t}$	=	Proportion of the total catch in fishery *f* of stock *s* in time *t*
$EstCNRMorts_{f,t}$	=	External estimate of total CNR mortalities in fishery *f* at time step *t*
$CNRLegal_{s,a,f,t}$	=	Legal-sized adult non-retention mortality for stock *s*, age *a*, in fishery *f*, at time step *t*;
$RelRate_{f,t}$	=	Release mortality rate for fish in fishery *f* at time step *t*;
$LegalSelRate_{f,t}$	=	Legal-sized adult selectivity rate for fishery *f* in time step *t*, in response to changes in gear or fishing pattern (model input for Methods 4 and 5);
$TotalLegPop_{f,t}$	=	Total number of legal-sized fish from modeled stocks available to fishery *f* at time step *t*;
$TotalSubLegPop_{f,t}$	=	Total number of sub-legal sized fish from modeled stocks available to fishery *f* at time step *t*;
$EncRate_{f,t}$	=	For modeled stocks, the ratio of sub-legal sized Chinook encountered for every legal-sized Chinook in fishery *f* at time step *t*;
$TotCatch_{f,t}$	=	Total landed catch in fishery *f* at time step *t*;
$CNRSub_{s,a,f,t}$	=	Sub-legal sized non-retention mortality for stock *s*, age *a*, in fishery *f*, at time step *t*;
$SubSelRate_{f,t}$	=	Sub-legal sized selectivity rate for fishery *f* in time step *t*, in response to changes in gear or fishing pattern (model input for Methods 4 and 5);
$PropSubPop_{s,a,f,t}$	=	Proportion of sub-legal sized population for stock *s*, age *a*, in fishery *f*, at time step *t*;
$CNRDays_{f,t}$	=	Number of non-retention days in fishery *f*, at time step *t* (model input for Method 4);
$RetentDays_{f,t}$	=	Number of retention days in fishery *f* at time step *t* (model input for

Method 4);

$Shakers_{s,a,f,t}$	=	Sub-legal shaker mortality for stock *s*, age *a*, in fishery *f*, at time step *t* (see following sub-section for method of calculation);
$LegalPropCatch_{s,a,f,t}$	=	Proportion of legal-sized catch for stock *s*, age *a*, in fishery *f*, at time step *t*;
$SubLegPop_{s,a,t}$	=	Sub-legal sized population for stock *s*, age *a*, at time step *t*;
$SubLegNR_{s,a,f,t}$	=	Sub-legal sized non-retention mortalities for stock *s*, age *a*, in fishery *f*, at time step *t*;
$SubER_{s,a,f,t}$	=	Sub-legal sized encounter rate for stock *s*, age *a*, in fishery *f*, at time step *t* calculated from base period data;
$SubLegPropEnc_{s,a,f,t}$	=	Sub-legal sized proportion of encounters for stock *s*, age *a*, in fishery *f*, at time step *t*;
$LegalEnc_{f,t}$	=	Total number of legal-sized encounters in fishery *f* at time step *t* (model input for Method 2);
$SubLegEnc_{f,t}$	=	Total number of sub-legal sized encounters in fishery *f* at time step *t* (model input for Method 2);
$LegalEnc_{s,a,f,t}$	=	Legal-sized encounters for stock *s*, age *a*, in fishery *f*, at time step *t*;
$SubLegEnc_{s,a,f,t}$	=	Sub-legal sized encounters for stock *s*, age *a*, in fishery *f*, at time step *t*;
$CNRScalar_{f,t}$	=	Non-retention scalar in fishery *f* at time step *t*;
$TotalEstCNR_{f,t}$	=	Total estimated non-retention (legal and sub-legal) in fishery *f* at time step *t* (model input for Method 3);
$PropCatch_{s,f,t}$	=	Proportion of coho catch for stock *s* in fishery *f* at time step *t*;
$EstCNRMorts_{f,t}$	=	Estimated coho non-retention mortalities in fishery *f* at time step *t* (model input for Method 1); and
$CNR_{s,f,t}$	=	Coho non-retention mortality for stock *s* in fishery *f*, at time step *t*.

6.4.2 Sub-Legal Shaker Mortality

Sub-legal shaker mortality is not estimated for coho since most minimum size limits - if they exist - apply to age 2 fish that are not represented in the model. FRAM models sub-legal sized Chinook shaker mortalities through the use of the von Bertalanffy growth equation for stocks that contribute to each fishery. The mean size of each stock at the midpoint of the time step is evaluated against the stock-specific growth equation to get the proportion vulnerable by stock.

(27) $$KTime_{s,a,t} = (Age_s - 1) * 12 + MidTimeStep(Months)$$

(28) $$MeanSize_{s,a,t} = L_s * (1 - (\exp(-K_s) * (KTime_{s,a} - T0_s)))$$

(29) $$StdDev_{s,a,t} = CV_{s,a} * MeanSize_{s,a,t}$$

(30) $$PV_{s,a,t} = 1 - NormalDistr(Minsize_{f,t}, Meansize_{s,a,t}, StdDev_{s,a})$$

Where:

$PV_{s,a,t}$	Percent Vulnerable for stock ***s,*** age ***a***, at time step ***t***
L_s	Von Bertalanffy growth parameter for stock ***s (Max Size)***
K_s	Von Bertalanffy growth parameter for stock ***s (Slope)***
$T0_s$	Von Bertalanffy growth parameter for stock ***s (Time Zero)***
$KTime_{s,a}$	Time for estimate of growth equation for stock ***s***, age ***a***
$CV_{s,a}$	Coefficient of Variation of size distribution at $KTime_{s,a}$ for stock ***s***, age ***a***
$MinSize_{f,t}$	Minimum Size Limit for fishery ***f***, time step ***t***
$MeanSize_{s,a,t}$	Mean total length of a fish of stock s at age a in time t

The distribution of Chinook sizes by age at a particular time is assumed to be normal with a variance that was calculated using lengths from CWT recovery data. Evaluation of the normal distribution is done using a calculation method developed for the original WDF/NBS Chinook model.

(31) $Z = (Minsize_{f,t} - Meansize_{s,a,t}) / StdDev_{s,a}$

(32) $A1 = Z * (0.000005383 * Z + 0.0000488906) + 0.0000380036$

(33) $A2 = Z * (A1 + 0.0032776263) + 0.0211410061$

(34) $A3 = 1/(1 + Z * (Z * A2 + 0.049867347))$

(35) $A4 = 1 - (0.5 * A3\hat{}16)$

For Chinook, the sub-legal and legal size encounters are stock and age specific and are calculated using von Bertalanffy growth curves described above. The calculations for sub-legal sized Chinook (shakers) are shown below:

(36) $SubLegProp_{s,a,t} = 1 - PV_{s,a,f,t}$

(37) $SubLegPop_{s,a,t} = Cohort_{s,a,t} \ x \ SubLegProp_{s,a,t}$

(38) $Shakers_{s,a,f,t} = SubER_{s,a,f,t} \ x \ SubLegPop_{s,a,t} \ x \ FishScalar_{f,t} \ x \ RelRate_{f,t}$

where all components are defined previously and (1-$PV_{s,a,f,t}$) is the proportion of the cohort for stock *s*, age *a*, not vulnerable to the gear at time step *t* (for Chinook *PV* is function of von Bertalanffy growth curve; for coho *PV* is always = 1).

6.5 Mark-Selective Fisheries

The implementation of mark-selective fishery regulations requires the use of more complex computations that incorporate release and retention mortality parameters that are not part of normal nonselective fishery accounting. Both coho and Chinook FRAM allow the user to input the values for: 1) release mortality rate; 2) unmarked fish retention error (i.e. proportion of unmarked fish brought to the boat that are improperly retained); 3) marked recognition error (i.e. proportion of marked fish brought to the boat that are released; and 4) drop-off mortality (a commonality with nonselective fisheries). Other than the inclusion of the mark selective fishery parameters (1-3 above), FRAM cycles through algorithms the same as in non mark selective fisheries keeping separate accounting of cohort sizes and mortalities of unmarked and marked components. The time-period specific forms of the general equations utilized in coho FRAM under non-selective and mark-selective fisheries are depicted in the following table. Computations for Chinook mark-selective fisheries must account for sub-legal mortality, which does not differ between marked and unmarked components. The counterpart equations for Chinook would contain the elements associated with sub-legal mortality, but due to the increased complexity this introduces the analogous equations for Chinook are not presented here.

	Non-Selective Fisheries	Mark-Selective Fisheries	
	Discrete Equations	Marked Fish	Unmarked Fish
Landed mortalities	(39) $C_{s,f} = ER_{s,f}\ x\ N_{s,t}$	(40) $C_{s,f} = ER_{s,f}\ x\ N_{s,t}\ x\,(1 - mre_f)$	(41) $C_{s,f} = ER_{s,f}\ x\ N_{s,t}\ x\ ure_f$
Release mortalities		(42) $R_{s,f} = ER_{s,f}\ x\ N_{s,t}\ x\ mre_f\ x\ rm_f$	(43) $R_{s,f} = ER_{s,f}\ x\ N_{s,t}\ x\,(1 - ure_f)\ x\ rm_f$
Drop-off mortalities	(44) $D_{s,f} = C_{s,f}\ x\ dmr_f$	(45) $D_{s,f} = ER_{s,f}\ x\ N_{s,t}\ x\ dmr_f$	(46) $D_{s,f} = ER_{s,f}\ x\ N_{s,t}\ x\ dmr_f$

where:

$C_{s,f}$ = number of landed mortalities of stock *s* in fishery *f*;

$D_{s,f}$ = drop-off mortalities for stock *s* in fishery *f*;

dmr_f = drop-off mortality rate in fishery *f*;

$ER_{s,f}$ = exploitation rate for stock *s* in fishery *f* (this parameter is equivalent to *BPER* x *PV* x *SHRS* in the previously described formulation);

mre_f = marked recognition error (releasing marked fish in a selective fishery) in fishery *f*;

$N_{s,t}$ = cohort size for stock *s* at the beginning of time period *t*;

$R_{s,f}$ = number of release mortalities for stock *s* in fishery *f*;

rm_f = release mortality rate in fishery *f*; and

ure_f = unmarked retention error (retaining and landing unmarked fish in a selective fishery) in fishery *f*.

Base period estimates for the marked and unmarked stocks are generated by splitting each original stock cohort into two equal components and using the original stock exploitation rate for each component. This process was chosen because mass marking was not done during the base period years and is consistent with the assumption that the marked and unmarked components have the same geographical distribution and exploitation rate pattern. When the model is run with mark selective fisheries the differences in the exploitation rate pattern are accounted for by the different rate of change in the cohort sizes between the marked and unmarked components. The differences are accounted for in subsequent time steps because discrete catch equations are used for each time step on each single-pool stock. The $StockScalar_{s,a}$ variables for each model run must be calculated using the split cohort sizes for the marked and unmarked component stocks.

6.6 Maturation (Chinook only)

For Chinook, the maturation process occurs after the pre-terminal catch has been calculated and results in a mature cohort for each stock, age, and time step. The number of fish from the age *a* cohort for stock *s* that matures at time step *t* ($TermCohort_{s,a,t}$) is calculated as:

$$(47)\ TermCohort_{s,a,t} = Cohort_{s,a,t}\ x\ MatRate_{s,a,t}$$

where $MatRate_{s,a,t}$ is a stock, age, and time step specific maturation rate that is calculated from base period data. The mature portion of the cohort is available to those fisheries, during the same time period, that have been designated as harvesting only mature fish. The immature portion of the cohort ($Cohort_{s,at,}$ - $TermCohort_{s,a,t}$) is then used to initiate the next time step.

6.7 Escapement

Escapement is defined as any fish from the mature cohort that does not die from fishery-related mortality and is assumed to equal spawning escapement if mortality during "prespawning" holding time is negligible or ignored. In the current versions of the coho and Chinook base periods, all maturation and escapement of a stock occurs within a single time step. The only exceptions are Skagit stocks of spring and summer/fall Chinook and Columbia River summer Chinook. For coho, fisheries during time steps 1 through 4 are on immature fish and by default all coho fisheries in time step five are on mature fish. All 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 to the terminal areas. The equations for coho and Chinook are given below:

Coho:

(48) $$Escape_{s,a} = Cohort_{s,a,5} - (\sum_{f}(Catch_{s,f,5} + LegalShakers_{s,f,5} + Dropoff_{s,f,5} + CNR_{s,f,5}))$$

Chinook:

(49)
$$TotTermMort_{s,a,t} = \sum_{f-term}(Catch_{s,a,f,t} + Shakers_{s,a,f,t} + Dropoff_{s,a,f,t} + LegalShakers_{s,a,f,t} + CNR_{s,a,f,t})$$

(50) $$Escape_{s,a,t} = TermCohort_{s,a,t} - TotTermMort_{s,a,t}$$

where age = 3 and time step = 5 for coho:

$TotTermMort_{s,a,t}$	=	Total terminal fishery mortality for stock *s*, age *a*, at time step *t*;
$Escape_{s,a,t}$	=	Escapement for stock *s*, age *a*, at time step *t*;
$Catch_{s,a,f,t}$	=	Catch for stock *s*, age *a*, in terminal fishery *f*, at time step *t*;
$Shakers_{s,a,f,t}$	=	Sub-legal mortality for stock *s*, age *a*, in terminal fishery *f*, at time step *t*;
$Dropoff_{s,a,f,t}$	=	Non-landed mortality for stock *s*, age *a*, in terminal fishery *f*, at time step *t*;
$LegalShakers_{s,a,f,t}$	=	Legal-sized mortality of fish released during mark-selective fisheries for stock *s*, age *a*, in terminal fishery *f*, at time step *t*; and
$CNR_{s,a,f,t}$	=	Non-retention mortality (legal and sub-legal sized) for stock *s*, age *a*, in terminal fishery *f*, at time step *t*.

6.8 *Other Algorithms and Equations Used in the Model*

<u>Adult Equivalency</u> (Chinook only). Fishery-related mortality for Chinook is expressed as a nominal value or adjusted for "Adult Equivalents" (AEQ) to account for the multiple ages that the fish mature and are vulnerable to fisheries. Fishery-related mortalities are expressed as adult equivalent mortalities so that all fishery mortalities can be expressed in a common unit of measure, which is the number of fish that would have matured (escaped to spawn) in the absence of fishing. The AEQ factors adjust for the natural mortality that would have occurred between the time/age the fish were caught and the time/age that they would have matured or escaped to spawn. The factors used in FRAM are calculated during the CWT base period calibration process and take into account fixed age-specific natural mortality rates and age and stock specific maturation rates which are calculated from CWT recoveries during cohort analysis. Stock and age specific AEQ values are expressed relative to the expected contribution to the age-5, time step 3 fish, which is the oldest age-class at the final time step for mature fish. The AEQ value at the maximum age and final time-step is by definition 1.0 and all other age/time-step values are a proportion of this value. Note that all age classes have an AEQ value of 1.0 in designated "terminal fisheries" (exploitation rates for Chinook are usually expressed in terms of adult equivalent mortality). In other words, all mature fish have an AEQ equal to 1.0, regardless of age. The AEQ factor is calculated as:

$$(51)\quad AEQ_{s,a,t} = MatRate_{s,a,t} + [(1 - MatRate_{s,a,t}) \quad x \quad (1 - M_{a,t+1}) \quad x \quad AEQ_{s,a,t+1}]$$

where $AEQ_{s,a,t} = 1$ for $a = 5$ and $t = 3$ (maximum age and final time step for most Chinook stocks).

<u>Proportion Modeled Stocks</u> (for Chinook only and calculated using base period data). The "model stock proportion" is a value unique to Chinook and is the proportion of the total catch in a fishery that is accounted for by the modeled stocks. These proportion modeled stocks values (presented in Appendix 3) are calculated during the Chinook FRAM calibration process. They represent modeled stock proportions during the base period and are used "as-is" for preseason Chinook FRAM modeling even though the relative abundance of the nonmodeled stocks may differ significantly from the base period. Model stock proportions are fishery specific and remain constant through all time periods. The coho cohort analysis used to create the model base period exploitation rates include estimates for all stock production regions, thus the proportion modeled stock is 1.0.

$$(52)\quad PropModelStock_f = \frac{\sum_s \sum_a \sum_t Catch_{s,a,f,t}}{TotalCatch_f}$$

where $TotalCatch_f$ = the average total Base Period catch in fishery f.

Total Mortality. Total mortality is used to calculate simple exploitation rates by stock, age (Chinook), and time period. The equations used for coho and Chinook, respectively, are:

Coho:

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

The cohort surviving to the next time step:

(54) $Cohort_{s,t+1} = Cohort_{s,t} - TotalMort_{s,t}$

Chinook:

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

or

$$AEQTotMort_{s,a,t} = \sum_f [(Catch_{s,a,f,t} + Shakers_{s,a,f,t} + Dropoff_{s,a,f,t} + LegalShakers_{s,a,f,t} + CNR_{s,a,f,t}) x (AEQ_{s,a,t})]$$

The cohort surviving to the next time step:

(56) $Cohort_{s,a,t+1} = Cohort_{s,a,t} - \Sigma TotMort_{s,a,t} - Escape_{s,a,t}$

Total Exploitation Rate. The general equation for exploitation rate differs only by the use of adult equivalent mortalities (AEQ) for Chinook.

Coho:

(57) $$ER_s = \frac{\sum_a \sum_t TotMort_{s,a,t}}{\sum_a \sum_t TotMort_{s,a,t} + \sum_a \sum_t Escape_{s,a,t}}$$

or

Chinook:

$$ER_s = \frac{\sum_a \sum_t AEQTotMort_{s,a,t}}{\sum_a \sum_t AEQTotMort_{s,a,t} + \sum_a \sum_t Escape_{s,a,t}}$$

where all components are defined previously.

7. TERMINAL AREA MANAGEMENT MODULE (TAMM)

The FRAM program interacts with two species-specific (coho and Chinook) spreadsheet programs that contain detailed information on terminal fisheries in regional Terminal Area Management Modules (TAMM). These spreadsheets allow modelers to specify terminal fishery impacts on a finer level of resolution than possible with FRAM's temporally and spatially larger fishery units and larger aggregated stock units. The TAMM spreadsheet programs were first developed for 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 regional needs. The scope of the modeling results and information presented in the coho and Chinook TAMM spreadsheets has expanded dramatically from their initial focus on Puget Sound terminal fisheries. The Chinook TAMM still contains the original Puget Sound regional sections, while the coho TAMM has been expanded to allow FRAM output report generation for several non-Puget Sound stock groups. Both TAMM spreadsheets provide abundance, escapement, and fishery impact assessments for many of the key hatchery and natural stocks needed for PFMC and other fishery management processes.

Table 7-1. Puget Sound terminal management regions.

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

The expansion of stocks and fisheries in the present coho FRAM base period has contributed to diverging processes between the coho and chinook TAMM spreadsheets. Coho FRAM output now includes stock specific impacts from marine through freshwater fisheries (complete coverage for Puget Sound stocks and fisheries); thus, escapement values are calculated within FRAM in terms of "escapement from freshwater fisheries". The coho TAMM generates reports of escapements and exploitation rates for all coho stocks. In contrast, Chinook FRAM output is available only for pre-terminal fisheries and escapement values are in terms of "escapement from ocean fisheries", or "terminal run size". The chinook TAMM is used to both calculate and report Puget Sound stock escapements and exploitation rates. While the functions of the coho and Chinook TAMMs have diverged in recent years, as terminal area management modules they retain common features:

- Receive input for TAMM fisheries
- Receive input for TAMM stock abundances (now Chinook only)
- Receive input for TAMM stock management criteria
- Provide fishery input to FRAM for iterations with FRAM fisheries
- Receive FRAM output of FRAM fishery impacts upon FRAM stock units
- Use FRAM output to complete TAMM fishery impact modeling upon TAMM stocks
- Generate TAMM reports of combined FRAM and TAMM fishery impacts upon TAMM stock units (Chinook)
- Generate TAMM reports of FRAM fishery impacts upon FRAM stocks (coho only)

7.1 Coho TAMM

The current version of coho TAMM provides the following key functions:

1. Terminal fishery inputs to FRAM for Puget Sound stocks.
2. Catch/mortality calculations in Columbia River, and coastal Washington terminal fisheries.
3. Reports (Tables) of fishery impacts, catch distributions, exploitation rates, escapements, management criteria for all key U.S. and Canada hatchery and natural coho stocks.

After the upgrade of the coho base period database (see 'Coho FRAM Base Data Development') FRAM became able to model all stock/fishery interactions entirely within the FRAM program. With the stock and fishery coverage provided by this new base period, the coho TAMM could have been abandoned as obsolete. However, the decision was made to continue using the coho TAMM for the following reasons:

- generate the commonly used output reports,
- maintain continuity of establish methods for providing Puget Sound fishery inputs,
- facilitate input and error checking among a larger pool of knowledgeable participants,
- maintain a spreadsheet tool for functions outside of FRAM's program.

Terminal area fisheries (i.e. TAMM-type) for coho occur during model time steps 4 (Sept.) and 5 (Oct.-Dec.) (see Table 2-1 for difference between coho and Chinook time steps). The marine water fisheries can be modeled within both these time steps while the freshwater fisheries are modeled only for time step 5. Marine area fisheries, in both time steps, may be "mixed stock" fisheries impacting non-local stocks; while freshwater and a few marine "extreme terminal area" fisheries are modeled to impact only local stocks. There may be occasions when individual fisheries open prior to the first calendar date of the appropriate model time step. However, the catch is modeled as occurring within the upcoming step. This is justified, for example, when the run timing of maturing individual stocks do not strictly confirm to our monthly based time steps but the fisheries are being executed upon a stock composition consistent with the modeled base period.

The coho 1986-1991 coho base period expansion allows FRAM to estimate the impacts of 87 Puget Sound fisheries (see Appendix 4, fishery numbers 80-166) upon marked and unmarked components for 61 Puget Sound stocks (see Appendix 3, stock numbers 1-122). All coho stock abundance forecasts are now entered directly into FRAM. At the option of regional managers, Puget Sound extreme terminal and freshwater fishery inputs are still entered into the TAMM, as is the case for most marine area "mixed stock" net fisheries, however Puget Sound marine sport inputs are entered directly into FRAM. Those terminal area and freshwater net and sport fisheries entered via the TAMM model are often broken into smaller units for TAMM purposes. For example, where FRAM defines and models the Treaty Skagit River freshwater net fishery as a single unit, the TAMM input can be by temporal components (pink, coho, chum, or steelhead management periods) and/or by gear type (test fishery). The TAMM will sum the fishery components as needed to fit FRAM fishery definitions when providing input to FRAM.

Fishery impacts upon Puget Sound coho stocks are completely modeled by FRAM, but that is not the case for Washington coastal coho stocks. The present version of coho TAMM performs terminal fishery modeling tasks for Washington coastal coho stocks in their terminal fishery areas. This was needed to resolve discrepancies between the regional terminal area coastal coho harvest management models and FRAM modeling of those same terminal fisheries. The regional terminal models utilize a harvest rate approach for the terminal fisheries while FRAM models an exploitation rate approach over a more widely distributed set of fisheries.

Time step intervals are another difference between the FRAM and several coastal terminal fishery models. FRAM time step 4 is a month and time step 5 is three months, while the coastal regional models generally use weekly time steps. In several regions wild and hatchery coho have different return timing and the weekly arrangement of fishing schedules can be structured to take advantage of those differences and, when needed, minimize annual impacts on wild stocks.

Thus a regional terminal area model may produce total fishery harvest rates for individual local stocks (derived from weekly scheduled fisheries) that vary significantly from FRAM estimates based upon the average season built into base period rates by FRAM time steps. In this type of scenario, FRAM with a given total catch input for a coastal terminal fishery, will calculate a different local stock composition for that catch than the weekly harvest rate driven stock composition used by local managers. For the Washington coastal stocks, TAMM reconciles these differences and generates stock specific reports that use FRAM's stock impact estimates for the pre-terminal fisheries and TAMM's local stock impact estimates for the terminal fisheries.

Consistent with the harvest rate versus exploitation rate issue mentioned earlier, FRAM operates on an abundance pool of all stocks while the regional models operate on the terminal abundance of local stocks. Some stocks "dip-in" to foreign estuaries at significant levels before returning to their own terminal area. The FRAM base period fishery data includes "dip-in" catch, while several coastal regional models are based upon data which has "dip-in" catch removed. For the same fishery, while a regional model is structured for impacts only upon local stocks, FRAM may be modeling that fishery for mixed stocks with "pre-terminal" impacts upon other non-local stocks.

The FRAM estimated catch of non-local stocks within one terminal area will change the terminal run size of those stocks to other terminal areas. This could change the basis of the local regional harvest management agreements (i.e. changes relative to minimum wild escapement). For example, a new FRAM catch input for total catch in coastal region "A" terminal fishery will change the total local terminal run size to coastal region "B". Without any changes to the terminal area fishery schedules (constant harvest rates), the total catch in region "B" changes and must then also be re-modeled through FRAM (to capture changed non-local impacts). This, in turn, will change the terminal run size for region "A" fisheries. Generally three manual external iterations between TAMM and FRAM have been needed to stabilize the "ripple effect" throughout the various coastal terminal areas.

For Puget Sound stocks the above iteration process is built into the FRAM code. [Since the relatively recent addition of coastal coho terminal fisheries to the FRAM base period, the steps to institute an internal FRAM iteration process for those fisheries have not been completed.] FRAM's iteration process allows for TAMM Puget Sound coho fishery inputs to be provided in terms of:

- a fixed catch (as a FRAM or TAMM origin input),
- effort scalar (as a FRAM or TAMM origin input),
- harvest rate on terminal area abundance (TAA) (TAMM origin input only), or
- harvest rate on extreme terminal run size (ETRS) (TAMM origin input only).

The fixed catch and effort scalar input control mechanisms correspond directly to FRAM input types while the harvest rate options are unique to the TAMM. The harvest rates control mechanisms operate as percent of TAA or percent of ETRS. The TAA harvest rates would be applied to the sum of the escapement of all local area stocks and the terminal catch of local and non-local stocks (e.g. "dip-ins"). The ETRS rates would be applied to the sum of the escapement and terminal catch of local stocks only.

Each terminal area is defined by the specific rule FRAM uses for calculation of fishery specific TAA or ETRS abundance. These rules define what fishery catches and which stock escapements are part of the fishery specific abundances that the ETRS or TAA harvest rates will act upon. Correspondingly, the calculation of the fishery's harvest rate input for pre-season modeling should be consistent with the definitions of the TAA or ETRS style run reconstructions.

For a terminal fishery containing only local stocks both methods should produce the same catch by stock results. For a mixed-stock fishery the associated catch of non-local stocks is calculated by FRAM as the proportion of total catch observed during the base period (adjusted for present levels of abundance). Iterations between the terminal areas' harvest rate fisheries upon local stocks and the base period's data defining those fisheries as mixed stock are performed by FRAM internally.

7.1.1 Coho TAMM-FRAM interaction

Figure 3 illustrates the iterative process coho FRAM uses to solve the problem of fisheries impacting stocks which may be simultaneously "local" and "non-local", depending upon the fishery. This process addresses the ripple effect of "terminal area" fisheries changing the run size of stocks to other "terminal" areas. There are 41 Puget Sound ETRS and TAA abundance unit definitions (Table 7.2). These abundances are determined by summing catch of designated local fisheries and escapement of designated local stocks. The designations are presented to FRAM by the TAAETRSnum.txt file (Table 7.3).

The structure of the TAAETRSnum.txt file is:

1. first number – TAA or ETRS unit definition number,
2. second number – total number of stocks contributing escapement,
3. followed by stock id codes,
4. following number – total number of fisheries contributing catch,
5. followed by fishery id codes,
6. "04" & "05" - designating time steps 4 and 5
7. "00" - designates ETRS type abundance and harvest rate calculations, OR,
8. "01" - designates TAA type abundance and harvest rate calculations.

FRAM computes the estimated catch in the TAMM terminal fisheries using the harvest rate inputs from the spreadsheet and the appropriate ETRS or TAA estimate. The ratio of the TAMM catch estimate and calculated FRAM catch is used to calculate the TAMMScaler variable for each fishery and time step evaluated in the iterative loop. All the FishScalar variables for the TAMM fisheries are recalculated using the ratio for the next iteration.

FRAM begins by reading either %ETRS (harvest rate) or % TAA from TAMM spreadsheet and calculating the TAMM estimated catch. If a TAMM fishery is flagged for ETRS (Extreme Terminal Run Size) type calculations, then:

(58)

$$TAMMCatch_{f,t} = \sum\left(LocalEscapement_{f,t} + LocalCatch_{f,t}\right) \times \%ETRS_{f,t} \times \frac{\sum\left(LocalCatch_{f,t} + NonLocalCatch_{f,t}\right)}{\sum LocalCatch_{f,t}}$$

Where f= fishery, t = time step.

If TAMM is flagged for TAA (Terminal Area Abundance) type calculations, then:

$$(59)\quad TAMMCatch_{f,t} = \sum \left(LocalEscapement_{f,t} + LocalCatch_{f,t} + NonLocalCatch_{f,t} \right) \times \%TAA_{f,t}$$

The TAMMScalar variable used for scaling the FRAM FishScalar variables for the next iteration is calculated using Eq 60.

$$(60)\quad TAMMScalar_{f,t} = \frac{TAMMCatch_{f,t}}{\sum Catch_{s,f,t}}$$

The new FRAM FishScalar variable for each fishery and time step is calculated using Eq 61 when another iteration is needed.

$$(61)\quad FishScalar_{f,t} = FishScalar_{f,t} \times TAMMScalar_{f,t}$$

At the beginning of each iteration the time step 4 cohort sizes are reset to original value from the initial FRAM run. The normal FRAM catch calculations are then done for time steps 4 and 5 using the new FishScalar parameters for the TAMM fisheries. The iterative loop is done 5 times for coho without checking the TAMMScalar variables against convergence criteria as is done in the Chinook TAMM iterations. The coho calculations converge very quickly and 5 repetitions are adequate for all situations.

The magnitude of terminal area fisheries plays the key role in determining the TAA, or ETRS abundance in Eq 58 and 59. As catch of local stock in a terminal fishery increases with higher harvest rates, the corresponding catch of non-local stocks increases, thus increasing the TAA (same situation for catch of nonlocal stocks in the coastal discussion). This also applies when using ETRS harvest rates. In essence, the greater a fishery effort is, the larger the terminal area abundance becomes. This FRAM phenomenon is even more apparent where both treaty and non-treaty net fisheries co-exist within the same terminal fishery area. For example, the absence of either the treaty or non-treaty catch component, where it was normally present, will reduce the TAA run size with the ripple effect of decreasing the expected catches of local and non-local stock in the remaining fishery, based on harvest rates. The opposite is also true, for example the increase the treaty harvest rate will function to increase the TAA and thus increase the catch of the non-treaty fleet even though that non-treaty harvest rate remained the same. And the ripple effect would change the expected catch in all other harvest rate based terminal fisheries impacting the same stocks.

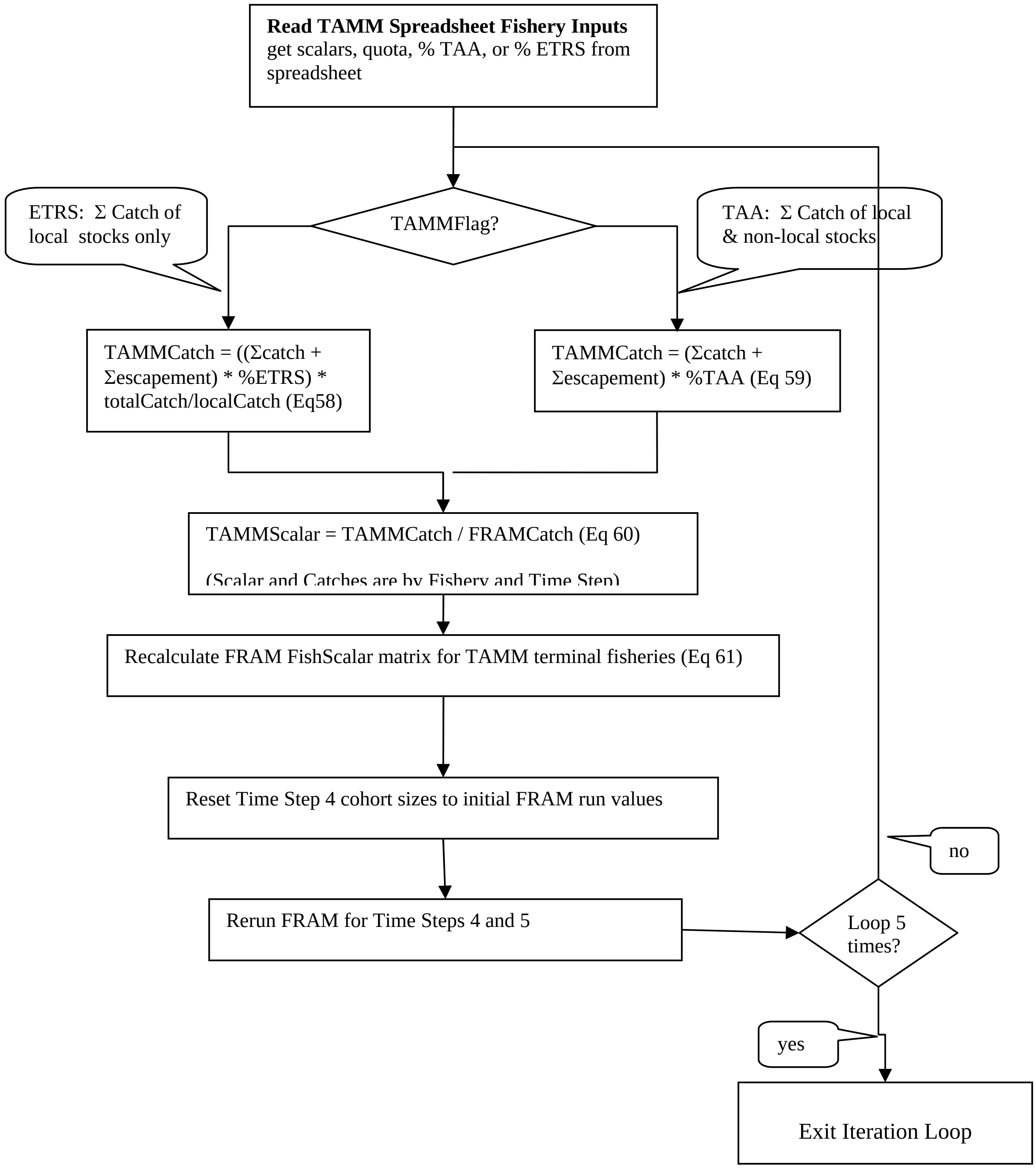

Figure 3. Flow chart for coho TAMM and FRAM terminal catch comparison.

Table 7-2. Coho TAMM TAA and ETRS name and number of stocks and fisheries within.

Definition #	TAA or ETRS Units	Number of Stocks	Number of Fisheries
1	Skagit NT TAA	12	5
2	Stilly-Snoh TAA	10	6
3	Hood Canal T TAA	20	15
4	SPS TAA	46	25
5	SPS Ar 10 TAA	16	8
6	SPS Ar 11 TAA	8	5
7	SPS Ar 13 TAA	22	16
8	Nook/Sam TAA	16	3
9	Straits TAA	16	9
10	Skagit Wild ETRS	4	4
11	Skagit ETRS	12	4
12	Stilly TAA	4	1
13	Snoh ETRS	4	2
14	Tulalip H TAA	2	2
15	HC Wld (no 9A,12A) ETRS	6	10
16	SPS Nisq H&W TAA	4	3
17	HC 9A H&W ETRS	4	2
18	Nooksack TAA no sport	6	2
19	E JDF TAA	4	2
20	Dung Bay T TAA	4	3
21	Elwha TAA	4	2
22	W. JDF TAA	2	2
23	HC 9A H&W TAA	4	2
24	Quil Bay 12A TAA	6	4
25	Hdspt Hatchery ETRS	2	0
26	Skokomish R TAA	4	2
27	TAA LaWA	4	2
28	TAA DuwamGrn	6	2
29	TAA So Sound Net Pens only	2	1
30	TAA Puyallup	4	2
31	TAA Ar 13A H&W	4	2
32	ETRS So Sound Net Pens	2	0
33	Skagit T TAA	12	6
34	HC 12CD TAA	8	5
35	Hood Canal NT TAA	20	10
36	Area 10E TAA	4	2
37	Area 11A TAA	4	4
38	Deep SPS TAA	6	6
39	Dung Bay NT TAA	4	2
40	Quil R TAA	6	2
41	Nook/Sam TAA with sport	16	5

Table 7-3. Coho TAAETRSnum.txt file, designating FRAM *stock* and fishery numbers for calculation of Puget Sound fishery specific TAA and ETRS abundance levels.

1, 12,*17,18,19,20,21,22,23,24,25,26,27,28*,05,101,102,103,104,105,04,05,01 "Skagit NT TAA"
2, 10,*29,30,31,32,33,34,35,36,37,38*,06,109,110,111,112,113,114,04,05,01 "Stilly-Snoh TAA"
3, 20,*41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60*,15,152,153,154,155,156,157,158,159,160,161,162,163,164,165,166,04,05,01 "Hood Canal T TAA"
4,46,*61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100,101,102,103,104,105,106*,25,119,120,121,122,123,124, 125,126,130,131,132,133,134,137,138,139,140,141,142,143,144,145,146,147,148,04,05,01 "SPS TAA"
5, 16,*91,92,93,94,95,96,97,98,99,100,101,102,103,104,105,106*,08,119,120,121,122,123,124,125,126,04,05,01 "SPS Ar 10 TAA"
6, 8,*83,84,85,86,87,88,89,90*,05,130,131,132,133,134,04,05,01 "SPS Ar 11 TAA"
7, 22,*61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82*,16,136,137,138,139,140,141,142,143,144,145,146,147,148,149,150,151,04,05,01 "SPS Ar 13 TAA"
8, 16,*01,02,03,04,05,06,07,08,09,10,11,12,13,14,15,16*,03,96,97,98,04,05,01 "Nook/Sam TAA"
9, 16,*107,108,109,110,111,112,113,114,115,116,117,118,119,120,121,122*,09,82,83,84,85,86,89,90,94,95,04,05,01 "Straits TAA"
10, 4,*17,18,23,24*,04,103,104,105,108,04,05,00 "Skagit Wild ETRS"
11, 12,*17,18,19,20,21,22,23,24,25,26,27,28*,04,103,104,105,108,04,05,00 "Skagit ETRS"
12, 4,*29,30,31,32*,01,113,04,05,01 "Stilly TAA"
13, 4,*35,36,37,38*,02,114,117,04,05,00 "Snoh ETRS"
14, 2,*33,34*,02,111,112,04,05,01 "Tulalip H TAA"
15, 6,*45,46,55,56,59,60*,10,155,156,157,158,161,162,163,164,165,166,04,05,00 "HC Wld (no 9A,12A) ETRS"
16, 4,*67,68,69,70*,03,147,148,150,04,05,01 "SPS Nisq H&W TAA"
17, 4,*41,42,43,44*,02,155,156,04,05,00 "HC 9A H&W ETRS"
18, 6,*01,02,03,04,05,06*,02,98,99,04,05,01 "Nooksack TAA no sport"
19, 4,*115,116,121,122*,02,86,89,04,05,01 "E JDF TAA"
20, 4,*107,108,109,110*,03,82,83,94,04,05,01 "Dung Bay T TAA"
21, 4,*111,112,113,114*,02,84,95,04,05,01 "Elwha TAA"
22, 2,*117,118*,02,85,90,04,05,01 "W. JDF TAA"
23, 4,*41,42,43,44*,02,155,156,04,05,01 "HC 9A H&W TAA"
24, 6,*47,48,49,50,51,52*,04,157,158,162,164,04,05,01 "Quil Bay 12A TAA"
25, 2,*53,54*,00,04,05,00 "Hdspt Hatchery ETRS"
26, 4,*57,58,59,60*,02,161,166,04,05,01 "Skokomish R TAA"
27, 4,*99,100,101,102*,02,125,128,04,05,01 "TAA LaWA"
28, 6,*95,96,97,98,103,104*,02,126,127,04,05,01 "TAA DuwamGrn"
29, 2,*65,66*,01,144,04,05,01 "TAA So Sound Net Pens only"
30, 4,*83,84,85,86*,02,134,135,04,05,01 "TAA Puyallup"
31, 4,*73,74,81,82*,02,141,142,04,05,01 "TAA Ar 13A H&W"
32, 2,*65,66*,00,04,05,00 "ETRS So Sound Net Pens"
33, 12,*17,18,19,20,21,22,23,24,25,26,27,28*,06,101,102,103,104,105,108,04,05,01 "Skagit T TAA"
34, 8,*53,54,55,56,57,58,59,60*,05,159,160,161,165,166,04,05,01 "HC 12CD TAA"
35, 20,*41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60*,10,153,154,155,156,157,158,159,160,161,162,04,05,01 "Hood Canal NT TAA"
36, 4,*91,92,93,94*,02,123,124,04,05,01 "Area 10E TAA"
37, 4,*83,84,85,86*,04,132,133,134,135,04,05,01 "Area 11A TAA"
38, 6,*61,62,63,64,65,66*,06,143,144,145,146,149,151,04,05,01 "Deep SPS TAA"
39, 4,*107,108,109,110*,02,82,83,04,05,01 "Dung Bay NT TAA"
40, 6,*47,48,49,50,51,52*,02,162,164,04,05,01 "Quil R TAA"
41, 16,*01,02,03,04,05,06,07,08,09,10,11,12,13,14,15,16*,05,96,97,98,99,100,04,05,01 "Nook/Sam TAA with sport"

7.2 Chinook TAMM

The Chinook TAMM provides the following key functions:

1) Puget Sound terminal fishery inputs to FRAM.
2) Catch/mortality calculations in the terminal fishery modules for Puget Sound terminal fisheries.
3) Forecast (usually pre-season terminal run size) proportions and adipose mark rates for Puget Sound hatchery and natural stocks.
4) Reports (Tables) showing fishery impacts, catch distributions, exploitation rates, escapements, management criteria for key Puget Sound hatchery and natural Chinook stocks and substocks.

It is through the use of the Chinook TAMM that total fishery impacts upon Puget Sound key management stocks can be estimated and reported. Puget Sound fishery inputs are initially entered into the Chinook TAMM, where they are rolled-up into the fishery units used by FRAM and passed to FRAM via a "tami" file. After FRAM calculates the impacts of FRAM fisheries upon Puget Sound FRAM stock units, the results are passed back to TAMM via three "tamx" transfer files containing: 1) terminal marine and freshwater run sizes, 2) total mortality for all stocks and stock specific AEQ total mortality for Puget Sound stocks, and 3) stock specific landed catch for Puget Sound stocks. TAMM apportions the run size and fishery impacts from the Puget Sound stock outputs in the tamx transfer files by the pre-season forecast proportions and terminal fishery details reported in "input' sections of the TAMM.

Thus, Chinook TAMM remains a critical element of pre-season Puget Sound modeling. It is the tool that is used to split the FRAM stock groupings into their Puget Sound subcomponents. The TAMM stocks are used for management purposes and their impacts determine allowable fishery levels during the pre-season planning processes. Table 7-4 shows FRAM stocks units with their corresponding TAMM stock units. Abundance levels of every Puget Sound Chinook hatchery and natural population are entered into the TAMM. These abundances are not passed to FRAM but are used within TAMM to proportion FRAM fishery impacts upon FRAM stocks into the appropriate Puget Sound stock sub-component (of the FRAM aggregate). TAMM then continues to calculate the harvest impacts from all Puget Sound TAMM fisheries to obtain the full set of fishery-specific impacts for all the population subcomponents

The Chinook base period data (as in the older versions of the coho base period) aggregates terminal area fisheries for FRAM modeling at a broader scale than used for management of Puget Sound fisheries. For example, Chinook FRAM does not model individual river freshwater terminal sport or freshwater net fisheries. Table 7-5 shows FRAM fishery units with their corresponding TAMM fishery units. Of major importance is TAMM's completion of the sets of freshwater sport (FRAM fishery #72) and net (FRAM fishery #73) fisheries. The Chinook TAMM provides the ability to not only model the individual Puget Sound marine and freshwater net fisheries, but to do so by smaller time scale associated with fisheries directed at Chinook, pink, coho, chum, or steelhead. In addition, test fisheries and fisheries in sub-areas can be included.

Table 7-4. Chinook Puget Sound FRAM and TAMM Stocks.

Unmarked Stock #	FRAM Puget Sound Stock Names	TAMM Puget Sound stock components (per 2005 Planning Cycle)
1	Nooksack-Samish summer/fall	Nooksack R & Samish R: composite of all hatchery & natural
		Glenwood Springs Hatchery
3	North Fork Nooksack early (spring)	Nooksack R spring hatchery & natural stocks
5	South Fork Nooksack early (spring)	
7	Skagit summer/fall fingerling	Skagit River summer/fall fingerling hatchery & natural stocks
9	Skagit summer/fall yearling	Skagit River summer/fall yearling hatchery & natural stocks
11	Skagit spring yearling	Skagit River spring hatchery & natural stocks
13	Snohomish summer/fall fingerling	Snohomish R summer/fall fingerling hatchery & natural stocks
15	Snohomish summer/fall yearling	Snohomish R summer/fall yearling hatchery & natural stocks
		Skykomish R natural as percent of Snohomish R natural
17	Stillaguamish summer/fall fingerling	Stillaguamish River summer/fall natural
19	Tulalip summer/fall fingerling	Tulalip Hatchery
21	Mid S. Puget Sound fall fingerling	Gorst Ck Hatchery
		Grovers Ck Hatchery
		Lake Washington hatchery and natural (Cedar River) stocks
		Green River, hatchery & natural stocks
		Puyallup River, hatchery & natural components
23	UW Accelerated fall fingerling	University of Washington Hatchery
25	Deep S. Puget Sound fall fingerling	McAllister Creek Hatchery
		Nisqually River, hatchery & natural stocks
		Minter Creek Hatchery
		Chambers Creek Hatchery
		Deschutes River & Capital Lake hatchery stocks
		Coulter Creek & Misc Area 13D-K hatchery stocks
27	South Puget Sound fall yearling	Contribution amount from each South Sound hatchery
29	White River spring fingerling	White River spring hatchery & natural stocks
31	Hood Canal fall fingerling	Area 12C-D natural
		Skokomish R, hatchery & natural stocks
		Area 12B, mid-Hood Canal natural
		Hoodsport Hatchery
33	Hood Canal fall yearling	Hood Canal fall yearling
35	Juan de Fuca Tribs. fall fingerling	Hoko R, hatchery & natural stocks
		Dungeness early, hatchery & natural stocks
		Elwha, composite hatchery & natural
65	White River spring yearling	Not modeled in TAMM

Table 7-5. Chinook Puget Sound FRAM and TAMM Fisheries.

FRAM Fishery #	FRAM Puget Sound Fisheries	TAMM Fishery Components of FRAM Fisheries.
36	Area 7 Sport	Area 7 Sport
37	NT San Juan Net (Area 6A,7,7A)	NT San Juan Net (Area 6A,7,7A)
38	T San Juan Net (Area 6A,7,7A)	T San Juan Net (Area 6A,7,7A)
39	NT Nooksack-Samish Net	NT Nooksack-Samish Net
40	T Nooksack-Samish Net	T Nooksack-Samish Marine Net
		T Nooksack-Samish Freshwater Net
41	T Juan de Fuca Troll (Area 5,6,7)	T Juan de Fuca Troll (Area 5,6,7)
42	Area 5/6 Sport	Area 5/6 Sport
43	NT Juan de Fuca Net (Area 4B,5,6,6C)	NT Juan de Fuca Net (Area 4B,5,6,6C)
44	T Juan de Fuca Net (Area 4B,5,6,6C)	T Juan de Fuca Net (Area 4B,5,6,6C)
45	Area 8 Sport [1]	Area 8 Sport [1]
46	NT Skagit Net (Area 8)	NT-Pink, and NT-Chum
47	T Skagit Net (Area 8)	T Marine: Chinook, Pink, Coho, Chum,
		and Steelhead directed.
		T Coho Evaluation, and T Bay Test Fishery
48	Area 8D Sport	Area 8D Sport
49	NT Stilly-Snohomish Net (Area 8A)	NT 8A pink, NT 8A coho, and NT 8A chum
50	T Stilly-Snohomish Net (Area 8A)	T 8A chinook, T 8A pink, T 8A coho directed,
		T 8A chum and steelhead, and 8A test fishery
51	NT Tulalip Bay Net (Area 8D)	NT Tulalip Bay Net (Area 8D)
52	T Tulalip Bay Net (Area 8D)	T Tulalip Bay Net (Area 8D)
53	Area 9 Sport	Area 9 Sport
54	NT Area 6B/9 Net	NT Area 6B/9 Net
55	T Area 6B/9 Net	T Area 6B/9 Net
56	Area 10 Sport	Area 10 Sport
57	Area 11 Sport	Area 11 Sport
58	NT Area 10/11 Net	NT Area 10/11 Net
59	T Area 10/11 Net	T Area 10/11 Net, and Area 10/11 test fisheries
60	NT Area 10A Net	NT Area 10A Sport
61	T Area 10A Net	T Area 10A Net, and Area 10A test fishery
62	NT Area 10E Net	NT Area 10E Sport
63	T Area 10E Net	T Area 10E Net
64	Area 12 Sport	Area 12 Sport
65	NT Hood Canal Net (Area 12,12B,12C)	NT Marine: chinook, coho, & chum
		NT 9A, 12A: coho, and chum
66	T Hood Canal Net (Area 12,12B,12C)	T Marine: chinook, coho, chum
		T 9A, 12A: chinook, coho, chum

Table continued next page:

Table 7-6 (continued). Chinook Puget Sound FRAM and TAMM Fisheries

FRAM Fishery #	FRAM Puget Sound Fisheries	TAMM Fishery Components of FRAM Fisheries.
67	Area 13 Sport	Area 13 Sport
68	NT Deep South Puget Sound	NT Deep S. Puget Sound Net (Area 13,13D-K)
69	T Deep South. Puget Sound N	T Deep S. Puget Sound Net (Area 13,13D-K)
70	NT Area 13A Net	NT Area 13A Net
71	T Area 13A Net	T Area 13A Net
72	Freshwater Sport	Freshwater sport fisheries modeled in TAMM include:
		Aggregated Bellingham Bay tributaries (Nooksack, Samish, etc.)
		Skagit R, Stillaguamish R., Snohomish R., Lake
		Lake Sammamish, Duwamish-Green R., Puyallup R.,
		Nisqually R., McAllister Ck., Chambers Ck., Minter Ck.,
		DeschutesR/Capital Lake, Kennedy/Johns/misc. "13B"
		Skokomish R., Misc. Area 12B tributaries, Quilcene R.,
		Misc. Area 12C/D tributaries, Dungeness R., Elwha R., and
		Hoko R.
		Mark Selective FW sport fisheries have included:
		Carbon R., Puyallup R., Skykomish R., and Nooksack R.
73	Freshwater Net	Freshwater net fisheries modeled in TAMM include: [2]
		T Skagit R: Chinook, Pink, Coho, Chum, Steelhead;
		T Skagit R Coho Evaluation, Skagit R Test Fishery;
		T Swinomish Channel;
		T Stillaguamish R: chinook, pink, coho, chum;
		T Snohomish R commercial, Snohomish R test;
		T Skokomish R: chinook, coho, and chum;
		T Hoodsport Hatchery Seine:
		T Lake Washington, T Lake Sammamish; T Duwamish/Green R;
		Puyallup R test fishery, T Puyallup R; T Minter Ck;
		White R Springs impacts: 11A/Puyallup R net, C&S in
		T McAllister Ck; T Nisqually R; T Chambers (13C & 83H)

Notes:
* (T = Treaty; NT = Nontreaty)
1 Sport areas 8-1 and 8-2 were combined and input into Fishery 45 as Area 8 Sport.
2 Puget Sound TAMM includes: Area 11A with Puyallup River; Area 13C with Chambers Creek.

7.2.1 Chinook TAMM-FRAM interaction

The Chinook TAMM-FRAM iteration process is shown in Figure 4 with details in Figures 5-7. The iteration process is needed to account for the circular affect from harvest in one terminal fishery affecting the harvest, terminal run size, and escapement in other terminal areas. The iteration process is considered completed when the FRAM based terminal fishery catches convergence with the TAMM based catches for six Puget Sound net fishery Total Terminal Areas (TTA) (Table 7-6; Figure 4 and 6). Two special case catch calculation options for Nooksack/Samish and Tulalip Hatchery fall Chinook stocks can be flagged in the TAMM and processed through FRAM via the "tami" input file. The Nooksack/Samish case is a harvest accounting between treaty and nontreaty fishers where the terminal fishery catches are set at the level that achieves 50:50 sharing of harvestable catch in combined preterminal and terminal fisheries (Figure 5). The Tulalip Hatchery case calculates the treaty net fishery catch that harvests the entire terminal run remaining after the nontreaty terminal fishery input is calculated (Figure 5).

Table 7-6. Total Terminal Areas (TTA) in Puget Sound Net
Nooksack Fall
Skagit Fall
Still./Snohomish/Tulalip Fall
Tulalip Fall
Hood Canal Fall
Nooksack Spring

For each of the Total Terminal Areas TTA shown in Table 7-6, the Chinook TAMM recalculates the terminal run sizes *TamkTTR* from escapement *TamkEsc*, catch *TamkCat,* freshwater sport catch *FWSpt*, and marine savings *MSA (*Eq 64).

$$(62)\ TamkEsc_{TTA} = \sum_{s} Escape_{s,a,t}$$

where s is FRAM stocks within each TTA

and terminal catch is:

$$(63)\ TamkCat_{TTA} = \sum_{f} Catch_{s,a,f,t}$$

where f is FRAM fisheries within each TTA.

$$(64)\ TamkTTR_{TTA} = TamkEsc_{TTA} + TamkCat_{TTA} - FWSpt_{TTA} + MSA_{TTA}$$

When the terminal run size changes, the TAMM expected catches will change according to the specified harvest rate (Figure 5)

$$(65)\ TamkEst_{TTA,t} = TamkTTR_{TTA} \times TamkPsHr_{TAA,t} \text{ if using harvest rates or}$$

$$(66)\ TamkEst_{TTA,t} = TamkPsHr_{TAA,t} \text{ if using quotas.}$$

and there is a ripple effect throughout all of the terminal fisheries including harvest sharing between the treaty and non-treaty fisheries (Figure 7). The FRAM program reruns the terminal fishery time steps until the difference between the TAMM expected fishery impacts *TamkEst* and FRAM estimates *TamkCat* are within ±0.1% of the of each other, i.e. TamkScale = 1.0001 or 0.0009,

$$(67)\ TamkScale_{TTA,t} = TamkEst_{TTA,t} \big/ TamkCat_{TTA,t}$$

or the difference between the two *Diff* is less than four fish (Figure 6).

$$(68)\ Diff = abs\left(TamkEst_{TTA,t} - TamkCat_{TTA,t}\right)$$

In each iteration, the FRAM fishery scalars *FishScalar* are adjusted by the *TamkScale* variable that was used for the evaluation of the convergence criteria above. The new FRAM fishery scalars are then used to produce the revised FRAM catch estimates (Eq 3) in the next iteration.

$$(69)\ (FishScalar_{f,t})_{i+1} = (FishScalar_{f,t})_{i} \times TamkScale_{TTA,t}$$

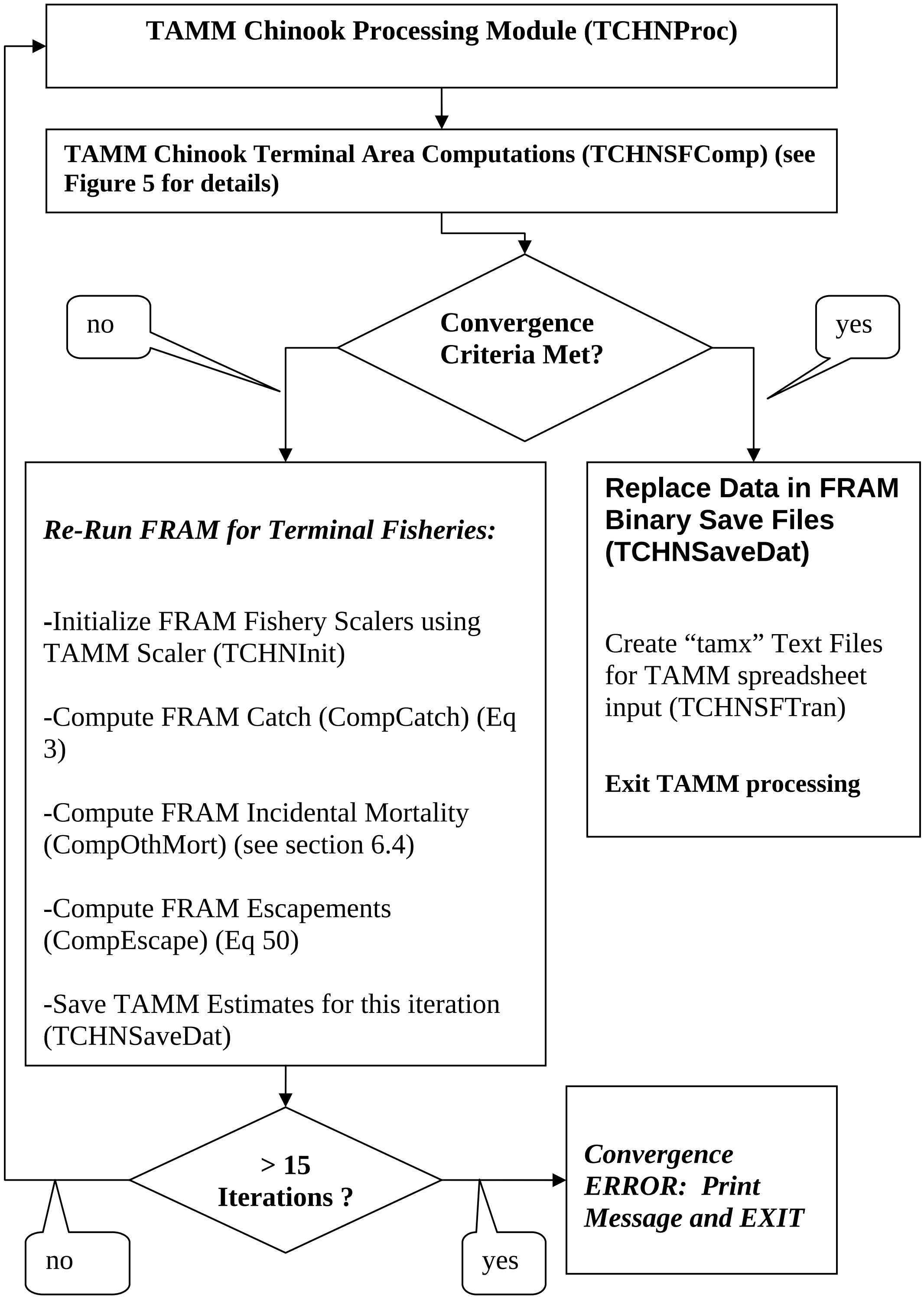

Figure 4. Flow chart for Chinook TAMM Processing Module.

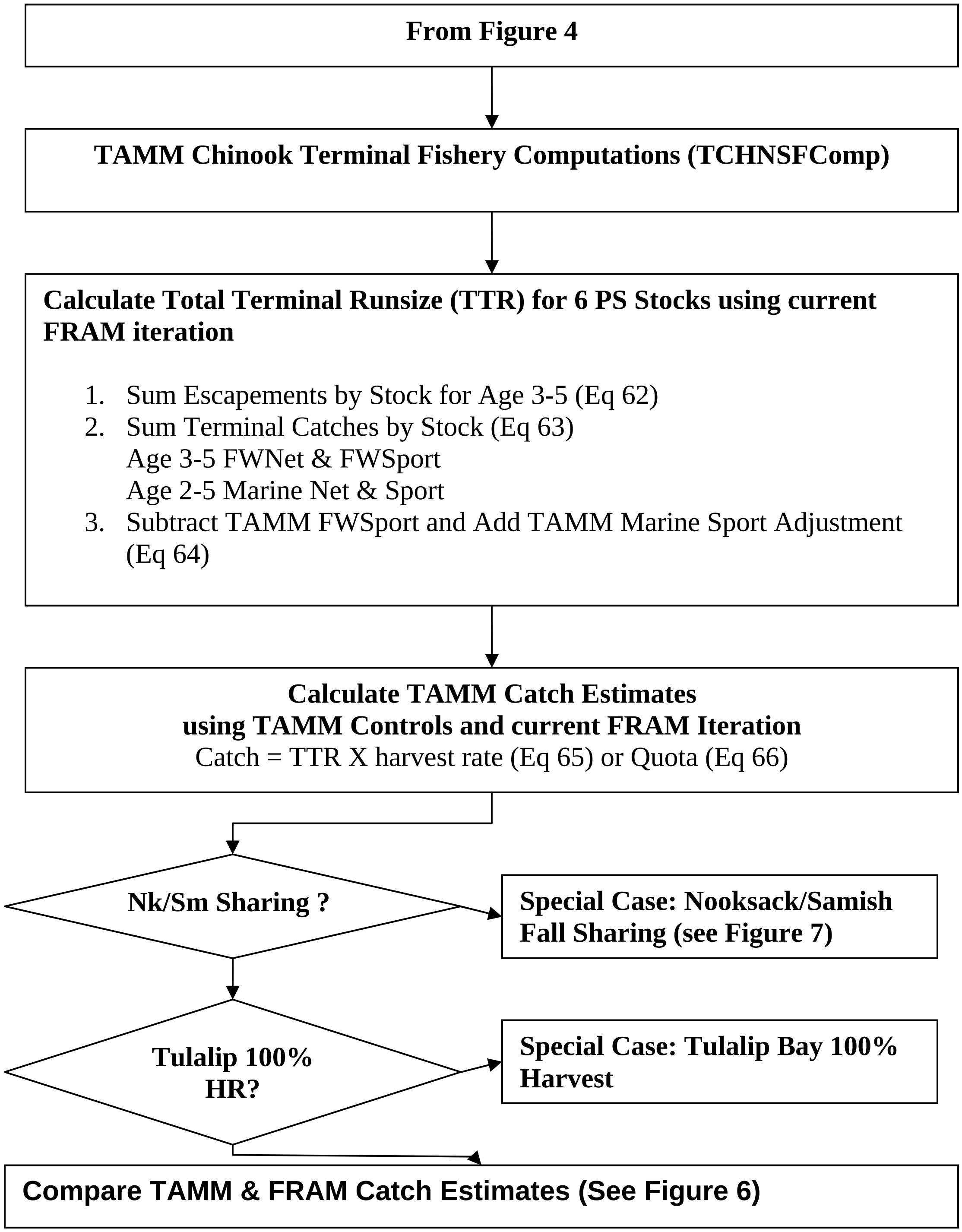

Figure 5. Flow chart for Chinook TAMM Computations and Comparisons.

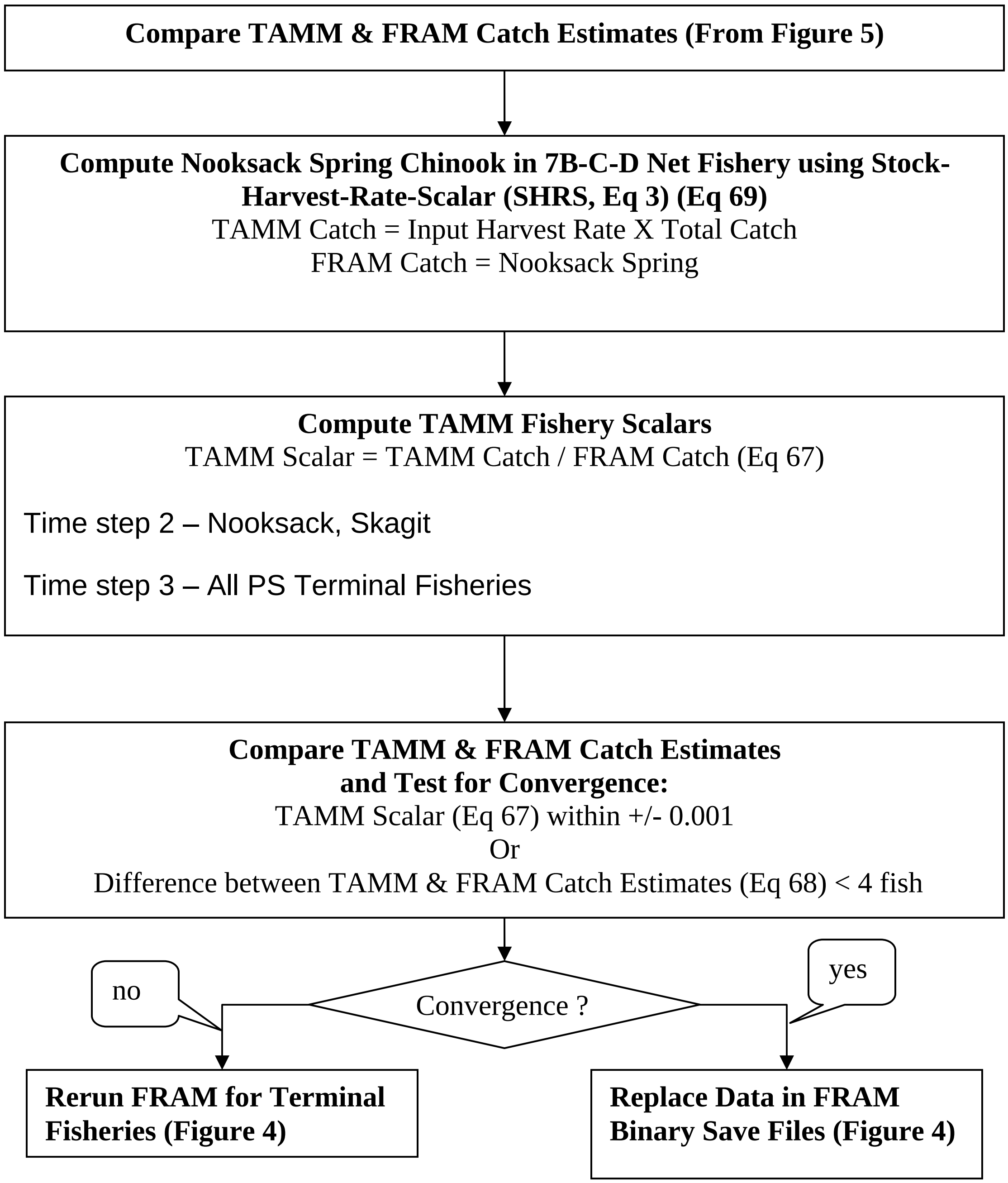

Figure 6. Flow chart for Chinook TAMM and FRAM Terminal Catch Comparisons.

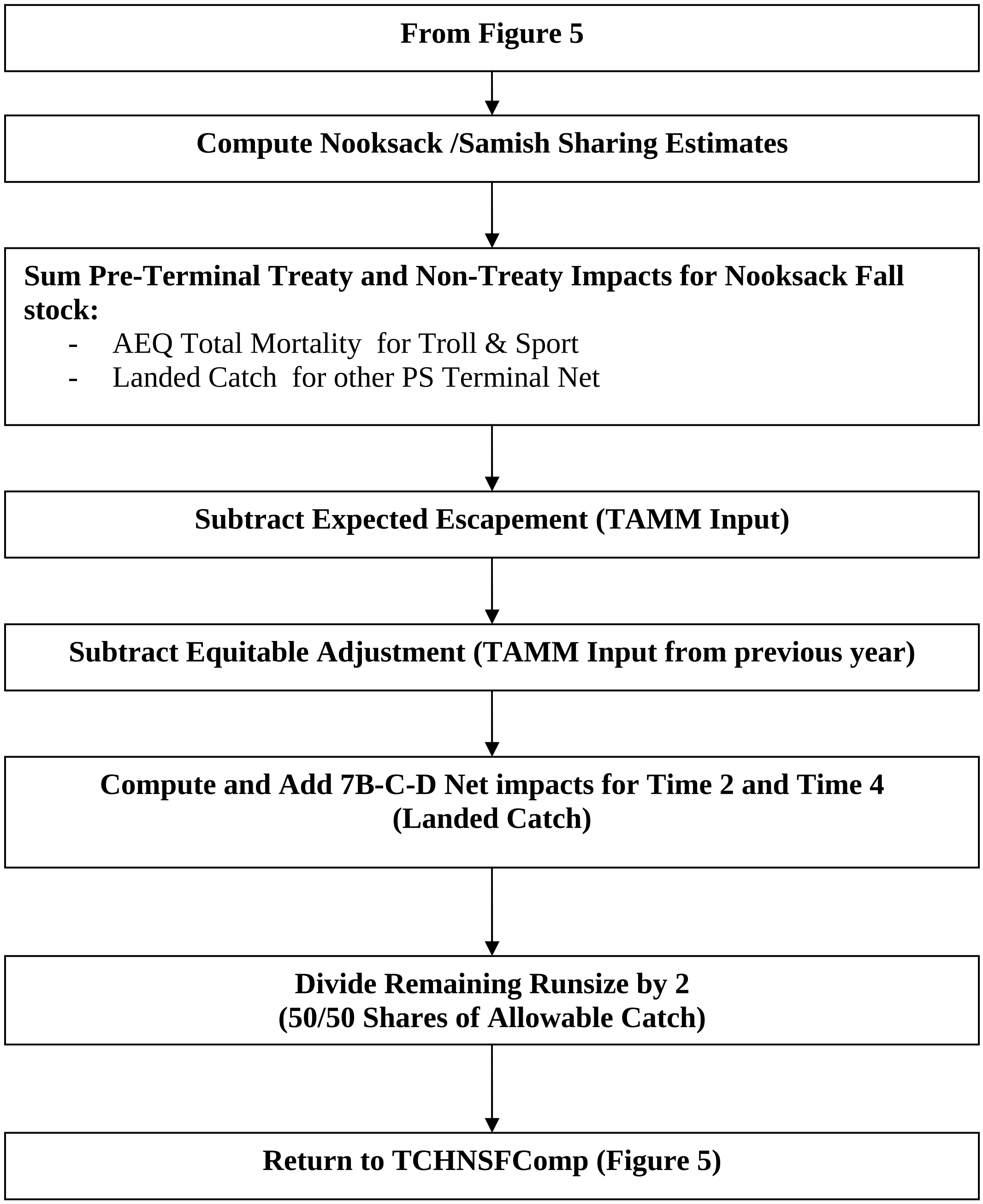

Figure 7. Flow chart for Nooksack/Samish Sharing Calculations.

8. PRE-SEASON MODEL INPUT DEVELOPMENT

The process for developing FRAM model inputs for assessing upcoming fishing season options begins with the forecasting of hatchery and wild stock abundances and proportions of each that are unmarked or adipose fin clipped. Fishery inputs for FRAM are generally developed later in the pre-season process beginning with the Council 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 the 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 unmarked retention error in mark selective fisheries, interim 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 staff during one or more technical meetings where relevant forecasting information are 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 forecast of abundances prior to any fishing impacts (which includes natural mortality and nonlanded fishery related mortality). The forecasts that are based on expectations of fish returning to the terminal area need to account for preterminal 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 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 abundance for each stock at each age. The input scalars account for those fish that die due to natural mortality per the constant rates as set during the development of the base period data.

8.1.1 Coho

The coho forecasts supplied by the local/regional technical staff also vary in methods and units of measure (Table 8.1). Common forecasting methods include jack to adult relationships using the previous year’s jack returns (age-2 fish) to produce age-3 adult (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 abundances that are expanded by 1.232 to account for natural mortality to estimate abundances in FRAM pre-fishing impact units. Any non-landed fishery related mortality that occurs is ignored in this ocean abundance-to-total abundance FRAM conversion step.

Table 8-1. 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 Rt	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/Klamath Hatchery x Surv Rt	Ocean Abundance	Ocean Abundance X 1.232

8.1.2 Chinook

The methods used to convert the forecasts made by the local/regional staff to FRAM inputs vary depending on the type of forecast (Table 8-2). Forecasts for Columbia River stocks are usually in terms of age specific returns to the river mouth using brood year sibling relationships on 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. Several methods have been developed that are used to convert the various Chinook forecasts to a FRAM input abundance scalar:

Method 1. Abundance Estimated from CWT Analysis

This method generates total abundance by applying preterminal fishery effort scalars, adult equivalency, and maturation rates from recent year CWT studies to age-specific terminal area forecasts. This method provides the most direct, independent estimates of abundance, especially if the CWT studies cover the years used to forecast the terminal run. Snohomish, Stillaguamish, and Tulalip Chinook forecasts are based on this method

Method 2. Abundance Estimated from Change in Preterminal Fishery Exploitation Rate (without CWT studies)

This method is similar to Method 1 except that changes in preterminal exploitation rates are estimated from fishery effort scalars from FRAM post-season validation runs covering the years included in the forecasts. In most cases, the terminal run size scalar is adjusted to account for preterminal fishery impacts, natural mortality, and maturation rates. For Puget Sound hatchery fall Chinook yearling, scalars are calculated from the number/pounds of fish released in the base period compared to the number/pounds released four years prior to the forecast year. Puget Sound fall Chinook stocks use the program RECON.bas (see Chinook FRAM Base Data Development Report) to generate these FRAM abundance scalars.

Method 3. Abundance Estimated from Base Year to Current Year Terminal Run Size Proportions
For this method, the FRAM abundance scalar input would be the ratio of the terminal run in the test year to the terminal run in the base period. This method assumes that preterminal exploitation rates have not changed from the base period of the model and is likely to produce overestimates of abundance unless adjustments are made to account for reduced preterminal fishing impacts from the model base data.

Table 8-2. 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

All three of these methods can yield FRAM abundance scalars that produce FRAM run abundance results that are different than the forecasts, and may require manual adjustments to the scalars. This is common for forecasts of terminal area run size. To evaluate, the method 1-3 based abundance scalars are run through FRAM configured with a "likely" fishery structure for the upcoming management year (the previous year's FRAM preseason fishing season package will usually suffice). When the terminal run size estimated from FRAM is dramatically different from the preseason forecast, the FRAM abundance scalars are adjusted iteratively until the FRAM produces a terminal run size estimate that is similar to the terminal run forecast produced by the local/regional staff. This manual adjustment process is done to get "ball-park" level precision on terminal run size and is not performed to fine-tune small differences in run size or adipose mark proportions between a FRAM output and the preseason forecast.

8.2 Fisheries

Fisheries are modeled using FRAM input methods that usually do not vary between yearly preseason model runs. The options for modeling fisheries are discussed above in Section 4 under "Fishery Catch Mortality". Generally, Council managed fisheries North of Cape Falcon are modeled as landed catch quotas, fisheries South of Cape Falcon 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 hasn't been used in recent years.

8.2.1 Coho

Council managed coho retention fisheries are modeled as landed fish quotas (Table 8-3). Inside fisheries are modeled as quotas managed as a landed catch expectation, as effort scalars, or as terminal area harvest rates used during TAMM processing.

Council managed coho nonretention fisheries are modeled using external estimates of mortalities generated from historical coho to Chinook ratios of landings when retention of both species was allowed (Section 6.4; Method 1). 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.

Table 8-3. FRAM input methods for coho retention fisheries.

Fishery Region	Fishery Input Type	Fishery Input Origin
Alaska	Effort Scalar or Quota	PFMC-STT/No.Falcon Staff
Canada		
Troll	Effort Scalar or Quota	PFMC-STT/No.Falcon Staff
Net	Effort Scalar or Quota	PFMC-STT/No.Falcon Staff
Sport	Effort 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, Effort Scalar or Harv Rate	No. Falcon Staff
Sport	Effort Scalar or Quota	No. Falcon Staff
WA Coast/Columbia R	Effort Scalar or Quota	No. Falcon Staff

8.2.2 Chinook

Input methods used for Chinook retention fisheries during recent year's preseason runs are shown in Table 8-4. 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 the case with 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 Pacific Salmon Commission (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 the PSC model fishery inputs for the current year are not available until late in the Council process 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.

Table 8-4. FRAM input methods for Chinook retention fisheries.

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

For Council managed fisheries South of Cape Falcon, exploitation rate scalars calculated from fishing effort data are used for inputs to the model. 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 terminal fishery harvest rates used during TAMM processing (e.g. Puget Sound terminal net).

Chinook nonretention fishery impacts are primarily modeled using estimates of sub-legal and legal size encounters (Section 6.4; Method 2).

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10. 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	sandew	Sandy Early Wild
COLRIV	171	clakew	Clakamas Early Wild
COLRIV	173	claklw	Clakamas Late 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

*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)
Area 2 Spt	37	Area 2 Sport (Westport)
Area3TrlNT	38	Area 3 Troll Non-treaty (LaPush)
Area3TrlTR	39	Area 3 Troll Treaty (LaPush)

Appendix 3. Coho FRAM Fisheries (continued)

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
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
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)

Appendix 3. Coho FRAM Fisheries (continued)

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
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
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)

Appendix 3. Coho FRAM Fisheries (continued)

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
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)
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)

Appendix 3. Coho FRAM Fisheries (continued)

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
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
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 2005 calibration

Fishery #	Fishery Name	FRAM Stock Portion Of Modeled Catch
1	Southeast Alaska Troll	0.5537
2	Southeast Alaska Net	0.2157
3	Southeast Alaska Sport	0.3118
4	North/Central British Columbia Net	0.5583
5	West Coast Vancouver Island Net	0.5461
6	Strait of Georgia Net	0.6812
7	Canada Juan de Fuca Net (Area 20)	0.9305
8	North/Central British Columbia Sport	0.8479
9	North/Central British Columbia Troll	0.5627
10	West Coast Vancouver Island Troll	0.8278
11	West Coast Vancouver Island Sport	1.0000
12	Strait of Georgia Troll	0.6265
13	North Strait of Georgia Sport	1.0000
14	South Strait of Georgia Sport	1.0000
15	BC Juan de Fuca Sport	0.8653
16	NT Cape Flattery-Quillayute Troll (Area 3-4)	0.8999
17	T Cape Flattery-Quillayute Troll (Area 3-4)	0.8256
18	Cape Flattery-Quillayute Sport (Area 3-4)	0.8404
19	Cape Flattery-Quillayute Net (Area 3-4)	1.0000
20	NT Grays Harbor Troll (Area 2)	0.8945
21	T Grays Harbor Troll (Area 2)	0.5510
22	Grays Harbor Sport (Area 2)	0.6984
23	NT Grays Harbor Net	0.1338
24	T Grays Harbor Net	0.0001
25	Willapa Net	0.1645
26	NT Columbia River Troll (Area 1)	1.0000
27	Columbia River Sport (Area 1)	0.6855
28	Columbia River Net	2.0605
29	Buoy 10 Sport	1.0000
30	Orford Reef-Cape Falcon Troll (Central OR)	0.1612
31	Orford Reef-Cape Falcon Sport (Central OR)	0.2154
32	Horse Mountain-Orford Reef Troll (KMZ)	0.0059
33	Horse Mountain-Orford Reef Sport (KMZ)	0.0756
34	Southern California Troll	0.0006
35	Southern California Sport	0.0001
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
40	T Nooksack-Samish Net	1.0000
41	T Juan de Fuca Troll (Area 5,6,7)	1.0000
42	Area 5/6 Sport	0.8906

Appendix 4. Chinook FRAM Fisheries, and the proportion of catch attributed to FRAM modeled Chinook stocks from 2005 calibration (continued)

Fishery #	Fishery Name	FRAM Stock Portion Of Modeled Catch
43	NT Juan de Fuca Net (Area 4B,5,6,6C)	0.8087
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 [b]	1.0000

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

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

[b] In Puget Sound, fishery 73 combines Area 11A with Puyallup River; Areas 9A, 12A, 12D with Hood Canal; Area 13C with Chambers Creek.

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

Coho	**Time Steps**				
Age	**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

Chinook	**Time Steps**			
Ages	**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

Appendix 6. 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 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 Pacific Coast salmon fisheries on Coho and Chinook 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 sport and commercial fishery regulations.

Non-landed Mortality - This category of fishery-related mortality includes hook-and-line drop-off, net gear drop-out, hooking mortality, and occasionally other sources of mortality such as unreported or illegal catch.

Nontreaty Fisheries - Fisheries conducted by fishers who are not members of the 24 Belloni or Boldt Case Area Tribes.

Pre-terminal - In FRAM, a "pre-terminal" fishery is one that operates on both mature and 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 24 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. , fisher fails to identify mark, 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.

Appendix Table 7-1. 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 collated by the STT for ocean fishery options.		
	Stock specific (Chinook) projected ocean escapement	Terminal Run Size Report
	Columbia Lower River Natural Tules (including Coweeman Index as calculated in Coweeman.xls spreadsheet)	Terminal Run Size Report Stock Catch by Fishery Report
	Snake River Fall Chinook Index (SRFI) for all ocean fisheries (Index calculated in SRFI spreadsheet, combining PSC model and FRAM outputs)	Exploitation Rate Comparison Report
	Key coho stocks: ocean escapement or various E.R. estimates (see Appendix Table 5-nB for coho TAMM report names)	FRAM output reports as summarized within coho TAMM
Table 6. Preliminary projections of chinook and coho harvest impacts adopted by the Council for ocean salmon fishery management options.		
		Fishery Summary Report
Table 7. Expected coastwide Oregon coastal natural (OCN) and Rogue/Klamath (RK) coho exploitation rates by fishery adopted by the Council for ocean fisheries management options. (see Appendix Table 5-nB for coho TAMM report name)		
		FRAM output reports as summarized within coho TAMM
Table 8. Projected coho mark rates for 2005 fisheries under base period fishing patterns (%marked)		
	Regional fisheries from Canada, Puget Sound, Washington, and Oregon	Stock Catch by Fishery Report as summarized within MarkRateTable.xls
Table A-3. STT preliminary analysis of impacts of tentatively-adopted management measures on Endangered Species Act (ESA) listed Evolutionarily Significant Units (ESUs) (Preseason Report III)		
	Puget Sound chinook stocks	FRAM output as modeled through TAMM

[a] Preseason Report II Analysis of Proposed Regulatory Options for XXXX Ocean Fisheries and Preseason Report III Analysis of Council Adopted Management Measures for XXXX Ocean Salmon Fisheries where XXXX = management year.

[b] ER = Exploitation Rate

[c] In Preseason Report III only

Appendix Table 7-2. 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 esc., marine E.R.s)			
	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 & esc.	TAMM report
Snake River Fall Chinook Index (SRFI) for all ocean fisheries			
	From PSC and PFMC fisheries: Total predict 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

Agenda Item G.1.a
Attachment 3
June 2006

Chinook FRAM
Base Data Development
(Auxiliary Report to FRAM Technical Documentation)

MODEL EVALUATION WORKGROUP[1]
May, 2006

[1] MEW Members: Andy Rankis, Chair (NWIFC); Larrie LaVoy, Vice-Chair (WDFW); Jim Packer (WDFW); Ethan Clemons (ODFW); Robert Conrad (NWIFC); C. Dell Simmons (NMFS); Rishi Sharma (CRITFC), Allen Grover, CDFG; Henry Yuen (USFWS)

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1. INTRODUCTION

This report describes the data types and process involved in developing the model “base” data inputs for Chinook salmon used in the Fishery Regulation Assessment Model (FRAM). The base data for Chinook FRAM covers the stock abundances and fishery impacts for production from 1974-79 brood years as estimated through coded-wire-tag (CWT) recovery analysis representing FRAM stocks. These base years are used because they covered a period of generally broad CWT tagging of stocks and nearly wide-open fisheries. By having a diverse set of stocks and fisheries covered by CWT analysis, FRAM is able to assess the impacts of likely fishery options proposed in current management forums. Chinook FRAM shares many of the same CWT tag groups that are used in the Chinook model used in fishery management by the Pacific Salmon Commission in accordance with the Pacific Salmon Treaty.

In addition to CWT recovery data representing FRAM stocks, other key data needed for development of the FRAM base period data set includes: 1) stock abundances/recruitment to fisheries and escapements, 2) life history information on maturation, age structure, natural mortality, and growth rates, 3) fishery landings or effort indices, and 4) fishery related mortality factors for fish released or fish encountering the gear.

The base period data is developed into the FRAM base input file through a process of cohort analysis using the CWT groups. Several FRAM stocks were not CWTed during the 1974-79 brood years. For these stocks, CWT groups from out-of-base (OOB) tagging years were used and were simulated back to the base period in a process of calibration. The OOB simulation performed through the calibration process is the most time consuming part of developing the base data input file for Chinook FRAM.

For a detailed discussion of model functions, specifications, and algorithms refer to the report “Fishery Regulation Assessment Model (FRAM) –Technical Documentation for Chinook and Coho” available from Pacific Fishery Management Council (PFMC). A more general discussion of FRAM is contained in a corresponding “Overview” report also available from PFMC.

2. BASE PERIOD MODEL INPUT DATA

Development of the base data is done without regard to fin clip mark status of each FRAM stock group during the base period. This approach is used to ease the computations and is logical since mark status of a stock should not influence the catch during the base period where there were no mark selective fisheries. At the completion of the base data development process, each FRAM stock-age cohort is split in half into “unmarked” and “marked” components to allow for processing of mark-selective fisheries in “forward-projection” runs of FRAM used in preseason fishery modeling (see Section 8 of FRAM Overview).

2.1 CWT Groups

CWT groups were identified representing each of the 33 FRAM stock units (Appendix 4.1). In most cases, CWT groups from hatcheries within a FRAM stock basin were used to represent both hatchery and naturally produced fish. Selected CWT groups were usually from “production” or “indicator” tag groups that were considered similar to the stock ancestry and freshwater and marine life history of the local natural stock. Estimated recoveries (observed expanded by sampling rates) from these tag groups were downloaded in July 2005 from the Regional Mark Information System of the Pacific States Marine Fisheries Commission website. For each of the FRAM stock CWT group aggregates, the “raw” recoveries were run through the program FRAMBUILDER which maps the estimated age-specific CWT recoveries to FRAM fishery and time strata. An example of the output is shown in Appendix 4.2.

2.2 Stock Profiles

Summaries of data and sources used during model base data development were completed for each of the FRAM stocks (Appendix 4.3). Key components used in data development were, of course, CWT groups, abundance information based on terminal area run reconstruction, and length-at-age growth functions used to estimate proportion of the stock-age vulnerable to harvest. Two length-at-age growth functions were developed for each stock; one to be used to estimate proportion vulnerable in mixed maturity fisheries (preterminal) and one for fisheries assumed to be on mature fish only. The length-at-age growth functions were developed from CWT groups for Chinook with similar age of migration as juveniles into salt water (i.e. fingerling vs. yearling) and/or timing as adults into freshwater (spring, summer, summer/fall).

2.3 Base Period Catch and Escapement

Annual catch for each of the FRAM fisheries and escapement for each of the FRAM stocks were compiled (Appendix 4.4). These base period catches and escapements weren’t necessarily an average of the same set of recovery years for each fishery or stock, because CWT releases from the stocks never covered all of the brood years considered as base period (1974-79). Therefore, some weighting of fishery catch and stock escapements were made depending on which of the specific brood year CWT release groups were used. For those fisheries that did not occur during the base period or where there was no CWT sampling, stock composition from similar existing fisheries were used as surrogate. .

Base period catch and escapement estimates were key components of the calibration and out-of-base (OOB) CWT recovery simulation process described below. Base period catches were used, in part, to derive an estimate of the proportion of the catch explained by FRAM stocks. This “proportion modeled stocks” was calculated during the model calibration process for the base data and was used as a constant adjustment factor for any out-of- base year model runs including those for preseason modeling. Base period escapement for each stock was used to derive a production expansion factor (PEF) from the base escapement divided by CWT escapement.

2.4 Fishery Induced Mortality Factors

Fishery related mortality factors include hook and release mortality, hook and line drop-off, and net drop-out. Rates associated with these factors are used for the base period data development process and the associated cohort reconstruction. Hook and release mortality rates can vary by region (e.g. ocean vs. Puget Sound), fishery type (commercial troll vs. sport), and gear type (barbed hooks vs. barbless). Hook and release mortality rates assigned are usually based on an ‘average’ value from a variety of separate studies. The PFMC Salmon Technical Team (STT) last reviewed these studies on sport fishery hooking mortality in March 2000 and the Council adopted their recommendation to changed to 14% from 8% in Council managed fisheries. Because of the difficulty in designing experimental tests, few studies address ‘hook and line drop-off’ and ‘net drop-out’ These are mortality types caused by gear contact with fish that are **not** brought to the boat. Drop-off and drop-out mortality may also includes marine mammal predation on gear entangled fish and loss from noncompliance with regulations. In FRAM, drop-off and drop-out rates were based on primarily on agreed values rather than from specific studies. Hook and line drop-off mortality rates are calculated as 5% of landed catch. Net drop-out mortality rates vary between 0-3% of landed catch depending on whether gear is purse seine, gill net or reef net.

3. CALIBRATION

3.1 Overview

The FRAM is one of many salmon fishery simulation models that rely on recoveries of CWTs to estimate stock specific catches, escapements, and exploitation rates. Stock-specific fishery harvests and exploitation rates are predicted using base period CWT recovery data from fishery and escapement sampling. The FRAM base period for Chinook salmon covers CWT recoveries for releases from brood years 1974-79. For stocks without representative CWT release groups during the base period, OOB CWT groups were used and their recoveries were simulated back into the base period in a process of calibration. Calibration involves iterative passes adjusting CWT recoveries for OOB tag groups back to the base period using FRAM derived fishery effort scalars from FRAM “validation” runs (Figure 1). FRAM validation runs are annual model runs which use best post-season estimates of fishery catches and stock abundances. Base period and OOB CWT recoveries by stock, age, and fishery are used to recalculate starting cohort sizes for all stocks during the base period. The final step in the calibration cycle is the development of a completed “base period” input file used by FRAM. This file contains stock abundances, time-age-fishery specific harvest rates, maturation rates, growth rates, and various fishery related parameters such as hooking mortality rates covering the base period considered roughly 1977-1984 fishing years. Calibration is considered “done” usually after at least 3 passes when the difference in cohort sizes, terminal run sizes and fishery harvest rates between passes changes insignificantly. A new calibration of FRAM is warranted when there are changes to the input data and/or model structure. Examples include changes to stocks, fisheries, CWT groups, time structure, and growth, natural, and fishery related handling mortality rates. All of these elements influence the estimates of the cohort sizes calculated during cohort analysis and the corresponding estimates of exploitation rates.

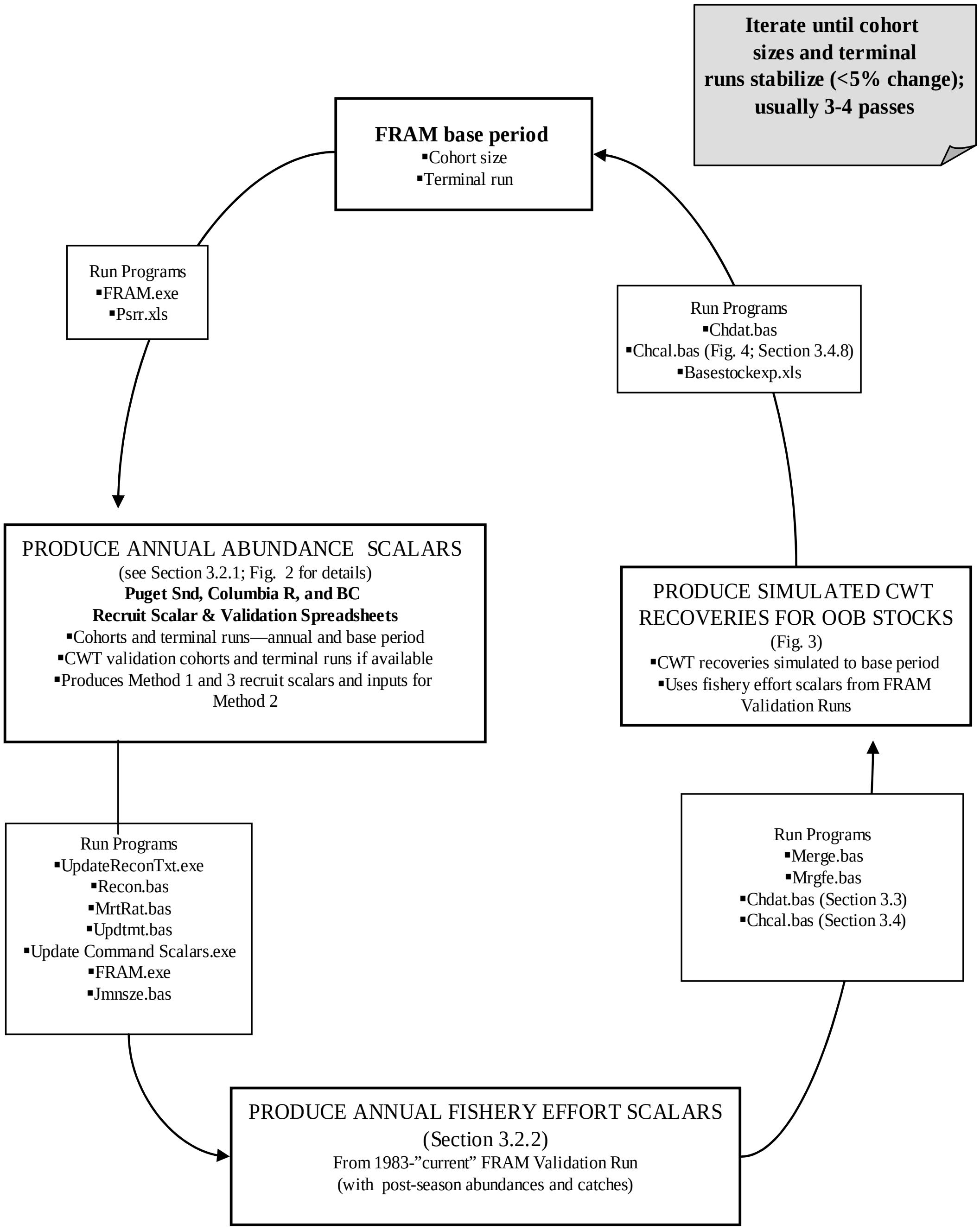
3.2 Calibration Iteration Process and Out-of Base Simulation

For FRAM, the primary purpose of a calibration pass is to create a CWT recovery data set that contains the number of CWT recoveries for stocks that were tagged in the base period with a simulated number of CWT recoveries for those stocks that were not tagged during the base period.

A calibration cycle involves producing annual FRAM "validation" runs for the fishing years that cover the associated brood years of the OOB stock groups. Validation runs are made with FRAM base period input file of stock/age specific cohort sizes, exploitation rates, growth functions, fishery related mortality parameters, etc and best estimates of yearly actual stock abundances and reported fishery catches and/or effort scalars. These validation runs could be considered as annual post season FRAM runs that contain best post-season estimates of annual stock abundance and reported fishery catches or effort by FRAM strata. Validation runs are used to derive fishery effort scalars relative to the FRAM base period for each of the FRAM fisheries. The annual fishery effort scalars are converted to age specific brood year fishery scalars (i.e. 1985 FRAM validation run provides fishery effort scalar for 1983 CWT brood year age-2 recoveries; 1982 CWT brood year age-3 recoveries etc). The brood year specific fishery scalars are applied to the corresponding OOB CWT recoveries in each fishery to yield an estimate of the number of CWTs that would have been recovered for that stock during the base period. The simulated CWT recoveries from the OOB stocks are combined with the base period stock CWT recoveries to create a "All-Stocks" CWT recovery data set. This "All-Stocks" CWT data set is then run through a data-checking program (CHDAT) and then a program (CHCAL) that conducts a cohort analysis for each stock and produces a final "outfile" of cohort sizes, exploitation rates, and other information that is required when running FRAM. (A detailed description of CHDAT and CHCAL presented below describes how the programs work in their two modes; OOB stock and "All-Stocks"). The outfile from the last calibration pass is run through the program SFMCHIN which splits the cohorts in half into marked and unmarked units for each stock. This is the base data file that is used in preseason FRAM runs.

A functional description of the programs and worksheets used during calibration is presented in Appendix 4.5. Stepwise instructions used during the 2005 calibration process are shown in Appendix 4.6.

Figure 1. Chinook FRAM Calibration Overview (Section 3.1)



3.2.1 Annual Abundance Scalar Derivation

Annual abundance scalars are derived from reconstruction of the terminal run size using several methods to account for preterminal fishing impacts. Base period cohort and terminal run sizes from the most recent FRAM base period run are updated in three “validation” run abundance spreadsheets for Puget Sound, Columbia River, and Canadian stocks (Figure 2; Appendix 4.7 for example). Annual abundance scalars used in the FRAM validation runs are generated by comparing annual cohort abundances to the base period cohort abundances calculated in the most recent calibration iteration. Annual pre-fishing cohort abundances for model-run years outside the base period are derived via three methods:

Method 1. Annual Cohort Estimated from CWT Cohort Analysis

From a cohort analysis using on-going CWT tagging studies, an expansion factor was estimated by dividing the CWT terminal run by age by total CWT cohort size. The expansion factor was then multiplied by the terminal run by age of all hatchery and natural production to get total cohort size by age. This method provides the most direct, independent estimate of cohort size since stock specific CWT recoveries are used to expand the terminal run to initial cohort abundance.

Method 2. Annual Cohort Estimated from Change in Preterminal Exploitation Rate

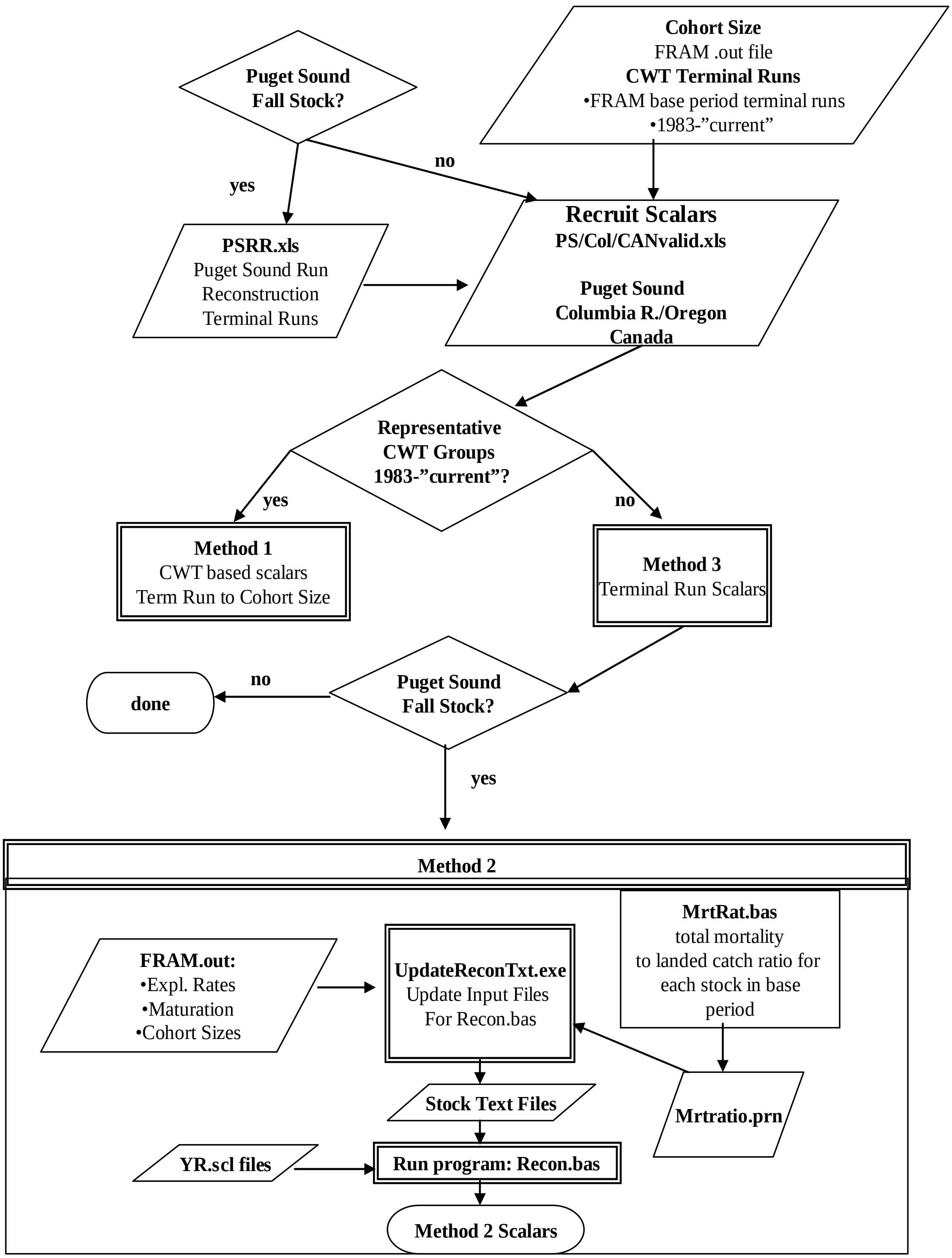
If estimates of changes in the preterminal exploitation rates were available, the cohort was estimated by dividing the terminal run by the survival rate, maturation rate, and escapement rate. This method is similar to Method 1 except that changes in preterminal exploitation rates are estimated from data sources other than CWT recoveries such as fishing effort changes relative to the base period (such as angler-trips or vessel fishing days). For Puget Sound fall chinook stocks, the Quick Basic program RECON was used for this method.

Method 3. Annual Cohort Estimated from Change in Terminal Run

For this method, the annual abundance scalar is simply the ratio of the terminal run in the test year to the terminal run in the base period. This method assumes that preterminal exploitation rates have not changed from the base period of the model and is likely to produce overestimates of abundance, especially in recent years of reduced preterminal fishing.

Method 1 is the preferred method but is not always available for all years and all ages for many stocks. Abundance scalars for Puget Sound stocks were derived from Method 1 or Method 2; Columbia River primarily from Method 1, and Canadian stocks from Method 1 or Method 3.

Figure 2. Chinook FRAM validation annual recruit scalar development



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There are several worksheet and file editing programs that are used during this process of updating year specific annual stock abundances and associated maturation rates including:

RECON.bas: Produces Method 2 abundance scalars.
UPDATERECONTXT.vbp: File editing utility for RECON input files.
MRTRAT.bas: Computes ratio of total mortality to landed catch from a FRAM base period model run; output is appended to RECON.bas input file.
UPDATE COMMAND SCALARS.exe: File editing utility that replaces abundance scalars in annual FRAM cmds with new Method 1, 2, or 3 abundance scalars from current calibration iteration.
UPDTMT.bas: File editing utility that replaces base period maturation rates in annual FRAM outfiles for eight Puget Sound fall stocks with year specific maturation rates derived from ongoing CWT programs.
.

3.2.2 Fishery Effort Scalar Derivation
After the abundance scalars in the annual validation FRAM cmd files have been updated, then each fishery year is run through FRAM and a file containing FRAM derived fishery effort scalars is produced. The file utility program JMNSZE reformats four successive years of FRAM runs of annual fishery effort scalars into single brood year files of fishery effort scalars for separate ages 2-5.

3.2.3 OOB CWT Expansion
After age specific brood year based fishery effort scalars have been derived, then OOB CWT recoveries for each fishery, age, and time step are expanded by corresponding scalars to yield an estimate of the number of CWTs that would have been recovered during the base period fishery. Two programs, CHDAT and CHCAL, are used to perform these expansions and are described in the next section. Simulated CWT recoveries from each brood year release are combined into a single data set using
MERGE for OOB groups or MRGFE for stocks with both OOB groups and base period CWT groups (as in Fraser Early and Juan de Fuca). A final adjustment to the terminal area CWT recovery data set for some stocks is made by inserting certain adjusted CWT recoveries into another series of worksheets (see Appendix 4.7 for excerpt from PSbasestockexp.xls).

3.3 Primary Calibration Program: CHDAT

CHDAT
The primary purpose of CHDAT is simple error checking of data and reformatting of calibration input data for use by other programs (Figure 3). Error checking includes flagging situations were CWT recoveries exist in fisheries where no legal size population should exist. Other program functions are to 'impute' CWT recoveries in fisheries with no sampling during the CWT recovery period. For example,

CHDAT is used for both OOB simulation (Figure 3) and "All-Stocks" base period data development (Figure 4). First, CHDAT is run separately for each OOB stock in FRAM. Each OOB stock requires a separate run through CHDAT to have the data reformatted for use in another program which estimates base cohort information for each OOB stock. The final run of CHDAT uses the input files (".chk", ".cwt") covering all modeled stocks to produce the corresponding input files (".cal", ".edt") for CHCAL.

3.3.1 CHDAT Input file description – ".CHK" file

CHK File Section 1: Input File Names and Global Model Constants

The data in this section of the CHK file, with the exception of line 2 is not modified by CHDAT in any way, but is simply copied to the CAL output file for further processing. Line 2 is replaced with the name of a modified file of CWT recoveries (see below)

TULALIP FALL FING 86 - RETURN TO BASE FILE	Title
TUL8605.CWT	Name of CWT recovery file
Y	Adjust to base period
BROOD864.SCL	File with exploitation rate scale factors – only included if line above = Y
10	Number of stocks in calibration if third line = N, Stock number if third line = Y
73	Number of fisheries in calibration
3	Number of time steps per year
5	Maximum age
4	Maximum age for encounter rate adjustment
.01	Convergence tolerance

CHK File Section 2: Stock Specific Growth Parameters

Von Bertalanffy growth functions are used to describe the growth of an individual fish. For each age, separate growth curves are assumed depending on whether the fish is maturing at that age or remains an 'immature' fish. While CHDAT uses this data to estimate vulnerable population size, the data is not modified in any way but is simply passed on to the CAL file for further processing. There are 14 lines per stock (see below); the total number of lines depends on the total number of stocks being processed.

982.1	LMax, Stock 1; Maturity 0 NSF
2.83	T0,Stock 1; Maturity 0
.029	K, Stock 1; Maturity 0
.11	CV, Stock 1; Maturity 0; Age 2
.12	CV, Stock 1; Maturity 0; Age 3
.09	CV, Stock 1; Maturity 0; Age 4
.09	CV, Stock 1; Maturity 0; Age 5
1085.2	LMax, Stock 1; Maturity 1
1.59	T0, Stock 1; Maturity 1
.03	K, Stock 1; Maturity 1
.11	CV, Stock 1; Maturity 1; Age 2
.11	CV, Stock 1; Maturity 1; Age 3
.11	CV, Stock 1; Maturity 1; Age 4
.11	CV, Stock 1; Maturity 1; Age 5
982.1	LMax, Stock 2; Maturity 0 NNN
	*
	*
.13	CV, Stock n, Maturity 1;Age 5

CHK File Section 3: Terminal Fishery Flags

This section lists, by FRAM time step, fisheries which are deemed 'terminal' for the stock or stocks being analyzed. By definition, a fish caught in a terminal fishery is mature. The information in this section is not modified in any way by CHDAT, but is passed through to the CAL file for further processing. The data is used in CHDAT to determine which growth curve (mature or immature) should be associated with a fishery. The number of lines in this section is variable, depending upon the number of fisheries deemed terminal in each time step

3	Step 1; Number of Terminal Fisheries;
28	Columbia River Net
72	Freshwater Sport
73	Freshwater Net
5	Step 2; Number of Terminal Fisheries;
28	Columbia River Net
46	NT Skagit Net
47	T Skagit Net
72	Freshwater Sport
73	Freshwater Net
23	Step 3; Number of Terminal Fisheries
	*
	*
	*

CHK File Section 4: Minimum Size Limits

The section lists, by fishery, minimum size limits in millimeters, one line for each fishery. Size limits are for fork length, and can vary by time step. None of the data in this section is changed, but is simply passed to the CAL file. The data is used in CHDAT along with the growth curve information in Section 2 to estimate the proportions of each age class that are above and below the size limit.

670	670	670	670	Fishery 1 (Alaska Troll)
100	100	100	100	Fishery 2 (Alaska Net)
670	670	670	670	Fishery 3 (Alaska Sport)
100	100	100	100	Fishery 4 (N/C BC Net)
	*			
	*			
	*			
100	100	100	100	Fishery 73 (Freshwater Net)

CHK File Section 5: Natural Mortality Rates

Natural mortality rates by age and time step are listed. The rates are simply the fraction of the starting cohort that dies before fishing begins. The data is not modified in CHDAT but is simply copied to the CAL file for use in other calibration programs.

.2577	Step 1; Age 2
.1878	Step 1; Age 3
.1221	Step 1; Age 4
.0596	Step 1; Age 5
.0816	Step 2; Age 2
.0577	Step 2; Age 3
.0365	Step 2; Age 4
.0174	Step 2; Age 5
.1199	Step 3; Age 2
.0853	Step 3; Age 3
.0543	Step 3; Age 4
.0260	Step 3; Age 5

CHK File Section 6: Shaker Mortality Rates

Shaker mortality rates by fishery are listed, one fishery per line. The information is not used in CHDAT but is simply copied to the CAL file for use in other calibration programs. The rate is simply the fraction of the sub-legal population which dies after encountering the gear as a direct result of the encounter.

.255	Fishery 1 (Alaska Troll TCCHINOOK (97)-1)
.3	Fishery 2 (Alaska Net)
.123	Fishery 3 (Alaska Sport TCCHINOOK (97)-1)
.3	Fishery 4 (N/C BC Net)
	*
	*
	*
.3	Fishery 73 (Freshwater Net)

CHK File Section 7: 'Other' Mortality Rates

Mortality rates by fishery are listed, one fishery per line. The information is not used in CHDAT but is simply copied to the CAL file for use in other calibration programs. The rate is simply the fraction of all encounters, including legal encounters, which die as a result of the encounter. Mortalities due to marine mammal predation are in this category.

.008	Fishery 1 (Alaska Troll TCCHINOOK (97)-1)
.03	Fishery 2 (Alaska Net)
.036	Fishery 3 (Alaska Sport TCCHINOOK (97)-1)
.03	Fishery 4 (N/C BC Net)
	*
	*
	*
.02	Fishery 73 (Freshwater Net WDFW and Tribes)

CHK File Section 8: Encounter Rate Adjustment Factors

FRAM has the capability to adjust estimated total encounter rates to match independent estimates of Chinook encounters in a fishery by using externally computed adjustment factors. The factors are both fishery and time period specific. The adjustment factors are not used in any computations within CHDAT, but are simply written to the CAL file for possible use in other calibration programs.

1.0900	Step 1; Fishery 1 (Alaska Troll)
-1.0000	Step 1; Fishery 2 (Alaska Net)
2.6200	Step 1; Fishery 3 (Alaska Sport)
-1.0000	Step 1; Fishery 4 (N/C BC Net)
	*
	*
	*
-1.0000	Step 3; Fishery 73 (Freshwater Net)

CHK File Section 9: Chinook Non-retention Data

The section contains data, by time step, for Chinook non-retention (CNR) fisheries. The data includes the fishery number of the non-retention fishery, and a flag to indicate the method to use to estimate CNR mortalities. CHDAT uses this information for error checking, but the data are not changed in any way, and are simply written to the CAL file for use in other calibration programs. The number of lines of data depends on the number of CNR fisheries in each time step. In this example, there are no CNR fisheries in any time step.

0	Step 1; Number of CNR fisheries
0	Step 2; Number of CNR fisheries
0	Step 3; Number of CNR fisheries

CHK File Section 10: Base Period Catches

This section contains data on the base period average annual catch in each FRAM fishery. A zero indicates that the base period average catch is not available. Also on each line is a flag signaling various options to adjust the estimated catch by stock to match the total catch in a fishery. Neither the catch information nor the option flag are used in CHDAT; both are simply passed to the CAL file for use in other programs.

283260	2	1-Southeast Alaska Troll
25117	2	2-Southeast Alaska Net
20472	2	3-Southeast Alaska Sport
115266	2	4-N/C BC Net
	*	
	*	
	*	
0	0	73-Freshwater Net

CHK File Section 11: Imputed Recoveries

This section contains data and instructions to CHDAT necessary to 'impute' recoveries from a fishery with CWT sampling (e.g. WCVI troll) to a fishery without CWT sampling (WCVI Sport Imputed Fishery). The procedure is used to 'fill in' missing recovery data in the CWT recovery file. Data in this section is used only by the CHDAT program and is written to a file for use in other programs.

8	Number of fisheries to impute recoveries
1	Impute Group 1
11	WCVI Sport Imputed Fishery
10	WCVI Troll
	*
	*
	*
8	Impute Group 8
70	NT Area 13A Net Imputed Fishery
71	T Area 13A Net

3.3.2 CHDAT Input file description – ".CWT" file

The CWT file has two sections, one listing base period escapements by stock, the second section lists CWT recoveries by stock, age, fishery, and time period. If line 3 of the CHK file = Y, data for only one stock (OOB) is present in the file. If line 3 of the CHK file = N, data for all stocks are present.

CWT File Section 1: Base Period Escapements

Base period escapements for one or more stocks are input in this section. The data here are not used by the CHDAT program, but are simply echoed to the EDT output file.

20224	1 Nooksack/Samish Fall
500	2 NF Nooksack Spr
500	3 SF Nooksack Spr
	*
	*
	*
100	33 White Spring Yearling

CWT File Section 2: CWT Expanded Recoveries

CWT recoveries by stock, age, fishery, and time period are input from the remainder of the CWT file. The general form of the data is shown below. As a rule, CHDAT does not modify this data, but simply echoes it to the EDT file for use by other programs. Two exceptions to this occur, however. First, if a recovery exists where no legal size population is available, that recovery is rejected. Second, if a fishery recovery is to be imputed, one or more lines for the imputed fishery are inserted into the EDT file.

SP	ST	AG	FSH	TP	Catch	Adj Esc		
1	1	2	5	2	8.44		May-June	West Coast Vancouver Island Net
1	1	2	14	2	68.27		May-June	South Georgia St. Sport
1	1	3	4	3	144.75		July-Sept	North/Central British Columbia Net
1	1	3	5	3	47.01		July-Sept	West Coast Vancouver Island Net
					*			
					*			
					*			
1	33	12	74	3	3.21	3.21	Jul-Sep	Escapement

a/ "AG" is index age see Appendix 4.7

3.3.3 CHDAT Program Flow and Calculations

Notation

$AnnSRate_a$	Annual survival rate at age.
a	Age in years (2 to 5) 'Birthday' is assumed to occur on October 1.
$CV_{s,a}$	Coefficient of variation in Length at age (input from section 2 of the CHK file)
t	Time step – there are 3 time steps per 'year' Oct – Apr, May – June, and July – Sept.
s	Stock number. There are currently 33 stocks in the model
f	Fishery number. There are currently 74 fisheries in the model
$CWTCatch_{s,a,f,t}$	Observed CWT recoveries expanded for sampling fraction (input from section 2 of the CHK file.
$CWT_{s,4,f,t}$	Expanded CWT recoveries for age 4
$DFCohort_{s,a}$	Total number of CWT fish alive, before natural mortality.
$DFER_{s,f}$	Fraction of $DFCohort_{s,a}$ caught in a fishery.
K_s	Parameter of the von Bertalanffy growth curve (input from section 2 of the CHK file)
L_{∞_s}	Parameter of the von Bertalanffy growth curve (input from section 2 of the CHK file)
$Mean_{s,a,t}$	Mean fork length.
$SD_{s,a}$	Standard Deviation
T_0	Parameter of the von Bertalanffy growth curve (input from section 2 of the CHK file)
$TotCWTCatch_{s,a}$	Total catch of CWTed fish, expanded for sampling fraction, across all fisheries (terminal and preterminal).

Depending on options chosen or defined by the form of the input files, CHDAT performs the following functions.

1) Pass-through and rearrangement of data.

   Data in the CHK file is rearranged and output to the CAL file. Data in the CWT file is rearranged and if it passes simple error checking outputs to the EDT file.

2) Simple error checking.

Two types of error checking occur. The first checks that a legal (above the size limit) population of a stock/age combination is available to a fishery if CWT recoveries for that stock exist in that fishery. If no legal population is estimated to exist, the recovery data is not written to the EDT file.

The 'legal proportion' is estimated by first computing the stock mean length at age using the input growth data and the von Bertalanffy growth function.

$$Mean_{s,a,t} = L_{\infty_s} * (1 - e^{-k_s(t-t_0)})$$

The Standard Deviation at age of the mean length is computed as:

$$SD_{s,a,t} = Mean_{s,a,t} * CV_a$$

Finally, if the size limit in the fishery is more than three standard deviations above the mean length at age of the stock, the population available to the fishery is assumed to be zero. In this case, an error message is generated and the CWT recovery information is not written to the EDT file for future use.

3) 'Imputing of CWT recoveries in specified fisheries

On occasion, a fishery may not have been sampled for CWT recoveries, while a fishery 'near' it was. In those cases, it can be desirable to use the sampled fishery to represent the stock composition of the unsampled fishery. The imputed recoveries are computed as:

$$CWTCatch_{s,a,f1,t} = \frac{CWTCatch_{s,a,f2,t}}{1000}$$

The imputed catches are written to the EDT file.

4) Setting of Shaker Inclusion Flags (designates stock-fisheries where shaker mortality rates are calculated).
Shaker inclusions flags are set using the following procedure:

    1) Sum CWT recoveries across all fisheries and time steps.

$$TotCWTCatch_{s,a} = \sum_{f,t} CWTCatch_{s,a,f,t}$$

2) Estimate the starting cohort size for the oldest age class.

$$DFCohorts_{s,5} = \frac{TotCWTCatch_{s,5}}{AnnSRate_5}$$

3) Estimate the starting cohort for the younger age classes.

$$DFCohort_{s,a} = \frac{DFCohort_{s,a+1} + TotCWTCatch_{s,a}}{AnnSRate_a}$$

4) Assuming age 4 are fully vulnerable to legal size limits, estimate the age 4 exploitation rate by stock and fishery as:

$$DFER_{s,f,4} = \frac{\sum_t CWT_{s,4,f,t}}{DFCohort_{s,4}}$$

Within a fishery, for the n stocks with non-zero age 4 exploitation rates, the .7*n stocks with the highest age 4 exploitation rates have their Shaker Inclusion flags set to true. The flags are then written to the bottom of the CAL file.

3.3.4 CHDAT Output File Descriptions –". CAL" file

The CAL file is identical to the input CHK file except that the last section (Section 11) of the CHK file, where instructions for imputing recoveries are replaced with Shaker Inclusion flags. There is one line for each stock/fishery combination.

0	Stock 1; Fishery 1;
0	Stock 1; Fishery 2;
0	Stock 1; Fishery 3;
0	Stock 1; Fishery 4;
	*
	*
	*
1	Stock 33; Fishery 73

3.3.5 CHDAT Output File Descriptions –“. EDT” file

Like the CWT input file, the EDT file has two sections. The first section contains data on base period escapements, and is identical to the same section in the CWT file. The second section contains the CWT recovery information and is similar, but not identical to, the same section in the CWT file. The differences between the sections are: 1) All escapement recoveries have been moved to the top of the CWT recovery section of the file, 2) Recoveries from stock/age/fishery combinations where no vulnerable (above the size limit) population exists are removed, and 3) Imputed recoveries by stock, age, fishery, and time step are added. The form of the second section of the EDT file is shown below.

SP	STK	AGE	FSH	TIM	RECOVERIES
1	1	2	74	3	71.3
1	1	3	74	1	0.0
1	1	3	74	3	392.2
1	1	4	74	1	0.0
			*		
			*		
			*		
1	33	4	74	3	26.01

3.3.6 CHDAT Output File Description – “.ERR” File

The ERR file lists details of any recoveries rejected because no vulnerable population existed for that stock/fishery/age combination, and flags situations where Chinook non-retention fisheries exist but no legal Chinook catch information is available in the same year. Currently, no procedure exists within FRAM to estimate CNR incidental mortalities without data from a directed fishery in that year.

3.4 Primary Calibration Program: CHCAL

CHCAL

The primary purpose of the CHCAL program is to complete cohort analyses for each stock in the FRAM model and estimate ‘base period’ exploitation rates by stock, fishery, FRAM time period, and age. Secondary purposes include estimation of the proportion of the catch in each fishery accounted for by stocks in the model, and estimating CWT recoveries that would have occurred for OOB stocks during the model base period using “backward” and “forward” CWT cohort reconstruction simulation. A simple example of backward and forward cohort reconstruction calculations is shown in Appendix 4.8.

CHCAL operates in two different modes depending on whether it is doing an OOB analysis on one stock (Figure 3, described in Sections 3.4.5-3.4.7) or it is completing a final cohort analysis during an “All-Stocks” run (Figure 4, described in Section 3.4.8-3.4.9). The number of input files used and the type of output generated is a function of the run type (OOB or “All-Stocks”), therefore each type of run will be described separately.

Figure 3. Chinook FRAM calibration cycle for OOB stocks

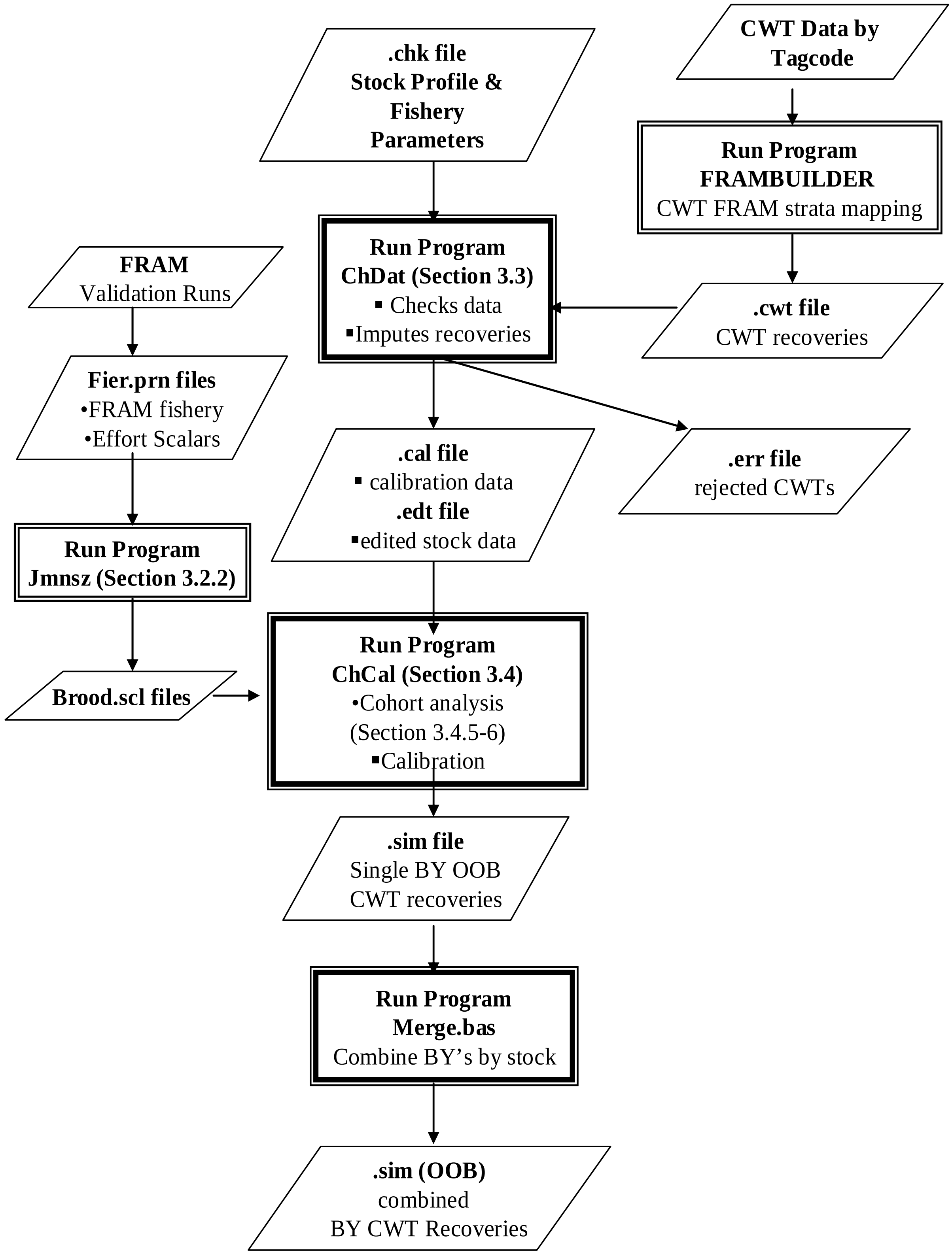
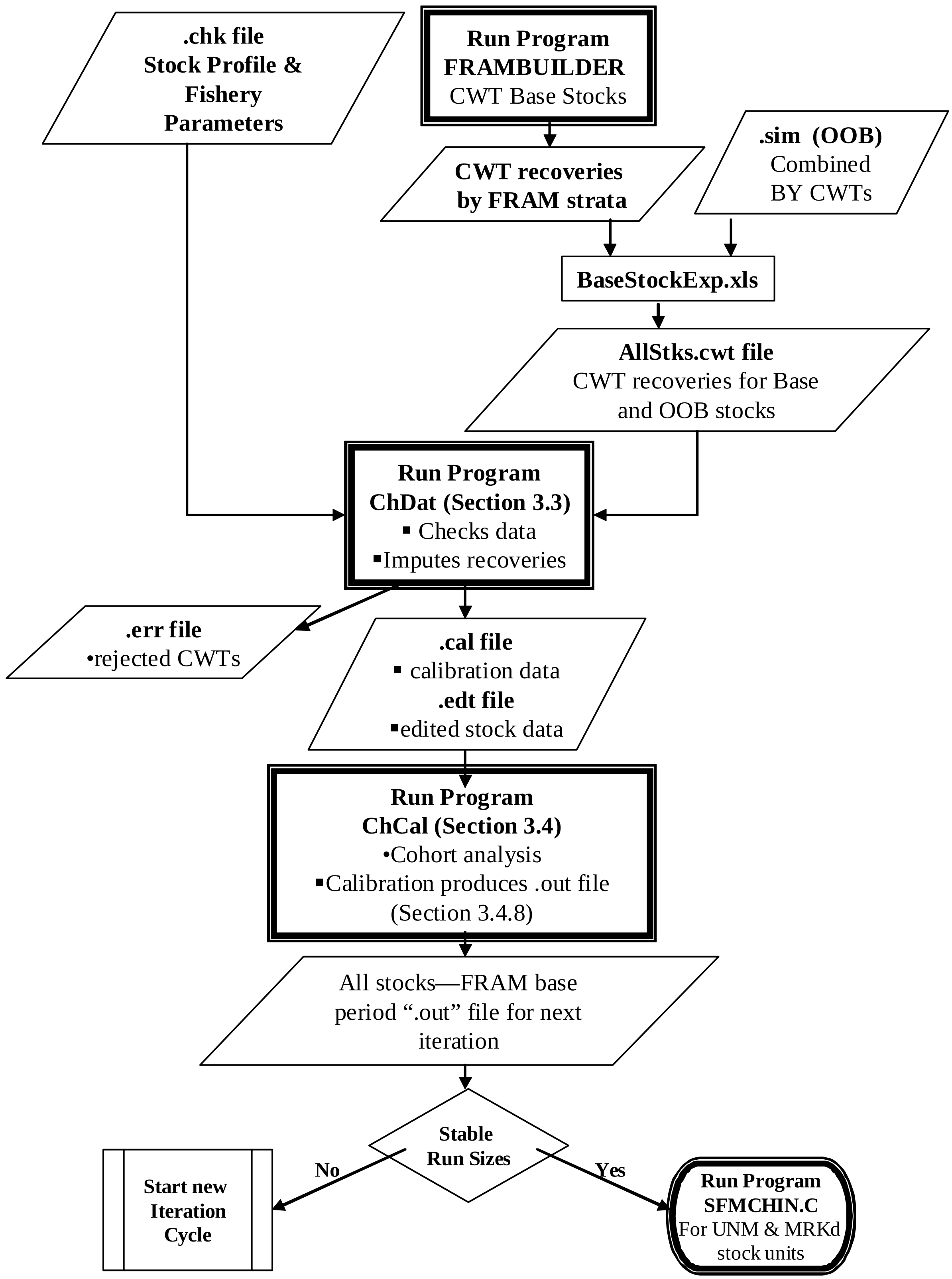


Figure 4. Chinook FRAM calibration for "all-stocks" base data development



3.4.1 CHCAL Input file description – ".CAL" file (from CHDAT)

CAL Section 1: Input File Names and Global Model Constants

The data in this section of the CAL file contains global information such as the names of other input files, the 'type' of run, and a number of constants related to model setup. If the third line = 'Y', the run is an 'OOB' run and the next line must contain the name of an input file containing exploitation rate scale factors. If the third line = 'N', the additional input file is not needed and the line below is omitted.

TULALIP FALL FING 86 - RETURN TO BASE FILE	Title
TUL8605.EDT	Name of CWT recovery file
Y	Adjust to base period
BROOD864.SCL	File with exploitation rate scale factors – only included if line about = Y
10	Number of stocks in calibration if third line = N, Stock number if third line = Y
73	Number of fisheries in calibration
3	Number of time steps per year
5	Maximum age
4	Maximum age for encounter rate adjustment
.01	Convergence tolerance

CAL Section 2: Stock Specific Growth Parameters

Von Bertalanffy growth functions are used to describe the growth of an individual fish. For each age, separate growth curves are assumed depending on whether the fish is maturing at that age or remains an 'immature' fish. There are 14 lines per stock; the total number of lines depends on the total number of stocks being processed.

982.1	LMax, Stock 1; Maturity 0 NSF
2.83	T0,Stock 1; Maturity 0
.029	K, Stock 1; Maturity 0
.11	CV, Stock 1; Maturity 0; Age 2
.12	CV, Stock 1; Maturity 0; Age 3
.09	CV, Stock 1; Maturity 0; Age 4
.09	CV, Stock 1; Maturity 0; Age 5
1085.2	LMax, Stock 1; Maturity 1
1.59	T0, Stock 1; Maturity 1
.03	K, Stock 1; Maturity 1
.11	CV, Stock 1; Maturity 1; Age 2
.11	CV, Stock 1; Maturity 1; Age 3
.11	CV, Stock 1; Maturity 1; Age 4
.11	CV, Stock 1; Maturity 1; Age 5
982.1	LMax, Stock 2; Maturity 0 NNN
	*
	*
	*
.13	CV, Stock n, Maturity 1;Age 5

CAL Section 3: Terminal Fishery Flags

This section lists, by FRAM time step, fisheries which are deemed ‘terminal’ for the stock or stocks being analyzed. By definition, a fish caught in a terminal fishery is mature. The data is used in CHCAL to determine which growth curve (mature or immature) should be associated with a fishery. The number of lines in this section is variable, depending upon the number of fisheries deemed terminal in each time step.

3	Step 1; Number of Terminal Fisheries;
28	Columbia River Net
72	Freshwater Sport
73	Freshwater Net
5	Step 2; Number of Terminal Fisheries;
28	Columbia River Net
46	NT Skagit Net
47	T Skagit Net
72	Freshwater Sport
73	Freshwater Net
23	Step 3; Number of Terminal Fisheries
	*
	*
	*

CAL Section 4: Minimum Size Limits

The section lists, by fishery, minimum size limits in millimeters, one line for each fishery. Size limits are for fork length, and can vary by time step. The data is used in CHCAL along with the growth curve information in Section 2 to estimate the proportions of each age class that are above and below the size limit.

670	670	670	670	Fishery 1 (Alaska Troll)
100	100	100	100	Fishery 2 (Alaska Net)
670	670	670	670	Fishery 3 (Alaska Sport)
100	100	100	100	Fishery 4 (N/C BC Net)
	*			
	*			
	*			
100	100	100	100	Fishery 73 (Freshwater Net)

CAL Section 5: Natural Mortality Rates

Natural mortality rates by age and time step are listed. The rates are simply the fraction of the starting cohort that dies before fishing begins.

.2577	Step 1; Age 2
.1878	Step 1; Age 3
.1221	Step 1; Age 4
.0596	Step 1; Age 5
.0816	Step 2; Age 2
.0577	Step 2; Age 3
.0365	Step 2; Age 4
.0174	Step 2; Age 5
.1199	Step 3; Age 2
.0853	Step 3; Age 3
.0543	Step 3; Age 4
.0260	Step 3; Age 5

CAL Section 6: Shaker Mortality Rates

Shaker mortality rates by fishery are listed, one fishery per line. The rate is simply the fraction of the sublegal population which dies after encountering the gear as a direct result of the encounter.

.255	Fishery 1 (Alaska Troll TCCHINOOK (97)-1)
.3	Fishery 2 (Alaska Net)
.123	Fishery 3 (Alaska Sport TCCHINOOK (97)-1)
.3	Fishery 4 (N/C BC Net)
	*
	*
	*
.3	Fishery 73 (Freshwater Net)

CAL Section 7: 'Other' Mortality Rates

Mortality rates by fishery are listed, one fishery per line. The rate is simply the fraction of the all encounters, including legal encounters, which die as a result of the encounter. Mortalities due to marine mammal predation are in this category.

.008	Fishery 1 (Alaska Troll TCCHINOOK (97)-1)
.03	Fishery 2 (Alaska Net)
.036	Fishery 3 (Alaska Sport TCCHINOOK (97)-1)
.03	Fishery 4 (N/C BC Net)
	*
	*
	*
.02	Fishery 73 (Freshwater Net WDFW and Tribes)

CAL Section 8: Encounter Rate Adjustment Factors

Encounter Rate Adjustment Factors are externally estimated as the ratio of Sublegal Encounters to Legal encounters in a fishery. They are used in the estimation of shaker mortalities. The factors are both fishery and time period specific.

1.0900	Step 1; Fishery 1 (Alaska Troll)
-1.0000	Step 1; Fishery 2 (Alaska Net)
2.6200	Step 1; Fishery 3 (Alaska Sport)
-1.0000	Step 1; Fishery 4 (N/C BC Net)
	*
	*
	*
-1.0000	Step 3; Fishery 73 (Freshwater Net)

CAL Section 9: Chinook Non-retention Data

The section contains data, by time step, on Chinook non-retention (CNR) fisheries. The data includes the fishery number of the non-retention fishery, and a flag to indicate the method to use to estimate CNR mortalities. The number of lines of data depends on the number of CNR fisheries in each time step. In this example, there are no CNR fisheries in any time step.

0	Step 1; Number of CNR fisheries
0	Step 2; Number of CNR fisheries
0	Step 3; Number of CNR fisheries

CAL Section 10: Base Period Catches

This section contains data on the base period annual catch in each FRAM fishery. A zero indicates that the base period average catch is not available. Also on each line is a flag signaling various options to adjust the estimated catch by stock to match the total catch in a fishery.

283260	2	1-Southeast Alaska Troll
25117	2	2-Southeast Alaska Net
20472	2	3-Southeast Alaska Sport
115266	2	4-N/C BC Net
	*	
	*	
	*	
0	0	73-Freshwater Net

CAL Section 11: Shaker Inclusion Flags

There is one line for each stock/fishery combination. A zero means do not include the stock when computing shaker mortalities in that fishery, a one indicates that the stock should be included.

0	Stock 1; Fishery 1;
0	Stock 1; Fishery 2;
0	Stock 1; Fishery 3;
0	Stock 1; Fishery 4;
	*
	*
	*
1	Stock 33; Fishery 73

3.4.2 CHCAL Input file description –“. EDT” file (from CHDAT)

EDT Section 1: Base Period Escapements

If the run is an ‘OOB’ run, this section simply lists the name of the OOB stock being analyzed and a flag indicating that no base period escapement data exists.

Total Base Period Escapement
-1 , Tulalip 86 brd

If the run is not an OOB run, the section contains the average base period escapement for each stock.

20224	1 Nooksack/Samish Fall
500	2 NF Nooksack Spr
500	3 SF Nooksack Spr
10443	4 Skagit Summer Fall Fingerling
	*
	*
	*
100	33 White Spring Yearling

EDT Section 2: CWT recoveries by stock, age, fishery, and time period.

This section of the input file is the same for both types of run. The only difference being that an OOB run contains recovery data from years outside the base period for only one stock, while a non OOB run contains observed or computed data for all stocks during the base period.

SP	STK	AGE	FSH	TIM	RECOVERIES
1	1	2	74	3	71.3
1	1	3	74	1	0.0
1	1	3	74	3	392.2
1	1	4	74	1	0.0
			*		
			*		
			*		
1	33	4	74	3	26.01

3.4.3 CHCAL Input file description –“. SCL” file (from FRAM validation runs for OOB)

The SCL file, which is used only for OOB simulation (Figure 3), is produced from the FRAM validation runs using the program JMNSZE (Section 3.2.2). Each SCL file is brood year specific and contains exploitation rate scale factors for each age, fishery and time period. The scale factors represent the ratio of the fishery exploitation rates in the ‘current’ year to the average fishery exploitation rates during the base period. The data is used when reconstructing base period cohorts and exploitation rates for an OOB stock.

Age 2 (1988) Exploitation Rate Scale Factors	
0.2879	Step 1; Fishery 1 (SEAK Troll)
0.0000	Step 1; Fishery 2 (SEAK Net)
0.6719	Step 1; Fishery 3 (SEAK Sport)
0.0000	Step 1; Fishery 4 (N/C BC Net)
	*
	*
	*

The SCL file also contains size limits for years corresponding to the scale factors. The format of this size limit section of the SCL file is identical to the format of section 4 of the CAL file.

3.4.4 CHCAL Variables and Notation

a	Age in years (2 to 5) 'Birthday' is assumed to occur on October 1.
$AEQ_{s,a,t}$	Adult Equivalence by stock, age, and time step. The probability that a fish will survive to spawn in the absence of future fishing (output to the OUT file).
$BPEscape_{s,a,t}$	Base period CWT recoveries by stock, age, and time step in escapement estimated using forward cohort analysis and exploitation rate scale factors (output to the SIM file for inclusion in the all stocks CHCAL run).
$BPObsCatch_{f}$	Observed catch by fishery during the base period (input from section 10 of the CAL file).
$BPPTCatch_{s,a,f,t}$	Base period CWT recoveries in preterminal fisheries by stock, age, and time step estimated using forward cohort analysis and exploitation rate scale factors (output to the SIM file for inclusion in the all stocks CHCAL run).
$BPTermCatch_{s,a,f,t}$	Base period CWT recoveries in terminal fisheries by stock, age, and time step estimated using forward cohort analysis and exploitation rate scale factors (output to the SIM file for inclusion= in the all stocks CHCAL run).
$CNRMorts_{s,a,f,t}$	Non-retention mortalities by stock, age, fishery, and time step.
$CV_{s,a}$	Coefficient of variation in length-at-age by stock and age (input from section 2 of the CAL file).
$CWTCatch_{s,a,f,t}$	Observed CWT recoveries by stock, age, fishery, and timestep expanded for sampling fraction (input from section 2 of the CWT file.
$CWTEscape_{s,a,t}$	CWTs by stock, age, and time step recovered in escapement past all fisheries expanded for sampling fraction (input from section 1 of the CWT file).
$DropOff_{f}$	Dropoff mortality rate by fishery (input from section 7 of the CAL file).
$EncAdj_{f,t}$	Encounter Rate Adjustment factor by fishery and time step (input from section 8 of the CAL file (output to the OUT file).
$ExpRate_{s,a,f,t}$	The fraction of the vulnerable cohort by stock, age, fishery, and time step, after natural mortality, taken as catch in a fishery.

f	Fishery number. There are currently 74 “fisheries” in CHCAL where fishery 74 is the number of CWT recoveries in escapement.
K_s	Stock specific parameter of the von Bertalanffy growth curve (input from section 2 of the CAL file).
L_{∞_s}	Stock specific parameter of the von Bertalanffy growth curve (input from section 2 of the CAL file).
$LandedCatch_{s,a,f,t}$ with CWTCatch.	Estimated total catch of a stock in a fishery by age and time step. Contrast CHECK IF THIS SHOULD BE IN HERE OR NOT
$LegalProp_{s,a,f,t}$	Proportion of the cohort (terminal or preterminal) which is above the legal size limit by stock, age, fishery, and time step.
$MatCohort_{s,a,t}$	The ‘mature’ cohort, i.e., the number of fish by stock, age, and time step destined to spawn in the current year in the absence of further fishing.
$MatRate_{s,a,t}$ step.	The fraction of the cohort by stock and age that matures in a given time
$Mean_{s,a,t}$	Mean fork length of a fish by stock, age, and time step.
$MinSize_{a,f,t}$	Minimum size limit in a fishery by age, fishery, and timestep. The age subscript is carried but not used in computations (input from section 4 of the CAL file).
$ModelRatio_f$	The proportion of the observed catch in a fishery that can be accounted for by stocks in the model (output to the OUT file as Recovery Adjustment Factor).
PEF_s	Stock specific Production Expansion Factor. The ratio of total stock escapement to the escapement of the CWTed population.
$PTCohort_{s,a,t}$	The preterminal (immature) ocean cohort size by stock, age, and time step.
$PTMorts_{s,a,t}$	Total mortalities of CWTed fish in preterminal fisheries by stock, age, and time step.
s	Stock number. There are currently 33 stocks in the model.
$ScaleFactor_{f,t}$	Fishery and time step specific ratio of fishery exploitation rate during the CWT recovery year to the fishery exploitation rate during the base (input from the SIM file).
$SD_{s,a}$ fish.	Standard Deviation by stock and age of the total length distribution of a
$Shakers_{s,a,f,t}$	Total mortalities of sublegal fish by stock, age, fishery, and time step.
$ShakEnc_{s,a,f,t}$	The fraction of the sublegal cohort, after natural mortality, encountered in a fishery by stock, age, fishery, and time step.
$ShakMortRate_f$ file).	Fishery specific shaker mortality rate (input from section 6 of the CAL
$SLProp_{s,a,f,t}$	The proportion, by stock and age, of the total sublegal population across all fisheries in a time step which is below the legal size limit in a given fishery and time step.
$SRate_{a,t}$	Compliment of the natural mortality rate by age and time step (natural mortality rates are input from section 5 of the CAL file).
$SubLegProp_{s,a,f,t}$	Proportion of the total cohort size by stock and age (terminal or preterminal) which is below the legal size limit in a given fishery and time step.

t	Time step. There are 3 time steps per 'year' Oct – Apr, May – June, and July – Sept.
$T_{0,s}$	Stock specific parameter of the von Bertalanffy growth curve (input from section 2 of the CAL file).
$TMorts_{s,a,t}$	Total mortalities of CWTed fish in terminal fisheries by stock, age, and time step.
$TotalBPEsc_s$	Adult total escapement by stock during the base period (input from the CWT file).
$TotalCohort_{s,a,t}$	The total cohort available at the start of each time period, before natural mortality by stock, age, and time step.
$TotalSLPop_{f,t}$	The total number of sublegal fish, by time step, across stocks, available to a fishery.

3.4.5 CHCAL "Backward" Cohort Analysis (Age 5 backward thru Age 2) for OOB stocks

CHCAL performs the following calculations during a cohort reconstruction of CWT recoveries for the OOB simulation. The first type of cohort analysis is a reconstruction of the cohort working from the age 5 CWT recoveries back through age 4, then age 3, and ending with age 2. The equations are numbered in this section and the next in order to follow the cohort reconstruction example shown in Appendix 4.8.

1) Read in all data from CHDAT output files

2) Perform a CWT cohort analysis for the OOB brood using the following procedure:

a) Compute the total number of CWT mortalities by age and time step for both terminal and preterminal fisheries.

$$PTMorts_{s,a,t} = \sum_{PTFisheries} CWTCatch_{s,a,f,t} * (1 + DropOff_f) + ShakMorts_{s,a,f,t} + CNRMorts_{s,a,f,t} \quad (1)$$

$$TMorts_{s,a,t} = \sum_{TFisheries} CWTCatch_{s,a,f,t} * (1 + DropOff_f) + Shakers_{s,a,f,t} + CNRMorts_{s,a,f,t} \quad (2)$$

b) Compute the 'terminal' or mature cohort by age and time step.

$$MatCohort_{s,a,t} = TMorts_{s,a,t} + CWTEscape_{s,a,t} \quad (3)$$

In the final time period, the immature cohort for the oldest age and after natural mortality is computed as:

$$PTCohort_{s,a=5,t=3} = MatCohort_{s,a=5,t=3} + PTMorts_{s,a=5,t=3} \quad (4)$$

The cohort size for the younger ages in the final time period is computed as:

$$PTCohort_{,s,a,t=3} = \frac{PTCohort_{s,a+1,t=1}}{SRate_{a+1,t=1}} + MatCohort_{s,a,t} + PTMorts_{s,a,t} \quad (5)$$

The cohort size for all ages in earlier time periods is computed as :

$$PTCohort_{s,a,t} = \frac{PTCohort_{s,a,t+1}}{SRate_{a,t+1}} + MatCohort_{s,a,t} + PTMorts_{s,a,t} \quad (6)$$

Once an initial estimate of preterminal and terminal CWT cohort sizes have been made, incidental (shaker) and CNR mortalities by fishery, age, and time period can be estimated.

For initial iteration, assume the number of encounters is equal to the landed catch.

$$Encounters_{f,t} = \sum_{s}\sum_{a=2}^{5} CWTCatch_{s,a,f,t} * EncAdj_{f,t} \quad (7)$$

Compute the proportions of the cohort at age that are above and below the size limit assuming a normal distribution of fish length at age.

$$Mean_{s,a,t} = L_{\infty_s} * (1 - e^{-k_s(t - t_{0_s})}) \quad (8)$$

$$SD_{s,a,t} = Mean_{s,a,t} * CV_{s,a} \quad (9)$$

$$SubLegProp_{s,a,f,t} = f(Minsize_{a,f,t}, Length_{s,a,t}), Length_{s,a,t} \sim N(Mean_{s,a,t}, SD_{s,a,t}{}^2)$$

$$LegalProp_{s,a,f,t} = 1 - SubLegProp_{s,a,f,t} \quad (10)$$

Compute the total sub-legal population.

$$TotalSLPop_{f,t} = \sum_{s}\sum_{a=2}^{5}(SubLegProp_{s,a,f,t} * Cohort_{s,a,t}) \quad (11)$$

Where:

$Cohort_{s,a,t} = PTCohort_{s,a,t}$ for Preterminal fisheries and

$Cohort_{s,a,t} = MatCohort_{s,a,t}$ for Terminal fisheries.

Compute the proportion of each stock and age that is sublegal.

$$\text{SLProp}_{s,a,f,t} = \frac{\text{SubLegProp}_{s,a,f,t} * Cohort_{s,a,t}}{TotalSLPop_{f,t}} \qquad (12)$$

Now compute the number of shaker mortalities as:

$$\text{Shakers}_{\text{s,a,f,t}} = Encounters_{f,t} * \text{SLProp}_{\text{s,a,f,t}} * ShakMortRate_{f} \qquad (13)$$

CNR mortalities are not generally estimated in FRAM calibration since CNR fisheries were rare during the base period. Computation details are not included in this description of CHCAL. Now that an initial estimate of shakers is available, cohort sizes are re-estimated based on the new number of total mortalities. This continues iteratively until the change in age 2 cohort size is less than a predefined limit (‘convergence tolerance’, CAL file line 10). Note that at this stage we have available at the start of each time step a preterminal cohort at age and a terminal, or mature cohort at age.

3.4.6 CHCAL “Forward” Cohort Analysis (Age 2 forward thru Age 5) for OOB stocks

Estimation of the recoveries that would have occurred during the base period for the OOB stock requires several steps.

Once cohort sizes are available, maturation rates by age and time step can be computed. The maturation rate for the oldest age in the final time step is assumed to be 1.0

In the last time step, compute a total cohort after fishing mortality.

$$TotalCohort_{s,a,t=3} = MatCohort_{s,a,t=3} + \frac{PTCohort_{s,a+1,t=1}}{SRate_{a+1,t=1}} \qquad (14)$$

And the Maturation rate is simply the mature portion of the total cohort after fishing.

$$MatRate_{s,a,t=3} = \frac{MatCohort_{s,a,t=3}}{TotalCohort_{s,a,t=3}}$$

(15)

For earlier time steps, maturation rates are computed in a similar way.

$$TotalCohort_{s,a,t} = MatCohort_{s,a,t} + \frac{PTCohort_{s,a,t+1}}{SRate_{a,t+1}}$$

(16)

$$MatRate_{s,a,t} = \frac{MatCohort_{s,a,t}}{TotalCohort_{s,a,t}}$$

(17)

Compute the exploitation rate on the vulnerable (legal size) cohort estimated from the cohort analysis just performed.

$$ExpRate_{s,a,f,t} = \frac{CWTCatch_{s,a,f,t}}{Cohort_{s,a,t} * SRate_{a,t} * LegProp_{f,a,t}}$$

(18)

Now start the forward analysis to estimate CWT recoveries during the base period, beginning with the youngest age:

1) $PTCohort_{s,a,t} = TotalCohort_{s,a=2,t=1}$

(19)

2) $PTCohort_{s,a,t} = TotalCohort_{s,a,t} * SRate_{a=2,t=1}$

(20)

3) $BPPTCatch_{s,a,f,t} = PTCohort_{s,a,t} * LegProp_{f,a,t} * \frac{ExpRate_{s,a,f,t}}{ScaleFactor_{f,t}}$

(21)

4) $MatCohort_{s,a,f,t} = (PTCohort_{s,a,t} - \sum_{PTF} BPPTCatch_{s,a,f,t}) * MatRate_{s,a,t}$

(22)

5) $BPTermCatch_{s,a,f,t} = MatCohort_{s,a,t} * LegProp_{s,a,f,t} * \frac{ExpRate_{s,a,f,t}}{ScaleFactor_{f,t}}$

(23)

6) $BPEscape_{s,a,t} = MatCohort_{s,a,f,t} - BPTermCatch_{s,a,f,t}$

(24)

Now, recompute the preterminal cohort if time step is less than 3 as:

6) $$TotalCohort_{s,a,t} = \frac{PTCohort_{s,a,t+1} - \sum_{PTF} BPPTCatch_{s,a,f,t}}{1 - MatRate_{s,a,t}}$$

(25)

or if time step =3 as:

$$TotalCohort_{s,a,t} = \frac{PTCohort_{s,a+1,t} - \sum_{PTF} BPPTCatch_{s,a,f,t}}{1 - MatRate_{s,a,t}}$$

(26)

Increment *a* by 1 and return to step 2 above.

3.4.7 CHCAL Outputs – ".SIM" file for OOB Run

Simulated base period recoveries by fishery, age, and time step ($BPPTCatch_{s,a,f,t}$ and $BPTermCatch_{s,a,f,t}$), and escapements by age and time step ($BPEscape_{s,a,t}$) from CHCAL in OOB mode are written to the SIM output file. The SIM files produced from individual brood year runs of CHCAL for a OOB stock are combined using MERGE to produce a single SIM file for each OOB stock.

SP	STK	AGE	FSH	TIM	RECOVERIES
1	1	2	74	3	71.3
1	1	3	74	1	0.0
1	1	3	74	3	392.2
1	1	4	74	1	0.0
			*		
			*		
			*		
1	33	4	74	3	26.01

3.4.8 CHCAL Program Flow and Calculations – All-Stocks Run

After all OOB stocks have been run through CHCAL and their base period CWT recoveries have been estimated, the data is combined with the data for all other stocks and all stocks are run through CHCAL at once. The sequence of computations for an All-Stocks run is as follows.

Estimate base period Production Expansion Factors (PEF) for each stock based on the ratio of the total adult escapement of each stock (from section 1 of the EDT file) to the total adult escapement of the CWTed stock (input from section 2 of the EDT file).

$$PEF_s = \frac{TotalBPEsc_s}{\sum_{a=3,t}^{a=5,t=3} CWTEscape_{s,a,t}}$$

Note that if a 'large' CWT group is used to represent the catch distribution of a 'small' hatchery stock, the expansion factors may be less than 1.0.

Depending on the setting of an input flag, the observed base period CWT recoveries are adjusted so that the sum across stocks of the CWT recoveries in each fishery, expanded by PEF_s, equals the total observed catch in each fishery. The adjustment formula is:

$$LandedCatch_{s,a,f,t} = CWTCatch_{s,a,f,t} * PEF_s * ModelRatio_f$$

Where

$$ModelRatio_f = \frac{BPObsCatch_f}{\sum_{s,a,t} (CWTCatch_{s,a,f,t} * PEF_s)}$$

The adjustment flags are:

"0" – indicates CWT recoveries are not adjusted. In this case,

$$LandedCatch_{s,a,f,t} = CWTCatch_{s,a,f,t} * PEF_s$$

"1" – indicates CWT recoveries are always adjusted to sum to the total catch in the fishery;
"2" – indicates CWT recoveries are adjusted only if the total catch in the fishery is greater than the sum of the CWT recoveries multiplied by the PEFs.

If the CWT recoveries are not adjusted $ModelRatio_f$ is set to 99 as a flag.

At this point, a final observed cath to 'model catch' ratio can be computed for each fishery. This value is, along with a saved to the outfile

$$RecoveryAdjustmentFactor_f = \frac{\sum_{s,a,t} LandedCatch_{s,a,f,t}}{BPObsCatch_f}$$

Now a cohort analysis is performed *for each stock* using the landed catch in each fishery. The cohort analysis procedures are exactly the same as those preformed for an 'OOB' run.

Compute the total number of CWT mortalities by age and time step for both terminal and preterminal fisheries:

$$PTMorts_{s,a,t} = \sum_{PTFisheries} LandedCatch_{s,a,f,t} * (1 + DropOff_f) + ShakMorts_{s,a,f,t} + CNRMorts_{s,a,f,t}$$

$$TMorts_{s,a,t} = \sum_{TFisheries} LandedCatch_{s,a,f,t} * (1 + DropOff_f) + ShakMorts_{s,a,f,t} + CNRMorts_{s,a,f,t}$$

Compute the ‘terminal’ or mature cohort by age and time step as:

$$MatCohort_{s,a,t} = TMorts_{s,a,t} + Escape_{s,a,t}$$

In the final time period, the immature cohort for the oldest age and after natural mortality is:

$$PTCohort_{s,a=5,t=3} = MatCohort_{s,a=5,t=3} + PTMorts_{s,a=5,t=3}$$

The cohort size for the younger ages in the final time period is computed as:

$$PTCohort_{s,a,t=3} = \frac{PTCohort_{s,a+1,t=1}}{SRate_{a+1,t=1}} + MatCohort_{s,a,t} + PTMorts_{s,a,t}$$

The cohort size for all ages in earlier time periods is computed as:

$$PTCohort_{s,a,t} = \frac{PTCohort_{s,a,t+1}}{SRate_{a,t+1}} + MatCohort_{s,a,t} + PTMorts_{s,a,t}$$

Once an initial estimate of preterminal and terminal cohort sizes for all stocks have been made, incidental (shaker) and CNR mortalities by stock, fishery, age, and time period can be estimated.

For initial iteration, assume the number of encounters of all stocks by fishery and time period is equal to the landed catch. The encounters can be scaled up or down to match available external estimates of encounter rates. The scalars are input in section 8 of the CAL file.

$$Encounters_{f,t} = \sum_{s} \sum_{a=2}^{5} CWTCatch_{s,a,f,t} * EncAdj_{f,t}$$

Compute the proportions of the cohort at age that are above and below the size limit assuming a normal distribution of fish length at age.

$$SubLegProp_{f,a,t} = f(Minsize_{a,f,t}, Length_{a,t}), Length_{a,t} \sim N(Mean_{a,t}, SD_{a,t}^{\ 2})$$

$$LegalProp_{f,a,t} = 1 - SubLegProp_{f,a,t}$$

Compute the total sub-legal population as:

$$TotalSLPop_{f,t} = \sum_{s} \sum_{a=2}^{5} SubLegProp_{s,f,a,t} * Cohort_{s,a,t}$$

where

$Cohort_{s,a,t} = PTCohort_{s,a,t}$ for Preterminal fisheries and

$Cohort_{s,a,t} = MatCohort_{s,a,t}$ for Terminal fisheries.

Compute the proportion of each age that is sublegal.

$$SLProp_{s,f,a,t} = \frac{SubLegProp_{s,f,a,t} * Cohort_{s,a,t}}{TotalSlPop_{f,t}}$$

Now compute the number of shaker mortalities as:

$$Shakers_{s,a,f,t} = Encounters_{f,t} * SLProp_{s,f,a,t} * ShakMortRate_{f}$$

CNR mortalities are not generally estimated in FRAM calibration since CNR fisheries were rare during the base period. Computation details are not included in this draft of CHCAL.

Now that an initial estimate of shakers is available, cohort sizes are re-estimated based on the new number of total mortalities. This continues iteratively until the change in age 2 cohort size is less than a predefined limit ('convergence tolerance', CAL file line 10). Note that at this stage we have available at the start of each time step a preterminal cohort at age and a terminal, or mature cohort at age.

Once cohort sizes are available, maturation rates by age and time step can be computed. The maturation rate for the oldest age in the final time step is assumed to be 1.0

In the last time step, compute a total cohort after fishing mortality.

$$TotalCohort_{s,a,t=3} = MatCohort_{s,a,t=3} + \frac{PTCohort_{s,a+1,t=1}}{SRate_{s,a+1,t=1}}$$

And the Maturation rate is simply the mature portion of the total cohort after fishing.

$$MatRate_{s,a,t=3} = \frac{MatCohort_{s,a,t=3}}{TotalCohort_{s,a,t=3}}$$

For earlier time steps, maturation rates are computed in a similar way as:

$$TotalCohort_{s,a,t} = MatCohort_{s,a,t} + \frac{PTCohort_{s,a,t+1}}{SRate_{s,a,t+1}}$$

$$MatRate_{s,a,t} = \frac{MatCohort_{s,a,t}}{TotalCohort_{s,a,t}}$$

Once maturation rates are available, adult equivalence (AEQ) can be computed. AEQ is the probability that a fish of a certain age will survive to spawn, in the absence of future fishing. AEQs are a function of the maturation rate of the stock and therefore are stock specific. AEQ is defined as 1.0 for the oldest age class at the final time step.

$$AEQ_{a=5,t=3} = 1.0$$

In earlier time steps, for all ages, AEQ is computed as

$$AEQ_{a,t} = MatRate_{s,a,t} + ((1 - MatRate_{s,a,t}) * SRate_{a+1,t} * AEQ_{s,a,t+1})$$

Finally, exploitation rates on the vulnerable cohort are computed as:

$$ExpRate_{s,a,f,t} = \frac{LandedCatch_{s,a,f,t}}{TotalCohort_{s,a,t} * SRate_{a,t} * LegalProp_{f,a,t}}$$

And shaker encounter rates are computed as:

$$ShakEnc_{s,a,f,t} = \frac{(Shakers_{s,a,f,t} / ShakMortrate_{f})}{TotalCohort_{s,a,t} * SRate_{a,t} * SLProp_{s,a,f,t}}$$

3.4.9 CHCAL Output— FRAM base period ".out" file from All Stocks Run

CHCAL writes one final output file, which is used as a basic driver file for the FRAM model. The OUT file is described below.

CHCAL OUT File: Section 1

Section 1 contains global values defining the dimensions of the model.

33	Number of Stocks
73	Number of Fisheries
3	Number of Time Steps
5	Maximum Age
4	Maximum Age for Encounter Rate Adjustment

CHCAL OUT File: Section 2

Section 2 contains Adult Equivalencies by stock, age, and time step.

0.95705235	step 4; Stock 1; Age 5
1.00000000	step 3; Stock 1; Age 5
0.97399998	step 2; Stock 1; Age 5
0.95705235	step 1; Stock 1; Age 5
	*
	*
	*
0.27315800	step 1; Stock 33; Age 2

CHCAL OUT File: Section 3

Section 3 contains the growth parameters, by stock.

982.1	Stock 1; LMAX; Maturity 0
2.83	T0
0.029	L
0.11	CV - Age2
0.12	CV - Age3
0.09	CV - Age4
0.09	CV - Age5
1085.2	Stock 1; LMAX; Maturity 1
	*
	*
	*
0.11 ,CV	Age5

CHCAL OUT File: Section 4

Section 4 contains data on the ‘midpoint’, in months from October, of each time step.

1.0	Midpoint month of time step 1
5.5	Midpoint month of time step 2
8.0	Midpoint month of time step 3
1.0	Midpoint month of time step 4

CHCAL OUT File: Section 5

Section 5 contains shaker inclusion flags for each stock/fishery combination in a matrix format. The rows correspond to fisheries, the columns to stocks. This data was input from the CAL file and not modified by CHCAL.

0 1 1 1 0 0 0 0 1 0 0 0 0 0 0 0 0 1 0 1 1 0 1 1 1 1 1 1 1 1 1 1 1
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 1 0 0 0 0 0 0 1 1 0 0 1 0
0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 1 0 1 1 1 1 0 1 1 0 1 1 0
0 0 0 0 1 0 0 1 0 0 0 0 0 0 0 0 0 1 0 1 1 0 1 1 1 1 0 1 1 0 1 1 0
*
*
*
*
1 0 0 1 0 1 0 0 1 1 1 1 0 0 0 1 1 1 0 0 0 1 0 0 0 0 0 0 0 0 1 0 1

CHCAL OUT File: Section 6

Section 6 contains base period starting cohort sizes (first time period) at age, before natural mortality.

744009	Stock 1; 2
423945	Stock 1; 3
195369	Stock 1; 4
12598	Stock 1; 5
	*
	*
	*
8	Stock 33; 5

CHCAL OUT File: Section 7

Section 7 contains the Recovery Adjustment Factors and the fraction of the observed catch during the base period which can be accounted for by FRAM stocks. This is sometimes called the “proportion modeled stocks”. A ‘99’ in the first column (the recovery adjustment factor)indicates no overall adjustment was made to the CWT recovery data to account for total catches. When adjustments were made, the values in the first and second columns will be the inverse of each other. The left column is for the user’s information and is deleted prior to use of the OUT file in FRAM.

99	.4967	Fishery 1;
99	.2016	Fishery 2;
99	.2709	Fishery 3;
1.636	.6112	Fishery 4;
		*
		*
		*
99		Fishery33;

CHCAL OUT File: Section 8

Section 8 contains ‘other’ mortality rates by fishery, as input in the CAL file.

.008	Fishery 1 (Alaska Troll TCCHINOOK (97)-1)
.03	Fishery 2 (Alaska Net)
.036	Fishery 3 (Alaska Sport TCCHINOOK (97)-1)
.03	Fishery 4 (N/C BC Net)
	*
	*
	*
.02	Fishery 73 (Freshwater Net WDFW and Tribes)

CHCAL OUT File: Section 9

Section 9 contains natural mortality rates during the first time period.

0.2577	Age 2
0.1878	Age 3
0.1221	Age 4
0.0596	Age 5

CHCAL OUT File: Section 10

Section 10 contains shaker mortality rates by fishery in the first time period.

0.2550	Fishery 1;
0.3000	Fishery 2;
0.1230	Fishery 3;
0.3000	Fishery 4;
	*
	*
	*
0.3000	Fishery 33;

CHCAL OUT File: Section 11

Section 11 contains the encounter rate adjustment factors for ages 2 to 4 in the first time period. A value for each age is written, even though the adjustments are currently not age specific.

1.0000 1.0000 1.0000	Fishery 1;
1.0000 1.0000 1.0000	Fishery 2;
1.0000 1.0000 1.0000	Fishery 3;
1.0000 1.0000 1.0000	Fishery 4;
	*
	*
	*
1.0000 1.0000 1.0000	Fishery 73;

CHCAL OUT File: Section 12

Section 12 contains the terminal fishery flags (0 = preterminal, 1 = terminal) in the first time period.

0	Fishery 1;
0	Fishery 2;
0	Fishery 3;
0	Fishery 4;
	*
	*
	*
1	Fishery 73;

CHCAL OUT File: Section 13

Section 13 contains maturation rates by age for stocks that mature in the first time period.

Stock 49	Age 3	0.0797452400
Stock 50	Age 3	0.0797452400
Stock 49	Age 4	0.5020105200
Stock 50	Age 4	0.5020105200
	*	
	*	
	*	
Stock 52	Age 5	0.9585540900

CHCAL OUT File: Section 14

Section 14 contains exploitation rates and shaker encounter rates by stock, age, and fishery for the first time period.

Stock	Age	Fishery	ER	Shak Enc
1	2	1	0.0000000000	0.0000034900
2	2	1	0.0000000000	0.0000034900
1	3	1	0.0000000000	0.0000034900
2	3	1	0.0000000000	0.0000034900
		*		
		*		
1	3	8	0.0011095100	0.0001878300
		*		
		*		
		*		
66	4	67	0.1635743400	0.0540591100

For the remainder of the OUT file, sections 9 through 14 are repeated for each time period. Time period 4 is included as the last section. It is simply a repeat of the data in time step 1.

4. APPENDIX

4.1 List of CWT groups

TABLE 1. CHINOOK CWT GROUPS USED IN 2005 FRAM CALIBRATION

FRAM	FR Name	RUN NAME	Code	BYR	AGE	DAT1	DAT2	TAGGED	ADS	UNMARKED	FPP	TOTL	Stock	Hatchery
1	NkSM FlFi	FALL CHIN	050324	77	1	780623	780623	96486	1969	101545	80	200000	BIG SOOS CR 09.0072	SKOOKUM CR HATCHERY
1	NkSM FlFi	FALL CHIN	050325	77	1	780620	780620	99240	2025	58266	71.1	159531	BIG SOOS CR 09.0072	SKOOKUM CR HATCHERY
1	NkSM FlFi	FALL CHIN	050726	79	1	800617	800617	59629	1219	2425200	127.4	2486048	SAMISH (FRIDAY CR)	SKOOKUM CR HATCHERY
1	NkSM FlFi	FALL CHIN	050727	79	1	800702	800702	40468	1686	7846	74	50000	SAMISH (FRIDAY CR)	LUMMI SEA PONDS
1	NkSM FlFi	FALL CHIN	632042	79	1	800523	800523	100514	1221	0	96	101735	SAMISH (FRIDAY CR)	SAMISH HATCHERY
1	NkSM FlFi	FALL CHIN	632101	79	1	800523	800523	106037	206	22287	103	128530	SAMISH (FRIDAY CR)	SAMISH HATCHERY
1	NkSM FlFi	FALL CHIN	632102	79	1	800523	800523	103023	1231	9300	93	113554	SAMISH (FRIDAY CR)	SAMISH HATCHERY
2	NF NK Spr	SPRG CHIN	632846	84	1	850531	850531	133418	15653	0	84.6	149071	KENDALL CR 01.0406	KENDALL CR HATCHERY
2	NF NK Spr	SPRG CHIN	633452	84	2	860410	860410	52274	26	48617	6.4	100917	KENDALL CR 01.0406	KENDALL CR HATCHERY
2	NF NK Spr	SPRG CHIN	633453	84	2	860410	860410	52599	26	48293	6.4	100918	KENDALL CR 01.0406	KENDALL CR HATCHERY
2	NF NK Spr	SPRG CHIN	634422	88	2	900402	900402	146729	8212	221851	7.6	376792	KENDALL CR 01.0406	KENDALL CR HATCHERY
4	Skag FlFi	SUMR CHIN	631606	76	1	770603	770603	147153	3928	6040	138	157121	SKAGIT R 03.0176	MARBLEMOUNT HATCHERY
4	Skag FlFi	SUMR CHIN	631624	76	1	7704	7704	5875	0	0	250.6	5875	SKAGIT R 03.0176	WILDSTOCK
4	Skag FlFi	SUMR CHIN	631625	76	1	7705	7705	5428	0	0	250.6	5428	SKAGIT R 03.0176	WILDSTOCK
4	Skag FlFi	SUMR CHIN	631626	76	1	7705	7705	5438	0	0	250.6	5438	SKAGIT R 03.0176	WILDSTOCK
4	Skag FlFi	SUMR CHIN	631627	76	1	770601	770601	5090	0	0	250.6	5090	SKAGIT R 03.0176	WILDSTOCK
4	Skag FlFi	SUMR CHIN	631628	76	1	7706	7706	2502	0	0	250.6	2502	SKAGIT R 03.0176	WILDSTOCK
4	Skag FlFi	SUMR CHIN	631629	76	1	770420	770617	2126	0	0	250.6	2126	SKAGIT R 03.0176	WILDSTOCK
4	Skag FlFi	SUMR CHIN	631630	77	1	7804	7804	2281	0	0	224.6	2281	SKAGIT R 03.0176	WILDSTOCK
4	Skag FlFi	SUMR CHIN	631631	77	1	780419	780501	3543	0	0	224.6	3543	SKAGIT R 03.0176	WILDSTOCK
4	Skag FlFi	SUMR CHIN	631632	77	1	780402	780402	9584	0	0	224.6	9584	SKAGIT R 03.0176	WILDSTOCK
4	Skag FlFi	SUMR CHIN	631633	77	1	7805	7805	10528	0	0	224.6	10528	SKAGIT R 03.0176	WILDSTOCK
4	Skag FlFi	SUMR CHIN	631635	77	1	7805	7805	7947	0	0	224.6	7947	SKAGIT R 03.0176	WILDSTOCK
4	Skag FlFi	SUMR CHIN	631636	77	1	7806	7806	2332	0	0	199.8	2332	SKAGIT R 03.0176	WILDSTOCK
5	Skag FlYr	SUMR CHIN	631610	76	2	780502	780502	73428	1575	72063	10	147066	SKAGIT R 03.0176	MARBLEMOUNT HATCHERY
6	Skag SpYr	SPRG CHIN	633114	90	2	920416	920416	146265	1687	136571	14	284523	CLARK CR 03.1421	MARBLEMOUNT HATCHERY
6	Skag SpYr	SPRG CHIN	634744	87	2	890418	890418	63808	159	0	9.5	63967	SUIATTLE R 03.0710	MARBLEMOUNT HATCHERY
6	Skag SpYr	SPRG CHIN	634902	87	2	890418	890418	25725	65	0	9.5	25790	CLARK CR 03.1421	MARBLEMOUNT HATCHERY
6	Skag SpYr	SPRG CHIN	635026	87	2	890418	890418	25379	64	0	9.5	25443	CLARK CR 03.1421	MARBLEMOUNT HATCHERY
6	Skag SpYr	SPRG CHIN	633314	86	2	880408	880408	80395	405	0		80800	SKAGIT TRIBUTARIES	MARBLEMOUNT HATCHERY
6	Skag SpYr	SPRG CHIN	633323	85	2	870429	870429	47521	191	0		47712	SKAGIT TRIBUTARIES	MARBLEMOUNT HATCHERY
8	Snoh FlYr	SUMR CHIN	631701	76	2	780326	780326	98972	1507	802521	8	903000	SNOHOMISH R 07.0012	WALLACE R HATCHERY
9	Stil FlFi	SUMR CHIN	211826	89	1	900516	900516	44964	1873	0	86.1	46837	STILLAGUAMISH R -NF	STILLAGUAMISH HATCH
9	Stil FlFi	CHINOOK	212026	90	1	910517	910520	63019	5862	219	68.9	69100	STILLAGUAMISH R -NF	STILLAGUAMISH HATCH
9	Stil FlFi	SUMR CHIN	212221	86	1	870414	870414	23904	996	0	90.2	24900	STILLAGUAMISH R	STILLAGUAMISH HATCH
9	Stil FlFi	SUMR CHIN	212555	87	1	880518	880518	127910	9333	7923	90.2	145166	STILLAGUAMISH R	STILLAGUAMISH HATCH
9	Stil FlFi	SUMR CHIN	213147	88	1	890517	890517	36599	4524	0	80	41123	STILLAGUAMISH R -NF	STILLAGUAMISH HATCH
10	Tula FlFi	FALL CHIN	212204	86	1	870519	870519	191825	14660	851175	89.1	1057660	SNOHOMISH R 07.0012	TULALIP SALMON HATCH
10	Tula FlFi	FALL CHIN	212544	87	1	880509	880509	188110	14377	1222513	90.2	1425000	GREEN R +TULALIP BAY	TULALIP SALMON HATCH
10	Tula FlFi	FALL CHIN	213141	88	1	890519	890519	181873	22479	420648	84.9	625000	MAY CR + WALLACE CR	TULALIP SALMON HATCH
11	MiPS Fl Fi	FALL CHIN	631814	78	1	790531	790531	61307	370	1061514	102	1123191	SKAGIT + SKYKOMISH	VOIGHTS CR HATCHERY
11	MiPS Fl Fi	FALL CHIN	631842	78	1	790531	790531	7752	408	134270	102	142430	SKAGIT + SKYKOMISH	VOIGHTS CR HATCHERY
11	MiPS Fl Fi	FALL CHIN	631935	78	1	790517	790517	99372	1207	173396	99	273975	BIG SOOS CR 09.0072	SOOS CREEK HATCHERY
11	MiPS Fl Fi	FALL CHIN	631936	78	1	790517	790517	100664	404	177958	112	279026	BIG SOOS CR 09.0072	SOOS CREEK HATCHERY
11	MiPS Fl Fi	FALL CHIN	631940	78	1	790523	790525	150554	2554	2558955	146.2	2712063	GREEN R + ISSAQUAH	ISSAQUAH HATCHERY
11	MiPS Fl Fi	FALL CHIN	631943	79	1	800509	800509	120515	3497	2691961	125	2815973	ISSAQUAH CR 08.0178	ISSAQUAH HATCHERY
11	MiPS Fl Fi	FALL CHIN	631944	79	1	800502	800502	119913	482	2737105	106	2857500	BIG SOOS CR 09.0072	SOOS CREEK HATCHERY
11	MiPS Fl Fi	FALL CHIN	631945	78	1	790517	790531	185133	1750	4203607	100	4390490	BIG SOOS CR 09.0072	SOOS CREEK HATCHERY
11	MiPS Fl Fi	FALL CHIN	632020	79	1	800523	800523	64238	304	1176650	139	1241192	VOIGHT CR 10.0414	VOIGHTS CR HATCHERY
12	UW-A FlFi	FALL CHIN	111601	77	1	780508	780508	26188	2357	169	31	28714	PORTAGE BAY STOCK UW	PORTAGE BAY HATCHERY

12	UW-A FlFi FALL CHIN	111602	77	1	780508	780508	26331	266	13	36	26610	PORTAGE BAY STOCK UW		PORTAGE BAY HATCHERY
12	UW-A FlFi FALL CHIN	111603	78	1	790518	790518	24639	1107	0	47	25746	PORTAGE BAY STOCK UW		PORTAGE BAY HATCHERY
12	UW-A FlFi FALL CHIN	111604	78	1	790518	790518	23653	858	0	44	24511	PORTAGE BAY STOCK UW		PORTAGE BAY HATCHERY
12	UW-A FlFi FALL CHIN	111605	78	1	790518	790518	27165	358	8	50	27531	PORTAGE BAY STOCK UW		PORTAGE BAY HATCHERY
12	UW-A FlFi FALL CHIN	111606	78	1	790518	790518	23078	689	0	56	23767	PORTAGE BAY STOCK UW		PORTAGE BAY HATCHERY
12	UW-A FlFi FALL CHIN	111618	78	1	790518	790518	53537	1093	0	52	54630	PORTAGE BAY STOCK UW		PORTAGE BAY HATCHERY
12	UW-A FlFi FALL CHIN	111624	78	1	790529	790529	3637	15	0	54	3652	PORTAGE BAY STOCK UW		PORTAGE BAY HATCHERY
12	UW-A FlFi FALL CHIN	111627	79	1	800528	800528	18488	2077	0	19	20565	PORTAGE BAY STOCK UW		PORTAGE BAY HATCHERY
12	UW-A FlFi FALL CHIN	111628	79	1	800519	800519	20573	887	184	37	21644	PORTAGE BAY STOCK UW		PORTAGE BAY HATCHERY
12	UW-A FlFi FALL CHIN	111629	79	1	800522	800522	20008	855	0	37	20863	PORTAGE BAY STOCK UW		PORTAGE BAY HATCHERY
12	UW-A FlFi FALL CHIN	111630	79	1	800519	800519	20435	697	0	38	21132	PORTAGE BAY STOCK UW		PORTAGE BAY HATCHERY
12	UW-A FlFi FALL CHIN	111631	79	1	800528	800528	20196	560	0	19	20756	PORTAGE BAY STOCK UW		PORTAGE BAY HATCHERY
12	UW-A FlFi FALL CHIN	111632	79	1	800519	800519	21822	220	0	52	22042	PORTAGE BAY STOCK UW		PORTAGE BAY HATCHERY
13	SPSo FlFi FALL CHIN	050722	79	1	800515	800515	33494	5635	776681	116	815810	BIG SOOS CR	09.0072	KALAMA CR HATCHERY
13	SPSo FlFi FALL CHIN	631903	79	1	800429	800516	14834	456	334052	83	349342	PUYALLUP + DESCHUTES		GARRISON HATCHERY
13	SPSo FlFi FALL CHIN	631907	78	1	790523	790523	28188	0	571678	116	599866	DESCHUTES R X MINTER		MINTER HATCHERY
13	SPSo FlFi FALL CHIN	632063	79	1	800630	800630	34619	69	623527	60	658215	BIG SOOS CR	09.0072	COULTER CR HATCHERY
13	SPSo FlFi FALL CHIN	632103	79	1	800531	800531	12843	0	6424157	120	6437000	UNDETERMINED MIXED		CAPITOL LAKE REARING
13	SPSo FlFi FALL CHIN	632104	79	1	800601	800601	72032	361	1612822	116.4	1685215	S PUGET SOUND STOCKS		MINTER HATCHERY
14	SpSo FlYr FALL CHIN	631853	78	2	800216	800216	3665	37	70316	5.7	74018	MINTER CR	15.0048	FOX ISLAND HATCHERY
14	SpSo FlYr FALL CHIN	631905	78	2	800228	800228	20400	0	308350	8	328750	BIG SOOS CR	09.0072	SOOS CREEK HATCHERY
14	SpSo FlYr FALL CHIN	632004	78	2	800131	800312	48196	231	961504	9.8	1009931	HOOD CANAL + GREEN R		CAPITOL LAKE REARING
14	SpSo FlYr FALL CHIN	632015	79	2	810306	810306	16080	278	294406	8	310764	S PUGET SOUND STOCKS		CAPITOL LAKE REARING
14	SpSo FlYr FALL CHIN	632019	79	2	810306	810306	30929	703	801336	8	832968	S PUGET SOUND STOCKS		CAPITOL LAKE REARING
14	SpSo FlYr FALL CHIN	632023	78	2	800310	800310	13495	0	28385	6.2	41880	BIG SOOS CR	09.0072	ALLISON SPRINGS HAT.
14	SpSo FlYr FALL CHIN	632027	79	2	800919	810214	10243	163	189887	5.4	200293	VOIGHT CR	10.0414	GARRISON HATCHERY
14	SpSo FlYr FALL CHIN	632055	79	2	810301	810301	9696	59	191526	7	201281	DESCHUTES R	13.0028	COULTER CR HATCHERY
14	SpSo FlYr FALL CHIN	632056	79	2	810301	810301	8681	21	164635	7	173337	DESCHUTES R X MINTER		COULTER CR HATCHERY
11	SpSo FlYr FALL CHIN	632128	79	2	810204	810204	10433	31	218532	9	228996	BIG SOOS CR	09.0072	CRISP CR HATCHERY
14	SpSo FlYr FALL CHIN	632220	79	2	810303	810531	4659	14	0	4.5	4673	DESCHUTES R	13.0028	HUPP SPRINGS REARING
14	SpSo FlYr FALL CHIN	632221	79	2	810217	810217	3060	0	59815	8.2	62875	BIG SOOS CR	09.0072	ALLISON SPRINGS HAT.
14	SpSo FlYr FALL CHIN	632228	79	2	810217	810217	10169	51	0	8.2	10220	BIG SOOS CR	09.0072	ALLISON SPRINGS HAT.
15	Whte SprF SPRG CHIN	211659	91	1	920527	920530	38231	1305	0	89.1	39536	WHITE R	10.0031	WHITE RIVER HATCHERY
15	Whte SprF SPRG CHIN	212209	91	1	920528	920604	221091	9835	6432	100.1	237358	WHITE R	10.0031	WHITE RIVER HATCHERY
15	Whte SprF SPRG CHIN	212245	91	1	920527	920530	141164	4817	29	89.1	146010	WHITE R	10.0031	WHITE RIVER HATCHERY
15	Whte SprF SPRG CHIN	212246	91	1	920527	920527	138995	11759	134918	77.9	285672	WHITE R	10.0031	WHITE RIVER HATCHERY
15	Whte SprF SPRG CHIN	212321	92	1	930610	930610	167830	4127	45850			WHITE R	10.0031	WHITE RIVER HATCHERY
15	Whte SprF SPRG CHIN	212322	92	1	930610	930610	214640	34362				WHITE R	10.0031	WHITE RIVER HATCHERY
15	Whte SprF SPRG CHIN	212462	93	1	940601	940421	218349	20888	3643	120.9		WHITE R	10.0031	WHITE RIVER HATCHERY
15	Whte SprF SPRG CHIN	212503	93	1	940512	940523	159348	3144	2978			WHITE R	10.0032	WHITE RIVER HATCHERY
15	Whte SprF SPRG CHIN	212463	93	1	940321	940325	75866	10248	28785			WHITE R	10.0033	WHITE RIVER HATCHERY
16	HdCl FlFi FALL CHIN	631752	78	1	790530	790530	37439	360	147624	120	185423	GEORGE ADAMS (PURDY)		GEORGE ADAMS HATCHRY
16	HdCl FlFi FALL CHIN	631915	78	1	790518	790518	34300	487	752200	100	786987	FINCH CR	16.0222	HOODSPORT HATCHERY
16	HdCl FlFi FALL CHIN	632041	79	1	800430	800430	73387	1193	1512620	150	1587200	S PUGET SOUND STOCKS		GEORGE ADAMS HATCHRY
16	HdCl FlFi FALL CHIN	632109	79	1	800425	800425	48954	847	669899	150	719700	FINCH CR	16.0222	HOODSPORT HATCHERY
17	HdCl FlYr FALL CHIN	631637	78	2	800223	800223	6792	60	137207	12	144059	FINCH CR	16.0222	HOODSPORT HATCHERY
17	HdCl FlYr FALL CHIN	631840	78	2	800311	800311	1098	6	19065	15	20169	FINCH CR	16.0222	MCKERNAN HATCHERY
17	HdCl FlYr FALL CHIN	631852	78	2	800311	800311	15935	77	276688	15	292700	FINCH CR	16.0222	MCKERNAN HATCHERY
17	HdCl FlYr FALL CHIN	632057	79	2	810206	810207	6245	25	130828	11	137098	FINCH CR	16.0222	HOODSPORT HATCHERY
18	SJDF FlFi FALL CHIN	631919	78	2	790815	800428	42386	780	815057	14.7	858223	ELWHA R	18.0272	ELWHA HATCHERY
18	SJDF FlFi FALL CHIN	632107	79	2	800815	810404	39629	170	762425	11	802224	ELWHA R	18.0272	ELWHA HATCHERY
18	SJDF FlFi FALL CHIN	633038	83	1	840615	840615	25316	2026	801553		802224	ELWHA R	18.0273	ELWHA HATCHERY
18	SJDF FlFi FALL CHIN	633039	83	1	840615	840615	24964	230	611062		802224	ELWHA R	18.0274	ELWHA HATCHERY
18	SJDF FlFi FALL CHIN	633419	84	1	850621	850621	26510	227	602571		802224	ELWHA R	18.0275	ELWHA HATCHERY
18	SJDF FlFi FALL CHIN	633420	84	1	850621	850621	26317	173	645988		802224	ELWHA R	18.0276	ELWHA HATCHERY
18	SJDF FlFi FALL CHIN	633543	85	1	860610	860610	25992	172	640840		802224	ELWHA R	18.0277	ELWHA HATCHERY
18	SJDF FlFi FALL CHIN	633544	85	1	860610	860610	26097	68	475337		802224	ELWHA R	18.0278	ELWHA HATCHERY
19	Oreg Tule FALL CHIN	071842	78	1	790501	790529	287916	68	475338			TANNER CR		BONNEVILLE HATCHERY
19	Oreg Tule FALL CHIN	072157	79	1	800520	800528	121071	4433	4947400			TANNER CR		BONNEVILLE HATCHERY
19	Oreg Tule FALL CHIN	072163	79	1		800529	51851	901	1170077			TANNER CR		OXBOW
20	Wash Tule FALL CHIN	631802	77	1	780619	780619	146001	7523	503262	133	656786	COWLITZ R	26.0002	COWLITZ SALMON HATCH

20	Wash Tule	FALL CHIN	631942	78	1	790627	791016	143568	2326	4157781	54.5	4303675	COWLITZ R	26.0002	COWLITZ SALMON HATCH
20	Wash Tule	FALL CHIN	632154	79	1	800603	800711	244267	9915	5671774	128.4	5925956	COWLITZ R	26.0002	COWLITZ SALMON HATCH
21	Low CR Wi	FALL CHIN	631611	77	1	780714	780714	48567	293	0	140	48860	LEWIS R	27.0168	LEWIS RIVER HATCHERY
21	Low CR Wi	FALL CHIN	631618	77	1	7805	7806	19806	439	0	199.8	20245	LEWIS R	27.0168	WILDSTOCK
21	Low CR Wi	FALL CHIN	631619	77	1	780613	780706	15887	407	0	150.2	16294	LEWIS R	27.0168	WILDSTOCK
21	Low CR Wi	FALL CHIN	631813	78	1	790713	790713	60912	368	0	141	61280	LEWIS R	27.0168	LEWIS RIVER HATCHERY
21	Low CR Wi	FALL CHIN	631858	78	1	7906	7906	26242	0	0	199.8	26242	LEWIS R	27.0168	WILDSTOCK
21	Low CR Wi	FALL CHIN	631859	78	1	790605	790605	23402	165	0	199.8	23567	GRAYS R	25.0093	WILDSTOCK
21	Low CR Wi	FALL CHIN	631902	78	1	7906	7906	21187	0	0	199.8	21187	LEWIS R	27.0168	WILDSTOCK
21	Low CR Wi	FALL CHIN	631920	78	1	790905	790905	51660	420	0	28	52080	LEWIS R	27.0168	SPEELYAI HATCHERY
21	Low CR Wi	FALL CHIN	632002	78	1	7907	7907	18238	55	0	199.8	18293	LEWIS R	27.0168	WILDSTOCK
22	BPH Tule	FALL CHIN	050433	78	1	790518	790518	140948	12590	3569570	52	3723108	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	050434	78	1	790420	790420	95581	11035	0	86.9	106616	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	050444	78	1	790420	790420	135537	19362	4357431	77.9	4512330	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	050446	78	1	790320	790321	245981	13219	9860784	125	1E+07	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	050639	79	1	800310	800310	130208	4863	7205064	122.9	7340135	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	050640	79	1	800408	800421	77720	2735	3833522	82.9	3913977	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	050641	79	1	800509	800509	61771	1325	3127581	51	3190677	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	050642	79	1	800807	800807	23563	456	1088462	19	1112481	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	054101	76	1	770418	770418	87707	0	1376816	77.1	1464523	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	054201	76	1	770418	770418	91438	0	1343481	81.6	1434919	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	054401	76	1	770408	770408	96767	0	0	85.9	96767	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	054501	76	1	770408	770408	95813	0	941640	79.9	1037453	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	054601	76	1	770524	770524	141161	0	3915686	42	4056847	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	055501	77	1	780512	780512	144278	11362	2983318	61	3138958	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	055601	77	1	780321	780321	149725	7549	9785283	103.8	9942557	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	055701	77	1	780518	780518	155177	5296	3758701	55.9	3919174	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	056001	77	1	780418	780418	98122	3643	0	64	101765	SPRING CR	29.0159	SPRING CR NFH
22	BPH Tule	FALL CHIN	056201	77	1	780418	780418	92314	7593	2031781	67.9	2131688	SPRING CR	29.0159	SPRING CR NFH
23	Upp CR Su	SUMR CHIN	631607	76	1	770528	770528	149308	2582	117582	32	269472	WELLS DAM	(47)	WELLS DAM SP CHANNEL
23	Upp CR Su	SUMR CHIN	631642	76	1	770614	770614	145946	6082	102628	160	254656	WELLS DAM	(47)	WELLS DAM SP CHANNEL
23	Upp CR Su	SUMR CHIN	631762	77	1	780613	780613	153604	1787	187921	43	343312	WELLS DAM	(47)	WELLS DAM SP CHANNEL
24	Upp CR Br	FALL CHIN	130713	75	1	760617	760617	102710	0	794778	46	897488	PRIEST RAPIDS	(36)	RINGOLD SPRINGS HATC
24	Upp CR Br	FALL CHIN	131101	75	1	760701	760701	132004	0	759480	95	891484	PRIEST RAPIDS	(36)	PRIEST RAPIDS HATCH.
24	Upp CR Br	FALL CHIN	131202	75	1	760701	760701	152412	0	296839	37	449251	PRIEST RAPIDS	(36)	PRIEST RAPIDS HATCH.
24	Upp CR Br	FALL CHIN	631662	76	1	770627	770627	147338	3287	611808	96	762433	PRIEST RAPIDS	(36)	PRIEST RAPIDS HATCH.
24	Upp CR Br	FALL CHIN	631741	77	1	780627	780627	152532	1308	385483	90	539323	PRIEST RAPIDS	(36)	PRIEST RAPIDS HATCH.
24	Upp CR Br	FALL CHIN	631745	77	1	780623	780623	146296	4836	346274	35	497406	PRIEST RAPIDS	(36)	RINGOLD SPRINGS HATC
25	Cowl Spr	SPRG CHIN	631817	77	2	790423	790423	24079	243	45667	5.3	69989	COWLITZ R	26.0002	COWLITZ SALMON HATCH
25	Cowl Spr	SPRG CHIN	631818	77	2	790423	790423	24341	246	40804	6.8	65391	COWLITZ R	26.0002	COWLITZ SALMON HATCH
26	Will Spr	SPRG CHIN	071737	77	1		781107	22989	1390	303489		327868	WILLAMETTE R		DEXTER PONDS
26	Will Spr	SPRG CHIN	071738	77	1	781106	781108	23974	1051	132996		158021	WILLAMETTE R		WILLAMETTE HATCHERY
26	Will Spr	SPRG CHIN	071741	77	2	790319	790320	30927	1023	397745		429695	WILLAMETTE R		DEXTER PONDS
26	Will Spr	SPRG CHIN	071742	77	2	790319	790320	29463	1920	229835		261218	WILLAMETTE R		DEXTER PONDS
26	Will Spr	SPRG CHIN	071925	78	1	791105	791108	14919	790	262923		278632	WILLAMETTE R		WILLAMETTE HATCHERY
26	Will Spr	SPRG CHIN	072042	78	2		800310	30726	1016	594105		625847	WILLAMETTE R		WILLAMETTE HATCHERY
26	Will Spr	SPRG CHIN	072047	78	1		791105	31309	574	0		31883	WILLAMETTE R		WILLAMETTE HATCHERY
26	Will Spr	SPRG CHIN	072049	78	1		791109	31558	2106	306		33970	MCKENZIE R		MCKENZIE
26	Will Spr	SPRG CHIN	072050	78	2		800315	34897	1959	71304		108160	MCKENZIE R		MCKENZIE
26	Will Spr	SPRG CHIN	091621	76	2	780309	780310	25007	5097	1752		31856	S SANTIAM R		SOUTH SANTIAM HATCH
26	Will Spr	SPRG CHIN	091622	76	2	780309	780310	29533	2217	382		32132	S SANTIAM R		SOUTH SANTIAM HATCH
26	Will Spr	SPRG CHIN	091623	76	2	780309	780310	26912	3506	1169		31587	S SANTIAM R		SOUTH SANTIAM HATCH
26	Will Spr	SPRG CHIN	091624	76	2	780309	780310	24609	6066	754		31429	S SANTIAM R		SOUTH SANTIAM HATCH
26	Will Spr	SPRG CHIN	091625	76	2	780309	780310	13412	1233	578		15223	S SANTIAM R		SOUTH SANTIAM HATCH
26	Will Spr	SPRG CHIN	091626	76	2	780309	780310	14917	1355	452		16724	S SANTIAM R		SOUTH SANTIAM HATCH
26	Will Spr	SPRG CHIN	091627	76	1	771107	771108	28734	4928	800		34462	S SANTIAM R		SOUTH SANTIAM HATCH
26	Will Spr	SPRG CHIN	091628	76	1	771107	771108	27558	2694	672		30924	S SANTIAM R		SOUTH SANTIAM HATCH
26	Will Spr	SPRG CHIN	091629	76	1	771107	771108	28703	2370	745		31818	S SANTIAM R		SOUTH SANTIAM HATCH
26	Will Spr	SPRG CHIN	091630	76	1	771107	771108	25946	4253	158		30357	S SANTIAM R		SOUTH SANTIAM HATCH
26	Will Spr	SPRG CHIN	091631	76	1	771107	771108	29047	2976	155		32178	S SANTIAM R		SOUTH SANTIAM HATCH
26	Will Spr	SPRG CHIN	091701	76	2	780313	780315	49142	1273	509		50924	N SANTIAM R		MARION FORKS

26	Will Spr	SPRG CHIN	091703	76	2	780313	780315	50076	770	514		51360	N SANTIAM R	MARION FORKS
27	Snake Fl	FALL CHIN	633226	84	1	850606	850606	78417	236	101400	67	180053	SNAKE R-LOWR 33.0002	LYONS FERRY HATCHERY
27	Snake Fl	FALL CHIN	633227	84	1	850606	850606	78064	235	100900	67	179199	SNAKE R-LOWR 33.0002	LYONS FERRY HATCHERY
27	Snake Fl	FALL CHIN	633228	84	1	850606	850606	78504	236	101400	67	180140	SNAKE R-LOWR 33.0002	LYONS FERRY HATCHERY
27	Snake Fl	FALL CHIN	633633	85	1	860613	860613	49112	366	0	46	49478	SNAKE R-LOWR 33.0002	LYONS FERRY HATCHERY
27	Snake Fl	FALL CHIN	633638	85	1	860610	860610	49325	468	0	58	49793	SNAKE R-LOWR 33.0002	LYONS FERRY HATCHERY
27	Snake Fl	FALL CHIN	633639	85	1	860610	860610	49325	468	0	58	49793	SNAKE R-LOWR 33.0002	LYONS FERRY HATCHERY
27	Snake Fl	FALL CHIN	633640	85	1	860610	860610	49325	468	0	58	49793	SNAKE R-LOWR 33.0002	LYONS FERRY HATCHERY
27	Snake Fl	FALL CHIN	633641	85	1	860610	860610	49325	468	0	58	49793	SNAKE R-LOWR 33.0002	LYONS FERRY HATCHERY
27	Snake Fl	FALL CHIN	633642	85	1	860610	860610	49325	468	0	58	49793	SNAKE R-LOWR 33.0002	LYONS FERRY HATCHERY
27	Snake Fl	FALL CHIN	634259	86	1	870601	870601	126076	2836	0	48	128912	SNAKE R-LOWR 33.0002	LYONS FERRY HATCHERY
27	Snake Fl	FALL CHIN	634261	86	1	870601	870601	125570	2824	0	48	128394	SNAKE R-LOWR 33.0002	LYONS FERRY HATCHERY
28	Ore No Fl	FALL CHIN	071643	77	1		781025	19800	4877	0		24677	SALMON R	SALMON RIVER
28	Ore No Fl	FALL CHIN	071644	77	1		780814	23974	921	0		24895	SALMON R	SALMON RIVER
28	Ore No Fl	FALL CHIN	071849	78	1		791026	20102	1058	5290		26450	SALMON R	SALMON RIVER
28	Ore No Fl	FALL CHIN	071850	78	1		790815	21558	1303	3430		26291	SALMON R	SALMON RIVER
28	Ore No Fl	FALL CHIN	091637	76	1		771005	21820	980	0		22800	SALMON R	SALMON RIVER
28	Ore No Fl	FALL CHIN	091638	76	1		770823	26281	446	652		27379	SALMON R	SALMON RIVER
29	WCVI Totl	FALL CHIN	020408	75	1	760604	760607	50731	1354	435060		487145	S-ROBERTSON CR/STAMP	H-ROBERTSON CREEK
29	WCVI Totl	FALL CHIN	020409	75	1	760611	760615	47724	2102	413159		462985	S-ROBERTSON CR/STAMP	H-ROBERTSON CREEK
29	WCVI Totl	FALL CHIN	020606	74	1		750611	46194	695	956988		1003877	S-STAMP RIVER	H-ROBERTSON CREEK
29	WCVI Totl	FALL CHIN	020906	74	1		750611	27383	673	425710		453766	S-STAMP RIVER	H-ROBERTSON CREEK
29	WCVI Totl	FALL CHIN	021630	76	1	770526	770610	64550	2385	3121137		3188072	S-ROBERTSON CR/STAMP	H-ROBERTSON CREEK
29	WCVI Totl	FALL CHIN	021631	76	1	770608	770617	69203	933	372351		442487	S-ROBERTSON CR/STAMP	H-ROBERTSON CREEK
29	WCVI Totl	FALL CHIN	022217	77	1	780529	780630	70816	4257	4103278		4178351	S-ROBERTSON CREEK	H-ROBERTSON CREEK
29	WCVI Totl	FALL CHIN	022218	77	1	780603	780617	66725	5400	3481062		3553187	S-ROBERTSON CREEK	H-ROBERTSON CREEK
30	Frasr Lt	FALL CHIN	022658	83	1	840531	840601	26088	475	323310		349873	S-HARRISON RIVER	H-CHILLIWACK RIVER
30	Frasr Lt	FALL CHIN	022659	83	1	840531	840601	24015	415	297349		321779	S-HARRISON RIVER	H-CHILLIWACK RIVER
30	Frasr Lt	FALL CHIN	022660	83	1	840531	840601	26829	219	329214		356262	S-HARRISON RIVER	H-CHILLIWACK RIVER
30	Frasr Lt	FALL CHIN	023414	84	1	850616	850617	14266	1069	148713		164048	S-CHILLIWACK R	H-CHILLIWACK R
30	Frasr Lt	FALL CHIN	023415	84	1	850606	850607	14892	228	147001		162121	S-CHILLIWACK R	H-CHILLIWACK R
30	Frasr Lt	FALL CHIN	023416	84	1	850616	850617	14100	1069	146982		162151	S-CHILLIWACK R	H-CHILLIWACK R
30	Frasr Lt	FALL CHIN	023417	84	1	850616	850617	14233	1069	148368		163670	S-CHILLIWACK R	H-CHILLIWACK R
30	Frasr Lt	FALL CHIN	023418	84	1	850606	850607	15100	228	149055		164383	S-CHILLIWACK R	H-CHILLIWACK R
30	Frasr Lt	FALL CHIN	023419	84	1	850606	850607	14883	227	146912		162022	S-CHILLIWACK R	H-CHILLIWACK R
31	Frasr Erly	SUMR CHIN	021601	79	1	800604	800609	45440	1200	0		46640	S-SHUSWAP R LOWER	
31	Frasr Erly	SUMR CHIN	021602	78	1	790705	790716	45932	2316	0		48248	S-CHILKO RIVER	
31	Frasr Erly	SUMR CHIN	021625	78	1	790613	790624	122797	1125	0		123922	S-SHUSWAP R LOWER	
31	Frasr Erly	SUMR CHIN	021638	78	1	790621	790624	18705	118	0		18823	S-SHUSWAP R LOWER	
31	Frasr Erly	SUMR CHIN	021658	78	1	790705	790716	149523	2492	0		152015	S-CHILKO RIVER	
31	Frasr Erly	SUMR CHIN	021755	79	1		800610	12402	283	0		12685	S-SHUSWAP R LOWER	
31	Frasr Erly	SUMR CHIN	024247	86	1	870507	870508	25256	255	153506		179017	S-CLEARWATER R UP/TO	H-CLEARWATER R UP/TO
31	Frasr Erly	SUMR CHIN	024248	86	1	870527	870528	24910	470	153540		178920	S-CLEARWATER R UP/TO	H-CLEARWATER R UP/TO
31	Frasr Erly	SUMR CHIN	024249	86	1	870623	870624	25507	159	146313		171979	S-CLEARWATER R UP/TO	H-CLEARWATER R UP/TO
31	Frasr Erly	SUMR CHIN	024250	86	1	870722	870724	25687	355	147808		173850	S-CLEARWATER R UP/TO	H-CLEARWATER R UP/TO
31	Frasr Erly	SUMR CHIN	024316	86	1	870521	870523	51771	347	499882		552000	S-SHUSWAP R LOW	H-SHUSWAP R
31	Frasr Erly	SUMR CHIN	024521	86	1	870502	870503	25292	255	117360		142907	S-CLEARWATER R LW/BC	H-CLEARWATER R UP/TO
31	Frasr Erly	SUMR CHIN	024522	86	1	870519	870520	24877	466	114593		139936	S-CLEARWATER R LW/BC	H-CLEARWATER R UP/TO
31	Frasr Erly	SUMR CHIN	024523	86	1	870620	870621	26091	0	115935		142026	S-CLEARWATER R LW/BC	H-CLEARWATER R UP/TO
31	Frasr Erly	SUMR CHIN	024524	86	1	870721	870722	25302	288	117250		142840	S-CLEARWATER R LW/BC	H-CLEARWATER R UP/TO
31	Frasr Erly	SUMR CHIN	024525	86	1	870414	870416	24846	486	96808		122140	S-FINN CREEK	H-CLEARWATER R UP/TO
31	Frasr Erly	SUMR CHIN	024526	86	1	870513	870514	25338	122	101470		126930	S-FINN CREEK	H-CLEARWATER R UP/TO
31	Frasr Erly	SUMR CHIN	024527	86	1	870421	870424	25558	330	216492		242380	S-FINN CREEK	H-CLEARWATER R UP/TO
31	Frasr Erly	SUMR CHIN	024528	86	1	870415	870421	25942	262	1912		28116	S-DEADMAN R	H-SPIUS CR
31	Frasr Erly	SUMR CHIN	024529	86	1	870415	870421	26455	267	1949		28671	S-DEADMAN R	H-SPIUS CR
31	Frasr Erly	SUMR CHIN	024530	86	1	870415	870421	26197	265	1931		28393	S-DEADMAN R	H-SPIUS CR
31	Frasr Erly	SUMR CHIN	024531	86	1		870402	25988	262	0		26250	S-BONAPARTE R	H-SPIUS CR
31	Frasr Erly	SUMR CHIN	024532	86	1		870402	26730	270	0		27000	S-BONAPARTE R	H-SPIUS CR
31	Frasr Erly	SUMR CHIN	024533	86	1		870402	25443	257	0		25700	S-BONAPARTE R	H-SPIUS CR
31	Frasr Erly	SUMR CHIN	024534	86	1		870409	26009	0	271591		297600	S-SHUSWAP R. MIDDLE	H-SHUSWAP R
31	Frasr Erly	SUMR CHIN	024535	86	1	870520	870522	26505	272	286523		313300	S-SHUSWAP R. MIDDLE	H-SHUSWAP R

31	Frasr ErlySUMR CHIN	024536	86	1	870505	870506	25743	164	86017		111924	S-THOMPSON R N		H-CLEARWATER R UP/TO
31	Frasr ErlySUMR CHIN	024537	86	1	870505	870506	25182	253	84142		109577	S-THOMPSON R N		H-CLEARWATER R UP/TO
31	Frasr ErlySUMR CHIN	024538	86	1	870505	870506	25434	0	84985		110419	S-THOMPSON R N		H-CLEARWATER R UP/TO
31	Frasr ErlySUMR CHIN	024562	86	1	870908	870915	30322	618	10684		41624	S-NICOLA R		H-SPIUS CR
31	Frasr ErlySUMR CHIN	024563	86	1	870908	870915	20913	426	7368		28707	S-NICOLA R		H-SPIUS CR
31	Frasr ErlySUMR CHIN	024601	86	1	870908	870915	25400	520	8949		34869	S-NICOLA R		H-SPIUS CR
31	Frasr ErlySUMR CHIN	024607	86	1	870403	870506	50787	513	75220		126520	S-COLDWATER RIVER		H-SPIUS CR
31	Frasr ErlySUMR CHIN	024610	86	1	870427	870429	49392	500	512008		561900	S-SHUSWAP R LOW		H-SHUSWAP R
31	Frasr ErlySUMR CHIN	024705	86	1	870918	870923	25565	1261	8793		35619	S-BONAPARTE R		H-SPIUS CR
31	Frasr ErlySUMR CHIN	024706	86	1	870918	870923	25697	795	8839		35331	S-BONAPARTE R		H-SPIUS CR
31	Frasr ErlySUMR CHIN	021717	84	1	850415	850507	102737	0	62171		164908	S-STUART R		H-FORT ST JAMES
32	Lwr Geo S FALL CHIN	021612	78	1		790604	72216	3205	559143		634564	S-BIG QUALICUM RIVER		H-BIG QUALICUM RIVER
32	Lwr Geo S FALL CHIN	021613	78	1		790604	73545	1654	696416		771615	S-BIG QUALICUM RIVER		H-BIG QUALICUM RIVER
32	Lwr Geo S FALL CHIN	021639	77	1		780604	56225	4213	113236		173674	S-CAPILANO RIVER		H-CAPILANO RIVER
32	Lwr Geo S FALL CHIN	021642	77	1		780620	72735	3205	401869		477809	S-CAPILANO RIVER		H-CAPILANO RIVER
32	Lwr Geo S FALL CHIN	021656	78	1		790604	74952	834	1072125		1147911	S-BIG QUALICUM RIVER		H-BIG QUALICUM RIVER
32	Lwr Geo S FALL CHIN	021726	77	1		780602	77775	1663	1595825		1675263	S-BIG QUALICUM RIVER		H-BIG QUALICUM RIVER
32	Lwr Geo S FALL CHIN	021727	77	1		780602	79317	399	1051346		1131062	S-BIG QUALICUM RIVER		H-BIG QUALICUM RIVER
32	Lwr Geo S FALL CHIN	021728	78	1		790607	82938	559	107266		190763	S-BIG QUALICUM RIVER		H-CAPILANO RIVER
32	Lwr Geo S FALL CHIN	021729	78	1		790511	84394	535	56360		141289	S-CAPILANO RIVER		H-CAPILANO RIVER
32	Lwr Geo S FALL CHIN	021730	78	1		790511	82723	524	55244		138491	S-CAPILANO RIVER		H-CAPILANO RIVER
33	Whte SprY SPRG CHIN	212263	91	2	930412	930412	55203	558		9.06	55761	WHITE R	10.0031	WHITE RIVER HATCHERY
33	Whte SprY SPRG CHIN	212048	92	2	940413	940419	71834	1392		13.09	73226	WHITE R	10.0031	WHITE RIVER HATCHERY
33	Whte SprY SPRG CHIN	212509	93	2	940601	950421	48971	2765	830		52566	WHITE R	10.0031	WHITE RIVER HATCHERY

4.2 Sample FRAMBUILDER output

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                     **********************************
                     *    FRAMBUILDER - Coded Wire     *
                     *    Tag Summarization Program    *
                     *     Version 0.2 for Windows     *
                     *                                 *
                     *     Washington Department of    *
                     *         Fish & Wildlife         *
                     *      600 Capitol Way North      *
                     *  Olympia, Washington 98501-1091 *
                     **********************************

                                July 22, 2005


Session began at 16:42

 *********************************************************
 * Selected option to summarize CWT recovery data        *
 *********************************************************

 * Summary format: Generate Input for FRAM Chinook Index Model
 * Description name: Hood Canal Fingerling Base05
 * Description code:    16
 * Selected option to apply age-specific PEF's from release database
 * Selected option to split catches between Treaty & Non-Treaty fisheries based on year-specific proportions
 * Selected option to backshift annual age of winter recoveries
 * Selected option to summarize data by calendar month
 * Selected option to delete actual WCVI sport recoveries
 * Selected option to delete actual Alaska sport recoveries
 * Selected option to generate WCVI sport catch from troll catch (recoveries)
 * Selected option to generate Alaska sport catch from troll catch (recoveries)
 * Summary Tables Located in File: C:\Data\05calib\FRAM05test.mdb
   [File Date Unknown or Unavailable]
 * CWT Recovery Table: tblFRAMcwtrecoveries2005
   [File Date Unknown or Unavailable]
 * CWT Release Table: tblFRAMcwtreleases2005
   [File Date Unknown or Unavailable]
 * Recovery Location Code Table: tblRMISlocations2005
   [File Date Unknown or Unavailable]

Translation Tables:
 * Areas Table: AREAS
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[File Date Unknown or Unavailable]
* Gears Table: GEARS
  [File Date Unknown or Unavailable]
* Fisheries Table: FISHERIES
  [File Date Unknown or Unavailable]
* Link Table: LINKS
  [File Date Unknown or Unavailable]

* The following tags were specified:

Agcy	Tag	By	Race & Species	Stock	Hatchery	Tagged	Shed Tag	Untagged	Release Weight(gm)
COOP	631752	1978	Fall Chin	GEORGE ADAMS (PURDY)	PURDY CR 16.0005	37439	0	147624	4.00
WDFW	631915	1978	Fall Chin	FINCH CR 16.0222	FINCH CR 16.0222	34300	0	752200	5.00
COOP	632041	1979	Fall Chin	S PUGET SOUND STOCKS	PURDY CR 16.0005	73387	0	1512620	3.00
WDFW	632109	1979	Fall Chin	FINCH CR 16.0222	FINCH CR 16.0222	48954	0	669899	3.00

* The following weights by age were specified for each tag:

Tag	Age 2	Age 3	Age 4	Age 5
631752	1.0000	1.0000	1.0000	1.0000
631915	1.0000	1.0000	1.0000	1.0000
632041	3.2879	3.2879	3.2879	3.2879
632109	3.2879	3.2879	3.2879	3.2879

NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 8 Area = 6 User = 2 Gear = 95 Time = 2 Catch = 0.383000
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 9 Area = 6 User = 2 Gear = 95 Time = 3 Catch = 1.399000
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 9 Area = 6 User = 2 Gear = 95 Time = 3 Catch = 1.399000
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 9 Area = 6 User = 2 Gear = 95 Time = 3 Catch = 1.399000
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 8 Area = 6 User = 2 Gear = 95 Time = 2 Catch = 0.383000
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 6 Area = 6 User = 2 Gear = 95 Time = 3 Catch = 1.475000
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 5 Area = 6 User = 2 Gear = 95 Time = 2 Catch = 0.447000
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 5 Area = 6 User = 2 Gear = 95 Time = 2 Catch = 0.407000
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 4 Area = 6 User = 2 Gear = 95 Time = 1 Catch = 0.740000
WARNING: Invalid catch (recovery estimate): 0.00; tag: 631915; recovery date 19810817; recovery location 5M22203 O3 10; fishery/gear 10; sample type: 5
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 9 Area = 6 User = 2 Gear = 95 Time = 3 Catch = 0.464000
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 6 Area = 6 User = 2 Gear = 95 Time = 3 Catch = 0.482000
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 8 Area = 6 User = 2 Gear = 95 Time = 2 Catch = 0.383000
NOTE: Deleted Actual WCVI Sport Catch: Age/Index = 6 Area = 6 User = 2 Gear = 95 Time = 3 Catch = 4.500000
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 9 Area = 5 User = 2 Gear = 95 Time = 3 Catch = 1.071000
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 8 Area = 6 User = 2 Gear = 95 Time = 2 Catch = 0.416000
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 8 Area = 6 User = 2 Gear = 95 Time = 2 Catch = 0.355000
NOTE: Duplicated WCVI Troll as WCVI Sport: Age/Index = 8 Area = 6 User = 2 Gear = 95 Time = 2 Catch = 0.355000

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 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index = 12 Area =    6 User =  2 Gear =  95 Time =   3 Catch = 0.913000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  6 Area =    5 User =  2 Gear =  95 Time =   3 Catch = 0.574000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  8 Area =    5 User =  2 Gear =  95 Time =   2 Catch = 0.406000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  8 Area =    5 User =  2 Gear =  95 Time =   2 Catch = 0.212000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  8 Area =    5 User =  2 Gear =  95 Time =   2 Catch = 0.439000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  8 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 0.395000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  8 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 0.355000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  8 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 0.426000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  4 Area =    6 User =  2 Gear =  95 Time =   1 Catch = 0.777000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  9 Area =    6 User =  2 Gear =  95 Time =   3 Catch = 1.030000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  9 Area =    6 User =  2 Gear =  95 Time =   3 Catch = 1.030000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  8 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 0.416000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  7 Area =    6 User =  2 Gear =  95 Time =   1 Catch = 0.382000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  7 Area =    6 User =  2 Gear =  95 Time =   1 Catch = 0.382000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  8 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 0.355000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  6 Area =    6 User =  2 Gear =  95 Time =   3 Catch = 0.613000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  5 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 0.493000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  5 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 0.447000
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  7 Area =    6 User =  2 Gear =  95 Time =   1 Catch = 1.696556
 WARNING: Invalid catch (recovery estimate):   0.00; tag: 632041; recovery date 19820821; recovery location 2MS45           000;
fishery/gear 23; sample type: 5
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index = 11 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 1.903694
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  6 Area =    6 User =  2 Gear =  95 Time =   3 Catch = 2.278515
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  8 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 2.140423
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  8 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 1.657102
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  8 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 2.656623
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  7 Area =    6 User =  2 Gear =  95 Time =   1 Catch = 1.318448
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  6 Area =    6 User =  2 Gear =  95 Time =   3 Catch = 4.619500
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  5 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 1.400645
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index = 12 Area =    6 User =  2 Gear =  95 Time =   3 Catch = 1.472979
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  9 Area =    6 User =  2 Gear =  95 Time =   3 Catch = 2.906504
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  8 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 2.656623
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  8 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 2.656623
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  8 Area =    6 User =  2 Gear =  95 Time =   2 Catch = 2.130559
 NOTE:  Duplicated WCVI Troll as WCVI Sport: Age/Index =  6 Area =    6 User =  2 Gear =  95 Time =   3 Catch = 2.955822

 Records extracted from database tblFRAMcwtrecoveries2005: 735
 Records used in constructing summary: 732
 Fabricated records used in summary:   49
NOTE: Numeric items on summary line:
 WDFW species code, stock (or summary code), age index,  fishery code, time period, catch/escapement

*CATCH  Hood Canal FIngerling Base05  CHINOOK
1    16   2   5   2      5.54  May-Jun  West Coast Vancouver Island Net
1    16   2  56   2      3.72  May-Jun  Seattle (10) Sport
1    16   3   4   3      2.55  Jul-Sep  North/Central British Columbia Net
1    16   3   6   3      1.90  Jul-Sep  Georgia/Fraser/Johnstone Net
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1	16	3	7	3	33.59	Jul-Sep	Canadian Juan de Fuca Net
1	16	3	15	3	12.45	Jul-Sep	Canadian Juan de Fuca Sport
1	16	3	33	3	2.84	Jul-Sep	Horse Mountain - Orford Reef Sport
1	16	3	40	3	1.18	Jul-Sep	Nooksack-Samish (7B, 7C, 7D) Net [T]
1	16	3	39	3	0.57	Jul-Sep	Nooksack-Samish (7B, 7C, 7D) Net [NT]
1	16	3	42	3	3.29	Jul-Sep	Strait of Juan de Fuca (5 & 6) Sport
1	16	3	45	3	6.05	Jul-Sep	Skagit (8-1) Sport
1	16	3	53	3	24.80	Jul-Sep	Discovery-Admiralty (9) Sport
1	16	3	56	3	22.92	Jul-Sep	Seattle (10) Sport
1	16	3	64	3	9.49	Jul-Sep	Hood Canal (12) Sport
1	16	3	66	3	40.48	Jul-Sep	Hood Canal (12, 12B, 12C, 12D) Net [T]
1	16	3	67	3	6.92	Jul-Sep	South Sound (13) Sport
1	16	3	71	3	10.32	Jul-Sep	Carr Inlet (13A) Net [T]
1	16	3	74	3	62.89	Jul-Sep	Escapement
1	16	4	10	1	15.17	Oct-Apr	West Coast Vancouver Island Troll
1	16	4	11	1	1.52	Oct-Apr	West Coast Vancouver Island Sport
1	16	4	13	1	9.22	Oct-Apr	North Georgia St. Sport
1	16	4	14	1	29.93	Oct-Apr	South Georgia St. Sport
1	16	4	15	1	25.44	Oct-Apr	Canadian Juan de Fuca Sport
1	16	4	17	1	11.64	Oct-Apr	Cape Flattery-Quillayute (3, 4, 4B) Troll [T]
1	16	4	36	1	43.43	Oct-Apr	San Juans (7) Sport
1	16	4	42	1	12.05	Oct-Apr	Strait of Juan de Fuca (5 & 6) Sport
1	16	4	45	1	20.17	Oct-Apr	Skagit (8-1) Sport
1	16	4	47	1	0.21	Oct-Apr	Skagit (8) Net [T]
1	16	4	46	1	1.65	Oct-Apr	Skagit (8) Net [NT]
1	16	4	53	1	42.42	Oct-Apr	Discovery-Admiralty (9) Sport
1	16	4	55	1	42.18	Oct-Apr	Discovery-Admiralty (6B, 9) Net [T]
1	16	4	54	1	2.66	Oct-Apr	Discovery-Admiralty (6B, 9) Net [NT]
1	16	4	56	1	68.04	Oct-Apr	Seattle (10) Sport
1	16	4	57	1	50.71	Oct-Apr	Tacoma (11) Sport
1	16	4	59	1	1.34	Oct-Apr	Central Sound (10, 11) Net [T]
1	16	4	58	1	10.14	Oct-Apr	Central Sound (10, 11) Net [NT]
1	16	4	64	1	120.41	Oct-Apr	Hood Canal (12) Sport
1	16	4	66	1	2.22	Oct-Apr	Hood Canal (12, 12B, 12C, 12D) Net [T]
1	16	4	65	1	1.53	Oct-Apr	Hood Canal (12, 12B, 12C, 12D) Net [NT]
1	16	4	67	1	37.60	Oct-Apr	South Sound (13) Sport
1	16	5	5	2	30.37	May-Jun	West Coast Vancouver Island Net
1	16	5	10	2	31.95	May-Jun	West Coast Vancouver Island Troll
1	16	5	11	2	3.19	May-Jun	West Coast Vancouver Island Sport
1	16	5	12	2	15.07	May-Jun	Georgia/Juan de Fuca/Johnstone Troll
1	16	5	15	2	6.00	May-Jun	Canadian Juan de Fuca Sport
1	16	5	17	2	0.51	May-Jun	Cape Flattery-Quillayute (3, 4, 4B) Troll [T]
1	16	5	16	2	1.96	May-Jun	Cape Flattery-Quillayute (3, 4, 4B) Troll [NT]
1	16	5	22	2	3.08	May-Jun	Grays Harbor Sport
1	16	5	42	2	4.87	May-Jun	Strait of Juan de Fuca (5 & 6) Sport
1	16	5	44	2	4.29	May-Jun	Str. Juan de Fuca (4B, 5, 6, 6C, 6D) Net [T]
1	16	5	45	2	7.95	May-Jun	Skagit (8-1) Sport

1	16	5	53	2	3.04	May-Jun	Discovery-Admiralty (9) Sport
1	16	5	57	2	2.72	May-Jun	Tacoma (11) Sport
1	16	5	64	2	9.99	May-Jun	Hood Canal (12) Sport
1	16	5	67	2	3.34	May-Jun	South Sound (13) Sport
1	16	6	4	3	11.47	Jul-Sep	North/Central British Columbia Net
1	16	6	5	3	8.97	Jul-Sep	West Coast Vancouver Island Net
1	16	6	9	3	15.39	Jul-Sep	North/Central British Columbia Troll
1	16	6	10	3	129.98	Jul-Sep	West Coast Vancouver Island Troll
1	16	6	11	3	13.00	Jul-Sep	West Coast Vancouver Island Sport
1	16	6	14	3	10.54	Jul-Sep	South Georgia St. Sport
1	16	6	17	3	2.48	Jul-Sep	Cape Flattery-Quillayute (3, 4, 4B) Troll [T]
1	16	6	16	3	11.14	Jul-Sep	Cape Flattery-Quillayute (3, 4, 4B) Troll [NT]
1	16	6	22	3	15.45	Jul-Sep	Grays Harbor Sport
1	16	6	30	3	3.40	Jul-Sep	Orford Reef - Cape Falcon Troll
1	16	6	36	3	13.30	Jul-Sep	San Juans (7) Sport
1	16	6	38	3	6.36	Jul-Sep	San Juans (7, 7A, 6A) Net [T]
1	16	6	37	3	20.84	Jul-Sep	San Juans (7, 7A, 6A) Net [NT]
1	16	6	42	3	27.16	Jul-Sep	Strait of Juan de Fuca (5 & 6) Sport
1	16	6	44	3	21.25	Jul-Sep	Str. Juan de Fuca (4B, 5, 6, 6C, 6D) Net [T]
1	16	6	43	3	6.07	Jul-Sep	Str. Juan de Fuca (4B, 5, 6, 6C, 6D) Net [NT]
1	16	6	53	3	47.64	Jul-Sep	Discovery-Admiralty (9) Sport
1	16	6	64	3	9.23	Jul-Sep	Hood Canal (12) Sport
1	16	6	66	3	148.32	Jul-Sep	Hood Canal (12, 12B, 12C, 12D) Net [T]
1	16	6	69	3	7.65	Jul-Sep	South Sound (13, 13B-13K) Net [T]
1	16	6	71	3	3.82	Jul-Sep	Carr Inlet (13A) Net [T]
1	16	6	73	3	73.48	Jul-Sep	Freshwater net
1	16	6	74	3	90.20	Jul-Sep	Escapement
1	16	7	9	1	3.52	Oct-Apr	North/Central British Columbia Troll
1	16	7	10	1	37.79	Oct-Apr	West Coast Vancouver Island Troll
1	16	7	11	1	3.78	Oct-Apr	West Coast Vancouver Island Sport
1	16	7	15	1	11.19	Oct-Apr	Canadian Juan de Fuca Sport
1	16	7	17	1	9.84	Oct-Apr	Cape Flattery-Quillayute (3, 4, 4B) Troll [T]
1	16	7	36	1	13.21	Oct-Apr	San Juans (7) Sport
1	16	7	42	1	37.36	Oct-Apr	Strait of Juan de Fuca (5 & 6) Sport
1	16	7	53	1	13.04	Oct-Apr	Discovery-Admiralty (9) Sport
1	16	7	57	1	16.47	Oct-Apr	Tacoma (11) Sport
1	16	7	64	1	34.30	Oct-Apr	Hood Canal (12) Sport
1	16	7	66	1	11.72	Oct-Apr	Hood Canal (12, 12B, 12C, 12D) Net [T]
1	16	7	65	1	14.95	Oct-Apr	Hood Canal (12, 12B, 12C, 12D) Net [NT]
1	16	7	67	1	16.04	Oct-Apr	South Sound (13) Sport
1	16	7	74	1	43.01	Oct-Apr	Escapement
1	16	8	9	2	16.70	May-Jun	North/Central British Columbia Troll
1	16	8	10	2	191.77	May-Jun	West Coast Vancouver Island Troll
1	16	8	11	2	19.18	May-Jun	West Coast Vancouver Island Sport
1	16	8	17	2	1.39	May-Jun	Cape Flattery-Quillayute (3, 4, 4B) Troll [T]
1	16	8	16	2	1.88	May-Jun	Cape Flattery-Quillayute (3, 4, 4B) Troll [NT]
1	16	8	18	2	5.00	May-Jun	Cape Flattery-Quillayute (3, 4) Sport

1	16	8	26	2	1.22	May-Jun	Columbia River Mouth Troll [NT]
1	16	8	42	2	25.35	May-Jun	Strait of Juan de Fuca (5 & 6) Sport
1	16	8	53	2	10.88	May-Jun	Discovery-Admiralty (9) Sport
1	16	9	10	3	106.99	Jul-Sep	West Coast Vancouver Island Troll
1	16	9	11	3	10.70	Jul-Sep	West Coast Vancouver Island Sport
1	16	9	15	3	27.20	Jul-Sep	Canadian Juan de Fuca Sport
1	16	9	17	3	3.57	Jul-Sep	Cape Flattery-Quillayute (3, 4, 4B) Troll [T]
1	16	9	16	3	6.85	Jul-Sep	Cape Flattery-Quillayute (3, 4, 4B) Troll [NT]
1	16	9	42	3	3.81	Jul-Sep	Strait of Juan de Fuca (5 & 6) Sport
1	16	9	44	3	67.90	Jul-Sep	Str. Juan de Fuca (4B, 5, 6, 6C, 6D) Net [T]
1	16	9	43	3	17.55	Jul-Sep	Str. Juan de Fuca (4B, 5, 6, 6C, 6D) Net [NT]
1	16	9	50	3	6.16	Jul-Sep	Stilly-Snohomish (8) Net [T]
1	16	9	49	3	1.11	Jul-Sep	Stilly-Snohomish (8) Net [NT]
1	16	9	53	3	17.20	Jul-Sep	Discovery-Admiralty (9) Sport
1	16	9	66	3	153.14	Jul-Sep	Hood Canal (12, 12B, 12C, 12D) Net [T]
1	16	9	65	3	5.00	Jul-Sep	Hood Canal (12, 12B, 12C, 12D) Net [NT]
1	16	9	69	3	4.23	Jul-Sep	South Sound (13, 13B-13K) Net [T]
1	16	9	71	3	22.97	Jul-Sep	Carr Inlet (13A) Net [T]
1	16	9	73	3	105.34	Jul-Sep	Freshwater net
1	16	9	74	3	87.42	Jul-Sep	Escapement
1	16	10	66	1	1.19	Oct-Apr	Hood Canal (12, 12B, 12C, 12D) Net [T]
1	16	10	65	1	6.05	Oct-Apr	Hood Canal (12, 12B, 12C, 12D) Net [NT]
1	16	10	74	1	83.46	Oct-Apr	Escapement
1	16	11	10	2	19.04	May-Jun	West Coast Vancouver Island Troll
1	16	11	11	2	1.90	May-Jun	West Coast Vancouver Island Sport
1	16	12	10	3	23.86	Jul-Sep	West Coast Vancouver Island Troll
1	16	12	11	3	2.39	Jul-Sep	West Coast Vancouver Island Sport
1	16	12	42	3	7.91	Jul-Sep	Strait of Juan de Fuca (5 & 6) Sport
1	16	12	66	3	6.78	Jul-Sep	Hood Canal (12, 12B, 12C, 12D) Net [T]
1	16	12	65	3	1.39	Jul-Sep	Hood Canal (12, 12B, 12C, 12D) Net [NT]
1	16	12	73	3	60.86	Jul-Sep	Freshwater net
1	16	12	74	3	12.36	Jul-Sep	Escapement

*END Hood Canal FIngerling Base05 CHINOOK

4.3 FRAM Chinook Stock Profiles

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	1. Nooksack/Samish fall fingerling (NkSm F1Fi)
MANAGEMENT UNITS REPRESENTED:	Natural fall chinook production from Nooksack R., Samish R. and Area 7-7A streams. Hatchery production from Nooksack, Samish, and Skookum Creek hatcheries and Lummi Tribe Sea Ponds.
CALIBRATION CWT GROUPS:	050324 Skookum Creek Hatchery (1977 brd) 050325 Skookum Creek Hatchery (1977 brd) 050726 Skookum Creek Hatchery (1979 lid) 050727 Lummi Sea Ponds (1979 brd) 632042 Samish Hatchery (1979 brd) 632101 Samish Hatchery (1979 brd) 632102 Samish Hatchery (1979 brd)
VALIDATION CWT BROODS	1974-75, 1985-on
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from generalized PS summer/fall fingerling CWT groups)	Mean $FL_{mixmature}$ =982.1*(1-e**(-0.029(t-2.83)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1085.2*(1-e**(-0.030(t-1.59)) where Age 2 CV = 0.03 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement in Nooksack/Samish/Area 7-7A streams. Freshwater net Marine net in Area 7B,C for Samish and Nooksack, Area 7B,C,D for Lummi
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Natural and hatchery escapement in Nooksack/Samish/Area 7-7A streams Freshwater net Marine net in Area 7C for Samish and Nooksack, Area 7C,D for Lummi Base Period Escapement=20224
SCALE DATA ORIGIN:	Nooksack River net Marine Area 7B,C,D net
SUPPLEMENTAL DATA SOURCES:	Puget Sound Run Reconstruction (RR) WDFW Escapement Records (jacks) WDFW Hatchery Release Reports

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	3. North Fork Nooksack Native early (NFNK Sprg)
MANAGEMENT UNITS REPRESENTED:	North Fork Nooksack River springs
CALIBRATION CWT GROUPS:	632846 Nooksack Hatchery (1984 brd, NFK, fing.) 633452 Nooksack Hatchery (1984 brd, NFK, year.) 633453 Nooksack Hatchery (1984 brd, NFK, year.) 634422 Nooksack Hatchery (1988 brd, NFK, year.)
VALIDATION CWT GROUPS	Do not use 1991
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from generalized PS summer/fall fingerling CWT groups)	Mean $FL_{mixmature}$ =982.1*(1-e**(-0.029(t-2.83)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1085.2*(1-e**(-0.030(t-1.59)) where Age 2 CV = 0.03 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Freshwater net
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=500
SCALE DATA ORIGIN:	1??
SUPPLEMENTAL DATA SOURCES:	Puget Sound Spring Chinook Status Reports

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	5. South Fork Nooksack early (SFNK Sprg)
MANAGEMENT UNITS REPRESENTED:	South Fork Nooksack River springs
CALIBRATION CWT GROUPS:	632846 Nooksack Hatchery (1984 brd, NFK, fing.) 633452 Nooksack Hatchery (1984 brd, NFK, year.) 633453 Nooksack Hatchery (1984 brd, NFK, year.) 634422 Nooksack Hatchery (1988 brd, NFK, year.)
VALIDATION CWT GROUPS	Do not use 1991
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from generalized PS summer/fall fingerling CWT groups)	Mean $FL_{mixmature}$ =982.1*(1-e**(-0.029(t-2.83)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1085.2*(1-e**(-0.030(t-1.59)) where Age 2 CV = 0.03 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Freshwater net
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=500
SCALE DATA ORIGIN:	1??
SUPPLEMENTAL DATA SOURCES:	Puget Sound Spring Chinook Status Reports

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	7. Skagit summer/fall fingerling (Skag F1Fi)
MANAGEMENT UNITS REPRESENTED:	Wild production from Skagit River including upper Skagit summers, lower Sauk summers, and lower Skagit falls Marblemount (Skagit) Hatchery
CALIBRATION CWT GROUPS:	631606 Skagit Hatchery (1976 brd brd) 631624 Skagit R. (wild, 1976 brd) 631625 Skagit R. (wild, 1976 brd) 631626 Skagit R. (wild, 1976 brd) 631627 Skagit R. (wild, 1976 brd) 631628 Skagit R. (wild, 1976 brd) 631629 Skagit R. (wild, 1976 brd) 631630 Skagit R. (wild, 1977 brd) 631631 Skagit R. (wild, 1977 brd) 631632 Skagit R. (wild, 1977 brd) 631633 Skagit R. (wild, 1977 brd) 631635 Skagit R. (wild, 1977 brd) 631636 Skagit R. (wild, 1977 brd)
VALIDATION CWT GROUPS	1974, 1975, 1978-81
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from generalized PS summer/fall fingerling CWT groups)	Mean $FL_{mixmature}$ =982.1*(1-e**(-0.029(t-2.83)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1085.2*(1-e**(-0.030(t-1.59)) where Age 2 CV = 0.03 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Freshwater net Marine Area 8 net
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=10443
SCALE DATA ORIGIN:	Freshwater net Marine Area 8 net
SUPPLEMENTAL DATA SOURCES:	Puget Sound Run Reconstruction (RR) WDFW escapement records (jacks) WDFW hatchery release reports

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	9. Skagit summer/fall yearling (Skag FlYr)
MANAGEMENT UNITS REPRESENTED:	Hatchery production from Skagit River Marblemount (Skagit) Hatchery
CALIBRATION CWT GROUPS:	631610 Skagit Hatchery (1976 brd)
VALIDATION CWT GROUPS	None
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from So. PS summer/fall yearling CWT groups)	Mean $FL_{mixmature}$ =802.6*(1-e**(-0.051(t-9.57)) where Age 2 CV = 0.17 Age 3 CV = 0.14 Age 4 CV = 0.10 Age 5 CV = 0.10 Mean FL_{mature} =1460.9*(1-e**(-0.018(t-5.42)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Freshwater net Marine Area 8 net
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=2105
SCALE DATA ORIGIN:	Freshwater net Marine Area 8 net
SUPPLEMENTAL DATA SOURCES:	Puget Sound Run Reconstruction (RR) WDFW escapement records WDFW hatchery release reports

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	11. Skagit spring yearling (Skag SpYr)
MANAGEMENT UNITS REPRESENTED:	Skagit River wild Marblemount (Skagit) Hatchery Spring
CALIBRATION CWT GROUPS:	633323 Skagit Hatchery (1985 brd) 633314 Skagit Hatchery (1986 brd) 634744 Skagit Hatchery (1987 brd) 634902 Skagit Hatchery (1987 brd) 635026 Skagit Hatchery (1987 brd)
VALIDATION CWT GROUPS	1981-90 brd
Von Bertalanffy Growth Function Mean Fork Length(cm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (From Skagit H CWT group)	Mean $FL_{mixmature}$ =904.0*(1-e**(-0.043(t-9.54)) where Age 2 CV = 0.17 Age 3 CV = 0.14 Age 4 CV = 0.10 Age 5 CV = 0.10 Mean FL_{mature} =938.6*(1-e**(-0.048(t-11.31)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Area 8 net Freshwater net
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=1391
SCALE DATA ORIGIN:	???
SUPPLEMENTAL DATA SOURCES:	Puget Sound Spring Chinook Status Reports

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	13. Snohomish summer/fall fingerling (Snoh FlFi)
MANAGEMENT UNITS REPRESENTED:	Wild production from Snohomish River system Wallace R. Hatchery fingerlings
CALIBRATION CWT GROUPS:	For preterm.: 212221 Stillaguamish H. (1986 brd), 212555 Still. H. (1987 brd) 213147 Still. H. (1988 brd) For terminal H.R.: 212204 Tulalip H (1986 brd) 212544 Tulalip H.(1987 brd) 213141 Tulalip H.(1988 brd)
VALIDATION CWT GROUPS	None
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from generalized PS summer/fall fingerling CWT groups)	Mean $FL_{mixmature}$ =982.1*(1-e**(-0.029(t-2.83)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1085.2*(1-e**(-0.030(t-1.59)) where Age 2 CV = 0.03 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Freshwater net Marine Area 8A net
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Natural and hatchery escapement Freshwater net Base Period Escapement=4814
SCALE DATA ORIGIN:	Marine Area 8A net for fingerling age composition
SUPPLEMENTAL DATA SOURCES:	Puget Sound Run Reconstruction (RR) WDFW escapement records (jacks) WDFW hatchery release reports for basin yearling vs fingerling poundage percentage for ETRS breakdown

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	15. Snohomish summer/fall yearling (Snoh FlYr)
MANAGEMENT UNITS REPRESENTED:	Wild summer/fall yearling production from Snohomish Wallace R. Hatchery yearlings
CALIBRATION CWT GROUPS:	631701 Wallace R. (Skykomish) Hatchery Summer chinook (1976 brd)
VALIDATION CWT GROUPS	None
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from So. PS summer/fall yearling CWT groups)	Mean $FL_{mixmature}$ =802.6*(1-e**(-0.051(t-9.57)) where Age 2 CV = 0.17 Age 3 CV = 0.14 Age 4 CV = 0.10 Age 5 CV = 0.10 Mean FL_{mature} =1460.9*(1-e**(-0.051(t-5.42)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Freshwater net Marine Area 8A net
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Natural and hatchery escapement Freshwater net Base Period Escapement=3352
SCALE DATA ORIGIN:	Marine Area 8A net for yearling age composition
SUPPLEMENTAL DATA SOURCES:	Puget Sound Run Reconstruction (RR) WDFW escapement records (jacks) WDFW hatchery release reports for basin yearling vs fingerling poundage percentage for ETRS breakdown

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	17. Stillaguamish summer/fall fingerling (Stil F1Fi)
MANAGEMENT UNITS REPRESENTED:	Wild and supplementation production in Stillaguamish River
CALIBRATION CWT GROUPS:	212221 Stillaguamish H. (1986 brd) 212555 Stillaguamish H. (1987 brd) 213147 Stillaguamish H. (1988 brd)
VALIDATION CWT GROUPS	1980-83, 1986-91
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from generalized PS summer/fall fingerling CWT groups)	Mean $FL_{mixmature}$ =982.1*(1-e**(-0.029(t-2.83)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1085.2*(1-e**(-0.030(t-1.59)) where Age 2 CV = 0.03 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement (0) Freshwater net Marine Area 8A
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Natural and hatchery escapement (0) Freshwater net Base Period Escapement=831
SCALE DATA ORIGIN:	Marine Area 8A?
SUPPLEMENTAL DATA SOURCES:	Puget Sound Run Reconstruction (RR)

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	19. Tulalip summer/fall fingerling (Tula FlFi)
MANAGEMENT UNITS REPRESENTED:	Tulalip Hatchery
CALIBRATION CWT GROUPS:	212204 Tulalip H. (1986 brd) 212544 Tulalip H. (1987 brd) 213141 Tulalip H. (1988 brd)
VALIDATION CWT GROUPS	1986-91
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from generalized PS summer/fall fingerling CWT groups)	Mean $FL_{mixmature}$ =982.1*(1-e**(-0.029(t-2.83)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1085.2*(1-e**(-0.030(t-1.59)) where Age 2 CV = 0.03 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Marine Area 8D net Marine Area 8A net
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Natural and hatchery escapement Marine Area 8D net Base Period Escapement=1
SCALE DATA ORIGIN:	Marine Area 8D
SUPPLEMENTAL DATA SOURCES:	Puget Sound Run Reconstruction (RR)

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	21. Mid Puget Sound fall fingerling (MiPS FlFi)
MANAGEMENT UNITS REPRESENTED:	Natural production from Lake Washington, Green-Duwamish Rivers, Puyallup River, Misc. Area 10 streams (Seattle area), Misc. Area 10E streams (Port Orchard) Hatchery production from Issaquah, Soos Creek (Green River), Voights Creek (Puyallup), Crisp Creek, Grovers, Icy Creek facilities
CALIBRATION CWT GROUPS:	631814 Voights Creek (1978 brd) 631842 Voights Creek (1978 brd) 631935 Soos Creek (1978 brd) 631936 Soos Creek (1978 brd) 631940 Issaquah (1978 brd) 631945 Soos Creek (1978 brd) 631943 Issaquah (1979 brd) 631944 Soos Creek (1979 brd) 632020 Voights Creek (1979 brd)
VALIDATION CWT GROUPS	1974-75, 1978-on
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from generalized PS summer/fall fingerling CWT groups)	Mean $FL_{mixmature}$ =982.1*(1-e**(-0.029(t-2.83)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1085.2*(1-e**(-0.030(t-1.59)) where Age 2 CV = 0.03 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement in Lake Washington, Green-Duwamish River, Puyallup River and Area 10, 10E streams Freshwater net in Green-Duwamish, Puyallup rivers Marine net fisheries for stocks destined for Lake Washington (Area 10, 10B,C,D); Green Duwamish (Area 10, 10A); Puyallup (Area 10, 11, 11A); Misc. Area 10 streams (Area 10); Misc Area 10E streams (Area 10, 10E)
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Natural and hatchery escapement in Lake Washington, Green-Duwamish River, Puyallup River and Area 10, 10E streams Freshwater net in Green-Duwamish, Puyallup rivers Marine net fisheries for stocks destined for Lake Washington (Area 10B,C,D); Green Duwamish (Area 10A); Puyallup (Area 11A); Misc Area 10E streams (Area 10E) Base Period Escapement=20018

SCALE DATA ORIGIN:	Net fisheries for Lake Washington (Area 10B,C,D,F); Green-Duwamish (Area 10A and river); Puyallup (Area 11A and river); Misc. 10 streams (Area 10A and Green); Misc. 10E streams (Area 10E)
SUPPLEMENTAL DATA SOURCES:	Puget Sound Run Reconstruction (RR) WDFW escapement records (jacks)

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	23. UW Accelerated fall fingerling (UWAc F1Fi)
MANAGEMENT UNITS REPRESENTED:	Accelerated fingerling production from University of Washington Hatchery
CALIBRATION CWT GROUPS:	111601-02 UW Portage Bay (1977 brd) 111603-06 UW Portage Bay (1978 brd) 111617-18 UW Portage Bay (1978 brd) 111624 UW Portage Bay (1978) 111627-32 UW Portage Bay (1979)
VALIDATION CWT GROUPS	1980-84
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from UW for mixed maturity; So. PS summer/fall yearling for mature)	Mean $FL_{mixmature}$ =889.6*(1-e**(-0.039(t-1.96)) where Age 2 CV = 0.17 Age 3 CV = 0.14 Age 4 CV = 0.10 Age 5 CV = 0.10 Mean FL_{mature} =1460.9*(1-e**(-0.018(t-5.42)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Hatchery escapement
ACCOUNTED IN. EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=1062
SCALE DATA ORIGIN:	??
SUPPLEMENTAL DATA SOURCES:	University of Washington

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	25. South Puget Sound fall fingerling (SPSo FlFi)
MANAGEMENT UNITS REPRESENTED:	Wild production in deep south Puget sound tributaries including Nisqually and Deschutes Rivers, Minter Creek, and Misc Area 13 streams Hatchery production from Minter Creek, Hupp Springs, Coulter Creek, Kalama Creek, Garrison Springs (Chambers Creek), Fox Island Net Pens, South Sound Net Pens, Allison Springs, McAllister Creek facilities
CALIBRATION CWT GROUPS:	631907 Minter Creek Hatchery (1978) 050722 Kalama Creek Hatchery (1979) 631903 Garrison Springs Hatchery (1979) 632063 Coulter Creek Hatchery (1979) 632103 Deschutes Hatchery (1979) 632104 Minter Creek Hatchery (1979)
VALIDATION CWT GROUPS	1974-75, 1978, 1980-on
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from generalized PS summer/fall fingerling CWT groups)	Mean $FL_{mixmature}$ =982.1*(1-e**(-0.029(t-2.83)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1085.2*(1-e**(-0.030(t-1.59)) where Age 2 CV = 0.03 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement in Nisqually, Deschutes rivers, Chambers Creek, and Misc. Area 13, 13A Carr Inlet/Minter Creek, 13B streams Freshwater net Marine net fisheries for stocks destined for Nisqually River (Area 10, 11, 13); Deschutes River (Area 10, 11, 13, 13B); Chambers Creek (Area 10, 11, 13); Misc. Area 13 streams (Area 10, 11, 13); Misc 13A streams (Area 10, 11, 13, 13A); Misc. 13B streams (Area 10, 11, 13, 13B)

ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Natural and hatchery escapement in Nisqually, Deschutes rivers, Chambers Creek, and Misc. Area 13, 13A Carr Inlet/Minter Creek, 13B streams Freshwater net Marine net fisheries for stocks destined for Nisqually River (none); Deschutes River (Area 13B); Chambers Creek (none); Misc. Area 13 streams (none); Misc. 13A streams (Area 13A); Misc. 13B streams (Area 13B) Base Period Escapement=10230
SCALE DATA ORIGIN:	Nisqually River net and Marine net fisheries in Area 13/13B and Area 13C-K
SUPPLEMENTAL DATA SOURCES:	Puget Sound Run Reconstruction (RR) WDFW escapement records (jacks)

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	27. South Puget Sound fall yearling (SPSo FlYr)
MANAGEMENT UNITS REPRESENTED:	Fall yearling portion of hatchery chinook in Mid- and South Puget Sound
CALIBRATION CWT GROUPS:	631853 Fox Island Net Pens (1978) 631905 Green River Hatchery (1978) 632004 Deschutes Hatchery (1978) 632023 Allison Springs Hatchery (1978) 632015 Deschutes Hatchery (1979) 632019 Deschutes Hatchery (1979) 632027 Fox Island Net Pens (1979) 632055-56 Coulter Creek Hatchery (1979) 632128 Crisp Creek Hatchery (1979) 632220 Hupp Springs Sp. Channel (1979) 632221 Allison Springs Hatchery (1979). 632228 Allison Springs Hatchery (1979)
VALIDATION CWT GROUPS	1974-75, 1980-on
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from So. PS summer/fall yearling CWT groups)	Mean $FL_{mixmature}$ =802.6*(1-e**(-0.051(t-9.57)) where Age 2 CV = 0.17 Age 3 CV = 0.14 Age 4 CV = 0.10 Age 5 CV = 0.10 Mean FL_{mature} =1460.9*(1-e**(-0.018(t-5.42)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Run Reconstruction TR of Mid- and South Puget Sound chinook adjusted to yearlings leaving Marine Area 10 Base Period Escapement=330

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	29. White River spring fingerling (White SpFi
MANAGEMENT UNITS REPRESENTED:	South Puget Sound spring fingerling
CALIBRATION CWT GROUPS:	211659 White River Hatchery (91 brd) 212209 White River Hatchery (91 brd) 212245 White River Hatchery (91 brd) 212246 White River Hatchery (91 brd) 212321 White River Hatchery (92 brd) 212322 White River Hatchery (92 brd) 212462 White River Hatchery (93 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from generalized PS summer/fall fingerling CWT groups)	Mean $FL_{mixmature}$ =982.1*(1-e**(-0.029(t-2.83)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1085.2*(1-e**(-0.030(t-1.59)) where Age 2 CV = 0.03 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Natural and hatchery escapement to White River Hatchery or Buckley Trap Freshwater net Base Period Escapement=100
SCALE DATA ORIGIN:	Age composition from CWT survival rate applied to number released
SUPPLEMENTAL DATA SOURCES:	Puget Sound Run Reconstruction (RR) WDFW escapement records (jacks) WDFW hatchery release reports

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	31. Hood Canal fall fingerling (HdCl FlFi)
MANAGEMENT UNITS REPRESENTED:	Wild production from Hood Canal region including Dosewallips, Duckabush, Hamma Hamma, Skokomish, Quilcene rivers and misc Area 12 streams Hatchery production from George Adams, Hood Canal (Hoodsport), Port Gamble Pens,
CALIBRATION CWT GROUPS:	631752 George Adams (1978) 631915 Hood Canal (1978) 632041 George Adams (1979) 632109 Hood Canal (1979)
VALIDATION CWT GROUPS	1974-75, 1980-81, 1985-on
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from generalized PS summer/fall fingerling CWT groups)	Mean $FL_{mixmature}$ =982.1*(1-e**(-0.029(t-2.83)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1085.2*(1-e**(-0.030(t-1.59)) where Age 2 CV = 0.03 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Freshwater net (primarily Skokomish) Marine net fisheries for stocks destined for Dosewallip (Area 12, 12B), Duckabush (Area 12, 12B), Mamma Hamma (Area 12 12B), Skokomish (Area 12, 12B,C,D), South Hood Canal (Area 12, 12B,C), Southeast Hood Canal (Area 12, 12B,C,D), Hoodsport (Area 12, 12B,C,D), Port Gamble (Area 9A,12)
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Natural and hatchery escapement Freshwater net (primarily Skokomish) Marine net fisheries for stocks destined for Skokomish (Area 12D), Southeast Hood Canal (Area 12D), Hoodsport (Area 12D), Port Gamble (Area 9A) Base Period Escapement=4078

SCALE DATA ORIGIN:	Net fisheries in Skokomish R. and marine Area 12 B,C,D
SUPPLEMENTAL DATA SOURCES:	Puget Sound Run Reconstruction (RR) WDFW escapement records (jacks)

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	33. Hood Canal fall yearling (HdCl FlYr)
MANAGEMENT UNITS REPRESENTED:	Fall yearlings from Hood Canal hatcheries
CALIBRATION CWT GROUPS:	631637 Hood Canal Hatchery (1978 brd) 631840 McKernan Hatchery (1978) 631852 McKernan Hatchery (1978) 632057 Hood Canal Hatchery (1979)
VALIDATION CWT GROUPS	1974, 1980-81, 1985-87, 1989-on
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from So. PS summer/fall yearling CWT groups)	Mean $FL_{mixmature}$ =802.6*(1-e**(-0.051(t-9.57)) where Age 2 CV = 0.17 Age 3 CV = 0.14 Age 4 CV = 0.10 Age 5 CV = 0.10 Mean FL_{mature} =1460.9*(1-e**(-0.018(t-5.42)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Yearling portion of the following components determined from CWT rather than scales because of small sample sizes Natural and hatchery escapement 0 Freshwater net (primarily Skokomish) Marine net fisheries for stocks destined for Dosewallip (Area 12, 12B), Duckabush (Area 12, 12B), Hamma Hamma (Area 12 12B), Skokomish (Area 12, 12B,C,D), South Hood Canal (Area 12, 12B,C), Southeast Hood Canal (Area 12, 12B,C,D), Hoodsport (Area 12, 12B,C,D), Port Gamble (Area 9A,12)
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Natural and hatchery escapement Freshwater net (primarily Skokomish) Marine net fisheries for stocks destined for Skokomish (Area 12D), Southeast Hood Canal (Area 12D), Hoodsport (Area 12D), Port Gamble (Area 9A) Base Period Escapement=126
SCALE DATA ORIGIN:	Net fisheries in Skokomish R. and marine Area 12 B,C,D for age composition of yearlings CWTs used to apportion Hood Canal fall chinook into fingerling and yearling type

SUPPLEMENTAL DATA SOURCES:	Puget Sound Run Reconstruction (RR) WDFW escapement records (jacks)

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	35. Juan de Fuca Tribs Fall Fingerling (SJDF FlFi)
MANAGEMENT UNITS REPRESENTED:	Natural production from Hoko, Elwha, Dungeness and minor tributaries Hatchery production from Hoko, Elwha, Dungeness
CALIBRATION CWT GROUPS:	631919 Elwha Spawning Channel (78 brd) 632107 Elwha Spawning Channel (79 brd) 633038,633039 Elwha (83 brd) 633419,633420 Elwha (84 brd) 633543,633544 Elwha (85 brd)
VALIDATION CWT GROUPS	1985-87, 1989 on Hoko
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from generalized PS summer/fall fingerling CWT groups)	Mean $FL_{mixmature}$ =982.1*(1-e**(-0.029(t-2.83)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1085.2*(1-e**(-0.030(t-1.59)) where Age 2 CV = 0.03 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Freshwater Net
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=2365
SCALE DATA ORIGIN:	??
SUPPLEMENTAL DATA SOURCES:	Puget Sound Run Reconstruction (RR)

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	37. Oregon Hatchery Tule (OR LRH)
MANAGEMENT UNITS REPRESENTED:	Natural and hatchery fall chinook from Oregon tribs below Bonneville Dam
CALIBRATION CWT GROUPS:	071842 Bonneville Hatchery (78 brd) 072157 Bonneville Hatchery (79 brd) 072163 Oxbow Hatchery (79 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from OR and Spring Crk Tule CWT groups)	Mean $FL_{mixmature}$ =970.8*(1-e**(-0.038(t-2.60)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =912.8*(1-e**(-0.064(t-3.97)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Columbia River Net Columbia River and tributary sport
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=42000
SCALE DATA ORIGIN:	Columbia River Net, Sport, Escapement
SUPPLEMENTAL DATA SOURCES:	Columbia River Fish Runs and Fisheries Status Report

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	39. Washington Hatchery Tule (WA LRH)
MANAGEMENT UNITS REPRESENTED:	Natural and hatchery fall chinook from Washington tribs below Bonneville Dam
CALIBRATION CWT GROUPS:	631802 Cowlitz Salmon Hatchery (77 brd) 631942 Cowlitz Salmon Hatchery (78 brd) 632154 Cowlitz Salmon Hatchery (79 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from Cowlitz H CWT groups)	Mean $FL_{mixmature}$ =1182.9*(1-e**(-0.024(t-3.41)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1122.5*(1-e**(-0.020(t+5.80)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Columbia River Net Columbia River and tributary sport
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=33400
SCALE DATA ORIGIN:	Columbia River Net, Sport, Escapement
SUPPLEMENTAL DATA SOURCES:	Columbia River Fish Runs and Fisheries Status Report

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	41. Lower Columbia River Wild (Low CR wild)
MANAGEMENT UNITS REPRESENTED:	Natural “bright” fall chinook from Lewis River and small components in other Lower Columbia tribs (Cowlitz, Sandy)
CALIBRATION CWT GROUPS:	631611 Lewis River Hatchery (77 brd) 631618 Lewis River Wild (77 brd) 631619 Lewis River Wild (77 brd) 631813 Lewis River Hatchery (78 brd) 631858 Lewis River Wild (78 brd) 631859 Lewis River Wild (78 brd) 631902 Lewis River Wild (78 brd) 631920 Speelyai Hatchery (78 brd) 632002 Lewis River Wild (78 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from No. Lewis R wild fingerling CWT groups)	Mean $FL_{mixmature}$ =3412.3*(1-e**(-0.006(t-1.57)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1294.1*(1-e**(-0.013(t+10.29)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Columbia River Net Columbia River and tributary sport
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=14192
SCALE DATA ORIGIN:	Columbia River Net, Sport, Escapement
SUPPLEMENTAL DATA SOURCES:	Columbia River Fish Runs and Fisheries Status Report

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	43. Bonneville Pool Hatchery (BPH Tule)
MANAGEMENT UNITS REPRESENTED:	Tule type hatchery fall chinook from Spring Creek NFH and some past Klickitat Hatchery, White Salmon Rearing Pond and Little White Salmon NFH. Minor tule type natural production in Bonneville Pool tributataries (Wind, White Salmon, Klickitat R)
CALIBRATION CWT GROUPS:	050433 Spring Creek (78 brd) 050434 Spring Creek (78 brd) 050444 Spring Creek (78 brd) 050446 Spring Creek (78 brd) 050639 Spring Creek (79 brd) 050640 Spring Creek (79 brd) 050641 Spring Creek (79 brd) 050642 Spring Creek (79 brd) 054101 Spring Creek (76 brd) 054201 Spring Creek (76 brd) 054401 Spring Creek (76 brd) 054501 Spring Creek (76 brd) 054601 Spring Creek (76 brd) 055501 Spring Creek (77 brd) 055601 Spring Creek (77 brd) 055701 Spring Creek (77 brd) 056001 Spring Creek (77 brd) 056201 Spring Creek (77 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from OR and Spring Crk tule CWT groups	Mean $FL_{mixmature}$ =970.8*(1-e**(-0.038(t-2.60)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =912.9*(1-e**(-0.064(t-3.97)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Columbia River Net Columbia River and tributary sport
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=40367
SCALE DATA ORIGIN:	Columbia River Net, Sport, Escapement
SUPPLEMENTAL DATA SOURCES:	Columbia River Fish Runs and Fisheries Status Report

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	45. Columbia Upriver Summer (Upp CR Su)
MANAGEMENT UNITS REPRESENTED:	Natural summer chinook from mainstem and tributaries upstream of Priest Rapids Dam. Hatchery summer chinook from Wells Dam Hatchery, Rocky Reach Hatchery, and Eastbank Hatchery, Methow Hatchery, and Similkameen Rearing Pond supplementation facilities.
CALIBRATION CWT GROUPS:	631607 Wells Dam Sp Channel (76 brd) 631642 Wells Dam Sp Channel (76 brd) 631762 Wells Dam Sp Channel (77 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step (from No. Lewis R wild fingerling CWT groups)	Mean $FL_{mixmature}$ =3412.3*(1-e**(-0.006(t-1.57)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1294.1*(1-e**(-0.013(t+10.29)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Columbia River Net Columbia River and tributary sport
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=22205
SCALE DATA ORIGIN:	No data
SUPPLEMENTAL DATA SOURCES:	Columbia River Fish Runs and Fisheries Status Report

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	47. Columbia Upriver Bright (Col R Brt)
MANAGEMENT UNITS REPRESENTED:	Natural fall chinook from Deschutes River, brights in Klickitat, White Salmon, and Wind rivers and Columbia main stem and tributaries upstream of McNary Dam, excluding Snake River. Hatchery bright fall chinook at Priest Rapids Hatchery (URB), Mid-Columbia Brights (MCB) at Ringold Rearing Pond, Irrigon Hatchery, Umatilla Hatchery and Bonneville Pool brights (BUB) at Bonneville Hatchery, Klickitat Hatchery, and Little White Salmon NFH.
CALIBRATION CWT GROUPS:	130713 Ringold Rearing Pond (75 brd) 131101 Priest Rapids (75 brd) 131202 Priest Rapids (75 brd) 631662 Priest Rapids (76 brd) 631741 Priest Rapids (77 brd) 631745 Ringold Rearing Pond (77 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= $L_{max}*(1-e**(-k(t-t_0))$ where t= (Age-1)*12 + midpt. of time step	Mean $FL_{mixmature}$ =1313.5*(1-e**(-0.023(t-3.17)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1069.4*(1-e**(-0.023(t+4.86)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Columbia River Net Columbia River and tributary sport
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=51025
SCALE DATA ORIGIN:	Columbia net, sport and escapement
SUPPLEMENTAL DATA SOURCES:	Columbia River Fish Runs and Fisheries Status Report

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	49. Washington lower river spring (WaLR Sprg)
MANAGEMENT UNITS REPRESENTED:	Natural spring chinook from Cowlitz, Kalama, and Lewis rivers. Hatchery spring chinook at Cowlitz, Kalama Falls, Lower Kalama, Lewis River, and Speelyai hatcheries.
CALIBRATION CWT GROUPS:	631817 Cowlitz (77 brd) 631818 Cowlitz (77 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step	Mean $FL_{mixmature}$ =994.6*(1-e**(-0.046(t-11.36)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =922.0*(1-e**(-0.069(t-16.52)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Columbia River Net Columbia River and tributary sport
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=23720
SCALE DATA ORIGIN:	Columbia net, sport and escapement
SUPPLEMENTAL DATA SOURCES:	Columbia River Fish Runs and Fisheries Status Report

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	51. Willamette River spring (Will Sprg)
MANAGEMENT UNITS REPRESENTED:	Natural spring chinook from Willamette and Sandy rivers. Hatchery spring chinook at Marion Forks, Mckenzie, Willamette/Dexter Pond, S. Santiam, and Clackamas H.
CALIBRATION CWT GROUPS:	071737 Dexter Pond (77 brd) 071738 Willamette (77 brd) 071741 Dexter Pond (77 brd) 071742 Dexter Pond (77 brd) 071925 Willamette (78 brd) 072042 Willamette (78 brd) 072047 Willamette (78 brd) 072049 McKenzie (78 brd) 072050 McKenzie (78 brd) 091621 So. Santiam (76 brd) 091622 So. Santiam (76 brd) 091623 So. Santiam (76 brd) 091624 So. Santiam (76 brd) 091625 So. Santiam (76 brd) 091626 So. Santiam (76 brd) 091627 So. Santiam (76 brd) 091628 So. Santiam (76 brd) 091629 So. Santiam (76 brd) 091630 So. Santiam (76 brd) 091631 So. Santiam (76 brd) 091701 Marion Forks (76 brd) 091703 Marion Forks (76 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step	Mean $FL_{mixmature}$ =994.6*(1-e**(-0.046(t-11.36)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =922.0*(1-e**(-0.069(t-16.52)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Columbia River Net Columbia River and tributary sport
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=37928
SCALE DATA ORIGIN:	Columbia net, sport and escapement
SUPPLEMENTAL DATA SOURCES:	Columbia River Fish Runs and Fisheries Status Report

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	53. Snake River fall chinook (SnakeR Fl)
MANAGEMENT UNITS REPRESENTED:	Natural fall chinook from Snake River and tributaries. Hatchery fall chinook at Lyons Ferry and Nez Perce Tribal hatcheries.
CALIBRATION CWT GROUPS:	633226 Lyons Ferry (84 brd) 633227 Lyons Ferry (84 brd) 633228 Lyons Ferry (84 brd) 633633 Lyons Ferry (85 brd) 633634 Lyons Ferry (85 brd) 633635 Lyons Ferry (85 brd) 633636 Lyons Ferry (85 brd) 633637 Lyons Ferry (85 brd) 633638 Lyons Ferry (85 brd) 633639 Lyons Ferry (85 brd) 633640 Lyons Ferry (85 brd) 633641 Lyons Ferry (85 brd) 633642 Lyons Ferry (85 brd) 634259 Lyons Ferry (86 brd) 634261 Lyons Ferry (86 brd) 634262 Lyons Ferry (86 brd) 634401 Lyons Ferry (86 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step	Mean $FL_{mixmature}$ =1313.5*(1-e**(-0.023(t-3.17)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1069.4*(1-e**(-0.023(t+4.86)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Columbia River Net Columbia River and tributary sport
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=1000
SCALE DATA ORIGIN:	Columbia net, sport and escapement
SUPPLEMENTAL DATA SOURCES:	Columbia River Fish Runs and Fisheries Status Report

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	55. Oregon north migrating fall (Ore No Fl)
MANAGEMENT UNITS REPRESENTED:	Natural fall chinook from Oregon north coastal tributaries. Hatchery fall chinook at Salmon River Hatchery.
CALIBRATION CWT GROUPS:	071643 Salmon River (77 brd) 071644 Salmon River (77 brd) 071849 Salmon River (78 brd) 071850 Salmon River (78 brd) 091637 Salmon River (76 brd) 091638 Salmon River (76 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step	Mean $FL_{mixmature}$ =1313.5*(1-e**(-0.023(t-3.17)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1069.4*(1-e**(-0.023(t+4.86)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=41074
SCALE DATA ORIGIN:	??
SUPPLEMENTAL DATA SOURCES:	

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	57. West coast Vancouver Island (WCVI Totl)
MANAGEMENT UNITS REPRESENTED:	Natural chinook from west coast Vancouver Island. Hatchery chinook at Robertson Creek Hatchery.
CALIBRATION CWT GROUPS:	020408 Robertson Creek (75 brd) 020409 Robertson Creek (75 brd) 020606 Robertson Creek (74 brd) 020906 Robertson Creek (74 brd) 021630 Robertson Creek (76 brd) 021631 Robertson Creek (76 brd) 022217 Robertson Creek (77 brd) 022218 Robertson Creek (77 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step	Mean $FL_{mixmature}$ =1313.5*(1-e**(-0.023(t-3.17)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1069.4*(1-e**(-0.023(t+4.86)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Fraser River net
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=123406
SCALE DATA ORIGIN:	??
SUPPLEMENTAL DATA SOURCES:	

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	59. Fraser Late (Fraser Lt)
MANAGEMENT UNITS REPRESENTED:	Natural and hatchery fall chinook from lower Fraser River
CALIBRATION CWT GROUPS:	022658 Chilliwack (83 brd) 022659 Chilliwack (83 brd) 022660 Chilliwack (83 brd) 023414 Chilliwack (84 brd) 023415 Chilliwack (84 brd) 023416 Chilliwack (84 brd) 023417 Chilliwack (84 brd) 023418 Chilliwack (84 brd) 023419 Chilliwack (84 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step	Mean $FL_{mixmature}$ =982.1*(1-e**(-0.029(t-2.83)) where Age 2 CV = 0.11 Age 3 CV = 0.12 Age 4 CV = 0.09 Age 5 CV = 0.09 Mean FL_{mature} =1085.2*(1-e**(-0.030(t-1.59)) where Age 2 CV = 0.11 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Fraser River net
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=120000
SCALE DATA ORIGIN:	??
Supplemental Data Sources:	

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	61. Fraser Early (Fraser Er)
MANAGEMENT UNITS REPRESENTED:	Natural and hatchery fall chinook from upper Fraser River
CALIBRATION CWT GROUPS:	021601 Shuswap Wild (79 brd) 021602 Chilko Wild (78 brd) 021625 Shuswap Wild (78 brd) 021638 Shuswap Wild (78 brd) 021658 chilko Wild (78 brd) 021755 Shuswap Wild (79 brd) 024247 Clearwater (86 brd) 024248 Clearwater (86 brd) 024249 Clearwater (86 brd) 024250 Clearwater (86 brd) 024316 Shuswap (86 brd) 024521 Clearwater (86 brd) 024522 Clearwater (86 brd) 024523 Clearwater (86 brd) 024524 Clearwater (86 brd) 024525 Clearwater (86 brd) 024526 Clearwater (86 brd) 024527 Clearwater (86 brd) 024528 Spius (86 brd) 024529 Spius (86 brd) 024530 Spius (86 brd) 024531 Spius (86 brd) 024532 Spius (86 brd) 024533 Spius (86 brd) 024534 Shuswap (86 brd) 024535 Shuswap (86 brd) 024536 Clearwater (86 brd) 024537 Clearwater (86 brd) 024538 Clearwater (86 brd) 024562 Spius (86 brd) 024563 Spius (86 brd) 024601 Spius (86 brd) 024607 Spius (86 brd) 024510 Shuswap (86 brd) 024705 Spius (86 brd) 024706 Spius (86 brd) 021717 Fort St James (86 brd)
VALIDATION CWT GROUPS	

Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step	Mean $FL_{mixmature}$ =1080.3*(1-e**(-0.032(t-3.00)) where Age 2 CV = 0.16 Age 3 CV = 0.08 Age 4 CV = 0.13 Age 5 CV = 0.16 Mean FL_{mature} =1080.3*(1-e**(-0.032(t-3.00)) where Age 2 CV = 0.16 Age 3 CV = 0.08 Age 4 CV = 0.13 Age 5 CV = 0.16
ACCOUNTED IN TERMINAL RUN	Natural and hatchery escapement Fraser River net
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=43631
SCALE DATA ORIGIN:	??
SUPPLEMENTAL DATA SOURCES:	

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	63. Lower Georgia Strait fall (Lwr Geo St)
MANAGEMENT UNITS REPRESENTED:	Natural and hatchery fall chinook from Georgia Strait tributaries
CALIBRATION CWT GROUPS:	021612 Big Qualicum (78 brd) 021613 Big Qualicum (78 brd) 021639 Capilano (77 brd) 021642 Capilano (77 brd) 021656 Big Qualicum (78 brd) 021726 Big Qualicum (77 brd) 021727 Big Qualicum (77 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= L_{max}*(1-e**(-k(t-t_0)) where t= (Age-1)*12 + midpt. of time step	Mean $FL_{mixmature}$ =1445.7*(1-e**(-0.020(t-1.25)) where Age 2 CV = 0.21 Age 3 CV = 0.10 Age 4 CV = 0.08 Age 5 CV = 0.04 Mean FL_{mature} =1445.7*(1-e**(-0.020(t-1.25)) where Age 2 CV = 0.21 Age 3 CV = 0.10 Age 4 CV = 0.08 Age 5 CV = 0.04
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement Freshwater net
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=16947
SCALE DATA ORIGIN:	??
SUPPLEMENTAL DATA SOURCES:	

FRAM UNMARKED STOCK NUMBER/NAME/ABBREVIATION:	65. White River spring yearling (White SpYr)
MANAGEMENT UNITS REPRESENTED:	South Puget Sound spring yearling
CALIBRATION CWT GROUPS:	212263 White River Hatchery (91 brd) 212048 White River Hatchery (92 brd) 212509 White River Hatchery (93 brd)
VALIDATION CWT GROUPS	
Von Bertalanffy Growth Function Mean Fork Length(mm)= $L_{max}*(1-e**(-k(t-t_0))$ where t= (Age-1)*12 + midpt. of time step	Mean $FL_{mixmature}$ =904.0*(1-e**(-0.043(t-9.54)) where Age 2 CV = 0.17 Age 3 CV = 0.14 Age 4 CV = 0.10 Age 5 CV = 0.10 Mean FL_{mature} =938.6*(1-e**(-0.048(t-11.31)) where Age 2 CV = 0.048 Age 3 CV = 0.11 Age 4 CV = 0.11 Age 5 CV = 0.11
ACCOUNTED IN TERMINAL RUN (TR) (or Terminal Area Abundance (TAA) in Puget Sound):	Natural and hatchery escapement to White River Hatchery or Buckley Trap Freshwater net
ACCOUNTED IN EXTREME TERMINAL RUN SIZE (ETRS):	Same as TR Base Period Escapement=100
SCALE DATA ORIGIN:	??
SUPPLEMENTAL DATA SOURCES:	

4.4 Fishery and Stock List

FRAM Fsh Num	Chinook FRAM Fishery Name	Base Catch
1	SEAK Troll	283,260
2	SEAK Net	25,117
3	SEAK Sport	20,472
4	N/C BC Net	115,266
5	WCVI Net	57,783
6	GS Net	88,793
7	Canada JDF Net	25,432
8	Outside BC Sport	15,448
9	N/C BC Troll	321,046
10	WCVI Troll	467,376
11	WCVI Sport	0
12	GS Troll	214,175
13	No GS Sport	104,633
14	So GS Sport	125,934
15	BC JDF Sport	52,729
16	NT Area 3:4:4B Troll	41,789
17	T Area 3:4:4B Troll	20,454
18	NT Area 3:4 Sport	3,954
19	N Wash. Coastal Net	423
20	NT Area 2 Troll	59,869
21	T Area 2 Troll	713
22	NT Area 2 Sport	55,902
23	NT G. Harbor Net	2,387
24	T G. Harbor Net	699
25	Willapa Bay Net	13,836
26	Area 1 Troll	20,435
27	Area 1 Sport	30,099
28	Columbia River Net	67,919
29	Buoy 10 Sport	0
30	Central OR Troll	109,061
31	Central OR Sport	8,796
32	KMZ Troll	261,101
33	KMZ Sport	22,158
34	S. Calif. Troll	424,672
35	S. Calif.Sport	89,045
36	NT Area 7 Sport	13,423

37	NT Area 6A:7:7A Net	34,303
38	T Area 6A:7:7A Net	12,190
39	NT Area 7B-7D Net	25,449
40	T Area 7B-7D Net	39,075
41	T JDF Troll	600
42	NT Area 5-6 Sport	54,503
43	NT JDF Net	5,152
44	T JDF Net	14,807
45	NT Area 8 1-2 Sport	11,161
46	NT Skagit Net	1,455
47	T Skagit Net	1,711
48	NT Area 8D Sport	1
49	NT St/Snohomish Net	1,402
50	T St/Snohomish Net	16,423
51	NT Tulalip Bay Net	1
52	T Tulalip Bay Net	483
53	NT Area 9 Sport	29,586
54	NT Area 6B:9 Net	1,648
55	T Area 6B:9 Net	533
56	NT Area 10 Sport	21,309
57	NT Area 11 Sport	28,258
58	NT Area 10:11 Net	6,151
59	T Area 10:11 Net	4,955
60	NT Area 10A Sport	1
61	T Area 10A Net	5,880
62	NT Area 10E Net	1
63	T Area 10E Net	399
64	NT Area 12 Sport	7,550
65	NT Hood Canal Net	1,228
66	T Hood Canal Net	4,859
67	NT Area 13 Sport	22,997
68	NT SPS Net	1
69	T SPS Net	4,650
70	NT Area 13A Net	1
71	T Area 13A Net	5,084
72	Freshwater Sport	NA
73	Freshwater Net	NA

Model Stock	Model Years	Escapement Timing	Data Source Escapement Magnitude	Base Esc
Nk/Sam Fall Fingerling	77,79	July - Sept	PS Run Reconstruction	20,224
NF Nooksack Spring	OOB 84,88 NF	July - Sept	OOB	500
SF Nooksack Spring	OOB 84,88 NF	July - Sept	OOB	500
Skag Su/Fall Fing	76,77	July - Sept	PS Run Reconstruction	10,443
Skag Su/Fall Year	76	July - Sept	PS Run Reconstruction	2,105
Skagit Spring Year	OOB 85-87,90	May-June, July - Sept	OOB	1,391
Snoh Fall Fing	OOB 86-88	July - Sept	OOB	4,814
Snoh Fall Year	76	July - Sept	not adjusted	3,352
Stil Fall Fing	OOB 86-90	July - Sept	OOB	831
Tulalip Fall Fing	OOB 86-88	July - Sept	OOB	1
Mid PS Fall Fing	78,79	July - Sept	PS Run Reconstruction	20,018
UW Accelerated	77-79	July - Sept	PS Run Reconstruction	1,062
SPS Fall Fing	78,79	July - Sept	PS Run Reconstruction	10,230
SPS Fall Year	78,79	July - Sept	not adjusted	330
White R. Spring Fing	OOB 91-93	July - Sept	ACOE Buckly Trap	100
HC Fall Fing	78,79	July - Sept	PS Run Reconstruction	4,078
HC Fall Year	78,79	July - Sept	PS Run Reconstruction	126
JDF Tribs. Fall Fing	78,79,OOB 83-85	July - Sept	PS Run Reconstruction	2,365
OR Hatchery Tule	78,79	July - Sept	CR Run Reconstruction	42,000
WA Hatchery Tule	77,79	July - Sept	CR Run Reconstruction	33,400
Lower Col R Wild	77,78	July - Sept	CR Run Reconstruction	14,192
Bonneville Pool Hatchery	76-79	July - Sept	CR Run Reconstruction	40,365
Col R. Upriver Summer	76,77	May - June (53%), July - Sept (47%)	PSC Chinook Model	22,205
Col R. Upriver Bright	75-77	July - Sept	CR Run Reconstruction	51,025
Cowlitz Spring	77	Oct - April	CR Run Reconstruction	23,720
Willamette Spring	76-78	Oct - April	CR Run Reconstruction	37,928
Snake River Fall	OOB 84-86	July - Sept	OOB	1,000
OR North Fall	76-78	July - Sept	PSC Chinook Model	41,074
WCVI Total	74-77	July - Sept	PSC Chinook Model	123,406
Fraser Late	OOB 83,84	July - Sept	OOB	120,000
Fraser Early	78,79,OOB 84,86	July - Sept	PSC Chinook Model	43,631
Lower Georgia Strait	77,78	July - Sept	PSC Chinook Model	16,947
White R. Spring Year	OOB 91-93	July - Sept	ACOE Buckly Trap	100

4.5 Functional Description of Calibration Programs and Worksheets

FRAM.exe: Run as base period or as annual 83-03 "validation" runs. Validation runs are made with FRAM base period input file of stock/age specific cohort sizes, exploitation rates, growth functions, fishery related mortality parameters, etc and best estimates of yearly actual stock abundances and reported fishery catches and/or effort scalars.

PSRR.xls: Produces base period terminal run sizes for insertion into Puget Sound stock validation abundance spreadsheets.

Validation Abundance Spreadsheet (Puget Sound, Columbia River, British Columbia): Contains annual terminal run size accounting for various post-season run reconstruction accounting systems, and from these produces age-stock-year specific abundance scalars used in Method 1-3 FRAM starting cohort abundance scalar derivation .

UPDATERECONTXT.exe: Updates input stock text files used by RECON.bas for Method 2 abundance scalar derivation.

RECON.bas: Obtains Method 2 estimates of recruit scale factors for Puget Sound summer/fall stocks by adjusting terminal run based abundance scalars by year-timestep-fishery specific independent effort scalars. These effort scalars are usually derived from comparing within year vessel days, angler-trips, or deliveries to the same measured during the 1979-82 base period.

UPDTMT.bas: Replaces base period maturation rates in the FRAM base period data file ("outfile') with year-specific maturation rates calculated from year-specific CWT groups for eight Puget Sound fall stocks to create annual outfiles.

MRTRAT.bas: Calculates ratio of total mortality to landed catch for Puget Sound summer/fall Chinook. These data are pasted into the RECON text input file and are used in accounting for preterminal fishing impacts in order to derive prefishing age-stock specific abundances.

UPDATE COMMAND SCALARS.exe: Creates new FRAM validation command files with new yearly stock and age specific abundance scalars relative to the base period cohorts.

JMNSZE.bas: Reformats four successive years of FRAM model estimates of annual fishery effort scalars into single brood year files of fishery effort scalars for separate ages 2-5. These brood year specific scale factor files are key part of the process that simulates out-of-base period CWT recoveries back to the base period.

CHDAT.bas: Error checks data and reformats calibration input data for use by other programs.

CHCAL.bas: Has two primary functions: 1) Estimates base period CWT recoveries for out-of-base stocks and brood years; 2) Produces FRAM base period data file containing base period cohort abundances, exploitation rates by stock-age-time, maturation rates, adult equivalency factors, and other model parameters such as natural mortality rates, fishery related mortality rates, etc.

MERGE.bas: Combines OOB CWT recovery simulations for several single brood year tag groups for a stock into single base period CWT recovery list.

MRGFE.bas: Special case for Fraser Early stocks of Merge.bas, which combines OOB simulation CWT groups with base period CWT groups.

BASESTOCKEXP.xls: CWT recovery adjustment spreadsheet for base period terminal net fisheries and escapements.

SFMCHIN.c: converts the final FRAM base period data file ("outfile") produced during calibration to an outfile containing equal numbers of marked and unmarked units of each FRAM stock which sum to the original total.

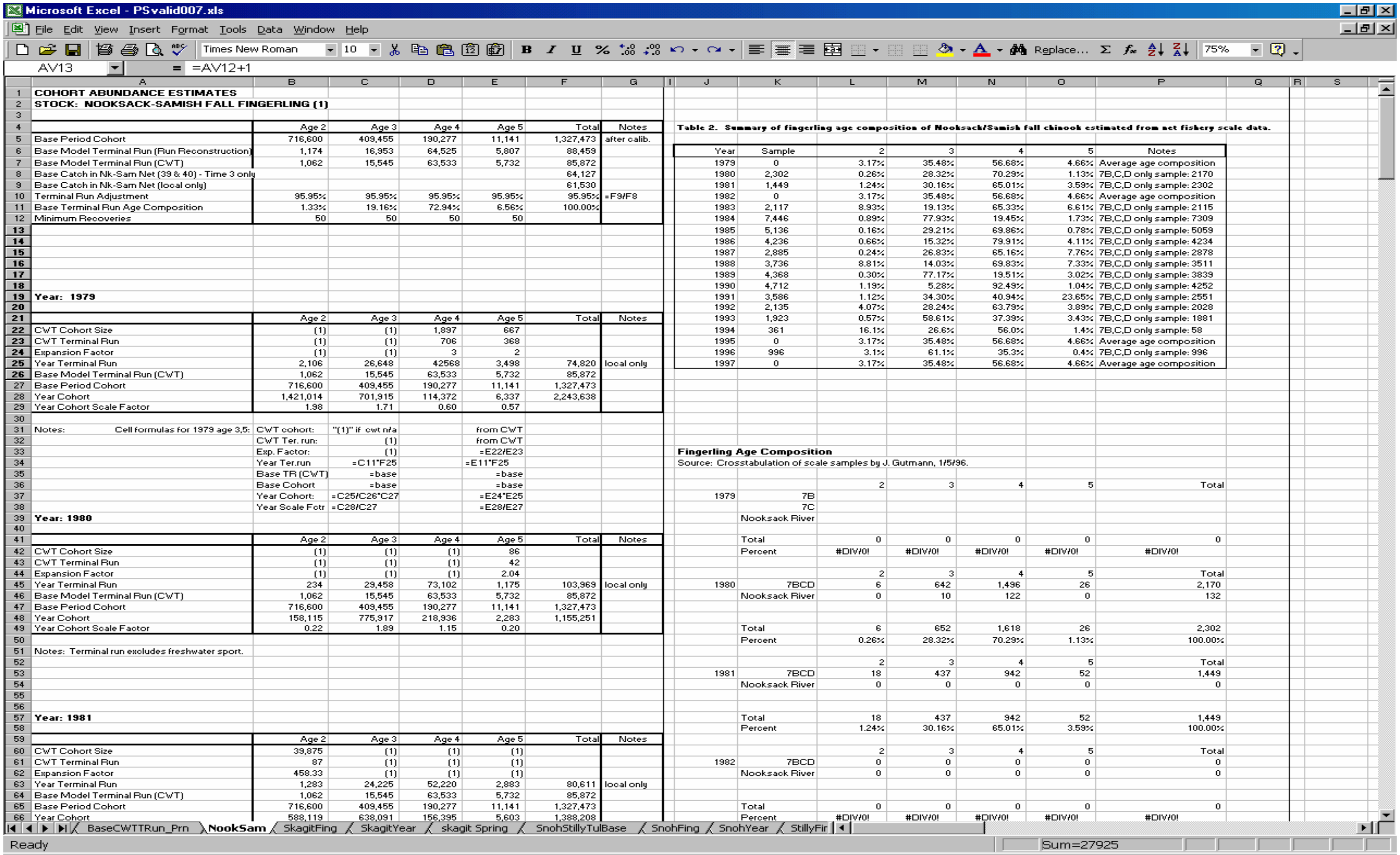
4.6 Stepwise Calibration Instruction

1. Identify CWT groups to represent stocks.
2. Retrieve CWT recoveries from coast wide data source PSMFC.
3. Compile or map the stock and brood year specific CWT recoveries to FRAM fisheries and time periods by age using program FRAMBUILDER.
4. If undergoing major model structure changes to fisheries, stocks, time periods:
   - Update base period landings and escapements.
   - Update terminal run fisheries and escapements with CWT and run reconstruction data in the terminal run spreadsheets for base period stock adjustments.
   - Update validation command files (xxxx.cmd) if warranted.
5. Decide where to "start" the calibration. Generally, where you begin calibration depends on the nature of the changes. Major overalls which involve modifications of base period stock, fisheries, structures, or parameters probably will require building of new base period outfile (stkxxxx .out) and base period command file (base.cmd). Minor changes such as updates to OOB stock(s) are best started with a simulation back to the base period for the updated stock(s). Theoretically, the iterative nature of the calibration minimizes the affect of picking a starting point.
6. Start a new calibration (or pass) using the final input files, validation spreadsheets, stock adjustment spreadsheets, and base and validation .out files and .cmds from the previous calibration (or pass).
7. Run base .cmd and .out in FRAM.
8. Estimate Recruit Scale Factors for validation years using terminal run size and escapement data from this run (Figure 3).
9. Create New Validation and .cmd and .out Files.
10. Run FRAM with new validation command and outfiles to obtain fishery scale factors by fishery year.
11. Estimate Exploitation Rate Scale Factors.
12. Simulate OOB Stocks.
13. Incorporate the new adjusted CWT recoveries from the simulations into the All-Stocks cwt file.

14. Create new .out file. Complete the calibration pass by running Chdat and Chcal on the All-Stocks CWT file to create a new .out file.
15. Run base.cmd and new .out file and begin the next cycle.

4.7 Sample Calibration Inputs, Outputs and worksheets

Puget Sound recruit scalar and validation spreadsheet: Psvalidxx#.xls



Microsoft Excel - PSvalid007.xls

AV13 = =AV12+1

COHORT ABUNDANCE ESTIMATES

STOCK: NOOKSACK-SAMISH FALL FINGERLING (1)

	Age 2	Age 3	Age 4	Age 5	Total	Notes
Base Period Cohort	716,600	409,455	190,277	11,141	1,327,473	after calib.
Base Model Terminal Run (Run Reconstruction)	1,174	16,953	64,525	5,807	88,459	
Base Model Terminal Run (CWT)	1,062	15,545	63,533	5,732	85,872	
Base Catch in Nk-Sam Net (39 & 40) - Time 3 only					64,127	
Base Catch in Nk-Sam Net (local only)					61,530	
Terminal Run Adjustment	95.95%	95.95%	95.95%	95.95%	95.95%	=F9/F8
Base Terminal Run Age Composition	1.33%	19.16%	72.94%	6.56%	100.00%	
Minimum Recoveries	50	50	50	50		

Year: 1979

	Age 2	Age 3	Age 4	Age 5	Total	Notes
CWT Cohort Size	(1)	(1)	1,897	667		
CWT Terminal Run	(1)	(1)	706	368		
Expansion Factor	(1)	(1)	3	2		
Year Terminal Run	2,106	26,648	42568	3,498	74,820	local only
Base Model Terminal Run (CWT)	1,062	15,545	63,533	5,732	85,872	
Base Period Cohort	716,600	409,455	190,277	11,141	1,327,473	
Year Cohort	1,421,014	701,915	114,372	6,337	2,243,638	
Year Cohort Scale Factor	1.98	1.71	0.60	0.57		

Notes:	Cell formulas for 1979 age 3,5:			
		Age 3		Age 5
	CWT cohort:	"(1)" if cwt n/a		from CWT
	CWT Ter. run:	(1)		from CWT
	Exp. Factor:	(1)		=E22/E23
	Year Ter.run	=C11*F25		=E11*F25
	Base TR (CWT)	=base		=base
	Base Cohort	=base		=base
	Year Cohort:	=C25/C26*C27		=E24*E25
	Year Scale Fctr	=C28/C27		=E28/E27

Year: 1980

	Age 2	Age 3	Age 4	Age 5	Total	Notes
CWT Cohort Size	(1)	(1)	(1)	86		
CWT Terminal Run	(1)	(1)	(1)	42		
Expansion Factor	(1)	(1)	(1)	2.04		
Year Terminal Run	234	29,458	73,102	1,175	103,969	local only
Base Model Terminal Run (CWT)	1,062	15,545	63,533	5,732	85,872	
Base Period Cohort	716,600	409,455	190,277	11,141	1,327,473	
Year Cohort	158,115	775,917	218,936	2,283	1,155,251	
Year Cohort Scale Factor	0.22	1.89	1.15	0.20		

Notes: Terminal run excludes freshwater sport.

Year: 1981

	Age 2	Age 3	Age 4	Age 5	Total	Notes
CWT Cohort Size	39,875	(1)	(1)	(1)		
CWT Terminal Run	87	(1)	(1)	(1)		
Expansion Factor	458.33	(1)	(1)	(1)		
Year Terminal Run	1,283	24,225	52,220	2,883	80,611	local only
Base Model Terminal Run (CWT)	1,062	15,545	63,533	5,732	85,872	
Base Period Cohort	716,600	409,455	190,277	11,141	1,327,473	
Year Cohort	588,119	638,091	156,395	5,603	1,388,208	

Table 2. Summary of fingerling age composition of Nooksack/Samish fall chinook estimated from net fishery scale data.

Year	Sample	2	3	4	5	Notes
1979	0	3.17%	35.48%	56.68%	4.66%	Average age composition
1980	2,302	0.26%	28.32%	70.29%	1.13%	7B,C,D only sample: 2170
1981	1,449	1.24%	30.16%	65.01%	3.59%	7B,C,D only sample: 2302
1982	0	3.17%	35.48%	56.68%	4.66%	Average age composition
1983	2,117	8.93%	19.13%	65.33%	6.61%	7B,C,D only sample: 2115
1984	7,446	0.89%	77.93%	19.45%	1.73%	7B,C,D only sample: 7309
1985	5,136	0.16%	29.21%	69.86%	0.78%	7B,C,D only sample: 5059
1986	4,236	0.66%	15.32%	79.91%	4.11%	7B,C,D only sample: 4234
1987	2,885	0.24%	26.83%	65.16%	7.76%	7B,C,D only sample: 2878
1988	3,736	8.81%	14.03%	69.83%	7.33%	7B,C,D only sample: 3511
1989	4,368	0.30%	77.17%	19.51%	3.02%	7B,C,D only sample: 3839
1990	4,712	1.19%	5.28%	92.49%	1.04%	7B,C,D only sample: 4252
1991	3,586	1.12%	34.30%	40.94%	23.65%	7B,C,D only sample: 2551
1992	2,135	4.07%	28.24%	63.79%	3.89%	7B,C,D only sample: 2028
1993	1,923	0.57%	58.61%	37.39%	3.43%	7B,C,D only sample: 1881
1994	361	16.1%	26.6%	56.0%	1.4%	7B,C,D only sample: 58
1995	0	3.17%	35.48%	56.68%	4.66%	Average age composition
1996	996	3.1%	61.1%	35.3%	0.4%	7B,C,D only sample: 996
1997	0	3.17%	35.48%	56.68%	4.66%	Average age composition

Fingerling Age Composition

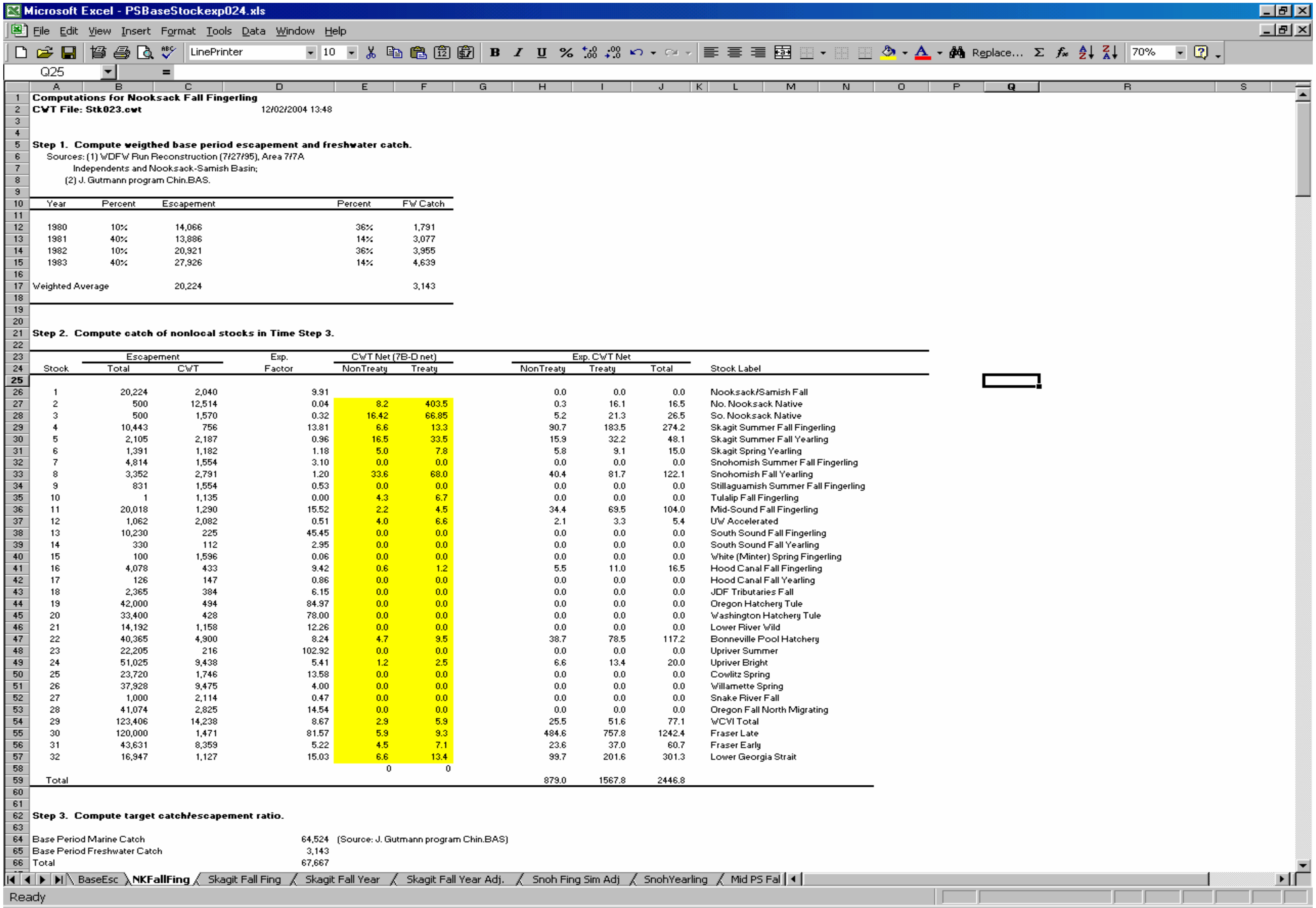
Source: Crosstabulation of scale samples by J. Gutmann, 1/5/96.

		2	3	4	5	Total
1979	7B					
	7C					
	Nooksack River					
	Total	0	0	0	0	0
	Percent	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
		2	3	4	5	Total
1980	7BCD	6	642	1,496	26	2,170
	Nooksack River	0	10	122	0	132
	Total	6	652	1,618	26	2,302
	Percent	0.26%	28.32%	70.29%	1.13%	100.00%
		2	3	4	5	Total
1981	7BCD	18	437	942	52	1,449
	Nooksack River	0	0	0	0	0
	Total	18	437	942	52	1,449
	Percent	1.24%	30.16%	65.01%	3.59%	100.00%
		2	3	4	5	Total
1982	7BCD	0	0	0	0	0
	Nooksack River	0	0	0	0	0
	Total	0	0	0	0	0
	Percent	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

BaseCWTTRun_Prn / NookSam / SkagitFing / SkagitYear / skagit Spring / SnohStillyTulBase / SnohFing / SnohYear / StillyFir

Ready | Sum=27925

Base period freshwater catch and escapement adjustment spreadsheet: PSBaseSoockExpxx#.xls



Microsoft Excel - PSBaseStockexp024.xls

Computations for Nooksack Fall Fingerling

CWT File: Stk023.cwt 12/02/2004 13:48

Step 1. Compute weigthed base period escapement and freshwater catch.

Sources: (1) WDFW Run Reconstruction (7/27/95), Area 7/7A
Independents and Nooksack-Samish Basin;
(2) J. Gutmann program Chin.BAS.

Year	Percent	Escapement	Percent	FW Catch
1980	10%	14,066	36%	1,791
1981	40%	13,886	14%	3,077
1982	10%	20,921	36%	3,955
1983	40%	27,926	14%	4,639
Weighted Average		20,224		3,143

Step 2. Compute catch of nonlocal stocks in Time Step 3.

	Escapement		Exp.	CWT Net (7B-D net)		Exp. CWT Net			
Stock	Total	CWT	Factor	NonTreaty	Treaty	NonTreaty	Treaty	Total	Stock Label
1	20,224	2,040	9.91			0.0	0.0	0.0	Nooksack/Samish Fall
2	500	12,514	0.04	8.2	403.5	0.3	16.1	16.5	No. Nooksack Native
3	500	1,570	0.32	16.42	66.85	5.2	21.3	26.5	So. Nooksack Native
4	10,443	756	13.81	6.6	13.3	90.7	183.5	274.2	Skagit Summer Fall Fingerling
5	2,105	2,187	0.96	16.5	33.5	15.9	32.2	48.1	Skagit Summer Fall Yearling
6	1,391	1,182	1.18	5.0	7.8	5.8	9.1	15.0	Skagit Spring Yearling
7	4,814	1,554	3.10	0.0	0.0	0.0	0.0	0.0	Snohomish Summer Fall Fingerling
8	3,352	2,791	1.20	33.6	68.0	40.4	81.7	122.1	Snohomish Fall Yearling
9	831	1,554	0.53	0.0	0.0	0.0	0.0	0.0	Stillaguamish Summer Fall Fingerling
10	1	1,135	0.00	4.3	6.7	0.0	0.0	0.0	Tulalip Fall Fingerling
11	20,018	1,290	15.52	2.2	4.5	34.4	69.5	104.0	Mid-Sound Fall Fingerling
12	1,062	2,082	0.51	4.0	6.6	2.1	3.3	5.4	UW Accelerated
13	10,230	225	45.45	0.0	0.0	0.0	0.0	0.0	South Sound Fall Fingerling
14	330	112	2.95	0.0	0.0	0.0	0.0	0.0	South Sound Fall Yearling
15	100	1,596	0.06	0.0	0.0	0.0	0.0	0.0	White (Minter) Spring Fingerling
16	4,078	433	9.42	0.6	1.2	5.5	11.0	16.5	Hood Canal Fall Fingerling
17	126	147	0.86	0.0	0.0	0.0	0.0	0.0	Hood Canal Fall Yearling
18	2,365	384	6.15	0.0	0.0	0.0	0.0	0.0	JDF Tributaries Fall
19	42,000	494	84.97	0.0	0.0	0.0	0.0	0.0	Oregon Hatchery Tule
20	33,400	428	78.00	0.0	0.0	0.0	0.0	0.0	Washington Hatchery Tule
21	14,192	1,158	12.26	0.0	0.0	0.0	0.0	0.0	Lower River Wild
22	40,365	4,900	8.24	4.7	9.5	38.7	78.5	117.2	Bonneville Pool Hatchery
23	22,205	216	102.92	0.0	0.0	0.0	0.0	0.0	Upriver Summer
24	51,025	9,438	5.41	1.2	2.5	6.6	13.4	20.0	Upriver Bright
25	23,720	1,746	13.58	0.0	0.0	0.0	0.0	0.0	Cowlitz Spring
26	37,928	9,475	4.00	0.0	0.0	0.0	0.0	0.0	Willamette Spring
27	1,000	2,114	0.47	0.0	0.0	0.0	0.0	0.0	Snake River Fall
28	41,074	2,825	14.54	0.0	0.0	0.0	0.0	0.0	Oregon Fall North Migrating
29	123,406	14,238	8.67	2.9	5.9	25.5	51.6	77.1	WCVI Total
30	120,000	1,471	81.57	5.9	9.3	484.6	757.8	1242.4	Fraser Late
31	43,631	8,359	5.22	4.5	7.1	23.6	37.0	60.7	Fraser Early
32	16,947	1,127	15.03	6.6	13.4	99.7	201.6	301.3	Lower Georgia Strait
				0	0				
Total						879.0	1567.8	2446.8	

Step 3. Compute target catch/escapement ratio.

Base Period Marine Catch	64,524	(Source: J. Gutmann program Chin.BAS)
Base Period Freshwater Catch	3,143	
Total	67,667	

Base period freshwater catch and escapement adjustment spreadsheet: PSBaseStockExp.xls

Microsoft Excel - PSBaseStockexp024.xls

Spreadsheet to compute base period Snohomish Fall Fingerling terminal net harvest.

Sim file stl023, tul023

File: SNFAdj.XLS — This page must be done manually and added into new .cwt file

Date: 02-Dec-04

Dells program does not touch this sheet

Stillaguamish Base

		— Base 8A —			— Base 8 —		
	Escp	NT	T	FW	NT	T	Run
2	126.7	3.4	53.3	23.6	0	0	207.0
3	366.1	1.2	18.4	22.5	60.28	147.59	616.1
4	985.5	0.0	0.0	32.8	0	0	1018.3
5	75.3	0.0	0.0	0.9	0	0	76.2

Tulalip Base

		— Base 8A —				— HR —	
Age	Escp	NT	T	8D+FW	Run	NT	T
2	13.1	1.7	26.5	16.01	57.4	0.0295	0.4624
3	477.7	11.4	177.9	124.8	791.7	0.0143	0.2247
4	588.4	46.0	720.1	147.33	1501.7	0.0306	0.4795
5	55.8	0.0	0.0	9.1	64.9	0.0000	0.0000

Snohomish Base

— Base 8A (zero out Area 8 net and FW net from Stilly simulation)

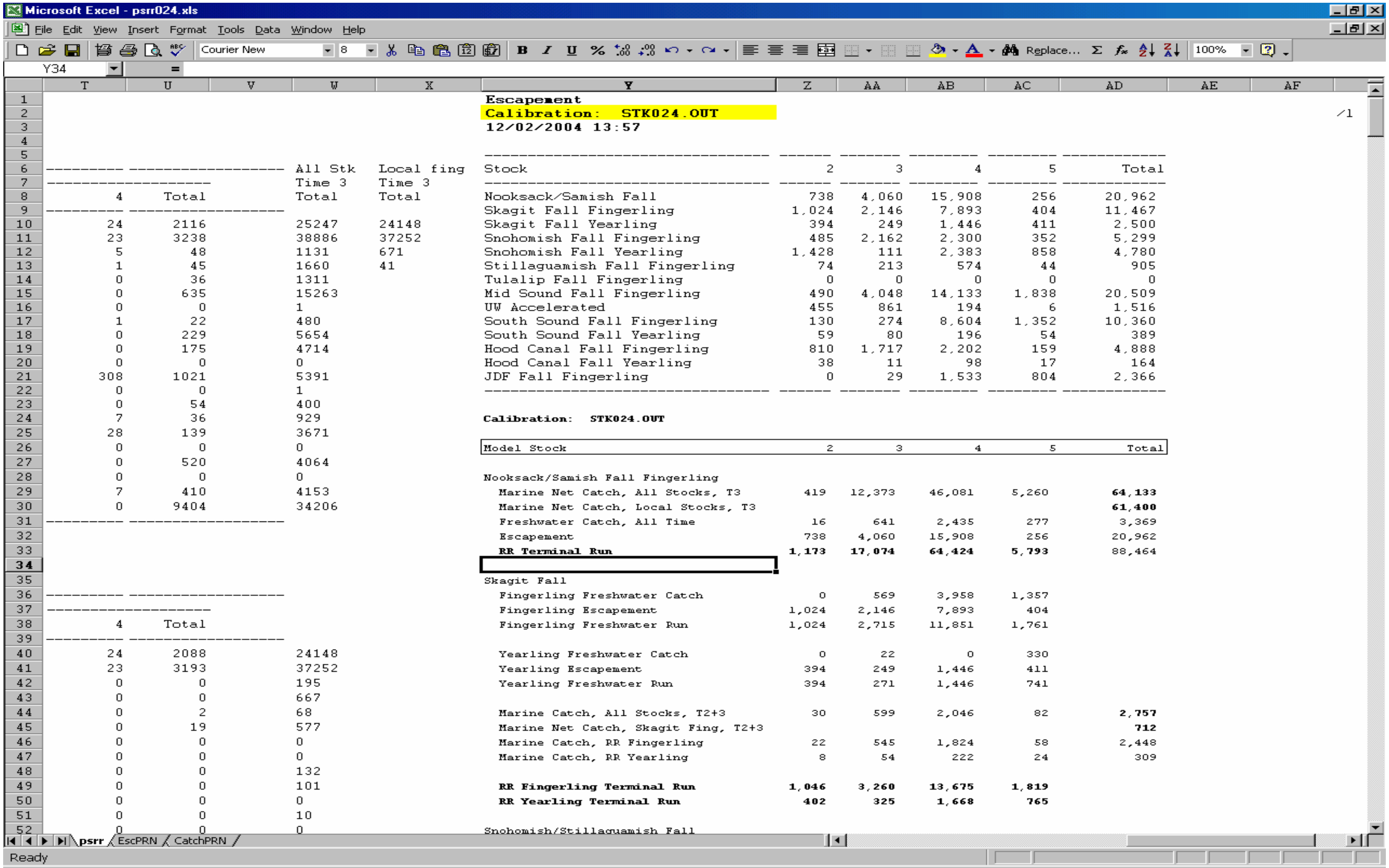
Age	Escp	NT	T		Run
2	105.2	6.1	95.7		207.0
3	468.9	8.8	138.4		616.1
4	498.9	31.2	488.3		1018.3
5	76.2	0.0	0.0		76.2

Tulalip CWT Run	2402.5
Run Reconstruction	484
Expansion Factor	0.201457
Adjusted CWT Esca	5
Base Escapement	1.007284

Skagit Fall Year Adj. | Snoh Fing Sim Adj | SnohYearling | Mid PS Fall Fing | UW Accelerated | SPS Fall Fing | SPSyearlingadj

Ready

Puget Sound Run Reconstruction spreadsheet: PSRR.xls



	T	U	V	W	X	Y	Z	AA	AB	AC	AD
1						**Escapement**					
2						**Calibration: STK024.OUT**					
3						**12/02/2004 13:57**					
4											
5						----------------------------------	------	-------	--------	--------	------------
6	----------	-------------------		All Stk	Local fing	Stock	2	3	4	5	Total
7	-------------------			Time 3	Time 3	----------------------------------	------	-------	--------	--------	------------
8	4	Total		Total	Total	Nooksack/Samish Fall	738	4,060	15,908	256	20,962
9	----------	-------------------				Skagit Fall Fingerling	1,024	2,146	7,893	404	11,467
10	24	2116		25247	24148	Skagit Fall Yearling	394	249	1,446	411	2,500
11	23	3238		38886	37252	Snohomish Fall Fingerling	485	2,162	2,300	352	5,299
12	5	48		1131	671	Snohomish Fall Yearling	1,428	111	2,383	858	4,780
13	1	45		1660	41	Stillaguamish Fall Fingerling	74	213	574	44	905
14	0	36		1311		Tulalip Fall Fingerling	0	0	0	0	0
15	0	635		15263		Mid Sound Fall Fingerling	490	4,048	14,133	1,838	20,509
16	0	0		1		UW Accelerated	455	861	194	6	1,516
17	1	22		480		South Sound Fall Fingerling	130	274	8,604	1,352	10,360
18	0	229		5654		South Sound Fall Yearling	59	80	196	54	389
19	0	175		4714		Hood Canal Fall Fingerling	810	1,717	2,202	159	4,888
20	0	0		0		Hood Canal Fall Yearling	38	11	98	17	164
21	308	1021		5391		JDF Fall Fingerling	0	29	1,533	804	2,366
22	0	0		1		----------------------------------	------	-------	--------	--------	------------
23	0	54		400							
24	7	36		929		**Calibration: STK024.OUT**					
25	28	139		3671							
26	0	0		0		Model Stock	2	3	4	5	Total
27	0	520		4064							
28	0	0		0		Nooksack/Samish Fall Fingerling					
29	7	410		4153		Marine Net Catch, All Stocks, T3	419	12,373	46,081	5,260	**64,133**
30	0	9404		34206		Marine Net Catch, Local Stocks, T3					**61,400**
31	----------	-------------------				Freshwater Catch, All Time	16	641	2,435	277	3,369
32						Escapement	738	4,060	15,908	256	20,962
33						**RR Terminal Run**	**1,173**	**17,074**	**64,424**	**5,793**	88,464
34											
35						Skagit Fall					
36	----------	-------------------				Fingerling Freshwater Catch	0	569	3,958	1,357	
37	-------------------					Fingerling Escapement	1,024	2,146	7,893	404	
38	4	Total				Fingerling Freshwater Run	1,024	2,715	11,851	1,761	
39	----------	-------------------									
40	24	2088		24148		Yearling Freshwater Catch	0	22	0	330	
41	23	3193		37252		Yearling Escapement	394	249	1,446	411	
42	0	0		195		Yearling Freshwater Run	394	271	1,446	741	
43	0	0		667							
44	0	2		68		Marine Catch, All Stocks, T2+3	30	599	2,046	82	**2,757**
45	0	19		577		Marine Net Catch, Skagit Fing, T2+3					**712**
46	0	0		0		Marine Catch, RR Fingerling	22	545	1,824	58	2,448
47	0	0		0		Marine Catch, RR Yearling	8	54	222	24	309
48	0	0		132							
49	0	0		101		**RR Fingerling Terminal Run**	**1,046**	**3,260**	**13,675**	**1,819**	
50	0	0		0		**RR Yearling Terminal Run**	**402**	**325**	**1,668**	**765**	
51	0	0		10							
52	0	0		0		Snohomish/Stillaguamish Fall					

4.8 Example of CHCAL Cohort Analysis Process (Section 3.4 Equations 1-26)

"Backward" Cohort Analysis (Cohort Reconstruction) Using Section 3.4 Equations 1-13

The next section is a numeric example of a simple cohort analysis using the above equations. Some simplifying assumptions are made.

1) The example is for one stock, and one brood.
2) The example consists of four fisheries, two ocean troll fisheries, one ocean sport fishery, and one freshwater net fishery.
3) Size limits differ between the fisheries. However, size at age (i.e. proportion vulnerable) is assumed, not computed.
4) There is a single, annual timestep.
5) The maximum age is five.
6) 'Dropoff' mortality is assumed to be zero.
7) No CNR fisheries or periods

The starting data set, in practice taken directly from the RMIS CWT database is:

	Expanded Recoveries of BY 1995 CWTs				
	Ocean (Immature)			Inside (Mature)	
	Fishery 1	Fishery 2	Fishery 3	Fishery 4	Escapement
Age 5	0.00	4.84	10.00	25.00	8.00
Age 4	8.00	16.50	30.00	25.00	75.00
Age 3	10.00	9.60	40.00	75.00	106.67
Age 2	0.00	10.00	0.00	0.00	10.00

Assumed or input parameter values are:

	Annual Survival Rates	Proportion Vulnerable				Incidental Mortality Rates	
		Fish 1	Fish 2	Fish 3	Fish 4		
Age 5	0.9	99%	99%	99%	99%	Fishery 1	.25
Age 4	0.8	85%	85%	90%	99%	Fishery 2	.25
Age 3	0.7	70%	70%	80%	95%	Fishery 3	.15
Age 2	0.6	40%	40%	70%	95%	Fishery 4	.40

Encounter Rate Adjustment Factors	
Fishery 1	.382
Fishery 2	.382
Fishery 3	.179
Fishery 4	.035

Some of the simplifying assumptions require slightly different subscripting than is used in CHCAL, and some equations used in CHCAL are not needed. For that reason, new equations will be presented for this example. Notation is straightforward and will not be described. All new, simplified equations and numeric examples are enclosed in boxes.

Step 1) Sum up all age 5 mortalities and escapements, then divide by the age 5 survival rate to estimate an age 5 cohort after natural mortality. Corresponds roughly to equations 1, 2, and 4. (At this stage, Shaker mortalities are zero.)

$$Age5Cohort = \sum Age5OceanCatch + \sum Age5TermCatch + Age5Escapement$$
$$Age5Cohort = 14.84 + 25 + 8$$
$$Age5Cohort = 47.84$$

Step 2) The age 4 starting cohort, after natural mortality, consists of the age 4 fish caught in the ocean, the mature run, and those that remained in the ocean to become the age 5 cohort. Corresponds to equations 5 and 6. Age 3 and age 2 cohorts are computed the same way:

$$Age4Cohort = \frac{Age5Cohort}{.9} + \sum Age4OceanCatch + \sum Age4TermCatch + Age4Escapement$$
$$Age4Cohort = \frac{47.84}{.9} + 54.5 + 25 + 75$$
$$Age4Cohort = 207.66$$

$$Age3Cohort = \frac{Age4Cohort}{.8} + \sum Age3OceanCatch + \sum Age3TermCatch + Age3Escapement$$
$$Age3Cohort = \frac{207.66}{.8} + 59.60 + 75 + 106.67$$
$$Age3Cohort = 500.85$$

$$Age2Cohort = \frac{Age3Cohort}{.7} + \sum Age2OceanCatch + \sum Age2OceanCatch + Age2Escapement$$
$$Age2Cohort = 715.5 + 10 + 10$$
$$Age2Cohort = 735.5$$

Once an initial estimate of cohort sizes is available, an initial estimate of Shaker (bycatch) mortality can be made. Required information includes the number of sublegal encounters by fishery, the proportion of sublegals by age and fishery, and the incidental mortality rate.

Step 1) Compute sublegal encounters by fishery – recall that the Encounter Rate Adjustment Factor is the ratio of sublegal to legal encounters in a fishery. Analogous to Equation 7.

$$Fishery1SLEncounters = Fishery1Catch * Fishery1EncAdjustFactor$$
$$Fishery1SLEncounters = 18 * .382$$
$$Fishery1SLEncounters = 6.88$$

$$Fishery2SLEncounters = Fishery2Catch * Fishery2EncAdjustFactor$$
$$Fishery2SLEncounters = 40.94 * .382$$
$$Fishery2SLEncounters = 15.64$$

Similarly,
$$Fishery3SLEncounters = 14.32$$
$$Fishery4SLEncounters = 4.38$$

Step 2) Within each fishery, compute the sublegal cohorts by age (analogous to Equations 11 and 12):

$$Fishery1Age2SubLegPOP = Age2Cohort * (1 - Fishery1Age2PropVulnerable)$$
$$Fishery1Age2SubLegPOP = 735.5 * (1 - .40)$$
$$Fishery1Age2SubLegPOP = 441.3$$
*
*
*
$$Fishery3Age5SubLegPOP = .48$$

For Fishery4, the Cohort size equals the Terminal Run :
$$Fishery4Age2SubLegPOP = (\sum Fishery4Age2Catch + Age2Escape) * (1 - Fishery4Age2PropVulnerable)$$
$$Fishery4Age2subLegPOP = 10 * .05$$
$$Fishery4Age2SubLegPOP = .5$$
*
*
*
$$Fishery4Age5SubLegPOP = .3$$

This generates a set of sublegal population sizes by fishery and age as show below. Bold numbers correspond to the calculations shown above.

Sub Legal Populations				
	Fishery 1	Fishery 2	Fishery 3	Fishery 4
Age 5	0.5	0.5	**0.48**	**0.3**
Age 4	31.1	31.1	20.8	1.0
Age 3	150.3	150.3	100.2	9.1
Age 2	**441.3**	441.3	220.6	**0.5**
Total	623.2	623.2	342.1	10.9

Now the Sublegal proportion by age within a fishery can be easily computed:

Sub Legal Proportions

	Fishery 1	Fishery 2	Fishery 3	Fishery 4
Age 5	0.1%	0.1%	0.1%	3.0%
Age 4	5.0%	5.0%	6.1%	9.2%
Age 3	24.1%	24.1%	29.3%	83.2%
Age 2	70.8%	70.8%	64.5%	4.6%
Total	100.0%	100.0%	100.0%	100.0%

Now Shaker mortalities can be computed by fishery and age (Equation 13):

$$Fishery1Age2Shakers = Fishery1SLEncounters * Fishery1Age2SubLegProportion * Fishery1IMRate$$
$$Fishery1Age2Shakers = 6.88 * .708 * .25$$
$$Fishery1Age2Shakers = 1.22$$
$$Fishery1Age3Shakers = Fishery1SLEncounters * Fishery1Age3SubLegProportion * Fishery1IMRate$$
$$Fishery1Age3Shakers = 6.88 * .241 * .25$$
$$Fishery1Age3Shakers = .41$$

*

*

*

$$Fishery4Age5Shakers = Fishery4SLEncounters * Fishery4Age5SubLegProportion * Fishery4IMRate$$
$$Fishery4Age5Shakers = 4.38 * .03 * .40$$
$$Fishery4Age5Shakers = .05$$

This generates a first estimate of shaker mortalities by fishery and age as shown below. Bold numbers correspond to the example.

Shaker Mortalities

	Fishery 1	Fishery 2	Fishery 3	Fishery 4
Age 5	0.00	0.00	0.00	**0.05**
Age 4	0.09	0.20	0.13	0.16
Age 3	**0.41**	0.94	0.63	1.45
Age 2	**1.22**	0.25	1.38	0.08

Finally, the estimated shaker mortalities are added back into the starting data set of observed recoveries, to generate a new recovery data set that includes shaker mortalities. The new recovery data set is:

	Expanded Recoveries of BY 1995 CWTs +Shakers				
	Ocean (Immature)			Inside (Mature)	
	Fishery 1	Fishery 2	Fishery 3	Fishery 4	Escapement
Age 5	0.00	4.84	10.00	25.05	8.00
Age 4	8.09	16.70	30.13	25.16	75.00
Age 3	10.41	10.54	40.63	76.45	106.67
Age 2	1.22	10.25	1.38	0.08	10.00

Now a backward cohort analysis and shaker mortality estimation is done again with the new recovery data set. This process is repeated until the age 2 cohort size stabilizes (usually three or four iterations).
For this example, the cohort sizes stabilized after 4 iterations. The cohort sizes (after natural mortality) at each iteration were:

	Iteration 1	Iteration 2	Iteration 3	Iteration 4	Iteration 5
Age 5	47.8	47.9	47.9	47.9	47.9
Age 4	207.7	208.3	208.6	208.3	208.3
Age 3	500.8	505.1	505.4	505.3	505.3
Age 2	735.5	747.0	746.7	747.7	747.7

The complete cohort reconstruction looks like this:

		Fishery 1		Fishery 2		Fishery 3		Term	Fishery 4		
	Cohort	Catch	IM	Catch	IM	Catch	IM	Run	Catch	IM	Escape
Age 5	47.9	0.0	0.0	4.8	0.0	10.0	0.0	33.1	25.0	0.1	8.0
Age 4	208.3	8.0	0.1	16.5	0.2	30.0	0.1	100.2	25.0	0.2	75.0
Age 3	505.3	10.0	0.5	9.6	1.0	40.0	0.6	183.1	75.0	1.5	106.7
Age 2	747.7	0.0	1.3	10.0	3.1	0.0	1.4	10.1	0.0	0.1	10.0

Example of "Forward" Cohort Analysis (Forward Reconstruction) for OOB Return to Base Simulation Using Section 3.4 Equations 14-26.

The objective of a return to base, or OOB analysis, is to estimate the CWTs that would have been recovered from a 'current year' brood had that brood been fished on under base period conditions.
Statistics required for an OOB analysis and forward cohort analysis are

1) the maturation rate at age,
2) the exploitation rate by fishery and age on the *vulnerable* cohort of the 'current year' brood,
3) the proportion vulnerable, by age and fishery, during the base period. This may differ from the 'current year' due to size limit changes, and
4) the ratio of the exploitation rate by each fishery in the current year to the exploitation rate of the same fishery during the base period. This scalar is derived independently of the calibration process. Ideally, it would be estimated for each fishery using a number of CWT stocks, similar to the stock in question, which were tagged both in the 'current year' and during the base period. Ideally, the scalar should be estimated using vulnerable cohorts, not total cohorts.

Starting data sets:

Maturation rates are easily computed from the data in the final backwards cohort analysis (analogous to equations 15 and 17:

$$Age2MatRate = \frac{Age2TerminalRun}{Age2Cohort - \sum Age2OceanMortalities}$$
$$Age2MatRate = \frac{10.1}{747.7 - 15.8}$$
$$Age2MatRate = .0138$$

$$Similarly,$$
$$Age3MatRate = .413$$
$$Age4MatRate = .653$$
$$Age5MatRate \equiv 1.000$$

The exploitation rates on the 'current year' vulnerable cohort are simply (analogous to Equation 18):

$$Fishery1Age2ER = \frac{Fishery1Age2Recoveries}{Age2Cohort * (Fishery1Age2PropVulnerable)}$$
$$Fishery1Age2ER = \frac{0}{747.7 * .4}$$
$$Fishery1Age2ER = 0.00$$

$$Fishery1Age3ER = \frac{Fishery1Age3Recoveries}{Age3Cohort * (Fishery1Age3PropVulnerable)}$$
$$Fishery1Age3ER = \frac{10.0}{505.3 * .7}$$
$$Fishery1Age3ER = .0283$$

*

*

*

$$Fishery4Age5ER = \frac{Fishery4Age5Recoveries}{Age5TerminalRun * (Fishery4Age5PropVulnerable)}$$
$$Fishery4Age5ER = \frac{25}{33.1 * .99}$$
$$Fishery4Age5ER = .763$$

Computing the vulnerable cohort exploitation rate for all fisheries and ages yields (values computed in the example are bolded):

Exploitation Rates by age and Fishery ('current year' Vulnerable Cohort)

	Fishery 1	Fishery 2	Fishery 3	Fishery 4
Age 5	0.0000	0.1020	0.2109	**0.7640**
Age 4	0.0452	0.0932	0.1600	0.2521
Age 3	**0.0283**	0.0271	0.0990	0.4311
Age 2	**0.0000**	0.0334	0.0000	0.0000

In this example, the size limit in fishery 3 was less during the base that in the current year, and the size limits in fishery 2 and fishery 3 were the same:

Base Proportion Vulnerable

	Fishery 1	Fishery 2	Fishery 3	Fishery 4
Age 5	99%	99%	99%	99%
Age 4	85%	99%	99%	99%
Age 3	70%	90%	90%	95%
Age 2	40%	85%	85%	95%

In this example, the two troll fisheries are a little smaller than they were during the base period, the ocean sport fishery is much bigger, and the freshwater net fishery has not changed. The exploitation rate scalars are:

	ER Scalar
Fishery 1	0.80
Fishery 2	0.85
Fishery 3	4.00
Fishery 4	1.00

A forward cohort analysis simply starts with the age 2 cohort, and moves it forward through time, with natural mortality and fishing processes occurring instantaneously. Again, the objective is to estimate recoveries by age and fishery during the base period. Starting with the age2 cohort from the current year (analogous to equations 19-26):

$$Fish1Age2BP\,\mathrm{Re}\,c = 747.7 * .99 * \frac{0}{.4}$$
$$Fish1Age2BP\,\mathrm{Re}\,c = 0$$
$$Fish2Age2BP\,\mathrm{Re}\,c = Age2Cohort * Fish2Age2\,\mathrm{Pr}\,opVu\,\ln * \frac{Fish2Age2ExpRate}{Fish2ERScalar}$$
$$Fish2Age2BP\,\mathrm{Re}\,c = 747.7 * .85 * \frac{.0334}{.85}$$
$$Fish2Age2BP\,\mathrm{Re}\,c = 25.0$$
$$Fish3Age2BP\,\mathrm{Re}\,c = Age2Cohort * Fish3Age2\,\mathrm{Pr}\,opVu\,\ln * \frac{Fish3Age2ExpRate}{Fish3ERScalar}$$
$$Fish3Age2BP\,\mathrm{Re}\,c = 747.7 * .85 * \frac{0}{4.0}$$
$$Fish3Age2BP\,\mathrm{Re}\,c = 0$$
$$Age2TerminalRun = (Age2Cohort - \sum OceanFisheryAge2Catches) * Age2MatRate$$
$$Age2TerminalRun = (747.7 - (0 + 25 + 0)) * .014$$
$$Age2TerminalRun = 10.0$$
$$Fish4Age2BP\,\mathrm{Re}\,c = Age2Ter\min alRun * Fish4Age2\,\mathrm{Pr}\,opVu\,\ln * \frac{Fish4Age2ExpRate}{Fish4ERScalar}$$
$$Fish4Age2BP\,\mathrm{Re}\,c = 10.0 * .95 * \frac{0}{1.0}$$
$$Fish4Age2BP\,\mathrm{Re}\,c = 0$$

$$Age3Cohort = RemainingAge2Cohort * Age3NatMortality$$
$$Age3Cohort = (Age2Cohort - \sum OceanFisheryAge2Catches - Age2TerminalRun) * Age3NatMortality$$
$$Age3Cohort = (747.7 - 25.0 - 10.0) * .7$$
$$Age3Cohort = 498.9$$

$$Fish1Age3BP\,\mathrm{Re}\,c = Age3Cohort * Fish1Age3\,\mathrm{Pr}\,opVu\,\ln * \frac{Fish1Age3ExpRate}{Fish1ERScalar}$$
$$Fish1Age3BP\,\mathrm{Re}\,c = 498.9 * .7 * \frac{.0283}{.8}$$
$$Fish1Age3BP\,\mathrm{Re}\,c = 12.35$$

*

*

*

After the above calculations are complete, the result is a reconstructed cohort using a forward analysis as shown below. Derivation of the bold numbers is shown above. Some slight rounding may be present as the table below was computed directly in a spreadsheet.

	Cohort after NM	Fish1	Fish 2	Fish 3	Cohort After Fishing	Terminal Run	Fish 4	Escape	Remaining Ocean Cohort
Age 2	747.7	**0.0**	**25.0**	**0.0**	**722.7**	**10.0**	**0.0**	**10.0**	**712.8**
Age 3	**499.0**	**12.34**	14.3	11.1	461.2	190.4	78.0	112.4	270.8
Age 4	216.6	10.4	23.5	8.6	174.1	113.7	28.4	85.3	85.3
Age 5	76.8	0.0	9.1	4.0	63.7	63.7	48.1	15.5	_-

The data derived from the examples show above, and written to the SIM file are shown in the table below, and are taken directly from data in the forward cohort analysis table in the previous section. Note that this data is directly comparable, and in exactly the same form, as the data set of expanded CWT recoveries used to begin the backward cohort analysis.

	Recoveries of Base Period CWTs from OOB analysis				
	Ocean (Immature)			Inside (Mature)	
	Fishery 1	Fishery 2	Fishery 3	Fishery 4	Escapement
Age 5	0.00	9.1	4.0	48.10	15.5
Age 4	10.4	23.5	8.6	28.40	85.3
Age 3	12.34	14.3	11.1	78.00	112.4
Age 2	0.00	25.0	0.00	0.00	10.00

4.9 Calibration Program "pseudo" code

Chinook FRAM Calibration Programs

ChDat.Bas

This program checks data from the stock spreadsheets and merges it with CWT data from the tag code summary program to create input files for the calibration program.

Input Files are:
- File from stock spreadsheet (for each stock) with stock-specific parameters and target encounter rate (for each fishery). [Stk???.chk]
- File with summarized CWT recoveries (by stock, age, fishery, time step) [Stk???.Cwt]
- File with FRAM fishery effort scalars (by fishery, time step) [Brood??.Scl]

Output Files are:
- Merged Calibration [Stk???.Cal]
- Error Checking [Stk???.Err]

Program Flow

ReadControl – Reads Chk-File Variables
- File names, array sizes, and convergence tolerance

Init – Initialize Arrays

ReadParam – Reads remainder of Chk-File
- Growth (L, T0, K, CV), Terminal Flags (TermFlag), Minimum Legal Size (MinSize), Natural Mortality (NatMort), Release Mortality Rate (MortRate), Dropoff Rate (DropOff), Encounter Rate Adjustment Factor (EncRateAdj), Non-Retention (CNR), Total Landed Catch (TrueCatch), Fishery Catch Impute Flags (ImputeFlag)

ReadRecov – Read CWT-File Variables
- Base Period Escapement (ObsEscpmnt)
- Expanded CWT Recovery (Catch) and Modified Escapement (Escape)

Impute – Copy CWT Recoveries from selected fishery to new fishery

CheckLegal – Check if Legal Sized Population exists for each CWT Recovery
- CompLegProp - Compute Legal Sized Proportion (LegalProp)
  - Mean = L * (1-10**(-K * (T-T0)))
  - SD = CV * Mean
  - LegalProp = 1 – NormalDistr(MinSize, Mean, SD)

CheckCNR – Check if Fishery has Landed Catch for CNR Estimation

ShakDistr – Compute Stock Concentration and set Shaker Inclusion Flag
- Sum CWT Recoveries by Stock, Fishery (StkFishCatch)
- Compute Concentration (Conc = StkFishCatch / TrueCatch)
- Set Inclusion Flags (StkCheck) for Upper 70% of "Conc" Fisheries

ChCal.Bas

This program estimates the base period CWT recoveries for each out-of-base (OOB) stock by brood year.

Input Files are:

Calibration Data from ChkDat.Bas program (Stk???.Cal)
Edited CWT Recovery File (Stk???.Edt)
Brood Year FRAM Fishery Scalars (Brood??.Scl)

Output File is:

Simulation with OOB Stocks included (Stk???.Sim)

Program Flow

ReadControl – Reads Cal-File Variables
- File names, array sizes, and convergence tolerance

Init – Initialize Arrays

ReadParam – Reads remainder of Cal-File
- Growth (L, T0, K, CV), Terminal Flags (TermFlag), Minimum Legal Size (MinSize), Natural Mortality (NatMort), Release Mortality Rate (ShakMortRate), Drop-off Rate (OtherMort), Encounter Rate Adjustment Factor (EncRateAdj), Non-Retention (CNRInput), Total Landed Catch (TrueCatch), Stock Shaker Inclusion Flags (StkCheck)

ReadCatch – Reads Escapement and Edited, Expanded CWT Recoveries
- Base Period Escapement (ObsEscpmnt)
- CWT Recoveries (Escape and StkMortRec.Catch)

CompExpFact - Computes the expansion factor for CWT recoveries by dividing the total (tagged + untagged) observed escapement by the CWT escapement and the total expanded catch in each fishery.
- CWTEscpmnt = Sum of "Escape" by Stock
- ExpFact =ObsEscpmnt / CWTEscpmnt

AddCatch – Add Expanded Catch in all Fisheries and compute the proportion of the catch comprised of each stock.
- Total Catch = ExpFact * Catch (by Stock)
- StockCatchProp = Annual Stock Catch / Total Catch

AdjCatch – Adjust CWT Recoveries for each flagged Fishery to equal Observed Catch (flags are user defined)
- Recovery Adjustment Factor = TrueCatch / AnnualCatch

AddCatch – Recalculate Expanded Catch and Stock Proportions

CompCohort - Reconstruct cohort from CWT recoveries and estimated shaker and CNR mortality. Cohort reconstruction proceeds backwards in time beginning with the oldest age class and last time step.
- Total Escapement = Escapement * ExpFact
- Total Mortality = (Catch + CNR + Shaker) * ExpFact
- Cohort = Total Escapement + Total Mortality
- Cohort in Time Step –1 = Cohort / (1 – NatMort)

Loop Until Age 2 Cohort for all Stocks Stabilizes (< 1% change/loop)
CompIncMort – Compute Incidental Mortality with new Cohort Sizes
CompShakers – Compute Shaker Mortalities in each fishery based upon the ratio of the sublegal population to the legal population. A stock is included within the population for the fishery if its catch comprises more than the value of the parameter StkInclCrit. Encounter rates are adjusted to match those specified in the .Cal file by means of the EncRateAdj array.

Total Encounters (Total Time Step Catch * Target Encounter Rate)
Loop for each Stock
Loop for each Age
Compute Sub-Legal Proportion (SubLegalProp, LegalProp)
Compute Sub-Legal Population (Cohort * SubLegalProp)
Compute Sub-Legal Proportions by Age
Loop for each Age
Shakers = TotalEnc * PropSubPop * ShakMortRate * StockCatch Prop
CompCNR – Compute Non-Retention Mortality using one of two methods
Method 1- Ratio of CNR Days to normal regulation days to get total
Uses normal Fishery stock composition for Non-Retention
Method 2 – External estimates of legal and sub-legal encounters
Loop for each Stock
Loop for each Age
LegProp = ExpFact * StkMortRec.Catch / TotalCatch
Legal-CNR = LegProp * LegalEnc * ShakMortRate
SubLegal-CNR = SubLegProp * SubEnc * ShakMortRate
CohortCheck – Check Age-2 Cohort Size change with Convergence Tolerance
Forward - Adjust recoveries to a different base period using OOB calibration year fishery effort scalars to adjust the base period exploitation rates.

- Compute Exploitation Rates in Recovery Years
Loop for each Time Step
Loop for each Stock
Loop for each Fishery
Loop for each Age
Compute Legal Sized Proportion (LegalProp)
ExRate = ExpFact * Catch / (Cohort * LegalProp)
- Compute Maturation Rates in Recovery Years
Loop for each Time Step
Loop for each Stock
Loop for each Fishery
Loop for each Age

MatRate = TermCohort / [(TermCohort + Cohort) / (1 – NatMort)]

- Read Fishery Effort Scalars from Brood??.Scl File

Initial Cohort = Time 1, Age 2 Cohort / (1 – NatMort)

Loop for each Stock

Check ExRate < 1 else set to .9

Check if new Fisheries have Base Period CWT Recoveries

Loop for each Age

Loop for each Time Step

Loop for each Preterminal Fishery

Compute Legal Sized Proportion (LegalProp)

CompCatch = ExplAdjFact * (ExRate / ExplScale) * Cohort * LegalProp

MixedCatch = Sum of CompCatch

Cohort = Cohort – MixedCatch

MatCohort = Cohort * MatRate

Loop for each Terminal Fishery

Compute Legal Sized Proportion (LegalProp)

CompCatch = ExplAdjFact * (ExRate / ExplScale) * Cohort * LegalProp

MatCatch = Sum of CompCatch

CompEscape = MatCohort – MatCatch

Cohort = Cohort * (1 – MatRate)

Print Output to Stk???.Sim File

- CompEscape (by Stock, Age, Time Step)
- CompCatch (by Stock, Age, Time Step)

SaveDat – Creates FRAM .Out File for validation

ReCalculate Maturation Rates with new Cohort Sizes

Calculate Adult Equivalent (AEQ) Rates with new Maturation Rates

Loop for each Stock

Loop for each Age descending order

Loop for each Time Step descending order

MaxAge AEQ = 1

AEQ = {MatRate + [(1 – MatRate) * (1 – NatMort)]} * (AEQ+1 Time Step)

Print AEQ, Growth, Shaker Inclusion Flags, Initial Cohort Sizes, Model Stock Proportions, Dropoff Rates, Natural Mortality Rates, Shaker Mortality Rates, Encounter Rate Adjustment Factors, Terminal Fishery Flags, Maturation Rates, Exploitation Rates, Shaker Encounter Rates

Merge.Bas

This program merges several non-base period datasets and re-splits the Treaty/Non-Treaty fisheries using preset proportions.

Input File are:

File containing names of ???.sim files to use in merge calculations. [????.cmd]
Simulation files listed in command file above.

Output file is:

Merged simulation file [????.Sim]

Program Flow

Read Command File to get Simulation File names.
Read CWT Recovery Simulation Files

- Species, Stock, Age, Fishery, Time Step, Catch
- Sum Catch for each year

Calculate weighting factors (proportion by year or external if flagged)
Sum weighted catches across years
Split Treaty/Non-Treaty fisheries using PropTreaty array

Treaty Catch Proportion Array

Fishery	Oct-Apr	May-Jun	Jul-Sep
Area 3/4 Troll	1	.19	.22
Area 2 Troll	0	.01	.02
GH Net	0	0	.06
SJ Net	.17	1	.27
NKSM Net	.38	1	.61
JDF Net	.96	1	.71
Area 8 Net	.06	1	.71
Area 8A Net	.81	1	.94
Area 8D Net	1	1	.99
6B/9 Net	.17	1	.54
10-11 Net	.27	1	.6
10A Net	1	1	1
10E Net	1	1	1
HC Net	.53	1	.98
13B Net	1	1	1
13A Net	1	1	1

MrtRatio.Bas

This program calculates the ratio of total mortality to landed catch from the Chinook FRAM base period file.

Input Files are:

Chinook FRAM base period command file [????.CMD]
Chinook FRAM base period calibration file [????.OUT]
Binary save file of Mortality [????MRT]
Binary save file of Cohort Sizes [????COH]

Output File is:

File containing ratios [MrtRatio.Prn]

Program Flow

Read Stock and Fishery names from command file
Read Terminal Fishery Flags from calibration file
Read Landed Catch and Total Mortality from 'MRT' file
Calculate Ratio (Total Mortality / Landed Catch)
If Landed Catch = 0 but Total Mortality <> 0

- Get Cohort Size from 'COH' file
- Ratio = Total Mortality / Cohort Size

Recon.Bas

ReadStk – Read Data from stock text files created by UpDtTxt.Bas

- Base Period Terminal Run (BaseTermRun by age)
- Terminal Run Scalars for OOB years (Scale)
- TermRun = BaseTermRun * Scale (for each year by age)
- Base Period Variables [Cohort Size (Cohort), Maturation Rate (MatRate), Growth (L, T0, K, CV), Terminal Flags (TermFlag), Exploitation Rates (BaseU)]
- Average Ratio of Total Mortality to Landed Catch (MrtRatio)

Loop for each OOB Year

ReadInp – Read Data from stock/year specific SCL file

- Natural Morality Rate (NatMort)
- Minimum Legal Size (MinSize)
- Fishery Scale Factors (UScale)

Loop for each Age

Compute Mature Run (CompMatRun)

- o Compute Legal Sized Proportion (CompLegProp=LegalProp)
- o Compute Terminal Exploitation Rate
  - ▪ U = BaseU * LegalProp
  - ▪ TermU = U * UScale * MrtRatio
- o MatRun = TermRun / (1 – TermU)

Loop for each Time Step

Compute Preterminal Mortality

- ▪ Cohort = Cohort from Time Step +1
- ▪ Cohort = MatRun / MatRate (Terminal Time Step)

Loop for each Preterminal Fishery

- • Compute Legal Sized Proportion (LegalProp)
- • U = BaseU * LegalProp
- • PretermU = U * UScale * MrtRatio

Cohort = Cohort / (1 – PretermU)

Save Results (SaveRes)

- o Print Terminal Run, Cohort Size, Expansion Factor, Recruit Scaler
- o Expansion Factor = Initial Cohort / TermRun
- o Recruit Scaler = Initial Cohort / ModelCohort

[Simulation for Predicted Catch]

Loop for each Age

Loop for each Time Step

- o Cohort = Cohort * (1 – NatMort)

Loop for each Preterminal Fishery

- ▪ Compute Legal Sized Proportion (LegalProp)
- ▪ Catch = UScale * BaseU * LegalProp * Cohort
- ▪ Total = Catch * MrtRatio
- o Cohort = Cohort – TotalMort

Loop for each Terminal Fishery

- ▪ MatRun = Cohort * MatRate

- Compute Legal Sized Proportion (LegalProp)
- Catch = UScale * BaseU * LegalProp * Cohort
- Total = Catch * MrtRatio

End

SfmFram.C

This program splits the stocks into marked and unmarked components for use with mark selective fishery calculations. This process involves splitting the original cohort size for each stock into two equal components and duplicating the variables used for maturation, growth, exploitation, and shakers. Unmarked stock components are always odd numbered and marked components even numbered in the base period and command files.

Input File are:
    Base Period File from Calibration Process. [????.out]

Output file is:
    New Base Period File with Marked and UnMarked components for each original stock [????.out]

Program Flow
    Read Calibration Base Period File.
    For Each Line Determine if Marked/UnMarked Split is needed.
        If Yes, Write the required two sections for each component.

Coho FRAM Base Period Development

by

James F. Packer
Jeffrey D. Haymes
Washington State Department of Fish and Wildlife
600 Capitol Way North
Olympia, Washington 98501-1091

Carrie Cook-Tabor
U.S. Fish and Wildlife Service
510 Desmond Drive SE Suite 102
Olympia, Washington 98503

May 2006

Abstract

This report describes the data types and process involved in developing the model "base" data inputs for coho salmon used in the Fishery Regulation Assessment Model (FRAM). Coho FRAM is the primary tool used to evaluate performance of fisheries regimes adopted by the Pacific Fishery Management Council (PFMC) and the parties to the Pacific Salmon Treaty (PST). The dual role of this model necessitates the complete documentation of the data and algorithms used to create the base period input variables. Documentation is also essential in reaching agreement between all of the parties that use the FRAM.

The base period data is developed into the FRAM base input file through a process of cohort analysis using coded-wire-tag (CWT) groups. The base period data development process was successfully completed for the 1986-1991 catch years and the Coho FRAM has been implemented for all PFMC and PST evaluations since 2002. Previous versions of the Coho FRAM were used for PFMC activities since 1992. Current research investigations include evaluation of additional catch years for future inclusion in FRAM, starting with the 1992-1997 time period. These investigations are subject to review by the PFMC Scientific and Statistical Committee (SSC) and the Pacific Salmon Commission bilateral Coho Technical Committee (PSC CoTC). By having a diverse set of stocks and fisheries included in the base period, FRAM is able to assess the impacts of likely fishery options proposed in current management forums.

Successful implementation of the PSC Southern Coho Management Plan (JTC 2002) depends on the development of planning tools for evaluating fishery regulations. The current research represents a large portion of the essential tasks that have been defined by the CoTC and PSC Southern Panel, which oversees all fishery management issues on the southern US/Canada border.

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1. Introduction

The Coho Fishery Regulation Assessment Model (FRAM) is a forward projecting evaluation tool that uses current year estimates of stock abundances and fishery regulations scaled to a base period average. This model is the primary tool used to evaluate performance of fisheries regimes adopted by the Pacific Fishery Management Council (PFMC) and the parties to the Pacific Salmon Treaty (PST). The adoption of Coho FRAM for both fishery management processes has greatly simplified the exchange of information between all parties charged with managing salmon populations and the user groups affected by the adopted regulations.

The algorithms, input variables, and processing procedures for FRAM are described in the PFMC Model Evaluation Workgroup (MEW) document title "Fishery Regulation Assessment Model – An Overview for Chinook and Coho" (PFMC 2003). The model uses two input files. The first is a command file that contains all the current year variables that are accessible to the user. The second is a base period file that contains all the static information that has been averaged over the range of catch years analyzed. This information includes initial cohort sizes for each stock; exploitation rates by stock, fishery, and time-period; landed catch by fishery and time-period; and gear-related incidental mortality rates by fishery. The purpose of this document is to describe the development of this base-period file and the current research underway to expand the range of catch years available for use in the FRAM.

The base-period development for Coho FRAM uses a coastwide cohort analysis that includes all stocks and fisheries. The cohort analysis is accomplished by combining the results from two Microsoft Visual Basic (VB) applications. The Mixed Stock Model (MSM-VB) estimates stock contribution rates in mixed-stock fisheries using Coded-wire-tag (CWT) recovery data expanded by Production Expansion Factors (PEFs) that represent all production from a particular geographic region. The RRTERM program calculates terminal run estimates for other marine and freshwater fisheries using terminal run and escapement data. The cohort analysis process uses data from these two sources, plus estimates of incidental fishery-related mortalities and natural mortality, to estimate exploitation rates by stock, fishery, and time period.

There is a need to improve the information base available to the PSC Coho Technical Committee (PSC CoTC) for assessing fishery exploitation and stock distribution profiles to be used in regional fishery management planning models. Recent research, where an integrated system of PC programs (MSM-VB) was developed that can quickly generate annual estimates of exploitation rates for Coho salmon from production regions coastwide, overcomes limitations of previous programs employed to generate these data. These older programs were written in several different languages on a UNIX platform, were time consuming, and error-prone. The MSM-VB system will provide the means to accelerate postseason evaluation of each catch year as the data become available. When results are routinely incorporated into an historical database, a convenient source of information will become available to support many types of analyses and facilitate tailoring input files for use in regional Coho fishery planning models (e.g. Coho FRAM).

2. Coho FRAM Base Period Development Process

The Coho FRAM base period development process requires a complete cohort analysis of all stocks and fisheries within the study area. This is accomplished in two distinct and separate steps. First, the MSM-VB program is used to estimate stock composition in the mixed stock fisheries using expanded CWT recovery data. This information is then combined with terminal run and escapement data from the terminal area run reconstruction program (RRTERM) to complete the cohort analysis. Figure 1 shows the relationship between the various programs and the input data sources needed to create the base period file.

The MSM-VB system is comprised of an integrated set of programs. The User interacts with this system through input files that specify the data to be used and the analysis options to be employed (Figure 2).

Generally, the process of creating a new FRAM base period consists of the following steps (Figure 1):

For each Catch Year-

User Specification of Fishery and Stocks (MSM-VB system)-

> The User identifies: (a) The production regions and CWT codes selected to characterize fishery distribution profiles for selected production regions; and (b) The fishery strata to be used for estimation. All Coho salmon stocks coastwide are represented by regional groupings of CWT data.

CWT and Catch Matrices by Stock (MSM-VB system)-

> The MSM-VB System then extracts relevant CWT release and recovery information and maps recoveries and total catch into appropriate fishery strata (annual time strata), creating CWT and catch by stock and fishery matrices.

Production Expansion Factor (PEF) Estimation (MSM-VB system)-

> The above files are then used as input to the MSM-VB to generate estimates of PEFs for each MSM stock. MSM-VB is an analytical tool that estimates PEFs from the stock CWT distribution profiles and reported catches. Two MSM algorithms have been incorporated into the system. One is a simple unconstrained least squares model (ULS) that minimizes the difference in total expanded catch to total observed catch in mixed stock fisheries from California to Alaska. The second is a Bayesian estimation method developed under a separate project completed under the Southern Boundary Restoration & Enhancement Fund (Gazey 2005). PEFs are assumed to be constant across all fisheries for individual production regions.

Catch Adjustment (MSM-VB system)-

> Once the PEFs are estimated, a Catch Adjustment Program (CAP) is used to adjust CWT recoveries so that the estimated and reported catches are equivalent.

Terminal Run Estimates (RRTerm and MSMSplit programs)-

The PEFs estimated by MSM-VB are employed for pre-terminal fishing areas. Because of the complexity of interactions between fisheries and individual stocks represented by regional production units, separate programs (RRTERM and MSMSplit) are employed for the terminal area fisheries. RRTERM uses terminal runsize, harvest, and escapement data, plus user-specified fishery sequences (gauntlet) to generate estimates of escapement and terminal run sizes of individual Coho populations (Management Units, or MUs) within a production region. MSMSplit generates estimates of catches by pre-terminal fisheries for each MU among the fishery-time strata desired for analysis and modeling (PEFs are estimated annually, but fishery-time strata desired for analysis and modeling is often finer).

Cohort Analysis-

Cohort analysis is then performed for individual MUs using estimates of terminal catch and escapement from RRTERM and Pre-Terminal catches from MSMSplit. Results of Cohort Analysis are then placed in a MS Access Database. Finally, MSM-VB includes a program to extract estimates for years specified by the user to generate stock distribution profile input files for FRAM.

3. MSM-VB Project Objectives

Problems experienced during the development of the 1986-1991 stock distribution input file currently used for FRAM and the length of time (nearly 10 years) it took to analyze the data served as the impetus for the development of the new MSM-VB program. The procedures employed to generate the initial Coho FRAM base period file involved the use of programs written in “C”, “PERL”, and text editors. The “C” and “PERL” program code was fragmented into many separate programs and needed substantial user involvement to create and edit the input files needed for each program. The file editing process was prone to transcription errors and the formats of the various input files were undocumented and typically contained several disjointed sections where parameter values had to be entered. Many of the fragmented programs were written in response to analytical problems that arose in the development process. This fragmentation is understandable because the focus of the original work was development of a new technique for analyzing CWT recovery information. In addition to program fragmentation, the “C” code itself was undocumented and key files needed for program compilation were missing.

The MS Visual Basic (VB) language was chosen to create an integrated analysis system because it is widely used in salmon management. Additionally, the use of VB will smoothly integrate with existing analytical tools, including RRTERM and FRAM. All of these programs use the MS Access database program for data input and output. VB is able to use the Access database files without having the user install the Access program and can use the “Active-X Data Object” (ADO) methodology to perform input and output functions for each of the various tables contained in the database file. The ADO method uses the “Standard Query Language” (SQL) for its core functions. This combination of language and database programs forms a seamless development environment that greatly simplifies development work and is easy to modify when necessary. The MSM-VB system combines seven previously separate programs into one and greatly simplifies the analytical process needed for cohort analysis.

Flowcharts depicting the general associations between major processes and data structures handled by the most important subroutines within the MSM-VB program are shown in Figures 3-9. The initialization of the fishery-related arrays is shown in Figure 3. This subroutine creates a temporary table of the selected fisheries combined with the input values for the terminal fisheries. The creation of the temporary stock table is shown in Figure 4. The temporary table of CWT recovery information uses the results from the stock and fishery initialization subroutines (Figure 5). The matrix used for the PEF estimation routines is compressed from the original data using the fishery and stock combinations selected by the user (Figure 6). The calculation of the sweep vector values is shown in Figure 7. The ULS method for PEF calculation is shown in Figure 8 and the general process for the Bayesian analysis is shown in Figure 9.

System validation of the MSM-VB was completed to insure accuracy and compatibility with the previous version of the MSM process. This evaluation was difficult because the old MSM programs could not be recompiled to yield values at intermediate steps of the calculation process. The calculation of PEF values involves association of CWT releases by stock, summarization of CWT recoveries by variable fishery definitions, user-defined PEF values, year-specific combinations of stocks and fisheries, and the addition of terminal run estimates. When errors occurred in the MSM-VB development process, it was difficult to compare input values because of the size and sorting of the data input matrices. The most difficult process to test was summarization of the CWT recovery data. Some of the recovery and catch data changed since the original catch years were analyzed and PSC recovery location codes used to summarize the data varied among catch years.

Two basic tests were performed to evaluate the MSM-VB program algorithms. First, the original input data for the 1986-1991 catch years were modified to be read by the program and the PEF calculations were done. This yielded results that were exactly the same as the original estimates. Second, the MSM-VB program was used to summarize the latest available CWT data and calculate the PEFs. The PEF results were slightly different due to changes in CWT recovery and fishery catch information, which were primarily from Southeast Alaska net and Canadian Strait of Juan de Fuca troll and sport fisheries.

Current research goals include the development of an expanded historical database for all the catch years with adequate CWT recovery information. The priority of analysis is 1992-1997, followed by 1979-1985, and 1998-2005. The period 1992-1997 is given the highest priority because of interest in exploring different stock distribution patterns (inside Georgia Strait vs. outside) and changes in fisheries that have occurred during these years. The period 1979-1985 is given the next highest priority because fishery harvest rates were relatively high, yielding more CWT recoveries for parameter estimation. The period 1998-2005 is assigned the lowest priority because the emergence of non-retention and mark-selective fisheries are problematic for the algorithms employed to estimate PEFs.

Development of the historical database for catch years 1992-1997 is almost complete and required the selection of CWT groups for each production region and year, gathering RRTERM data for each region and catch year, and MSM-VB analysis of PEF values for each catch year. Contacts were made with the management agencies responsible for each region and the majority of necessary data was collected. Some important CWT-based estimates for the RRTERM fisheries using localized PEF values were not readily available and alternate estimates using landed catch and escapement numbers were derived from various agency publications. The CWT associations by stock and catch year have been made and have been reviewed by most of the affected agencies.

The preliminary PEF estimation process for the 1992-1997 catch years yielded some poor results that were very similar to those encountered in the 1986-1991 analyses. The initial calculations, without user-defined PEFs and terminal run data, resulted in many large positive and negative PEF values for some production regions due to poor CWT representation for some stocks and similar recovery distribution patterns among the stocks. Stocks with low numbers of recoveries can be more easily expanded by the MSM algorithms to estimate observed catch. Stocks with similar distribution patterns can be canceled out with large positive and negative MSM estimated PEF values. The pattern of nonsensical initial PEF estimates for stocks during the 1992-1997 catch years was very similar to that observed of the 1986-1991 catch years.

Investigation on the use of user-defined PEFs and terminal run information to force the MSM-VB analysis to produce more plausible results was begun for the 1992-1997 catch years. Preliminary investigations show that the PEF values are very unstable and small changes in one stock can result in major changes in many other stocks. Production regions with poor initial PEF estimates were from the Puget Sound, Washington coast, and Canadian regions. The Puget Sound regions, including the Stillaguamish, Hood Canal, Strait of Juan de Fuca, and Makah production regions, were usually assigned user-defined PEFs. The Washington coastal regions were combined for PEF estimation and usually included the Hoh, Quillayute, and Queets production regions. The Canadian regions from the Georgia Strait and Vancouver Island areas were always combined for PEF estimation. In addition to the use of user-defined PEFs, terminal run data was added for some stocks to help constrain the PEF estimation process to produce more plausible results. Typically this data was either hatchery rack or wild smolt outmigration estimates of tagged to untagged ratios applied to terminal returns. Externally estimated PEF values were used when either the data was considered to be “good” or when the use of terminal area data in the mixed-stock-model continued to produce nonsensical PEF estimates. A preliminary set of plausible PEF values for the catch years 1992-1997 has been developed and needs to be reviewed by the CoTC.

The designation of stocks for the MSM-VB analysis generally follows a set of guidelines for regional groupings of production regions. The production regions defined in MSM-VB are the same as those used in the terminal run reconstruction. The production regions are collections of stock management units. The management units are typically the smallest groupings of Coho stocks that enter into the negotiations for fishery regulation impacts and form the consistent link between MSM-VB estimation, terminal run reconstruction, cohort analysis, and development of fishery regulation models. Management unit groupings are used as MSM-VB stocks when PEF estimation problems occur for production regions or when good quality data is available for a particular management unit. The majority of the management units are designated as hatchery or natural production, rather than a combination of the two types of production.

The MSM-VB fishery groupings combine similar gear and adjacent areas, CWT recovery data, and generally follow the scheme used to estimate the sampling expansion factors for those fisheries. Larger fishery groupings are often made to address poor CWT sampling and for fisheries with similar CWT recovery patterns. The fishery groupings used for PEF estimation are generally different than the groupings used for FRAM and cohort analysis. For example, smaller fisheries with inconsistent sampling and recovery data are often grouped for PEF estimation, while they are broken out for cohort analysis and for use in FRAM.

4. Estimation of PEFs Using the ULS

The Unconstrained linear Least Squares (ULS) model was developed with the assumption that the variance of the estimated catch does not vary with the size of the catch and only the PEF values are estimated. The ULS estimates can be found analytically and there are no constraints on the solution space. The model can be written as:

Equations 4.1 and 4.2--

$$\min \sum_{f} (RC_f - TotalCatch_f)^2$$

Where: *RC* = reported catch in fishery *f* and

$$TotalCatch_f = \sum_{s} (PEF_s \times CWTRec_{s,f}) + e_f$$

Where:

$TotalCatch_f$	Total Landed Catch for year in fishery ***f***
PEF_s	Production Expansion Factor for stock ***s***
$CWTRec_{s,f}$	Coded Wire Tag Recoveries for stock ***s*** in fishery ***f***
e_f	Error in estimate of catch in fishery ***f***

Assumptions of the ULS model include:

1) CWT recoveries are obtained from a random sample.
2) CWT groups represent all stocks caught in modeled fisheries.
3) CWT groups are representative of all untagged production within their release or production region (i.e. ocean distributions of tagged groups and untagged wild stocks are similar).
4) Harvest rates are the same for tagged and untagged stock components in all fisheries.
5) The PEFs are essentially constant across fisheries for each stock.
6) The CWT recovery profile for each stock or production region is distinct from the CWT recovery profile of other groups.

5. MSM-VB Development and Processes

The MSM-VB system was developed to replace a set of computer programs developed for the UNIX operating system. The original programs were written in the “C” programming language and the “PERL” scripting language. These programs used all text-based input and output files that required many steps to create or change. In many cases the output from one program was used to create the input file for the next program in the estimation process. This system was cumbersome and fraught with many transcription errors. Any data or selection changes usually resulted in re-running of all components of the system. This typically required 2-3 days of intense work for two people. Some of the original code for the “C” programs could not be located so it was not possible to re-compile the programs for a new computer platform.

The decision to re-write the MSM estimation procedure into a PC-based system was done so that all the programs used for Coho cohort analysis were in the same language and data could be easily and efficiently exchanged using PC database files. The terminal run reconstruction program (RRTERM) and the FRAM base period construction program are both written in MS Visual Basic and both use MS Access database files for data storage and retrieval. The MSM-VB program uses both these features as well. In addition, the basic data needed was retrieved from the PSMFC RMIS (Pacific Salmon Marine Fishery Council – Regional Mark Information System) internet site so that in the future, the data can be easily obtained and the Access database updated. The previous MSM estimation programs used truncated files of the same information obtained from various sources.

The MSM-VB estimation process for Coho salmon is divided into two distinct procedures for use in cohort analysis. The first involves the estimation of production expansion factors (PEFs) for each stock or stock group selected using CWT data for each catch year analyzed. Each stock group must have CWT recovery data available that represents the relative distribution of fishery impacts. The PEF values are used to estimate all the production from the particular regions they represent, which includes both hatchery and wild production. In the second step, the PEFs are applied to CWT recovery data for a similar but standardized set of stocks that are used for management purposes. The selection of stocks and fisheries for the first step requires the user to make year-specific decisions based on the availability and quality of CWT data. The selection of CWT data to represent each stock is one of the most important steps that must be taken in the analytical procedure. The MSM-VB program was created to aid with the selection of stocks, fisheries, and CWT groups and to apply the MSM algorithms to those selections.

The CWT release, recovery, and catch-sample data were downloaded from the PSMFC RMIS site using the PSC standard format protocol. The decision to use this data source and format was made because the data is readily available and the datafile formats are standardized, allowing for quick update of the data on a catch year basis for any data that changes and when new catch years become available.

The MSM-VB program is organized into 3 main sections (Figure 2). The first section deals with selection of the database file and the recordset within the database file for the catch year being analyzed. The second section involves the CWT release data and association to stock groups. The final section deals with the MSM-VB analysis and contains many functions. Stocks and mixed-stock fisheries can be selected, combined, or deleted. Terminal fisheries can also be defined and estimated CWT recoveries entered. Summaries of total catch by time period and numbers of CWT recoveries by stock and fisheries can be displayed. The matrices of CWT recoveries and catches are very important because they are used in the MSM-VB algorithms for estimating the PEF values. The CWT matrix has always been very difficult to create because it summarizes multiple CWT release codes for each stock group and uses multiple recovery location codes in each fishery for the CWT recovery data. Summarizing the recovery location codes is further compounded by the use of variable length specification criteria for each area and differing codes among the gear types used (sport, troll, and net).

The MS Access database constructed to be used by the MSM-VB program holds multiple recordsets representing each catch year analyzed and/or multiple recordsets for each catch year. This was accomplished by having a unique identification number (RunID) for each recordset in the database. Each variable table in the database file contains records that are linked by the RunID value. Tables were created for the stock, fishery, CWT associations, terminal runs, and rejected CWT recoveries that were linked by the RunID values. Other tables in the database are static and are not linked by the RunID variable. These tables include the "Catch Area" and the "Management Unit" tables used in RRTERM and FRAM, and the CWT release, recovery, and catch-sample data from RMIS. The CWT recovery and catch-sample tables are arranged into separate tables by catch year to reduce size and to allow for quick updating. The RunID information is stored in a separate table and each record is linked to the individual catch year recovery and catch-sample information using the "year" variable in each table. The separation of the data into year-specific tables allows for multiple database files that do not need to retain all the data for all years. The large numbers of recovery records for each catch year required this table design structure. It also lets the user easily export analyses for an individual year or range of years into a single database. This database structure also aids in the sharing of the data and analyses with multiple users of the program.

The MSM-VB system allows the user to estimate PEF values using two different methodologies. The standard method for previous Coho cohort analyses used the Unconstrained Least Squares (ULS) method described by Scott et al. (1995) for the PSC Coho Technical Committee. The committee accepted this algorithm after investigating several calculation techniques including constrained least squares and non-linear approaches. The second method of PEF estimation in the MSM-VB program was developed for this project using a Bayesian estimation technique (Gazey 2005). This method uses a Bayesian approach where weighting factors can be applied to the CWT recoveries by fishery. The estimated PEF values using this technique when all fisheries are weighted equally are identical to those produced by the ULS algorithm. The Bayesian approach using variable fishery weighting factors will be used in future work to allow the fisheries with the most recoveries to have the greatest effect on the PEF estimation process. The production regions from the Columbia River, Puget Sound, and the Strait of Georgia have the highest production of hatchery fish and the highest CWT release and recovery rates. Using the Bayesian method with a fishery-weighting scheme proportional to CWT recovery rates will improve the PEF estimation for these production regions.

A bootstrap method is used to calculate the PEF variances estimated using the ULS algorithm. The Bayesian method also includes a variance calculation as described in Gazey (2005).

The final calculations done by the MSM-VB program are the catch adjustment factors by fishery and time step. These factors are the ratio between the total estimated catch and the observed total catch. The estimated catch is calculated by multiplying the PEF values times the CWT recoveries for each stock. The catch and CWT recovery data for this procedure are summarized by the standard definitions for fisheries and time steps used in the RRTERM and FRAM programs. The catch and CWT recovery data are summarized on an annual basis for estimation of the PEF values so they cannot be used in this step of the cohort analysis.

The general design of the MSM-VB program is illustrated in the flowcharts depicted in Figures 2-9. Figure 2 shows the processes available from the program's main menus. The other flowcharts illustrate the progression of steps and algorithms for each of the major processes. Table 1 is a list of the tables contained in the MS-Access datafile that are used by the MSM-VB program. Table 2 lists the variables in each of these tables.

5.1 Stocks used in MSM-VB PEF Estimation

The selection of stocks for the MSM-VB PEF estimation process closely follows the stock designation used in the Coho FRAM model, but has some variation within each catch year analyzed. The list of FRAM stocks from each production region is listed in Table 3. The stocks used in the MSM-VB process are usually aggregated at the production region level but can be specified for any of the FRAM management units listed in Table 3. The variations are the result of differences in the quality and availability of CWT recovery data for each of the stock groupings. The designation and description of production regions and the individual management units or stocks within the regions is the same for all the major processes used to analyze Coho CWT data. These processes include the terminal run reconstruction program RRTERM, the MSM-VB and associated cohort analysis programs described in this report, the FRAM base period calculation program, and the FRAM program. The estimation of PEF values using the MSM-VB program is usually done for stock groupings on the production region level. Some management units have been estimated separately because of high quality CWT recovery data for that stock. Typically CWT data for the Puget Sound and Columbia River stocks allows for management unit use in some cases. In cases where the distribution data is well known and adequate numbers of CWT recoveries were available, the PEF values were fixed or "user-defined" for those stocks.

One of the more difficult problems to deal with for stock designations is the low CWT tagging rate in many years for some stocks, including those from Southeast Alaska, North and Central British Columbia coast, and California. Most of these areas have low hatchery production and are so remote that it is logistically impractical to tag significant numbers of smolts. In addition, stock distributions for the Alaskan and Northern BC stocks are fairly similar and the PEF estimates are easily confounded in the ULS process, resulting in both high positive and high negative estimated PEF values for the stocks. This was often the case for Puget Sound stocks also with good CWT recovery data, but similar catch distribution patterns. The fixed PEF method could be used with the Puget Sound stocks because better information was available for escapement and total terminal run estimates. In contrast, escapement and terminal run estimates are typically not available for the stocks from remote areas and fixed PEF values could not be estimated and used. In the MSM-VB process, stocks with poor CWT data were usually combined with other production regions. The data availability was fairly similar for most years and the combinations of stocks were also similar between the catch years analyzed. This results in the same PEF value for each of the components of a combined stock grouping. This technique greatly helps in the estimation of total catch in the major marine mixed stock fisheries, but probably gives a somewhat biased view of the relative contribution rates within the combined stock groupings. This outcome is unavoidable given the poor quality and low tagging rates for these areas. This is not an unacceptable outcome because it reflects the low priority for assessment of these stocks.

5.2 Fisheries used in MSM-VB PEF Estimation

The selection of fisheries for the MSM-VB PEF estimation process is similar to the stock selection in that the description of fisheries follows the standardized lists used in the other Coho CWT programs. The list of available fisheries is shown in Table 4 and is the same as that used for the Coho FRAM program. One important difference for the MSM-VB process is the exclusion of many terminal area fisheries. One of the basic assumptions of the ULS estimation technique is that the grouping of CWT recoveries is uniform for all the tag codes used for each stock. This assumption is not satisfied for many terminal areas where the fish from individual tag codes have different migration routes. An example would be for the South Sound group for Puget Sound. This production region stretches from the Seattle area to Olympia and includes many management units. The fish originating from the northern portion of the production region would not be expected to contribute to fisheries in the southern portion. Terminal area fisheries are generally included in the PEF process if they have considerable non-local origin fish contributing to the catch. Estimates of non-local contribution are calculated for those fisheries and are used in the RRTERM program.

Some fisheries are combined for PEF estimation because of low CWT recovery rates or poor sampling rates. These fisheries are typically combined for the PEF estimation but the catch adjustment program and cohort analysis use a standardized set of fisheries for the FRAM base period (Table 4).

5.3 CWT Selection Process

The selection of CWT release groups to associate with the stocks used in the MSM-VB PEF estimation process is the most important first step taken in this analysis. Selection of CWT groups associated with each production region has been completed for Alaska, Canada, Washington, Oregon, and California. Tag group selection was accomplished using 4 steps: 1) Compilation of all Coho CWT release information; 2) Compilation of all CWT recovery data; 3) Assessment of tag recovery rates, tag recovery distributions, and other criteria; and 4) Review of draft CWT lists by state, tribal, and federal fisheries managers.

The CWT release information and CWT recovery records were downloaded from the PSMFC RMIS site using the PSC standard format protocol and placed in the MS-Access datafile for record retrieval and manipulation by the program. All Coho release and recovery data available from RMIS was downloaded for all years in an attempt to avoid missing any data. Earlier versions of the MSM program used CWT release selection criteria for region-of-origin and a small range of brood years, but several problems were encountered and CWTs were missed. The program now provides all possible Coho CWT releases to the program user during the CWT selection process.

The majority of Coho salmon harvested in marine fisheries are 3 year-old fish, so the CWT groups considered for inclusion in the model are from the brood year 3 years previous to the catch year being analyzed. Exceptions were made for Alaskan and northern Canadian stocks that have significant fishery contributions and escapements of 4 year-old fish and from Oregon coastal ocean ranching facilities with primarily 2 year-old returns. The northern stocks have fish that reside in freshwater for two years, resulting in four year-old returns, while the Oregon ocean ranching facilities used accelerated rearing practices that reduced ocean residency time. Our data base development process has determined that very little information for these years is available for representing California Coho production. While our intention was to include complete representation of Coho CWT and production data, this discovery is not considered a serious shortcoming to the project's purpose.

To assess a CWT group for inclusion in the model, estimated tag recoveries were summed over all fisheries for each tag group by catch year and the tag recovery rate (estimated tag recoveries in fisheries / total tags released *100) was calculated. Mean tag recovery rates and standard deviations were then calculated for each management unit by age and catch year using all tag codes with at least 1 estimated recovery for that catch year. A CWT group was included in the lists of potential CWTs to use in the MSM-VB process if its tag recovery rate was above the lower confidence limit (alpha = 95%) of the mean. Regional biologists familiar with the stocks then reviewed the draft CWT selections and release data for each area and additional deletions to the list were made. CWT groups were removed from consideration if they were released early due to flooding, released diseased or the stock was transferred and released outside of the management unit area. The current CWT groups chosen to represent MSM-VB production regions and management units are listed in Table 5.

6. RRTERM Program

The RRTERM program was designed to calculate and store estimates of terminal runsize, terminal harvest, and escapement for all Coho salmon populations defined in the MSM-VB/FRAM management system. It was created to accomplish two major objectives:

1) To serve as a repository for terminal area and escapement information;
2) Replace run reconstruction algorithms that had been used for terminal area runsize estimation for Puget Sound Coho populations for the 1967 to 1996 catch years. Those algorithms had several flaws and did not make use of CWT recovery information when it was available.

There are currently 34 production regions (PRs) on the Pacific Coast for which terminal runsize estimates are derived for the Coho cohort reconstruction process. Terminal run reconstruction estimates are required for each of these PRs to estimate the abundance of the portion of the cohort not accounted for by the MSM-VB PEF analysis of stock composition in mixed stock fisheries. In addition, the MSMSplit program uses the relative abundance of the terminal runsize estimates to help estimate the MSM-VB user-defined PEF values.

The production regions were identified on the criteria of being geographically distinct freshwater/estuarine location nodes from which significant natural and or hatchery-origin salmon production originates. There are usually multiple individual Management Units (MUs) within each PR, each representing distinct major freshwater natural spawning streams, hatcheries, or net pens.

A terminal reconstruction consists of the sum of:

1) Spawning escapement(s) for each of the stock(s) being reconstructed, for year $_x$;

2) Portion of the terminal marine and freshwater fishery catch(es) assigned to each of the stock(s) being reconstructed for year $_x$, time period $_i$, and optionally;

3) Estimates of mortality from non-landed fishery losses, marine mammal predation, or other sources.

The RRTERM terminal runsize estimation program uses the following inputs to derive the terminal runsize estimates for each MU in each PR:

1) Adult (age 3 and or 4) escapement values for each MU;
2) Adult landed catch values for each sport and commercial fishery described in the RRTERM model (values typically constrained to Sept. 1-Dec. 31 in the estuarine fisheries, because landing prior to this time period often have significant numbers of non-local origin Coho present, and the MSM-VB model itself allocates these catches to locations of origin);
3) PEFs (juvenile-release or adult-recovery based);
4) CWT recovery values from each sampled fishery (constrained to the same time period of the fishery catch inputs);
5) The non-local catch estimate for each MSM-VB fishery flagged for terminal area calculation (this estimate is not available until the initial MSM-VB run, which typically is done after the preliminary terminal runsize estimates are completed).

Escapement data used in this process were collected from the WDFW annual post season hatchery escapement reports, summaries provided by ODFW biologists, natural escapement estimates directly provided by regional state and tribal biologists, the PFMC 2004 Review of Ocean Salmon Fisheries report (PFMC 2005), and other sources. Catch data were retrieved from the WDFW commercial fish ticket database, WDFW annual post-season sport catch reports, summaries provided by ODFW biologists, PFMC 2004 Review of Ocean Salmon Fisheries report, and other sources.

Fishery catch allocation to the MUs of origin is conducted in the RRTERM model by a combination of CWT recovery expansions and proportional escapement-based catch allocation. The CWT recoveries are used to estimate the portion of the catch belonging to each MU for which tag recovery data is provided by multiplication of the MU-of-origin-specific CWT recoveries for each fishery by the MU-of-origin-specific PEF value provided for each MU. The order of precedence for the allocation of catch in each fishery is to first allocate catch to MUs for which CWT recovery values were entered, then, the remainder of the catch is distributed among the MUs for which CWT data were not provided (or not used due to problems with the CWT recovery data and/or PEF) by the ratio of the MU escapement values. The raw CWT recovery data were extracted from the PSMFC RMIS database and imported into Microsoft Access for summarization and analysis. To expand the CWT recoveries for terminal fisheries, PEF values for the CWT grouping were calculated.

There are two types of terminal area PEFs:

1) Release PEF = Total number of smolts produced from MU / Number of tagged smolts released from MU.
2) Recovery PEF = Total adults recovered in hatchery rack or extreme terminal fishery / Number of tagged adults recovered in hatchery rack or extreme terminal fishery.

Release PEFs were used almost exclusively for the CWT recovery expansions in this process due to the consistent availability of information to derive these values. The historical hatchery release data for Washington was downloaded from the RMIS database to derive the values. The use of recovery PEFs was briefly examined, but the difficulty of finding "clean" fisheries that would allow calculation of an accurate terminal adult PEF was problematic, and apparent year-to-year inconsistencies in sampling/tag expansion accuracy at many hatchery rack locations made use of hatchery-rack derived PEFs difficult also.

Proportional-abundance based estimation of management unit catches is the default method used in the RRTERM program. This method assumes that a gauntlet of terminal fisheries can be defined for the management unit(s) in question based on knowledge of the migrational paths of the units. Then, as Starr and Hilborn (1988) describe, the terminal return is reconstructed working backwards from the escapement and last terminal (or extreme terminal) fishery. It is assumed that the management units present in each fishery are known and that the harvest rate in a fishery is equal on all management units present in the fishery. Then, for the last fishery in the gauntlet, the proportion of each management unit exiting the fishery is estimated using escapement estimates.

Equations 6.1 and 6.2 —

$$\hat{\pi}_{jkl} = \frac{\hat{E}_j}{\sum_{j \in l} \hat{E}_j}$$

and its variance,

$$V(\hat{\pi}_{jkl}) = \hat{\pi}^2_{jkl} \left[\frac{V(\hat{E}_j)}{\hat{E}^2_j} + \frac{\sum_{j \in l} V(\hat{E}_j)}{(\sum_{j \in l} \hat{E}_j)^2} \right]$$

where:

$\hat{\pi}_{jkl}$	MU proportion of escapement for stock ***j*** in production region ***k*** for fishery ***l***
E_j	Escapement for stock ***j***
V	Variance of parameter
C_{jkl}	Catch of stock ***j*** in production region ***k*** for fishery ***l***
N_{jl}	Cohort Size (Abundance) for stock ***j*** for fishery ***l***

Under the assumption of equal harvest rates on all management units present in the fishery, then this proportion can be used to apportion the terminal catch in the last fishery to each management unit by,

Equations 6.3 and 6.4 —

$$\hat{C}_{jkl} = C_l \ \hat{\pi}_{jkl}$$

with a variance of,

$$V(\hat{C}_{jkl}) = V(\hat{C}_l)\hat{\pi}^2_{jkl} + \hat{C}^2_l V(\hat{\pi}_{jkl}) + V(\hat{C}_l)V(\hat{\pi}_{jkl})$$

The terminal area abundance of management unit *j* entering the last fishery will then be,

Equation 6.5 –

$$\hat{N}_{jl} = \hat{E}_j + \hat{C}_{jl}$$

where *l* indicates the last fishery. The variance of the abundance is the sum of the variances of the escapement and the estimated catches.

The combined abundance for all management units entering this last fishery is calculated similarly. The proportion of management unit *j* exiting the next to last fishery is,

Equation 6.6 –

$$\hat{\pi}_{jk(l1)} = \frac{\hat{E}_j + \hat{C}_{jkl}}{\sum_{j \in l} \hat{E}_j + \sum_{j \in l} \hat{C}_{jkl}}$$

and the variance is estimated as in equation above for the last fishery. This proportion is then used to apportion catches in the next to last fishery. In this manner the abundances of management units entering each fishery can be estimated and the proportion used to allocate the catch to each unit. The equation for estimation of this proportion for fisheries prior to the last fishery is,

Equation 6.7 –

$$\hat{\pi}_{jk(lx)} = \frac{\hat{E}_j + \sum_{\eta}^{x} \hat{C}_{jk(l\eta+1)}}{\sum_{j \in l} \hat{E}_j + \sum_{j \in l} \sum_{\eta}^{x} \hat{C}_{jk(l\eta+1)}}$$

where *x* indicates the location of the fishery away from the last fishery (e.g. *x*=1) for the second to last fishery. The variance of this ratio is estimated as described above.

As the process moves forward in the fishery gauntlet the number of management units assumed to be present in the terminal fishery might increase or decrease. The total terminal runsize of a management unit is then estimated by summing all the escapement and catch estimates for that unit and the variance estimated by summing their variances.

6.1 Overview of 1992-97 Terminal Runsize Estimation Process

It was our intent to prepare the terminal runsize estimates for the 1992-97 time period in a cooperative process with state and tribal biologists. An RRTERM/MSM overview meeting was held in July 2004 at the Northwest Indian Fisheries Commission (NWIFC) office in Olympia, Washington. Attendees included technical representatives from WDFW, NWIFC, Boldt Case area tribes, and CDFO. Presentations were conducted showing the basic theory and design of the MSM and RRTERM process and software tools that had been developed. A follow-up meeting to discuss coastal Washington terminal runsize estimation issues was held in December 2004 at the NWIFC office in Forks, Washington.

Over the course of winter-summer of 2005 a series of individual meetings were held between WDFW and technical representatives of the Nooksack, Swinomish, Upper Skagit, Tulalip, Quileute, and Quinault Tribes to discuss the terminal runsize estimation process for the Nooksack-Samish, Skagit, Stillaguamish-Snohomish, Quillayute, Queets, Quinault, and Grays Harbor production regions. Preliminary estimates of terminal runsize with co-manager technical agreement have been completed for the Skagit, Stillaguamish-Snohomish, Quillayute, and Queets productions regions. The remainder of the current production regions estimates presented in this report for Washington and Oregon are preliminary estimates to facilitate the MSM-VB model run process, and have not yet been subject to formal review or agreement by the co-managers in each production region. No estimates have had “non-local” catch removed yet, pending completion of the initial MSM-VB estimation process.

Appendix C contains summary tables of the terminal runsize estimates for each production region for the 1992-1997 time period, and relevant background information specific to each terminal estimate.

7. User-Defined PEF Values

The preliminary user-defined PEF values for Coho stocks originating in Washington State are listed in Table 6. These values were calculated from hatchery release numbers of tagged and untagged fish and the estimated numbers of wild-origin smolts. The hatchery release information was obtained from the PSMFC RMIS database. The estimated wild smolt numbers were obtained from the WDFW preseason forecast report. Actual estimated numbers were used from river systems that have wild smolt enumeration projects. The numbers for other areas were derived by formulas relating size of the watershed to expected production potential. These estimates are potentially biased by the wild smolt estimates but are reasonable for the expected rate of CWT returns for each of the stocks.

The only other production region where user-defined PEF values were used in these analyses was the Upper Fraser / Thompson River stock (FRSUPP). The management of this stock has been significantly important for Canada for several years because of low returns and is usually the focus of bi-lateral fishery management issues because of the constraints on overall exploitation rate due to its critical status. Extensive analyses have been done on escapements and exploitation for recovery planning purposes. The user-defined PEF values were calculated using the CWT recovery data for the tag codes associated with this production region so that the MSM-VB analysis would exactly match the data used in the recovery planning process. This was accomplished by dividing the total marine landed catch by the number tags from the MSM-VB summary as shown in Table 7. The total marine landed catch was calculated by multiplying the escapement number times the ratio of total marine exploitation rate over the escapement rate. The escapement and exploitation rate numbers were obtained from the Canadian recovery planning documents.

A subjective evaluation of each user-defined PEF value was made and a flag of “good” or “poor” was assigned. The stocks assigned “good” PEFs were considered to have reasonable estimates of escapement, terminal run size, and CWT recovery rates.

8. Revised Canadian CWT Recoveries and Catch Data

The expansion of CWT recoveries for the Canadian fisheries in the Johnstone Strait and lower Fraser River areas were aggregated into large geographic areas for most of the catch years to be analyzed in this project. These fisheries are now managed at a finer scale than these larger aggregated areas and it was necessary to identify and expand the CWT recoveries by the new fisheries designations, and apportion the catch by the new fisheries. This work was done by the CDFO Southern Boundary Restoration and Enhancement Fund project (Tompkins 2005) and the updated information is stored in separate tables for record keeping in the MSM-Access datafile.

9. Catch Adjustment Procedure

The Catch Adjustment Procedure (CAP) is used to modify the summed estimated catch by stock to equal the observed total catch by fishery and time period. The same CWT release and recovery information used in the MSM-VB analysis to estimate PEFs are used in CAP, except that the catch and recovery data are summed using the standard FRAM definitions for fisheries and time periods. A catch adjustment factor is calculated for each fishery/time-period stratum and applied to the estimated catches by stock. This can be viewed as applying the stock composition estimated by CWT recoveries to total landed catch. The adjustment procedure insures that all catch is assigned to the contributing stocks in each stratum in the forwarding projecting FRAM program.

An exception to the adjustment procedure is made for stocks with “good” user-defined PEF values. The catch for these stocks is deleted from the total and estimated catches before the catch adjustment factor is calculated. The user-defined PEFs flagged as “poor” are included in the calculation.

CAP also generates estimates of “non-local” catch in terminal fisheries. Non-local refers to Coho salmon originating from production regions outside of where the terminal fishery occurs. The non-local estimates are used by RRTERM to calculate stock composition in terminal fisheries with substantial non-local contribution. These terminal fisheries generally had more than 5% non-local contribution for more than half of the years analyzed.

Equations 9.1- 9.5 —

$$CAPCatch_{f,t} = TotCatch_{f,t} - \sum_{s=s1}^{s2}\sum_{a}(PEF_{s,a} \times CWTRec_{s,a,f,t})$$

$$EstPEFCatch_{f,t} = \sum_{s=s3}^{s4}\sum_{a}(PEF_{s,a} \times CWTRec_{s,a,f,t})$$

$$CatAdjFact_{f,t} = CAPCatch_{f,t} / EstPEFCatch_{f,t}$$

$$MSMCatch_{s,a,f,t} = MSMCatch_{s,a,f,t} \times CatAdjFact_{f,t}$$

$$NonLocal_{f,t} = \sum_{s=s5}^{s6}\sum_{a} MSMCatch_{s,a,f,t}$$

Where:

$CAPCatch_{f,t}$	Catch after deleting for MSM stocks with "good" PEF values
$TotCatch_{f,t}$	Total Catch for fishery ***f,*** at time step ***t***
$PEF_{s,a}$	Production Expansion Factor for stock ***s,*** age ***a***
$CWTRec_{s,a,f,t}$	Coded Wire Tag Recovery for stock ***s,*** age ***a***, in fishery ***f,*** at time step ***t***
$EstPEFCatch_{f,t}$	Estimated Catch of remaining stocks for fishery ***f*** at time step ***t***
$MSMCatch_{s,a,f,t}$	Catch for MSM stock ***s,*** age ***a***, in fishery ***f*** at time step ***t***
$NonLocal_{f,t}$	Catch of NonLocal stocks in terminal fishery ***f*** at time step ***t***
Stocks s_1, s_2	List of stocks with "good" or user-defined PEF estimates
Stocks s_3, s_4	List of stocks with estimated PEF estimates (from MSM)
Stocks s_5, s_6	List of stocks from other regions in terminal fishery ***f*** at time step ***t***

10. MSMSplit Program Algorithms

The MSMSplit program divides the stock aggregations used for the MSM-VB process into the management unit components defined in the terminal run reconstruction program RRTERM. The MSM-VB stocks are generally defined as either production regions or management units. The production regions are groupings of MUs that are used for management purposes. The exceptions for MSM-VB stocks are aggregations of production regions for northern British Columbia in years without CWT representation and Columbia River late runs.

The program determines which MUs are included in each MSM-VB stock definition and uses the terminal run proportions from RRTERM to allocate the MSM catch estimates. The MSM-VB stock names must match either the PR or MU names from RRTERM. The terminal run proportions from RRTERM are recalculated when MSM-VB stock corresponds to a MU name because that stock is longer included in the production region PEF estimate. A file containing catch estimates by MU is created for use in the cohort analysis program.

The MSM-VB stocks that are aggregations of production regions are allocated with user-defined proportions contained in the MSM-VB input file. These estimates are usually averages of recent years.

The Columbia River late run stock group is treated essentially like a separate production region for MSM-VB estimation. The MU components are lower river hatchery and Clackamas River wild. They are split using the RRTERM proportions separately from the early-timed MUs.

Equations 10.1- 10.4 —

$$MSMProp_{s,a} = RRPct_{s,a} \Big/ \sum_{s=s1}^{s2} \sum_{a} RRPct_{s,a}$$

$$Catch_{s,a,f,t} = MSMCatch_{k,a,f,t} \times MSMProp_{s,a} \quad \textbf{where stock } \boldsymbol{s} \textbf{ is subset of MSM stock } \boldsymbol{k}$$

Columbia River Late Hatchery

$$Catch_{h,a,f,t} = ColLHW_{f,t} \times (RRPct_{h,a,s,a} \big/ (RRPct_{h,a,s,a} + RRPct_{w,a,s,a}))$$

Columbia River (Clackamas) Late Wild

$$Catch_{h,a,f,t} = ColLHW_{f,t} \times (RRPct_{w,a,s,a} \big/ (RRPct_{h,a,s,a} + RRPct_{w,a,s,a}))$$

Where:

$MSMProp_{s,a}$	MU proportion of MSM stock
$RRPct_{s,a}$	MU proportion of Terminal Run for stock ***s,*** age ***a*** from RRTERM
$Catch_{s,a,f,t}$	Landed Catch by MU for stock ***s,*** age ***a***, in fishery ***f,*** at time step ***t***
$MSMCatch_{k,a,f,t}$	Catch for MSM stock ***k,*** age ***a***, in fishery ***f*** at time step ***t***
$ColLHW_{f,t}$	Catch for MSM stock Columbia River Late Hatchery/Wild
Stocks s_1, s_2	List of MU stocks contained in MSM grouping
Stock *k*	MSM stock grouping of MUs
Stocks *h,w*	Columbia River Late Hatchery and Clackamas River Late Wild

11. MSM Cohort Analysis Program Algorithms

The MSM Cohort Analysis Program calculates abundances by MU and time-step using catch data from the MSMSplit program, terminal catch and escapement data from RRTERM, and estimates of incidental fishing mortality and natural mortality. The cohort abundances are then used to calculate exploitation rates that can be used for fishery modeling purposes.

The cohort reconstruction starts with escapement and works backwards through time adding fishery impacts and natural mortality. Landed catch data comes directly from MSMSplit and RRTERM. Incidental fishery impacts include dropoff and non-retention. Dropoff is calculated as add-on mortality to landed catch. Non-retention estimates are input as numbers of dead fish and must be associated with the stock composition of another fishery. The associated fishery is generally the same gear/area fishery in another time-step or an adjacent area fishery in the same time-step. A small group of fisheries with either no sampling or no CWT recoveries were handled in the same way as the non-retention estimates. These fisheries were typically in terminal areas with relatively small catches.

The exploitation rate calculations were done using either the initial cohort sizes or with the time-step cohort sizes. The non-retention mortalities were treated like landed catch for these computations. Exploitation rates using the initial abundances can be summed across time-steps but are not particularly useful for modeling of regulation impacts. The time-step exploitation rates are used to create the base period information for FRAM. They are calculated after natural mortality has been subtracted from the time-step cohort size to match the sequence of computations used in FRAM.

Equations 11.1- 11.6 —

$$Cohort_{s,a,t} = Cohort_{s,a,t+1} + (\sum_{f}(Catch_{s,a,f,t} + IncMort_{s,a,f,t}) + Escape_{s,a,t}) \Big/ (1 - NatMort_t)$$

$$IncMort_{s,a,f,t} = Dropoff_{s,a,f,t} + CNR_{s,a,f,t}$$

$$Dropoff_{s,a,f,t} = Catch_{s,a,f,t} \times DropoffRate_{f,t}$$

$$CNR_{s,a,f,t} = CNRMort_{f,t} \times (Catch_{s,a,f',t} / TotCatch_{f',t})$$

$$Catch_{s,a,f,t} = NOSMort_{f,t} \times (Catch_{s,a,f',t} / TotCatch_{f',t})$$

$$ExplRate_{s,a,f,t} = Catch_{s,a,f,t} / (Cohort_{s,a,t} \times (1 - Natmort_t))$$

Where:

$Cohort_{s,a,t}$	MU Population Size for stock ***s,*** age ***a***, at time step ***t***
$Escape_{s,a,t}$	Escapement for stock ***s,*** age ***a***, at time step ***t***
$Catch_{s,a,f,t}$	Landed Catch by MU for stock ***s,*** age ***a***, in fishery ***f,*** at time step ***t***
$IncMort_{s,a,f,t}$	Incidental Fishery Mortality for stock ***s,*** age ***a***, in fishery ***f,*** at time step ***t***
$Dropoff_{s,a,f,,t}$	Dropoff Mortality for stock ***s,*** age ***a***, in fishery ***f,*** at time step ***t***
$DropoffRate_{f,t}$	Dropoff Mortality Rate for fishery ***f,*** at time step ***t***
$CNRMort_{f,,t}$	Total Non-Retention Mortality for fishery ***f,*** at time step ***t***
$CNR_{s,a,f,,t}$	Non-Retention Mortality for stock ***s,*** age ***a***, in fishery ***f,*** at time step ***t***
$NOSMort_{f,,t}$	Total Catch for fishery ***f,*** at time step ***t*** with No Sample or No CWT Recovery
Fishery *f'*	Associated Fishery for stock composition of CNR and NOS mortalities
$ExplRate_{s,a,f,,t}$	Exploitation Rate for stock ***s,*** age ***a***, in fishery ***f,*** at time step ***t***

12. Coho FRAM Base Period Algorithms

The Coho FRAM Base Period file is generated by averaging cohort sizes and exploitation rates over a range of selected years. The base period file contains the initial cohort sizes by stock and age, plus the average exploitation rate by stock, age, fishery, and time-step.

The base period cohort size is an average of initial cohorts from all the years selected divided equally into marked and un-marked components. The two components are necessary for evaluating mark-selective fisheries. There were no mass-marked Coho during the base period years. Each component uses the same, original MSM exploitation rate because the cohort split was weighted equally.

Four methods were evaluated for averaging exploitation rates: 1) Average over all years selected; 2) Average over years with a fishery occurring; 3) Average over all years selected weighted by cohort size; and 4) Average over years with fishery occurring weighted by cohort size. The second method was chosen by the PFMC Scientific and Statistical Committee (SSC) because it averaged actual rates without missing values. The only exception was for Thompson River Coho, were the 1986 data was excluded because of poor escapement data.

The exploitation rates for troll and net fisheries in Washington State were split into Treaty Tribal and Non-Treaty fisheries so that sharing allocation summaries could be calculated. The MSM-VB fisheries for Washington State were combined Treaty and Non-Treaty to increase the number of CWT recoveries and decrease the variance of the exploitation rates. The exploitation rate split was made using the average Treaty proportion for the years selected. If either component was missing for all years it was arbitrarily set to 0.01 and no average was allowed to be lower than that value.

Equations 12.1- 12.6 —

$$BPCohort_{s,a,t} = \left(\sum_{y=y1}^{y2} Cohort_{s,a,t,y} \middle/ NumYears\right) \times 0.5$$

Method 1- Average Exploitation Rate Over All Years Selected

$$BPER_{s,a,f,t} = \sum_{y=y1}^{y2} ExplRate_{s,a,f,t,y} \Big/ NumYears$$

Method 2- Average Exploitation Rate Over Years with Fishery Occurring

$$BPER_{s,a,f,t} = \sum_{y=y3}^{y4} ExplRate_{s,a,f,t,y} \Big/ NumYears \qquad \text{(except Thompson)}$$

Method 3- Average Exploitation Rate Over All Years Selected Weighted by Cohort size

$$BPER_{s,a,f,t} = \left(\sum_{y=y1}^{y2} (ExplRate_{s,a,f,t,y} \times Cohort_{s,a,f,t,y}) \Big/ NumYears\right) \Bigg/ \left(\sum_{y=y1}^{y2} Cohort_{s,a,f,t,y} \Big/ NumYears\right)$$

Method 4- Average Exploitation Rate Over Years with Fishery Occurring Weighted by Cohort size

$$BPER_{s,a,f,t} = \left(\sum_{y=y3}^{y4}(ExplRate_{s,a,f,t,y} \times Cohort_{s,a,f,t,y}) \Big/ NumYears\right) \Bigg/ \left(\sum_{y=y3}^{y4} Cohort_{s,a,f,t,y} \Big/ NumYears\right)$$

$$AvgTreatyPct_{f,t} = \sum_{y=y1}^{y2} TreatyPct_{f,t,y} \Big/ NumYears$$

Where:

$BPCohort_{s,a,t}$	FRAM Base Period Cohort Size for stock ***s,*** age ***a***, at time step ***1***
$Cohort_{s,a,t1,y}$	MSM Cohort for stock ***s,*** age ***a***, at time step ***1***, year ***y***
$BPER_{s,a,f,t}$	FRAM Base Period Expl. Rate for stock ***s,*** age ***a***, in fishery ***f,*** at time step ***t***
$ExplRate_{s,a,f,t,y}$	MSM Exploitation Rate for stock ***s,*** age ***a***, in fishery ***f,*** at time step ***t***, year ***y***
$AvgTreatyPct_{f,t}$	Average Treaty Percent for fishery ***f,*** at time step ***t***
$TreatyPct_{f,t,y}$	Treaty Percent for fishery ***f,*** at time step ***t***, year ***y***
NumYears	Number of Years in List Selected
Years *y1, y2*	List of Years Selected
Years *y3, y4*	List of Years Selected where fisheries occurred

13. Current Coho FRAM Base Period

Estimates resulting from the 1986-1991 coastwide cohort analyses were averaged to be used as the base dataset for the current Coho FRAM. The cohort analyses were started by the PSC CoTC in 1992 (PSC 1994) and involved development of the MSM algorithms for estimating PEFs and selection of the input data. This was a lengthy and tedious process that identified estimation and data quality issues for the stocks and fisheries used in the analyses. The base period analyses were completed in 2002 and used for the PFMC and PSC regulation processes that year. The data and general methodology were reviewed and approved by the PFMC SSC and PSC CoTC, but the need for specific documentation of the base period development process was identified.

Some of the problems encountered in the analyses for the 1986-1991 catch years included definition and aggregation of stocks and fisheries, and confounding issues of PEF estimation for stocks with poor CWT representation. These problems are discussed in the previous sections concerning each of the variable types.

The most important step for the cohort analyses is the PEF estimation process. The PEF-expanded CWT recoveries combined with the CAP analysis computes a complete stock composition estimate for all mixed-stock fisheries. The ability to estimate these stock compositions by fishery is the fundamental assumption for the cohort analyses.

The CWT groups chosen to represent production regions and management units for catch years 1986-1991 are listed in Table 8. The PEF estimates for the 1986-1991 catch years are listed in Tables 9-14. The CWT list and PEF estimates have been reviewed extensively by the PSC CoTC and represent the best available information for the MSM-VB defined stocks and fisheries. Tables 9-14 also includes columns labeled “CV” and “User Flag”, where “PEF CV” is the coefficient of variation and “User Flag” is a subjective determination for user-defined PEFs of the quality of the estimate. A flag value of 1 is used for “good” estimates and 2 for “poor”. The tables are listed separately by year because there is no correlation of PEF values between years. The PEF estimates are dependent on CWT tagging rates and total runsize. User-defined PEF values were calculated for the Upper Fraser / Thompson River production region (FRSUPP) for catch years 1986-1991 (Table 15), following the same process used to calculate PEFs for catch years 1992-1997.

The results from the CAP procedure are contained in Appendix D, which can be downloaded from the ftp site listed below. These tables include the observed landed catch, the sum of all PEF expanded CWT recoveries, and the catch adjustment factors by fishery and time-step for all the FRAM defined fisheries for each catch year.

14. Recommendations for Future Work

The future work for Coho cohort analysis should include adding all years with adequate CWT recovery information, refinement of the techniques used to estimate PEF values by production region, and development of algorithms to estimate effects from mark-selective fishery regulations. Completion of this work would yield a historical database of fishery-related mortality that could be used in a variety of applications. The focus of the current work is development of a base period file for the FRAM program, which is used to estimate preseason fishery impacts so that appropriate regulations can be developed for stock conservation concerns and user-group allocation issues. Other uses of the historical database include stock recruitment analysis and preseason forecasting techniques.

The range of years available with adequate CWT recovery information is fairly limited. The MSM PEF estimation technique was first applied to the 1986 to 1991 catch years and was successfully incorporated into the FRAM base period development process. The current MSM-VB project focused on the 1992-1997 catch years because of the similarity to the previous range of years in terms of overall catch and stock exploitation rates and the absence of mark-selective regulations. During both these ranges of years there were CWT release and recovery information available for nearly all the production regions defined in the cohort analysis process and adequate sampling levels in all the major mixed stock fishery areas. The 1979-1981 catch years were previously used for the FRAM base period development, but did not include all the current production regions and stocks used in the current configuration. This is characteristic of the 1972-1978 catch years when fewer regions had representative CWT information. The 1982-1985 catch years have better CWT representation than the previous years, but are also missing data for some important regions.

The latest catch years (1998-2005) have an increasing number of fisheries with mark-selective regulations that will require an additional set of algorithms to estimate the differential effects by stock. The technique used in the FRAM program to assess mark-selective regulations was to split each model stock into marked and unmarked components and to use new algorithms and parameters to estimate the differential effects between the marked and unmarked groups. The MSM-VB PEF estimation program and the cohort analysis will need to be modified in a similar manner to analyze the 1998 to 2005 catch years.

The MSM-VB PEF program needs substantial user input and analysis for various stocks and fisheries to yield meaningful results. This is most likely due to low CWT tagging levels for large geographic regions within the range of this study, which results in low numbers of CWT recoveries for many of the large ocean mixed stock fisheries. The estimation algorithms typically yield nonsensical results such as large positive and negative PEF values for many of the stocks. The use of user-defined PEF values for stocks with low numbers of CWT recoveries, combining of stocks with similar catch distribution patterns, and estimation of terminal runs and associated CWT recoveries is needed to make plausible estimates for the remaining stocks with adequate CWT information. Estimation of these parameters is somewhat subjective and can greatly influence the PEF estimates of the other stocks.

User-defined PEF values were used for many stocks in the current analysis. This technique essentially removes a stock with PEF estimation problems from the analysis and insures that the stock estimates are within a reasonable range of production and exploitation rate values. This technique was typically applied to stocks with low CWT recovery numbers. While this technique greatly improved the overall performance of the MSM-VB PEF estimation process, it most likely results in a poor representation of the overall contribution and distribution of the user-defined PEF stock. This result is unavoidable until better information becomes available for the stock in question.

The estimation of terminal run and associated CWT recovery numbers was used for some of the stocks in each of the years analyzed. This technique was generally used when the CWT recovery distribution pattern was similar to another stock and the PEF results between the two stocks were confounded. This occurred most often in the Puget Sound regions where the production regions are defined on a smaller geographic basis. The Puget Sound production regions typically have better CWT and escapement information because of higher hatchery production with CWT tagging levels and more extensive natural escapement estimation programs. These data can be used to estimate total terminal runs and the expected numbers of CWT recoveries much easier than for other production regions. The proportion of CWT recoveries to the total terminal run is essentially the inverse of the PEF value for that production region. This forces the estimation algorithm to make the PEF value for that region fairly close to the terminal run PEF estimate without removing the stock from the MSM-VB PEF process.

Future analysis of PEF estimation should include runs where some or all of the stocks with estimation problems use the terminal run technique instead of user-defined PEF values. This would allow those stocks to remain in the estimation process and let the resulting PEF value be modified slightly from the user-defined value. This may result in a better fit between the observed and estimated catch in the mixed stock fisheries where those stocks contribute the most.

The Bayesian estimation technique developed for the MSM-VB PEF program (Gazey 2005) has not been analyzed at this time. This technique uses an algorithm that incorporates weighting factors by fishery for the PEF values. Use of appropriate weighting factors could alleviate estimation problems for many of the stocks with poor CWT representation. In most years the stocks originating in Southeast Alaska and Northern Canada have very poor CWT release and recovery information and contribute to the largest fisheries, which also occur in these areas. The ULS algorithm minimizes the difference between observed and PEF estimated catch summed across all fisheries. This results in a default weighting of total catch by fishery. The result is the largest fisheries with the lowest CWT recovery rates have the largest weighting factor. This is not an overwhelming problem because the stock composition of these fisheries is primarily from the stocks in that region. Unfortunately, the default weighting can cause a problem for stocks in other regions by creating a “ripple effect” between the estimated PEF values. Changes in the large fisheries with low CWT recoveries can significantly change the PEF values for the stocks with minor contribution rates in those fisheries. This, in turn, changes the PEF values for all the other stocks that contribute to the fisheries where the original stock has a significant contribution rate.

Different fishery weighting factor schemes should be used in the MSM-VB PEF estimation process to investigate the importance of the weighting factors to the overall PEF estimation by stock. The weighting schemes could include sampling rate, sampling rate times catch, or CWT recovery rate for the total catch in a fishery. The CWT recovery rate would seem to be the most likely candidate to weight fisheries because it would be a function of the CWT tagging rate for the stocks contributing to each fishery.

15. Literature Cited

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16. Figures

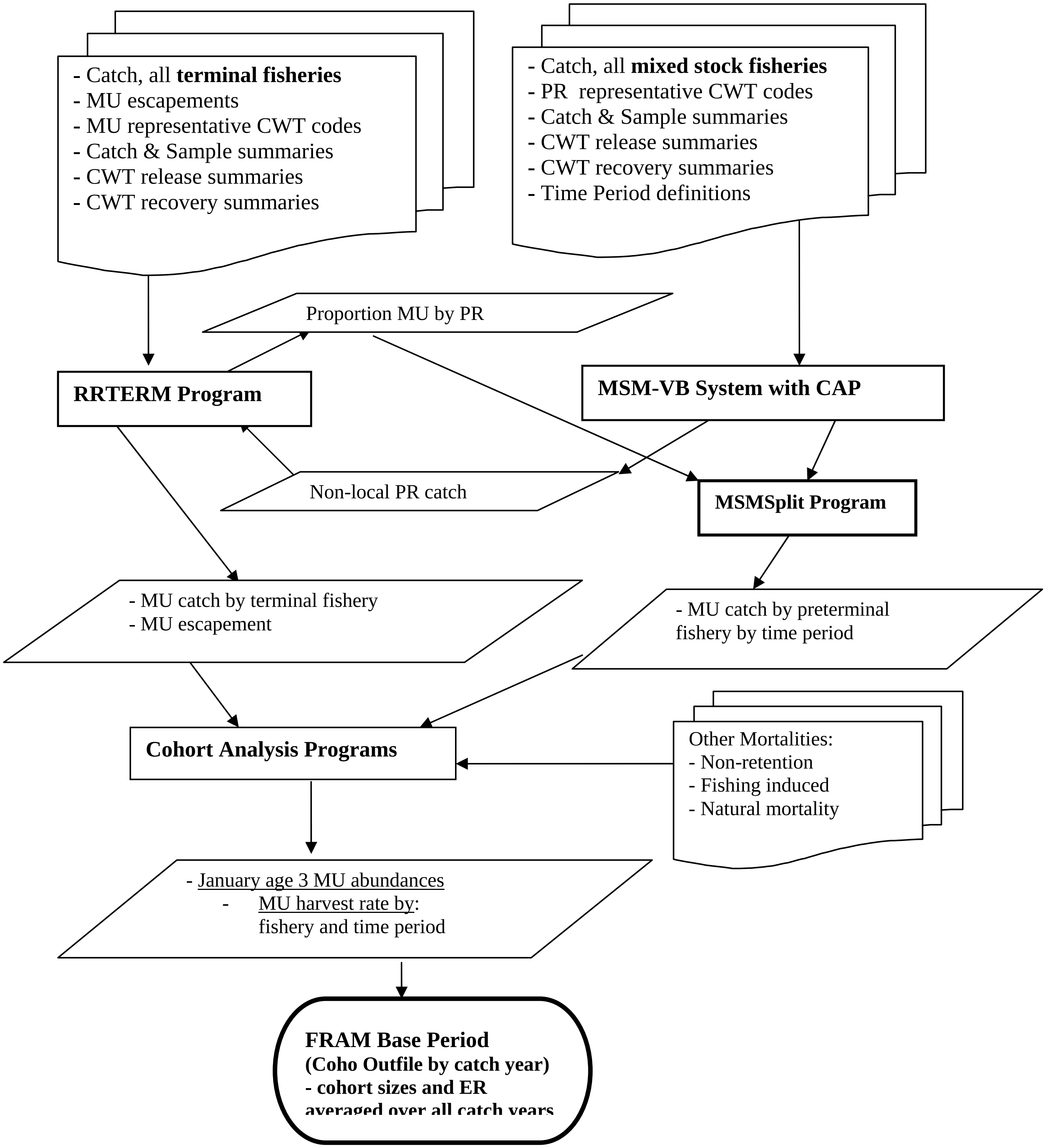

Figure 1. Flowchart of Coho FRAM base period development process. MU = Management Unit, PR = Production Region.

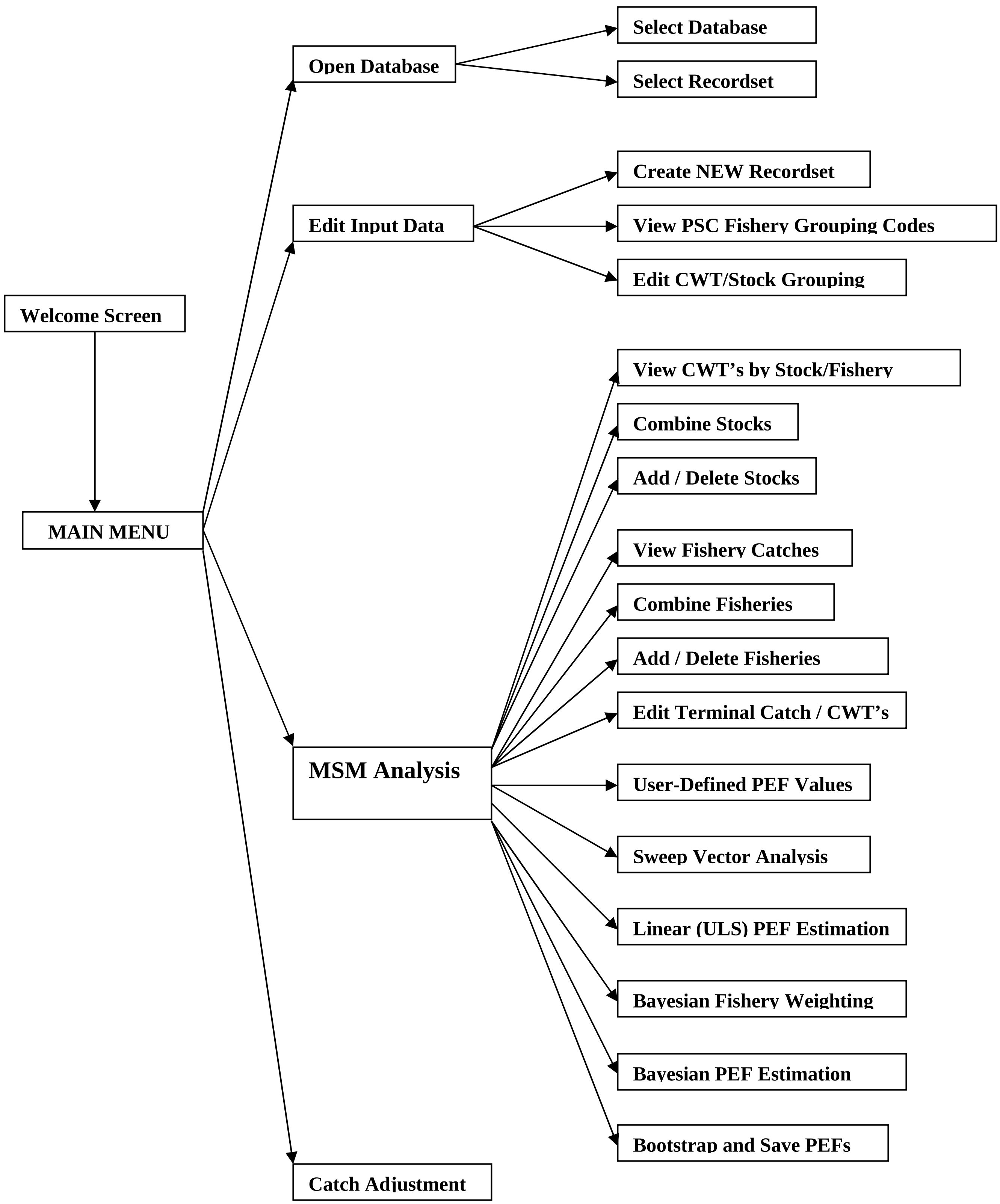

Figure 2. Flowchart of MSM-VB system.

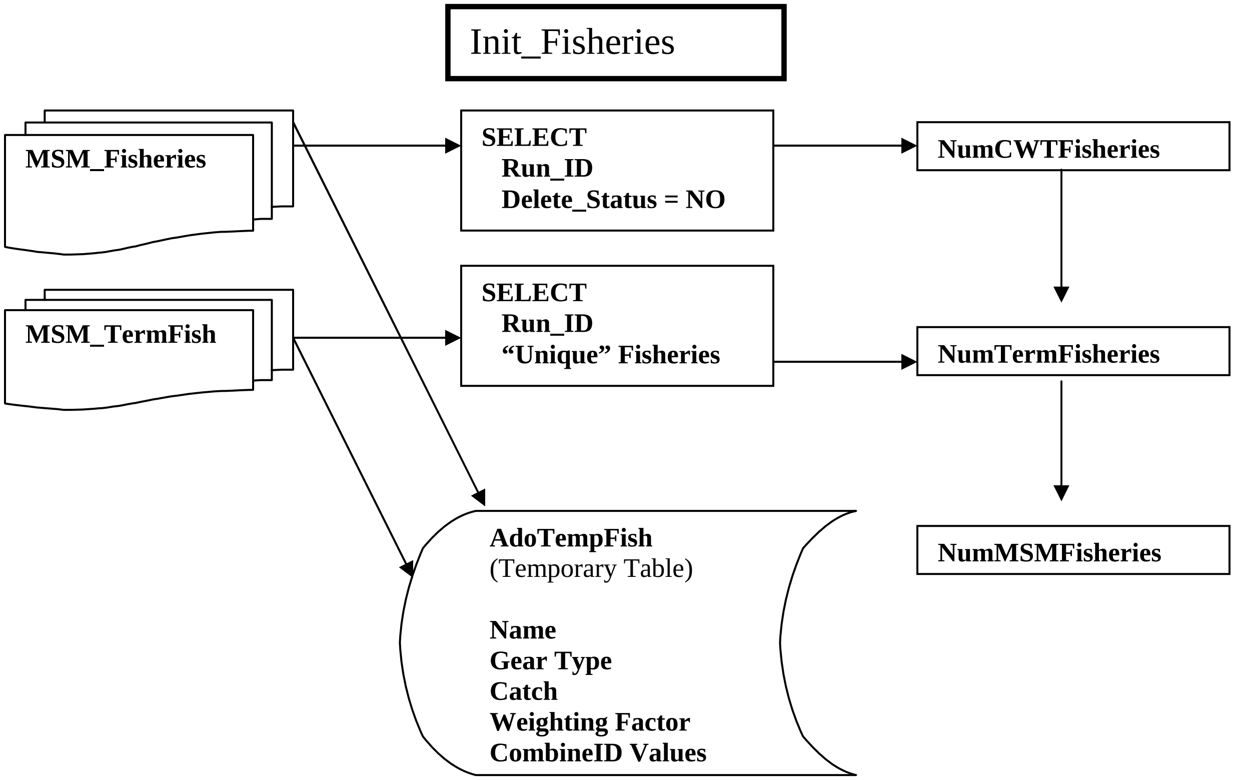

Figure 3. Flowchart of subroutine "Init_Fisheries" in MSM-VB program.

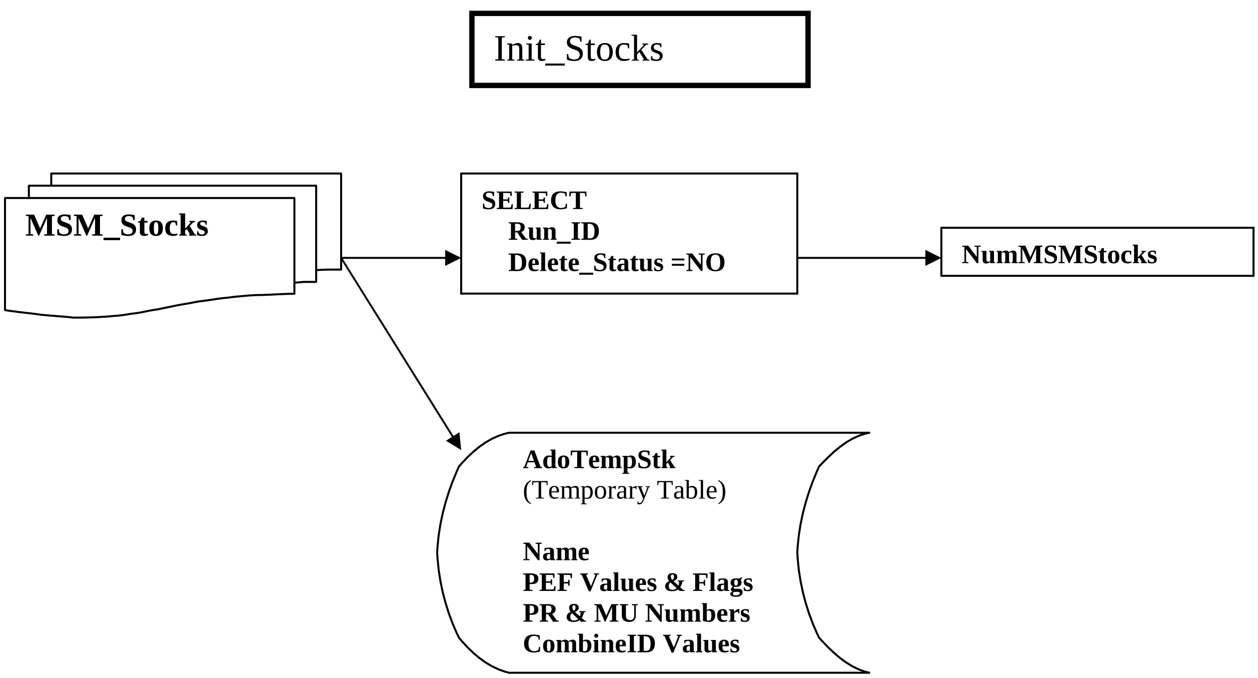

Figure 4. Flowchart of subroutine "Init_Stocks" in MSM-VB program.

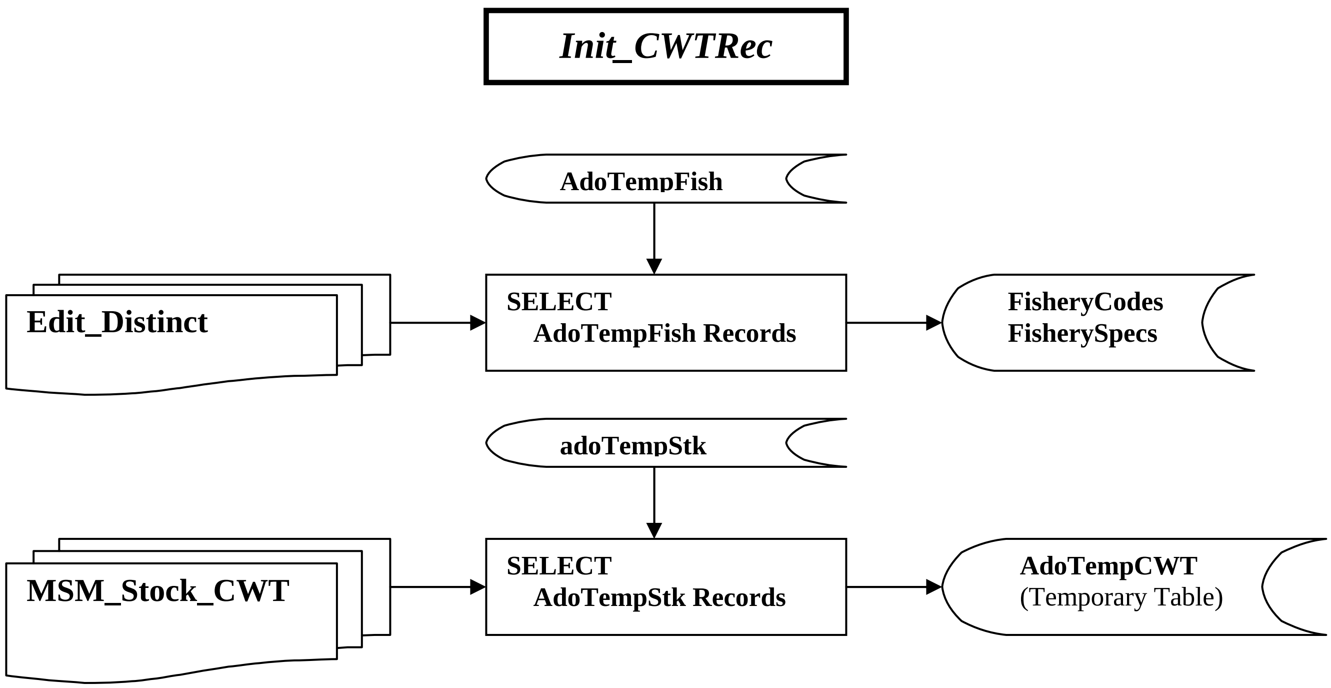

Figure 5. Flowchart of subroutine “Init_CWTRec” in MSM-VB program.

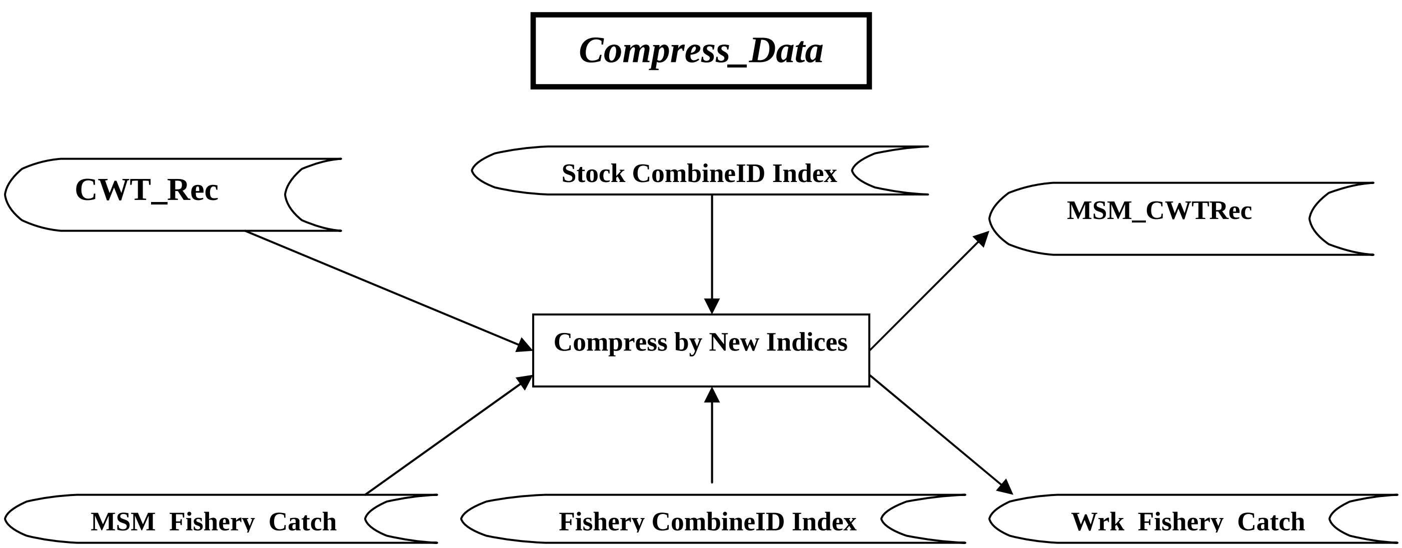

Figure 6. Flowchart of subroutine “Compress_Data” in MSM-VB program.

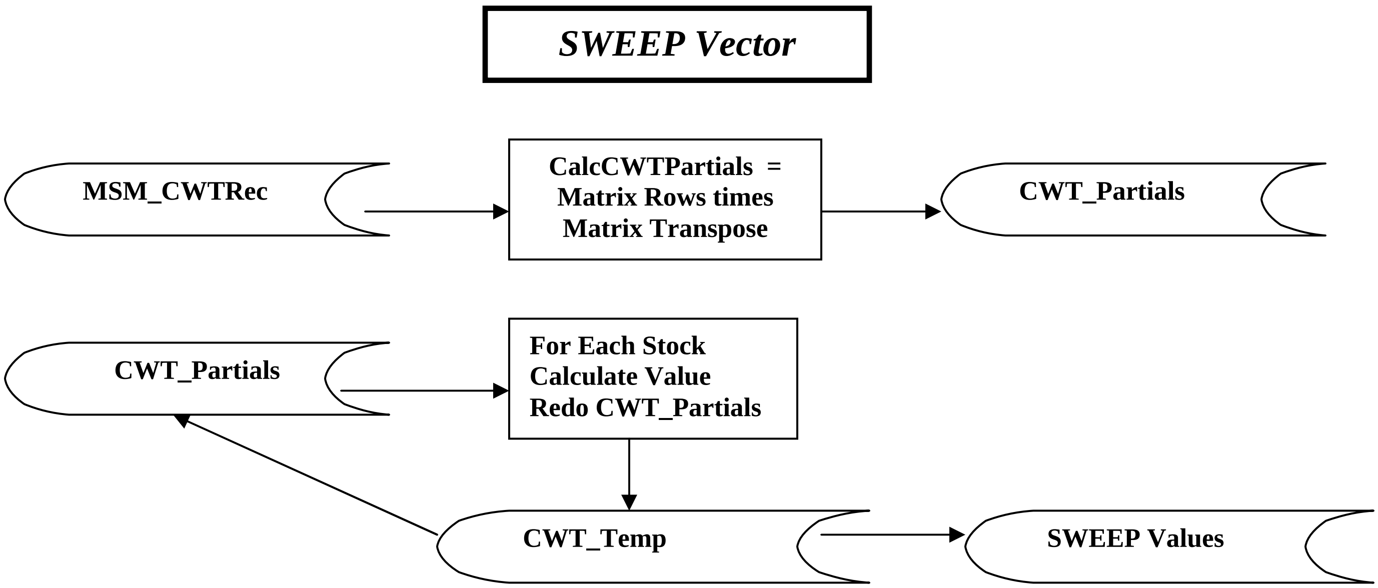

Figure 7. Flowchart of subroutine “SweepVector” in MSM-VB program.

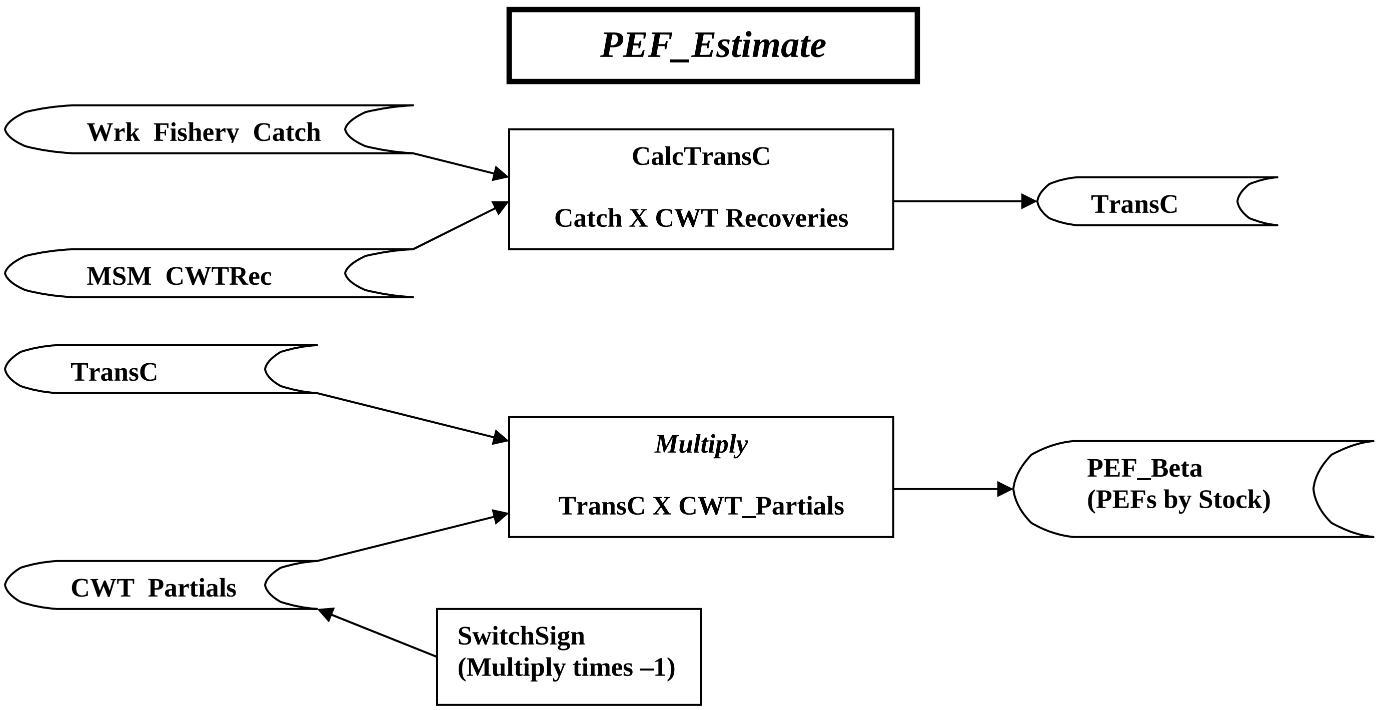

Figure 8. Flowchart of subroutine “PEF_Estimate” in MSM-VB program.

Bayesian PEF Estimate

Create Bayesian Arrays from Compressed Data
Add Prior Probabilities (default = 1)
Scale Weighting Factors
Pack Design Vector
Factor Symetric Matrix using Choleski Decomposition
Invert Matrix
Calculate PEFs
Calculate Residual Error
Calculate Standard Error

Figure 9. Steps performed by the subroutine "Bayesian_PEF_Estimate" in MSM-VB program.

17. Tables

Table 1. Description of tables in MSM-VB MS-Access database file.

Table Name	Description
Run_Data	Recordset attributes; including Recordset index number, catch year, and run description
CohoCWTyyyy	CWT recovery data by catch year – yyyy is catch year
CS_yyyy	CWT catch/sample data by catch year – yyyy is catch year
All_Releases	All CWT release data available from RMIS
Edit_Distinct	Specifications of PSC Recovery_Location_Code for each fishery
MSM_Fisheries	Indexed fishery list and fishery status (Flag) by Recordset Number
MSM_Stock	Indexed stock list and stock status (Flag) by Recordset Number
MSM_Stock_CWT	CWT release codes associated with MSM_Stocks
MSM_TermRun	Terminal run catch and estimated CWT recoveries
MSM_CWT_Reject	CWT recoveries not used (record does not meet Recovery_Location_Code specifications in Edit_Distinct table)
CA_Data	Catch Area data used in RRTERM and FRAM
PR_Data	Production Region data used in RRTERM and FRAM
MU_Data	Management Unit data used in RRTERM and FRAM

Table 2. Variables included in MSM-VB MS-Access database tables (table names).

CWT Recovery tables (CohoCWTyyyy and MSM_CWT_Reject)	**Catch/Sample** tables (CS_yyyy)
record_code	record_code
format_version	format_version
submission_date	submission_date
reporting_agency	reporting_agency
sampling_agency	sampling_agency
recovery_id	catch_sample_id
species	species
run_year	catch_year
recovery_date	period_type
recovery_date_type	period
period_type	first_period
period	last_period
fishery	fishery
gear	adclip_selective_fishery
adclip_selective_fishery	estimation_level
estimation_level	catch_location_code
recovery_location_code	detection_method
sampling_site	sample_type
recorded_mark	sampled_maturity
sex	sampled_run
weight	sampled_length_range
weight_code	sampled_sex
weight_type	sampled_mark
length	number_caught
length_code	escapement_estimation_method
length_type	number_sampled
detection_method	number_estimated
tag_status	number_recovered_decoded
tag_code	number_recovered_no_cwts
tag_type	number_recovered_lost_cwts
sequential_number	number_recovered_unreadable
sequential_column_number	number_recovered_unresolved
sequential_row_number	number_recovered_not_processed
catch_sample_id	number_recovered_pseudotags
sample_type	mr_1st_partition_size
sampled_maturity	mr_1st_sample_size
sampled_run	mr_1st_sample_known_ad_status
sampled_length_range	mr_1st_sample_obs_adclips
sampled_sex	mr_2nd_partition_size
sampled_mark	mr_2nd_sample_size
estimated_number	mr_2nd_sample_known_ad_status
recovery_location_name	mr_2nd_sample_obs_adclips
record_origin	mark_rate
	awareness_factor
	sport_mark_incidence_sampl_size
	sport_mark_inc_sampl_obs_adclips

Table 2. Variables included in MSM-VB MS-Access database tables (continued).

CWT Release table (All_Releases)
record_code
format_version
submission_date
reporting_agency
release_agency
coordinator
tag_code_or_release_id
release_location_state
release_location_psc_region
release_location_psc_basin
release_location_name
tag_type
first_sequential_number
related_group_type
related_group_id
species
run
brood_year
first_release_date
last_release_date
release_location_code
hatchery_location_code
stock_location_code
release_stage
rearing_type
study_type
release_strategy
avg_weight
avg_length
study_integrity
cwt_1st_mark
cwt_1st_mark_count
cwt_2nd_mark
cwt_2nd_mark_count
non_cwt_1st_mark
non_cwt_1st_mark_count
non_cwt_2nd_mark
non_cwt_2nd_mark_count
counting_method
tag_loss_rate
tag_loss_days
tag_loss_sample_size
tag_reused
comments
hatchery_location_name
stock_location_name
record_origin

PSC Fishery Specification table (Edit_Distinct)
Gear
Fishery_Short_Name
Fishery_Number
Num_Chars
PSC_Code

MSM_Fisheries table
Run_ID
CA_Number
CA_Short_Name
Delete_Status
CombineID
Weight_Factor

MSM_Stock table
Run_ID
PR_Number
PR_MU_Number
MSM_Short_Name
MSM_Long_Name
PSC_State
Combine_StockID
Delete_Status
MSM_User_PEF
MSM_User_PEF_Flag

MSM_Stock_CWT table
Run_ID
PR_Number
PR_MU_Number
CWT_Code

CA_Data table
PR_Short_Name
CA_Number
FRAM_Flag

Table 2. Variables included in MSM-VB MS-Access database tables (continued).

MSM_TermRun table	**MU_Data** table
Run_ID	PR_Short_Name
Terminal_Name	MU_Short_Name
PR_Number	FRAM_MU_Number
PR_MU_Number	PR_Number
MSM_Short_Name	PR_MU_Number
MSM_Long_Name	MU_Long_Name
Terminal_RunSize	IOFlag
Terminal_SampleRate	PSC_State
Terminal_CWT_Recs	Type_Calc
Weight_Factor	State
Terminal_Description	CA_Long_Name
	CWT_Flag
	Cat_Flag
	CA_Short_Name
	FRAM_CA_Number
PR_Data table	
PR_Short_Name	
PR_Number	
PR_Long_Name	
PSC_State	

Table 3. Stocks included in the Coho FRAM.

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
SPGSND	75	ar13mw	Area 13 Miscellaneous Wild
SPGSND	77	chambh	Chambers Creek Hatchery

Table 3. Stocks included in the Coho FRAM (continued).

Production Region	Unmarked Stock #	Abbreviated Name	Coho Stock Name
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
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

Table 3. Stocks included in the Coho FRAM (continued).

Production Region	Unmarked Stock #	Abbreviated Name	Coho Stock Name
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	sandew	Sandy Early Wild
COLRIV	171	clakew	Clakamas Early Wild
COLRIV	173	claklw	Clakamas Late 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
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

Table 3. Stocks included in the Coho FRAM (continued).

Production Region	Unmarked Stock #	Abbreviated Name	Coho Stock Name
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

Table 4. Fisheries included in the Coho FRAM.

Fishery Abbrev.	Fish Num.	Fishery Long Name	Fishery Abbrev.	Fish Num.	Fishery Long Name
No Cal Trm	1	North California Coast Terminal Catch	Area3TrlNT	38	Area 3 Troll Nontreaty (LaPush)
Cn Cal Trm	2	Central California Coast Term Catch	Area3TrlTR	39	Area 3 Troll Treaty (LaPush)
Ft Brg Spt	3	Fort Bragg Sport	Area 3 Spt	40	Area 3 Sport (LaPush)
Ft Brg Trl	4	Fort Bragg Troll	Area 4 Spt	41	Area 4 Sport (Neah Bay)
Ca KMZ Spt	5	KMZ Sport (Klamath Management Zone)	A4/4BTrlNT	42	Area 4/4B (Neah Bay PFMC Regs) Troll NotTreaty
Ca KMZ Trl	6	KMZ Troll (Klamath Management Zone)	A4/4BTrlTR	43	Area 4/4B (Neah Bay PFMC Regs) Troll Treaty
So Cal Spt	7	Southern California Sport	A 5-6C Trl	44	Area 5, 6, 6C Troll (Strait of Juan de Fuca)
So Cal Trl	8	Southern California Troll	Willpa Spt	45	Willapa Bay (Area 2.1) Sport
So Ore Trm	9	South Oregon Coast Terminal Catch	Wlp Tb Spt	46	Willapa Tributary Sport
Or Prv Trm	10	Oregon Private Hatchery Terminal Catch	WlpaBT Net	47	Willapa Bay & FW Trib Net
SMi Or Trm	11	South-Mid Oregon Coast Terminal Catch	GryHbr Spt	48	Grays Harbor (Area 2.2) Sport
NMi Or Trm	12	North-Mid Oregon Coast Terminal Catch	SGryHb Spt	49	South Grays Harbor Sport (Westport Boat Basin)
No Ore Trm	13	North Oregon Coast Terminal Catch	GryHbr Net	50	Grays Harbor Estuary Net
Or Cst Trm	14	Mid-North Oregon Coast Terminal Catch	Hump R Spt	51	Humptulips River Sport
Brkngs Spt	15	Brookings Sport	LwCheh Net	52	Lower Chehalis River Net
Brkngs Trl	16	Brookings Troll	Hump R C&S	53	Humptulips River Ceremonial & Subsistence
Newprt Spt	17	Newport Sport	Chehal Spt	54	Chehalis River Sport
Newprt Trl	18	Newport Troll	Hump R Net	55	Humptulips River Net
Coos B Spt	19	Coos Bay Sport	UpCheh Net	56	Upper Chehalis River Net
Coos B Trl	20	Coos Bay Troll	Chehal C&S	57	Chehalis River Ceremonial & Subsistence
Tillmk Spt	21	Tillamook Sport	Wynoch Spt	58	Wynochee River Sport
Tillmk Trl	22	Tillamook Troll	Hoquam Spt	59	Hoquiam River Sport
Buoy10 Spt	23	Buoy 10 Sport (Columbia River Estuary)	Wishkh Spt	60	Wishkah River Sport
L ColR Spt	24	Lower Columbia River Mainstem Sport	Satsop Spt	61	Satsop River Sport
L ColR Net	25	Lower Columbia River Net (Excl Youngs Bay)	Quin R Spt	62	Quinault River Sport
Yngs B Net	26	Youngs Bay Net	Quin R Net	63	Quinault River Net
LCROrT Spt	27	Below Bonneville Ore. Tributary Sport	Quin R C&S	64	Quinault River Ceremonial & Subsistence
Clackm Spt	28	Clackamas River Sport	Queets Spt	65	Queets River Sport
SandyR Spt	29	Sandy River Sport	Clrwtr Spt	66	Clearwater River Sport
LCRWaT Spt	30	Below Bonneville Washington Tributary Sport	Salm R Spt	67	Salmon River (Queets) Sport
UpColR Spt	31	Above Bonneville Sport	Queets Net	68	Queets River Net
UpColR Net	32	Above Bonneville Net	Queets C&S	69	Queets River Ceremonial & Subsistence
A1-Ast Spt	33	Area 1 (Illwaco) & Astoria Sport	Quilly Spt	70	Quillayute River Sport
A1-Ast Trl	34	Area 1 (Illwaco) & Astoria Troll	Quilly Net	71	Quillayute River Net
Area2TrlNT	35	Area 2 Troll Nontreaty (Westport)	Quilly C&S	72	Quillayute River Ceremonial & Subsistence
Area2TrlTR	36	Area 2 Troll Treaty (Westport)	Hoh R Spt	73	Hoh River Sport
Area 2 Spt	37	Area 2 Sport (Westport)	Hoh R Net	74	Hoh River Net

Table 4. Fisheries included in the Coho FRAM (continued).

Fishery Abbrev.	Fish Num.	Fishery Long Name	Fishery Abbrev.	Fish Num.	Fishery Long Name
Hoh R C&S	75	Hoh River Ceremonial & Subsistence	Ar8A NetNT	109	Area 8A Stillaguamish/Snohomish Net Nontreaty
Mak FW Spt	76	Makah Tributary Sport	Ar8A NetTR	110	Area 8A Stillaguamish/Snohomish Net Treaty
Mak FW Net	77	Makah Freshwater Net	Ar8D NetNT	111	Area 8D Tulalip Bay Net Nontreaty
Makah C&S	78	Makah Ceremonial & Subsistence	Ar8D NetTR	112	Area 8D Tulalip Bay Net Treaty
A 4-4A Net	79	Area 4, 4A Net (Neah Bay)	Stil R Net	113	Stillaguamish River Net
A4B6CNetNT	80	Area 4B, 5, 6C Net Nontreaty (Strait of JDF)	Snoh R Net	114	Snohomish River Net
A4B6CNetTR	81	Area 4B, 5, 6C Net Treaty (Strait of JDF)	Ar 8-2 Spt	115	Area 8.2 Marine Sport
Ar6D NetNT	82	Area 6D Dungeness Bay/River Net Nontreaty	Stil R Spt	116	Stillaguamish River Sport
Ar6D NetTR	83	Area 6D Dungeness Bay/River Net Treaty	Snoh R Spt	117	Snohomish River Sport
Elwha Net	84	Elwha River Net	Ar 10 Spt	118	Area 10 Marine Sport (Seattle)
WJDF T Net	85	West JDF Straits Tributary Net	Ar10 NetNT	119	Area 10 Net Nontreaty (Seattle)
EJDF T Net	86	East JDF Straits Tributary Net	Ar10 NetTR	120	Area 10 Net Treaty (Seattle)
A6-7ANetNT	87	Area 7, 7A Net Nontreaty (San Juan Islands)	Ar10ANetNT	121	Area 10A Net Nontreaty (Elliott Bay)
A6-7ANetTR	88	Area 7, 7A Net Treaty (San Juan Islands)	Ar10ANetTR	122	Area 10A Net Treaty (Elliott Bay)
EJDF FWSpt	89	East JDF Straits Tributary Sport	Ar10ENetNT	123	Area 10E Net Nontreaty (East Kitsap)
WJDF FWSpt	90	West JDF Straits Tributary Sport	Ar10EnetTR	124	Area 10E Net Treaty (East Kitsap)
Area 5 Spt	91	Area 5 Marine Sport (Sekiu)	10F-G Net	125	Area 10F-G Ship Canal/Lake Washington Net Treaty
Area 6 Spt	92	Area 6 Marine Sport (Port Angeles)	Duwm R Net	126	Green/Duwamish River Net
Area 7 Spt	93	Area 7 Marine Sport (San Juan Islands)	Duwm R Spt	127	Green/Duwamish River Sport
Dung R Spt	94	Dungeness River Sport	L WaSm Spt	128	Lake Washington-Lake Sammamish Tributary Sport
ElwhaR Spt	95	Elwha River Sport	Ar 11 Spt	129	Area 11 Marine Sport (Tacoma)
A7BCDNetNT	96	Area 7B-7C-7D Net Nontreaty (Bellingham Bay)	Ar11 NetNT	130	Area 11 Net Nontreaty (Tacoma)
A7BCDNetTR	97	Area 7B-7C-7D Net Treaty (Bellingham Bay)	Ar11 NetTR	131	Area 11 Net Treaty (Tacoma)
Nook R Net	98	Nooksack River Net	Ar11ANetNT	132	Area 11A Net Nontreaty (Commencement Bay)
Nook R Spt	99	Nooksack River Sport	Ar11ANetTR	133	Area 11A Net Treaty (Commencement Bay)
Samh R Spt	100	Samish River Sport	Puyl R Net	134	Puyallup River Net
Ar 8 NetNT	101	Area 8 Skagit Marine Net Nontreaty	Puyl R Spt	135	Puyallup River Sport
Ar 8 NetTR	102	Area 8 Skagit Marine Net Treaty	Ar 13 Spt	136	Area 13 Marine Sport (South Puget Sound)
Skag R Net	103	Skagit River Net	Ar13 NetNT	137	Area 13 Net Nontreaty (South Puget Sound)
SkgR TsNet	104	Skagit River Test Net	Ar13 NetTR	138	Area 13 Net Treaty (South Puget Sound)
SwinCh Net	105	Swinomish Channel Net	Ar13CNetNT	139	Area 13C Net Nontreaty (Chambers Bay)
Ar 8-1 Spt	106	Area 8.1 Marine Sport	Ar13CNetTR	140	Area 13C Net Treaty (Chambers Bay)
Area 9 Spt	107	Area 9 Marine Sport (Admiralty Inlet)	Ar13ANetNT	141	Area 13A Net Nontreaty (Carr Inlet)
Skag R Spt	108	Skagit River Sport	Ar13ANetTR	142	Area 13A Net Treaty (Carr Inlet)

Table 4. Fisheries included in the Coho FRAM (continued).

Fishery Abbrev.	Fish Num.	Fishery Long Name	Fishery Abbrev.	Fish Num.	Fishery Long Name
Ar13DNetNT	143	Area 13D Net Nontreaty (South Puget Sound)	No BC Trl	175	Northern British Columbia Troll
Ar13DNetTR	144	Area 13D Net Treaty (South Puget Sound)	NoC BC Trl	176	North Central British Columbia Troll
A13FKNetNT	145	Area 13F-13K Net Nontreaty (South PS Inlets)	SoC BC Trl	177	South Central British Columbia Troll
A13FKNetTR	146	Area 13F-13K Net Treaty (South PS Inlets)	NW VI Trl	178	NW Vancouver Island Troll
Nisq R Net	147	Nisqually River Net	SW VI Trl	179	SW Vancouver Island Troll
McAlls Net	148	McAllister Creek Net	GeoStr Trl	180	Georgia Straits Troll
13D-K TSpt	149	13D-13K Tributary Sport (South PS Inlets)	BC JDF Trl	181	British Columbia Juan de Fuca Troll
Nisq R Spt	150	Nisqually River Sport	No BC Net	182	Northern British Columbia Net
Desc R Spt	151	Deschutes River Sport (Olympia)	Cen BC Net	183	Central British Columbia Net
Ar 12 Spt	152	Area 12 Marine Sport (Hood Canal)	NW VI Net	184	NW Vancouver Island Net
1212BNetNT	153	Area 12-12B Net Nontreaty (Upper Hood Canal)	SW VI Net	185	SW Vancouver Island Net
1212BNetTR	154	Area 12-12B Net Treaty (Upper Hood Canal)	Johnst Net	186	Johnstone Straits Net
Ar9A NetNT	155	Area 9A Net Nontreaty (Port Gamble)	GeoStr Net	187	Georgia Straits Net
Ar9A NetTR	156	Area 9-9A Net Treaty (Port Gamble/On Reservation)	Fraser Net	188	Fraser River Gill Net
Ar12ANetNT	157	12A Net Nontreaty (Quilcene Bay)	BC JDF Net	189	British Columbia Juan de Fuca Net
Ar12ANetTR	158	12A Net Treaty (Quilcene Bay)	No BC Spt	190	Northern British Columbia Sport
A12CDNetNT	159	12C-12D Net Nontreaty (Lower Hood Canal)	Cen BC Spt	191	Central British Columbia Sport
A12CDNetTR	160	12C-12D Net Treaty (Lower Hood Canal)	BC JDF Spt	192	British Columbia Juan de Fuca Sport
Skok R Net	161	Skokomish River Net	WC VI Spt	193	West Coast Vancouver Island Sport
Quilcn Net	162	Quilcene River Net	NGaStr Spt	194	North Georgia Straits Sport
1212B TSpt	163	12-12B Tributary FW Sport	SGaStr Spt	195	South Georgia Straits Sport
Quilcn Spt	164	12A Tributary FW Sport (Quilcene River)	Albern Spt	196	Alberni Canal Sport
12C-D TSpt	165	12C-12D Tributary FW Sport	BCCNTL TTR	197	BCCNTL Terminal Run (Catch + Escapement)
Skok R Spt	166	Skokomish River Sport	BCNCST TTR	198	BCNCST Terminal Run (Catch + Escapement)
GSMLND Trm	167	Georgia Strait Mainland Terminal Catch	QUEENC TTR	199	QUEENC Terminal Run (Catch + Escapement)
GSVNCI Trm	168	Georgia Strait Vancouver Island Terminal Catch	NASSRV TTR	200	NASSRV Terminal Run (Catch + Escapement)
JNSTRT Trm	169	Johnstone Strait Terminal Catch	SKEENA TTR	201	SKEENA Terminal Run (Catch + Escapement)
SWVNCI Trm	170	SW Vancouver Island Terminal Catch	SW AK Trl	202	Southwest Alaska Troll
NWVNCI Trm	171	NW Vancouver Island Terminal Catch	SE AK Trl	203	Southeast Alaska Troll
FRSLOW Trm	172	Lower Fraser River Terminal Catch	NW AK Trl	204	Northwest Alaska Troll
FRSUPP Trm	173	Upper Fraser River Terminal Catch	NE AK Trl	205	Northeast Alaska Troll
THOMPR Trm	174	Thompson River Terminal Catch	Alaska Net	206	Alaska Net (Areas 182:183:185:192)

Table 5. Coded-wire-tag groups chosen to represent Mixed-Stock-Model (MSM) stocks for catch years 1992-1997.

MSM Stock Production Region	Mgt Unit	Catch Year 1992	1993	1994	1995	1996	1997
BRITISH COLUMBIA CENTRAL COAST		020161	021127	020922	021254	180147	181119
		020162	021128	020923	021255	180412	181120
		020233	021357	020924	021256	180713	181121
		020746	021358	180141	021258	181242	
		020747	021359	180142	021259	181315	
		021015	021415	180143	021260	181326	
		021016	180125	180533	021340	181550	
		021017	180207	180534	021341	181857	
		026151	180208	180838	021355		
		026152	180240	180919	181221		
		026153	180241	180920			
				181005			
BRITISH COLUMBIA NORTH COAST (BCNCST)		020824	020508	020925	021241	080163	080905
		020825	020545	020926	021242	081613	181116
		020843	020546	020927	021243	082915	181117
		020844	020911	020935	021247	180701	181118
		020845	020912	020936	021248	180702	
		020846	020913	020937	021249	180703	
		025041	020914	021228	021336	180704	
		026028	020915	021229	021337	180705	
		026204	020916	021230	082912	180706	
		026205	021036	021231	082913	180707	
		026206	021037	021232	082916	180708	
		026306	021308	021233	180847	180709	
		080801	021309	021234	180922	180710	
		080805	021416	080125	180933	180711	
		080909	021417	080129		180712	
			025656	080151		180714	
			080126	080152		180715	
			080128	080153		180716	
			080802	080802		181218	
			080803	180145		181250	
			180925	180146		181842	
			180926	180537		181843	
			180927	180801		181856	
			180928	180832		182051	

MSM Stock Production Region	Mgt Unit	Catch Year 1992	1993	1994	1995	1996	1997
				180929			
				180930			
COLUMBIA RIVER (COLRIV)		052532	052749	071428	053305	053626	053248
		052533	074045	071516	070256	070137	070925
		074222	074046	071521	070257	070138	070958
		074517	074047	071522	070337	070356	070959
		074518	074520	071523	070338	070554	071147
		075426	074644	071524	070339	070555	071148
		075427	074645	071530	070340	070556	071149
		075533	075616	071534	070341	071544	075334
		075534	075617	074832	070342	071545	075415
		075535	075620		070362	075262	075901
		075536	075621		075130	075329	635433
		075538	075622		076145	075445	635448
		075549	075624		634805	075446	635450
		075551	075625		634860	635361	635739
		631155	075721		634862	635363	635763
		633722	075748		635063	635444	635917
		633723	634003		635104	635462	635951
		633944	634005		635301		
		635531	634006				
		635631	634248				
		635632	634342				
	Clakamas Early Wild	075552	052620	052745	053260	053624	053827
		075553		052746	053261		
					053262		
					053263		
	Col Rvr Late Hatchery/ Wild	631359	075747	071533	074936	635342	075414
		631462	633963	634440	635101	635356	635730
		633338	634001	634641	635236	635359	635731
		633339	634002	634727	635348	635360	635732
		633922	634007		635349	635463	635740
		633923	634253			635725	635741
		633924	634254			635955	635742
		633945	634343				635802
		635532	634344				635912
		635635					
	Sandy Early W	075542	075720	071531	070239	070551	070837

MSM Stock Production Region	Mgt Unit	1992	1993	1994	1995	1996	1997
		Catch Year					
		075543	075724	071532	074929	070552	070838
		075544		075951	074930		070839
		075545		076016	074933		070840
		075546		076017	074934		071134
		075547		076018	075126		071135
				076019	075127		
	Youngs Bay Hatchery	075554	075455	075952	070124		070961
		075555	075712	076014	070135		071222
		075558		076015	070136		071223
		075559		076111	076142		071242
				076128			
				076129			
				076130			
GEORGIA STRAIT MAINLAND		020617	021046	021046	180757	180720	181134
		021018	021124	021311	180758	181107	181302
		021027	021125	021351	180759	181108	181303
		021028	021126	021353	180760	181638	181806
		021111	021219	021354	180944	181743	182101
		021116	021224	025213	180945	181744	182102
		021117	180101	025214	181601	181745	182103
		026162	180102	180128	181602	181806	182104
		026207	180103	180129	181603	181958	182107
		026208	180104	180130	181604	181959	182108
		026228	180109	180131	181605	181960	
		026229	180110	180604	181606	181961	
		026230	180111	180739	181607	182101	
		026233	180112	180740	181608	182102	
		026360	180237	180741	181609	182103	
		026361	180238	180742	181610	182104	
		026362					
		026363					
GEORGIA STRAIT VANCOUVER ISLAND (GSVNC)		020812	021008	020839	080145	080150	080813
		021019	021040	080141	080147	080707	080814
		021020	021151	080142	080148	080810	181940
		021021	021225	080143	080149	080811	181941
		021023	021226	080144	080154	080812	181942
		021024	021227	080145	080155	080813	181943
		021025	080123	080147	080156	181251	182012

MSM Stock Production Region	Mgt Unit	Catch Year 1992	1993	1994	1995	1996	1997
		021026	080134	080148	080157	181252	182013
		021040	080142	080149	080158	181253	182054
		021152	081007	080156	080160	181747	182109
		026154	081008	080159	080810	182004	182110
		026201	081009	081834	080812	182005	
		026202	081010	081835	180736	182006	
		026203	081011	081836	180737	182007	
		080804	081832	180127	180946	182008	
		081001	081833	180559	180947	182009	
		081002	081834	180560	180948	182010	
		081003	081836	180724	181618	182011	
		081004	180114	181003	181620		
		081005	180115	181004	181621		
		081006	180116		181624		
		081007	180117		181625		
		081008	180120		181626		
		081009	180121		181634		
		081010	180122		181746		
		081011	180123		182005		
		082715			182006		
		082717					
		180120					
		180121					
		180122					
		180123					
GRAYS HARBOR (GRAYHB)		633403	634258	634712	634753	635115	635430
		633917	634307	634718	634906	635116	635456
		633918	634308	634733	635060	635403	635746
		633919	634345	634734	635102	635404	635747
		633920	634346	634808	635103	635447	635803
		633921	634347	634809	635212	635503	635804
		633942	634348	634829	635215	635505	635853
		633943	634349	634838	635402	635636	635929
		633946	634350	634839	635411	635726	635933
		633947	634359		635412	635727	635945
		633961	634360			635743	635954
		634009	634453				636010
		634010	634454				

MSM Stock Production Region	Mgt Unit	Catch Year 1992	1993	1994	1995	1996	1997
		634033	634532				
		634157					
HOH		213516	212050	212304	212422	635337	635854
		631322	212248	212405			
		631325					
		631416					
HOOD CANAL (HOODCL)		052451	052613	052450	053418	053746	054058
		052452	052614	052910	053419	053747	054059
		052453	052615	052911	053420	053748	054060
		211823	211825	053140	212334	053749	054061
		633934	634018	634445	634963	212458	212460
		633935	634352	634828	635304	635455	634334
		633936	634415		635658	635744	635653
		633937	634439		635660		635818
		634310	634650				
JOHNSTONE STRAIT		020157	180105	180132	180243	180961	181304
		025758	180106	180133	181611	181762	181305
		026145	180107	180134	181612	181763	181306
		026146	180108	180135	181613		181307
		026147	180132	180545	181614		182115
			180133		181615		182116
			180134				182629
			180135				182630
			180206				182631
			180249				182632
							182633
							182634
							182635
							182636
LOWER FRASER RIVER (FRSLOW)		020158	020229	020134	180652	082909	023245
		020160	020551	020135	180653	181555	181308
		020218	020917	026352	180654	181760	181309
		020219	020919	026353	180655	181761	182112
		020220	020920	180136	180656	181801	182113
		020221	020921	180157	180657	181802	182114
		020228	021412	180158	180659	181844	182301
		020318	021413	180646	180660	181845	182302
		020544	021414	180647	180661	181846	182305

MSM Stock Production Region	Mgt Unit	Catch Year 1992	1993	1994	1995	1996	1997
		020849	180113	180648	180662	181847	182431
		020850	180118	180939	180663	181848	182601
		020851	180119	180940	181616	181849	182603
				180941	181617	181850	
				180942	181619	181851	
				180943	181627	181854	
					181628	181855	
					181635	181962	
					181636	181963	
					181637	182001	
						182002	
						182003	
MAKAH COASTAL		052352	052616	052912	053136	053424	054044
		052505	052618	052913	053421	053750	054045
		052506	052658	052914	053422	053751	054046
		052507	052660	053123	053423	053752	054047
							054057
NOOKSACK/ SAMISH		211859	212021	212227	212230	212456	212623
		211861	212024	212229	212243	212457	212627
		631159	634112	212310	212421	212539	635457
				634448	634754	212627	635648
				634710	634909	635260	635939
					635233	635346	635940
NORTHERN ALASKA INSIDE		042944	040704	040707	040714	040715	040717
		043106	042850	040708	043837	043555	043734
		043110	042851	043554	043841	043842	043735
		043544	043622	043649	043956	043843	043836
		043545	043624	043840	043957	043954	044015
		043550	043649	043909	043958	043960	044448
		043551	043650	043910	043959	044330	044449
		043610	043725	043911	044048	044360	044450
		043611	043730	044023	044122	044361	044515
		043612	043731	044024	044123	044362	044516
		043613	043732	044039	044124	044363	044517
		043614	043808	044040	044125	044403	044518
		043615	043831	044041	044130	044433	044529
		043621	043832	044042	044131	044434	044535
		043623	043833	044043	044132	044435	044660

MSM Stock Production Region	Mgt Unit	Catch Year 1992	1993	1994	1995	1996	1997
		043634	043834	044054	044246	044436	044661
		0401011505	043835	0401020503	044247	044443	500406
			043844	0401020901	044248	044447	500407
			043846		044249	044514	500408
			0401011505		044250		500409
			0401011512		044322		500410
			0401020503		044323		044534*1
NORTHERN ALASKA OUTSIDE (NOASKA)		043138	042852	0401010912	0401010912	0401021310	0401030209
		043354	043335	043654	044114	0401021313	0401030514
		043433	043636	043807	044115	044018	044347
		043434	043637	043915	044116	044327	044401
		043538	043638	043916	044117	044328	044402
			043656	043921	044119	044332	044404
			043722	043922	044217	044356	044520
			043723	043924	044306	044357	044612
			043760	044053		044510	
			043761	044055			
NORTHWEST VANCOUVER ISLAND		020227	020908		181208	181417	181515
		020534	020909				
		020535	020910				
		020536	180159				
		020610					
OREGON NORTH AND MID COAST	Oregon North Coast Hatchery	074819	074932	070316	070316	070853	071137
		075424	074935	074920	070317	075251	075339
		075425	075731	074923	070853	075252	075410
		075556	075750	074924	075137		
		075557	075751	074927	075138		
			075752		075139		
					075251		
					075252		
	Oregon North-Mid Coast Hatchery	074829	074413	071519	070258	075253	071224
		074830	074919	071520	070260	075254	075416
		074831	074921	075953	070262	075255	
		074902	074922	076008	070263	075257	
		074904	074941	076012	070312	075258	
		074907	074942		070363		
		074908	075817		076035		
		074911					

MSM Stock Production Region	Mgt Unit	Catch Year 1992	1993	1994	1995	1996	1997
		074913					
		074922					
	Oregon South-Mid Coast Hatchery	072338	074937	071422	070248	075249	075332
		074937	074938	071423	070319	075250	075411
		075238	075609	076005	070320	075260	075412
		075239	075610	076006	075261	075261	075736
		075240	075612	076007		075411	091811
		075241	075613			075412	091812
		075242	075614				
		075428					
		075431					
		075432					
		075610					
		075613					
		075614					
OREGON SOUTH/ CALIFORNIA COAST (ORECAL)	California North Coast Hatchery	065660	0601080106	062820	062819		
		066320	065657		065760		
		066323	066325				
	Oregon South Coast Hatchery	075531	075615	071526	070642	070641	071116
				071527	076354	070642	071221
				071528	076355	070643	
				075950	076356	070645	
					076357	070646	
					076358		
					076359		
					076360		
QUEETS	Queets River Fall Hatchery	211936	212056	B50814	212415	212543	212935
		212007	212057				
	Queets River Fall Natural	211943	212031	212336	212346	212433	212846
		211945	212032	212338	212352	212438	212901
		211946	212105	212341	212353	212443	212904
		211948	212109	212342	212354	212445	212906
		211951	212110	212343	212356	212446	212908
		211953	212112	212345	212357	212447	212909
		211954	212118	212347	212358	212448	212912
		211957	212123	212348	212360	212848	212915
		211958	212124		212361	212851	212916
		211960	212127		212362	212853	213005

MSM Stock Production Region	Mgt Unit	Catch Year 1992	1993	1994	1995	1996	1997
		211963	212129		212363	212854	213006
		212001	212130		212430	212857	213007
		212002	212133		212431	212863	213008
		212003	212134		212434	212902	213009
		212004	212136		212435	212903	213010
		212005	212139		212436	212905	213011
		212030			212440	212913	213012
		213541			212442		213014
							213015
	Queets River Suppl. Hatchery	633925	634524	633732	212417	212512	212523
			634525	634410	212418	212515	212932
					212419	212517	
					212420	212518	
						212520	
						212524	
QUILLAYUTE		211854	212050	212304	212422	635337	635854
		211855	212248	212405	635333		
			634230	634729			
QUINAULT		211857	052659	053128	053137	053615	053857
		211863	052661	053129	053138	053616	053858
			052714	053130	053139	053617	053859
			211939	212307		212545	053860
			212058				212937
SKAGIT		212008	212036	212151	212148	635130	635909
		212009	212038	212312	634910	635254	635910
		212033	212041	212313	635128	635345	635927
		212034	212063	212316	635401	635745	635946
		212035	212103	212318			
		212037	212140	212319			
		212039	212143	212320			
		212040	212145	634715			
		631355	634536	634717			
		634011		634820			
				634846			
SOUTH PUGET SOUND		211821	212025	053220	053536	053540	212459
		211822	212233	053221	053537	053541	212630
		631331	213708	053222	053538	053542	212924
		631332	634353	053223	053539	053543	634324

MSM Stock Production Region	Mgt Unit	Catch Year 1992	1993	1994	1995	1996	1997
		631356	634354	212223	212331	212424	634325
		631361	634356	212311	212332	212455	634326
		631442	634357	634322	212411	212540	634327
		633948	634358	634451	212427	212557	634328
		633949	634409	634540	634954	634333	635423
		633950	634457	634541	634957	635131	635426
		633952	634458	634801	634960	635258	635427
		633956	634460	634802	635105	635362	635657
		634518		634803	635109	635438	635736
		634519			635129	635439	635810
		634520			635303	635451	635915
						635452	635924
						635454	
SOUTHERN ALASKA INSIDE (SIASKA)		043361	043143	043729	042856	043724	043733
		043448	043145	043754	043743	043728	043809
		043451	043151	043758	043744	044156	044214
		043452	043630	043759	043961	044226	044215
		043453	043631	043850	044009	044256	044321
		043454	043659	043851	044010	044257	044458
		043455	043660	043852	044011	044258	044459
		043456	043661	043853	044014	044307	044460
		043457	043662	043854	044045	044308	044461
		043458	043703	043855	044136	044309	044462
		043459	043709	043856	044138	044310	044463
		043460	043710	043908	044139	044311	044501
		043461	043711	043931	044140	044312	044540
		043520	043712	043932	044141	044313	044541
		043521	043713	043935	044144	044405	044542
		043522	043714	043940	044145	044406	044545
		043523	043715	043941	044146	044408	044546
		043524	043716	043942	044147	044409	044547
		043525	043717	043943	044150	044410	044548
		043526	043718	043944	044151	044411	044549
		043527	043719	044012	044152	044412	044550
		043528	043814	044013	044153	044413	044551
		043529	043848	044016	044154	044414	044552
		043552	471650	044022	044155	044415	044553
		043602	471652	471655	044245	044422	044554

MSM Stock Production Region	Mgt Unit	Catch Year 1992	1993	1994	1995	1996	1997
		043603	0401011514	471656	044259	044423	044555
		043632	0401011515	471657	471659	044424	044556
		471607		0401011003	471662	044429	044557
		471611			471663	044444	044558
		471649			0401021212	044445	044559
						044446	044560
						471702	044609
						471703	471721
						471704	471722
						471706	471724
						471707	
						471710	
SOUTHERN ALASKA OUTSIDE		043425	043515	043755		044341	044613
		043444	043516	043806		044342	044614
		043503	043517	043860			
		043505	043752	043861			
		043506	043753	043862			
		043508		043901			
		043509					
		043510					
		043511					
		043512					
		043513					
		043514					
SOUTHWEST VANCOUVER ISLAND (SWVNCI)		020316	020222	021342	180949	181209	181210
		020317	020514	021343	180950	181210	
		020529	021030	021344	180951	181803	
		020530	021031	180605	181629	181804	
		020531	021032	180606	181630		
		020537	021360	180607	181631		
		020538	021361		181632		
		020539	021362				
		020540	021554				
		020541					
		020542					
		020816					
		082815					
		082821					

MSM Stock Production Region	Mgt Unit	Catch Year 1992	1993	1994	1995	1996	1997
STILLAGUAMISH/ SNOHOMISH		211824	212023	212022	212333	212224	212633
		631362	634436	212301	634958	212534	212926
				634804		212536	212927
						635453	212928
							212929
							635735
							635811
STRAIT OF JUAN DE FUCA		211858	212047	212220	212406	212423	212454
		633340	634302	634821	212409	212458	212460
		634316		634822	212410	212510	212620
		634317					
TRANSBOUNDARY ALASKA CANADA		042849		043801	044209	044232	044233
				043802	044210		
UPPER FRASER RIVER (FRSUPP)		020651	020745	020510	020137	021103	181257
		020718	020761	020862	021338	025948	181262
		020719	020762	020931	021339	181249	181263
		020720	020852	020932	021447	181254	181301
		020721	020853	020933	025926	181255	181513
		020722	020854	020934	180649	181310	182243
		020723	020855	021047	180650	181559	182244
		020724	020856	180126	180952	181639	
		020725	020857	180205	180953	181757	
		020726	020858		181207	181758	
		020737	020859		181219	181852	
		025953	020860		181220		
		025954	021538				
		025955	021539				
		026218	180257				
		026219	180258				
		026220	180307				
		026221	180308				
		026222	180331				
		026223					
		026224					
		026225					
		026226					
		026227					
		026335					

MSM Stock Production Region	Mgt Unit	Catch Year 1992	1993	1994	1995	1996	1997
		026336					
		026337					
		026338					
WILLAPA BAY		633403	634355	634538	635108	635720	635857
		633961					
		634010					
		634033					

Table 6. Preliminary “User-Defined” PEF values for Washington State Production Regions for potential use in MSM PEF estimation process. These values were derived using release information and smolt trap information, when available.

Brood year >	1989	1990	1991	1992	1993	1994
Return year >	1992	1993	1994	1995	1996	1997
MSM Production Region						
NOOKSM						
Wild smolts	113,000	113,000	113,000	113,000	113,000	113,000
H smolts	4,221,656	5,202,979	4,846,242	5,284,854	4,802,550	3,744,483
Total smolts	4,334,656	5,315,979	4,959,242	5,397,854	4,915,550	3,857,483
Tagged H smolts	145,420	149,141	200,645	276,459	193,780	196,531
Tagged W smolts	n/a	n/a	n/a	n/a	n/a	n/a
Total tagged smolts	145,420	149,141	200,645	276,459	193,780	196,531
PEF	**29.81**	**35.64**	**24.72**	**19.52**	**25.37**	**19.63**
SKAGIT						
Wild smolts	652,000	1,073,000	623,000	1,129,000	727,000	1,125,000
H smolts	355,616	577,024	500,905	403,366	682,386	363,878
Total smolts	1,007,616	1,650,024	1,123,905	1,532,366	1,409,386	1,488,878
Tagged H smolts	96,451	129,971	125,587	44,613	126,198	347,307
Tagged W smolts	43,550	37,674	39,686	27,261	21,060	19,687
Total tagged smolts	140,001	167,645	165,273	71,874	147,258	366,994
PEF	**7.20**	**9.84**	**6.80**	**21.32**	**9.57**	**4.06**
STILSN						
Wild smolts	1,192,000	1,192,000	1,192,000	1,192,000	1,192,000	1,192,000
H smolts	1,278,447	1,310,771	1,271,672	1,256,500	1,368,012	1,307,813
Total smolts	2,470,447	2,502,771	2,463,672	2,448,500	2,560,012	2,499,813
Tagged H smolts	253,305	94,162	116,283	92,223	109,751	143,080
Tagged W smolts	n/a	n/a	n/a	n/a	n/a	n/a
Total tagged smolts	253,305	94,162	116,283	92,223	109,751	143,080
PEF	**9.75**	**26.58**	**21.19**	**26.55**	**23.33**	**17.47**
SPGSND						
Wild smolts w/out Deschutes	443,000	443,000	443,000	443,000	443,000	443,000
Deschutes	14,103	56,170	20,353	7,191	19,130	n/a
H smolts	9,132,989	10,369,813	8,124,913	7,709,098	7,663,714	9,415,423
Total smolts	9,590,092	10,868,983	8,588,266	8,159,289	8,125,844	9,858,423
Tagged H smolts	348,180	377,372	403,062	493,025	531,680	449,813
Tagged W smolts	1,996	7,154	10,908	1,354	3,571	5,817
Total tagged smolts	350,176	384,526	413,970	494,379	535,251	455,630
PEF	**27.39**	**28.27**	**20.75**	**16.50**	**15.18**	**21.64**
HOODCL						
Wild smolts	550,000	550,000	550,000	550,000	550,000	550,000
H smolts	1,587,365	1,704,802	1,543,980	1,509,655	1,516,464	1,298,758
Total smolts	2,137,365	2,254,802	2,093,980	2,059,655	2,066,464	1,848,758

Brood year >	1989	1990	1991	1992	1993	1994
Return year >	1992	1993	1994	1995	1996	1997
MSM Production Region						
Tagged H smolts	299,773	247,209	130,492	204,682	247,151	141,209
Tagged W smolts	21,149	16,979	10,908	16,274	15,146	21,834
Total tagged smolts	320,922	264,188	141,400	220,956	262,297	163,043
PEF	**6.66**	**8.53**	**14.81**	**9.32**	**7.88**	**11.34**
SJDFCA						
Wild smolts	300,000	300,000	300,000	300,000	300,000	300,000
H smolts	1,017,646	1,219,378	949,400	1,542,131	1,609,700	1,593,821
Total smolts	1,317,646	1,519,378	1,249,400	1,842,131	1,909,700	1,893,821
Tagged H smolts	108,955	97,791	107,025	149,488	145,368	144,895
Tagged W smolts	n/a	n/a	n/a	n/a	n/a	n/a
Total tagged smolts	108,955	97,791	107,025	149,488	145,368	144,895
PEF	**12.09**	**15.54**	**11.67**	**12.32**	**13.14**	**13.07**
MAKAHC						
Wild smolts	n/a	n/a	n/a	n/a	n/a	n/a
H smolts	366,500	351,028	335,210	359,880	341,489	1,047,163
Total smolts	366,500	351,028	335,210	359,880	341,489	1,047,163
Tagged H smolts	130,022	95,259	108,709	68,054	60,683	127,551
Tagged W smolts	n/a	n/a	n/a	n/a	n/a	n/a
Total tagged smolts	130,022	95,259	108,709	68,054	60,683	127,551
PEF	**2.82**	**3.68**	**3.08**	**5.29**	**5.63**	**8.21**
QUILUT/HOH						
Wild smolts	618,000	618,000	618,000	618,000	618,000	618,000
H smolts	1,276,311	855,133	586,376	594,211	822,900	793,400
Total smolts	1,894,311	1,473,133	1,204,376	1,212,211	1,440,900	1,411,400
Tagged H smolts	87,228	69,717	65,163	63,922	73,116	73,302
Tagged W smolts	9,838	9,411	16,611	22,751	0	0
Total tagged smolts	97,066	79,128	81,774	86,673	73,116	73,302
PEF	**19.52**	**18.62**	**14.73**	**13.99**	**19.71**	**19.25**
QUEETS						
Wild smolts	444,000	444,000	444,000	444,000	444,000	444,000
H smolts	628,293	1,009,418	650,108	753,374	1,057,131	999,033
Total smolts	1,072,293	1,453,418	1,094,108	1,197,374	1,501,131	1,443,033
Tagged H smolts	108,518	155,009	106,122	157,126	212,569	135,330
Tagged W smolts	32,163	41,156	20,202	31,319	31,738	23,460
Total tagged smolts	140,681	196,165	126,324	188,445	244,307	158,790
PEF	**7.62**	**7.41**	**8.66**	**6.35**	**6.14**	**9.09**
QUINLT						
Wild smolts	217,000	217,000	217,000	217,000	217,000	217,000
H smolts	592,758	741,785	713,553	659,322	731,806	270,774
Total smolts	809,758	958,785	930,553	876,322	948,806	487,774

Brood year >	1989	1990	1991	1992	1993	1994
Return year >	1992	1993	1994	1995	1996	1997
MSM Production Region						
Tagged H smolts	78,662	99,812	145,697	68,802	107,068	85,806
Tagged W smolts	n/a	n/a	n/a	n/a	n/a	n/a
Total tagged smolts	78,662	99,812	145,697	68,802	107,068	85,806
PEF	**10.29**	**9.61**	**6.39**	**12.74**	**8.86**	**5.68**
GRAYHB						
Wild smolts	1,702,000	1,702,000	1,702,000	1,702,000	1,702,000	1,702,000
H smolts	2,618,250	3,209,508	3,444,173	3,319,376	3,115,790	3,682,514
Total smolts	4,320,250	4,911,508	5,146,173	5,021,376	4,817,790	5,384,514
Tagged H smolts	466,538	495,724	261,238	250,741	285,816	299,169
Tagged W smolts	89,028	42,971	32,027	76,161	57,321	46,942
Total tagged smolts	555,566	538,695	293,265	326,902	343,137	346,111
PEF	**7.78**	**9.12**	**17.55**	**15.36**	**14.04**	**15.56**
WILLAP						
Wild smolts	425,000	425,000	425,000	425,000	425,000	425,000
H smolts	2,939,175	3,905,934	3,470,035	3,421,495	2,117,300	2,543,000
Total smolts	3,364,175	4,330,934	3,895,035	3,846,495	2,542,300	2,968,000
Tagged H smolts	n/a	50,374	26,502	23,781	74,758	76,069
Tagged W smolts	n/a	n/a	n/a	n/a	n/a	n/a
Total tagged smolts	0	50,374	26,502	23,781	74,758	76,069
PEF	**n/a**	**85.98**	**146.97**	**161.75**	**34.01**	**39.02**

Table 7. Estimated escapement, average marine exploitation rate and total CWT recovery data used to derive total marine catch and preliminary "User-Defined" Production Expansion Factors (PEF) for upper Fraser River Coho (FRSUPP) Production Region for catch years 1992-1997. Marine Catch = (Esc-(1-ER))-Esc). PEF = Marine Catch / MSM Tag Recoveries.
MSM Tag Recoveries include all recoveries made in MSM fisheries of FRSUPP tag groups listed in Table 5.

	Catch Year					
Estimate	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Total Escapement (Esc)	50,528	29,381	35,517	22,996	9,294	18,675
Average Marine Exploitation Rate (ER)	0.81	0.88	0.43	0.56	0.83	0.40
Marine Catch	222,077	206,635	27,160	29,458	47,022	12,704
MSM Tag Recoveries	7,870	4,279	2,585	1,248	496	455
PEF	28.22	48.29	10.51	23.60	94.86	27.95

Table 8. Coded-wire-tag groups chosen to represent Mixed-Stock-Model (MSM) stocks for catch years 1986-1991.

MSM Stock		**Catch Year**					
Production Region	**Mgt Unit**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
BRITISH COLUMBIA CENTRAL COAST		022910	023515	023847	023805	023917	020139
		022911	023516	023848	023806	023962	020140
		022952	023517	023849	023807	023963	020141
		022953		024107	023808	024001	020142
		022954		024108	023907	024333	023917
		022955		024109	023962	024432	024333
				024110	023963	024433	025442
				024111	024001	024434	025618
				024112	024432	024435	025619
				024113	024433	024436	026002
				024114	024434	024655	026003
				024115	024435	024811	
					024436	024837	
					024605	024838	
					024651	024839	
					024928	024928	
					024929	025142	
					025018	025143	
					025019	025347	
					025062	025442	
					025063	025563	
					025101	025601	
						025602	
BRITISH COLUMBIA NORTH COAST		022444	022835	023249	023526	023109	020143
		022449	023249	023250	023527	024430	020144
		022508	023250	023501	023528	024431	024857
		022746	023426	023502	023529	024444	025041
			023427	023521	023932	024445	025044
			023428	023526	024332	024446	025045
			023429	023527	024422	024447	025046
			023430	023528	024423	024448	025047
			023431	023529	024424	024449	025119
			023501	023852	024425	024450	025120
			023502	023853	024426	024451	025125
			023521	023854	024427	024857	025313
				023855	024428	025044	025314
				023856	024429	025045	025460
				023857	024430	025046	025540
				023858	024431	025047	025545
				023859	024444	025119	025546

MSM Stock		Catch Year					
Production Region	Mgt Unit	1986	1987	1988	1989	1990	1991
				023901	024445	025120	025548
				023902	024446	025121	025551
				023903	024447	025122	025559
				023904	024448	025123	025560
				023905	024449	025124	025561
				023906	024450	025125	025621
				023925	024451	025126	025622
				023926	024901	025456	025711
				023927	024902	025535	025712
				023928	025020	025540	025713
				023929	025021	025543	025714
				023930	025022	025545	025715
				023931	025023	025546	025716
				023932	025024	025548	025717
				023933	025025	025551	025718
				023934	025026	025556	025917
					025027	025557	026104
					025028	025559	026105
					082456	025560	026106
					082457	025561	026107
					082458	025603	026108
						025604	026109
						025605	026110
						025606	026111
						025607	026112
						025608	026113
						025609	026114
						025610	026115
						025611	026116
						082622	026117
						082625	026118
						082626	026119
						082627	026120
						082629	026121
						082647	026122
						082648	026123
						082649	026133
							026134
							026135
							026214
							026215
							026216
							026217

MSM Stock		Catch Year					
Production Region	Mgt Unit	1986	1987	1988	1989	1990	1991
							026306
							026307
							082630
							082634
							082707
							082718
							082719
COLUMBIA RIVER		072654	073056	073547	074226	074244	052225
		072802	073057	073548	074228	074247	052226
		072811	073058	073549	074231	074410	074209
		073030	073061	073550	074232	074412	074210
		073031	073062	073551	074235	074445	074211
		073032	073063	073552	074237	074454	074502
		073045	073251	073616	074426	074457	074712
		073046	073252	073617	074726	074458	074810
		073047	073253	073624	074728	074606	074811
		073048	073254	073625	074950	074607	074812
		073049	073255	073958	074952	074608	074845
		073050	073261	074108	074955	074609	074846
		073105	073262	074111	074956	074610	074945
		073106	073263	074113	074959	074611	074946
		073107	073301	074114	074961	074703	075029
		073108	073302	074116	634450	074705	630141
		633030	073303	074119	634735	074706	630144
		633031	073304	074121		635256	631128
		633132	073305	074441		635507	631319
		633133	073618	074442			635044
		633134	073619	074444			635047
		633135	073620	074447			
		633259	073621	074449			
		633260	073622	074450			
		633261	073623	633663			
		633262	073630	633701			
		633263	073743	633702			
		633301	073744	634247			
			073745	634249			
			073746	634250			
			633515	634252			
			633516				
			633517				
			633518				
			633519				
			633520				

MSM Stock		Catch Year					
Production Region	Mgt Unit	1986	1987	1988	1989	1990	1991
			633531				
			633532				
			633533				
			633534				
			633535				
			633536				
	Col Rvr Late Hatchery/Wild	633156	633106	633649	634213	634747	630147
		633157	633142	633650	634214		630238
		633232	633143	633658	634919		630241
		633233	633454	633659	634956		630750
		633249	633455	634138			630762
		633250	633456	634208			631131
		633253	633457	634211			631137
		633254	633513	634216			631161
			633514	634219			631162
			633521	634221			631316
			633522	634222			
			633523				
			633524				
			633525				
			633526				
			633527				
			633528				
	Youngs Bay Hatchery	072801	073306	073444	073532	074156	074219
		073029	073307	073445	073533	074157	074220
		073343	073308	073446	073534	074158	074221
		073344	073309	073614	074551	074463	074307
			073310	073615		074501	074308
			073311			074744	075128
GEORGIA STRAIT MAINLAND		022445	022811	022854	024116	024417	025051
		022617	022844	023115	024117	024418	025052
		022629	022846	023447	024123	024452	025053
		022638	022854	023452	024241	024548	025057
		022640	022931	023455	024242	024713	025918
		022641	022935	023456	024246	025051	025919
		022642	023061	023817	024417	025052	025920
		022649	023062	023818	024418	025053	025921
		022809	023137	023942	024438	025054	026130
		022810	023339	023943	024439	025055	026131
		022811	023340	023957	024548	025056	026140
		022843	023447	023958	024713	025057	026141
		022844	023452	023959	024845	025210	026142
		022845	023453	024116	024846	025211	026143

MSM Stock		Catch Year					
Production Region	Mgt Unit	1986	1987	1988	1989	1990	1991
		022846	023454	024117	024903	025212	026144
		022853	023455	024118	024904	025455	026251
		022862	023456	024122	024905	025553	
		022931	023518	024123	024906	025554	
		022932	023817	024241	024927	025633	
		022933	023818	024242	025115	025634	
		022934	023820	024243	025116	025639	
		022935	023821	024246	025117		
		022936	082249	082408	025118		
		023008	082250	082409			
		023009	082408	420122			
		023056	082409				
		023137	420122				
		082249					
		082250					
GEORGIA STRAIT/ VANCOUVER ISLAND		022645	022904	023655	023916	025133	020840
		022644	022801	023446	023915	024621	020138
		022723	022905	023825	023918	025233	020841
		022763	022906	023829	024628	025234	025136
		022801	023120	023833	024629	025235	025239
		022903	023121	023918	024630	025415	025321
		022906	023124	023919	024631	025501	025322
		022912	023125	023920	024638	025502	025323
		022913	023126	023921	024639	025508	025416
		022914	023127	024058	024719	025719	025729
		022915	023130	024124	025102	025720	025941
		022937	023152	024125	025111	025721	025942
		022938	023153	024126	025112	025722	025943
		022939	023154	024127	025130	025723	025949
		022943	023232	024128	025133	025724	025950
		022944	023233	024129	025134	025916	025951
		022945	023432	024130	082410	080001	025952
		022946	023433	024131	082435	080002	026238
		022957	023434	024144	082436	080003	081607
		022958	023443	024145	082437	080004	081608
		022959	023444	024146	082438	080005	082650
		022960	023445	024149	082439	080006	082651
		023119	023446	024150	082440	080007	082652
		023120	023712	024151	082441	080008	082653
		023121	023815	024440	082442	080009	082654
		023122	023823	024441	082443	080010	082655
		023123	023824	024442	082446	081606	082658
		082251	023825	024443	082447	081609	082660

MSM Stock		Catch Year					
Production Region	**Mgt Unit**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
		082252	023826	082406	082448	081610	082661
			023827	082410	082449	081611	082662
			023828	082411	082450	082459	082663
			023829	082417	082451	082463	082703
			023830	082418	082453	082505	082704
			023831	082419	082459	082507	082705
			023832	082421	082460	082511	082706
			023833	082422	082461	082513	082708
			023837	082423	082462	082514	082709
			023841	082424	082501	082516	082711
			023918	082425	082502	082519	082712
			081603*1	082426	082503	082521	082713
			081604*1	082427	082504	082522	082714
			082251	082429	082508	082525	082720
			082406	082431	082516	082526	082721
			082407	082432		082528	082722
				082438		082531	082723
				082501		082532	082724
						082535	082725
						082537	082726
						082538	
						082541	
						082542	
						082544	
						082547	
						082549	
						082550	
						082552	
						082555	
						082556	
						082559	
						082561	
						082562	
						082617	
						082618	
						082620	
						082623	
						082631	
						082638	
						082639	
						082640	
						082641	
						082642	

MSM Stock		Catch Year					
Production Region	**Mgt Unit**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
						082643	
						082644	
						082645	
						082646	
GRAYS HARBOR		632817	633138	633110	634449	630252	630259
		632818	633139	633655	634452	630428	630728
		632819	633163	633656	634901	634749	630752
		632823	633201	633657	635021	635255	630816
		632824	633540	633660	635022	635521	630828
		632825	633541	633661	635032		630831
		632826	633542	633662			630832
		632827	634131	634238			630837
		632828	634137	634425			631438
		632829	634141	634426			
		632830		634438			
		632831					
		633010					
		633035					
		633209					
		633345					
		633346					
		633347					
		633348					
		633423					
		633424					
		633425					
		633443					
		633444					
	Bingham Hatchery				634449	634749	
	Grays Harbor Net Pens						630437
							630721
							631335
							631337
							631338
							631341
							631342
							631344
	Humptulips River Hatchery		633138				
			633139				
			633163				
			633201				
HOH		211638	211736	211735	211813	213250	213516

MSM Stock		Catch Year					
Production Region	**Mgt Unit**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
		211639	211737	211762	211814	213252	
		211640	211738	211763	211815	634907	
			632511	211801	211816	634908	
				211802	211817		
				211803	212837		
				211811	633858		
				211812	633859		
					633906		
					634154		
					634237		
					634428		
HOOD CANAL		632751	211909	212225	212814	052107	630438
		632752	633355	633361	635041	052108	633312
		632832	633356	633617		052111	
		632833	633357	633621		630159	
		633034	633358	634226		634761	
			633359	634241			
			633360				
			633614				
			633615				
			633616				
			634144				
	Area 12/12B Wild					211729	
						630432	
	Area 12A Wild					211729	
						630432	
	Area 12C/12D Wild					211729	
						630432	
	George Adams Hatchery				633718		631142
					633719		631144
					633720		
	Hoodsport Hatchery				633718		631138
					633719		
					633720		
	Port Gamble Net Pens				634231		213150
	Quilcene Bay Net Pens				634231		052253
							052254
							052255
	Quilcene Hatchery				634231		631141
	Skokomish					211729	

MSM Stock		Catch Year					
Production Region	**Mgt Unit**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
	River Wild					630432	
JOHNSTONE STRAIT		022839	022836	023439	024453	025144	020837
		022916	022962	023835	024454	025612	020838
		022917	022963	024106	024455	025613	025928
		022918	023001	024135	024456	025614	025929
		022919	023002	024136	024457	082445	025930
		022920	023111	024138	024458		025931
		022921	023201	024139	024459		082710
		022922	023202	024140	024460		
		022923	023205	082420	024461		
		022949	023207		024505		
		022950	023435		024506		
		022951	023436		024507		
		022962	023437		082444		
		022963	023438		082445		
		023001	023439				
		023002	023440				
		082244	023441				
		082313	023442				
		082314	023834				
			023835				
			023836				
			082313				
LOWER FRASER RIVER		022832	022851	023138	024632	024640	020834
		022907	023035	023840	024851	024649	020835
		022908	023139	023938	024852	024650	020836
		022909	023140	023939	024853	024820	024649
		022924	023141	023940	024854	024832	025236
		022925	023216	023941	024855	025137	025237
		022926	023448	023944	024938	025138	025238
		022927	023449	023945	025033	025139	025725
		022928	023450	023946	025034	025140	025932
		022929	023451	023947	025035	025141	025933
		022930	023457	023948	025036	025725	025934
		022942	023458	023949	025037	026322	025935
		022947	023459	023950	025038		025936
		022948	023460	023951	025039		025937
		022956	023461	023952	025113		025938
		022961	023462	023953	025114		025939
		023003	023463	023954			025940
		023004	023506	023955			025945

MSM Stock		Catch Year					
Production Region	Mgt Unit	1986	1987	1988	1989	1990	1991
		023420	023811	023956			025946
			023812	024310			025947
			023813	420121			026322
			023814				
			023816				
			023838				
			023839				
			023840				
			420121				
MAKAH COASTAL					051740		052256
					051741		052257
					051742		052258
					051743		052259
					051949		
NOOKSACK/SAMISH		632753	211721	211944	212501	212528	213155
		632754	211722	211947	212502	212855	213156
			211723	633626	634432	635516	630716
			211724	633627	634708		
			211725	633628			
			211726				
			420116				
			633144				
			633145				
			633146				
			633147				
			633148				
	Bellingham Bay Net Pens				634431	635526	
NORTHERN ALASKA INSIDE		031822	031900	032023	042646	041318	041319
		031823	032020	032024	042656	042833	042661
		031841	032021	032025	042659	042855	042662
		031842	032022	032026	042708	042923	042931
		040317	032023	042305	042727	042926	042953
		041862	032024	042656	042729	042927	043105
		042310	041336	042707	042730	042942	043146
		042311	042135	042709	042740	042947	043216
		042312	042423	042820	042751	042948	043217
		042329	042446	B41100	042752	042949	043218
		042351	042455	B41200	042811	042950	043228
		042362			042836	042951	043230
		042416			042855	042953	043234
		042417			042916	043146	043235
		042418			042917	043153	043236

MSM Stock		Catch Year					
Production Region	**Mgt Unit**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
		042419			042942	043154	043237
		042420			042946	043155	043345
		042421			042947	043156	043419
		042433			042948	043231	043420
		042434			042949	043235	043421
		042436			042950	043237	043422
		042446			042951	0401010403	043423
					043014	0401010404	043424
					043015	0401010405	043443
					043153	0401010406	
					043154	B31402	
					043155	B31403	
					B31402	B31501	
					B31403		
NORTHERN ALASKA OUTSIDE		040326	040351	040318	042315	042918	042941
		041324	041324	041339	042555	042922	043227
		041325	041325	042303	042657	043111	043438
		042127	042440	042527	042844	043113	
		042128	042447	042549	042860	043114	
		042308	042617	042623	043005	043116	
		042309	042618	042624	043006	043119	
		042320	042619	042625	043007	043121	
		042328	B40315	042657		043122	
		042332	B40506	042701		043125	
		042333	B40507	042802		043126	
		042427		042803		043128	
		042429		042804		043131	
		042435		042805		043222	
		042438		042806		043224	
		042439		042807			
		042440		042808			
				042809			
				042860			
NORTHWEST VANCOUVER ISLAND		022705	022705	024055	024724	025452	025259
		022706	023213				026136
		022840	023214				026334
			023343				
			023344				
OREGON NORTH AND MID COAST		072754	072927	073339	073558	074249	074552
		072755	073043	073340	073559	074350	074808
		072756	073059	073341	074055	074351	074809
		072757	073060	073544	074238	074352	074816
		072758	073101	073545	074241	074353	074817

MSM Stock		Catch Year					
Production Region	Mgt Unit	1986	1987	1988	1989	1990	1991
		072759	073102	073546	074242	074354	074840
		072760	073256	073554	074310	074355	074841
		072958	073257	073610	074311	074435	074842
		073022	073258	073611	074312	074437	074843
		073025	073259	073612	074313	074438	074844
		073026	073260	073647	074314	074660	074848
		073027	073331	073648	074363	074661	074858
		073028	073332	073649	074403	074662	074939
		073033	073333	074414	074405	074663	074940
		073034	073411	074416	074406	074748	074943
		073035	073412	074419	074409	074751	075155
			073413	074421	074428		075156
			073414	074422	074431		075157
			073415		074432		
			073416				
			073417				
			073418				
			073601				
			073602				
			073603				
			073604				
			073605				
			073606				
			073607				
	Oregon Anadromous Hatchery	623047	620518	620634	621633	622135	
		623048	620636	621729	621913	622137	
		623122	620637	621833	621921	622138	
		623123	620640	621838	621925	622141	
		623124	620641	621839	621928	622142	
		623125	621810			622144	
		623126	621811				
		623127	621812				
		623128	621814				
		623129	621816				
	Oregon Aqua-Foods Hatchery	603658	603824	603629	603912	603910	603950
		603659	603826	603816	603913	603928	603963
		603704	603827	603817	603914	603929	604009
		603705	603831	603853	603915	603930	604010
		603820	603832	603854	603916	603931	604011
		603821	603833	603855	603917	603935	604012
		603822	603834	603856	603925	603936	604015
		603823	603835	603857		603939	
		603825	603836			603940	

MSM Stock		Catch Year					
Production Region	Mgt Unit	1986	1987	1988	1989	1990	1991
			603837			603941	
			603838			603944	
						603945	
						603946	
						603947	
						603948	
						603953	
						604007	
						604008	
OREGON SOUTH/CALIFORNIA COAST		065650	062901	062913	062916	065121	066322
		065651	062902	065109	065115	065122	
		065930	062903	065110	065116	065123	
			065103	065111	065656	065124	
			065104	065112		065938	
			065105	065654			
			065106	073613			
			065652	073723			
			065653	074004			
			065655	074005			
			065943				
			065961				
	Oregon South Coast Hatchery	073011	073161		074058	074060	074847
					074059	074550	
	Oregon South Coast Wild	073011	073161		074058	074060	074847
					074059	074550	
QUEETS		211642	211719	211955	212252	212562	211655
		211643	211743	211956	212255	212601	211848
		211648	211744	212104	212514	212602	211849
		211710	211747	212107	212516	212604	211851
		211711	211748	212111	212559	212849	213114
		211713	211749	212113	212561	212850	213508
		211714	211750	212114	212608	212856	213511
		211715	211751	212116	212611	212859	213513
		211718	211752	212119	212613	212861	213531
			211753	212121	212614	212862	213537
			211754	212122	212616	213101	213538
			211755	212125	212619	213102	213542
			211757	212126	212621	213104	213544
			211933	212237	212622	213107	213547
				212250	212625	213108	213549
				632512	212626	213111	213550
				633245	212831	213113	213552

MSM Stock		Catch Year					
Production Region	**Mgt Unit**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
					212832	213116	213555
					634461	213119	213556
					634462	213122	213561
						213125	213562
						213126	213701
						213128	213702
						213131	
						213259	
						213261	
						213507	
						635513	
						635514	
QUILLAYUTE		633255	633052	633549	633861	634762	211844
		633256	633053	633550	633862	635511	630459
		633257	633136	633551	634232		
		633258	633137	633552	634235		
		633417	633441	633553	634444		
		633418	633839	633554	634456		
				633555	634459		
				633556	635025		
				633557			
				633558			
				633559			
				634244			
QUINAULT		211635	211656	211952	212259	212535	213161
		211636					213532
SKAGIT		211703	211731	212132	212659	213162	211838
		211704	211732	212135	212661	213201	211839
		632755	211758	212137	212662	213202	211840
		632756	420119	212138	212801	213242	211841
		632757	633149	212141	212802	213244	211842
		632758	633150	212142	212804	630149	211843
		633154	633151	212238	212807	630216	211852
		633155	633206	634225	212808	630219	213247
			633207		212811	630221	213249
			633603		212813	630222	213502
			633604		633711		213504
			633605		633712		630747
					633713		631425
							631426
							631428
							631431
	Baker			633651	633717	635055	

MSM Stock		Catch Year					
Production Region	Mgt Unit	1986	1987	1988	1989	1990	1991
	Hatchery			633652	633916	635056	
				633653	634711	635522	
				633654	634713	635525	
					634928		
	Oak Harbor Net Pens			633622			
				633623			
	Skagit River Hatchery		420119				
			633149				
			633150				
			633151				
			633206				
			633207				
			633603				
			633604				
			633605				
	Swinomish Channel Hatchery	211705	211702	211804	212508	212521	
SOUTH PUGET SOUND		632454	633208	211949	212262	212522	213522
		632759	633210	211950	212504	212852	213704
		632760	633211	633629	633714	630116	630125
		632761	633362	633630	633715	630119	630126
		632762	633363	633704	633716	630121	630128
		632804	633438	633705	634441	630122	630256
		632805	633439	633706	634719	630150	630441
		632806	633440	633707	634721	630152	630722
		632807	633606	633708	634722	630156	630726
		632855	633607	633709	634726	633310	630822
		632856	633608	633710	635001	633311	630825
		633057	633609	633754	635002	633901	630826
		633058	633610	633755	635004	633902	634026
		633059	633611	633756	635007	635528	
		633140	633734	633757	635008		
		633204	633735	633758	635011		
		633205	633736	633851			
		633352	633846	633852			
		633426	633847	633853			
		633427	633848	633854			
			633849	633855			
			633850	633856			
				633857			
				634147			
	Nisqually River				212504	212852	213704

MSM Stock		Catch Year					
Production Region	Mgt Unit	1986	1987	1988	1989	1990	1991
	Hatchery						
	Puyallup River Hatchery			633629	635008		
				633630	635011		
				633704			
				633705			
				633706			
SOUTHERN ALASKA INSIDE		040319	040319	042635	042641	042718	042720
		040320	040323	042636	042663	042720	042919
		042155	040324	042637	042718	042957	043256
		042156	040327	042638	042753	043023	043257
		042324	040328	042639	042842	043024	043258
		042358	040334	042640	042845	043025	043259
		042359	040335	042641	042861	043050	043260
		042432	040337	042642	042862	043051	043261
		042450	040338	042643	042901	043052	043262
		042451	040339	042652	042902	043053	043263
		042452	040340	042736	042903	043054	043301
		042461	040341	042810	042904	043055	043302
		042462	041337	471637	042905	043056	043307
		042504	042134		042906	043057	043325
		042506	042441		042907	043060	043326
		042507	042453		042910	043061	043327
		042508	042561		042911	043062	043328
		042509	471632		042912	043152	043329
		042514	471633		042913	043211	043330
		042515	471634		042957	471606	043331
		042516			043010		043332
		042517			043016		043405
		042521			471640		043442
		042522			471641		471612
		471630					
SOUTHERN ALASKA OUTSIDE		042318	041955	042313	042543	0401010407	043203
		042325	042327	042314	042741	0401010408	043205
		042410	042454	042316	042914	042834	043219
		042413	042518	042317	042915	042914	043311
		042414	042519	042518	043019	043017	043312
				042543	043021	043018	043313
				042553		043019	043314
				042554		043021	043315
				042611		043022	043316
				042613			043317

MSM Stock		Catch Year					
Production Region	Mgt Unit	1986	1987	1988	1989	1990	1991
							043318
SOUTHWEST VANCOUVER ISLAND		023007 023006	023504 023503 023505	024142 024141 024143	024560 024437 024561	025336 024161 025337 025418 025419 082515 082558 082560 082563	025731 025337 025732 025737 025944 082825 082826 082827 082828
STILLAGUAMISH/ SNOHOMISH		211634 633051 633141 633203 633429 633430	211662 211663 211701 211922 211923 211924 211925 211926 211928 211929 211931 633618 633619 633620 634142	211927 211930 211942 212144 212147 212149 212150 212152 212155 212156 212159 212161 212162 212201 212202 212241 212242 212244 212247 212249 634228	212261 212631 212632 212635 212637 212638 212641 212642 212644 212647 212649 212650 212652 212655 212656 634701	212531 213208 213211 213213 213214 213216 213219 213221 213222 213225 213226 213228 213231 213232 213235 630155	213149 631147
	Area 8A Net Pens				633337	635519	
STRAIT OF JUAN DE FUCA		B10408 B10409 B10410 B10411 B10412 B10414 B10415 B10508 B10509	211913 211914	211941 212222 212226	212256 212821 634728 634731	211728 212532 213237 213238 213514	213159

MSM Stock		Catch Year					
Production Region	**Mgt Unit**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
		B10510					
	Dungeness Hatchery	B10408			634728		
		B10409			634731		
		B10410					
		B10411					
		B10412					
		B10414					
		B10415					
		B10508					
		B10509					
		B10510					
	Elwha Hatchery					212532	213159
	Port Angeles Net Pens						631321
TRANSBOUNDARY ALASKA CANADA		B40909	B40603	024340	024340	024345	025048
		B40910	B40604	024341	024345	024346	025623
			B40605	024342	024346	024843	025625
			B41207	024347	024347	025623	025626
				024348	024821	025624	025628
					024822	025625	026159
					042647	025626	026329
					042653	025627	031503
						025628	042920
						031503	
						042920	
						042921	
UPPER FRASER RIVER		022829	023058	023106	024132	024807	024808
		022850	023104	023227	024133	024808	025242
		023005	023114	023413	024134	025127	025243
			023118	023649	024147	025128	025244
			023163	023650	024148	025129	025245
			023263	023914	024329	025405	025307
			023301	023935	024330	025406	025308
			023309	023936	024508	025412	025309
				023937	024602	025413	025403
				024004	024603	025414	025558
				024005	024604	025506	025726
				024006	024932	025513	025727
				024043	024933		025728
				024044			025730
				024045			025860
				024046			025861

MSM Stock		Catch Year					
Production Region	**Mgt Unit**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
							025862
							025863
							025903
							025905
							025911
							026012
							026013
							026024
							026025
							026026
							026027
							026037
							026038
WILLAPA BAY		632808	633537	633624	634447		
		632809	633538	633625			
		632810	633539	634207			
		632811	633612				
		632812	633613				
		632813					
		632814					
		632815					
		632816					
		633341					
		633342					
		633343					
		633344					

Table 9. MSM estimated PEF values for 1986 catch year. CV = coefficient of variation.

MSM Stock	PEF	PEF-CV	User Flag
BCCNTL	505.20	0.0391	0
STILSN	47.49	0.1052	0
SPGSND	44.86	0.0377	0
HOODCL	38.69	0.0944	0
QUEETS	12.29	0.0500	1
QUINLT	42.96	0.0822	0
GRAYHB	27.99	0.0659	0
WILLAP	23.21	0.0392	0
COLRIV	20.46	0.0000	0
collhw	62.01	0.0171	0
OREGON	23.59	0.0911	0
BCNCST	292.37	0.1739	0
oraqah	35.78	0.0092	0
oranah	56.22	0.0066	0
swinch	1.28	0.0500	1
SJDFCA	11.62	0.3300	2
dungeh	1.52	0.0500	1
oresow	1.60	0.3300	2
oresoh	6.80	0.3300	2
ORECAL	3.83	0.3300	2
HOHRIV	25.77	0.3300	2
QUILUT	14.53	0.3300	2
FRSLOW	20.25	0.0136	0
GSMLND	20.25	0.0136	0
GSVNCI	20.25	0.0136	0
JNSTRT	20.25	0.0136	0
youngh	29.97	0.3300	2
FRSUPP	273.94	0.3300	2
NWVNCI	71.36	0.0506	0
SWVNCI	71.36	0.0506	0
NIASKA	49.48	0.2528	0
TRANAC	49.48	0.2528	0
NOASKA	49.48	0.2528	0
SIASKA	109.57	0.0337	0
SOASKA	248.64	0.0809	0
NOOKSM	89.94	0.0600	0
SKAGIT	15.44	0.0500	0

Table 10. MSM estimated PEF values for 1987 catch year. CV = coefficient of variation.

Stock	PEF	PEF-CV	User Flag
BCCNTL	198.50	0.0353	0
BCNCST	198.50	0.0353	0
SPGSND	55.26	0.0297	0
HOODCL	39.19	0.0662	0
QUEETS	9.66	0.0000	0
QUINLT	70.95	0.1443	0
GRAYHB	49.99	0.1511	0
WILLAP	91.64	0.0808	0
COLRIV	16.60	0.0393	0
collhw	34.65	0.0383	0
OREGON	10.21	0.3202	0
oraqah	35.84	0.0226	0
FRSLOW	15.52	0.0162	0
GSMLND	15.52	0.0162	0
GSVNCI	15.52	0.0162	0
JNSTRT	15.52	0.0162	0
oranah	40.56	0.0511	0
ORECAL	19.78	0.0622	0
skagth	1.91	0.0500	1
swinch	2.00	0.0500	1
SJDFCA	127.90	0.3300	2
oresow	2.07	0.3300	2
oresoh	10.30	0.3300	2
QUILUT	49.69	0.3300	2
HOHRIV	28.05	0.3300	2
humpth	17.47	0.3300	1
NWVNCI	125.11	0.0508	0
SWVNCI	125.11	0.0508	0
youngh	31.15	0.3300	2
FRSUPP	25.79	0.3300	2
NIASKA	173.36	0.0466	0
NOASKA	173.36	0.0466	0
SIASKA	43.87	0.0595	0
SOASKA	326.69	0.1050	0
NOOKSM	28.38	0.0364	0
SKAGIT	8.87	0.0500	0
STILSN	14.17	0.0375	0

Table 11. MSM estimated PEF values for 1988 catch year. CV = coefficient of variation.

Stock	PEF	PEF-CV	User Flag
BCCNTL	198.50	517.40	0
STILSN	198.50	51.67	0
SPGSND	55.26	37.33	0
QUEETS	39.19	4.68	0
QUINLT	9.66	21.35	0
GRAYHB	70.95	28.90	0
WILLAP	49.99	42.91	0
COLRIV	91.64	5.21	0
collhw	16.60	45.23	0
OREGON	34.65	17.23	0
oraqah	10.21	30.40	0
BCNCST	35.84	79.90	0
oranah	15.52	12.52	0
ORECAL	15.52	7.46	0
skgbkh	15.52	1.08	1
swinch	15.52	2.00	1
oakhbh	40.56	1.02	1
puyalh	19.78	13.15	1
HOODCL	1.91	39.20	2
SJDFCA	2.00	46.42	2
QUILUT	127.90	10.58	2
HOHRIV	2.07	6.79	2
FRSLOW	10.30	25.42	0
GSMLND	49.69	25.42	0
GSVNCI	28.05	25.42	0
JNSTRT	17.47	25.42	0
youngh	125.11	19.31	2
FRSUPP	125.11	28.57	2
NWVNCI	31.15	166.73	0
SWVNCI	25.79	166.73	0
TRANAC	173.36	100.47	0
NIASKA	173.36	100.47	0
NOASKA	43.87	100.47	0
SOASKA	326.69	117.47	0
SIASKA	28.38	47.86	0
NOOKSM	8.87	24.82	0
SKAGIT	14.17	14.57	0

Table 12. MSM estimated PEF values for 1989 catch year. CV = coefficient of variation.

Stock	PEF	PEF-CV	User Flag
BCCNTL	190.63	0.0346	0
BCNCST	190.63	0.0346	0
STILSN	59.73	0.0928	0
SPGSND	37.70	0.0276	0
QUEETS	8.06	0.0500	0
QUINLT	37.54	0.1249	0
GRAYHB	18.03	0.0919	0
WILLAP	69.51	0.0497	0
COLRIV	14.16	0.0000	0
collhw	61.46	0.0251	0
OREGON	34.45	0.0516	0
oraqah	29.80	0.0488	0
FRSLOW	15.85	0.0811	0
GSMLND	15.85	0.0811	0
oranah	34.25	0.1215	0
bhambh	1.01	0.0500	1
skgbkh	1.39	0.0500	1
swinch	2.00	0.0500	1
puyalh	23.97	0.0500	1
nisqlh	9.90	0.0500	1
HOODCL	24.38	0.3300	2
dungeh	3.00	0.0500	1
SJDFCA	3.71	0.3300	2
MAKAHC	5.68	0.3300	2
GSVNCI	21.01	0.0463	0
JNSTRT	21.01	0.0463	0
chehlh	20.40	0.0500	1
ar8anh	1.00	0.0500	1
oresow	3.15	0.3300	2
oresoh	4.30	0.3300	2
HOHRIV	8.92	0.3300	2
QUILUT	10.43	0.3300	2
ORECAL	18.46	0.3300	2
hoodsh	5.96	0.3300	2
qlcenh	12.32	0.3300	2
qlcnbh	4.15	0.3300	2
NWVNCI	112.61	0.0848	0
SWVNCI	112.61	0.0848	0
ptgamh	9.21	0.3300	2
gadamh	7.49	0.3300	2
youngh	22.10	0.3300	2
FRSUPP	17.33	0.3300	2
TRANAC	78.78	0.0349	0
NIASKA	78.78	0.0349	0
NOASKA	78.78	0.0349	0
SOASKA	129.34	0.1169	0
SIASKA	102.22	0.0486	0
NOOKSM	27.41	0.0403	0
SKAGIT	11.22	0.0900	0

Table 13. MSM Estimated PEF values for 1990 catch year. CV = coefficient of variation.

Stock	PEF	PEF-CV	User Flag
BCCNTL	303.40	0.1234	0
SKAGIT	12.32	0.1234	0
STILSN	21.88	0.1234	0
SPGSND	22.27	0.1234	0
HOODCL	52.90	0.1234	0
QUEETS	6.88	0.1234	0
QUINLT	42.47	0.1234	0
GRAYHB	21.85	0.1234	0
COLRIV	18.96	0.1234	0
collhw	437.32	0.1234	0
OREGON	24.25	0.1234	0
BCNCST	47.16	0.1234	0
oraqah	24.56	0.1234	0
oranah	77.66	0.1234	0
WILLAP	40.35	0.1234	0
bhambh	1.30	0.0500	1
skgbkh	1.07	0.0500	1
swinch	2.15	0.0500	1
ar8anh	1.00	0.0500	1
nisqlh	10.28	0.0500	1
ar12bw	2.06	0.3300	2
ar12aw	0.50	0.3300	2
FRSLOW	42.25	0.1234	0
GSMLND	42.25	0.1234	0
GSVNCI	42.25	0.1234	0
JNSTRT	42.25	0.1234	0
ar12dw	4.13	0.3300	2
skokrw	10.15	0.3300	2
SJDFCA	9.65	0.3300	2
elwhah	6.80	0.3300	2
chehlh	19.66	0.0500	1
oresow	13.37	0.3300	2
oresoh	5.30	0.3300	2
QUILUT	116.33	0.3300	2
HOHRIV	25.45	0.3300	2
youngh	16.10	0.3300	2
NWVNCI	110.33	0.1234	0
SWVNCI	110.33	0.1234	0
FRSUPP	19.01	0.1234	2
TRANAC	71.12	0.1234	0
NIASKA	71.12	0.1234	0
NOASKA	71.12	0.1234	0
SOASKA	32.07	0.1234	0
SIASKA	43.09	0.1234	0
ORECAL	14.86	0.1234	0
NOOKSM	28.48	0.1234	0

Table 14. MSM Estimated PEF values for 1991 catch year. CV = coefficient of variation.

Stock	PEF	PEF-CV	User Flag
BCCNTL	113.96	0.0232	0
BCNCST	113.96	0.0232	0
SKAGIT	12.97	0.0000	0
STILSN	67.31	0.0865	0
SPGSND	36.00	0.0361	0
QUEETS	10.59	0.0000	0
QUINLT	18.03	0.0717	0
GRAYHB	19.38	0.0322	0
COLRIV	29.26	0.0500	0
collhw	40.94	0.0196	0
OREGON	28.15	0.0697	0
oraqah	31.03	0.0480	0
FRSLOW	34.80	0.0424	0
GSMLND	34.80	0.0424	0
ORECAL	25.70	0.1598	0
WILLAP	40.11	0.1601	0
bhambh	1.18	0.0500	1
skagth	2.81	0.0500	1
swinch	2.04	0.0500	1
nisqlh	9.70	0.0500	1
qlcenh	6.38	0.3300	2
ptgamh	53.50	0.3300	2
HOODCL	33.88	0.3300	2
gadamh	3.90	0.0500	1
GSVNCI	34.80	0.0424	0
JNSTRT	34.80	0.0424	0
NWVNCI	54.74	0.0834	0
SWVNCI	54.74	0.0834	0
elwhah	7.25	0.3300	2
ptangh	1.00	0.0500	1
chehlh	9.31	0.0500	1
gryhbh	1.30	0.0500	1
SJDFCA	234.92	0.3300	2
MAKAHC	3.61	0.3300	2
oresow	1.14	0.3300	2
oresoh	8.50	0.3300	2
QUILUT	48.79	0.3300	2
HOHRIV	17.95	0.3300	2
TRANAC	286.49	0.2177	0
qlcnbh	8.25	0.3300	2
hoodsh	0.95	0.3300	2
youngh	23.99	0.3300	2
FRSUPP	13.42	0.3300	2
SIASKA	25.36	0.0269	0
SOASKA	43.08	0.0705	0
NIASKA	27.16	0.0363	0
NOASKA	125.24	0.0805	0
NOOKSM	35.47	0.0938	0

Table 15. Estimated escapement, average marine exploitation rate and total CWT recovery data used to derive total marine catch and "User-Defined" Production Expansion Factors (PEF) for upper Fraser River Coho (FRSUPP) Production Region for catch years 1986-1991.
Marine Catch = (Esc-(1-ER))-Esc). PEF = Marine Catch / MSM Tag Recoveries.
MSM Tag Recoveries include all recoveries made in MSM fisheries of FRSUPP tag groups listed in Table 8.

	Catch Year					
Estimate	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**
Total Escapement (Esc)	158,380	103,242	127,542	66,067	49,866	29,022
Average Marine Exploitation Rate (ER)	0.65	0.54	0.71	0.65	0.74	0.68
Marine Catch	293,388	121,197	312,259	122,695	141,927	61,672
MSM Tag Recoveries	1,071	4,700	10,931	7,078	7,466	4,597
PEF	273.94	25.79	28.57	17.33	19.01	13.42

18. Appendices

Appendix A. CWT recoveries by fishery and Production Region are updated frequently, stored in a file titled “92-97 cwt matrices.xls” and can be downloaded at:
http://www.fws.gov/filedownloads/ftp_westwafwo/FRAM

Appendix B. Catches by fishery and year are stored in a file titled “92-97 catch.xls” and can be downloaded at:
http://www.fws.gov/filedownloads/ftp_westwafwo/FRAM

Appendix C. RRTERM summary tables of the terminal runsize estimates are stored in a file titled “MSM_Appendix_C.Zip” and can be downloaded at:
http://www.fws.gov/filedownloads/ftp_westwafwo/FRAM

Appendix D. Catch Adjustment Factor summary tables of the PEF expanded CWT recovery estimates by fishery and time-step are stored in a file titled “MSM_Appendix_D.Zip” and can be downloaded at:
http://www.fws.gov/filedownloads/ftp_westwafwo/FRAM

Agenda Item G.1.b
Supplemental MEW Report
June 2006

MODEL EVALUTATION WORKGROUP REPORT ON THE FISHERY REGULATION ASSESSMENT MODEL

The Model Evaluation Workgroup (MEW) Chair and Vice Chair met earlier this week with the Scientific and Statistical Committee (SSC) and the Salmon Technical Team (STT) to discuss further progress on the MEW's task of documentation of the Fishery Regulation Assessment Model (FRAM). The FRAM is used for Chinook and coho salmon fisheries impact assessment in Council area fisheries and other waters. The meetings with the SSC and STT reviewed FRAM documentation reports that incorporated their comments from the November, 2005 statements to the Council.

FRAM documentation originally consisted of an overview report. It now comprises a set of five reports. Four of these reports were included in a Briefing Book CD to provide the SSC and STT an opportunity to quickly review the material before the June Council Meeting. These reports are:

1. An Overview of FRAM, for a general audience.
2. FRAM Technical Documentation Report, a more detailed description.
3. Coho FRAM Base Data Development Report.
4. Chinook FRAM Base Data Development Report.

The fifth piece of documentation was provided at this June meeting as supplemental material.

5. A FRAM Users Manual.

In 2004, the Council accepted the MEW report entitled A FRAM Overview. The MEW requests that the previous Overview be replaced with this latest version. This version of the Overview has been simplified technically and is targeted toward a more general audience, while the FRAM Technical Documentation provides material appropriate for a more analytically oriented audience. Thus, although the SSC and STT are familiar with the previous "Overview," the MEW requests their review of these latest products with consideration of the target audience.

The two Base Data Development reports describe how data were compiled and analyzed for model usage. The MEW considers the Chinook Base Data Report as a final draft, pending SSC and STT review over the summer. The Coho Base Data Report remains a preliminary draft until the Coho Technical Committee of the Pacific Salmon Commission (PSC) finishes the documentation of the base data used in coho FRAM for PSC modeling.

This is the first opportunity the STT and SSC have had to review the FRAM Users Manual. Although largely complete, MEW work on this product will continue through the summer. A few sections still need to be added.

For all five reports, the MEW would appreciate reviewers' comments prior to the September Council Meeting with the hope of finalizing this documentation project this fall.

PFMC
06/15/06

Agenda Item G.1.c
Supplemental SSC Report
June 2006

SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON FISHERY REGULATION ASSESSMENT MODEL (FRAM)

Mr. Andy Rankis and Mr. Larrie LaVoy met with the Scientific and Statistical Committee (SSC) and described recent progress by the Model Evaluation Workgroup (MEW) on the Fishery Regulation Assessment Model (FRAM) documentation. They presented five documents:

1) User Manual,
2) FRAM Overview,
3) FRAM Technical Documentation,
4) Chinook FRAM Base Data Development, and
5) Coho FRAM Base Data Development.

Documents 2 through 5 were revisions of documents reviewed by the SSC and Salmon Technical Team (STT) in November 2005. Document 1, the User Manual, was newly created in response to review comments.

The MEW made a concerted effort to address the comments of the SSC and the STT from the November 2005 review. As a result, the documentation is clearer and better organized. Figures are better linked to the text, fuller explanations of processes such as Production Expansion Factor development and Out-of-Base-Period stock methods are provided, and background material has been added. These, among other changes, represent substantial improvements to the documentation.

Mr. Rankis reported that the Coho FRAM Base Data Development documentation is still under revision. Completion depends on the work of the Coho Technical Team of the Pacific Salmon Commission, which is currently developing methods to integrate Canadian stocks into the model.

The MEW has requested comments from the SSC to guide continuing refinement of the model documentation. To achieve this, the SSC salmon subcommittee is planning a meeting, perhaps in late August, to consider these documents more fully. The MEW cited several areas where improvements are needed and will continue to work on the documents over the summer.

PFMC
06/14/06

Agenda Item G.1.c
Supplemental STT Report
June 2006

SALMON TECHNICAL TEAM REPORT ON THE FISHERY REGULATION ASSESSMENT MODEL (FRAM)

The Salmon Technical Team (STT) met briefly with Mr. Larrie LaVoy to discuss the final draft documentation of the FRAM model produced by the Model Evaluation Workgroup (MEW). The FRAM documentation is now composed of five separate documents:

1. A FRAM User Manual
2. FRAM Overview
3. FRAM Technical Documentation
4. Chinook FRAM Base data development
5. Coho FRAM Base data development

Except for the FRAM User Manual, the STT reviewed and commented on these documents in November, 2005. The current versions of the documentation reflect many of the comments made by the STT and are a substantial improvement over earlier versions. With the exception of the Coho FRAM Base data development report, the FRAM documentation is now complete. The Coho Base data report depends on work currently underway by the Coho Technical Committee of the Pacific Salmon Commission.

The STT intends to review the documentation in detail over the summer and to discuss the reports with the MEW as part of the methodology review process this fall. Because the number of people familiar with the computer code used to implement FRAM is very limited, the STT believes that a programmer's guide should be written to document the actual computer code used to implement FRAM.

PFMC
06/15/06

FISHERY MANAGEMENT PLAN AMENDMENT 15 (*DE MINIMIS* FISHERIES)

At its March 2006 meeting, the Council directed development of Amendment 15 to the Salmon Fishery Management Plan (FMP). The primary focus of Amendment 15 will be defining allowable *de minimis* impacts to stocks that do not already qualify for exceptions to the Overfishing Criteria listed in the FMP, which requires conservation objectives to be met during the preseason process for all FMP stocks.

At the March Council meeting, the Council identified two issues to be considered in Amendment 15, identified three preliminary alternatives in addition to status quo, and adopted an intended schedule leading to final action. The two issues identified were (1) modifying the current FMP as to criteria and Council action for a Conservation Alert and (2) modifying the current Klamath River fall Chinook natural escapement objective to define an allowable *de minimis* fishery take at low abundance levels. The three possible preliminary alternatives to be analyzed were (1) use of a sliding scale for a spawner reduction rate as suggested by the Klamath Fishery Management Council, (2) prescribing an exploitation rate level (e.g., ≤ 5% or ≤10%) below which fisheries could be prosecuted depending on yearly circumstances, and (3) use of an exploitation rate matrix that takes into account such things as the abundance of the stock in question, the abundance of co-mingled healthy stocks, and technical uncertainty. The Council may consider other issues and alternatives, which could be developed through the Ad Hoc Salmon Amendment Committee (SAC), other advisory bodies, and public comment.

The schedule and process adopted by the Council was intended to reduce the probability of requiring an emergency rule for 2007 fisheries, should circumstances require. This schedule included (1) a review at the June Council meeting in Foster City of preliminary alternatives and adoption of a range of reasonable alternatives for analysis over the summer, (2) a review at the September Council meeting in Foster City of the analysis of alternatives and adoption of a preferred alternative for public review, and (3) final action on an FMP amendment tentatively planned for the November Council meeting in San Diego.

Council Chairman Hansen appointed 21 members to the SAC to develop and review the proposed amendment. The committee structure includes two subcommittees with specific duties, with the balance of the committee providing a review and advisory role. The Document Subcommittee is responsible for preparing the draft Environmental Assessment and Council or public review documents, including modeling or analytical components and written narratives. The Regulatory Streamlining Subcommittee is charged with facilitating Federal responsibilities, including the Council:NMFS interface and Federal internal necessities, to allow for timely Secretarial review and decision on final Council action, which is scheduled for the November 2006 meeting in San Diego. A draft schedule for the Amendment 15 process is provided within Agenda Item G.2.a, Attachment 1.

The Document Subcommittee met May 11 in Portland to discuss analytical strategies and possible alternatives in preparation for the full SAC meeting at the June Council meeting. The full SAC is expected to develop a range of alternatives for Council consideration, and the Council should adopt a range of reasonable alternatives for public review at the June meeting.

<u>Council Action</u>:

1. Provide direction to SAC on preliminary alternatives and proposed analytical framework.

<u>Reference Materials</u>:

1. Agenda Item G.2.a, Attachment 1: Preliminary Draft Pacific Coast Salmon Plan Amendment 15: An Initiative to Provide for *De Minimis* Fishing Opportunity (First Draft for Salmon Amendment Committee and Council Review).

<u>Agenda Order</u>:

a. Agenda Item Overview — Chuck Tracy
b. Salmon Amendment Committee Report
c. Reports and Comments of Advisory Bodies
d. Public Comment
e. **Council Action**: Provide Direction on Selection and Analysis of Preliminary Draft Alternatives

PFMC
05/24/06

Agenda Item G.2.a
Attachment 1
June 2006

PRELIMINARY DRAFT
Pacific Coast Salmon Plan Amendment 15:
An Initiative to Provide for *De Minimis* Fishing Opportunity
(First Draft for Salmon Amendment Committee and Council Review)

Pacific Fishery Management Council
May 2006

Table of Contents

List of Tables

1.0 INTRODUCTION

This Salmon Fishery Management Plan (FMP) amendment process began in November 2005 for the purpose of initiating scoping of an FMP amendment to consider *de minimis* fisheries associated with impacts on Klamath River fall run Chinook salmon (KRFC) and other stocks that are not exceptions to the Overfishing Criteria in the FMP. The initial interest in the amendment was the result of constraints on the 2005 fishery due to depressed status of KRFC, which precluded access to a record forecast abundance of California Central Valley fall run Chinook salmon. The Council's direction came after Scientific and Statistical Committee (SSC) review of the Salmon Technical Team's (STT) analysis of stock recruitment relationships for naturally spawning KRFC (STT 2005), a recommendation from the Klamath Fishery Management Council (KFMC) to initiate an FMP amendment (PFMC 2005), and National Marine Fisheries Service (NMFS) review of emergency rule implementation and other procedures to facilitate management aimed at meeting annual conservation objectives as specified in Table 3-1 of the FMP. Analyses are provided in the following sections that demonstrate the effects of policy alternatives on the long-term viability of depressed salmon stocks and the economic impacts of those policy alternatives on fishing communities.

1.1 Document Organization

(for next draft)

1.2 Purpose and Need for Action

This action is to consider proposed changes to the Pacific Coast Salmon Plan (FMP) (PFMC 1997), which directs ocean salmon fishery management actions relative to the exclusive economic zone (EEZ) off the coasts of Washington, Oregon, and California. The purpose of this action is to provide for minimal or *de minimis* salmon fishery impacts to Council-managed salmon stocks[1] that currently are managed under conservation objectives that prohibit any salmon fishery impacts in the Council area during times when lower or limiting conservation objectives for those stocks are projected to not be met. This action is needed to prevent a level of fishery restrictions that can lead to severe economic consequences to local communities that target more robust salmon stocks, which are typically available for harvest in the Council area, while ensuring the ability of depressed stocks to produce maximum sustainable yield (MSY) in the long term is not jeopardized. Currently, this can be addressed only through the emergency regulation process as provided in the Magnuson-Steven Fishery Management and Conservation Act (MFCMA) and implemented by the National Marine Fisheries Service (NMFS).

The current status of KRFC includes failure to meet the 35,000 natural adult spawner lower reference point (previously, "escapement floor") for the stock for the past two years, and a projected natural spawner escapement of 29,200 absent any fishing impacts in 2006. A preseason projection that the lower limit reference point will not be met in any single year triggers a Conservation Alert, which, according to the FMP, requires the Council to close all salmon fisheries within its jurisdiction that impact the stock. Council area fisheries in September and October, 2006 harvested approximately 6,100 KRFC, and assuming freshwater tribal fisheries harvested their entitled equal number of KRFC, the natural spawning escapement projection was 25,400. An emergency rule promulgated by NMFS permitted additional Council area salmon fisheries in 2006 that are projected to result in a natural spawning escapement of 21,100 adult spawners. If the stock does not meet its minimum conservation objective in 2006, it will be

[1] Here we define Council-managed stocks as those listed in Table 3-1 of the FMP, excluding stocks listed under the federal Endangered Species Act, hatchery stocks, and natural stocks with minimal impact in Council area fisheries, which are listed as exceptions in FMP section 3.2.4.

the third consecutive year, and will trigger an Overfishing Concern, which will likely result in declaration by the NMFS of the stock being overfished and initiation by the Council of a stock rebuilding plan.

The current FMP objective for KRFC (and other stocks, as explained below) provide for ocean salmon fishing in the Council area only to the extent that the lower limit reference point of 35,000 natural adult spawners will allow. For the 2006 season, the pre-season STT projection for KRFC ocean abundance showed no surplus of natural spawners, which meant no level of ocean salmon fishing impact should be allowed in the Council area, according to the FMP. However, after reviewing the available data on the stock during its March and April meetings, and in collaboration with NMFS, the states, tribes and ocean fishermen, the Council determined that conditions in 2006 would allow for a temporary amendment to the FMP KRFC conservation objective to allow for 21,100 natural adult spawners, which was determined to be acceptable in terms of maintaining the long-term productivity of the stock. NMFS concurred with the Council assessment and implemented the emergency regulations effective May 1, 2006 (see www.pcouncil.org/newsreleases/noaa_pr_04-28-2006.pdf).

The actions that are addressed in the proposed FMP amendment are described in the following:

1. evaluate various alternatives relating to *de minimis* levels of ocean salmon fishing for KRFC,
2. evaluate *de minimis* fishing levels for other Council-managed stocks and/or the adoption of a technical process involving the STT and SSC to establish *de minimis* levels without the need for an FMP amendment,
3. recommend revision to or modification of existing FMP wording relating to a) *de minimis* fishing levels for Council-managed stocks, b) criteria for Council action in response to a Conservation Alert or Overfishing Concern, and c) appropriateness of existing FMP terminology in the context of the amended Plan sections (e.g., change "escapement floor" reference to "lower limit reference point"),
4. initiate the stock rebuilding process for KRFC as specified in the FMP (see: http://www.pcouncil.org/salmon/salfmp/fmpthrua14.pdf) under the expectation that the stock will fail to meet its conservation objective for the third consecutive year, and

Finally, it is possible that the MFCMA may be reauthorized in 2006. Thus, the current amendment proposal must remain flexible in order to incorporate any new provisions that may be required in the final document. At the same time, the final recommendations must be consistent with amending the Salmon FMP as it relates to the management of KRFC in time for adoption of regulations commencing May 1, 2007. The subsections below provide background information on this FMP action and further details on the need to which this proposal responds.

1.3 Plan Development Schedule and Council Advisory Committee Participation

The expectation for this FMP action is that the Council will recommend to the Secretary of Commerce (Secretary) adoption of an amended FMP in time for implementation of regulations affecting ocean salmon fisheries commencing May 1, 2007. However, the exact form and wording of the final recommendations will depend on the results of the analyses and findings that will be presented in the final document. To facilitate this effort an ad hoc Salmon Amendment Committee (SAC) has been appointed to report to the Council on the progress of the overall initiative.

The committee structure includes two subcommittees with specific duties, with the balance of the committee in essentially an advisory role with regard to reviewing and making recommendations on technical approaches or policy considerations, reviewing subcommittee reports, and providing general quality control inputs. One subcommittee is responsible for preparing the draft Environmental Assessment (EA) and Council or public review documents, including modeling and analytical components and written narratives (Document Subcommittee). The other subcommittee is charged with Federal regulatory streamlining responsibilities, including the Council: NMFS interface and federal internal policies to allow for timely Secretarial review and an approval/disapproval decision of a final Council action at the November 2006 meeting (Regulatory Streamlining Subcommittee). Individual SAC members may be called upon to prepare report sections depending on their particular area of expertise and availability to assist in Council activities. The names of committee members and their affiliations appear in Attachment 1. The proposed schedule for document preparation and finalization appears below.

May 11 2006	Document Subcommittee (DS) meet informally in Portland to initiate development of the amendment alternatives and work tasks to prepare a presentation to the SAC and Council at the June Council meeting.
May 24	Preliminary outline of potential range of amendment alternatives and possible analytical approaches due for inclusion in the Council June briefing book.
June 14	Salmon Amendment Committee (SAC) meets in Foster City, California to review work products of the DS and provide proposed recommendations to the Council.
June 16	Presentation of the SAC report to the Council in Foster City, California for review and direction for further development and refinement.
Wk of June 19 or June 26	DS meets in Portland to review Council action and assign work tasks for development of the amendment and analysis for review by the SAC prior to the September Council meeting.
Second Wk in August	SAC meets in Portland to review DS work products and provide comments and direction for presentation of Draft Amendment 15 at the September Council meeting.
August 23	Preliminary Draft Amendment 15 due for collation into September briefing book.
Wk of September 11	Council reviews Preliminary Draft Amendment 15 and adopts for Public Review at meeting in Foster City, CA. (If schedule cannot be met, a new schedule is identified at this point).
Wk of September 18	DS meets in Portland to review Council action and assign work tasks to complete Draft Amendment 15 for hearings and presentation at November Council meeting.
Wk of October 16	Hearings on Amendment 15 at Santa Rosa, Coos Bay, and Westport
October 25	Draft Amendment due for inclusion in November Council meeting briefing book.
Wk of November 13	Council reviews Draft Amendment 15 at meeting in Del Mar, California and adopts preferred alternative for implementation by NMFS.
December ?	DS completes Amendment 15 and EA and submits to NMFS HQ.
No later than May 1, 2007	Amendment 15 implemented by Final Rule.

1.4 Relevant Issues

(for next draft)

2.0 DESCRIPTION OF ALTERNATIVES

2.1 Alternatives for Klamath River Fall Chinook Salmon Management

At its March 2006 meeting the Council identified three possible alternatives to allow for *de minimis* fishing for KRFC. This would bring to four the number of alternatives for consideration at this time. These alternatives are outlined in Table 1 and described below.

Table 1. De minimis fishing level alternatives for KRFC adopted by the Council at its March 2006 meeting**.**		
Alternative	**Description**	**Comment**
1 - Status quo (no action)	No *de minimis* rate expressed. Impacts determined by 66-67% annual adult spawner reduction rate[1] except not less than 35,000 natural adult spawners in any year	No *de minimis* fisheries would be allowed if the 35,000 adult spawner lower reference point could not be achieved with a total fishery closure.
2 – Sliding scale	10% to 0% linear spawner reduction rate in the range of 39,000 to zero natural adult spawners	Recommended by the KFMC.
3 – Fixed exploitation rate	The Council has recommended a fixed rate in the range of ≤5% to ≤10% for consideration.	This rate may be substituted when the lower reference point is constraining harvest, but does not replace it for issuing Conservation Alerts or Overfishing Concerns.
4 – Exploitation rate matrix	The Council recommended consideration of an exploitation rate matrix alternative, with consideration for some or all of the following factors: adult stock size, ocean survival conditions, abundance of co-mingled stocks, and data quality.	A similar approach was implemented for Oregon Coastal natural coho salmon in Amendment 13.

[1] Spawner reduction rate as used by the Klamath River Technical Advisory Team is an annual rate computed as the number of potential adult natural spawners (aka: “adult equivalents” or “ocean adults”) impacted in ocean and river fisheries divided by the initial number of potential natural adult spawners in the ocean at the start of the biological year for KRFC (September 1). “Impact” includes landed catch plus shaker and drop off mortalities, adjusted for natural mortalities.

2.1.1 Status Quo Alternative

The current exploitation rate management strategy for KRFC was adopted in 1987 and modified in 1993 to allocate, on an annual basis, 50% of the available harvest to the Yurok and Hoopa tribes of the lower Klamath and Trinity rivers, respectively (Pierce 1998). The original exploitation rate plan required the adoption of fixed exploitation rates for ocean and river fisheries over multiple, continuous seasons (KRTT 1986). The court allocation decision led to annual harvest sharing of the available harvest on a 50/50 basis between tribal and non-tribal sectors. This change required that spawner reduction rates objectives be determined on an annual basis. The current escapement goal for the stock is to allow a 66%-67% spawner reduction rate annually except that a minimum of 35,000 naturally spawning adult spawners shall be protected in all years. At the outset, the lower limit reference point (“floor”) was specifically protected from modification except by FMP amendment. The exploitation rate approach for KRFC was adopted in 1987 in lieu of sufficient biological information for setting a single number goal for the stock and was expected to generate data over time that could be used for setting a single number goal or other approach for managing the stock.

A considerable amount of stock recruitment data have been collected since comprehensive fishery and resource monitoring of KRFC began circa 1977. Those data will be valuable as part of this process in evaluating the appropriateness of the current management of the stock, including the lower limit reference point ("escapement floor")[2]. However, it should be noted that modification of the reference point to some other value would not address the issue of *de minimis* fishing opportunity in low abundance years, which is a primary reason for the current FMP amendment effort.

Adoption of the status quo alternative or cessation of this amendment process places the onus of adopting annual salmon fishing regulations during low stock abundance years on the emergency rule process of the MFCMA as implemented by the NMFS. As experienced in 2006, the NMFS emergency rule process results in considerable uncertainty in the final regulations, which may not be decided by the PFMC and NMFS until the last few days of the annual salmon regulation process, and is likely to deviate from many fishermen's and manager's expectations for the coming season. Looking to the 2007 season and beyond, the expectation is that low abundance of KRFC will persist through 2009. This protracted projection of low stock abundance stems from low flows and associated high water temperatures that occurred in the river through the summer of 2004 (affecting the 2003 brood) coupled with high ocean exploitations rates associated with unusual ocean distribution of KRFC during 2003-2005 (affecting the 2003-2005 broods) (SSC 2006).

2.1.2 Sliding Scale Alternative

The sliding scale alternative was recommended for consideration by the KFMC (PFMC 2006). Their decision was premised on the inability of NMFS to approve *de minimis* fisheries except by emergency rule and provided the FMP amendment is limited in scope to the potential for addressing such fisheries. The KFMC urged that the analysis be based on a prudent, precautionary approach regarding the protection of sub-stocks within the Klamath River basin and that the allowable harvest should be scaled to projected stock abundance. The KRFC stock recruitment study by Prager and Mohr (1999) was used as the basis for their recommendation. They noted that while this study showed no adverse effect of fisheries up to a 20% spawner reduction rate, the authors recommended that if such a fishery was established, a maximum rate of 10% should be adopted to protect substocks, subject to review after a few years of actual fishery experience. The KFMC recommendation, again based on the Prager and Mohr paper, was that *de minimis* fishing rates should be reduced linearly from 10% to 0% when projected natural adult spawners, in the absence of fishing, were in the range of 39,000 to zero fish. Moreover, when such fisheries are conducted, a technical review of the cause for the depressed stock condition should be conducted before the start of the next salmon season. The KFMC sliding scale alternative is illustrated in Figure 1.

[2] Here we propose to use the phrase "lower limit reference point" or "lower reference point" to describe the 35,000 natural adult spawning escapement objective for KRFC, replacing the phrase "escapement floor" if this FMP initiative is successfully implemented.

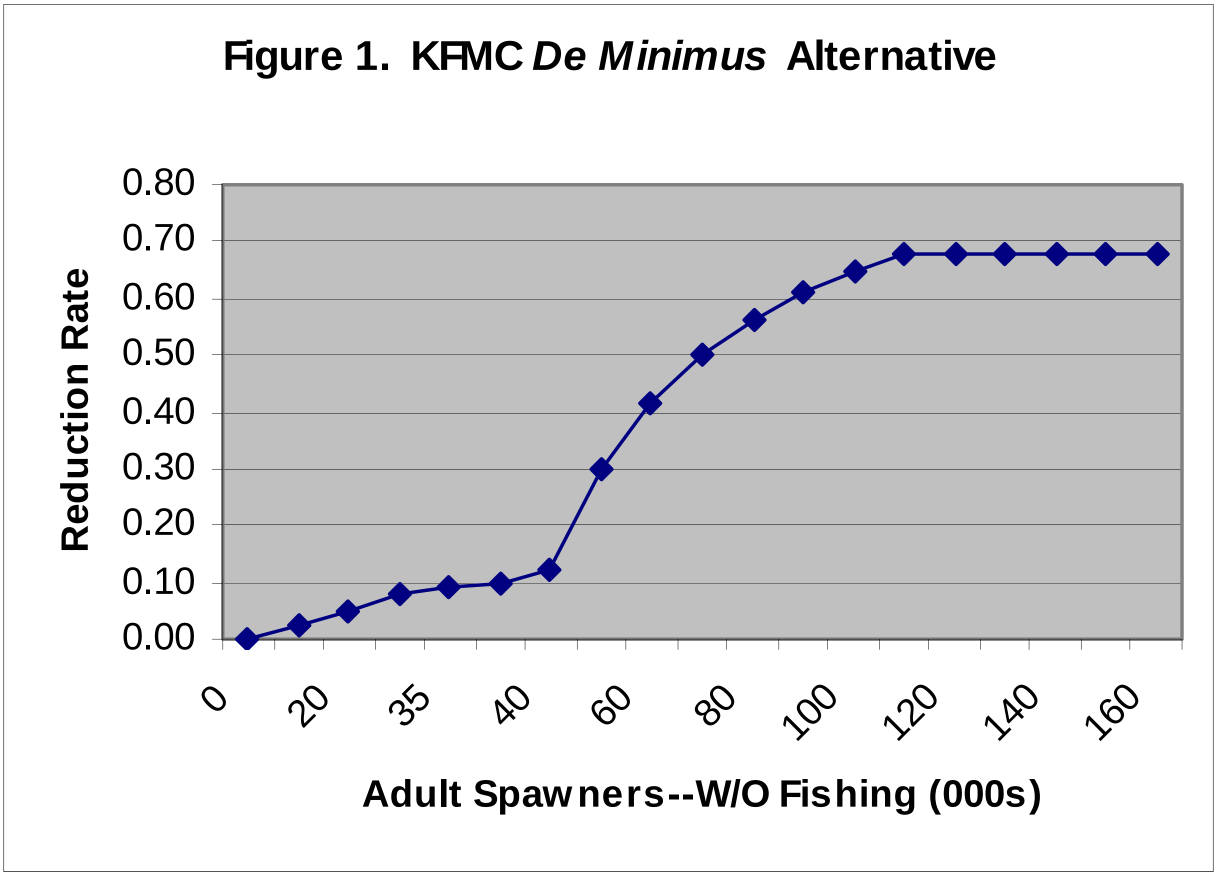

Figure 1. KFMC *De Minimus* Alternative

2.1.3 Fixed Exploitation Rate Alternative

The Council developed and approved the fixed exploitation rate alternative at its March 2006 meeting. The range of possible rates was recommended to be ≤5%-≤10%. There are several ways the rate could be calculated and expressed. However, the method that is most consistent with the current approach for allocating KRFC between the tribal and non-tribal sectors is to calculate the fraction of ages 3-5 fish that are proposed to be harvested based on projected age-specific abundance levels of fish at the start of the biological year on September 1 and taking into account fishery selectivities and minimum size limits. This approach is also consistent with the method used to calculate ocean exploitation rate for age-4 KRFC, which is used in the NMFS jeopardy opinion for California Coastal (CC) Chinook salmon (see Table II-5, Pre-season Report I). The Klamath Ocean Harvest Model (KOHM) (Prager and Mohr 2001) would likely be used by the STT for making the fixed exploitation rate calculation. The fixed exploitation rate alternative is not proposed to replace the lower reference point for the stock of 35,000 natural adult spawners, which would continue as a trigger for issuance of Conservation Alerts and Overfishing Concerns.

The ≤5% alternative appears to be similar to the provision in the FMP at section 3.2.4.2, which specifies that stocks with minimal Council impact are not subject to the FMP Overfishing Criteria and subsequent Council actions. Such stocks are those that are not available to harvest in Council fisheries because of migration timing and/or distribution, and are identified by a cumulative adult equivalent exploitation rate of less than 5% in ocean fisheries under Council jurisdiction in the appropriate fishery regulation assessment model (which, for Chinook salmon, is 1979-1982). The ≤5% standard was developed for stocks that are primarily harvested in the Pacific Salmon Treaty Area and that are outside the purview of the Council decision process, but suggests that a similar rate, based on total fish harvested, may be an appropriate *de minimis* impact level for Council consideration.

Use of a fixed exploitation rate for age-4 fish would be consistent with the current NMFS ESA consultation standard that is being used for CC Chinook salmon, which is a listed stock under the federal Endangered Species Act (ESA). Due to the absence of stock status data for CC Chinook, NMFS has opted to use age-4 KRFC as a surrogate stock for ESA purposes. The rate was set at ≤16% of age-4 KRFC in ocean salmon fisheries, and may suggest that such a rate should be acceptable for KRFC, which has been determined by NMFS not to be warranted for listing. The rate was based on a recent years' average, which reflected a substantially lower exploitation rate compared to historic levels of over 50%. There is no certainty that the NMFS consultation standard will continue to be based on age-4 KRFC data or that their consultation standard will not be reduced to a lower rate at some future date. Implementation of a CC Chinook monitoring plan might in the future allow for direct measurement of stock status. Such a plan could be based on direct escapement monitoring or an alternate approach such as genetic stock identification monitoring of ocean fishery catches.

Other Council area stocks are subject to ESA consultation standards specifying an exploitation rate allowance, including Rogue-Klamath coho salmon, lower Columbia River natural tule fall Chinook salmon, and Puget Sound Chinook salmon stocks.

To provide context for the impact of pre-season harvest objectives in ocean fisheries, a table for 2002-2006 fisheries has been constructed showing the number of open fishing days in selected ocean fisheries with respective pre-season exploitation and spawner reduction rates during September-August, which corresponds to the biological year currently used for KRFC. The analysis has been narrowed to include only the San Francisco and Coos Bay landing areas as used in the Klamath Ocean Harvest Model (KOHM) because these are the areas that have been most impacted by regulations aimed at meeting KRFC conservation objectives in recent years. The Fort Bragg or Klamath Management Zone fisheries were not included in the analysis because these fisheries have been highly constrained even in years of relatively high KRFC abundance. In addition, because of the unusually high impacts to KRFC in the fall troll fisheries in 2005, an additional comparison is made showing troll fishing days scheduled to be open during March-August of 2006 in the respective fisheries with ocean fishery exploitation and spawner reduction rates for comparison (Table 2).

Table 2. Comparison of open fishing days in the EEZ in the San Francisco (SF) and Coos Bay (CO) port areas with pre-season exploitation and spawner reduction rates for the 2001-2006 biological years for Klamath River fall Chinook salmon including 2006 projected data with fall 2005 troll seasons omitted [1]

Biological year	**Exploitation rate pct.** [2]	**Spawner Reduction Rate**	**Projected natural escapement**	**SF Troll Days**	**CO Troll Days**	**SF Sport Days**	**CO Sport Days**
2001	10.5 (4.6)	n/a	47.0	140	173	214	214
2002	8.2 (4.9)	n/a	35.0	163	177	215	169
2003	10.0 (13.1)	n/a	35.0	167	193	213	231
2004	12.2 (33.9)	51.6	35.0	164	205	207	231
2005	3.0	19.7	35.0	98	117	227	231
2006-actual	8.8	35.2	21.1	77	54	193	231
2006-w/o fall troll fisheries	4.5	17.0	27.7	37	0	193	231

[1] Columns 2-4 were taken from or derived from Table 5 of annual Pre-season Report III. Columns 5-8 were tallied based on tables C-1 thru C-4 of the 2005 Fishery Review. The KOHM was run to produce the estimates shown in columns 204 for 2006 with fall 2005 troll catches excluded.

[2] Post-season estimates, available in Pre-season Report I, are shown in parentheses.

2.1.4 Exploitation Rate Matrix Alternative

This alternative would use multiple data sets to determine the level of fishing that would be appropriate for KRFC in all years, including low abundance years. The variables that have been identified by the Council so far for consideration include: (1) ocean adult stock size, (2) ocean survival conditions, (3) abundance of co-mingled stocks, and (4) data quality. The decision matrix approach is currently used for Oregon Coastal natural (OCN) coho salmon. For OCN coho salmon the matrix variables are aimed at promoting stock rebuilding. The matrix uses general parental stock size status and ocean survival conditions for hatchery jacks to extrapolate an allowable exploitation rate range, which varies from ≤13% under poor conditions to ≤35% under optimal conditions (PFMC 1999). The matrix provides for greater exploitation rate levels when the parental stock size meets or exceeds specified rebuilding criteria. The OCN coho salmon exploitation rate matrix is aimed at rebuilding the stock through habitat improvement in combination with fishery regulation.

A similar matrix could be constructed for KRFC, but would be slightly more complicated because of the multiple age class spawning of the species. However, the status of the stock and ability to accurately project annual stock abundance level is probably comparable to OCN coho salmon. Additional information on the carrying capacity of the various subbasins would help determine appropriate escapement objectives. The OCN matrix approach could also be used as a rebuilding strategy for stocks declared to be overfished.

The following example is an exploitation rate matrix that uses the status of KRFC and Sacramento River fall Chinook (SRFC) to determine the exploitation rate level for the coming season for KRFC (Table 3). The matrix allows for *de minimis* fishing levels at all status levels for the two stocks. SRFC abundance is a reasonable variable to consider in the management of KRFC because of its usually high abundance and relatively high economic importance to ocean fisheries throughout the Council area, but especially off the Oregon and California coasts. Three stock levels are considered for each stock depending on the status of the respective stocks relative to existing stock reference points. In the case of KRFC the three levels are: > 39,000 natural spawning adults before fishing, 20,000-39,000 natural spawning adults before fishing, and < 20,000 natural spawning adults before fishing. These levels were selected because 39,000 is the spawning level below which the KFMC has recommended that *de minimis* fishing opportunity may be appropriate for consideration. The 20,000 abundance level is about 50% of the MSY level recommended for consideration for KRFC natural spawning stocks by the STT, SSC and KFMC (see PFMC 2006). The three levels suggested for SRFC correspond to the current management goal for the stock of an annual range of 122,000-180,000 adult spawners. The selected *de minimis* fishing levels are those that have been suggested for KRFC by the Council of ≤5% and ≤10%, and the NMFS ESA consultation standard for CC Chinook of ≤16% on age-4 KRFC. Oregon coastal Chinook salmon stocks were not included in the matrix because annual ocean abundance projections are not currently made for these aggregate stocks. (Table 3, footnote 2).

Table 3. Decision matrix example for allowable KRFC ocean exploitation rate for adult fish **(draft for discussion only)**			
KRFC natural spawners	Allowable ocean exploitation rate for KRFC		
> 39,000	≤ 10%	≤ 16% [1]	> 16% [1]
20,000-39,000	≤ 5	≤ 10	≤ 16
< 20,000	≤ 5	≤ 5	≤ 10
SRFC projected spawning escapement:	< 122,000	122,000-180,000	>180,000

[1] At these abundance levels the primary harvest rate constraint would be aimed at meeting the limit reference point for the stock of 35,000 natural adult spawners or a 66%-67% spawner reduction rate, whichever produces the lower catch.

2.2 Proposed Interim *De Minimis* Fishing Rates for Other Council-managed Salmon Stocks

There are other Council-managed stocks for which *de minimis* fishing standards do not currently exist and that may be needed in the event of a downturn in productivity in one or all of these stocks. These stocks along with their respective conservation objectives and stock projection methodologies are described in Table 4. It is proposed that an interim *de minimis* fishing rate be proposed as part of this initiative and retained for the purpose of setting annual fishing regulations until such time as an analysis can be completed for each stock and approved by the Council following the procedures and guidelines outlined in Section 2.2.1, below. The interim rate for each stock is proposed to be 10 % ocean exploitation rate for adult fish in fisheries operating within the Council area. The allowable rate would apply in years that the number of potential spawners for a stock is projected to be at or below its minimum conservation goal, as described in Table 4. Adoption of this interim allowance does not alleviate the need for Council response in issuing Conservation Alerts and Overfishing Concerns as described in the FMP.

Table 4. Additional Council-managed stocks for which de minimis fishing rates are needed**.**		
Stock	**Conservation goal**	**Description of pre-season stock projection methodology**
Sacramento River fall Chinook salmon	Goal range of 122,000-180,000 adult spawners, to be met in all years	Regression of Central Valley index on previous year jack return
Oregon coastal Chinook salmon	Goal range of 150,000-200,000 adult spawners in the aggregate, to be met in all years	None at present
Willapa Bay coho salmon	13,090 natural spawners (currently a WDFW goal, not a Council goal)	Smolt production adjusted by recent survival rate average.

2.2.1 Procedure for Adoption or Modification of De Minimis Fishing Rates for Council-managed Salmon Stocks

We propose that *de minimis* fishing rates for the individual stocks identified in Table 4, in addition to KRFC, may be adopted or modified through the Council process and without FMP amendment based upon technical review by the STT and SCC. The expectation is that sponsors of such proposals will generally be state or tribal agencies, who would be responsible for developing and submitting the necessary analyses in time for final adoption at the November Council meeting. Such proposals must address the impacts on long-term production of the stock and economic importance of the stock and co-mingled stocks to local communities.

2.3 Initiation of Stock Rebuilding Process for Overfished Klamath River Fall Chinook Salmon

(for next draft)

2.4 Council Process for Setting or Modifying *De Minimis* Fishing Levels Applicable to Overfished Salmon Stocks

(for next draft)

3.0 AFFECTED ENVIRONMENT

(for next draft)

3.1 History of the Salmon Fishery Management Plan

It may be instructive to examine *de minimis* fishing opportunities that have been approved for other Council salmon fisheries. Prior to the adoption of Salmon Plan Amendment 11, Oregon coastal natural (OCN) coho salmon were managed to meet an annual escapement of 200,000 adult spawners, except that an incidental catch rate of 20% was allowed when ocean stock size was estimated to be below 240,000 adults (see PFMC 1999). Salmon Plan Amendment 13 changed the approach used for OCN coho salmon to one based on adult exploitation rate depending on parent stock size and ocean survival conditions. It reduced the maximum allowable exploitation rate for the stock under poor ocean survival conditions and low parent stock size to 15%, except that the rate could be reduced to below 13% under extremely adverse production and survival conditions (PFMC 1999). It is difficult to compare management criteria for Chinook and coho salmon because of their substantially different life history patterns, but the OCN coho salmon example shows that some level of *de minimis* fishing is already allowed for Council stocks.

(more for next draft)

3.2 History of Klamath River Fall Chinook Salmon Management

(for next draft)

4.0 ANALYSIS OF ALTERNATIVES

4.1 Biological Impacts of De Minimis Fishing

Stock and recruitment data for KRFC will be important to use for evaluating the effect of various *de minimis* fishing alternatives on the long-term production potential of the stock. Some work has been done to date with the data set by the Klamath River Technical Advisory Team (KRTAT) and STT, but additional work will be needed to evaluate the specific alternatives that will be developed as part of the current FMP initiative. However, interpretation of the analysis needs to account for likely differences in production potential of the diverse sub-stocks within the basin, as recently described and recommended by the KFMC.

Stock and recruitment data for naturally spawning KRFC have been generated for the 1979-2000 broods. The STT has recently analyzed the data for estimating stock size at sustainable equilibrium production (S_{EQ}), maximum sustainable production (S_{MSP}) and maximum sustainable yield (S_{MSY}) for naturally-spawning KRFC. They used three different models in the analysis: Model 1 was based on a single co-variate, adult stock size; Model 2 incorporated data on juvenile early life history survival rates as a second co-variate (as indicated by hatchery fish survival data); and Model 3 used a watershed size-based approach currently under development by Canadian biologists (STT 2005) (Table 5).

Table 5. Spawner reference points for Ricker stock-recruitment Models 1,2,3 (Reference: STT 2005)

Spawner Reference Point	**Model 1 (parent spawners)**	**Model 2 (parent spawners, survival)**	**Model 3 (watershed area)**
S_{EQ}	101,300	112,300	185,000
S_{MSP}	39,700	56,900	111,200
S_{MSY}	32,700	40,700	70,900

A previous analysis of a shorter but comparable data set was made for the 1979-1993 broods. In this analysis the KRTAT (1999) reported slightly higher production estimates than those shown for Model 1 in Table 5. For example, S_{MSP} was reported to be 43,000 adult spawners compared to 39,700 in Table 5. They did long-term simulation modeling and found that reducing the lower reference point to less than 35,000 adult spawners reduced the long-term catch production from the stock and that the median yield from the resource was relatively insensitive to the lower limit reference point, except at higher values. They found that reducing the lower reference point resulted in more fishery stability, but also provided less of a safety margin against poor recruitment events. They also commented that a provision for *de minimis* fishing in low abundance years could eliminate the need for fishery closures entirely and would be a more constructive management approach than reducing the lower reference point, which appeared to be near optimal in terms of maximizing long-term catches in ocean and river fisheries (see pages 30-31 of report).

We propose to use available stock recruitment data to evaluate the alternatives developed for this initiative that are described in the previous section. We propose to develop a stochastic, age-structured, life-cycle model that will include a stock recruitment relationship and incorporate fishery selectivity data for ocean and river fisheries that currently are used in the KOHM. The fishery model structure and input variables in the KOHM are described by Prager and Mohr (2001). Allowable fishery catches are proposed to be allocated consistent with current legal requirements for tribal:non-tribal shares and Council policies or actions relative to non-tribal shares. Sensitivity analysis is proposed to be used to relate the relative importance of the various input parameters such as the Ricker curve α and β parameters. Considerations will be given to using a conservative overall stock productivity parameter for the basin to address the issue of likely/possible differences in sub-basin stock productivities.

4.2 Economic Analysis of De Minimis Fishing

(under development)

5.0 CONSISTENCY WITH OTHER APPLICABLE LAW

(for next draft)

6.0 PROPOSED MODIFICATIONS TO SALMON FISHERY MANAGEMENT PLAN VERBIAGE RELATED TO *DE MINIMIS* FISHING LEVELS FOR COUNCIL-MANAGED SALMON STOCKS

(for next draft)

7.0 LITERATURE CITED

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STT (Salmon Technical Team). 2005. Klamath River Fall Chinook Stock-recruitment analysis. Agenda Item G.1.b, Sept 2005. PFMC, Portland OR 97220. 36p. (see: http://www.pcouncil.org/salmon/salother/G1b_KlamathConsObj_STT_Rpt.pdf)

APPENDIX A - NAMES AND AFFILIATIONS OF SALMON AMENDMENT COMMITTEE AND SUBCOMMITTEE MEMBERS

<u>Document Subcommittee</u>

L.B. Boydstun, CDFG, retired	Primary role for document drafting and construction
Ray Beamesderfer, Cramer Fish Sci.	Primary role for population dynamics modeling
Larrie LaVoy, WDFW	Primary role for population dynamics modeling
Corinne Pinkerton, NMFS SWR	Primary role for fishery economic analysis
Chuck Tracy, Council staff	Document subcommittee staffing
Mike Burner, Council staff	Document subcommittee staffing

<u>Regulatory Streamlining Subcommittee</u>

Eric Chavez, NMFS HQ, and SWR
Peter Dygert, NMFS HQ, and NWR
Chris Wright, NMFS HQ
Kit Dahl, Council staff

<u>Remainder of Full Committee (in addition to above members)</u>

Alan Grover, CDFG	Fishery management and policy analysis
Michael Mohr, NMFS-SWFSC	Population dynamics analysis
Robert Kope, NMFS-NWFSC	Population ecology analysis
Gary Morishima, STT	Population dynamics and fishery management
Pete Lawson, NMFS-NWFSC	Population dynamics analysis
George Kautsky, Hoopa Tribe	Fishery management and policy analysis
Dave Hillemeier, Yurok Tribe	Fishery management and policy analysis
Cindy Thomson, NMFS-SWFSC	Fishery economic analysis
Duncan MacLean, SAS, Troll Fisheries	Fishery management and policy analysis
Dan Wolford, SAS, Sport Fisheries	Fishery management and policy analysis
Environmental rep (vacant)	Fishery management and policy analysis
Jim Seger, Council staff	Economic analysis

SALMON AMENDMENT COMMITTEE REPORT ON FISHERY MANAGEMENT PLAN AMENDMENT 15 (DE MINIMIS FISHERIES)

The Salmon Amendment Committee (SAC) met and discussed Preliminary Draft Amendment 15 and has the following recommendations and comments:

1. Limit the amendment action (page 2) to issue 1, *de minimis* fishing rate for Klamath River fall Chinook salmon (KRFC). The other 3 issues are either technical in nature (issue 3) or not feasible to complete within the amendment time frame shown on page 3. The Council is urged to focus on the importance of "avoiding the emergency rule process" for 2007 when KRFC is again likely to be below its conservation objective and require emergency regulations to allow any level of ocean fishing within the KRFC management area.
2. Maintain the current KRFC conservation objective and provide for stock-specific *de minimis* fisheries under Section 3.2 re: Overfishing Criteria.
3. The Council should consider adopting a tentatively preferred alternative at its September meeting, before the public hearings, rather than waiting until the November decision meeting.
4. All of the fishing rates shown in Table 1 should be expressed as age-4 ocean impact rates, which includes landed catch and non-landed catch mortalities. The SAC had a lengthy discussion about the various ways to express fishing rates. It was decided that inclusion of the other adult age classes (3s and 5s) in the metric might be confusing to fishermen and managers (because of the variable annual contribution of these other age classes to the catch). The metric currently used in the jeopardy opinion for California coastal (CC) Chinook is based on landed catch only of age 4 fish. In 2006, the age-4 ocean harvest rate on KRFC was 11.5%; if nonlanded mortalities were included the age-4 rate would be 13.8%. The inclusion of non-landed catch in Council fishing rate metrics is important because it includes all fishery-related mortalities including those stemming from existing and potential future ocean selective fisheries for marked hatchery fish and associated non-catch mortality of unmarked fish.
5. A table should be provided in the document showing the relationship between age-4 ocean impact rate and other ways for expressing ocean fishing rates for KRFC; i.e., age-4 ocean harvest rate, spawner reduction rate and ocean harvest rate (across all age classes). It is important to note that Table 2, page 7, will need to be modified to show ocean fishing rates in column 2 in terms of age-4 ocean impact rates.
6. The catch of KRFC under all the alternatives will remain as ≤16% age 4 KRFC ocean harvest rate, the jeopardy standard for CC Chinook salmon.
7. The SAC recommends that alternative 4, "Exploitation Rate Matrix," be eliminated, at least for the current amendment effort. The inclusion of a second stock, Sacramento River fall Chinook salmon (SRFC) greatly complicates the analysis. Moreover, such an analysis should not be attempted until the components of the matrix are evaluated individually and collectively
8. The SAC recommends that document verbiage with regard to "lower limit reference point" be changed to "de minimis fishery threshold," which is a population abundance level slightly higher, depending on the alternative, than the conservation standard for KRFC of 35,000

adult natural spawners. No change in reference to the escapement floor is proposed as part of this initiative.

9. Separate alternatives should be developed for the two fixed rate alternatives, shown as Alternative 3 on page 4 (See Table, below).
10. A fifth alternative should be added, which we will call the “Rebuilding” alternative (see Table below). This proposed new alternative is basically an add-on feature to each of the *de minimis* fishery alternatives. It would specify that no *de minimis* fishery for KRFC can be prosecuted for more than three (3) consecutive seasons and that *de minimis* fishing cannot resume until the stock has sustained itself at or above its minimum conservation objective for three consecutive seasons. Inclusion of such a provision would be consistent with existing overfishing criteria, would serve to initiate stock rebuilding in a timely manner, and shows that overfishing requirements under the Magnuson-Stevens Fishery Conservation and Management Act are being addressed.
11. The Council could consider a provision for the fishery management plan (FMP) that establishes a Council internal process to add or change *de minimis* fishing rates for Council-managed stocks (including KRFC) without the need for an FMP amendment. This process should specify the need to maintain the long-term productivity of the stock and to carefully analyze the impact of the action on coastal communities as well as terminal area fisheries. An example of an existing FMP provision for changing natural stock objectives can be found at Section 3.1.2. **Please note: there was not consensus on the inclusion of this provision in the amendment.**
12. A Monitoring and Evaluation section should be added to the document. It should specify the need for ongoing fishery monitoring, include a description of a process for reviewing and evaluating the effectiveness of the amendment, and the inclusion of criteria for the measuring amendment effect relative to amendment objectives and the relevant issues identified in document Section 1.4.
13. The SAC identified a number of relevant issues for inclusion under Section 1.4 including KRFC sub-stock concerns, community impacts, ESA constraints, inriver recreational harvest opportunity, tribal/nontribal sharing, achievement of MSY or OY over the long term, and salmon carcass ecosystem contributions.
14. SAC members were provided e-copies of the Preliminary Draft Amendment and have been asked to provide editorial comments directly to the Document Team coordinator.
15. SAC members provided input to the Document Team regarding features of the biological model. Further discussions will be held regarding the economic analysis. One (of many) recommendations for the biological model was that fall fisheries should not be allowed in years when *de minimis* fishing takes place.
16. The SAC is very concerned about the time available for economic impact analysis, because economic input data will be dependent upon completion of the biological modeling. There are only 7 weeks between the end of the June Council meeting and the next SAC meeting in early August when the Draft Amendment is supposed to be ready for SAC review. This does not give much time for either analysis (biological or economic), technical review of the analyses, and to prepare a second, larger document. **We request the Council discuss the possibility of implementing a Plan amendment for 2007 on a less strenuous time schedule, particularly for preparation of the Draft Amendment, when most of the work will have to be done.**

Table. SAC recommended alternatives for Amendment 15.		
Alternative	**Description**	**Comment**
1--Status Quo	(no change is proposed in existing wording)	(no change proposed in existing wording)
2--Sliding Scale	Reword to explain metrics in terms of age-4 ocean impact rates	Equivalent to the KFMC recommendation, but expressed in terms of the metric proposed by the SAC
3--5% Ceiling	Metric should be expressed as age-4 ocean impact rate and provide for a range of 0-5%	(no change proposed in existing wording)
4--10% Ceiling	Metric should be expressed as age-4 ocean impact rate and provide for a range of 0-10%.	(no change proposed in existing wording)
5--Rebuilding	Under this add-on alternative, no *de minimis* fishery for KRFC could be prosecuted for more than three consecutive seasons and that *de minimis* fishing may not resume until the stock has sustained itself above its minimum conservation objective for no less than three consecutive seasons.	Inclusion of this provision with any of the above *de minimis* fishing options would be consistent with existing overfishing criteria and would serve to initiate stock rebuilding in a timely manner.

PFMC
06/16/06

Agenda Item G.2.c
Supplemental SAS Report
June 2006

SALMON ADVISORY SUBPANEL REPORT ON FISHERY MANAGEMENT PLAN AMENDMENT 15 (DE MINIMIS FISHERIES)

The Salmon Advisory Subpanel (SAS) met to discuss the preliminary draft of Amendment 15 and appreciates the work of the Salmon Amendment Committee.

At this time the SAS reserves its comments until a more refined draft is prepared for *de minimis* fisheries.

We encourage this work so that the Council has the flexibility to deal with the Klamath issues in the future without resorting to emergency rule action.

The SAS does however want to remind the Council that the real problems of the Klamath River are habitat and water quality related issues.

PFMC
06/15/06

Agenda Item G.2.c
Supplemental SSC Report
June 2006

SCIENTIFIC AND STATISTICAL COMMITTEE REPORT ON THE DRAFT PACIFIC SALMON PLAN AMENDMENT 15 – *DE MINIMIS* FISHERIES

Ray Beamesderfer presented the analytical framework for evaluating the effects of the various alternatives for *de minimis* fisheries on Klamath River fall Chinook salmon. The general analysis approach will be to define a range of options and then simulate the outcome of these management measures. Another approach to arriving at a preferred alternative would be to define the goals of management in terms of performance and then search for a set of rules that achieves those goals.

The base model presented was equivalent to Model 1 of the "Klamath River Fall Chinook Stock-Recruitment Analysis" report (Agenda Item G.1.b, STT Report, September 2005). The Scientific and Statistical Committee (SSC) concluded previously that Model 2 better captures the variability and S_{MSY} level and should be considered for simulation. Random changes and trends in in-river survivorship should be included in simulations using Model 2, which will allow for making different assumptions about future changes in the state of the Klamath River basin.

The SSC suggests including parameter uncertainty in the stock-recruit relationship as well as implementation and process errors, and notes further that the down-turn of the descending limb of the Ricker curve at high stock size in Model 1 may be due largely to the in-river environmental effects, rather than density-dependent effects. Sensitivities to different representations of stock recruitment variance about the stock-recruitment curve may have large effects. These issues should be considered in the analysis.

It is important to adequately model the difference between management action and implementation, i.e. target F and actual F. In recent years these two quantities have been quite dissimilar. One approach to address the impacts of this difference and minimize the need for *de minimis* fisheries is a precautionary buffer above the 35,000 spawner "reference point". The SSC further notes that the target 35,000 spawner escapment level is irrespective of spawner age, despite the difference in fecundity with age.

The SSC notes that the modeling exercise used to analyze the alternatives cannot capture all the important issues. For example, the Klamath fall Chinook stock consists of several smaller populations, and low composite spawning escapement could lead to localized extinction and damage to long-term productivity. The stock-recruitment model assumes relatively high productivity at low stock size and may underestimate threats to the stock at low stock size. Inclusion of a depensatory parameter can partially address these concerns. The SSC notes, despite the above concerns, that the proposed analysis approach is useful for comparison of the various alternatives, although the absolute numbers arrived at will be highly dependent upon the model assumptions.

PFMC
6/14/06

Agenda Item G.2.c
Supplemental STT Report
June 2006

SALMON TECHNICAL TEAM REPORT ON FISHERY MANAGEMENT PLAN AMENDMENT 15 (DE MINIMIS FISHERIES)

The Salmon Technical Team (STT) met for 2 hours with Mr. L.B. Boydstun to discuss the alternatives described in Table 1 of the draft report "Pacific Coast Salmon Plan Amendment 15: An Initiative to Provide for *De Minimis* Fishing Opportunity". The STT had no comments on the merits of the four proposed alternatives *per se*. Instead, the STT focused its comments on the computer simulations being proposed to analyze the alternative. Because these variables affect how well the simulations mimic the real world, the STT discussed:

1. Annual variation in recruitment from spawners (i.e. the Ricker Curve) and early life survival rates, to include serial correlations in low production years.
2. Contribution of hatchery origin fish to the natural spawning population.
3. Productivity of hatchery origin fish relative to wild origin fish.
4. Annual variation in forecast accuracy and management precision and its effect on projected harvest and fishery escapement.
5. Annual variation in abundance of co-mingled stocks and its effect on impacts to Klamath stocks (alternately, simulate results with a low, mid-level, and high abundance of co-mingled stocks).
6. Change in fisher behavior in response to management actions, i.e. transfer of effort during a *de minimis* fishery.
7. Management actions in response to low abundance forecast including allocation among user groups/gear types.

The STT believes the proposed time frame for completing a proposed fishery management plan amendment in time for application in 2007 is extremely ambitious. There is a danger that the biological and economic assessment of proposed *de minimis* control rules will not be sufficiently developed and documented by September 2006 to serve as an adequate basis for informed public comment and administrative review. Further, the STT is concerned that the proposed process for development of the amendment does not provide an adequate opportunity for technical review.

The STT also recommends an alternative *de minimis* control rule that becomes more restrictive if the rule is applied in consecutive years or if the impact limit established for the previous year is exceeded.

PFMC
06/15/06

Agenda Item G.3
Situation Summary
June 2006

APPLICATION OF GENETIC STOCK IDENTIFICATION IN OCEAN SALMON FISHERIES

Scientists at the National Marine Fisheries Service (NMFS) Southwest Fisheries Science Center (SWFSC) are investigating techniques to estimate stock and age composition of salmon for use in management of ocean harvest. The use of genetic stock identification (GSI) is now well validated, has become relatively inexpensive, and can be accomplished very rapidly. In addition, current methods require only small amounts of tissue that require no special storage and can be obtained non-lethally. The SWFSC has recently started a pilot program by sampling recreational ocean salmon fisheries in the Monterey Bay area and has developed estimates of stock composition for this fishery in the month of April (Agenda Item G.3.a, Attachment 2).

GSI has several advantages over traditional tag recovery methods, the most important of which is that sample size can be increased as much as needed, because all fish are "tagged" genetically, whereas <20% of fish typically receive coded-wire-tags (CWTs). In addition, GSI allows unambiguous identification of most wild stocks, whereas few wild stocks receive CWTs. These attributes make GSI particularly useful for estimating stock composition in small or poorly sampled fisheries, in test fisheries and observer programs employing catch and release or mark-selective techniques, and for sub-legal and other non-landed catch. While GSI generally only provides stock of origin, it can be combined with scale analysis to provide age information as well. A novel technique recently developed by the SWFSC, full parental genotyping (FPG), will also provide both stock of origin and age for every hatchery-spawned fish by establishing a pedigree that identifies its exact parents. FPG also offers the promise of highly cost-efficient "tagging", since genetic data for broodstock fish provides tags for 100% of their offspring.

The SWFSC is organizing several workshops to discuss and evaluate both technical and practical aspects of using genetic techniques in management of West Coast salmon fisheries. The first of these will be held in conjunction with the biennial Coastwide Salmon Genetics Meeting which is being hosted by the SWFSC in Santa Cruz on June 22-24.

Council Task:

Discussion implications and use of genetic stock identification techniques.

Reference Materials:

1. Agenda Item G.3.a, Attachment 1: Genetic Stock Identification and Full Parental Genotyping for Management of California's Chinook Salmon Fisheries
2. Agenda Item G.3.a, Attachment 2: Chinook Salmon Genetic Stock ID-Monterey Bay Sport Fishery 2006

Agenda Order:

a. Agenda Item Overview — Chuck Tracy
b. NMFS SWFSC Presentation — Churchill Grimes, Carlos Garza
c. Reports and Comments of Advisory Bodies
d. Public Comment
e. Council Discussion and Guidance

PFMC
05/23/06

Genetic Stock Identification and Full Parental Genotyping for Management of California's Chinook Salmon Fisheries

John Carlos Garza, Eric Anderson
Southwest Fisheries Science Center, 110 Shaffer Road Santa Cruz, CA 95062
carlos.garza@noaa.gov; Tel. 831-420-3903

Genetic tools have a long history in fishery management, with the use of genetic "tags" to distinguish hatchery and wild trout described more than 20 years ago (Taggart and Ferguson 1984). More recently, the use of genetic stock identification (GSI) techniques have been used to elucidate ocean migration patterns and to estimate stock proportions in a mixed stock fishery context (e.g. Teel et al. 2004). Such GSI for estimation of stock proportions can occur either post-season or in-season. An in-season GSI system requires a facility with dedicated staff and can typically produce stock proportion estimates from fishery or port samples within approximately one day of delivery (Beacham et al. 2004). Such stock composition estimates can then be used to adaptively focus fishery effort to avoid stocks of conservation concern, or to best target abundant stocks.

Because of the current and potential future utility of GSI methods to assist in fishery management, the Pacific Salmon Commission has recently funded a collaborative effort to develop a coastwide genetic database for GSI of Chinook salmon. This $1.1 million effort has resulted in an unprecedented database of 13 microsatellite loci, which have been standardized across most major Pacific salmon genetics labs, typed in over 105 Chinook salmon populations (~120 fish per population) from Alaska to California and is capable of accurately distinguishing most major stocks of Chinook salmon in the northeast Pacific. The Southwest Fisheries Science Center in Santa Cruz is the California representative to this consortium of collaborating salmon genetics labs.

The ability of the coastwide genetic database to distinguish Chinook salmon from the different basins and ESUs in California is straightforward and relatively trivial with this database, due to substantial genetic differences between CA Chinook salmon populations (Figure 1). These differences are also reflected in the performance of individual assignment tests, which correctly identify nearly every fish to basin/stock/ESU of origin. This is particularly true with salmon from the Klamath/Trinity basin, which are correctly distinguished from other California ESUs with near-perfect accuracy, because of their substantial genetic divergence from all other California Chinook salmon stocks (Figure 1; Waples et al. 2004). The coastwide GSI database can also identify individual fish to tributary of origin more than 80% of the time. Additional microsatellite genes in use by our lab can increase that accuracy to above 95%.

The existence of this database for GSI thus provides a powerful tool for determining and minimizing fishery impacts on salmon stocks of conservation concern. For example, a well-designed GSI program can be used to distinguish salmon from the Klamath/Trinity basin from those of the Central Valley and Coastal ESUs in fishery catches. Such information can be used to directly measure fishery impacts on fish from the Klamath ESU, as well as provide a much clearer picture of ocean migration/distribution patterns of all California Chinook salmon stocks. We believe that such information could be used to design fishing regimes that minimize impacts on Klamath/Trinity Chinook salmon, while allowing maximum exploitation of abundant stocks, such as the Central Valley Fall run.

The current fishery management regime for Chinook salmon is based on cohort reconstruction, and therefore requires more information than just the stock of origin provided by traditional GSI. Traditionally, genetic methods have not been able to provide cohort/broodyear information for salmonids. However, we have developed a novel genetic technique that provides both stock and cohort of origin for individual salmonids from hatcheries: precisely the same information provided by a traditional coded wire tag (CWT) system. This method, termed full parental genotyping (FPG; Anderson and Garza 2005), actually provides more information than just stock and cohort of origin; it identifies the specific parent pair for a sampled fish.

The basic idea behind FPG is that DNA is an individual-specific "fingerprint" which is transmitted from one generation to the next in reproduction. Therefore, by collecting genotype data from all broodstock adults at a hatchery (or theoretically, but not practically, in-stream), one can identify offspring of particular matings through parentage analysis on fishery samples. By identifying the particular parent pair, the stock and cohort of origin are then known. Anderson and Garza (2006) have shown how this can be done essentially without error using a surprisingly modest amount of genetic information.

Two other important elements of an FPG tagging system are that its implementation provides a 100% tagging rate for those hatcheries where it is practiced and that the tagging costs are much lower than with CWTs or any other tagging system with which we are familiar. Tag recovery, through determination of the genotype of a fish sampled in the fishery or at escapement, is currently more expensive than recovery of a CWT, but the overall cost of the two systems should be roughly similar. Moreover, substantial cost-savings are possible with genetic-based tagging methods; the cost of such work in the human genetics area is several times less than it is in fishery and wildlife genetics. Implementation of an FPG tagging program at the Trinity River and Iron Gate Hatcheries could be achieved at modest cost and provide the ability to identify every fish from these facilities in a mixed fisheries context. This would provide a potentially important improvement to the data used in stock assessment and forecasting for Klamath Chinook salmon.

One of the greatest advantages of an FPG tagging system is that it is easily and economically integrated with a GSI system (Anderson and Garza 2005). This allows a staged genetic analysis to be employed on both marked (adipose fin clipped) and unmarked fish, with GSI yielding stock of origin for every sampled fish. Those fish that are assigned to "stocks" that are hatcheries where FPG is performed would then be subjected to additional genetic analysis yielding cohort of origin. Such an integrated system can also easily accommodate samples from released sub-legals and strays from stocks that normally are not detected in fishery sampling.

We suggest that management agencies charged with determining salmon fishery regulations support a pilot study to evaluate the utility of genetic based methods to help further define ocean distribution of California's Chinook salmon stocks and possibly replace CWTs for stock assessment. We also recommend that they consider whether an in-season rapid response GSI system might help to best meet both conservation and fishery access goals for California's salmon fisheries.

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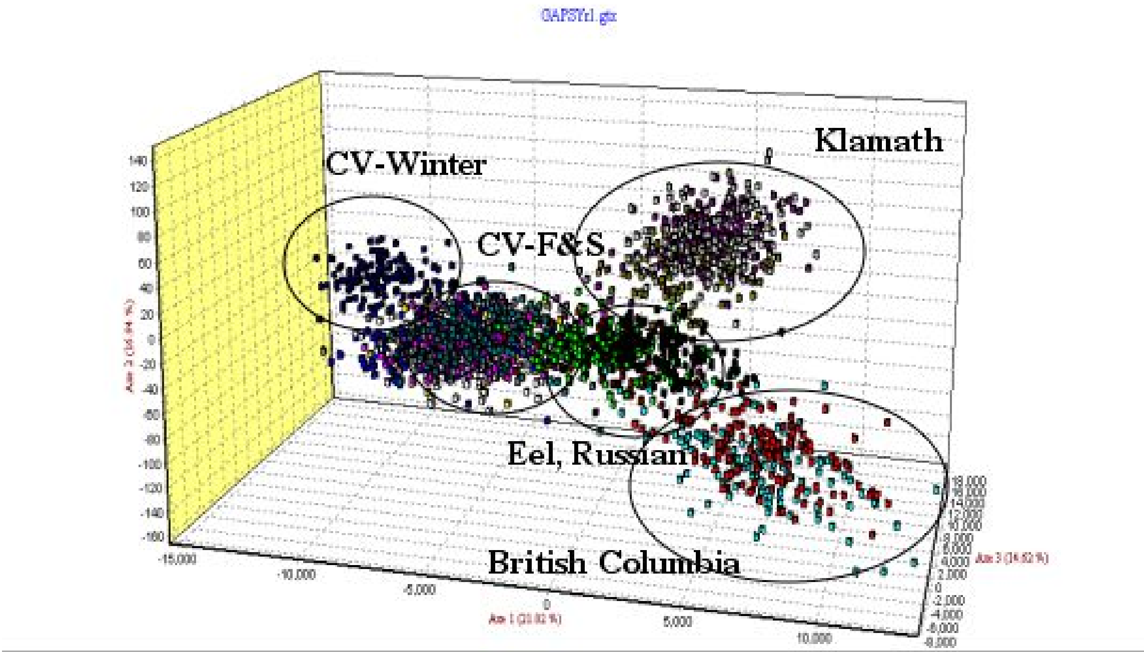
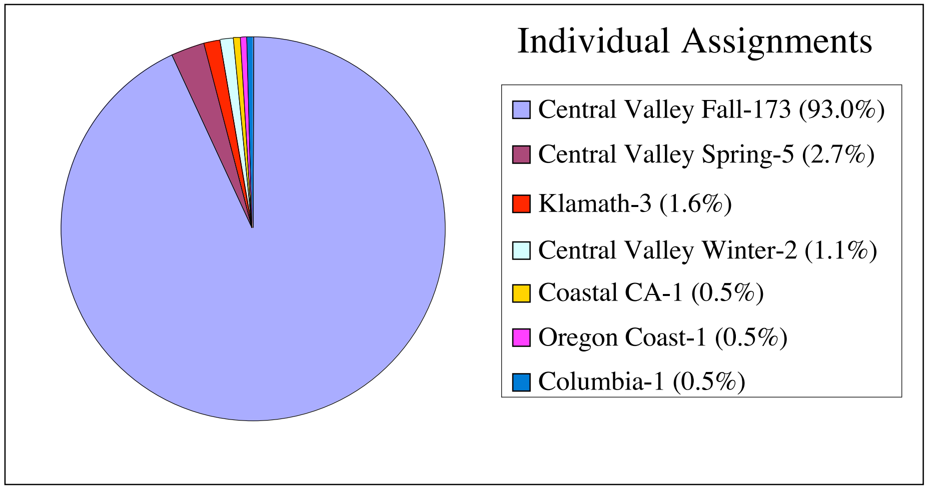


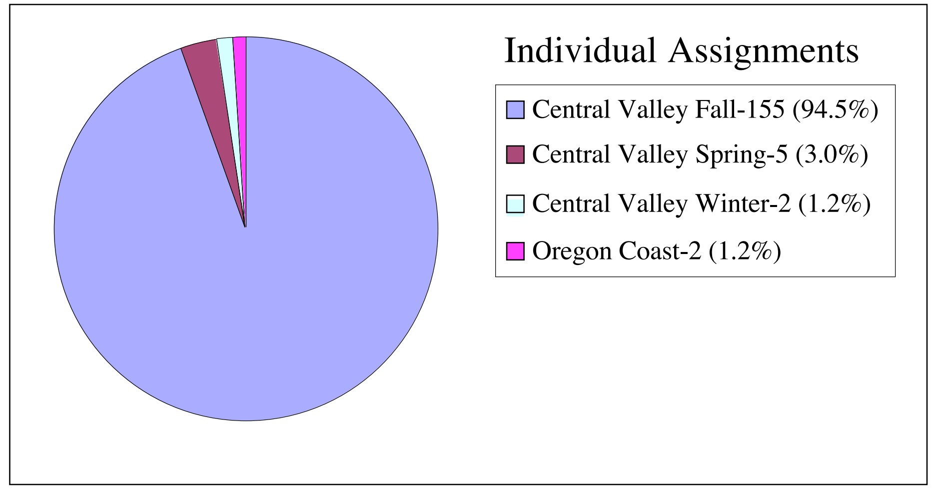
Figure 1: Factorial Correspondence Analysis of individual genotypes for Chinook salmon from California and three populations from Canada. The ability to easily distinguish Central Valley, Coastal and Klamath/Trinity salmon is evident from the lack of overlap in the distribution of genotypes.

Chinook Salmon Genetic Stock ID-Monterey Bay Sport Fishery 2006

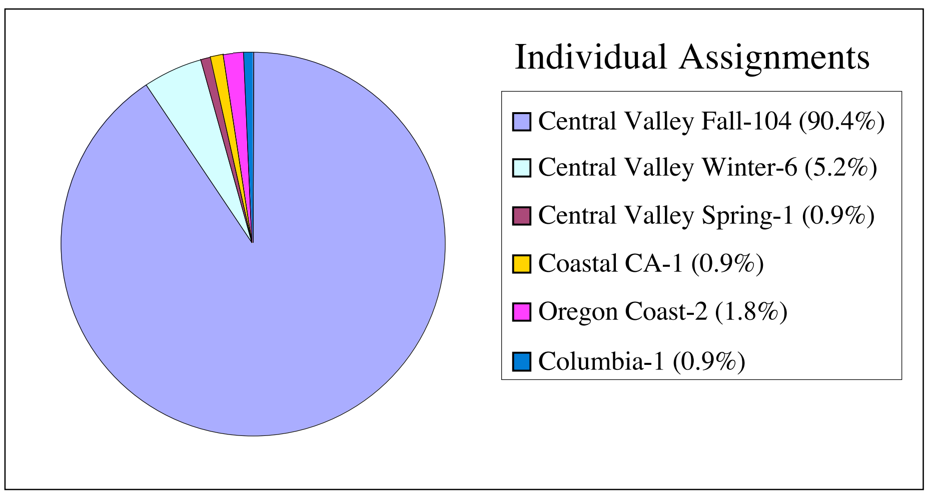
April 1: N=186



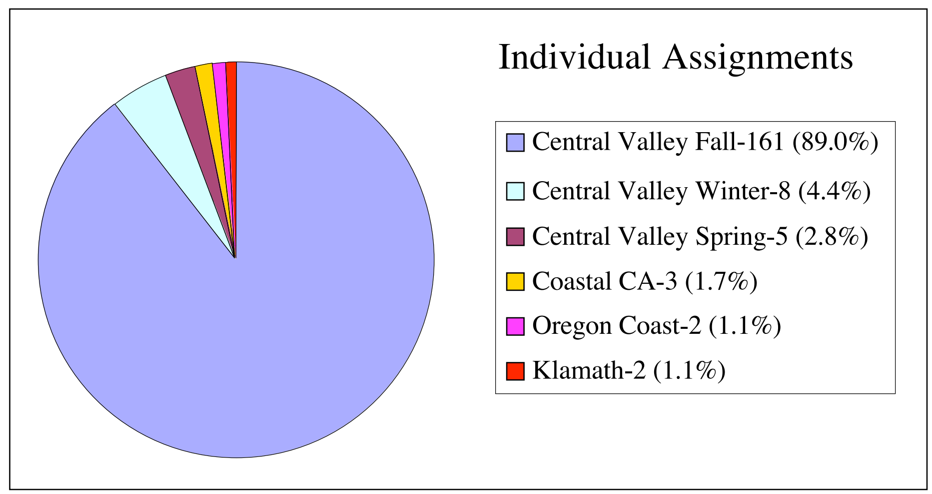
April 8: N=164



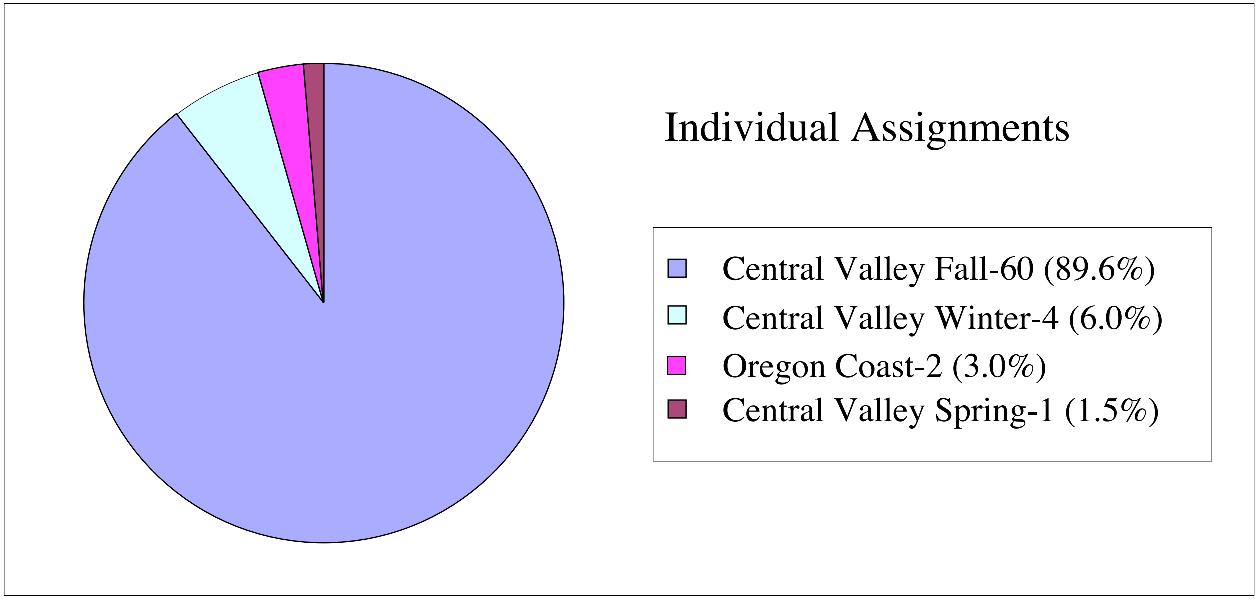
April 15: N=115



April 22: N=209

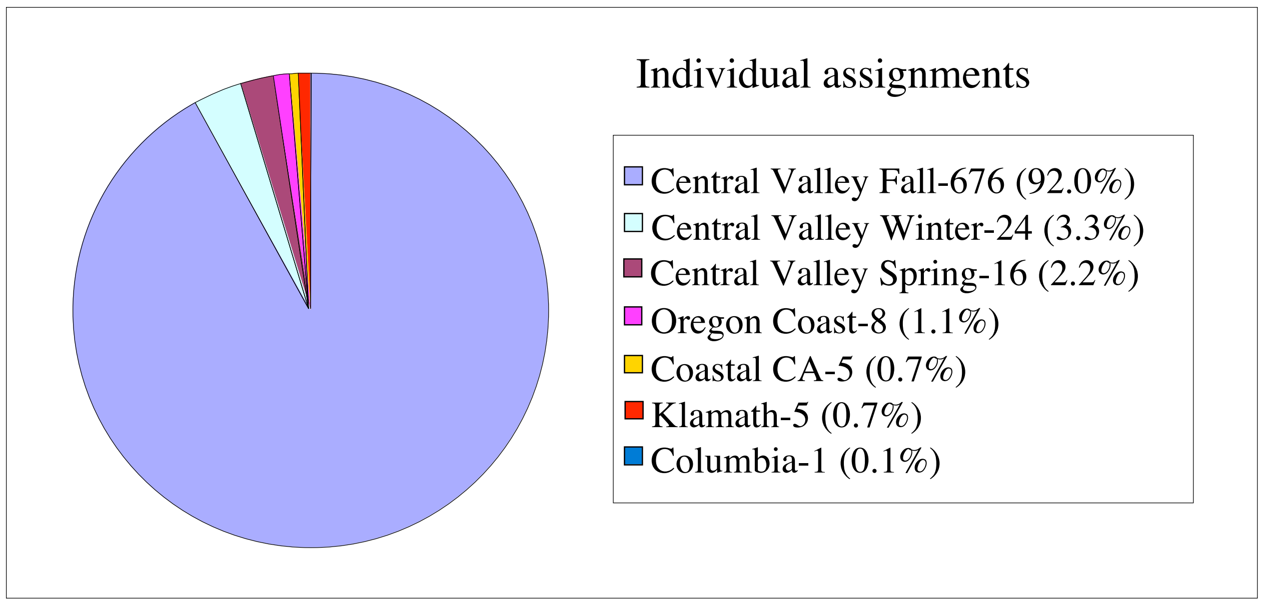


Chinook Salmon Genetic Stock ID-Monterey Bay Sport Fishery 2006



April 29: N=67

April 2006-
Cumulative total:
N=735 fish



Agenda Item G.3.b
Supplemental SWFSC PowerPoint Presentation
June 2006

Molecular Genetic Technology in Chinook Salmon Fishery Management

NOAA Fisheries
National Marine Fisheries Service

Molecular Ecology and Genetic Analysis Team
SWFSC Fisheries Ecology Division, Santa Cruz

Mission Statement

Provide biological inference, through collection of statistically robust molecular genetic datasets and development of rigorous analytical methods, to support NOAA protected resource and sustainable fishery mandates.

NOAA Fisheries
National Marine Fisheries Service

Molecular Population Genetics in Fishery Biology

- Variation in specific sections of the hereditary material, DNA, or its products, proteins, used for biological inference including:
  - Population structure and size
  - Population History
  - Behavior
  - Kin relationships
  - Natural Selection
  - Individual discrimination
  - Gender determination
  - Fishery stock proportions

Molecular Population Genetics in Fishery Biology

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  - Natural Selection
  - Individual discrimination
  - Gender determination
  - Fishery stock proportions

REPORT OF THE EXPERT PANEL ON THE FUTURE OF THE CODED WIRE TAG RECOVERY PROGRAM FOR PACIFIC SALMON

Panel Members

- John Clark, ADFG
- Rick Deriso, IATTC
- Carlos Garza, NMFS, CA
- David Hankin, HSU, CA (chair)
- Gary Morishima, MORI-ko, WA
- Brian Riddell, DFO, BC
- Carl Schwarz, SFU, BC
- Jim Scott, WDFW

  w/technical support from

  Marianna Alexandersdottir, NWIFC

MAJOR FINDINGS: Existing & Future Technologies

- 11-12. Existing technologies (otolith thermal marking & genetic stock identification (GSI) methods) can complement the CWT system, but cannot replace it.

- 14. “Typical” GSI methods can provide estimates of stock composition, but not of age or brood year. Scale ages are not judged reliable enough to adjust GSI data.

MAJOR FINDINGS: Existing & Future Technologies

- 16. GSI methods might be used to reduce fishery mortalities of natural stocks of concern….

- 17. Over the next several years, we believe that SNPs (single nucleotide polymorphisms) will replace microsatellite markers as the genetic tool of choice. Reasons include ease of standardization and greatly reduced costs.

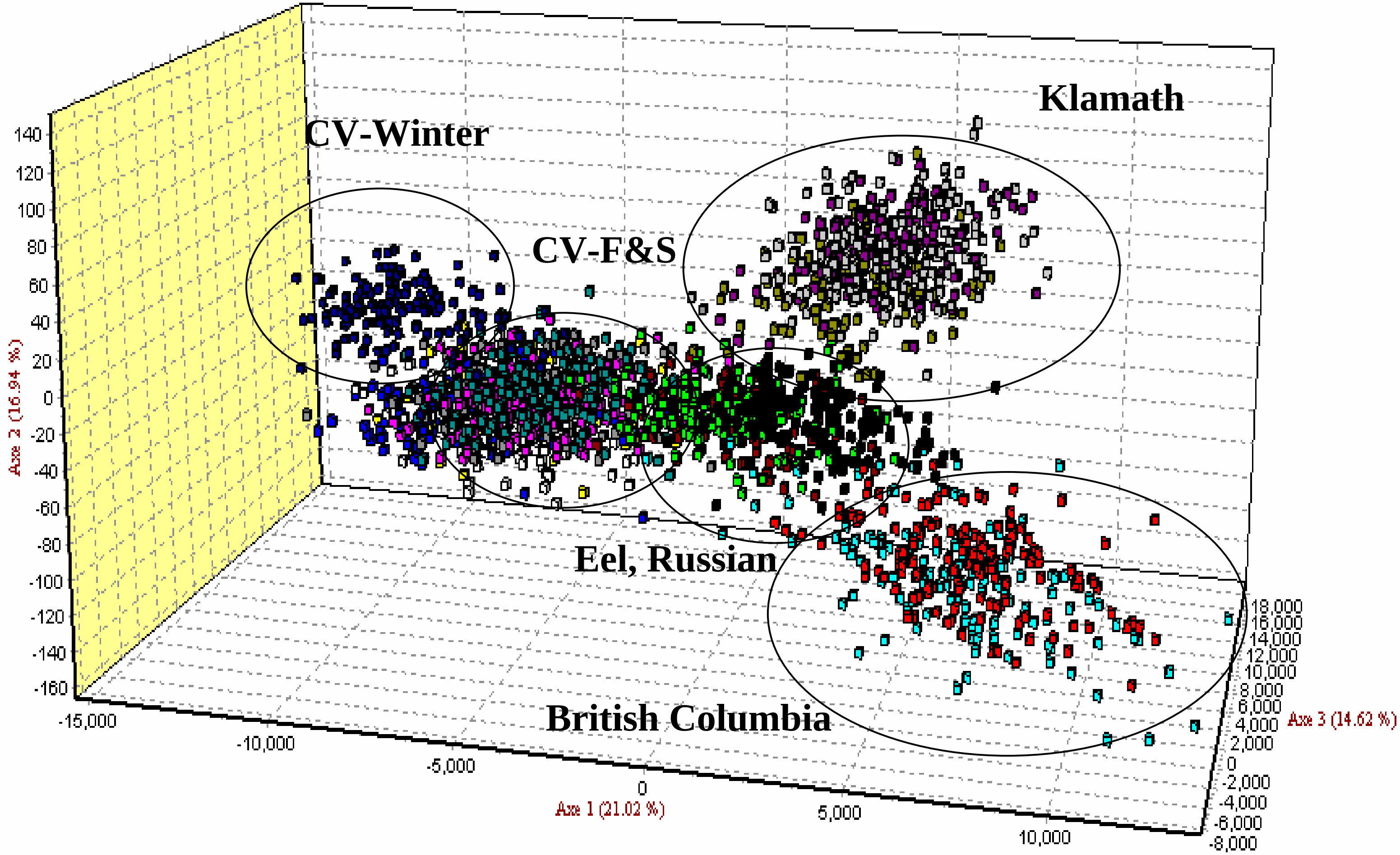
MAJOR FINDINGS: Existing & Future Technologies

- 18. A novel genetic method, termed full parental genotyping (FPG), has been presented as an alternative to coded wire tagging. An empirical demonstration is needed to validate promising theoretical results.

Coastwide Chinook Salmon Genetic Stock ID

- GAPS (Genetic Analysis of Pacific Salmonids) Consortium
  - Eight lab collaboration to standardize microsatellite data for use in management of chinook salmon fisheries
  - Funding: Pacific Salmon Commission-Chinook Technical Committee
  - Participating labs: ADFG; CDFO-Nanaimo; CRITFC; NWFSC-Seattle; OSU; WDFW; SWFSC-Santa Cruz
  - Products: 1). Standard set of 13 microsatellites which can be used in all labs for mixed fishery analysis; 2). Genetic baseline dataset of ~120 fish from 105 populations that can identify all major stocks from Alaska to California

Factorial Correspondence Analysis of CA Chinook Salmon Individual Genotypes



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National Marine Fisheries Service

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

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Molecular Genetic Technology in California Chinook Salmon Fishery Management- Proposal

Evaluation of catch stock composition on a fine temporal and spatial scale using genetic stock identification.

-Divide the coast south of Cape Falcon into 5 sectors

-Port sampling of recreational and commercial fisheries in each sector every 3-7 days

-200 samples per sector per sampling period

-Genetic stock identification techniques applied with 2-4 day turnaround time for catch stock composition estimates.

-Accurate and precise estimates of fishery mortality on a sector by sector basis for very fine time strata.

Genetic Stock Identification - An Example in Monterey Bay

-Recreational fishery: April, 2006

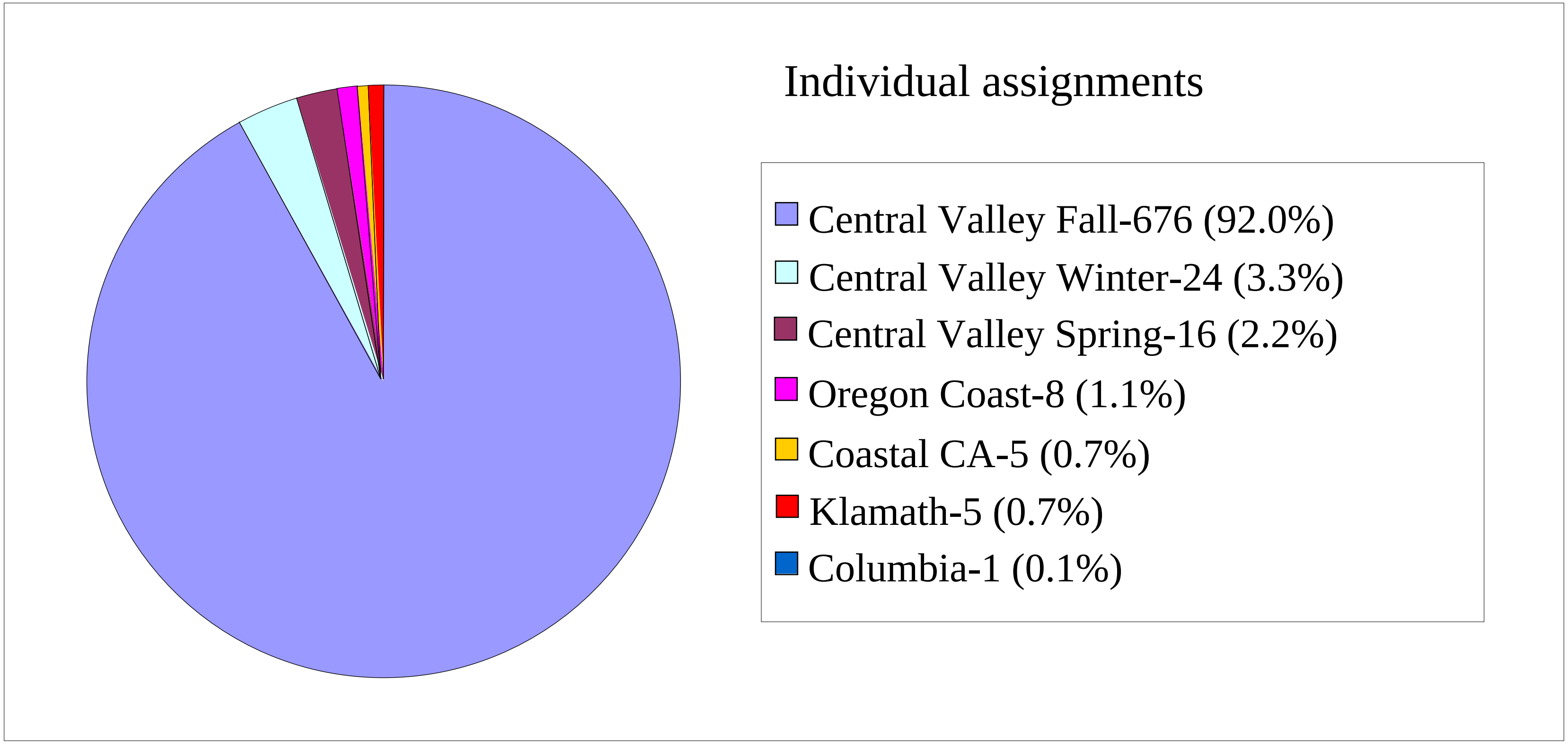
-Sampling from Monterey Bay ports: Santa Cruz, Moss Landing, Monterey - charter and private boats:

-735 fish sampled, small clips ($1 cm^2$) from caudal fin, and genotyped at 13 GAPS microsatellite genes and compared to coastwide baseline database for stock assignment.

-Stock composition estimates available in 4-7 days from receipt of samples.

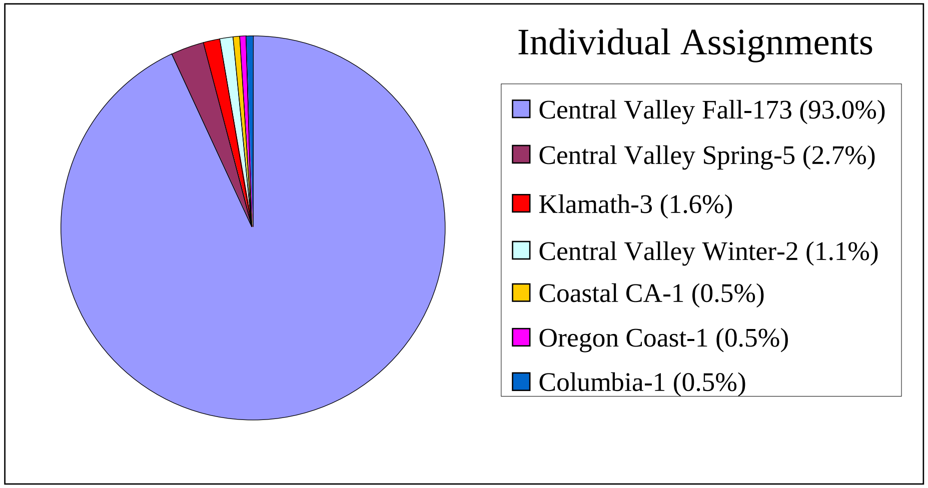
Genetic Stock Identification - An Example in Monterey Bay

Stock composition estimate-735 fish sport-caught: April, 2006

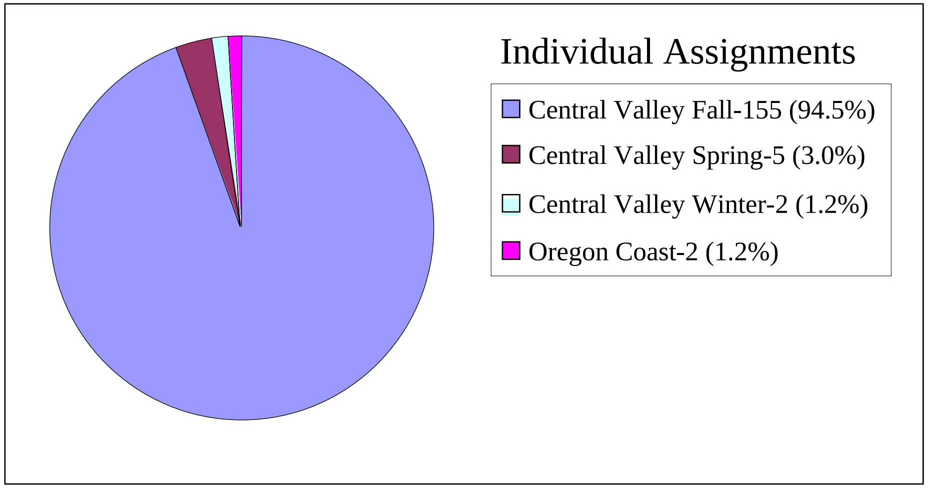


Chinook Salmon Genetic Stock ID-Monterey Bay Sport Fishery 2006

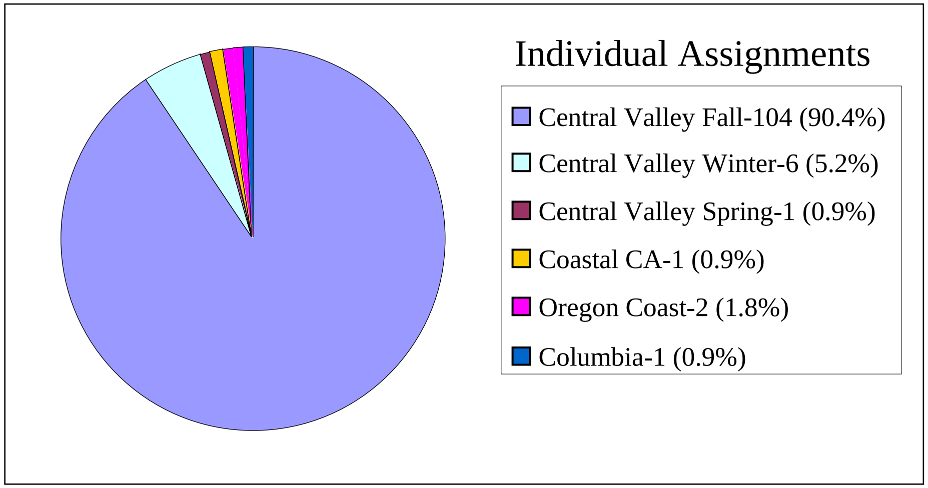
April 1: N=186



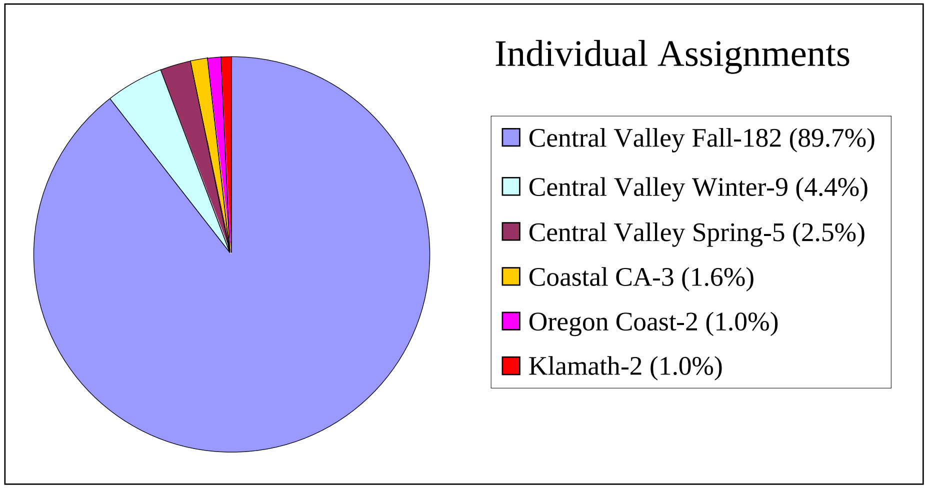
April 8: N=164



April 15: N=115

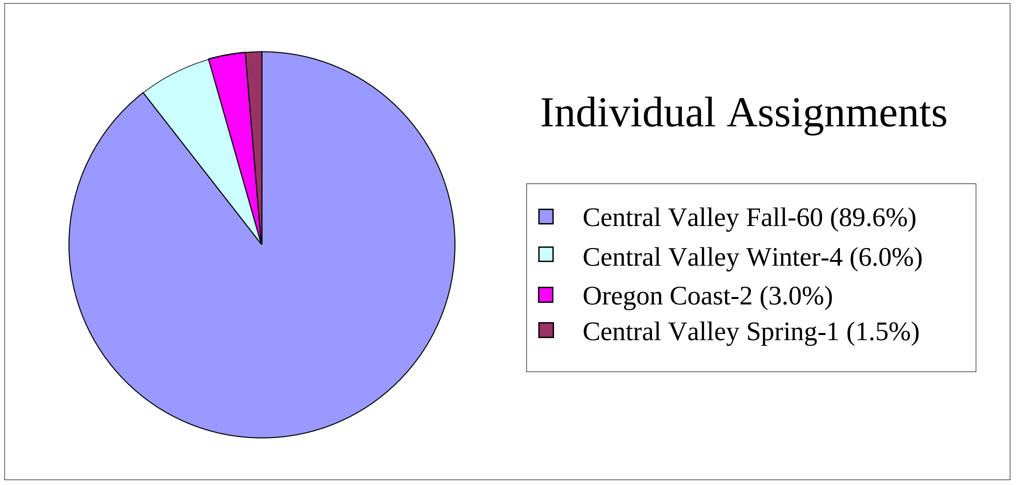


April 22: N=203



Chinook Salmon Genetic Stock ID-Monterey Bay Sport Fishery 2006

April 29: N=67



Difference in estimated catch proportion of Central Valley Winter fish before (1.1%) and after (4.9%) April 14 is suggestive, but not statistical significant after adjustment for multiple tests.

Current operational plan-SWFSC Chinook GSI project

-Integration of SWFSC sampling with existing California Recreational Fishery Survey sampling for continued collection of genetic samples from Monterey Bay ports.

-Collaboration with CDFG Ocean Salmon Project to analyze tissue samples collected from commerical fisheries this year and archived in past years

-Genetic analysis of ~200 samples/week for remainder of season.

-Workshops to discuss technical, logistical and policy aspects of genetic stock ID in Chinook salmon fishery management.

Uses of Genetic Stock Composition Information

-Stock-specific ocean distribution/migration patterns on fine spatial and temporal scales: prediction of contact rates

-Determination of cumulative fishery mortality for stocks of conservation concern in a quota fishery-possible this year

-Real-time (in-season) adaptive management of fisheries on fine spatial and temporal scales-possible next year.

Genetic Stock Composition in Fishery Management
Future prospects

-Validation of full parental genotyping (FPG) in Central Valley and Klamath Chinook hatcheries

-Implementation of integrated FPG and GSI sampling program for simultaneous collection of cohort/stock of origin for fish from FPG hatcheries and stock of origin for ALL sampled fish

-Evaluation of correlations between ocean conditions and ocean distribution/migration patterns of Chinook stocks?

Genetic Stock Identification for Coho Salmon

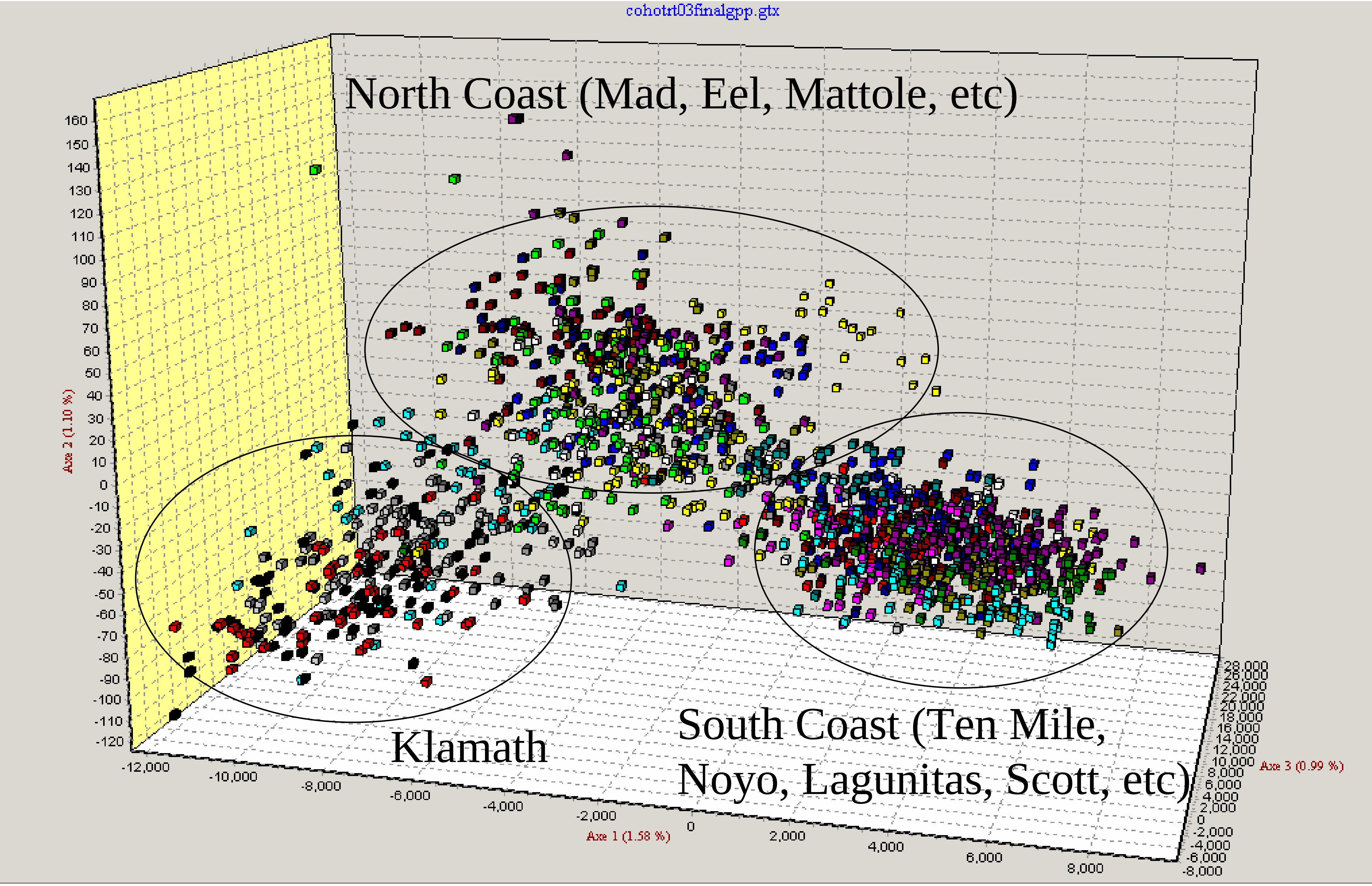
-Tissue from coho and Chinook salmon easily distinguished with genetic methods.

-Of ~750 fish sampled in April pilot project, 1 fish identified as coho salmon

-Southwest Fisheries Science Center has NON-standardized baseline that includes >6000 fish and representing all major coho salmon populations in California. High ID accuracy

-Southwest and Northwest Centers in process of integrating CA and OR baseline datasets for more widespread GSI.

California Coho Salmon-Factorial Correspondence Analysis



Acknowledgements

- Eric Anderson
- Scott Blankenship
- Gregory Charrier
- Anthony Clemento
- Celeste Gallardo
- Libby Gilbert-Horvath
- Allen Grover
- Heidi Fish
- Bill Fox
- Edith Martinez
- Paul Moran
- Devon Pearse

SALMON TECHNICAL TEAM REPORT ON THE APPLICATION OF GENETIC STOCK IDENTIFICATION IN OCEAN SALMON FISHERIES

The Salmon Technical Team (STT) is unable to provide specific comments regarding the proposed pilot study because the purpose, nature, and scope of the study are not clearly articulated.

The STT recommends that individuals familiar with fishery management needs and sampling programs be active participants in deliberations regarding practical considerations involved in the use of genetic techniques in the management of ocean salmon fisheries.

Council Guidance on Research Projects

The Council adopted Operating Procedures (COP 18) which establish the protocol for Industry Sponsored Salmon Test Fishery Proposals in November 1999, and amended it in September 2004 (excerpt below). Under this protocol,

- Proposals are to be submitted approximately three weeks prior to the November Council meeting.
- Proposals are to be screened for content.
- Screened proposals are to be provided to the Scientific and Statistical Committee (SSC), STT, and Salmon Advisory Subpanel (SAS) for review and comment at the November Council meeting.
- The SSC, STT, and SAS are to provide written comments to the Council at the March Council Meeting and the Council determines which proposals are to be included in the options provided for public comment.
- The Council decides which proposals are to be incorporated into its recommended regulations at its April meeting.

The Council's protocol also outlines the required content of proposals.

STT Comments Regarding GSI-Based Study

The STT provides these comments to inform the Council of considerations that should be taken into account in designing research projects.

1) The objectives of the study must be clearly defined in both general requirements and statistical specifications.

General Requirements:

Desired stratification: Times, areas, fishery (sport, troll), gear (e.g., lure restrictions), contribution type (e.g., all ages, age-specific, legal versus sub-legal sized fish)

Statistical specifications:

The desired level of precision could be expressed in either absolute or relative terms. Absolute precision expresses the tolerance for error of the estimated contribution of the stock of interest in terms of percentages, regardless of the magnitude of the contribution; for example, estimate the contribution plus or minus 5%. In contrast, relative precision expresses the tolerance for error of the estimated contribution of the stock of interest in terms of a percentage of the true value; for example, estimate the contribution plus or minus 5% of the true value. Obviously, clarity of the target would have a great effect on the level of precision required. If the need is to estimate the contribution of a stock that comprises a small fraction of the total exploited population, a small absolute error would represent a large relative error. With relative error, the level of required precision increases (and with it sampling sizes) as the fraction comprised of the stock of interest decreases.

In addition to these general statistical requirements, the precision and accuracy of the methods for analysis of sampling data need to be taken into account. For example, the genetic baseline to be employed, uncertainty surrounding the capacity to correctly identify fish to their parental populations, and uncertainty surrounding the ability to correctly identify ages of fish (if required).

Depending on these factors and the desired stratification, the required sample sizes to attain the desired level of precision and accuracy of the stock contribution estimates can be determined. Sample sizes would be expected to vary substantially depending on the expected contribution of stocks/ages of interest to target strata, with largest samples required for strata with smallest contributions.

2) Logistical Considerations:

(1) The study design and methods employed to collect tissue samples must be designed to generate reliable data suitable for the purpose for which the results are intended to be applied (e.g., time-area stratifications). Depending on the desired objectives, it is likely that vessels will need to be chartered to collect sufficient samples for analysis.

(2) Tissue collected from each individual fish (e.g., punches taken from a fin, and scales taken if age data are required) should be kept separate and preserved for later processing. Individual samples must also be logged with appropriate information to identify the time, location, etc. Using genetic stock identification (GSI) methods, tissue could be collected without sacrificial sampling, so impacts on natural stocks could be reduced to hooking mortality losses.

(3) Fish with clipped adipose fins (adipose fin clips are still sequestered to indicate the presence of a coded-wire tag (CWT) for the areas likely to be involved in the study for California Chinook), should be retained, tissue for GSI analysis collected, and CWTs extracted. This would provide a means to validate the capacity of GSI and scale aging methods to correctly identify fish from a given stock and age.

(4) The length of time between tissue collection and availability of results should be recorded and evaluated to provide insight into the potential to apply GSI methods on a real-time basis.

(5) Because of inter-annual variability in relative abundance of stocks contributing to target fishery strata, the study should be conducted for a minimum of three years.

(6) Note that a variety of additional methods could be employed to collect data that would be useful for comparative analysis. For example, trollers could be provided with tissue collection kits and receive training in collection procedures, or dockside sampling could be employed to collect data for comparison with contribution estimates resulting from the tissue collected from the chartered vessels.

PFMC
06/15/06