

Coho FRAM Base Period Development

by

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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.

Table of Contents

List of Figures	iv
List of Tables	iv
1. Introduction.....	1
2. Coho FRAM Base Period Development Process.....	2
3. MSM-VB Project Objectives.....	3
4. Estimation of PEFs Using the ULS	6
5. MSM-VB Development and Processes	6
5.1 Stocks used in MSM-VB PEF Estimation.....	9
5.2 Fisheries used in MSM-VB PEF Estimation.....	10
5.3 CWT Selection Process	10
6. RRTERM Program	11
6.1 Overview of 1992-97 Terminal Runsize Estimation Process.....	15
7. User-Defined PEF Values.....	15
8. Revised Canadian CWT Recoveries and Catch Data	16
9. Catch Adjustment Procedure	16
10. MSMSplit Program Algorithms.....	17
11. MSM Cohort Analysis Program Algorithms	18
12. Coho FRAM Base Period Algorithms	20
13. Current Coho FRAM Base Period	22
14. Recommendations for Future Work.....	23
15. Literature Cited	26
16. Figures.....	27
17. Tables.....	33
18. Appendices.....	87

List of Figures

Figure 1. Flowchart of Coho FRAM base period development process. MU = Management Unit, PR = Production Region.	27
Figure 2. Flowchart of MSM-VB system.	28
Figure 3. Flowchart of subroutine “Init_Fisheries” in MSM-VB program.	29
Figure 4. Flowchart of subroutine “Init_Stocks” in MSM-VB program.	29
Figure 5. Flowchart of subroutine “Init_CWTRec” in MSM-VB program.	30
Figure 6. Flowchart of subroutine “Compress_Data” in MSM-VB program.	30
Figure 7. Flowchart of subroutine “SweepVector” in MSM-VB program.	31
Figure 8. Flowchart of subroutine “PEF_Estimate” in MSM-VB program.	31
Figure 9. Steps performed by the subroutine “Bayesian_PEF_Estimate” in MSM-VB program.	32

List of Tables

Table 1. Description of tables in MSM-VB MS-Access database file.	33
Table 2. Variables included in MSM-VB MS-Access database tables (table names).	34
Table 3. Stocks included in the Coho FRAM.	38
Table 4. Fisheries included in the Coho FRAM.	42
Table 5. Coded-wire-tag groups chosen to represent Mixed-Stock-Model (MSM) stocks for catch years 1992-1997.	45
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.	58
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.	60
Table 8. Coded-wire-tag groups chosen to represent Mixed-Stock-Model (MSM) stocks for catch years 1986-1991.	61
Table 9. MSM estimated PEF values for 1986 catch year. CV = coefficient of variation.	80
Table 10. MSM estimated PEF values for 1987 catch year. CV = coefficient of variation.	81
Table 11. MSM estimated PEF values for 1988 catch year. CV = coefficient of variation.	82
Table 12. MSM estimated PEF values for 1989 catch year. CV = coefficient of variation.	83
Table 13. MSM Estimated PEF values for 1990 catch year. CV = coefficient of variation.	84
Table 14. MSM Estimated PEF values for 1991 catch year. CV = coefficient of variation.	85
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.	86

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,

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

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,

$$V(\hat{C}_{jkl}) = V(\hat{C}_l) \hat{\pi}_{jkl}^2 + \hat{C}_l^2 V(\hat{\pi}_{jkl}) + V(\hat{C}_l) V(\hat{\pi}_{jkl})$$

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 —

$$\hat{\pi}_{jk(l)} = \frac{\hat{E}_j + \hat{C}_{jkl}}{\sum_{j \in l} \hat{E}_j + \sum_{j \in l} \hat{C}_{jkl}}$$

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 —

$$MSMProp_{s,a} = RRPct_{s,a} \left/ \sum_{s=s1}^{s2} \sum_a RRPct_{s,a} \right.$$

$$Catch_{s,a,f,t} = MSMCatch_{k,a,f,t} \times MSMProp_{s,a} \quad \text{where stock } s \text{ is subset of MSM stock } k$$

Columbia River Late Hatchery

$$Catch_{h,a,f,t} = ColLHW_{f,t} \times (RRPct_{h,a,s,a} / (RRPct_{h,a,s,a} + RRPct_{w,a,s,a}))$$

Columbia River (Clackamas) Late Wild

$$Catch_{h,a,f,t} = ColLHW_{f,t} \times (RRPct_{w,a,s,a} / (RRPct_{h,a,s,a} + RRPct_{w,a,s,a}))$$

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 —

$$Cohort_{s,a,t} = Cohort_{s,a,t+1} + \left(\sum_f (Catch_{s,a,f,t} + IncMort_{s,a,f,t}) + Escape_{s,a,t} \right) / (1 - NatMort_t)$$

$$IncMort_{s,a,f,t} = Dropoff_{s,a,f,t} + CNR_{s,a,f,t}$$

$$Dropoff_{s,a,f,t} = Catch_{s,a,f,t} \times DropoffRate_{f,t}$$

$$CNR_{s,a,f,t} = CNRMort_{f,t} \times (Catch_{s,a,f,t} / TotCatch_{f,t})$$

$$Catch_{s,a,f,t} = NOSMort_{f,t} \times (Catch_{s,a,f,t} / TotCatch_{f,t})$$

$$ExplRate_{s,a,f,t} = Catch_{s,a,f,t} / (Cohort_{s,a,t} \times (1 - Natmort_t))$$

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, where 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 —

$$BPCohort_{s,a,t} = \left(\sum_{y=y1}^{y2} Cohort_{s,a,t,y} \right) / NumYears \times 0.5$$

Method 1- Average Exploitation Rate Over All Years Selected

$$BPER_{s,a,f,t} = \sum_{y=y1}^{y2} ExplRate_{s,a,f,t,y} / NumYears$$

Method 2- Average Exploitation Rate Over Years with Fishery Occurring

$$BPER_{s,a,f,t} = \sum_{y=y3}^{y4} ExplRate_{s,a,f,t,y} / NumYears \quad (\text{except Thompson})$$

Method 3- Average Exploitation Rate Over All Years Selected Weighted by Cohort size

$$BPER_{s,a,f,t} = \frac{\left(\sum_{y=y1}^{y2} (ExplRate_{s,a,f,t,y} \times Cohort_{s,a,f,t,y}) \right) / NumYears}{\left(\sum_{y=y1}^{y2} Cohort_{s,a,f,t,y} \right) / NumYears}$$

Method 4- Average Exploitation Rate Over Years with Fishery Occurring Weighted by Cohort size

$$BPER_{s,a,f,t} = \frac{\left(\sum_{y=y3}^{y4} (ExplRate_{s,a,f,t,y} \times Cohort_{s,a,f,t,y}) \right) / NumYears}{\left(\sum_{y=y3}^{y4} Cohort_{s,a,f,t,y} \right) / NumYears}$$

$$AvgTreatyPct_{f,t} = \sum_{y=y1}^{y2} TreatyPct_{f,t,y} / NumYears$$

Where:

BPCohort _{s,a,t}	FRAM Base Period Cohort Size for stock s , age a , at time step 1
Cohort _{s,a,t,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

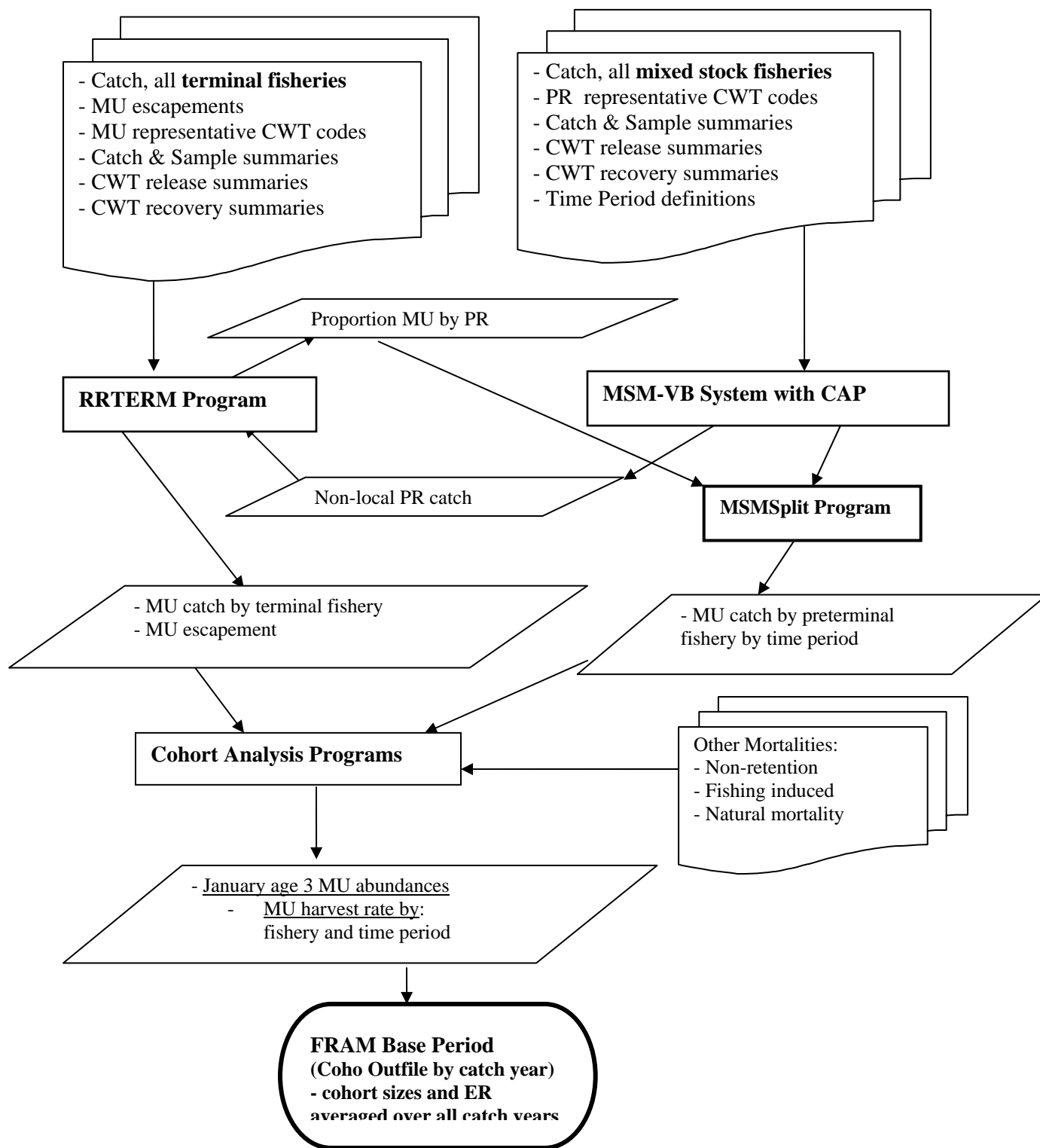


Figure 1. Flowchart of Coho FRAM base period development process. MU = Management Unit, PR = Production Region.

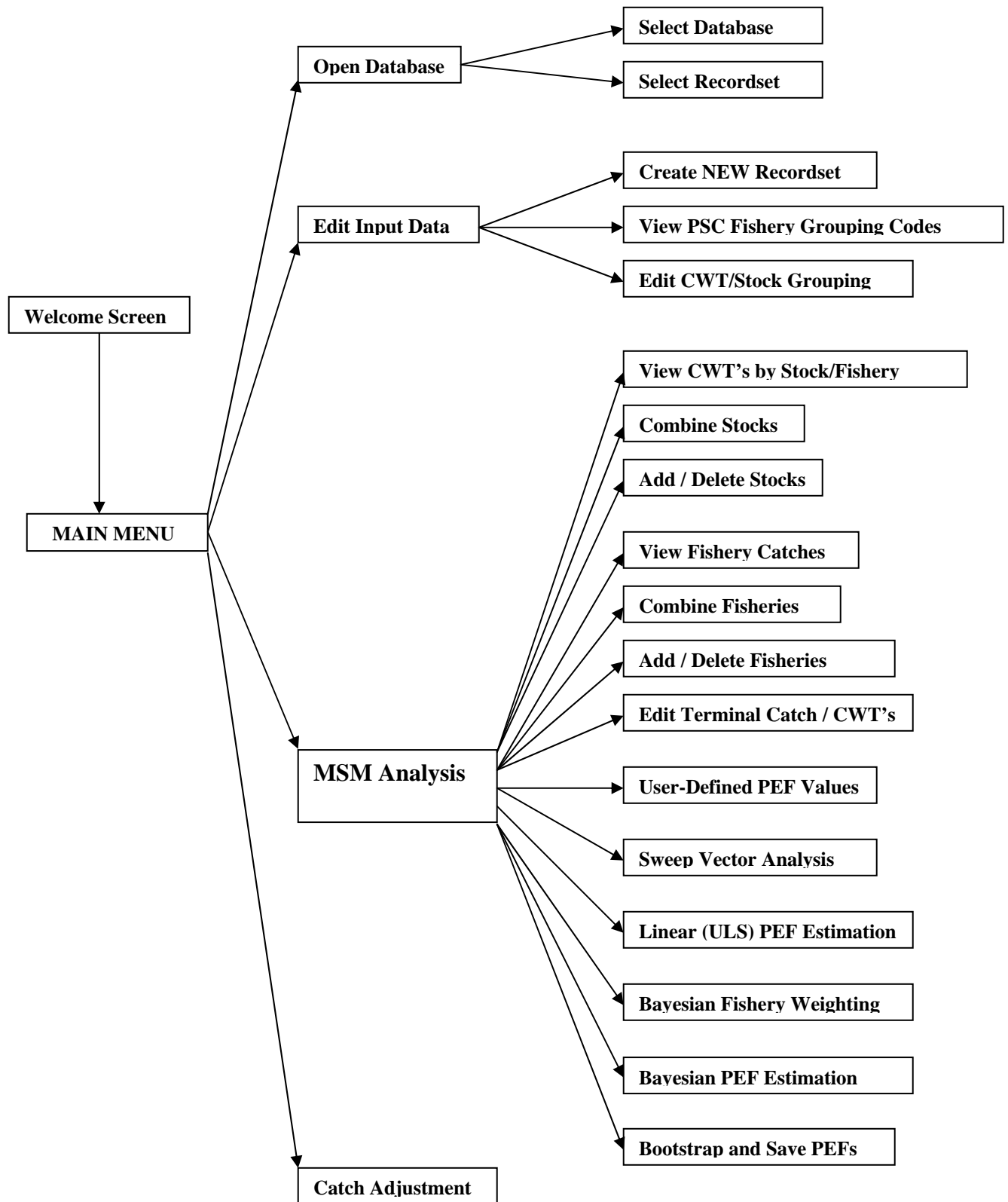


Figure 2. Flowchart of MSM-VB system.

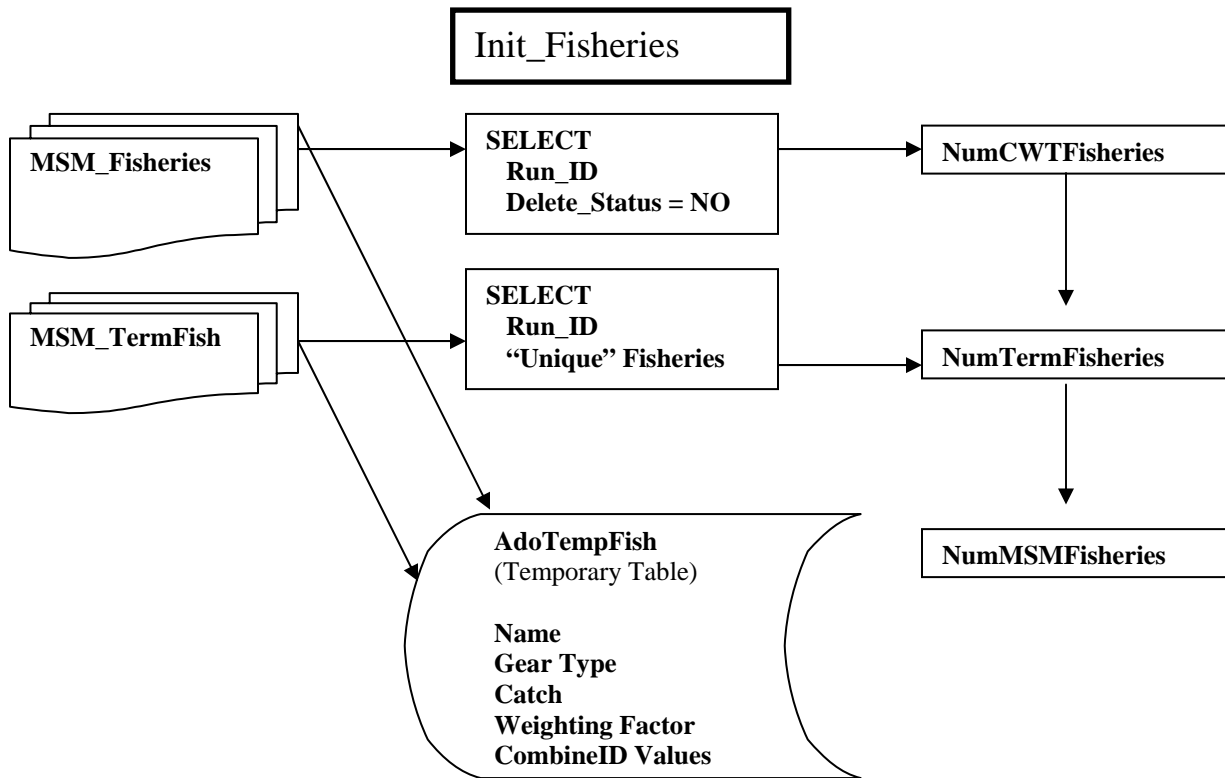


Figure 3. Flowchart of subroutine “Init_Fisheries” in MSM-VB program.

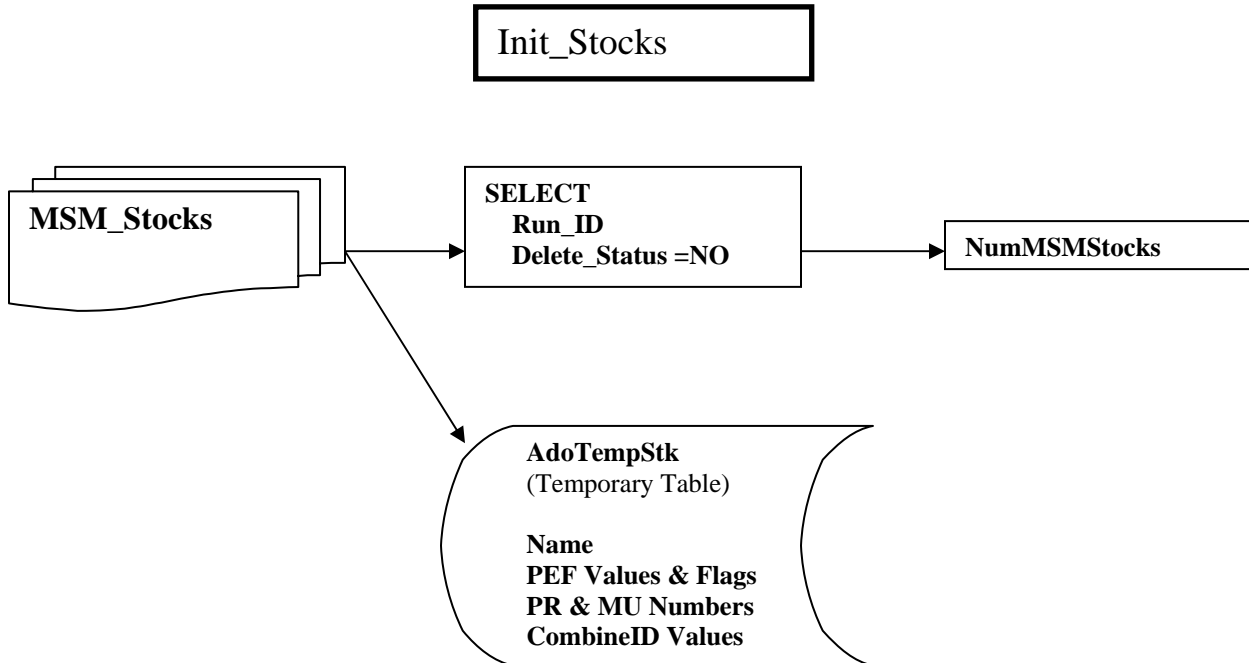


Figure 4. Flowchart of subroutine “Init_Stocks” in MSM-VB program.

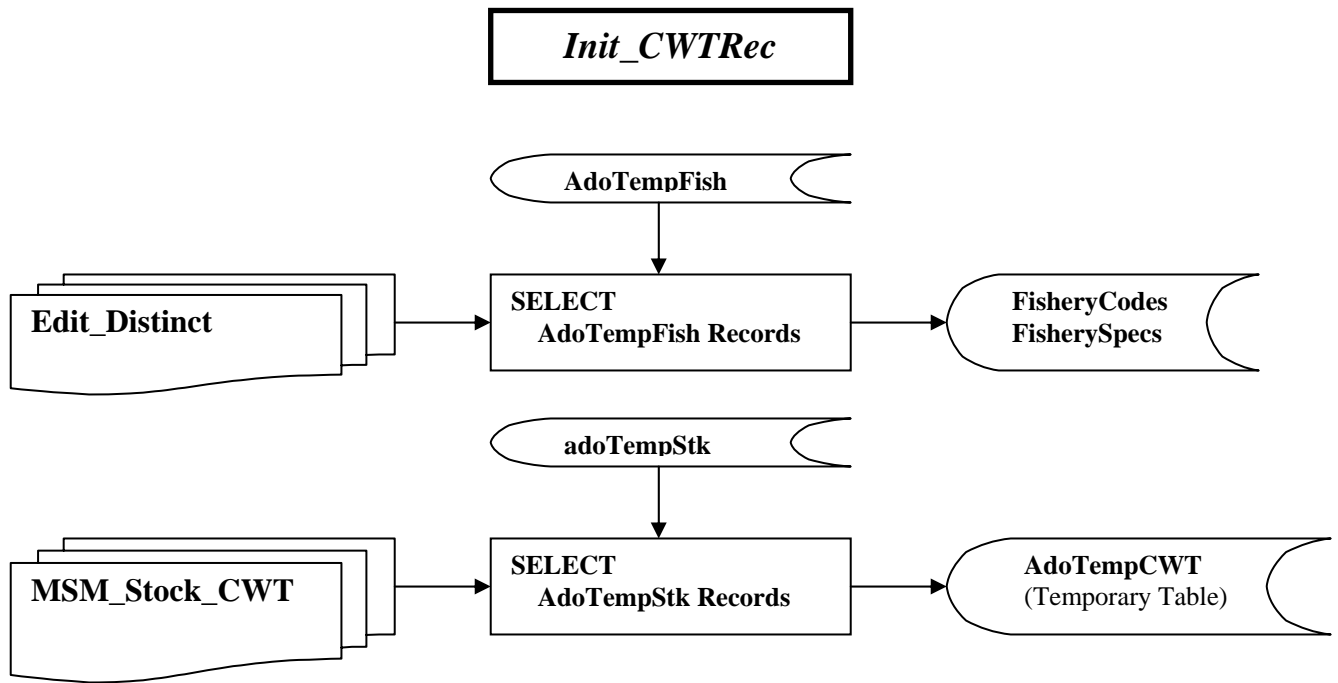


Figure 5. Flowchart of subroutine “Init_CWTRec” in MSM-VB program.

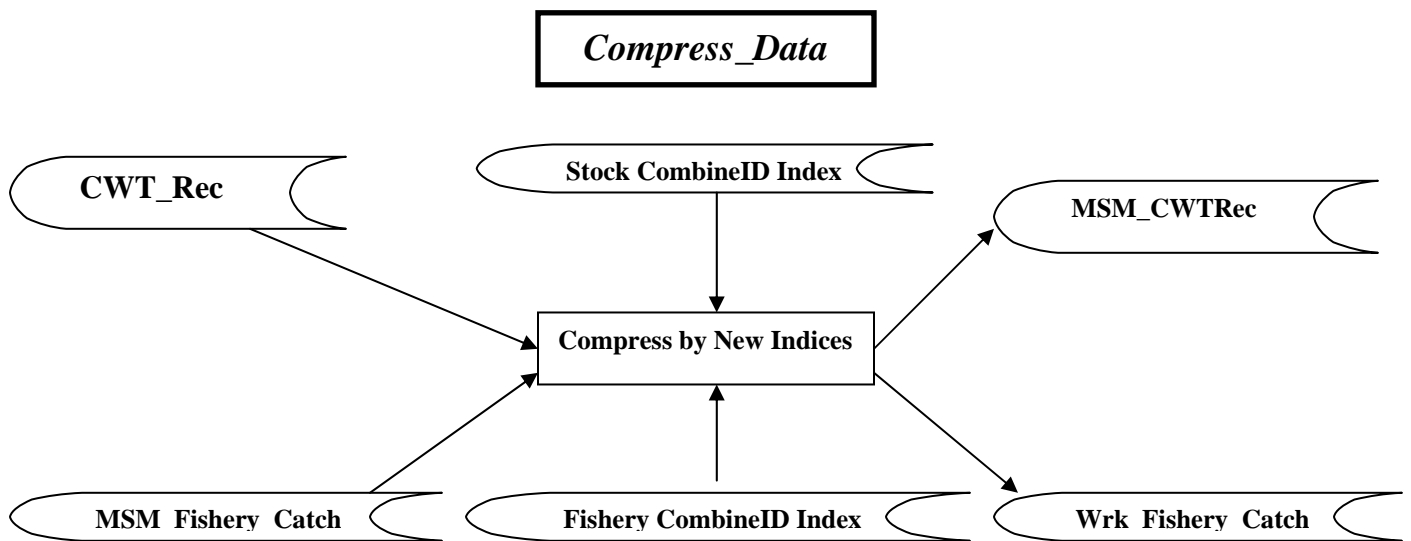


Figure 6. Flowchart of subroutine “Compress_Data” in MSM-VB program.

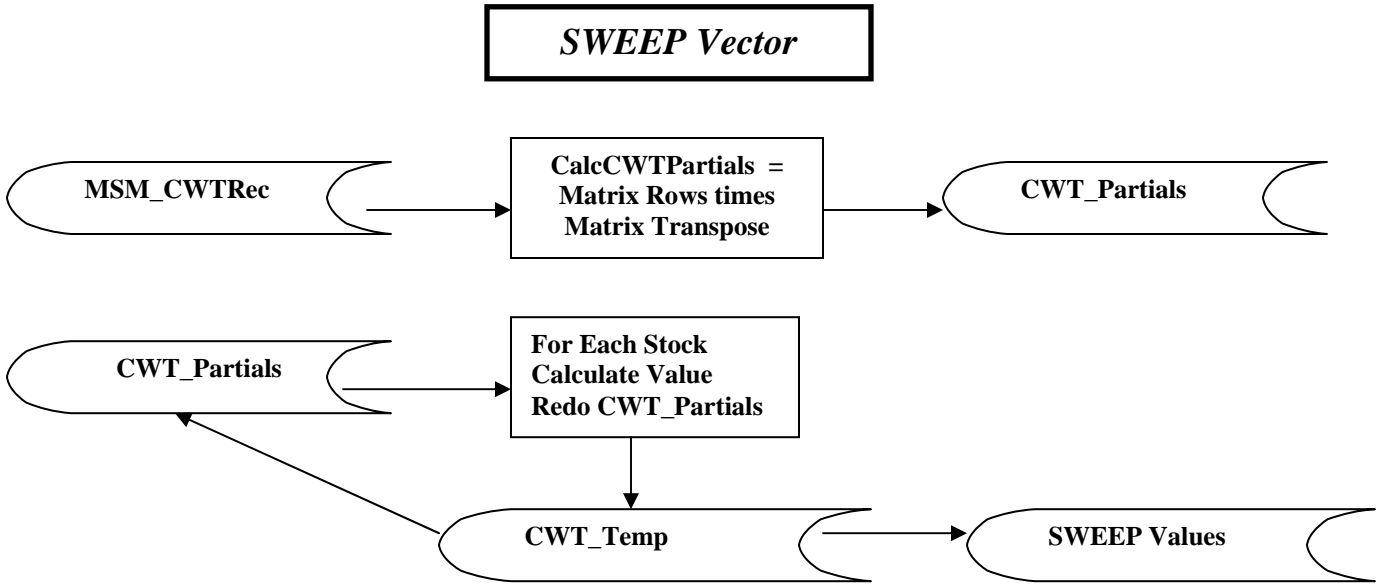


Figure 7. Flowchart of subroutine “SweepVector” in MSM-VB program.

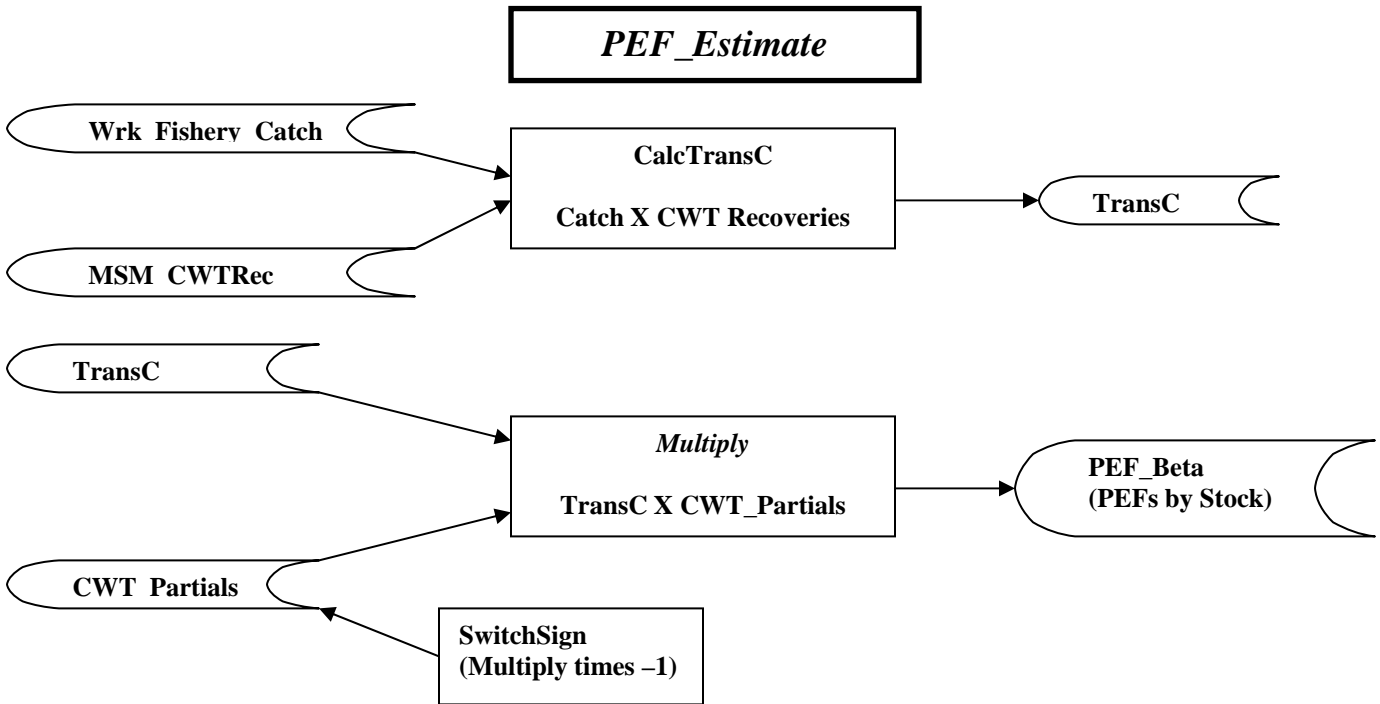


Figure 8. Flowchart of subroutine “PEF_Estimate” in MSM-VB program.

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
CohoCWYyyy	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)	PSC Fishery Specification table (Edit_Distinct)
record_code	Gear
format_version	Fishery_Short_Name
submission_date	Fishery_Number
reporting_agency	Num_Chars
release_agency	PSC_Code
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	
	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	Hoodspout 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	Area3TrlINT	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)	A4/4BTrlINT	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	Clrwr 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
Area2TrlINT	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	Ar10EneTR	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	PuyI R Net	134	Puyallup River Net
Ar 8 NetNT	101	Area 8 Skagit Marine Net Nontreaty	PuyI 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		Catch Year					
Production Region	Mgt Unit	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		Catch Year						
Production Region	Mgt Unit	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		Catch Year					
Production Region	Mgt Unit	1992	1993	1994	1995	1996	1997
		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		Catch Year					
Production Region	Mgt Unit	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		Catch Year					
Production Region	Mgt Unit	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			
QUINALT		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		Catch Year					
Production Region	Mgt Unit	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		Catch Year					
Production Region	Mgt Unit	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.

Estimate	Catch Year					
	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		022445	022811	022854	024116	024417	025051
MAINLAND		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					211729	
	Wild					630432	
	Area 12A					211729	
	Wild					630432	
	Area 12C/12D					211729	
	Wild					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		623047	620518	620634	621633	622135	
Anadromous		623048	620636	621729	621913	622137	
Hatchery		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		603658	603824	603629	603912	603910	603950
Aqua-Foods		603659	603826	603816	603913	603928	603963
Hatchery		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		065650	062901	062913	062916	065121	066322
SOUTH/CALIFORNIA		065651	062902	065109	065115	065122	
COAST		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 074059	074060 074550	074847
	Oregon South Coast Wild	073011	073161		074058 074059	074060 074550	074847
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 633630 633704 633705 633706	635008 635011		
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	023504	024142	024560	025336	025731	
	023006	023503	024141	024437	024161	025337	
		023505	024143	024561	025337	025732	
					025418	025737	
					025419	025944	
					082515	082825	
					082558	082826	
					082560	082827	
					082563	082828	
STILLAGUAMISH/ SNOHOMISH	211634	211662	211927	212261	212531	213149	
	633051	211663	211930	212631	213208	631147	
	633141	211701	211942	212632	213211		
	633203	211922	212144	212635	213213		
	633429	211923	212147	212637	213214		
	633430	211924	212149	212638	213216		
		211925	212150	212641	213219		
		211926	212152	212642	213221		
		211928	212155	212644	213222		
		211929	212156	212647	213225		
		211931	212159	212649	213226		
		633618	212161	212650	213228		
		633619	212162	212652	213231		
		633620	212201	212655	213232		
		634142	212202	212656	213235		
			212241	634701	630155		
			212242				
			212244				
			212247				
			212249				
		634228					
	Area 8A Net Pens			633337	635519		
STRAIT OF JUAN DE FUCA	B10408	211913	211941	212256	211728	213159	
	B10409	211914	212222	212821	212532		
	B10410		212226	634728	213237		
	B10411			634731	213238		
	B10412				213514		
	B10414						
	B10415						
	B10508						
	B10509						

MSM Stock		Catch Year					
Production Region	Mgt Unit	1986	1987	1988	1989	1990	1991
	B10510						
	Dungeness	B10408			634728		
	Hatchery	B10409			634731		
	B10410						
	B10411						
	B10412						
	B10414						
	B10415						
	B10508						
	B10509						
	B10510						
	Elwha Hatchery					212532	213159
	Port Angeles Net Pens						631321
TRANSBOUNDARY		B40909	B40603	024340	024340	024345	025048
ALASKA CANADA		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.

Estimate	Catch Year					
	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