FISHERY REGULATION ASSESSMENT MODEL (FRAM)

- An OVERVIEW for CHINOOK and COHO -

MODEL EVALUATION WORKGROUP[1]

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1. INTRODUCTION

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

1.1 Background

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

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

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

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

2. MODEL OVERVIEW

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

2.1 Stocks

Currently, 33 stock groups are represented in Chinook FRAM and 128 stock groups are represented in Coho FRAM (see Appendices 1 and 2 for lists of the stocks). Each of these groups have both marked and unmarked components to permit assessment of mark-selective fishery regulations. For most wild stocks and hatchery stocks without marking or tagging programs, the cohort size of the marked component is zero and therefore the current version of FRAM has a virtual total of 66 stock groups for chinook and 256 for coho. Stocks or stock-aggregates represented in the FRAM were chosen based on the level of management interest, their contribution rate to PFMC fisheries, and the availability of representative CWT recoveries in the fisheries.

2.2 Fisheries

The FRAM includes pre-terminal and terminal fisheries in southeast Alaska, Canada, Puget Sound, and off the coasts of Washington, Oregon, and California. There are 73 fisheries in Chinook FRAM and 206 fisheries in Coho FRAM. The intent is to encompass all fishery impacts to modeled chinook and coho stocks in order to account for all fishing-related impacts and thereby improve model accuracy. Terminal fisheries in Chinook FRAM are aggregations of gears and management areas. Terminal fisheries in Coho FRAM are modeled with finer resolution, most notably by including individual freshwater fisheries. Fishery number and fishery name for each of the FRAM fisheries are listed in Appendix 3 for chinook and Appendix 4 for coho.

2.3 Time Steps

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

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

Table 2-1. FRAM time steps for coho and chinook.

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

The recovery data available in the CWT database limit the time-step resolution of the model. Increasing the time-step resolution of the model usually decreases the number of CWT recoveries for a stock within a time period. Since estimation of fishery impacts, like exploitation rates, is dependent on CWT recovery information, decreasing the number of CWT recoveries in time/area strata increases the variance of the estimated exploitation rates in those strata. In recognition of these data limitations, efforts were made to restrict the level of time-step resolution to that necessary for fishery management purposes.

2.4 Assumptions and Limitations

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

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

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

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

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

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

3. BASE PERIOD DATA

The Chinook FRAM is calibrated using escapement, catch, and CWT recovery data from 1974-1979 brood year CWT releases. During the late 1970s and early 1980s, fisheries were being conducted across an extensive geographic area and over an extended period of time, thus giving the best available representation of CWT stock distribution. Not all stocks represented in the Chinook FRAM have CWT recovery data available from the 1974-1979 brood year base period (e.g., Snake River fall chinook). These stocks are categorized as "Out-of-Base" stocks. Available CWT data for these stocks are translated to equivalent base period recovery and escapement data using known fishing effort and harvest relationships between recovery years.

Model base period data for the Coho FRAM is derived from fishery and escapement recoveries of CWTs and terminal area run size estimates for the return years 1986-1991.

Chinook and coho base period data are used to estimate base period stock abundances and age-specific time-area fishery exploitation rates and maturation rates for modeled stocks. These estimates are derived through species-specific cohort analysis procedures. Cohort analysis is a series of steps and processes that uses CWT recoveries and base period catch and escapement data to "back-calculate" or reconstruct a pre-fishing cohort size for each stock and age group using assumed natural mortality and incidental mortality rates.

4. GENERAL INPUT TYPES

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

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

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

3. Fishery Catch Mortality: The model provides five options for estimating mortality in a fishery: a quota, an exploitation rate scalar, a ceiling, "selective", and harvest rate (for Puget Sound terminal fisheries only).
   a) Quota. Catch in the fishery is set equal to a value input by the user.
   b) Exploitation rate scalar. The exploitation rate in the fishery is scaled, relative to the base period, using a scalar input by the user.
   c) Ceiling. Catch is first calculated based on an exploitation rate scalar and then compared to a ceiling; if the estimated catch exceeds the ceiling, then the catch is truncated at the ceiling value.
   d) Selective. Identified as either a quota or exploitation rate scalar controlled fishery with additional calculations to cover catches and encounters for marked and unmarked groups.
   e) Harvest rate. A terminal area harvest rate is applied to either all fish present in the terminal area or to the number of local-origin stock only.

4. Release Mortality: This is the mortality associated with the release of landed fish from hook-and-line and other gears. Release mortality rates assumed for coho are shown in Table 3-1a and for chinook in Table 3-1b. Hook-and-release mortality is assessed when coho or chinook are not allowed to be retained (so-called "chinook/coho non-retention", or CNR fisheries), when size limits apply, or in mark-selective fisheries. Release mortality has been estimated in a number of studies of hook-and-line fisheries, and release mortality rates for troll and recreational fisheries in the ocean have been formally adopted by the PFMC. Release mortality in net fisheries for chinook or coho non-retention is estimated external to FRAM and input into the model as either "landed catch" or as CNR mortality.

   Mark-selective fisheries have two additional variations of "release" mortality that are described as either the inappropriate retention of an unmarked fish or the release of a marked fish which consequently endures some release mortality. The failure to release an unmarked fish is a user input to the model called "Unmarked Recognition Error" (or Retention Error Rate) and is the proportion of the unmarked fish encountered that are retained. The release of marked fish that subsequently die due to release is a user input to the model called "Marked Recognition Error" and is the proportion of the marked fish encountered that are released. These rates are identified in Table 3-2.

5. Other Non-landed Mortality: This category includes fishing-induced mortality not associated with direct handling (or landing) of the fish (see Table 3-1a for coho and Table 3-1b for chinook). Application is for sport and troll hook-and-line "drop-off" (fish that drop off from the hook before they are brought to vessel but die from hook injuries), and net gear "drop-out" (fish which are not brought on board but die from injury as a result of being netted). In general, a 5% mortality rate is applied to the landed catch to account for "other non-landed mortality" in hook-and-line fisheries. Net drop-out mortality rates vary depending on species, net type, or terminal versus pre-terminal nature of the fishery.

Table 3-1a. FRAM/TAMM fishery-related mortality rates for coho salmon used for Southern U.S. fisheries in 2003.

Fishery: designated by area, user group, and/or gear type	Fishery Type	Comments	Release Mortality	"Other" Mortality[a]
PFMC Ocean Recreational	MSF	barbless	14.0%	5.0%
	Non-Retention	N. Pt. Arena	14.0%[b]	5.0%[b]
	Non-Retention	S. Pt. Arena	23.0%[b]	5.0%[b]
PFMC Ocean T-Troll	Retention		n.a.[c]	5.0%
PFMC Ocean NT-Troll	MSF	barbless	26.0%	5.0%
Area 5, 6C Troll	Retention		n.a.	5.0%
Puget Sound Recreational	Retention		n.a.	5.0%
	MSF	barbless	7.0%	5.0%
WA Coastal Recreational	Retention		n.a.	5.0%
Buoy 10 Recreational	MSF	barbed	16.0%	5.0%
Gillnet and Setnet			n.a.	2.0%
PS Purse Seine			26.0%[b]	0.0%
PS Reef Net, Beach Seine, Round Haul			n.a.	n.a.
Freshwater Net			n.a.	2.0%
Freshwater Recreational	Retention		n.a.	5.0%
	Non-Retention		10.0%[b]	5.0%

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

[b] Rate assessed external to FRAM.

[c] None assessed.

Table 3-1b. FRAM/TAMM fishery-related mortality rates for chinook salmon used for Southern U.S. fisheries in 2003.

Fishery: designated by area, user group, and/or gear type	Fishery Type	Comments	"Shaker" Release Mortality	"Adult" Release Mortality	"Other" Mortality[a]
PFMC Ocean Recreational	Retention	N Point Arena	14.0%	n.a.[c]	5.0%
	Retention	S Point Arena	23.0%	n.a.	5.0%
PFMC Ocean Troll	Retention	barbless	25.5%	n.a.	5.0%
Area 5,6,7 T-Troll	Retention	barbed	30.0%	n.a.	5.0%
Puget Sound (PS) Recreational	Retention	barbless	20.0%	n.a.	5.0%
	MSF	barbless	20.0%	10.0%	5.0%
	Non-Retention	barbless	20.0%	10.0%	n.a.
Buoy 10 Recreational	not modeled within FRAM		n.a.	n.a.	n.a.
Commercial Net					
PS Areas 4B,5,6,6C	PT[d] GN, SN		n.a.	n.a.	3.0%
WA Coastal & Col R. Net	PT[d] GN, SN		n.a.	n.a.	3.0%
PS Areas 6A,7,7A	PT[d] GN, SN, Purse S		n.a.	n.a.	1.0%
NT PS Areas: 6B,9,12,12B,12C	PT[d] GN, SN, Purse S		n.a.	n.a.	1.0%
T PS Areas:7B,7C,7D	PT[d] GN, SN, Purse S		n.a.	n.a.	1.0%
All other PS marine net	Terminal GN, SN		n.a.	n.a.	2.0%
PS Purse Seine		immature	n.a.	45.0%[b]	0.0%
		mature	n.a.	33.0%[b]	0.0%
PS Reef Net, Beach Seine, Round Haul			n.a.	n.a.	n.a.
Freshwater Net			n.a.	n.a.	n.a.
Freshwater Recreational	Retention		n.a.	n.a.	n.a.
	MSF	TAMM	n.a.	10.0%[b]	n.a.
	Non-Retention	TAMM	n.a.	10.0%[b]	n.a.

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

[b] Rate assessed external to FRAM.

[c] None assessed.

[d] PT = Pre-terminal.

Table 3-2. Mark-selective fishery input values for Southern U.S. fisheries.

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

5. OUTPUT REPORTS AND MODEL USE

Model results are available as either standard FRAM printed output reports or in Excel spreadsheets that are linked to FRAM results/reports. The TAMM spreadsheets provide comprehensive summaries of fishery mortality, exploitation rate, run size, and escapement for key stocks in the PFMC and North of Falcon annual salmon season setting processes. Early versions of these spreadsheets focused on finer resolution of stocks and fisheries for Puget Sound terminal areas. The TAMM spreadsheets have now broadened in scope and contain information for both pre-terminal and terminal fisheries as well as FRAM fishery inputs for terminal fisheries in coastal Washington (coho) and in Puget Sound (both species). Other model results not shown in the spreadsheets can be generated directly from FRAM. These reports include summaries of catch by fishery, catch by stock, catch by age, and escapement/run size reports. A new report has been created for FRAM to provide more detailed information relative to mark-selective fisheries for chinook and coho. For a full scope of FRAM report generating functions, refer to "Users Manual for the Fishery Regulation Assessment Models (FRAM) for Chinook and Coho" (MEW *in prep*.).

6. COMPUTATIONAL STRUCTURE

For each time step and fishery, FRAM simulates fishery regulations following the sequence of computations depicted for coho (Figure 1) and chinook (Figure 2). The first step for both coho and chinook is to scale the predicted cohort size for the current year to the base period: this is done by stock for the January age-3 cohort for coho and for the age-2 through age-5 cohorts for chinook. Each stock's cohort is then processed through a time step loop defined for the species (five time steps for coho and four for chinook). Within the time step loop: (1) natural mortality is applied to the beginning cohort size; (2) the procedures to calculate projected catches for the all fisheries in the time step are executed; and (3) all fishery mortalities for the cohort (stock) are totaled and the remaining abundance of the stock is calculated.

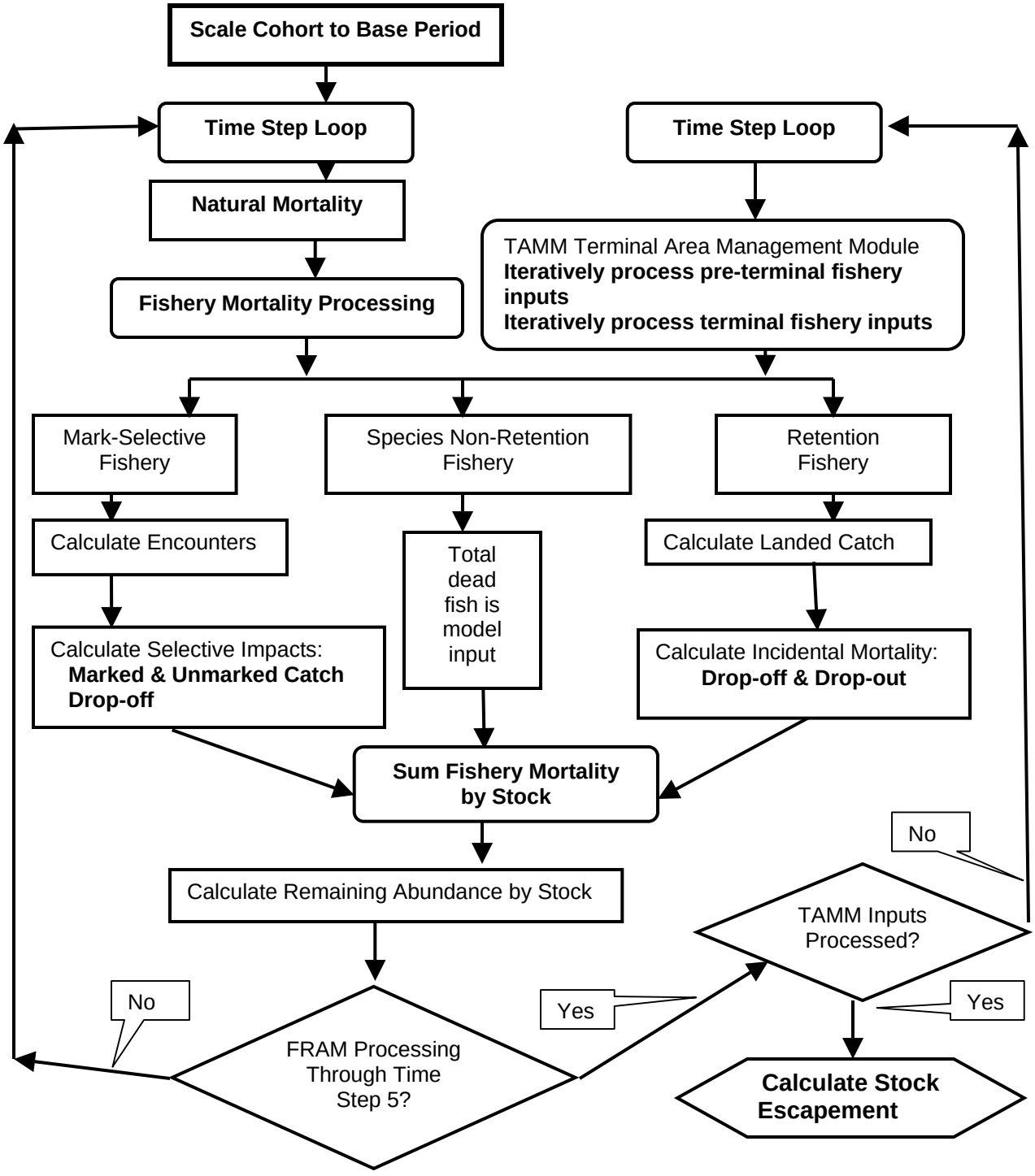

Figure 1. Flow chart for FRAM coho model.

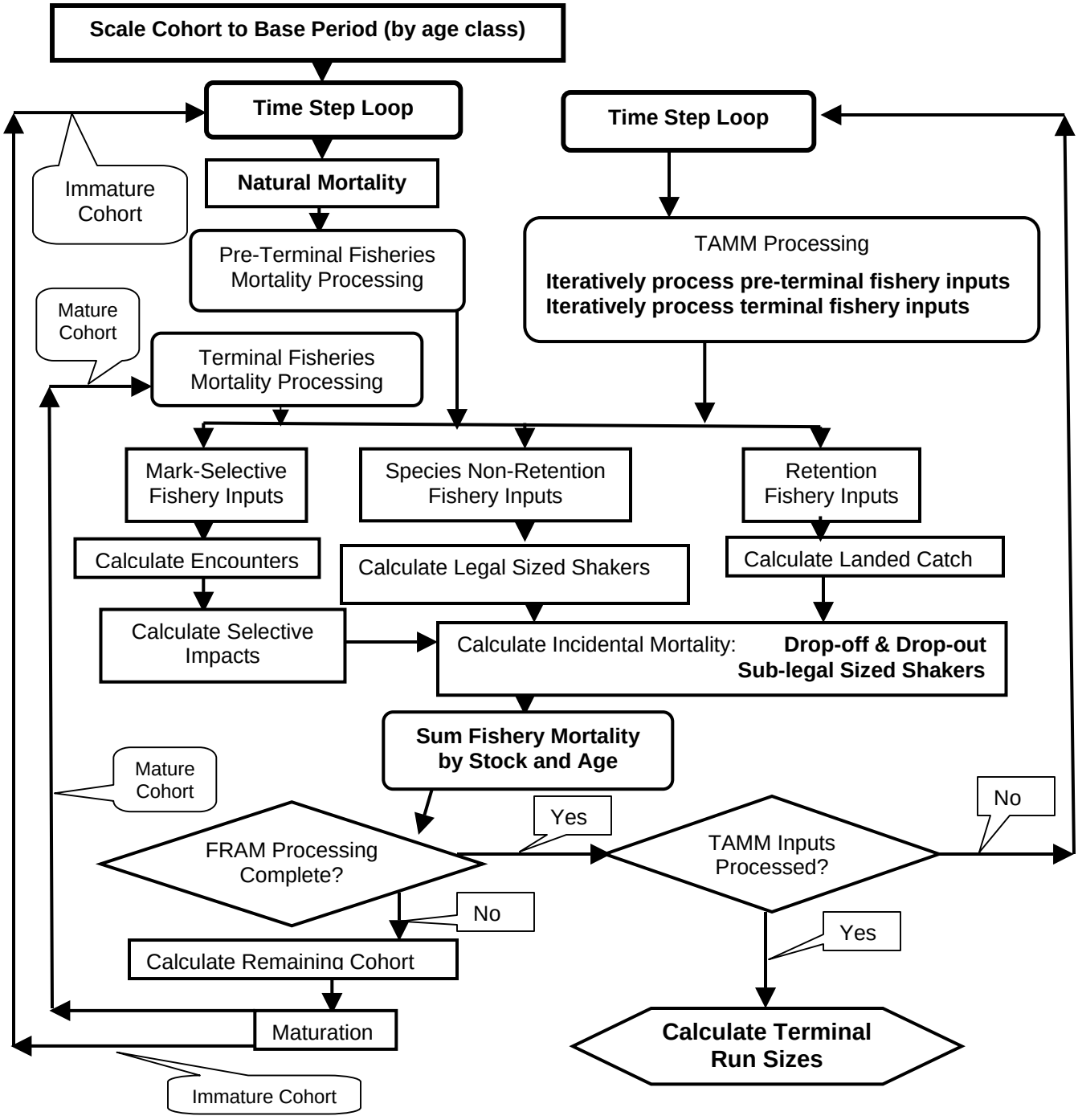

Figure 2. Flow chart for FRAM chinook model.

After FRAM has processed all steps in the time step loop, the program checks for the presence of an optional Terminal Area Management Module (TAMM). If the model user has not specified a TAMM input file for additional modeling, FRAM processing is complete and final terminal run sizes (chinook) or escapements (coho) are calculated. If a TAMM has been specified, then FRAM will repeat processing through the specified fisheries and time step loops. Although TAMMs are focused upon terminal area fisheries, some of these fisheries are in mixed-stock areas and may also impact both mature and immature chinook. Thus there exists an iterative FRAM/TAMM process to obtain the final tabulations of fishery mortalities and stock escapements (see Section 7 for further TAMM explanation).

6.1 Scale Cohort to Base Period

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

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

6.2 Natural Mortality

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

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

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

6.3 Catch

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

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

where:

$Catch_{s,a,f,t}$	=	Catch of stock *s*, age *a*, in fishery *f*, at time step *t;*
$BPER_{s,a,f,t}$	=	Base Period Exploitation Rate (harvest rate for terminal fisheries) for stock *s*, age *a*, in fishery *f*, at time step *t* (*BPER* is derived from cohort analysis using CWT release and recovery data);
$Cohort_{s,a,t}$	=	Number of fish in cohort (chinook are expressed as both immature and mature cohorts) for stock *s* at age *a* in time step *t*;

$PV_{s,a,t}$	=	Proportion of cohort for stock *s*, age *a*, vulnerable to the gear at time step *t* (for chinook *PV* is a function of a Von Bertalanffy growth curve; for coho *PV* is always = 1.0);
$FishScalar_{f,t}$	=	Impact scalar for fishery *f* at time step *t* relative to the base period; and
$SHRS_{s,f,t}$	=	Stock-specific exploitation rate scalar for stock *s*, in fishery *f*, at time step *t* (the default value of 1.0 is rarely changed).

The parameter $FishScalar_{f,t}$ is the foundation for the model's fishery simulation algorithms. FRAM can evaluate two general types of fisheries: (1) effort-based or (2) catch-based. For effort-based fisheries, the parameter $FishScalar_{f,t}$ is specified by the modeler to reflect expected effort relative to the average effort observed during the model's base period. For catch-based fisheries, $FishScalar_{f,t}$ is computed automatically so as to attain a specified catch level. If the catch level is to be modeled as a quota, then $FishScalar_{f,t}$ is computed as:

$$FishScalar_{f,t} = \frac{QuotaLevel_{f,t}}{\sum_{s}\sum_{a} Catch_{s,a,f,t} \;\; x \;\; (1/\, PropModelStock_{f})}$$

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

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

6.4 Incidental Mortality

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

Mortalities in species non-retention fisheries (CNR) are derived using four different methods for chinook and one for coho. Chinook non-retention mortalities are model estimates from inputs of: the level of open versus non-retention effort within each time step (Methods 1 and 2), legal and sub-legal encounters (Method 3), or from total encounters (Method 4). The method for coho is simply an external-to-the-model estimate of coho mortalities in a fishery based on historical observations. The methods were developed to fit the observations from various fisheries. Method 1 was developed for Canadian and Alaskan fisheries that had both open and non-retention regulation periods and had changes in the gear or fishing patterns to avoid chinook encounters.

METHOD 1 – Computed Mortalities

$$CNRLegal_{s,a,f,t} = Catch_{s,a,f,t} \; x \; \frac{1 - FishScaler_{f,t}}{FishScaler_{f,t}} \; x \; RelRate_{f,t} \; x \; LegalSelRate_{f,t}$$

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

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

$$EncRate_{f,t} = TotalSubLegPop_{f,t} / TotalLegPop_{f,t}$$

$$TotCatch_{f,t} = \sum_{s} \sum_{a} Catch_{s,a,f,t} \; x \; (1 / PropModelStock_{f})$$

$$CNRSub_{s,a,f,t} = TotCatch_{f,t} \; x \; EncRate_{f,t} \; x \; \frac{1 - FishScaler_{f,t}}{FishScaler_{f,t}} \; x \; RelRate_{f,t} \; x \; SubSelRate_{f,t} \; x \; PropSubPop_{s,a,f,t}$$

METHOD 2 – Ratio of Non-Retention to Retention Days

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

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

METHOD 3 – External Estimates of Legal and Sub-Legal Sized Encounters

$$LegalPropCatch_{s,a,f,t} = Catch_{s,a,f,t} / TotCatch_{f,t}$$

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

$$SubLegNR_{s,a,f,t} = SubLegPop_{s,a,t} \; x \; SubER_{s,a,f,t} \; x \; RelRate_{f,t}$$

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

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

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

METHOD 4 – External Estimate of Total Encounters

$$LegalPropCatch_{s,a,f,t} = Catch_{s,a,f,t} / TotCatch_{f,t}$$

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

$$SubLegEnc_{s,a,f,t} = SubER_{s,a,f,t} \; x \; SubLegPop_{s,a,t}$$

$$CNRScaler_{f,t} = \frac{TotalEstCNR_{f,t}}{\sum_s \sum_a LegalEnc_{s,a,f,t} + \sum_s \sum_a SubLegEnc_{s,a,f,t}}$$

$$CNRLegal_{s,a,f,t} = LegalEnc_{s,a,f,t} \; x \; CNRScaler_{f,t} \; x \; RelRate_{f,t}$$

$$CNRSub_{s,a,f,t} = SubLegEnc_{s,a,f,t} \; x \; CNRScaler_{f,t} \; x \; RelRate_{f,t}$$

METHOD 5 – Coho Non-Retention Mortalities from External Estimates

$$PropCatch_{s,f,t} = \frac{BPER_{s,f,t} \; x \; Cohort_{s,t} \; x \; SHRS_{s,f,t}}{\sum_s BPER_{s,f,t} \; x \; Cohort_{s,t} \; x \; SHRS_{s,f,t}}$$

$$CNR_{s,f,t} = EstCNRMorts_{f,t} \; x \; PropCatch_{s,f,t}$$

where $Cohort_{s,a,t}$, $Catch_{s,a,f,t}$, $FishScaler_{f,t}$, $PV_{s,a,t}$, $PropModelStock_f$, $BPER_{s,a,f,t}$, and $SHRS_{s,f,t}$, are previously defined and:

$CNRLegal_{s,a,f,t}$	=	Legal-sized adult non-retention mortality for stock *s*, age *a*, in fishery *f*, at time step *t*;
$RelRate_{f,t}$	=	Release mortality rate for fish in fishery *f* at time step *t*;
$LegalSelRate_{f,t}$	=	Legal-sized adult selectivity rate for fishery *f* in time step *t*, in response to changes in gear or fishing pattern (model input for Methods 1 and 2);
$TotalLegPop_{f,t}$	=	Total number of legal-sized fish from modeled stocks available to fishery *f* at time step *t*;
$TotalSubLegPop_{f,t}$	=	Total number of sub-legal sized fish from modeled stocks available to fishery *f* at time step *t*;
$EncRate_{f,t}$	=	For modeled stocks, the ratio of sub-legal sized chinook encountered for every legal-sized chinook in fishery *f* at time step *t*;
$TotCatch_{f,t}$	=	Total landed catch in fishery *f* at time step *t*;
$CNRSub_{s,a,f,t}$	=	Sub-legal sized non-retention mortality for stock *s*, age *a*, in fishery *f*, at time step *t*;
$SubSelRate_{f,t}$	=	Sub-legal sized selectivity rate for fishery *f* in time step *t*, in response to changes in gear or fishing pattern (model input for Methods 1 and 2);
$PropSubPop_{s,a,f,t}$	=	Proportion of sub-legal sized population for stock *s*, age *a*, in fishery *f*, at time step *t*;
$CNRDays_{f,t}$	=	Number of non-retention days in fishery *f*, at time step *t* (model input for Method 2);
$RetentDays_{f,t}$	=	Number of retention days in fishery *f* at time step *t* (model input for Method 2);

$Shakers_{s,a,f,t}$	=	Sub-legal shaker mortality for stock *s*, age *a*, in fishery *f*, at time step *t* (see following sub-section for method of calculation);
$LegalPropCatch_{s,a,f,t}$	=	Proportion of legal-sized catch for stock *s*, age *a*, in fishery *f*, at time step *t*;
$SubLegPop_{s,a,t}$	=	Sub-legal sized population for stock *s*, age *a*, at time step *t*;
$SubLegNR_{s,a,f,t}$	=	Sub-legal sized non-retention mortalities for stock *s*, age *a*, in fishery *f*, at time step *t*;
$SubER_{s,a,f,t}$	=	Sub-legal sized encounter rate for stock *s*, age *a*, in fishery *f*, at time step *t* calculated from base period data;
$SubLegPropEnc_{s,a,f,t}$	=	Sub-legal sized proportion of encounters for stock *s*, age *a*, in fishery *f*, at time step *t*;
$LegalEnc_{f,t}$	=	Total number of legal-sized encounters in fishery *f* at time step *t* (model input for Method 3);
$SubLegEnc_{f,t}$	=	Total number of sub-legal sized encounters in fishery *f* at time step *t* (model input for Method 3);
$LegalEnc_{s,a,f,t}$	=	Legal-sized encounters for stock *s*, age *a*, in fishery *f*, at time step *t*;
$SubLegEnc_{s,a,f,t}$	=	Sub-legal sized encounters for stock *s*, age *a*, in fishery *f*, at time step *t*;
$CNRScalar_{f,t}$	=	Non-retention scalar in fishery *f* at time step *t*;
$TotalEstCNR_{f,t}$	=	Total estimated non-retention (legal and sub-legal) in fishery *f* at time step *t* (model input for Method 4);
$PropCatch_{s,f,t}$	=	Proportion of coho catch for stock *s* in fishery *f* at time step *t*;
$EstCNRMorts_{f,t}$	=	Estimated coho non-retention mortalities in fishery *f* at time step *t* (model input for Method 5); and
$CNR_{s,f,t}$	=	Coho non-retention mortality for stock *s* in fishery *f*, at time step *t*.

Sub-legal shaker mortality is not estimated for coho since most minimum size limits - if they exist - apply to age 2 fish that are not represented in the model. The sub-legal and legal size encounters are stock and age specific and are calculated using Von Bertalanffy growth curves generated from CWT data. The calculations for sub-legal sized chinook (shakers) are shown below:

$$SubLegProp_{s,a,t} = 1 - PV_{s,a,t}$$

$$SubLegPop_{s,a,t} = Cohort_{s,a,t} \; x \; SubLegProp_{s,a,t}$$

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

where all components are defined previously and (1-$PV_{s,a,t}$) is the proportion of the cohort for stock *s*, age *a*, vulnerable to the gear at time step *t* (for chinook *PV* is function of Von Bertalanffy growth curve; for coho *PV* is always = 1).

6.5 Mark-Selective Fisheries

The implementation of mark-selective fishery regulations requires the use of more complex computations. Different equations are employed for marked and unmarked fish. The time-period specific forms of the equations utilized in Coho FRAM under non-selective and mark-selective fisheries are depicted in the following table. Computations for chinook mark-selective fisheries must account for sub-legal mortality, which does not differ between marked and unmarked components. The counterpart equations for chinook would contain the elements associated with sub-legal mortality, but due to the increased complexity this introduces the analogous equations for chinook are not presented here.

	Non-Selective Fisheries	Mark-Selective Fisheries	
	Discrete Equations	Marked Fish	Unmarked Fish
Landed mortalities	$C_{s,f} = ER_{s,f} \times N_{s,t}$	$C_{s,f} = ER_{s,f} \times N_{s,t} \times (1-mre_f)$	$C_{s,f} = ER_{s,f} \times N_{s,t} \times ure_f$
Release mortalities		$R_{s,f} = ER_{s,f} \times N_{s,t} \times mre_f \times rm_f$	$R_{s,f} = ER_{s,f} \times N_{s,t} \times (1-ure_f) \times rm_f$
Drop-off mortalities	$D_{s,f} = C_{s,f} \times dmr_f$	$D_{s,f} = ER_{s,f} \times N_{s,t} \times dmr_f$	$D_{s,f} = ER_{s,f} \times N_{s,t} \times dmr_f$

where:

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

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

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

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

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

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

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

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

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

6.6 Maturation (chinook only)

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

$$TermCohort_{s,a,t} = Cohort_{s,a,t} \times MatRate_{s,a,t}$$

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

6.7 Escapement

All chinook fisheries in FRAM are designated as pre-terminal or terminal in the base period data. The terminal fisheries only harvest fish from the mature cohort thus simulating a migration pattern from the pre-terminal mixed stock areas. Escapement is defined as any fish from the mature cohort that does not die from fishery-related mortality. For coho, fisheries during time steps 1 through 4 are on immature fish and by default all coho fisheries in time step five are on mature fish. In the current versions of the chinook and coho base periods, all maturation and escapement of a stock occurs within a single time step. The only exceptions are Skagit stocks of spring and summer/fall chinook and Columbia River summer chinook. The equations for chinook and coho are given below:

chinook:

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

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

coho:

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

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

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

6.8 Other Algorithms and Equations Used in the Model

Adult Equivalency (chinook only). Fishery-related mortality for chinook is expressed as a nominal value or adjusted for "Adult Equivalents" (AEQ) to account for the multiple ages that the fish mature and are vulnerable to fisheries. Fishery-related mortalities are expressed as adult equivalent mortalities so that all fishery mortalities can be expressed in a common unit of measure, which is the number of fish that would have matured (escaped to spawn) in the absence of fishing. The AEQ factors adjust for the natural mortality that would have occurred between the time/age the fish were caught and the time/age that they would have matured or escaped to spawn. The factors used in FRAM are calculated in the CWT base period calibration process and take into account fixed age-specific natural mortality rates and age and stock specific maturation rates which are calculated from CWT recoveries. Stock and age specific AEQ values

are expressed in terms of the expected contribution to the age-5, time step 3 fish, which is the oldest age-class at the final time step for mature fish. The AEQ value at the maximum age and final time-step is 1.0 and all other age/time-step values are a proportion of this value. Note that all age classes have an AEQ value of 1.0 in designated "terminal fisheries" (exploitation rates for chinook are usually expressed in terms of adult equivalent mortality). The AEQ factor is calculated as:

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

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

Proportion Modeled Stocks (for chinook only and calculated using base period data). The "model stock proportion" is a value unique to chinook and is the proportion of the total catch in a fishery that is accounted for by the modeled stocks. These proportion modeled stocks values are calculated during the chinook FRAM calibration process. They are fishery specific and remain constant through all time periods. The coho cohort analysis used to create the model base period exploitation rates include estimates for all stock production regions, thus the proportion modeled stock is assumed to always be 1.0.

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

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

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

chinook:

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

coho:

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

and Total Exploitation Rate is then estimated as:

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

where all components are defined previously.

7. TERMINAL AREA MANAGEMENT MODULE (TAMM)

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

Table 7-1. Puget Sound terminal management regions.

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

Historically, managers used TAMMs to analyze fishery impacts on individual population components of the larger FRAM stock groupings. The relatively new 1986-1991 coho base period now includes individual Puget Sound populations (61 stocks) at the management level of resolution. Similarly, the expanded Puget Sound coho fisheries are comprehensive; thus coho TAMM now serves more as a recipient of FRAM output for customized report generation. In contrast, chinook TAMM remains a critical element of pre-season Puget Sound modeling, as many populations of management focus need to be "extracted" from the aggregated FRAM stock groupings. Abundance levels of every Puget Sound chinook hatchery and natural population are entered into the TAMM, as are harvest impacts from all Puget Sound fisheries, to allow fishery-specific impact analyses on all the populations of interest.

The current chinook base period data (as in the older versions of the coho base period) aggregates terminal area fisheries for FRAM modeling at a higher level than used for management. Typically chinook FRAM has no individual area freshwater terminal sport fisheries or freshwater net fisheries. The chinook TAMM provides the ability to model the individual Puget Sound marine and freshwater net fisheries by smaller date increments associated with fisheries directed at chinook, pink, coho, chum, or steelhead. In addition, test fisheries and fisheries in sub-areas can be specified. Similarly, the ability to model individual Puget Sound freshwater sport fisheries is also provided. The appropriate chinook TAMM fishery impacts are summed into the terminal fishery definitions used by FRAM to calculate the FRAM fishery scalar inputs.

The TAMM fishery inputs, in addition to a fixed catch, allow for two fishery control mechanisms that are not used by FRAM. The control mechanisms (harvest rates) are percent of terminal area abundance (TAA) and percent of extreme terminal run size (ETRS). Each terminal area has specific rules for calculation of the TAA and ETRS values. Basically, the TAA rules include the escapement of all local area stocks and the terminal catch of all stocks. The ETRS rules include escapement and only the terminal catch of the local area stocks, but for a mixed-stock area an associated non-local stock catch is also calculated by FRAM as a base period proportion of total fishery catch. The derivation of these rules comes from the definitions used in the annual terminal run reconstruction for each of the species. Run reconstruction estimates are used in the calculation of modeling inputs for terminal area fishery impacts under the TAA and ETRS methods. The same run reconstructions may be used to develop in-season run size update models.

The TAA and ETRS methods create a problem for estimating the FRAM fishery scalars because the run size in each terminal region is dependent on the impacts from all the other regions. For example, a

decrease in Skagit terminal fisheries results in higher escapement for Nooksack and higher TAA and ETRS values. The fishery impacts in Nooksack terminal fisheries would then be calculated higher which lowers the original Skagit TAA and ETRS values.

An iterative process was developed to solve the problem of simultaneous equations between the terminal areas. The FRAM program reruns the terminal fishery time steps until the difference between the TAMM specified expected fishery impacts and FRAM estimates (calculated from base period exploitation rates) are within ±0.1% of the expected value or the difference is less than one fish. On each iteration the FRAM fishery scalars are adjusted by a proportion that is calculated as the expected value divided by the FRAM estimate for each terminal fishery.

As already discussed, the current FRAM coho base period data has much finer resolution of the terminal area fisheries than does the chinook base period. This is a result of the coho run reconstruction program RRTERM fishery definitions that were used to develop this coho base period data. The coho TAMM fishery definitions are the same as the FRAM terminal fisheries and thus allow direct input for effort base fishery scalars and quota values. An iterative process is still needed for the TAA and ETRS abundance based methods.

The TAMM spreadsheets are used to create most of the output reports needed by fishery managers during the pre-season fishery negotiation processes. This functionality was preserved in the current TAMM spreadsheets to ensure continuity and familiarity with the older versions of the program and to divide the duties and responsibilities for input and error checking during the intense management sessions.

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APPENDICES

Appendix 1. Chinook FRAM Stocks.

Unmarked Stock #	Stock Name	Abbreviated Name	CWT Broods Included*
1	Nooksack-Samish summer/fall	NkSm FlFi	77,79
3	North Fork Nooksack early (spring)	NFNK Sprg	OOB - 84,88 (N. Fk.)
5	South Fork Nooksack early (spring)	SFNK Sprg	OOB - 84,88 (N. Fk.)
7	Skagit summer/fall fingerling	Skag FlFi	76,77
9	Skagit summer/fall yearling	Skag FlYr	76
11	Skagit spring yearling	Skag SpYr	OOB - 85, 86, 87,90
13	Snohomish summer/fall fingerling	Snoh FlFi	OOB - 86, 87, 88
15	Snohomish summer/fall yearling	Snoh FlYr	76
17	Stillaguamish summer/fall fingerling	Stil FlFi	OOB - 86, 87, 88,89,90
19	Tulalip summer/fall fingerling	Tula FlFi	OOB - 86, 87, 88
21	Mid S. Puget Sound fall fingerling	USPS FlFi	78,79
23	UW Accelerated fall fingerling	UW-A FlFi	77-79
25	Deep S. Puget Sound fall fingerling	DSPS FlFi	78,79
27	South Puget Sound fall yearling	SPSo FlYr	78,79
29	White River spring fingerling	Whte SpFi	OOB – 91-93
31	Hood Canal fall fingerling	HdCl FlFi	78,79
33	Hood Canal fall yearling	HdCl FlYr	78,79
35	Juan de Fuca Tribs. fall fingerling	SJDF FlFi	78,79
37	Oregon Lower Columbia River Hatchery	Oregn LRH	78,79
39	Wash. Lower Columbia River Hatchery	Washn LRH	77,79
41	Lower Columbia River Wild	Low CR Wi	77-78
43	Bonneville Pool Hatchery tule	BP H Tule	76-79
45	Columbia Upriver summer	Upp CR Su	76,77
47	Columbia Upriver bright	Col R Brt	75-77
49	Washington Lower River spring	WaLR Sprg	77
51	Willamette spring	Will Sprg	76-78
53	Snake River fall	SnakeR Fl	OOB - 84, 85, 86
55	Oregon North Migrating fall	Ore No Fl	76-78
57	West Coast Vancouver Island Total	WCVI Totl	74-77
59	Fraser Late	Fraser Lt	OOB - 81,82,83
61	Fraser Early	Fraser Er	78,79; OOB -, 86
63	Lower Georgia Strait fall	Lwr Geo St	77,78
65	White River spring yearling	Whte SpYr	OOB – 91-93

*OOB = Out-of-base stock.

Appendix 2. Coho FRAM Stocks.

Production Region	Unmarked Stock #	Abbreviated Name	Coho Stock Name
NOOKSM	1	nkskrw	Nooksack River Wild
NOOKSM	3	kendlh	Kendall Creek Hatchery
NOOKSM	5	skokmh	Skookum Creek Hatchery
NOOKSM	7	lumpdh	Lummi Ponds Hatchery
NOOKSM	9	bhambh	Bellingham Bay Net Pens
NOOKSM	11	samshw	Samish River Wild
NOOKSM	13	ar77aw	Area 7/7A Independent Wild
NOOKSM	15	whatch	Whatcom Creek Hatchery
SKAGIT	17	skagtw	Skagit River Wild
SKAGIT	19	skagth	Skagit River Hatchery
SKAGIT	21	skgbkh	Baker (Skagit) Hatchery
SKAGIT	23	skgbkw	Baker (Skagit) Wild
SKAGIT	25	swinch	Swinomish Channel Hatchery
SKAGIT	27	oakhbh	Oak Harbor Net Pens
STILSN	29	stillw	Stillaguamish River Wild
STILSN	31	stillh	Stillaguamish River Hatchery
STILSN	33	tuliph	Tulalip Hatchery
STILSN	35	snohow	Snohomish River Wild
STILSN	37	snohoh	Snohomish River Hatchery
STILSN	39	ar8anh	Area 8A Net Pens
HOODCL	41	ptgamh	Port Gamble Net Pens
HOODCL	43	ptgamw	Port Gamble Bay Wild
HOODCL	45	ar12bw	Area 12/12B Wild
HOODCL	47	qlcnbh	Quilcene Hatchery
HOODCL	49	qlcenh	Quilcene Bay Net Pens
HOODCL	51	ar12aw	Area 12A Wild
HOODCL	53	hoodsh	Hoodsport Hatchery
HOODCL	55	ar12dw	Area 12C/12D Wild
HOODCL	57	gadamh	George Adams Hatchery
HOODCL	59	skokrw	Skokomish River Wild
SPGSND	61	ar13bw	Area 13B Misc. Wild
SPGSND	63	deschw	Deschutes R. (WA) Wild
SPGSND	65	ssdnph	South Puget Sound Net Pens
SPGSND	67	nisqlh	Nisqually River Hatchery
SPGSND	69	nisqlw	Nisqually River Wild
SPGSND	71	foxish	Fox Island Net Pens
SPGSND	73	mintch	Minter Creek Hatchery
SPGSND	75	ar13mw	Area 13 Miscellaneous Wild
SPGSND	77	chambh	Chambers Creek Hatchery

Appendix 2. Coho FRAM Stocks (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

Appendix 2. Coho FRAM Stocks (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 Hat.
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

Appendix 2. Coho FRAM Stocks (continued).

Production Region	Unmarked Stock #	Abbreviated Name	Coho Stock Name
THOMPR	233	thomph	Thompson River Hatchery
THOMPR	235	thompw	Thompson River Wild
BCCNTL	237	bccnhw	BC Central Coast Hat./Wild
BCNCST	239	bcnchw	BC North Coast Hatchery/Wild
QUEENC	241	quenhw	Queen Charlotte Is. Hat/Wild
NASSRV	243	nasshw	Nass River Hatchery/Wild
SKEENA	245	skeehw	Skeena River Hatchery/Wild
TRANAC	247	tranhw	Trans Boundary Hatchery/Wild
NIASKA	249	niakhw	Alaska No. Inside Hat./Wild
NOASKA	251	noakhw	Alaska No. Outside Hat./Wild
SIASKA	253	siakhw	Alaska So. Inside Hat./Wild
SOASKA	255	soakhw	Alaska So. Outside Hat./Wild

Appendix 3. Chinook FRAM Fisheries.

#	Fishery Name	#	Fishery Name
1	Southeast Alaska Troll	38	T San Juan Net (Area 6A,7,7A)
2	Southeast Alaska Net	39	NT Nooksack-Samish Net
3	Southeast Alaska Sport	40	T Nooksack-Samish Net
4	North/Central British Columbia Net	41	T Juan de Fuca Troll (Area 5,6,7)
5	West Coast Vancouver Island Net	42	Area 5/6 Sport
6	Strait of Georgia Net	43	NT Juan de Fuca Net (Area 4B,5,6,6C)
7	Canada Juan de Fuca Net (Area 20)	44	T Juan de Fuca Net (Area 4B,5,6,6C)
8	North/Central British Columbia Sport	45	Area 8 Sport [a]
9	North/Central British Columbia Troll	46	NT Skagit Net (Area 8)
10	West Coast Vancouver Island Troll	47	T Skagit Net (Area 8)
11	West Coast Vancouver Island Sport	48	Area 8D Sport
12	Strait of Georgia Troll	49	NT Stilly-Snohomish Net (Area 8A)
13	North Strait of Georgia Sport	50	T Stilly-Snohomish Net (Area 8A)
14	South Strait of Georgia Sport	51	NT Tulalip Bay Net (Area 8D)
15	BC Juan de Fuca Sport	52	T Tulalip Bay Net (Area 8D)
16	NT Cape Flattery-Quillayute Troll (Area 3-4)	53	Area 9 Sport
17	T Cape Flattery-Quillayute Troll (Area 3-4)	54	NT Area 6B/9 Net
18	Cape Flattery-Quillayute Sport (Area 3-4)	55	T Area 6B/9 Net
19	Cape Flattery-Quillayute Net (Area 3-4)	56	Area 10 Sport
20	NT Grays Harbor Troll (Area 2)	57	Area 11 Sport
21	T Grays Harbor Troll (Area 2)	58	NT Area 10/11 Net
22	Grays Harbor Sport (Area 2)	59	T Area 10/11 Net
23	NT Grays Harbor Net	60	NT Area 10A Net
24	T Grays Harbor Net	61	T Area 10A Net
25	Willapa Net	62	NT Area 10E Net
26	NT Columbia River Troll (Area 1)	63	T Area 10E Net
27	Columbia River Sport (Area 1)	64	Area 12 Sport
28	Columbia River Net	65	NT Hood Canal Net (Area 12,12B,12C)
29	Buoy 10 Sport	66	T Hood Canal Net (Area 12,12B,12C)
30	Orford Reef-Cape Falcon Troll (Central OR)	67	Area 13 Sport
31	Orford Reef-Cape Falcon Sport (Central OR)	68	NT Deep S. Puget Sound Net (13,13D-K)
32	Horse Mountain-Orford Reef Troll (KMZ)	69	T Deep S. Puget Sound Net (13,13D-K)
33	Horse Mountain-Orford Reef Sport (KMZ)	70	NT Area 13A Net
34	Southern California Troll	71	T Area 13A Net
35	Southern California Sport	72	Freshwater Sport
36	Area 7 Sport	73	Freshwater Net [b]
37	NT San Juan Net (Area 6A,7,7A)		

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

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

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

Appendix 4. Coho FRAM Fisheries.

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
No Cal Trm	1	North California Coast Terminal Catch
Cn Cal Trm	2	Central California Coast Terminal Catch
Ft Brg Spt	3	Fort Bragg Sport
Ft Brg Trl	4	Fort Bragg Troll
Ca KMZ Spt	5	KMZ Sport (Klamath Management Zone)
Ca KMZ Trl	6	KMZ Troll (Klamath Management Zone)
So Cal Spt	7	Southern California Sport
So Cal Trl	8	Southern California Troll
So Ore Trm	9	South Oregon Coast Terminal Catch
Or Prv Trm	10	Oregon Private Hatchery Terminal Catch
SMi Or Trm	11	South-Mid Oregon Coast Terminal Catch
NMi Or Trm	12	North-Mid Oregon Coast Terminal Catch
No Ore Trm	13	North Oregon Coast Terminal Catch
Or Cst Trm	14	Mid-North Oregon Coast Terminal Catch
Brkngs Spt	15	Brookings Sport
Brkngs Trl	16	Brookings Troll
Newprt Spt	17	Newport Sport
Newprt Trl	18	Newport Troll
Coos B Spt	19	Coos Bay Sport
Coos B Trl	20	Coos Bay Troll
Tillmk Spt	21	Tillamook Sport
Tillmk Trl	22	Tillamook Troll
Buoy10 Spt	23	Buoy 10 Sport (Columbia River Estuary)
L ColR Spt	24	Lower Columbia River Mainstem Sport
L ColR Net	25	Lower Columbia River Net (Excl Youngs Bay)
Yngs B Net	26	Youngs Bay Net
LCROrT Spt	27	Below Bonneville Oregon Tributary Sport
Clackm Spt	28	Clackamas River Sport
SandyR Spt	29	Sandy River Sport
LCRWaT Spt	30	Below Bonneville Washington Tributary Sport
UpColR Spt	31	Above Bonneville Sport
UpColR Net	32	Above Bonneville Net
A1-Ast Spt	33	Area 1 (Illwaco) & Astoria Sport
A1-Ast Trl	34	Area 1 (Illwaco) & Astoria Troll
Area2TrlNT	35	Area 2 Troll Non-treaty (Westport)
Area2TrlTR	36	Area 2 Troll Treaty (Westport)
Area 2 Spt	37	Area 2 Sport (Westport)
Area3TrlNT	38	Area 3 Troll Non-treaty (LaPush)
Area3TrlTR	39	Area 3 Troll Treaty (LaPush)

Appendix 4. Coho FRAM Fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
Area 3 Spt	40	Area 3 Sport (LaPush)
Area 4 Spt	41	Area 4 Sport (Neah Bay)
A4/4BTrlNT	42	Area 4/4B (Neah Bay PFMC Regs) Troll Non-treaty
A4/4BTrlTR	43	Area 4/4B (Neah Bay PFMC Regs) Troll Treaty
A 5-6C Trl	44	Area 5, 6, 6C Troll (Strait of Juan de Fuca)
Willpa Spt	45	Willapa Bay (Area 2.1) Sport
Wlp Tb Spt	46	Willapa Tributary Sport
WlpaBT Net	47	Willapa Bay & FW Trib Net
GryHbr Spt	48	Grays Harbor (Area 2.2) Sport
SGryHb Spt	49	South Grays Harbor Sport (Westport Boat Basin)
GryHbr Net	50	Grays Harbor Estuary Net
Hump R Spt	51	Humptulips River Sport
LwCheh Net	52	Lower Chehalis River Net
Hump R C&S	53	Humptulips River Ceremonial & Subsistence
Chehal Spt	54	Chehalis River Sport
Hump R Net	55	Humptulips River Net
UpCheh Net	56	Upper Chehalis River Net
Chehal C&S	57	Chehalis River Ceremonial & Subsistence
Wynoch Spt	58	Wynochee River Sport
Hoquam Spt	59	Hoquiam River Sport
Wishkh Spt	60	Wishkah River Sport
Satsop Spt	61	Satsop River Sport
Quin R Spt	62	Quinault River Sport
Quin R Net	63	Quinault River Net
Quin R C&S	64	Quinault River Ceremonial & Subsistence
Queets Spt	65	Queets River Sport
Clrwtr Spt	66	Clearwater River Sport
Salm R Spt	67	Salmon River (Queets) Sport
Queets Net	68	Queets River Net
Queets C&S	69	Queets River Ceremonial & Subsistence
Quilly Spt	70	Quillayute River Sport
Quilly Net	71	Quillayute River Net
Quilly C&S	72	Quillayute River Ceremonial & Subsistence
Hoh R Spt	73	Hoh River Sport
Hoh R Net	74	Hoh River Net
Hoh R C&S	75	Hoh River Ceremonial & Subsistence
Mak FW Spt	76	Makah Tributary Sport
Mak FW Net	77	Makah Freshwater Net
Makah C&S	78	Makah Ceremonial & Subsistence

Appendix 4. Coho FRAM Fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
A 4-4A Net	79	Area 4, 4A Net (Neah Bay)
A4B6CNetNT	80	Area 4B, 5, 6C Net Nontreaty (Strait of Juan de Fuca)
A4B6CNetTR	81	Area 4B, 5, 6C Net Treaty (Strait of Juan de Fuca)
Ar6D NetNT	82	Area 6D Dungeness Bay/River Net Nontreaty
Ar6D NetTR	83	Area 6D Dungeness Bay/River Net Treaty
Elwha Net	84	Elwha River Net
WJDF T Net	85	West Juan de Fuca Straits Tributary Net
EJDF T Net	86	East Juan de Fuca Straits Tributary Net
A6-7ANetNT	87	Area 7, 7A Net Nontreaty (San Juan Islands)
A6-7ANetTR	88	Area 7, 7A Net Treaty (San Juan Islands)
EJDF FWSpt	89	East Juan de Fuca Straits Tributary Sport
WJDF FWSpt	90	West Juan de Fuca Straits Tributary Sport
Area 5 Spt	91	Area 5 Marine Sport (Sekiu)
Area 6 Spt	92	Area 6 Marine Sport (Port Angeles)
Area 7 Spt	93	Area 7 Marine Sport (San Juan Islands)
Dung R Spt	94	Dungeness River Sport
ElwhaR Spt	95	Elwha River Sport
A7BCDNetNT	96	Area 7B-7C-7D Net Nontreaty (Bellingham Bay)
A7BCDNetTR	97	Area 7B-7C-7D Net Treaty (Bellingham Bay)
Nook R Net	98	Nooksack River Net
Nook R Spt	99	Nooksack River Sport
Samh R Spt	100	Samish River Sport
Ar 8 NetNT	101	Area 8 Skagit Marine Net Nontreaty
Ar 8 NetTR	102	Area 8 Skagit Marine Net Treaty
Skag R Net	103	Skagit River Net
SkgR TsNet	104	Skagit River Test Net
SwinCh Net	105	Swinomish Channel Net
Ar 8-1 Spt	106	Area 8.1 Marine Sport
Area 9 Spt	107	Area 9 Marine Sport (Admiralty Inlet)
Skag R Spt	108	Skagit River Sport
Ar8A NetNT	109	Area 8A Stillaguamish/Snohomish Net Nontreaty
Ar8A NetTR	110	Area 8A Stillaguamish/Snohomish Net Treaty
Ar8D NetNT	111	Area 8D Tulalip Bay Net Nontreaty
Ar8D NetTR	112	Area 8D Tulalip Bay Net Treaty
Stil R Net	113	Stillaguamish River Net
Snoh R Net	114	Snohomish River Net
Ar 8-2 Spt	115	Area 8.2 Marine Sport
Stil R Spt	116	Stillaguamish River Sport
Snoh R Spt	117	Snohomish River Sport

Appendix 4. Coho FRAM Fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
Ar 10 Spt	118	Area 10 Marine Sport (Seattle)
Ar10 NetNT	119	Area 10 Net Nontreaty (Seattle)
Ar10 NetTR	120	Area 10 Net Treaty (Seattle)
Ar10ANetNT	121	Area 10A Net Nontreaty (Elliott Bay)
Ar10ANetTR	122	Area 10A Net Treaty (Elliott Bay)
Ar10ENetNT	123	Area 10E Net Nontreaty (East Kitsap)
Ar10EnetTR	124	Area 10E Net Treaty (East Kitsap)
10F-G Net	125	Area 10F-G Ship Canal/Lake Washington Net Treaty
Duwm R Net	126	Green/Duwamish River Net
Duwm R Spt	127	Green/Duwamish River Sport
L WaSm Spt	128	Lake Washington-Lake Sammamish Tributary Sport
Ar 11 Spt	129	Area 11 Marine Sport (Tacoma)
Ar11 NetNT	130	Area 11 Net Nontreaty (Tacoma)
Ar11 NetTR	131	Area 11 Net Treaty (Tacoma)
Ar11ANetNT	132	Area 11A Net Nontreaty (Commencement Bay)
Ar11ANetTR	133	Area 11A Net Treaty (Commencement Bay)
Puyl R Net	134	Puyallup River Net
Puyl R Spt	135	Puyallup River Sport
Ar 13 Spt	136	Area 13 Marine Sport (South Puget Sound)
Ar13 NetNT	137	Area 13 Net Nontreaty (South Puget Sound)
Ar13 NetTR	138	Area 13 Net Treaty (South Puget Sound)
Ar13CNetNT	139	Area 13C Net Nontreaty (Chambers Bay)
Ar13CNetTR	140	Area 13C Net Treaty (Chambers Bay)
Ar13ANetNT	141	Area 13A Net Nontreaty (Carr Inlet)
Ar13ANetTR	142	Area 13A Net Treaty (Carr Inlet)
Ar13DNetNT	143	Area 13D Net Nontreaty (South Puget Sound)
Ar13DNetTR	144	Area 13D Net Treaty (South Puget Sound)
A13FKNetNT	145	Area 13F-13K Net Nontreaty (South PS Inlets)
A13FKNetTR	146	Area 13F-13K Net Treaty (South PS Inlets)
Nisq R Net	147	Nisqually River Net
McAlls Net	148	McAllister Creek Net
13D-K TSpt	149	13D-13K Tributary Sport (South PS Inlets)
Nisq R Spt	150	Nisqually River Sport
Desc R Spt	151	Deschutes River Sport (Olympia)
Ar 12 Spt	152	Area 12 Marine Sport (Hood Canal)
1212BNetNT	153	Area 12-12B Net Nontreaty (Upper Hood Canal)
1212BNetTR	154	Area 12-12B Net Treaty (Upper Hood Canal)
Ar9A NetNT	155	Area 9A Net Nontreaty (Port Gamble)
Ar9A NetTR	156	Area 9-9A Net Treaty (Port Gamble/On Reservation)

Appendix 4. Coho FRAM Fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
Ar12ANetNT	157	12A Net Nontreaty (Quilcene Bay)
Ar12ANetTR	158	12A Net Treaty (Quilcene Bay)
A12CDNetNT	159	12C-12D Net Nontreaty (Lower Hood Canal)
A12CDNetTR	160	12C-12D Net Treaty (Lower Hood Canal)
Skok R Net	161	Skokomish River Net
Quilcn Net	162	Quilcene River Net
1212B TSpt	163	12-12B Tributary FW Sport
Quilcn Spt	164	12A Tributary FW Sport (Quilcene River)
12C-D TSpt	165	12C-12D Tributary FW Sport
Skok R Spt	166	Skokomish River Sport
GSMLND Trm	167	Georgia Strait Mainland Terminal Catch
GSVNCI Trm	168	Georgia Strait Vancouver Island Terminal Catch
JNSTRT Trm	169	Johnstone Strait Terminal Catch
SWVNCI Trm	170	SW Vancouver Island Terminal Catch
NWVNCI Trm	171	NW Vancouver Island Terminal Catch
FRSLOW Trm	172	Lower Fraser River Terminal Catch
FRSUPP Trm	173	Upper Fraser River Terminal Catch
THOMPR Trm	174	Thompson River Terminal Catch
No BC Trl	175	Northern British Columbia Troll
NoC BC Trl	176	North Central British Columbia Troll
SoC BC Trl	177	South Central British Columbia Troll
NW VI Trl	178	NW Vancouver Island Troll
SW VI Trl	179	SW Vancouver Island Troll
GeoStr Trl	180	Georgia Straits Troll
BC JDF Trl	181	British Columbia Juan de Fuca Troll
No BC Net	182	Northern British Columbia Net
Cen BC Net	183	Central British Columbia Net
NW VI Net	184	NW Vancouver Island Net
SW VI Net	185	SW Vancouver Island Net
Johnst Net	186	Johnstone Straits Net
GeoStr Net	187	Georgia Straits Net
Fraser Net	188	Fraser River Gill Net
BC JDF Net	189	British Columbia Juan de Fuca Net
No BC Spt	190	Northern British Columbia Sport
Cen BC Spt	191	Central British Columbia Sport
BC JDF Spt	192	British Columbia Juan de Fuca Sport
WC VI Spt	193	West Coast Vancouver Island Sport
NGaStr Spt	194	North Georgia Straits Sport
SGaStr Spt	195	South Georgia Straits Sport

Appendix 4. Coho FRAM Fisheries (continued).

Fishery Abbreviation	Fishery Number	Coho FRAM Fishery Long Name
Albern Spt	196	Alberni Canal Sport
BCCNTL TTR	197	BCCNTL Terminal Run (Catch + Escapement)
BCNCST TTR	198	BCNCST Terminal Run (Catch + Escapement)
QUEENC TTR	199	QUEENC Terminal Run (Catch + Escapement)
NASSRV TTR	200	NASSRV Terminal Run (Catch + Escapement)
SKEENA TTR	201	SKEENA Terminal Run (Catch + Escapement)
SW AK Trl	202	Southwest Alaska Troll
SE AK Trl	203	Southeast Alaska Troll
NW AK Trl	204	Northwest Alaska Troll
NE AK Trl	205	Northeast Alaska Troll
Alaska Net	206	Alaska Net (Areas 182:183:185:192)

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

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

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

Appendix 6. Glossary.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Management System Evaluation - An evaluation of how well the model predicts variables of interest (e.g., terminal runs, catch by stock, and stock composition) when pre-season estimates of abundance and fishery catches are used as input data.

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

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

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

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

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

Pre-terminal - In FRAM, a “pre-terminal” fishery is one that operates on both mature and immature fish.

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

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

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

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

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

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