

FINAL PROJECT REPORT
UPDATE COHO FRAM BASE PERIOD FOR MARK-SELECTIVE
FISHING YEARS (1998-2009), YEAR 2: PHASE II
(USFWS COMPONENT)

Prepared for the PSC Southern Boundary Restoration and Enhancement Fund

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ABSTRACT

The Fishery Regulation Assessment Model (FRAM) is currently used by the Pacific Salmon Commission to annually estimate impacts of fisheries on Coho Salmon (*Oncorhynchus kisutch*) stocks. The model uses a base period average of coded-wire-tag (CWT) cohort analyses from selected years to scale stock abundance forecasts and expected fishery seasons for the current year. This method has the primary assumption that stock distribution remains the same each year and changes in fishery stock composition are a result of changes in relative stock abundances. The ability to test this assumption or to make changes in the model base period to reflect changes in stock distribution due to different oceanic conditions require continuing analysis of CWT recovery data.

Currently, cohort analyses have been completed for catch years 1986-1997. Analyses of more recent years are needed as recent stock abundances and fishery exploitation have dramatically changed from the base period. These changes include the implementation of mark-selective fisheries. The USFWS received support from the PSC Southern Boundary Restoration and Enhancement Fund (Year I, Phase I) to assist in the cohort analyses of catch years 1998-2009. In 2011, all available Coho CWT release data from brood years 1995-2006 and recovery data for 1998-2009 were downloaded, summarized, and reviewed for inclusion in the analyses. The data was then input into the new FRAM cohort database and initial (draft) production expansion factors were made for each stock.

The USFWS received further support from the PSC Southern Boundary Restoration and Enhancement Fund to continue the cohort analyses of catch years 1998-2009. Steps completed (by all parties involved) in reconstructing the cohorts include the gathering of catch and escapements, analyses of individual tag code groups for management units of concern, development of draft Canadian terminal area management modules, and more robust production expansion factors. Initial terminal area run reconstructions were also developed. Tasks completed by the USFWS in support of a base period expansion include further review of CWT groups to include in the base period, a review of recent tagging levels of all US Coho stocks, estimates of exploitation rates by individual stock, and summary tables and figures in support of the project. In addition, preliminary results were reviewed by the regional biologists, and review and validation of the exploitation rate estimates by PSC Coho Technical Committee members has begun. Next steps in the coast-wide Coho cohort reconstruction project include further review by the Pacific Fisheries Management Council Model Evaluation Workgroup. Once these assessments are complete, these most recent catch years with mark-selective fisheries will be available for use in the FRAM base period.

INTRODUCTION

The Coho Fisheries Regulation Assessment Model (Coho FRAM) has been bilaterally developed under the PST Coho Agreement (PSC 2009) and is employed for both pre-season fishery planning and post-season exploitation rate estimates (Packer et al. 2005). The FRAM is a discrete, time-step, age-structured, deterministic computer model used to predict the impacts from a variety of proposed fishery regulation mechanisms for a single management year (PFMC 2007). 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.

The Coho FRAM evaluates impacts on a comprehensive set of stocks originating from Central California to Southeast Alaska and is considered to represent total West Coast production. Expectations for southern Coho Salmon (*Oncorhynchus kisutch*) Management Unit status, cohort abundance, and fishery objectives are exchanged in March of each year for use in pre-season planning processes. In order to evaluate the impacts of proposed fishery regulations, the Coho FRAM uses base period data on stock-specific ocean distribution by fishery and time period (January to June, July, August, September, and October to December). The FRAM produces a variety of output reports that are used to examine the impacts of the proposed fisheries for compliance with management objectives, allocation arrangements, ESA compliance, and domestic and international legal obligations.

Base period distributions are developed from coded-wire-tag (CWT) recoveries in coastwide fisheries. The current FRAM base period includes catch years 1986-1992 (PSC 2009). Stock status and exploitation rates, and possibly exploitation patterns, have changed from this base period and the addition of more recent catch years in the base period is needed to improve future fishery management. To date, coded-wire-tag-based cohort reconstructions of catch years 1986-1997 have been completed to assess fishery impacts to stocks and for possible inclusion in the FRAM base period. Cohort analyses have not been completed for the most recent catch years (1998-2009) containing mark-selective fisheries. These analyses are needed to accurately assess fisheries under the current Pacific Salmon Treaty's abundance-based management regime for southern Coho Management Units. PSC Southern Funds recently supported the development by WDFW of an updated suite of FRAM programs necessary to complete these cohort reconstructions (Packer 2011). Funds were also provided to five other agencies to assist with the cohort analyses of these more recent catch years. The USFWS received support from the PSC Southern Boundary Restoration and Enhancement Fund (Year I, Phase I) to assist in the cohort analyses of catch years 1998-2009. The USFWS received further support (Phase II) from the PSC Southern Boundary Restoration and Enhancement Fund to continue the cohort analyses of catch years 1998-2009. This report describes the activities completed by the USFWS with Phase II funds in support of the Coho cohort reconstructions of catch years 1998-2009.

METHODS

FRAM Base Period – Background Information

The current FRAM 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. This base period is generated by averaging estimates of available analyses of catch years with sufficient data.

Cohort analyses are done in a two-step process which combines terminal area run size and escapement data with mixed stock fishery estimates from non-terminal marine areas. The terminal area estimates are made using the RRTERM computer program and the mixed-stock estimates are made using the Mixed Stock Model (MSM). The cohort analyses previously completed for the 1986-1997 catch years were when no mark-selective fisheries (MSFs) were present. The ability to complete the more recent years of CWT cohort analyses required that both of these computer programs be re-written to account for the differing effect of MSF on marked and unmarked components of each stock. In 2010 and 2011, PSC Southern Funds supported the development by WDFW of an updated suite of FRAM programs necessary to complete cohort reconstructions of more recent years (Packer 2011). The RRTERM program was modified to include inputting and processing all the catch and escapement input into marked and unmarked components. Other changes include differential CWT representation of marked and unmarked stock components and stock-strength calculations for all stocks. Changes to the MSM program were similar to the RRTERM program where marked and unmarked components are estimated separately because of the effect of differing MSF mortalities.

The basic concept of the MSM program is to estimate production expansion factors (PEFs) for representative CWT release groups that characterize a regional aggregation of stocks or production region. This means that all the stocks within a production region are represented by the MSM estimated PEF value, including both marked and unmarked components. A production region is typically a major watershed drainage including the nearby terminal marine catch areas. The stock components of a production region are the same as used in the FRAM and MSM programs.

Assessment of Data for Catch Years 1998-2009

Phase I

For catch years 1998 to 2009, all Coho CWT release and recovery records and catch/sample data were downloaded from the Pacific States Marine Fishery Council Regional Mark Information System (RMIS) (RMISD 2013). The data was then stored in a Microsoft Access database where custom queries were developed to analyze the data. CWT data were grouped by MSM stock, brood year, and catch year and were considered for inclusion in the coastwide cohort

reconstruction. Assessments included release sizes, survival and recovery rates, and differences in tag recovery patterns and rates amongst tag groups from a single MSM stock. Tag groups were removed from the cohort reconstruction for a variety of reasons, including fish diseases, early release (fry releases), out-of-basin transfers, extreme lack of recoveries, and special studies. The CWT groups and associated recovery assessments were then compiled by major region and sent to regional biologists for their input and approval. Upon review by the regional biologists, the CWT groups were input in the updated FRAM database for inclusion in the next step of the cohort analyses, the MSM.

The new FRAM program allows for all of the input and calculated output values to be stored and referenced in the database using a “RunID” variable that uniquely identifies each run (catch year). This indexing system allows for multiple years and multiple runs within a year to be stored in the same database, thus making cohort evaluations much more streamlined. The MSM database of the FRAM program houses the CWT release, recovery, and catch tables. The release data were input into the “MSM_Stock_CWT” table that describes the model stock for each brood year. The table also contains the hatchery, stock, and release site names for the associated CWT code. Each stock is typically and preferably associated with multiple CWT release codes. There are also 12 tables for CWT recoveries and 12 tables of Catch/Sample data. Each table is specific to a catch year from 1998 to 2009. The MSM program then analyzes patterns in CWT recovery data by stock to estimate a PEF for each stock.

Phase II

CWT groups identified earlier to include in the base period were further reviewed to determine if they should be removed. Due to previous summaries of tag recoveries (see method section), a review of recent tagging levels of all US Coho stocks was made (Appendix A). In addition, estimates of exploitation rates by individual stocks and summary tables and figures were developed in support of the project. Preliminary results were presented to co-managers and at various meetings. Review and validation of the exploitation rate estimates by the PSC Joint Coho Technical Committee members has begun.

RESULTS

Phase I

A total of 12 years of catch/sample data and CWT release and recovery data were downloaded from RMIS (Figures 1 and 2). The catch/sample data and recovery data were mapped to 189 FRAM fisheries and uploaded into the new FRAM database. Approximately 2,200 catch/sample records were available for each catch year. Recovery data was more variable from year to year, with a high of 131,792 records in 2001 to a low of 50,236 in 2009. Release data assessed for inclusion in the model ranged from 1.8 to 2.8 million total coded-wire-tagged Coho releases per year (Figure 3). Preliminary estimates of production expansion factors and very preliminary exploitation rate estimates have been made.

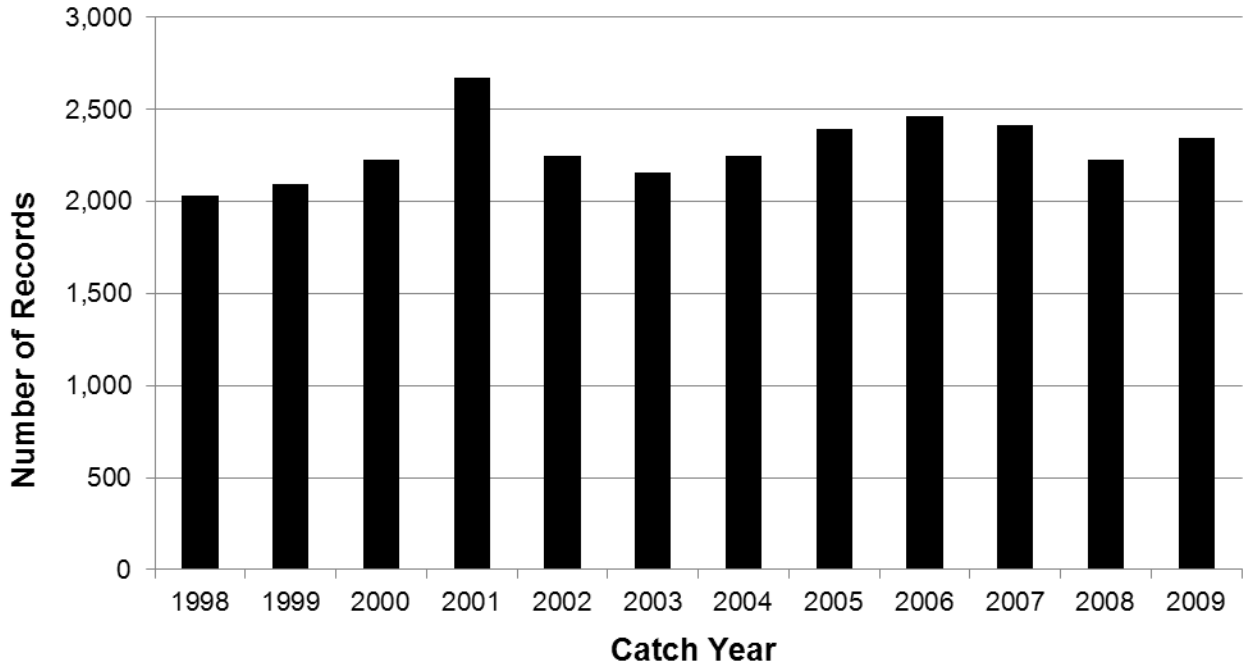


Figure 1. Total number of catch/sample records input into the new FRAM database.

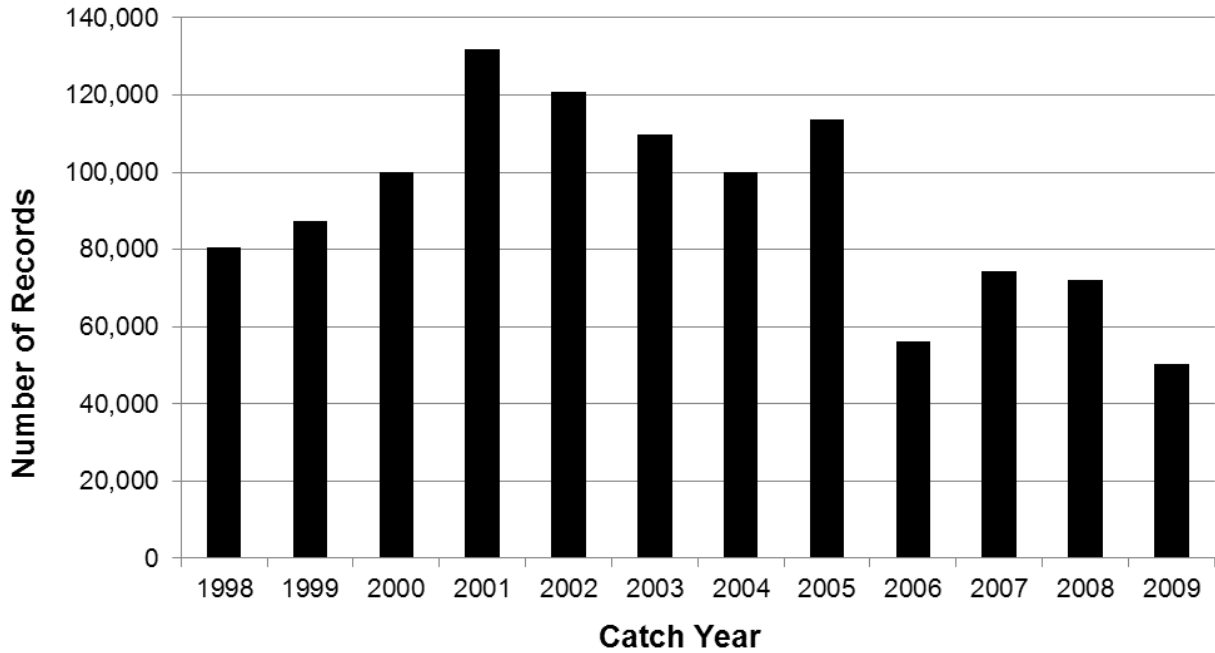


Figure 2. Total number of coded-wire-tag recovery records input into the new FRAM database.

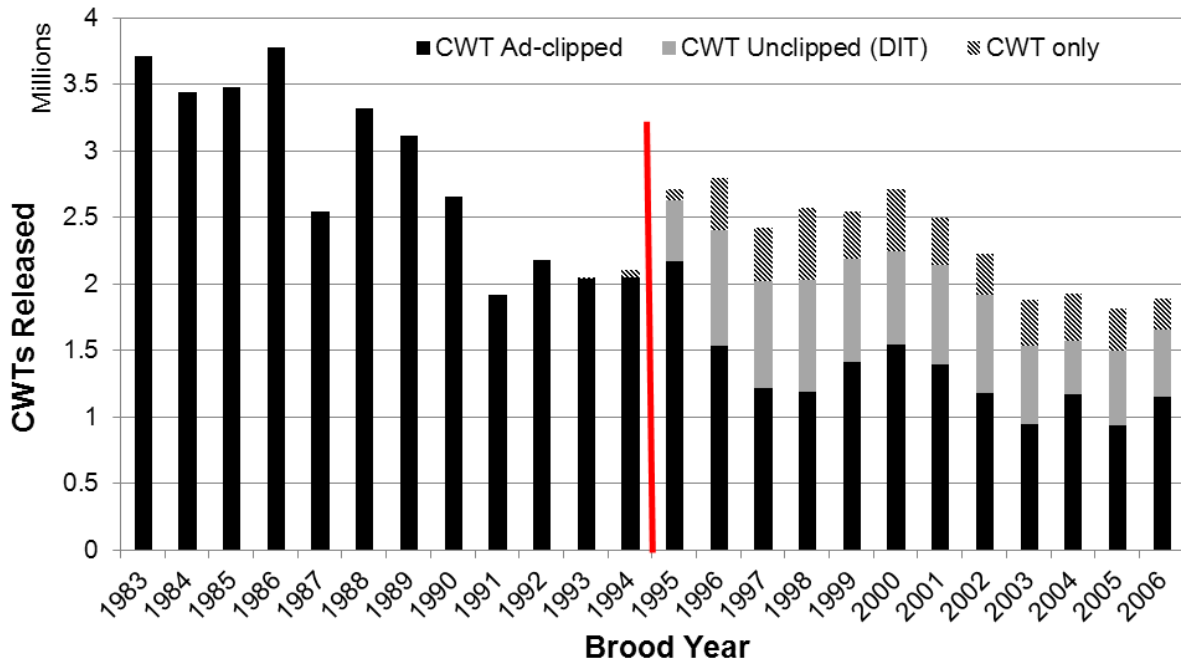


Figure 3. Total number of Coho Salmon with coded-wire tags released coastwide, brood years 1983-2006. Current analysis includes brood years 1995-2006. “DIT” = double index tagged.

Phase II

Coded-wire-tag (CWT) groups identified earlier to include in the base period were further reviewed to determine if they should be removed. A few of them were dropped from consideration due to a variety of reasons, including poor survivals or incomplete sampling or reporting of near terminal fishery impacts.

Cohort reconstruction using the Mixed-Stock Model and the Cohort Reconstruction program relies heavily on CWTs. The fewer the CWTs, the less robust (more uncertain) the resulting exploitation rates are. Due to previous summaries of tag recoveries where it was revealed that much fewer tags are being recovered in pre-terminal fisheries in more recent years, a review of recent tagging levels of all US Coho stocks was made (see the draft report in Appendix A for details). The tool used was developed by Annette Hoffman of Washington Department of Fish and Wildlife. The tag review revealed that tag recovery is lacking for most, if not all, of our Coho stocks. This is due to a combination of factors, including reduced survival, reduced tagging, and reduced exploitation. These evaluations resulted in recommendations made to increase tagging levels at a few of hatcheries. Figures 4 through 6 depict the estimated change in tagging levels to meet the assumptions and goals, such as minimizing uncertainty surrounding exploitation rate estimates, described in Appendix A.

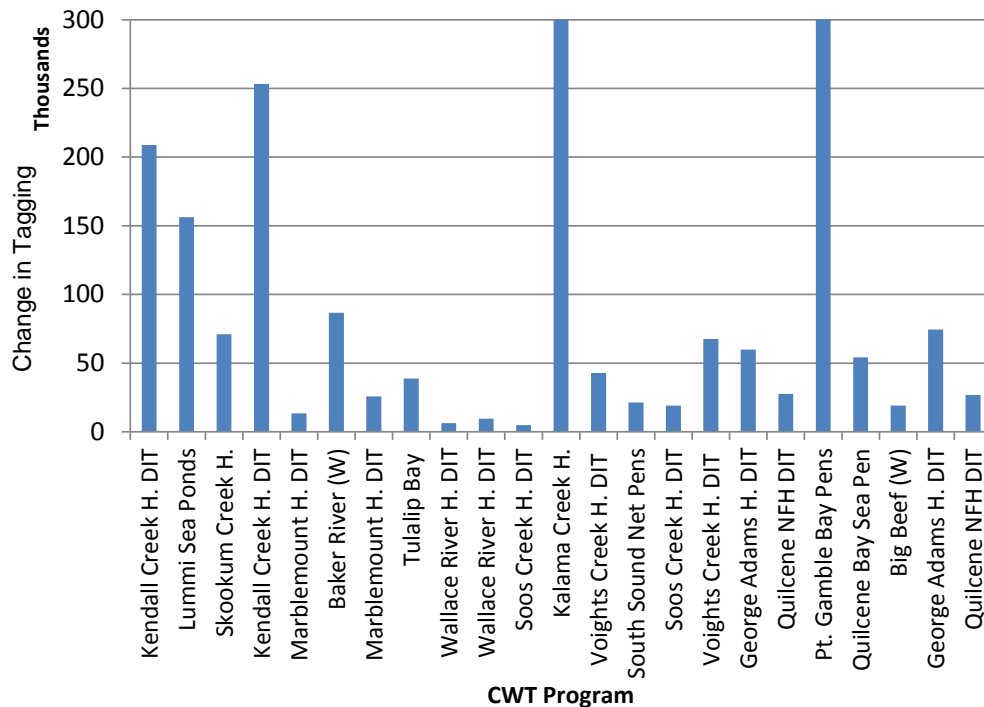


Figure 4. The increase in tags needed to meet the assumptions and goals described in Appendix A for Coho CWT programs in Puget Sound.

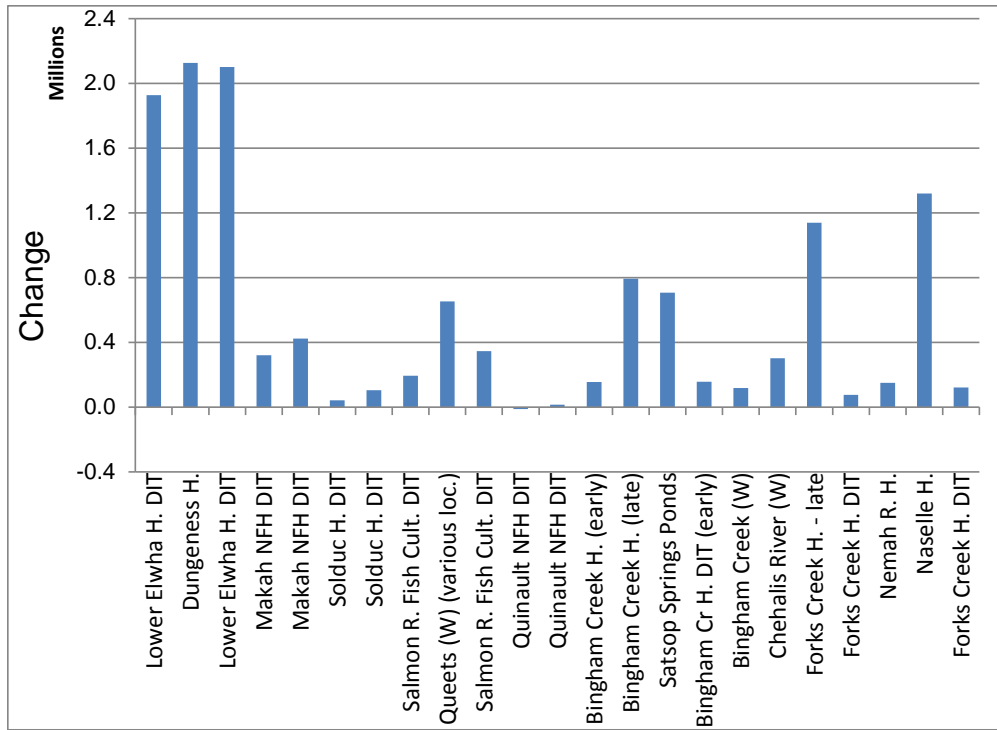


Figure 5. The increase in tags needed to meet the assumptions and goals described in Appendix A for Coho CWT programs in the Strait of Juan de Fuca and along the Washington Coast.

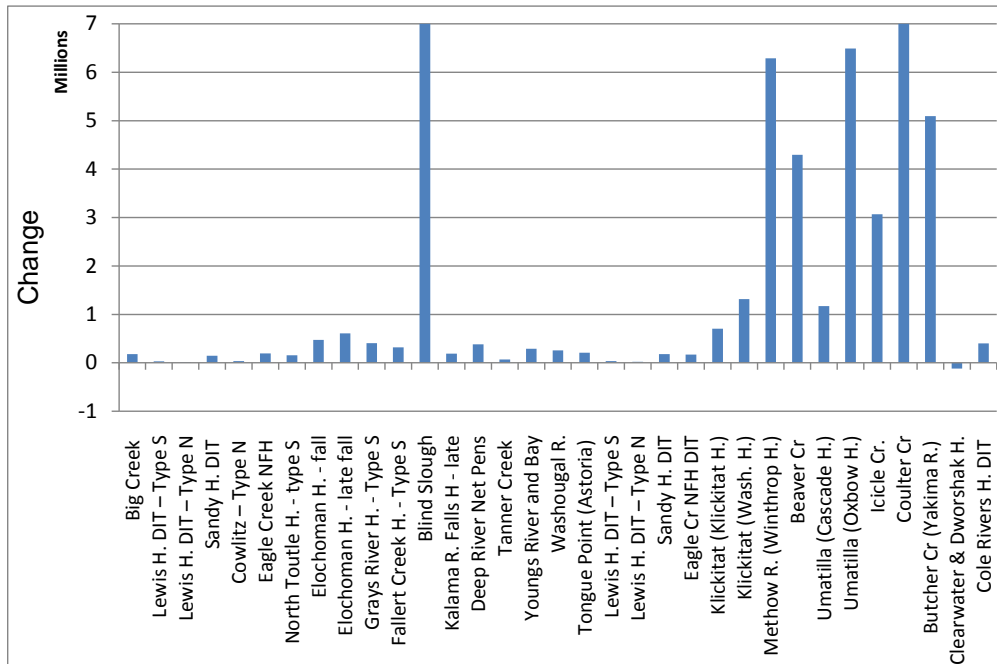


Figure 5. The increase in tags needed to meet the assumptions and goals described in Appendix A for Coho CWT programs in the Columbia River and along the Oregon Coast.

Summary tables and figures were also developed in support of the project. Review and validation of the exploitation rate estimates by the PSC Joint Coho Technical Committee members has begun. Updates on the FRAM database project and preliminary results were also made available to regional biologists and presented at the Annual Mark Meeting, the PSC Annual Meeting, and at a couple of co-manager's meetings. Example slides are included in Figures 7 and 8.

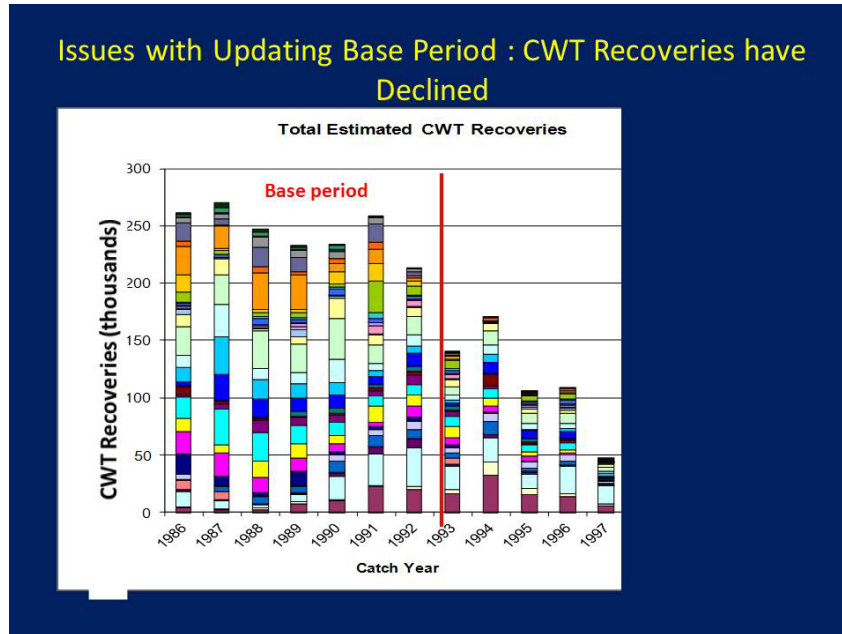


Figure 7. A slide from a presentation given to the PSC's Southern Panel on expanding the current Coho FRAM base period, depicting the trend in tags available to complete the cohort analyses.

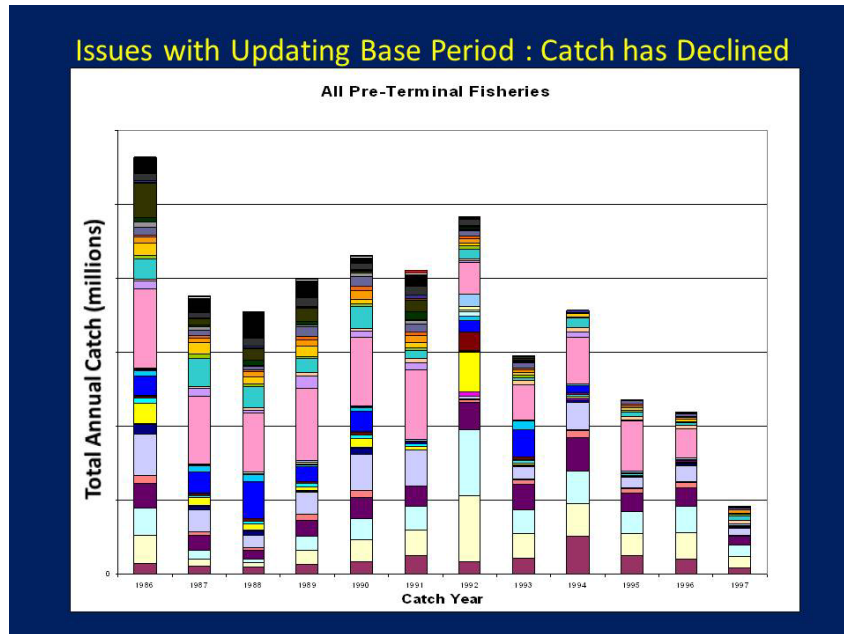


Figure 8. Another slide from a presentation given to the PSC's Southern Panel on expanding the current Coho FRAM base period, depicting the trend of a declining Coho catch in pre-terminal fisheries.

CONCLUSIONS AND NEXT STEPS

In recent years, fishery impacts to Coho stocks of management concern are constrained at stock-specific exploitation rates. These fishery impacts are assessed using the FRAM program based on catch years when stock abundances and exploitation patterns were vastly different. The inclusion of more recent catch years in the base year dataset should improve future fishery management. Stock abundances, and possibly stock distribution patterns, of priority stocks (i.e., Interior Fraser Management Unit) have changed and these changes will soon be represented in FRAM. The FRAM program has been re-written in Visual Studio NET and is now much easier to use. In addition, data has been uploaded into the new databases and preliminary estimates of production expansion factors and preliminary exploitation rate estimates have been made.

Next steps in expanding the FRAM base period include the following:

- Complete the cohort reconstruction for all catch years (1998-2009). This requires further review of escapement and production expansion factors by the regional biologists and PSC Coho Technical Committee members and exterior validation of the exploitation rate estimates by the CoTC.
- Final review by the Pacific Fisheries Management Council Model Evaluation Workgroup. Once these assessments are complete, these most recent catch years with mark-selective fisheries will be available for use in the FRAM base period.

REFERENCES

- Packer, J. F. 2011. Update coho FRAM base period support programs (RRTERM and MSM) used for coho cohort analyses. PSC Southern Boundary Restoration and Enhancement Fund Final Report, Project # SF-2010-I-16. Washington Department of Fish and Wildlife, Olympia, Washington.
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APPENDIX A. FINANCIAL STATEMENT OF EXPENDITURES

Attached is a draft summary report on the review of Coho Salmon indicator tagging levels.

APPENDIX B. FINANCIAL STATEMENT OF EXPENDITURES

A total of \$11,015 was awarded to the USFWS from the PSC Southern Fund to complete the catch/sample and CWT release and recovery analyses. To-date, the USFWS has received \$9,914 of these funds and has spent a total of \$11,015 on the project. The USFWS contributed an additional \$10,000 in in-kind (salary and overhead). Attached is a financial statement outlining the expenses charged to the PSC Southern Funds to-date.