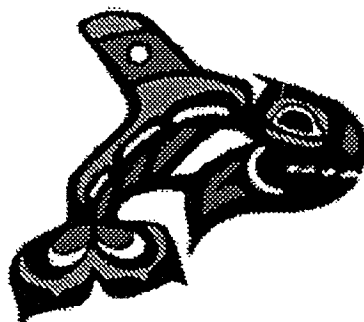


Review of Tribal CWT Indicator Stocks

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By

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Introduction

Chinook and Coho Indicator Stock programs were initiated by the Pacific Salmon Commission (PSC) Chinook Technical Committee (CTC) and the PSC Coho Technical Committee (CoTC) in 1985. An indicator stock is used to represent stocks with similar life histories and distribution patterns. The purpose of tagging these stocks was to monitor and evaluate the effectiveness of management measures prescribed by the PSC. Several criteria were considered when stocks were initially selected for inclusion in the program (Morishima, 1986):

1. In aggregate, indicator stocks should represent all major regions and racial types that are of interest to the PSC;
2. The stock must be sufficiently abundant and easily tagged so that the agency responsible can make a long-term commitment for tagging the stock;
3. The agency responsible for tagging the stock must make a commitment to sample and estimate the escapement of tagged fish and report the results to the Pacific States Marine Fisheries Commission (PSMFC) in a timely manner;
4. Reliable estimates of catch and escapement must be available.

Each year the Northwest Indian Fisheries Commission receives funding for the implementation of the Pacific Salmon Treaty. A significant portion of these funds are allocated for the tagging and sampling of chinook and coho indicator stocks. At the July 22, 1997 NWIFC meeting, direction was given to produce a technical review of the current CWT indicator stock program. The purpose of this review is to provide policy makers with the following information:

1. A description of the current exploitation rate indicator stock program
2. The purpose of the coded wire tagging
3. How the data are being used
4. The relative value of each project to the analytical capabilities that support our management of fisheries

For each stock the rearing program, the tagging history, and the escapement estimation procedures are reviewed. The multiple uses of the CWT data are described for each stock. The listing of PSC uses of CWT data were limited to those analyses that have been conducted by the CTC and CoTC within the past two years. The listing of "other" CWT uses is not considered all-inclusive.

Overview of the Chinook and Coho Exploitation Rate Indicator Stock Program

The coded wire tag (CWT) system is the most important stock identification technique used for salmonid research and management (Johnson 1990). Provisions of the Pacific Salmon Treaty (PST) underscore the important role that coded wire tag (CWT) data play in the management of salmon fisheries. The necessity of maintaining a viable coastwide CWT program was explicitly recognized in the Pacific Salmon Treaty accompanying Memorandum of Understanding, Section B (Data Sharing): *“The parties agree to maintain a coded-wire tagging and recapture program designed to provide statistically reliable data for stock assessments and fishery evaluations”*. No other data and/or methods exist that are currently capable of providing the information required to evaluate the stock specific effectiveness of fishery management actions undertaken by the Pacific Salmon Commission (PSC) (PSMFC, 1992).

The PST established a conservation program to rebuild depressed stocks of chinook salmon. This created the need to establish a set of stocks to represent all of the various wild stock types in the region. The PSC CTC identified two sets of indicator stocks, one for monitoring changes in spawning escapements (Escapement Indicator stocks) and the other for monitoring changes in fishery harvest rates and stock exploitation rates (Exploitation Rate Indicator stocks) (Chinook Technical Committee, 1987). This monitoring requires a long term commitment for tagging and adult sampling. The exploitation rate stocks (hereafter termed indicator stocks) are the ones that are coded wire tagged, and are the emphasis of this review. However, all of the tribal indicator stocks that are of the “wild broodstock” type, are also PSC Escapement Indicator stocks. Accurate estimates of natural spawning escapement are required for both of these types of indicator stocks.

The tagging of representative stocks is a regional rather than an agency need. Recognizing the importance of the indicator stock program, the Northwest Indian Fisheries Commission (NWIFC), the U.S. Fish and Wildlife Service (USFWS), and the Washington Department of Fish and Wildlife (WDFW) instituted a comprehensive tagging program in Washington State (Scott, Moore and Moore, 1992). The current list of chinook and coho indicator stocks is listed in Tables 1 and 2, respectively.

Table 1. 1997 PSC Chinook Harvest Rate Indicator Stocks and Tagging Levels for Puget Sound and the North Washington Coast.

Region Hatchery	Stock	WDWF	NWIFC	USFWS
Nooksack/Samish				
Nooksack	Spring 0+	200,000		
	Spring 1+	150,000		
Samish	Fall 0+	200,000		
Skagit				
Skagit	Summer 0+ (wild brood)		200,000	
Stilly/Snohomish				
Stillaguamish	Summer 0+ (wild brood)		200,000	
Mid Puget Sound				
Green R.	Fall 0+	200,000		
Grovers Cr.	Fall 0+		200,000	
South Puget Sound				
Minter Cr.	White R. Spring 0+	250,000		
	White R. Spring 1+	90,000		
Squaxin Is.Pens	Fall 1+	75,000		
Kalama Cr.	Fall 0+		225,000	
Deschutes	Fall 1+	75,000		
Hood Canal				
George Adams	Fall 0+	200,000		
Strait of Juan de Fuca				
Hoko	Fall 0+ (wild brood)		200,000	
North Coast				
Makah NFH	Fall 0+			260,000
Salmon R.	Fall 0+ (wild brood)		200,000	
Quinault NFH	Fall 0+			200,000

Table 2. 1997 PSC Coho Harvest Rate Indicator Stocks and Tagging Levels for Puget Sound and the North Washington Coast.

Region Hatchery	WDFW	NWIFC	USFWS
Nooksack/Samish			
Skookum Cr.		50,000	
Lummi Bay		50,000	
Nooksack	45,000		
Skagit			
Skagit	45,000 ^a		
Stilly/Snohomish			
Skykomish	45,000 ^a		
Tulalip		50,000	
Mid Puget Sound			
Green R.	45,000 ^a		
Agate Pass Pens		50,000	
Puyallup	45,000 ^a		
South Puget Sound			
Squaxin Is.Pens	50,000		
Kalama Cr.		50,000	
Deschutes (wild)	variable		
Hood Canal			
George Adams	45,000 ^a		
Port Gamble Pens		50,000	
Big Beef (wild)	variable ^a		
Strait of Juan de Fuca			
Lower Elwha		75,000 ^a	
North Coast			
Solduc	75,000 ^a		
Queets (wild)		variable	
Quinault NFH			75,000
Humptulips	75,000 ^a		
Bingham Creek (normal)	75,000		
Bingham Creek (late)	75,000		

^a Stocks proposed for double-index tagging under a WDFW coho mass marking plan

Uses of CWT Data

PSC Chinook and Coho Technical Committee Uses of CWT Data

The exploitation rate indicator stocks are used for a variety of analyses depending upon the type of data that are available. The following statistics are frequently reported by the CTC (see for example, CTC 1994; CTC 1996):

Fishery Harvest Rate Index:	Fishery harvest rate indices estimate the annual harvest rate in a fishery relative to the average harvest rate in the years 1979 through 1982; these indices are essential for monitoring the performance of fisheries and average values are often used for predictive purposes during preseason planning;
Brood Exploitation Rate:	Brood exploitation rates provide the best measure of the cumulative impact of fisheries upon all age classes of a stock. The rate is computed as the ratio of total fishing mortality (expressed in adult equivalents for chinook salmon) to total fishing mortality plus escapement;
Nonceiling Fishery Index:	The CTC has suggested the nonceiling fishery index as a measure of compliance with the passthrough provision of the PST;
Fishery Contribution:	Estimates the total catch to a fishery of the group of stocks that the indicator represents;
Survival Rates and Index:	Survival rates and survival rate indices are used to evaluate interannual trends in survival and for preseason forecasts of abundance; survival rates for a cohort of chinook salmon are predicted based on survival rate indices for age 2 and 3 year old fish. The information is used in planning appropriate harvests and identifying conservation concerns;
Catch Distribution:	Estimates the proportion of the total catch (or mortality of a stock) that occurs in each fishery.

Additional PSC Uses of the Data

Interception Estimates:	The equity principle of the PST has frequently resulted in requests for estimates of interceptions of U.S. fish; The CoTC relies upon CWT recovery data to estimate interceptions.
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Abundance Forecasting:	Forecasts of stock abundance are used by the CTC to predict the abundance indices for each fishery; the U.S. Letter of Agreement specifies a target catch for S.E. Alaska chinook fisheries that is dependent upon the abundance forecast. Similar procedures have been proposed by U.S. negotiators for some Canadian coho salmon fisheries.
In-season Management:	Quotas of wild stocks can be monitored based on identifying hatchery stocks through CWTs.
Escapement Rates:	Annual escapement estimates are derived from a set of naturally spawning chinook stocks (escapement indicator stocks). The escapement estimates are used to monitor stock rebuilding trends. The CTC anticipates that improved analyses of stock recruit relations and rebuilding will result in a closer coordination of the escapement and exploitation rate indicator stock programs.

Other Uses of CWT Data

CWT data are an integral component of the analytical tools used in our fisheries management. Aside from the PSC Technical Committee uses, the data from the indicator stocks are used for the following:

Specific Harvest Models: CWT data are essential in estimating parameters for harvest models. For example, CWT data were used in the PSC Selective Fisheries Model to estimate migration parameters and cohort sizes. Currently, a coast-wide harvest model is being jointly developed by the NMFS, the UW, and tribal, state, and federal agencies. This model will greatly improve our management capabilities, but its utility is dependent on the quality of data used to estimate parameters.

Model Validations: It is important to evaluate the accuracy of the harvest models we use. The chinook version of the Fishery Regulation Assessment Model (FRAM) is currently being validated by WDFW and the tribes. In order to validate a model, independent estimates of catch distributions and exploitation rates must be available. CWT data provide an independent estimate to which we can compare model output.

Management Units for the Fisheries Management Plan (FMP) used by PFMC: A tribal and WDFW technical group recently developed a preliminary list of chinook management units for the FMP and NMFS. The proposed list contains all five of the tribal Puget Sound indicator stocks, and nine additional stocks which are not currently tagged. In order to meet our commitment and effectively manage the proposed units, it is necessary to continue tagging all of the indicator stocks. With the move toward managing stocks at a finer scale, minimum tagging levels are expected to increase, and additional stocks will need to be tagged.

Comprehensive Coho/Chinook: Tribes have been working towards a management plan for coho that is “comprehensive” in terms of addressing fishery management, wild stock restoration, hatchery production, and the maintenance of habitat. CWT data have been used in a variety of ways throughout the Comprehensive Coho process, and will be used similarly in Comprehensive Chinook. Ocean survival rates and stock productivity parameters are estimated using CWT data, and are used in setting target exploitation rates and escapement breakpoints. CWT data are used to estimate input parameters in Comprehensive Coho models. These models include the South Puget Sound Coho Model, developed to analyze South Sound coho stocks and the effects of management decisions, and a future larger-scale model which will be developed to evaluate harvest options.

Coho Cohort Database: CWT data were used in the development of the coho cohort database to estimate production expansion factors (PEF's) and to reconstruct the terminal areas. The coho cohort database and CWT-based coho cohort reconstruction methodology address many of the previous data limitations and provide improved estimates of abundance and catch for management.

Stray Rate Evaluations: Stray rate estimates have become important in a variety of forums, including the Endangered Species Act, the proposed Wild Salmonid Policy, and in evaluating enhancement programs. CWT data have provided one of the few methods available to estimate stray rates (Ruggerone 1997, VanderHaegen 1995, Hayman 1994).

Intertribal Allocation: The Intertribal Allocation Technical Review Committee (TRC) used CWT data to estimate coho catch distributions by management unit and fishery. These CWT estimates were compared with catch distributions projected in the CARE model (S. Bishop 1994).

In-season Management: CWTs provide a means to monitor fisheries targeting on specific stock groups, separate hatchery from wild stock (i.e. in-river), and provide stock age separation (mostly chinook).

Abundance Forecasting: Puget Sound, Washington Coast and Columbia River managers use CWT data for developing pre-season forecasts for coho stocks.

Wild Stock Evaluation and Assessment: CWTs allow estimation of productivity and differential survival between hatchery and wild fish, and evaluate the degree to which hatchery fish can be used to evaluate impacts on wild fish. Estimates of stock productivity allow an assessment of the relationship between productivity and estimation of MSH.

Natural Production Estimates: For the Queets coho stock, wild smolts are trapped for tagging. The tagging and subsequent downstream smolt sampling provide annual estimates of total natural production from the basin.

Hatchery Evaluations: CWT data provide a direct means for enhancement biologists to evaluate the effectiveness of hatchery and supplementation programs. Survival rates and fishery

contribution rates are routinely estimated, and the estimates can be used to conduct cost/benefit analyses.

Selective Fishery Double Indexing: With the mass marking/selective fisheries proposals, double index tagging is essential to maintain the viability of the CWT program (Ad-Hoc Selective Fishery Evaluation Committee, 1995). The Lower Elwha coho stock has been identified as a double index stock. Additional regions, i.e. Nooksack/Samish and deep South Sound, are being reviewed for adequate representation.

Review of Chinook Stocks

The NWIFC began tagging tribal chinook salmon indicator stocks in 1986 (brood year 1985 fish). The current program involves the tagging and recovery of six stocks (Table 1). Four of the stocks (Skagit summer, Stillaguamish summer, Hoko fall, and Queets fall) are described as “wild broodstock” groups. These fish are derived from wild broodstocking efforts where returning adults are captured and brought to a hatchery for spawning, incubation, early rearing, and coded wire tagging. Since wild chinook smolts are too sensitive to capture and tag, the intent is to mark a group that represents the wild fish to the best extent possible. The fish are transferred as pre-smolts to an acclimation/imprinting pond adjacent to the native river. An attempt is made to release the fish at a size and time consistent with the wild chinook salmon smolt migration. All of the wild broodstock projects include spawning ground surveys to estimate escapement and sample carcasses to recover CWTs. The escapement estimation procedures vary for each stock.

The list of tribal chinook stocks has been subjected to two technical reviews. Scott et al. (1992) reviewed all of the Western Washington stocks in the report entitled *Review of the Chinook Exploitation Rate Indicator Stock Program For the Washington Coast and Puget Sound*. The intent of the review was to determine if representation of production regions and stock types is adequate, and if tagging levels for the indicator stocks are sufficient. The review identified serious problems with the overall program. Stock specific problems generally fell into 1 of the following 3 categories:

1. Estimates of the escapement of tagged fish are lacking, are unreliable, or have not been provided to PSMFC;
2. Survival of tagged fish has been poor or tagging levels have been too low to provide sufficient fishery recoveries; and
3. Budget cutbacks have reduced agency ability to maintain both adequate tagging and high quality escapement sampling programs.

Recommendations were made to discontinue some of the programs and to make improvements to other programs.

The report by Olson, Goddard and Phillipson (1993) was entitled *Review of Escapement Estimation and CWT Sampling Procedures for Tribal Exploitation Rate Indicator Stocks*. This review was conducted to address some of the problems identified (1 & 3 above) in the review by Scott et al. The following items were reviewed for each stock: escapement rates, hatchery and/or stream sampling programs, escapement estimation procedures for natural spawners, straying of CWT groups, and the status of reporting CWT escapement recoveries to the PSMFC/PSC database. For stocks where problems were identified, recommendations were made for measures to correct these problems.

These two reviews were used to refine the list of indicator stocks, the numbers of fish to tag in each stock, and the escapement estimation methodology. These reviews and other changes in tribal programs resulted in the following:

1. Discontinued tagging of 4 tribal indicator stocks (Lummi fall chinook, Tulalip fall chinook, Lower Elwha fall chinook, and Quillayute summer chinook)

2. Addition of 1 tribal/WDFW cooperative wild broodstock program (Skagit summer chinook)
3. Increased tagging level of the Kalama Cr. Fall chinook stock
4. Improved escapement estimation method for the Stillaguamish summer/fall chinook stock
5. Increased carcass sampling effort for the Queets fall chinook stock

SKAGIT SUMMER CHINOOK

Stock Type: Wild Broodstock

Program Description and History:

Broodsource: Eggs are obtained from annual wild broodstocking efforts in the Upper Skagit mainstem. CWT fish, or fish exhibiting hatchery scale patterns, are not used as broodstock in this program. Captured fish are transported to the WDFW Marblemount Hatchery where they are held for maturation and spawning.

Rearing and Release: Early rearing and tagging of the fish occurs at Marblemount Hatchery. In May the tagged fingerlings are transported to County Lines Pond for imprinting. Releases begin in mid June and continue through July. Smolt size and migration timing has been monitored and been found to be similar to the natural outmigration.

Tagging History: Tagging of Skagit summer chinook releases began with BY 1993 fish.

Estimation of the Escapement of Tagged Fish: Returning fish are sampled for CWT in the gillnet fishery, test fisheries, broodstock collection, and on the spawning grounds of the Skagit River Basin. Beginning in 1997, additional carcass surveys will be added to increase recoveries. CWT escapement will be estimated in three ways: 1) The percentage of tagged fish in upper Skagit carcass samples multiplied by the redd estimate of upper Skagit escapement; 2) the above percentage multiplied by a Jolley-Seber mark-recapture estimate of upper Skagit escapement; and 3) the percentage of indicator CWT in the lower river test fishery multiplied by the total Skagit escapement estimated from redd counts.

Reporting of Skagit River CWT sampling/recoveries is conducted by WDFW. All Skagit River chinook recoveries (net fisheries, hatchery rack, and spawning escapement) have been reported to the PSMFC/PSC database through 1996.

PSC CTC Purpose: The primary purpose of the indicator stock is to provide estimates of exploitation rates that can be used to evaluate the effect of the rebuilding program on natural summer and fall chinook from the Skagit River.

Current use of Data:

- PSC:** ☐ Fishery or Stock Harvest Rate Index
☐ Brood Exploitation Rate Analysis
☐ Catch Distribution
☐ Survival
☐ Chinook Model
☐ Abundance Forecasting
☒ Escapement Indicator Stock

Other:
(this is a new program)

Comments on the Performance of the Program: This is a new program. Tagging goals have not been met in two of the first three years of this program. This was primarily due to rearing problems at the hatchery.

Effect of Terminating Program: Scott et al. (1992) previously noted the conspicuous absence of an indicator stock for Skagit summer/fall chinook, the largest wild management unit in Puget Sound. This program was initiated to fill that need.

Table 3. Tagging History for Skagit River Summer Chinook.

Brood Year	Tag Code	Number Tagged	Stock
1994	212612	188,034	Skagit River
1995	635151	99,493	Skagit River
1996	634329	3,290	Skagit River
	630322	20,210	Skagit River

STILLAGUAMISH SUMMER CHINOOK

Stock Type: Wild Broodstock

Purpose: The primary purpose of the indicator stock is to provide estimates of exploitation rates that can be used to evaluate the effect of the rebuilding program on natural stocks of summer/fall chinook from the Stillaguamish River (and by default, the Snohomish River).

Program Description and History:

Broodsource: The Stillaguamish indicator stock relies upon natural broodstock for tagging. Broodstock are collected from the north fork of the river. The fish are transported to the Stillaguamish Tribal Hatchery for maturation and spawning.

Rearing and Release: The resulting fry are reared and tagged at the Stillaguamish Tribal Hatchery. The tagged fish are then transported to an upstream acclimation/release site. Beginning with BY 1990, the fish have been released at Washington Department of Wildlife's Whitehorse rearing ponds on the upper North Fork Stillaguamish River. This facility is located within an area where the majority of wild chinook spawning occurs. From 1988 - 1989 acclimation and releases occurred at Fortson Pond. In 1987 acclimation and release occurred at C-Post Pond. The tagged smolts are released as fingerlings in mid-May. The release time and size are based on native smolt data from previous field studies, and ATPase studies of the hatchery fish.

Tagging History: Tagging of this wild broodstock has occurred since BY 1980, except for BYs 1984 and 1985. For most of these years the tag group size has been low, resulting from difficulties in collecting sufficient broodstock from this depressed run.

Estimation of the Escapement of Tagged Fish: Stillaguamish River spawning ground surveys for summer chinook are conducted by WDFW and the Stillaguamish Tribe. The tribal surveys are primarily for carcass sampling. Extensive carcass sampling began in 1989 and annual sampling has increased from 63 carcasses sampled with 10 CWTs recovered in 1989, to 139 carcasses with 82 CWTs in 1991. Broodstock sampling has been conducted at the 100% rate.

WDFW estimates the escapement of the Stillaguamish summer chinook using a variety of methods. The primary method used to estimate escapement on the North Fork is a linear redd count interpolation graph. This method uses redd counts obtained from one or two helicopter surveys conducted around peak spawning. These one or two points are used to construct a curve built around the estimated beginning and ending times of the run, an assumed 21-day redd life, and an assumed 2.5 fish per redd. The precision of these estimates is unknown because of the methodologies used; therefore, confidence intervals cannot be placed on these estimates. Until the precision of these estimates can be assessed, their use in expanding CWT carcass recoveries is not considered satisfactory for PSC indicator stock analysis.

Beginning in the fall of 1992 the Stillaguamish Tribe initiated an alternative field method to derive an independent escapement estimate. This method utilized a mark-and-recapture procedure which used chinook salmon carcasses and a Jolly-Seber estimation model. Carcasses were marked with individually numbered jaw tags. The carcass survey design and Jolly-Seber estimation procedures

were similar to those described by Sykes and Botsford (1986). Results have produced lower estimates than the WDFW redd counting method for the same spawning ground area.

Recoveries from broodstocking have been reported to the PSMFC/PSC database. Stream survey carcass recoveries have been reported to PSMFC, but have only been expanded for the Jolly-Seber escapement estimates from 1992 to the present. Based on WDFW escapement estimates, combined stream survey and broodstocking sampling account for total escapement sampling rates of 15.5% in 1989, 28.6% in 1990, and 23.2% in 1991 (Olson et al. 1993).

Current use of Data:

PSC: ___ Fishery or Stock Harvest Rate Index
 ___ Brood Exploitation Rate Analysis
 √ Catch Distribution
 ___ Survival
 √ Chinook Model
 ___ Abundance Forecasting
 √ Escapement Indicator Stock

Other: This indicator stock has been used in the validation of the chinook version of FRAM.

Summary of Program Performance: Due to depressed run sizes, restricted broodstocking efforts have resulted in numerous years with low numbers of fish to tag. However, the survival rate of this stock has been consistently high which has resulted in useful data for the PSC in recent years. Because of the relatively high ratio of escapement for this stock (Olson et al. 1993), accurate and precise CWT escapement estimates are imperative for this stock to provide useful data as an indicator stock. Hydrological characteristics of the Stillaguamish River have been conducive to both redd counting and carcass recovery. Annual expansions of escapement tag recoveries have been possible since 1992, when Jolly-Seber carcass mark-recapture escapement estimates have been generated. Expansion factors have been low because of the relatively high CWT sampling rates, and the high percentage of CWTs found in the escapement. Further discussions between the tribe and the state would be useful to reach agreement on the best escapement estimation method and to coordinate sampling efforts.

Effect of Terminating Program: Termination of this program would result in the loss of the only wild stock tagging program with measured success in North Puget Sound.

Table 4.

Tagging History and Estimated Survival Rate for Stillaguamish River Summer Chinook (recoveries through 1995).

Brood Year	Tag Code	Number Tagged	Stock	Minimum Survival Rate (%) ^a
1983	211618	26,915	Stillaguamish	0.43
1986	212221	23,904	Stillaguamish	1.23
1987	212555	127,910	Stillaguamish	0.41
1988	213147	36,599	Stillaguamish	0.88
1989	211826	44,964	Stillaguamish	1.14
1990	212026	63,019	Stillaguamish	1.92
1991	212205	165,620	Stillaguamish	N/A
1992	212251	89,207	Stillaguamish	N/A
1993	212330	200,664	Stillaguamish	N/A
1994	212610	203,174	Stillaguamish	N/A
1995	212954	29,309	Stillaguamish	N/A
1996	212960	202,688	Stillaguamish	N/A
Mean Brood Year Rate =				1.00

^a Does not include expanded escapement recoveries.

GROVERS CREEK FALL CHINOOK

Stock: Grovers Creek

Stock Type: Hatchery

Program Description and History:

Hatchery: Grovers Creek (Suquamish Tribe). Located just above MHHW on Miller Bay, in central Puget Sound.

Broodsource: Returns to the hatchery have been used since BY 1982. The hatchery run was started with the use of the following stocks: Finch Cr. (BY 1978), Green River and Deschutes (BY 1979 to 1981).

Rearing and Release: Fish are reared and released on-station as fingerlings. Releases are volitional and occur in May.

Tagging History: Tagging has been conducted consistently at the Grovers Creek Hatchery since BY 1981.

Estimation of the Escapement of Tagged Fish: Escapement rates to the hatchery have been relatively high; averaging 37% of total CWT recoveries for brood year 1983 to 1987 CWT groups (Olson et al. 1993). Adult chinook have returned to the hatchery in relatively high numbers, averaging 2,379 fish for return years 1983 to 1995. Grovers Creek has a permanent weir and no adults are allowed upstream of the hatchery. Sampling at the rack has been at 100%. The hatchery sampling also includes carcass CWT sampling for fish stranded in the estuary below the rack.

There are no large drainages in the vicinity of the hatchery. The local streams on the eastern Kitsap Peninsula known to have escapements of spawning chinook are Dogfish, Gorst, Blackjack, and Curley creeks. These streams are all surveyed by the Suquamish tribe during the chinook spawning season. These small streams offer little attractant flow, have low numbers of spawners, and no CWTs have been recovered in the surveys (Jay Zischke, pers. comm.). The only other stream on the east side of Kitsap Peninsula supporting a substantial population of spawning chinook is Burley Creek, where one tag has been recovered. Burley Creek is located substantially south of Grovers Creek in the uppermost portion of Henderson Bay. This stream is surveyed by WDF personnel, and all carcass CWT recoveries are expanded and reported.

PSC CTC Purpose: The primary purpose of this stock is to monitor exploitation rates in PSC fisheries and to represent production of fall chinook fingerlings from the mid-Puget Sound Region.

Current use of Data:

PSC: ☒ Fishery or Stock Harvest Rate Index
☒ Brood Exploitation Rate Analysis
☒ Catch Distribution
☒ Survival
☐ Chinook Model
☐ Abundance Forecasting

Other: This indicator stock has been used in the validation of the chinook version of FRAM, hatchery evaluations, pre-season forecasting, and intertribal allocation.

Summary of Program Performance: The Grovers Creek Hatchery fall chinook stock is characterized by relatively high survival rates and escapement rates. No problems exist in the tagging, sampling, and reporting of the escapement component of this stock. Grovers Creek hatchery rack and estuarine sampling and recoveries have been reported for all years.

Effect of terminating program: Terminating this program would result in the loss of a high quality indicator stock for mid-Puget Sound, including reductions in the quality of fishery indices for the WCVI troll and Puget Sound sport fisheries.

Table 5. Tagging History and Estimated Survival Rate for Grovers Creek Fall Chinook (recoveries through 1995).

Brood Year	Tag Code	Number Tagged	Stock	Minimum Survival Rate (%)
1983	211622	40,324	Grovers Creek	0.76
1984	211657	45,9078	Grovers Creek	1.31
1985	211901	207,155	Grovers Creek	0.66
1986	211961	187,757	Grovers Creek	1.63
1987	212542	193,906	Grovers Creek	0.47
1988	213137	124,626	Grovers Creek	0.10
1989	211831	187,640	Grovers Creek	0.16
1990	212014	193,496	Grovers Creek	0.74
1991	212217	174,949	Grovers Creek	N/A
1992	212326	186,072	Grovers Creek	N/A
1993	212329	203,168	Grovers Creek	N/A
1994	Numerous	271,039	Grovers Creek	N/A
1995	212947	201,187	Grovers Creek	N/A
1996	212963	201,607	Grovers Creek	N/A
Mean Brood Year Rate =				0.73

NISQUALLY FALL CHINOOK

Stock Type: Hatchery

Program Description and History:

Hatchery: Kalama Creek (Nisqually Tribe). Located on a tributary to the Nisqually River at RM 9.

Broodsource: Because of initial difficulties in achieving egg take goals for this facility, eggs have come from a number of Puget Sound Hatcheries in past years. Eggs from Kalama returns have been primarily used since BY 1988.

Rearing and Release: Fish are reared and released on-station as fingerlings. Releases are volitional and occur late May through late June

Tagging History: Tagging has occurred at various levels since BY 1979. In 1996 and 1997 tagging was switched to the nearby Clear Creek hatchery because of flood related problems at the Kalama Creek Hatchery.

Estimation of the Escapement of Tagged Fish: Chinook returns to the Kalama Creek Hatchery rack have averaged 860 fish for return years 1983 to 1995. CWT sampling has been at the 100% level, and all recoveries have been reported to the PSMFC/PSC database.

The Nisqually Tribe conducts stream surveys for chinook redd counts and live fish counts in index sections of the Nisqually River. The river is glacial fed and poor water visibility can create survey difficulties in the mainstem. The current escapement estimate involves an equation that combines peak redd counts and peak live fish counts from index sections within the basin (Nisqually Chinook Population Model, 1986; Smith and Castle, 1992). Variance of the estimates cannot be calculated for this method, so their precision is unknown. Few chinook carcasses are observed during surveys and CWT sampling has not occurred consistently.

In 1992 the Nisqually Tribe and the NWIFC attempted a carcass mark-and-recapture estimation procedure using methodology similar to that described by Sykes and Botsford (1986). The attempt was unsuccessful as four weeks of stream surveys resulted in no carcass recoveries. The escapement for 1992 was predicted to be very low, and only 106 natural spawners were estimated by the current escapement estimation calculation.

PSC CTC Purpose: The purpose of the Nisqually fall chinook indicator stock is to monitor exploitation rates in PSC fisheries for fall chinook fingerling production from south Puget Sound. The Kalama Creek Hatchery is currently the only exploitation rate indicator stock for the stock aggregate.

Current use of Data:

PSC: ☐ Fishery or Stock Harvest Rate Index
☐ Brood Exploitation Rate Analysis
☒ Catch Distribution
☐ Survival
☒ Chinook Model
☐ Abundance Forecasting

Other: This indicator stock has been used in the validation of the chinook version of FRAM, hatchery evaluations, and intertribal allocation.

Summary of Program Performance: Tagging goals have been consistently met. Because of relatively low survival of the releases, tagging levels were increased to 225,000 in 1993. If survival of the Clear Creek Hatchery releases prove to be higher than releases from Kalama Creek, the tagging location of the stock should be switched. The lack of natural spawning escapement estimates for tagged fish continues to raise questions on accuracy of data from this indicator stock and limit its use in CTC analysis. Although the extent of hatchery straying is assumed to be low, the level of straying to the spawning grounds still needs to be assessed.

Effect of Terminating Program: Termination of this program would result in the loss of the only remaining indicator stock for fall fingerling production from the South Puget Sound region.

Table 6. Tagging History and Estimated Survival Rate for Kalama Creek Fall Chinook (recoveries through 1995).

Brood Year	Tag Code	Number Tagged	Stock	Minimum Survival Rate (%)
1983	211628	37,541	Kalama Creek / Green River	0.28
	211629	11,317	Kalama Creek / Green River	0.32
1984	211706	38,605	Kalama Creek	0.32
	211707	44,898	Deschutes River	0.12
1985	211759	94,552	Deschutes River	0.40
	211761	85,934	Deschutes River	0.07
1986	211962	194,459	Kalama Creek / Green River	1.22
1987	212541	195,101	Kalama Creek / Green River /McAllister	0.04
1988	213138	193,837	Kalama Creek	0.14
1989	211836	198,744	Kalama Creek / Green River	0.08
1990	211833	183,328	McAllister	0.58
1991	212206	190,732	Kalama Creek	N/A
1992	212323	216,185	Kalama Creek	N/A
1993	212450	205,814	Kalama Creek	N/A
1994	212606	203,635	Nisqually	N/A
1995	212946	215,503	Nisqually	N/A
1996	212957	226,022	Nisqually	N/A
Mean Brood Year Rate =				0.35

HOKO FALL CHINOOK

Stock Type: Wild Broodstock

Program Description and History:

Broodsource: Eggs are obtained from annual wild broodstocking efforts in the Hoko River. From BY 1952 to 1974 the Hoko River was sporadically planted with non-native stocks of fall and spring chinook. Planting of non-native stocks has not occurred since BY 1974 fish, and the stock is considered native Hoko River.

Rearing and Release: Beginning with BY 1990, fish are reared, tagged and released on-station at the Makah Tribe's Hoko Hatchery. The hatchery is located at RM 10 on the Hoko River. Fish are released as fingerlings in June. BY 1985 to 1987 fish were incubated, reared and tagged at the Makah NFH prior to transportation to the Hoko Pond for final rearing and release. BY 1988 fish were destroyed when VHS was detected at the Makah NFH while the fish were rearing. BY 1989 fish were temporarily reared and tagged at the Quilcene NFH.

Tagging History: Tagging began with BY 1985 fish for the indicator stock program. Tagging has been continuous except for BY 1988.

Estimation of the Escapement of Tagged Fish: Stream surveys are conducted jointly by Makah Fisheries Management (MFM) and WDFW crews. The sampling goal on the Hoko River is to survey all available chinook spawning habitat on a weekly basis during the spawning season. Stream surveyors walk or float a stream section marking each new chinook redd. Carcass surveys are conducted separately by MFM staff for CWT recovery and scales, sex, and length data. Carcass surveys for CWT recovery and CWT escapement estimation began in 1988 to sample for age 3 returns from the first year of tagging. Fish captured for broodstocking are sampled at the 100% level

The redd count methodology used on the Hoko River has been determined to be an accurate census of all chinook salmon redds built during a spawning season. Therefore, expansions are usually unnecessary to obtain a total redd estimate. The annual chinook spawning escapement estimate is determined by summing the number of new redds recorded during each survey and multiplying by 2.5 fish per redd. Poor stream conditions have occasionally prevented surveys from being conducted as scheduled. If a significant period of time elapsed between surveys, redd counts were expanded for the period

All broodstocking CWT recoveries have been reported. Spawning ground recoveries from 1988 to the present have been expanded for escapement estimates and have been reported to the PSMFC/PSC database.

PSC CTC Purpose: The primary purpose of this indicator stock is to provide estimates of exploitation rates that can be used to evaluate the effect of the rebuilding program on natural stocks of fall chinook originating from tributaries to the Strait of Juan de Fuca.

Current use of Data:

PSC: ☐ Fishery or Stock Harvest Rate Index
☒ Brood Exploitation Rate Analysis
☒ Catch Distribution
☒ Survival
☐ Chinook Model
☐ Abundance Forecasting
☒ Escapement Indicator Stock

Other: This indicator stock has been used in the validation of the chinook version of FRAM, intertribal allocation, and evaluation of supplementation.

Summary of Program Performance: Tagging goals have not always been met, however survival of the stock has generally been good. Because of a relatively high ratio of freshwater escapement (Olson et al 1993), accurate CWT escapement estimates are necessary for providing useful data from this indicator stock. The entire range of chinook spawning habitat in the Hoko River is now surveyed for new redds throughout the spawning season. The resulting redd count is considered comprehensive and accurate. Sampling has proved very successful for both carcass surveys and broodstocking. From 1988 to 1991 a total of 882 carcasses were sampled with 261 CWTs recovered. The relatively high levels of carcass sampling and CWT recoveries, combined with the escapement estimates, allow for precise estimates of CWT escapements. The only recommendations for improvement of the current sampling design are to ensure that stream surveys are conducted through the entire period of spawning activity (i.e., through the end of November), and to assess the accuracy of the estimated 2.5 spawners per redd.

Effect of Terminating Program: Termination of this program would result in the loss of the only indicator stock from the Strait of Juan de Fuca region, and the only long-term wild stock tagging program in Puget Sound with excellent estimates of the escapement of tagged fish.

Table 7. Tagging History and Estimated Survival Rate for Hoko River Fall Chinook (recoveries through 1995).

Brood Year	Tag Code	Number Tagged	Stock	Minimum Survival Rate (%)
1985	211935	123,563	Hoko River	0.17
1986	212216	144,482	Hoko River	0.73
1987	211907	199,740	Hoko River	0.63
1989	211829	110,572	Hoko River	0.26
1990	212018	164,815	Hoko River	0.40
1991	2122181	182,308	Hoko River	N/A
1992	212327	177,056	Hoko River	N/A
1993	212453	202,858	Hoko River	N/A
1994	212609	144,132	Hoko River	N/A
1995	212949	199,041	Hoko River	N/A
1996	212953	81,578	Hoko River	N/A
Mean Brood Year Rate =				0.44

QUEETS FALL CHINOOK

Stock Type: Wild Broodstock

Program Description and History:

Broodsource: Eggs are obtained from annual wild broodstocking efforts in the mainstem Queets and Clearwater Rivers. Tagged fish are not used as broodstock in this program. The fish are transported to Shale Creek Pond where they are held for maturation and spawning.

Rearing and Release: Beginning in 1995, incubation, rearing, and tagging has occurred at the Salmon River Fish Culture Facility. Salmon River is a major tributary to the lower Queets River. Fish are released volitionally as fingerlings from the Salmon River site. Releases begin in late July and continue through August. Previous studies by Quinault Fisheries Division (QFiD) have shown that fish reared and released in this manner migrate seaward at the same time as wild fish. Fish size is also monitored so that size at release is within the range of wild smolts.

Tagging History: Tagging of Queets fall chinook releases from Salmon River Pond began with BY 1977 fish. Annual tagging of this stock has been continuous with the only exception in BY 1980 when Quinault stock was used.

Estimation of the Escapement of Tagged Fish: Returning fish are sampled for tags in the gillnet fishery, in the broodstock collection, and on the spawning grounds of the Queets River Basin. The gillnet fishery is sampled at a rate of approximately 50%. Sampling occurs on the wild broodstock collection, but most adipose clipped fish are released back to the river. Extensive carcass sampling also occurs during stream surveys.

Beginning in 1980, the total natural escapement has been estimated using a redd count methodology. By 1985 the current survey and data collection procedures had been standardized. The methodology involves index (intensive) and supplemental (extensive) redd counting areas. Index sections are chosen to represent the range of spawning habitat utilized by the stock. Index sections are surveyed on a weekly basis. Supplemental surveys are conducted once or twice each season, over a wide range of spawning habitat not included in the index sections. The observed ratio (visible redds / cumulative redds) from index sections is used to expand visible redd counts from supplemental surveys. Supplemental surveys are conducted during the same time period, at or near peak spawning. Unsurveyed areas of spawning habitat are accounted for by expansion of redd densities estimated for surveyed reaches of similar habitat type and utilization. However, most all habitat utilized by chinook is covered by surveys.

Reporting of Queets River CWT sampling/recoveries is conducted by QFiD. All Queets River chinook recoveries (net fisheries, hatchery rack, and spawning escapement) have been reported to the PSMFC/PSC database through 1994.

PSC CTC Purpose: The primary purpose of the indicator stocks within the North Washington Coast region is to provide estimates of exploitation rates that can be used to evaluate the effect of the rebuilding program on natural fall chinook stocks from the Quillayute, Hoh, and Queets Rivers.

Current use of Data:

PSC: ☐ Fishery or Stock Harvest Rate Index
 ☐ Brood Exploitation Rate Analysis
 ☒ Catch Distribution
 ☐ Survival
 ☒ Chinook Model
 ☐ Abundance Forecasting
 ☒ Escapement Indicator Stock

Other: CWT recoveries from this stock are used for updating terminal run size estimates in-season, and evaluating enhancement activities.

Summary of Program Performance: A comprehensive program of broodstocking, CWT sampling, escapement estimation exists for this stock. Tagging goals have fallen short in several years, due to egg mortalities from problems during the incubation phase. New incubation strategies have since been instigated. Survival rates have been relatively high. The relatively high freshwater return rates (Olson et al. 1993) reveal the necessity of providing comprehensive CWT sampling and accurate escapement estimates for this stock. Despite the fact that hundreds of carcasses may be sampled in a year, the expansion rates for the recovered tags can be high, with past rates ranging from 16 in 1989 to 52 in 1988. Beginning in 1991, additional carcass surveys were added to increase recoveries. In order to assess the precision of the total Queets escapement estimate, it was previously recommended that the redd counting methodology be adjusted to include two or more index sections per stratum. This would allow a variance of the estimate to be calculated.

Effect of Terminating Program: Termination of this program would result in the loss of the only long-term wild stock tagging program on the Washington coast.

Table 8.

Tagging History and Estimated Survival Rate for Queets River Fall Chinook (recoveries through 1995).

Brood Year	Tag Code	Number Tagged	Stock	Minimum Survival Rate (%)
1983	211621	98,684	Queets River	1.50
1985	211908	117,674	Queets River	1.06
1986	212101	199,013	Queets River	0.53
1987	212835	101,914	Queets River	0.53
1988	213144	132,135	Queets River	0.17
1989	211835	120,787	Queets River	0.73
1990	212010	164,504	Queets River	0.40
1991	212260	168,795	Queets River	N/A
1992	212328	165,014	Queets River	N/A
1993	212452	170,604	Queets River	N/A
1994	212624	40,636	Queets River	N/A
	212425	43,449	Queets River	
1995	212948	209,929	Queets River	N/A
1996	212961	206,545	Queets River	N/A
Mean Brood Year Rate =				0.70

Review of Coho Stocks

The NWIFC began tagging tribal coho indicator stocks in the fall of 1986 (brood year 1985 fish). The current indicator stock program involves tagging and recovery of seven hatchery stocks and the Queets wild stock (Table 2). The Queets wild stock program involves the capture and tagging of natural smolts, the estimation of smolt yield, and spawning ground surveys to estimate the escapement of tagged fish. All activities of the Queets program are conducted by the Quinault Fisheries Division (QfID). Between 1986 and 1989 four other wild coho indicator stocks were tagged under tribal PST research projects. These included stocks from the Skagit, Stillaguamish, Skokomish, and Hoko Rivers. Subsequent spawning ground surveys for tag recoveries and escapement estimation occurred from 1987 to 1991. These projects were conducted by the Skagit System Cooperative (Skagit stock), the Tulalip Tribes (Stillaguamish stock), and the Point No Point Treaty Council (Skokomish and Hoko stocks).

The Coho Technical Committee has not conducted a review of the current list of coho indicator stocks. As part of the PSC indicator and wild stock tagging programs, the NWIFC is planning to summarize information on catch distributions, exploitation rates, and related statistics for Western Washington coho stocks. This project is summarized in a July 31, 1996 memo from J. Gutmann. The primary objective is to review and refine the regional indicator stock program. A secondary objective is to present the results of the past twenty years of tagging data. Unfortunately, due to other commitments and unresolved CWT escapement estimates from wild stock projects, this review has not been completed.

The analysis is intended to include:

- (1) a discussion of the current uses of data,
- (2) comparisons between regions (catch distributions and survival rates),
- (3) stock specific results by region (catch distributions, brood exploitation rates, survival rates, and stray rates),
- (4) comparisons of stocks within a region using catch distribution histograms and statistical tests (i.e., cluster analyses),
- (5) comparisons of hatchery and wild groups (catch distributions),
- (6) an analyses of tagging levels,
- (7) a discussion of fishery specific results (i.e. stock composition).

Western Washington has been divided into ten regions for the review (Nooksack/Samish, Skagit, Stillaguamish-Snohomish, Mid-Puget Sound, South Puget Sound, Hood Canal, Strait of Juan de Fuca, North Washington Coast, Grays Harbor, and Willapa Bay). Similar analyses will be conducted for each region.

The project is very time intensive, and since the Quantitative Services Division is currently understaffed, no estimated completion date has been provided. As a precursor to this analysis, NWIFC staff is using a subset of the data to evaluate the "double index" groups proposed in the WDFW mass marking/selective fishery proposal. The intent is to evaluate if representation of production regions is adequate. This analysis will be completed by Fall 1997.

LUMMI BAY COHO

Stock Type: Hatchery

Program Description and History:

Hatchery: Lummi Bay Sea Ponds (Lummi Tribe), N.E. shore of Lummi Bay, northern Puget Sound

Broodsource: The run was established with Nooksack River stocks, but other stocks have been occasionally used. Lummi Bay stock has been predominantly used since BY 1978.

Rearing and Release: Eggs are reared to fingerlings at Skookum Creek Hatchery and transported to Lummi Bay Sea Ponds as smolts.

Tagging History: Tagging has occurred since 1973, except for BYs 1980 - 1983.

Estimation of the Escapement of Tagged Fish: Escapement to the rack has been high, ranging from a high of 21,457 in 1992 to a low of 2,258 in 1991. Sampling for CWTs has been near 100% in recent years. There have been some unresolved sampling discrepancies in past years, and one year of missed sampling. Stream surveys are not routinely conducted for CWT sampling, and the extent of natural spawning in the Nooksack River has not been estimated.

Current use of Data:

PSC: This indicator stock has been used to estimate fishery stock composition and interceptions of U.S. coho salmon by Canadian fisheries.

Other: ☐ Fishery or Stock Harvest Rate Index
☐ Comprehensive Coho
☒ Abundance Forecasting
☒ Coho Cohort/Catch Database
☐ Stray Rate Evaluations
☒ Intertribal Allocation
☒ Hatchery Evaluations
☐ Natural Production Estimates

Summary of Program Performance: Tagging goals have been consistently met and survival rates for the stock have been relatively high. There have been some unresolved hatchery rack sampling discrepancies in past years. Calculations of production expansion factors (PEF) for this stock have been problematic, indicating either an overestimation of the unmarked release or errors in rack sampling (Tweit, 1995). The extent of straying to the Nooksack River is unknown.

Effect of Terminating Program: Termination of one of the three coho indicator stock programs in the Nooksack/Samish region may be possible; however, the effects of eliminating a project upon terminal area reconstructions should be carefully evaluated.

Table 9. Tagging History and Estimated Survival Rate for Lummi Bay Sea Ponds Coho (recoveries through 1995).

Brood Year	Tag Code	Number Tagged	Stock	Minimum Survival Rate (%)
1973	140702	12,116	Skookum	4.35
	140802	2,660	Skookum	0.84
	141302	14,740	Skookum	1.84
	141002	15,282	Skookum	14.57
1974	140211	15,397	Skookum	0.81
	140511	13,099	Skookum	0.93
	141102	15,009	Skookum	1.09
	140111	14,291	Skookum	0.77
	140611	11,942	Sandy River	11.15
	141510	14,090	Sandy River	8.40
1975	051601	27,540	Skookum	5.99
	052001	28,973	Skookum	4.95
	051801	28,114	Skookum	5.39
	052201	28,034	Skookum	4.69
	052501	26,475	Skookum	5.11
1976	050322	10,000	Skookum	11.66
	050323	19,570	Skookum	12.49
	053004	31,140	Skookum x Clark	9.32
	053104	29,784	Skookum x Clark	9.11
	053204	30,403	Skookum x Clark	7.54
	053304	76,705	Skookum x Clark	21.31
1977	050362	18,914	Samish	7.49
	050363	17,818	Samish	16.19
	050418	6,666	Samish	7.63

Table 9. Tagging History and Estimated Survival Rate for Lummi Bay Coho (recoveries through 1995). (continued)

Brood Year	Tag Code	Number Tagged	Stock	Minimum Survival Rate (%)
1978	050731	4,933	Baker	15.95
	050657	15,230	Lummi Bay	8.91
	050656	6,739	Lummi Bay	19.49
	050732	3,424	Lummi Bay	2.19
1979	050816	17,644	Lummi Bay	11.20
1984	211724	11,290	Lummi Bay	8.05
	211725	10,893	Lummi Bay	6.35
	211726	10,346	Lummi Bay	7.10
1985	211947	46,804	Lummi Bay	10.48
1986	212502	51,063	Lummi Bay	5.97
1987	212855	50,284	Clark Creek	4.64
1989	211861	47,988	Skagit / Skykomish	10.16
1990	212021	51,591	Lummi Bay	3.20
1991	212229	47,281	Lummi / Skookum / Kendall	3.93
1992	212243	51,901	Lummi Bay	1.97
Mean Brood Year Rate =				7.02

SKOOKUM CREEK COHO

Stock Type: Hatchery

Program Description and History:

Hatchery: Skookum Creek (Lummi Tribe), S.F. Nooksack River

Broodsource: Returns to the hatchery have been predominately used since BY 1973. In recent years eggs have been from Nooksack, Skykomish and Skagit stocks.

Rearing and Release: Fish are reared and released on-station as yearling smolts. Releases are volitional/forced and occur in mid May.

Tagging History: The hatchery production has been regularly tagged since BY 1973, except for BYs 1980 – 1983. Tagged fish from BY1988 were released from both Lummi hatchery sites.

Estimation of the Escapement of Tagged Fish: Escapement to the hatchery has been substantial, ranging from a high of 16,551 in 1989 to a low of 1,634 in 1994. Sampling at the rack has been near 100% in recent years. Some unresolved discrepancies with hatchery rack sampling have occurred in past years. Skookum Creek has a permanent weir and no fish are allowed upstream. However, attraction to the facility is not 100% and the rate of hatchery fish spawning in the Nooksack River has not been estimated. Stream surveys for CWT recoveries have not been routinely conducted in the Nooksack River and nearby streams.

Current use of Data:

PSC: This indicator stock has been used to estimate fishery stock composition and interceptions of U.S. coho salmon by Canadian fisheries.

Other: ☐ Fishery or Stock Harvest Rate Index
☐ Comprehensive Coho
☒ Abundance Forecasting
☒ Coho Cohort/Catch Database
☐ Stray Rate Evaluations
☒ Intertribal Allocation
☒ Hatchery Evaluations
☐ Natural Production Estimates

Summary of Program Performance: Tagging goals have been consistently met and survival rates of the stock have generally been high. There have been some discrepancies with hatchery rack sampling data in past years. Calculations of production expansion factors (PEF) for this stock have been problematic, indicating either an overestimation of the unmarked release or errors in rack sampling (Tweit, 1995). Stream surveys are not routinely conducted for CWT sampling, and the extent of natural spawning in the Nooksack River has not been estimated.

Effect of Terminating Program: Termination of one of the three coho indicator stock programs in the Nooksack/Samish region may be possible; however, the effects of eliminating a project upon terminal area reconstructions should be carefully evaluated.

Table 10. Tagging History and Estimated Survival Rate for Skookum Creek Coho (recoveries through 1995).

Brood Year	Tag Code	Number Tagged	Stock	Minimum Survival Rate (%)
1973	140902	15,010	Skookum	16.44
1974	140411	14,243	Kalama River	3.38
	140311	10,486	Kalama River	5.45
1975	051701	24,953	Skookum	20.02
	051901	28,695	Skookum	20.55
	052101	29,379	Skookum	18.58
	052301	22,373	Skookum	18.44
	052401	28,450	Skookum	19.49
1976	052904	31,934	Skookum	20.92
1977	050416	18,264	Samish	12.60
	050419	18,800	Samish	6.29
1978	050658	19,287	Skookum	11.59
1979	050760	19,542	Skookum	6.71
1984	211721	10,000	Skookum	11.61
	211722	11,100	Skookum	13.11
	211723	10,600	Skookum	11.42
1985	211944	49,589	Skookum	10.44
1986	212501	49,106	Skookum	10.02
1987	212528	45,893	Skookum	12.00
1988	213155	43,270	Skookum / Lummi Bay	2.35
1989	211859	52,079	Skookum	7.77
1990	212024	51,661	Skykomish / Skookum	3.06
1991	212227	54,573	Skykomish / Skookum	4.68
1992	212230	53,830	Skookum	3.40
Mean Brood Year Rate =				9.10

TULALIP CREEK COHO

Stock Type: Hatchery

Program Description and History:

Hatchery: Tulalip Salmon Hatchery (Tulalip Tribe), tributary to Tulalip Bay

Broodsource: Skykomish River stocks.

Rearing and Release: Eggs are transferred from the WDFW Wallace River (Skykomish) Hatchery. Fish are initially reared on station with final rearing occurring in a rearing pond on lower Tulalip Creek. Fish are released voluntarily as yearlings in mid May. The outlet of the rearing pond is on Tulalip Bay.

Tagging History: Tagging has been conducted at Tulalip Hatchery since 1978.

Estimation of the Escapement of Tagged Fish: An intensive terminal fishery occurs in Tulalip Bay and is sampled at $\geq 20\%$. Despite the terminal fishery targeting these fish, rack returns have been relatively high, with an annual average of 4,409 from 1985 to 1995. Sample rates at the rack are 100%. There is no spawning available between the Tulalip Bay and the hatchery rack. The Snohomish system is not routinely sampled for CWTs, and the extent of straying to that drainage is unknown. Intensive spawning ground surveys were conducted in the Stillaguamish system from 1987 – 1991, and revealed no recoveries of this stock (Nelson, Loch, and Lucchetti 1997).

Current use of Data:

PSC: This indicator stock has been used to estimate fishery stock composition and interceptions of U.S. coho salmon by Canadian fisheries.

Other: ☐ Fishery or Stock Harvest Rate Index

☒ Comprehensive Coho

☒ Abundance Forecasting

☒ Coho Cohort/Catch Database

☐ Stray Rate Evaluations

☒ Intertribal Allocation

☒ Hatchery Evaluations

☐ Natural Production Estimates

Summary of Program Performance: Tagging goals have been consistently met and survival rates of the stock have been high. The extent of natural spawning in the Snohomish system has not been estimated.

Effect of Terminating Program: Terminating this program would have significant deleterious impacts on the terminal area run reconstruction for the Snohomish and Stillaguamish natural management units, two of the five management units in Puget Sound currently managed for natural production.

Table 11. Tagging History and Estimated Survival Rate for Tulalip Coho (recoveries through 1995).

Brood Year	Tag Code	Number Tagged	Stock	Minimum Survival Rate (%)
1978	050335	31,914	Skykomish	12.45
1979	050757	29,562	Skykomish	8.76
1980	051062	18,413	Skykomish	7.34
1982	211601	124,439	Skykomish	7.80
1983	211634	61,349	Skykomish	7.93
1984	211662	52,863	Skykomish	12.54
	211663	51,398	Skykomish	14.41
	211701	50,864	Skykomish	15.02
1985	211942	51,761	Wallace	8.69
1986	212261	48,915	Skykomish	11.08
1987	212531	52,704	Skykomish	17.50
1988	213149	47,870	May / Wallace	7.18
1989	211824	50,063	Skykomish	10.23
1990	212023	49,183	Skykomish	5.68
1991	212022	48,583	Skykomish	10.77
1992	212333	49,761	Skykomish	6.84
Mean Brood Year Rate =				9.73

AGATE PASS SEA PENS COHO

Stock Type: Hatchery

Program Description and History:

Hatchery: Agate Pass Seapens (Suquamish Tribe), central Puget Sound

Broodsource: Varied, primarily Wallace or Minter Creek.

Rearing and Release: Fish are incubated at WDFW Minter Creek Hatchery, reared at the WDFW Coulter Creek Hatchery, and transferred to the saltwater net pens as yearlings in January. Release occur in May or June, dependent upon fish weight and water temperature.

Tagging History: The production release has been marked since 1980, except for BY 1984 and BY 1991.

Estimation of the Escapement of Tagged Fish : An intensive terminal fishery is conducted on this stock. This fishery is CWT sampled at a high rate. Recoveries of strays have been documented (Dorn, Appleby, DeLong and Lutz 1996). The two nearest hatcheries, Grovers Creek and Cowling Creek Hatcheries, have together received more strays than any other hatchery recovery location, other than Wallace River Hatchery. Nearly all other hatchery stray patterns have been related to broodstock origin (e.g., Wallace River Hatchery) or rearing site (e.g., Minter Creek Hatchery). Recoveries are also frequently found at the Big Beef Creek research facility. Local stream utilization in the East Kitsap area has also been documented with a few CWT recoveries.

Current use of Data:

PSC: This indicator stock has been used to estimate fishery stock composition and interceptions of U.S. coho salmon by Canadian fisheries.

Other: ☐ Fishery or Stock Harvest Rate Index

☒ Comprehensive Coho

☒ Abundance Forecasting

☒ Coho Cohort/Catch Database

☒ Stray Rate Evaluations

☒ Intertribal Allocation

☒ Hatchery Evaluations

☐ Natural Production Estimates

Summary of Program Performance: Tagging goals have been consistently met (except for BY 1991 due to fish health problems) and survival has generally been very high. Efforts are made to keep accurate estimates of mortalities during seapen rearing. The broodstock is usually Wallace (Skykomish) but has varied if eggs are not available. The extent of straying to streams in the region is unknown.

Effect of Terminating Program: Loss of this program would result in a substantial reduction in the quality of stock composition estimates of Area 10 and Area 12 net fisheries.

Table 12. Tagging History and Estimated Survival Rate for Agate Pass Seapen Coho (recoveries through 1995).

Brood Year	Tag Code	Number Tagged	Stock	Minimum Survival Rate (%)
1980	632406	48,130	Minter + G. Adams	9.01
1981	632729	30,029	Skykomish	9.84
1982	633022	29,843	Skykomish	11.15
1983	632804	15,219	Wallace	17.34
	632805	14,870	Wallace	15.01
1985	211949	48,015	Snohomish	17.93
1986	212262	48,494	Skykomish + George Adams	16.41
1987	212522	47,260	Skykomish	22.56
1988	213522	49,668	Skykomish & Wallace	12.62
1989	211822	44,809	Wallace	9.01
1990	212025	38,483	Wallace	4.90
1992	212332	49,051	Minter	2.81
Mean Brood Year Rate =				12.04

KALAMA CREEK COHO

Stock Type: Hatchery

Program Description and History:

Hatchery: Kalama Creek Hatchery (Nisqually Tribe), tributary to the Nisqually River

Broodsource: Varied. Recently an effort has been made to limit production to Kalama or Clear Creek stock.

Rearing and Release: Eggs are incubated and reared on station. Yearling smolts are released in April.

Tagging History: Tagging has occurred since 1985.

Estimation of the Escapement of Tagged Fish: Fish return to rack in relatively high numbers, ranging from a high of 5,536 in 1992, to a low of 1,483 in 1989. Returns are sampled at the 100% rate. Stream surveys are not conducted for CWT sampling.

Current use of Data:

PSC: This indicator stock has been used to estimate interceptions of U.S. coho salmon by Canadian fisheries.

Other: ☐ Fishery or Stock Harvest Rate Index

☒ Comprehensive Coho

☒ Abundance Forecasting

☒ Coho Cohort/Catch Database

☐ Stray Rate Evaluations

☒ Intertribal Allocation

☒ Hatchery Evaluations

☐ Natural Production Estimates

Summary of Program performance: Tagging goals have been consistently met. Survival of the fish has generally been low and the adequacy of the tagging level has not been evaluated. Prior to BY 1992, non-local broodstock have been used. Consistent and complete rack sampling occurs annually. The extent of hatchery fish spawning in the Nisqually River is unknown.

Effect of Terminating Program: Termination of this program would result in a substantial reduction in the quality of stock composition estimates for net fisheries in the South Puget Sound region. In addition, this stock is a potential candidate for pairing up with the Deschutes wild stock as part of the double index tagging program.

Table 13. Tagging History and Estimated Survival Rate for Kalama Creek Coho (recoveries through 1995).

Brood Year	Tag Code	Number Tagged	Stock	Minimum Survival Rate (%)
1985	211950	48,388	George Adams	6.16
1986	212504	50,804	George Adams	2.07
1987	212852	50,699	George Adams	2.82
1988	213704	50,529	George Adams	2.26
1989	211821	50,001	George Adams	3.26
1990	212233	47,214	George Adams	1.09
1991	212223	49,012	Wallace	2.38
1992	212331	52,418	Clear Creek	1.73
Mean Brood Year Rate =				2.72

PORT GAMBLE SEA PENS COHO

Stock Type: Hatchery

Program Description and History:

Hatchery: Port Gamble Bay Pens (Port Gamble S'Klallam Tribe), Hood Canal

Broodsource: The production brood stock primarily used through BY 1991 was the Dungeness Hatchery stock; however, George Adams Hatchery stock was also used in two of these early years. The Quilcene Hatchery stock has since replaced the Dungeness Hatchery stock as the preferred production source -- but during transition a combination of stocks (including Dungeness, George Adams and Quilcene) were used in several years. The specific stocks receiving tags are listed in Table 14.

Rearing and Release: Fish are transferred to the pens as tagged fingerlings and reared until released as yearling smolts in mid May.

Tagging History: Tagging began with BY 1979.

Estimation of the Escapement of Tagged Fish: An intensive terminal fishery is conducted on this stock. This fishery is CWT sampled at a high rate. Strays were recovered in local hatcheries and streams in a 1995 coho straying study in Hood Canal (Ruggerone, 1997). Although the rate of straying could not be quantified, net-pen origin coho comprised the majority of coho recovered in streams sampled within 10 miles of the two Hood Canal net pens in.

Current use of Data:

PSC: This indicator stock has been used to estimate fishery stock composition and interceptions of U.S. coho salmon by Canadian fisheries.

Other: ☐ Fishery or Stock Harvest Rate Index

☒ Comprehensive Coho

☒ Abundance Forecasting

☒ Coho Cohort/Catch Database

☒ Stray Rate Evaluations

☒ Intertribal Allocation

☒ Hatchery Evaluations

☐ Natural Production Estimates

Summary of Program Performance: Tagging goals have been consistently met. Survival rates have been highly variable. The extent of straying into the local streams has not been quantified, but may be substantial.

Effect of Terminating Program: Terminating this program would have significant deleterious impacts on the terminal area run reconstruction for Hood Canal natural coho, one of the five management units in Puget Sound currently managed for natural production.

Table 14. Tagging History and Estimated Survival Rate for Port Gamble Seapens Coho (recoveries through 1995).

Brood Year	Tag Code	Number Tagged	Stock	Minimum Survival Rate (%)
1979	632212	21,958	Dungeness	0.92
	632131	15,421	Dungeness	16.04
1980	632321	53,721	Dungeness	8.67
1981	632562	30,061	George Adams	15.30
1982	633028	27,578	George Adams	9.88
1983	632751	14,927	Dungeness	12.32
	632752	14,928	Dungeness	11.48
1984	633355	14,345	Dungeness	5.97
	633356	14,175	Dungeness	5.69
	633357	14,046	Dungeness	5.36
1985	633361	12,434	Dungeness	0.70
	633617	12,874	Dungeness	0.65
	633621	12,384	Dungeness	0.95
1986	634231	46,617	Dungeness	5.33
1987	634761	34,488	Dungeness	15.72
1988	213150	42,157	Dungeness	1.21
1989	211823	51,080	Dungeness	7.38
1990	211825	52,873	Dungeness	4.69
1991	052450	19,287	Quilcene	4.76
	053140	26,984	Quilcene	4.82
1992	212334	47,082	Quilcene	2.99
Mean Brood Year Rate =				6.95

LOWER ELWHA COHO

Stock Type: Hatchery

Program Description and History:

Hatchery: Lower Elwha (Lower Elwha Tribe), Elwha River

Broodsource: Lower Elwha River stock exclusively.

Rearing and Release: Fish are reared and released on-station as yearlings. Releases are volitional and occur April - May.

Tagging History: Tagging has been conducted at Lower Elwha since 1978.

Estimation of the Escapement of Tagged Fish: Escapement numbers to the hatchery have been relatively high, with an average of 1,200 fish for the past 10 years. Hatchery rack CWT sampling is conducted at the 100% level. Attraction to the facility may not be high and it is assumed that hatchery coho do spawn in the Elwha River. Extensive CWT sampling for coho has not been conducted on the spawning grounds.

Current use of Data:

PSC: This indicator stock has been used to estimate fishery stock composition and interceptions of U.S. coho salmon by Canadian fisheries.

Other: ☒ Fishery or Stock Harvest Rate Index
☒ Comprehensive Coho
☒ Abundance Forecasting
☒ Coho Cohort/Catch Database
☐ Stray Rate Evaluations
☒ Intertribal Allocation
☒ Hatchery Evaluations
☒ Natural Production Estimates

Summary of Program Performance: Tagging goals have been consistently met. Survival of the stock has been very low and the adequacy of the tagging level has not been evaluated. With the exception of one year, consistent and complete rack sampling has occurred. The extent of hatchery fish spawning in the river is unknown.

Effect of Terminating Program: Termination of this program would result in the loss the only consistent tagging program in tributaries to the Strait of Juan de Fuca, a region with significant conservation concerns.

Table 15. Tagging History and Estimated Survival Rate for Lower Elwha Coho (recoveries through 1995).

Brood Year	Tag Code	Number Tagged	Stock	Minimum Survival Rate (%)
1978	050556	27,868	Lower Elwha	1.80
1979	050738	28,370	Lower Elwha	0.85
1980	050853	28,410	Lower Elwha	0.66
1981	051127	8,849	Lower Elwha	1.84
	051128	9,430	Lower Elwha	3.76
	051129	8,808	Lower Elwha	3.97
1982	051430	8,145	Lower Elwha	3.69
	051431	7,782	Lower Elwha	2.34
	051432	7,720	Lower Elwha	2.80
1985	211941	72,340	Lower Elwha	0.25
1986	212256	71,404	Lower Elwha	2.44
1987	212532	60,809	Lower Elwha	0.65
1988	213159	70,405	Lower Elwha	0.18
1989	211858	69,572	Lower Elwha	1.11
1990	212047	68,446	Lower Elwha	0.16
1991	212220	77,287	Lower Elwha	0.42
1992	212406	75,279	Lower Elwha	0.26
Mean Brood Year Rate =				1.60

QUEETS RIVER COHO

Stock Type: Wild

Program Description and History:

Project Objectives: The objectives of this project are to annually capture and CWT naturally reared coho smolts in the Queets River, and to estimate tagged escapement for exploitation rate analysis and marine survival rates for the stock. Another activity associated with this project is smolt yield estimates for the Queets River.

Broodsource: Queets River wild smolts

Tagging History: Wild smolts have been trapped and tagged in the Queets system since 1981. Wild smolts are annually trapped and tagged from March – June. Approximately 16 tributary smolt traps are located throughout the basin in representative habitat types. A unique tag code is generally assigned to each trap site. Fish are annually tagged from specific locations to maintain the time series data on key streams.

Estimation of the Escapement of Tagged Fish: Beginning in 1980, the total natural escapement has been estimated using a redd count methodology. By 1985 the current survey and data collection procedures had been standardized. The methodology involves index (intensive) and supplemental (extensive) redd counting areas. Index sections are chosen to represent the range of spawning habitat utilized by the stock. Index sections are surveyed on a weekly basis. Supplemental surveys are conducted once or twice each season, at times of peak spawning, over a wide range of spawning habitat not included in the index sections. The observed ratio (visible redds / cumulative redds) from index sections is used to expand visible redd counts from supplemental surveys. Supplemental surveys are conducted during the same time period, at or near peak spawning. Unsurveyed areas of spawning habitat are accounted for by expansion of redd densities estimated for surveyed reaches of similar habitat type and utilization. However, approximately 75% of all habitat utilized by coho is covered by surveys. Extensive carcass sampling also occurs during stream surveys.

Reporting of Queets River CWT sampling/recoveries is conducted by QFiD. Expanded CWT escapement recoveries have not been reported to the PSMFC database because of idiosyncrasies resulting from the use of multiple small tag codes within each year. QfiD staff have estimated the combined escapement of tagged fish for each year using three different methods (Blair and Chitwood, 1996).

Current use of Data:

PSC: This indicator stock has been used to estimate fishery stock composition and interceptions of U.S. coho salmon by Canadian fisheries.

Other: ☐ Fishery or Stock Harvest Rate Index
☐ Comprehensive Coho
☒ Abundance Forecasting
☒ Coho Cohort/Catch Database
☐ Stray Rate Evaluations
☒ Intertribal Allocation
☐ Hatchery Evaluations
☒ Natural Production Estimates

Data from this project is used to monitor and evaluate stock production, survival, and ocean and river fishery parameters of the Queets and other wild coho stocks from the North Coast Region. The data allows a means to assess the biological basis for spawning goals, monitor changes in marine survival due to ocean conditions, and determine the effect of environmental factors on stock production.

Summary of Program Performance: A comprehensive program of tagging, smolt yield estimation and escapement estimation exists for this stock. Tagging levels have been close or exceeded the annual goal of 35,000 in most of the years since 1986. Previous GLIM analysis by QFiD was conducted to evaluate similarities between this stock and the Salmon River and Quinault National fish hatcheries. Significant differences were found in fishery contributions and in some comparisons of ocean distributions. The wild stock also has a peak run timing that is significantly later than the hatchery stocks.

Effect of Terminating Program: Termination of this project would result in a substantial reduction in management capabilities and in the understanding of stock productivity relationships for the wild coho of the Queets River.

Table 16. Tagging History and Estimated Survival Rate for Queets River Coho (recoveries through 1995).

Smolt Year	Tag Code	Number Tagged	Stock	Minimum Survival Rate (%)
1981	Numerous	11,485	Wild Queets System	9.66
1982	Numerous	15,393	Wild Queets System	5.70
1983	Numerous	34,855	Wild Queets System	5.55
1984	Numerous	27,032	Wild Queets System	4.02
1985	Numerous	16,438	Wild Queets System	6.72
1986	Numerous	40,861	Wild Queets System	4.62
1987	Numerous	19,940	Wild Queets System	4.98
1988	Numerous	28,276	Wild Queets System	4.02
1989	Numerous	44,613	Wild Queets System	4.21
1990	Numerous	41,108	Wild Queets System	4.49
1991	Numerous	32,163	Wild Queets System	5.03
1992	Numerous	41,156	Wild Queets System	2.51
1993	Numerous	20,202	Wild Queets System	1.07
1994	Numerous	31,319	Wild Queets System	3.57
1995	Numerous	49,300	Wild Queets System	N/A
Mean Brood Year Rate =				4.73

Summary

Tribal chinook and coho indicator stocks were reviewed for the following information:

1. Program description and history
2. Current use of data (PSC and other)
3. Program performance
4. Effects of terminating program

All chinook stocks are being used in PSC CWT analysis and there is technical consensus that the stocks are all essential components of the PSC indicator stock program. Some of the stocks have not been used in exploitation rate analysis because of questions surrounding the estimates of CWT escapement. The list of coho stocks has not been technically reviewed by the PSC CoTC. The CoTC has not been as active as the CTC with data analysis, so current PSC analyses have centered on estimates of fishery stock composition and interceptions of U.S. coho salmon by Canadian fisheries. This may change in the near future if new abundance based management proposals move forward.

The distinction between PSC purposes and other fisheries management purposes is not always clear cut. CWT data from all of the tribal indicator stocks is used for a wide variety of analytical and domestic management purposes. These uses include harvest model development, comprehensive coho and chinook management plans, abundance forecasting, in-season management, terminal area reconstruction, intertribal allocation, stray rate evaluations, natural stock productivity, hatchery evaluations and others.

Fisheries management is becoming finer tuned, with an increasing need to perform more stock specific evaluations. To meet these challenges will require more CWT data, and the need for more indicator stocks will likely be increasing.

The establishment of indicator stocks required an agency commitment to a long term investment in tagging and tag recovery. For most all of these stocks a long term trend in data collection has been established. These consistent data sets are invaluable for understanding biological parameters and monitoring trends in fishery impacts.

Terminating programs would result in the loss of certain analytical capabilities, loss of indicators for the associated region, and the analytical loss of long term data sets.

Recommendations

1. Maintain the tagging of all current tribal indicator stocks.
2. Continue with the plan to review the list of regional coho indicator stocks.
3. Develop proposals to address shortcomings in escapement estimation for certain indicator stocks.
4. After specific comprehensive coho, comprehensive chinook, and FMP management units have been designated, pursue an inter-agency review of the regional indicator stock program.
5. Conduct periodic performance reviews of the list of tribal indicator stocks.
6. Funding decisions need to consider the possibility of future changes in the indicator stock program (i.e. the addition of more stocks, and the changing costs of programs).

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