

**ASSESSMENT OF THOMPSON RIVER COHO
STOCK DISTRIBUTION IN
NORTH PUGET SOUND FISHERIES**

**PSC Southern Boundary Restoration & Enhancement Fund
2008**

Report

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By

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INTRODUCTION

The 2008 fisheries collection presented in this Northwest Indian Fisheries Commission (NWIFC) report completes four consecutive years of applied DNA genetic stock identification (GSI) stock composition analyses to assess the impacts on the threatened Thompson River Coho stocks in the Bellingham Bay commercial coho fisheries and the San Juan Islands / Point Roberts commercial chum fisheries. The assumption was made that it would be necessary to analyze the fisheries for at least four years to understand the annual variation in relative abundance, migration timing, and distribution. The DNA GSI analyses employed a Bayesian Markov-Chain Monte Carlo analysis (cBayes) stock composition algorithm model. Genotype profiles are known from an established baseline constructed from samples collected from hatcheries and on spawning grounds over a wide geographic range of baseline stocks. Samples collected from the fisheries landed catch are compared to the baseline to establish mix-stock contributions.

Historical coded-wire tag recoveries indicate presence of Thompson River/ Interior Fraser Coho in these fisheries. The fisheries have been restricted to meet objectives of the Southern Coho Management Plan (maximum U.S. fishery impact of 10% exploitation rate). This coded-wire tag information is not sufficient to represent potential differences in impact levels by sub-areas and time periods, useful to managers in minimizing Thompson River impacts while allowing harvest on target stocks and species. Management currently rely on CWT data collected from fisheries executed in the 1986 through 1991 catch years to calculate Thompson River coho exploitation rates in the above mentioned North Puget Sound fisheries (Anonymous 1994). The present geographical and temporal boundaries of those fisheries have changed. In addition, one Southern Coho Fishery Regulation Assessment Model (FRAM) time period for management and historic data compilation is from October through December. The present data or lack of does not provide the resolution needed to most effectively estimate impacts on Thompson coho. Specifically, Canadian fishery managers have asserted that these stocks have largely cleared lower Fraser River fisheries by mid-October, yet the FRAM modeling will show a relatively significant catch of Thompson coho in Area 7 chum directed fisheries occurring through-out the month of October.

Developing more accurate exploitation rates on Thompson Coho will give managers better information to shape fisheries to minimize impacts upon this stock of concern without unduly restricting fisheries targeting chum (Area 7/7A) and terminal area returns of coho (Area 7B). The added bonus will be to supply an accurate resolution of United States and Canadian stock contributions to the fisheries. A Washington State salmon catch areas map displays locations of the referenced salmon fisheries (Figure 1).

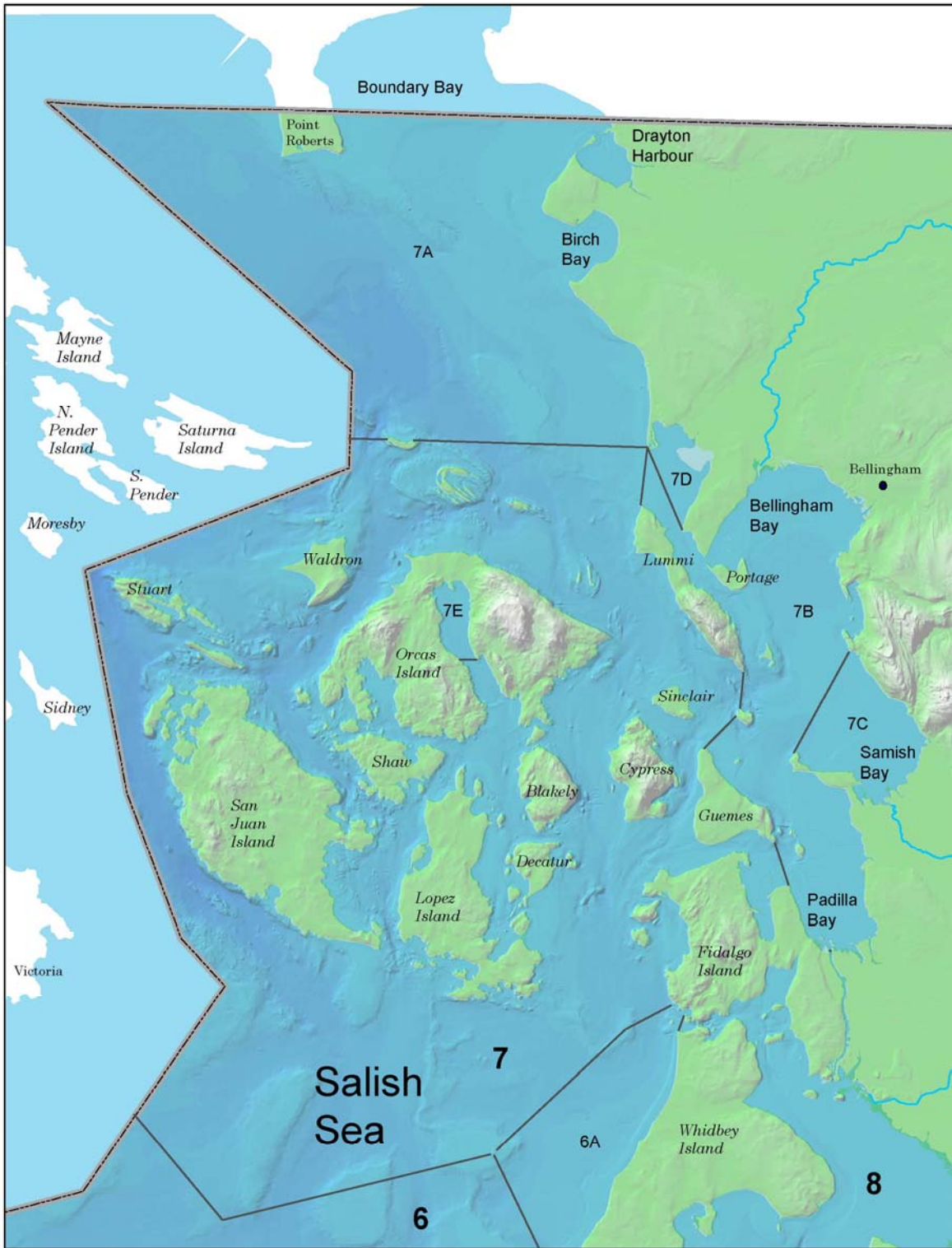


Figure 1. Washington State salmon fisheries catch areas for northern Puget Sound (Map developed by Northwest Indian Fisheries Commission).

Project Objectives:

1. Sampling commercial fisheries

Collect samples of operculum tissue from coho salmon in two targeted North Puget Sound 2008 commercial fisheries. Tissues will be collected from 200 randomly selected unmarked coho and 200 marked coho in each catch area per week of peak fishing activity. Fin-clips will be collected from coho bycatch in chum fisheries with no coho retention.

2. Genetic analysis

Operating under a subcontract, the Canadian Department of Fisheries and Oceans (DFO) Molecular Genetics Lab will complete microsatellite DNA analysis of the 2008 tissue samples. The resulting data will be entered into stock assessment program model, which generates statistical estimates of the stock composition of each weekly sample from each fishery.

3. Stock composition of sampled fisheries

Genetic analyses results will be presented for the 2008 fisheries describing the contribution of three aggregate stock groups: Washington, British Columbia, and the threatened Thompson River populations.

METHODS

Sampling Protocol

Northwest Indian Fisheries Commission (NWIFC) staff and Washington Department of Fish and Wildlife (WDFW) crews collected coho tissue samples weekly from the 2008 Bellingham Bay commercial coho fisheries and the San Juan Islands – Point Roberts 7/7A commercial chum fisheries. DNA samples were collected by operculum punch (fin-clip for live releases) and preserved in 95% ethanol. Samples were drawn from tenders or processing facilities where catches of many vessels are combined. This insures sampling representation from several vessels and different gear types. Considering the past difficulties of obtaining enough samples from the Area 7/7A Commercial Chum Fisheries, the WDFW observer program collected additional coho bycatch samples directly from non-treaty seine fishing vessels.

The objective was to collect 200 unmarked and 200 marked coho tissue samples per week from each fishery during the peak landed catch period. An unmarked coho was defined as an individual fish with a visible adipose fin and no detectable coded wire tag. A marked coho was defined as an individual fish missing the adipose fin (adipose clipped) and or with a detectable coded wire tag implant. The sample size goal was arrived at from two sources. Simulations from previous Puget Sound chum genetic stock studies using less accurate electrophoresis genetic analyses methods demonstrated large increases in precision when sample size increased from 100 to 200 and a small increase in precision for sample size above 200 (Anonymous 1988). In addition, the ‘Evaluation and application of micro-satellite and major histocompatibility complex variation for stock identification of Coho salmon in British Columbia’ report used fish samples in the 200 range in simulation analyses to determine effective loci for stock separation in fisheries (Beacham et al. 2001).

Management Weeks

In the Puget Sound salmon fisheries, management periods are established for each species and catch area during pre-season planning. These periods correspond to the timing of the target salmon species in the area waters. Fishery managers’ offer fishing opportunities during management weeks within the management period after considering conservation concerns.

Management weeks are defined as the period from Sunday to Saturday. If first management week of the year included fewer than four days, i.e. January 1 fell on a Friday, Saturday, or Sunday we redefined the first management week as beginning on the first Sunday in January. This adjustment allows for the comparison among management weeks to better approximate a Julian date comparison, and therefore to reflect the true annual variation in fisheries. Appendix 1 shows management week dates for 2008.

Fishery Sampling Summaries

The 2008 fisheries sampling began September 7 and ended mid-November. The landed commercial catch numbers displayed in the sampling summary tables were retrieved from the NWIFC Tribal Fish Ticket database. The landed catch are preliminary numbers taken from softdata.

Bellingham Bay commercial coho fishery (Catch Area 7B)

The fishery was open for seven weeks starting September 7 and ending October 25. Samples were collected over all 7 weeks. The marked Coho sampling objectives were met for the first 5 weeks. The unmarked Coho sampling objectives were obtained in management weeks 37, 38, 40, and 41. Peak landed catch occurred in the opening week (week 37) of the fishery and declined each succeeding week. Sampling results are summarized in table 1.

Table 1. Commercial coho harvest and sampling summary from Area 7B in 2008

Mgmt. Week	Preliminary Landed Commercial Catch			DNA	Samples
	Treaty	Non-treaty	Total	Unmarked	Marked
37	4973	2669	7642	190	208
38	2687	889	3576	210	221
39	2561	378	2939	74	194
40	1633	69	1702	223	203
41	1562	12	1574	210	306
42	283	0	283	84	127
43	81	0	81	57	65
Totals	13780	4017	17797	1048	1324

San Juan Islands commercial chum fisheries (Catch Area 7)

The commercial chum fisheries in catch area 7 are comprised of gillnet and purse seine fleets. For the non-treaty commercial chum fisheries, WDFW regulations required non-retention of unmarked coho with the exception of a non-selective coho reef net fishery operating during this time frame. Consequently, the majority of the sampling opportunities are from the treaty fishery.

In 2008, coho bycatch landings were recorded for the first three weeks of the fisheries. Sampling opportunities were few. Collection objectives were not met. The WDFW Observer Program crew did take live samples from the non-treaty seine fishery. Consequently, there is a discrepancy in landed catch and samples collected due to the fisher non-retention of unmarked coho. Catch and sampling results for catch area 7 are shown in table 2.

Table 2. Commercial coho bycatch harvest and sampling summary from Area 7 in 2008

Mgmt. Week	Preliminary Landed Commercial Catch			DNA	Samples
	Treaty	*Non-treaty	Total	Unmarked	Marked
41	0	50	50	0	1
42	30	0	30	45	22
43	6	0	6	4	3
44	0	0	0	0	0
45	0	0	0	0	0
Totals	36	50	86	49	26

* Non-retention of unmarked coho in non-treaty fishery.

Point Roberts commercial chum fisheries (Catch Area 7A)

The commercial chum fisheries in catch area 7A are essentially similar to catch area 7. Little fishing effort and few coho bycatch landed contributed to an unsuccessful sampling season. The WDFW Observer Program crew obtained the only samples taken occurring in week 42. Catch and sampling results for catch area 7A are shown in table 3.

Table 3. Commercial coho bycatch harvest and sampling summary from Area 7A in 2008

Mgmt. Week	Preliminary Landed Commercial Catch			DNA	Samples
	Treaty	*Non-treaty	Total	Unmarked	Marked
41	0	75	75	0	0
42	25	1	26	2	2
43	20	0	20	0	0
44	3	0	3	0	0
45	2	0	2	0	0
Totals	50	76	126	2	2

* Non-retention of unmarked coho in non-treaty fishery.

Laboratory and Stock Composition Analysis

The Canadian Department of Fisheries and Oceans (DFO) Molecular Genetics Laboratory (MGL) at the Pacific Biological Station isolated the genetic DNA from approximately 10-20mg. of tissue per sampled fish using Promega Wizard extraction techniques. MGL assayed samples for genetic variation at 13 microsatellite loci and 2 linked exons of a major histocompatibility complex locus. The loci surveyed are listed in Appendix 2 along with source references. Products amplified using polymerase chain reaction were size fractured with the ABI 3730 automated DNA sequencer. A more detailed description of laboratory techniques can be found in Beacham et al. 2006 and Beacham et al. 2001.

The baseline populations were derived from archived tissue samples or DNA specific sample collections usually taken from hatcheries or spawning grounds. The genomic DNA was extracted from operculum punches, fin clips, scales, or liver. To develop baseline stock profiles, genotypic frequencies were determined at each locus in each population. Appendix 3 lists DFO's 'southern coho baseline' of 110 populations.

A cBayes program developed by DFO (Neaves et al. 2005) using Bayesian estimators was used for the stock identification analysis (Pella and Masuda 2001). The procedure is outlined by Beacham et al. (2005a). Stock composition was generated for each marked and unmarked sample collection per week per fishery separately.

For the purposes of this analysis, we consider the genetic stock identification technique capable of accurately measuring the contributions of regional coho stock aggregates from Washington State, southern British Columbia, and the subset Thompson River. Using the available coho stock baseline and the sample sizes specified in the study protocol, contributions of individual stocks or river systems may not be accurately resolved.

STOCK COMPOSITION ESTIMATES

Bellingham Bay Commercial Coho Fishery (Area 7B)

The north Puget Sound stock aggregate received the largest proportion over all seven management weeks ranging from 76% to 94% and 93% to 98% for unmarked and marked fishery collections, respectively (Tables 4 and 5). The individual stock assignments indicate the Nooksack stock represents a significant proportion of the north Puget Sound aggregate. One exception occurred in the marked collection for week 37 where the Skykomish stock from the Snohomish River drainage was represented in over half (55%) of the total contribution and north Puget Sound aggregate.

Table 4. The cBayes model: percent contributions (\pm one standard deviation) of United States and Canadian *unmarked* coho stock aggregates to the 2008 commercial fishery in Bellingham Bay (CA 7B).

Stock Aggregates Unmarked*	Management Week						
	37	38	39	40	41	42	43
Sample size	204 (0)	207 (2)	74 (2)	203 (2)	205 (1)	81 (0)	56 (0)
A15-16-28 S. Mainland	0.6 \pm 0.9	1.4 \pm 1.1	6.6 \pm 3.5	0.6 \pm 1.0	0.3 \pm 0.6	1.4 \pm 2.4	0.1 \pm 0.9
A14-18 ECVI	3.2 \pm 1.9	3.6 \pm 2.3	2.2 \pm 2.9	2.8 \pm 1.9	3.6 \pm 1.8	5.5 \pm 4.3	0.2 \pm 1.0
A19-26 WCVI	0.0 \pm 0.2	0.6 \pm 0.8	0.0 \pm 0.6	0.1 \pm 0.3	0.1 \pm 0.4	0.2 \pm 0.9	0.0 \pm 0.6
Lower Fraser	0.9 \pm 0.9	4.2 \pm 1.9	0.3 \pm 1.1	2.4 \pm 1.7	0.1 \pm 0.4	0.9 \pm 2.0	4.1 \pm 5.1
Mid-Fraser	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.2	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.2	0.0 \pm 0.4
North Thompson	0.5 \pm 0.5	0.7 \pm 0.7	0.0 \pm 0.5	0.0 \pm 0.2	0.0 \pm 0.3	0.7 \pm 1.2	0.0 \pm 0.6
South Thompson	0.5 \pm 0.5	1.1 \pm 0.8	0.0 \pm 0.4	0.5 \pm 0.5	0.0 \pm 0.2	0.0 \pm 0.5	0.0 \pm 0.6
Lower Thompson	0.0 \pm 0.1	0.4 \pm 0.5	0.0 \pm 0.3	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.4	0.0 \pm 0.3
Fraser Canyon	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.0	0.0 \pm 0.2	0.0 \pm 0.2
North Puget Sound	92.0 \pm 2.8	84.8 \pm 4.2	75.7 \pm 6.6	91.8 \pm 2.9	93.5 \pm 2.7	89.3 \pm 5.8	87.6 \pm 8.5
South-Central Puget S.	2.2 \pm 1.7	3.0 \pm 2.6	11.8 \pm 4.6	1.7 \pm 1.6	1.9 \pm 1.9	1.5 \pm 2.4	6.4 \pm 7.7
Juan de Fuca Strait	0.0 \pm 0.1	0.1 \pm 0.4	0.2 \pm 1.0	0.1 \pm 0.4	0.0 \pm 0.3	0.4 \pm 1.2	1.4 \pm 2.3
Hood Canal	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.3	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.3	0.0 \pm 0.2
Washington Coast	0.0 \pm 0.2	0.1 \pm 0.4	3.1 \pm 2.6	0.0 \pm 0.2	0.2 \pm 0.5	0.0 \pm 0.4	0.2 \pm 0.9
Columbia River	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.2	0.0 \pm 0.1	0.2 \pm 0.4	0.0 \pm 0.2	0.0 \pm 0.3
California	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.3	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.2	0.0 \pm 0.3

The Canadian east coast Vancouver Island, south mainland, lower Fraser stock aggregates and the Washington south Puget Sound stock aggregate comprised most of the remaining proportions in any give week in the unmarked fishery samples. The east coast Vancouver Island and south mainland stock aggregates were not present in the marked fishery samples.

Thompson River stock aggregate contribution ranged from 0% to 2% in the unmarked fishery collections. There was no detectable presence in management weeks 39, 41, and 43. As expected Thompson River coho were not detected in the marked fishery collections.

Table 5. The cBayes model: percent contributions (\pm one standard deviation) of United States and Canadian *marked* coho stock aggregates to the 2008 commercial fishery in Bellingham Bay (CA 7B).

Stock Aggregates marked**	Management Week						
	37	38	39	40	41	42	43
Sample size	208 (1)	220 (3)	191 (0)	200 (3)	307 (5)	129 (3)	62 (0)
A15-16-28 S. Mainland	0.0 \pm 0.2	0.2 \pm 0.5	0.1 \pm 0.3	0.6 \pm 0.9	0.0 \pm 0.2	0.3 \pm 0.7	0.2 \pm 0.9
A14-18 ECVI	0.0 \pm 0.3	0.4 \pm 0.7	0.0 \pm 0.3	0.1 \pm 0.3	0.1 \pm 0.3	0.1 \pm 0.5	0.1 \pm 0.9
A19-26 WCVI	0.0 \pm 0.2	0.0 \pm 0.2	0.0 \pm 0.2	0.0 \pm 0.2	0.4 \pm 0.4	0.0 \pm 0.3	0.1 \pm 0.8
Lower Fraser	2.5 \pm 1.3	0.6 \pm 0.8	0.6 \pm 1.0	0.6 \pm 0.7	0.7 \pm 0.9	0.5 \pm 1.0	0.1 \pm 0.9
Mid-Fraser	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.2	0.0 \pm 0.4
North Thompson	0.0 \pm 0.2	0.0 \pm 0.2	0.0 \pm 0.2	0.0 \pm 0.2	0.0 \pm 0.1	0.0 \pm 0.3	0.3 \pm 1.0
South Thompson	0.0 \pm 0.2	0.0 \pm 0.2	0.0 \pm 0.2	0.0 \pm 0.2	0.0 \pm 0.1	0.0 \pm 0.3	0.0 \pm 0.6
Lower Thompson	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.2	0.0 \pm 0.3
Fraser Canyon	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.0	0.0 \pm 0.1	0.0 \pm 0.0	0.0 \pm 0.1	0.0 \pm 0.2
North Puget Sound	97.4 \pm 1.4	98.1 \pm 1.4	97.3 \pm 1.9	92.8 \pm 2.6	98.3 \pm 1.4	95.0 \pm 3.1	96.9 \pm 4.1
South-Central Puget S.	0.0 \pm 0.3	0.1 \pm 0.5	1.6 \pm 1.4	5.8 \pm 2.3	0.5 \pm 0.9	4.0 \pm 2.8	1.8 \pm 3.2
Juan de Fuca Strait	0.0 \pm 0.1	0.2 \pm 0.5	0.0 \pm 0.1	0.0 \pm 0.2	0.1 \pm 0.2	0.1 \pm 0.4	0.1 \pm 0.6
Hood Canal	0.0 \pm 0.1	0.3 \pm 0.6	0.0 \pm 0.2	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.2 \pm 0.8
Washington Coast	0.0 \pm 0.1	0.0 \pm 0.2	0.3 \pm 0.5	0.0 \pm 0.1	0.0 \pm 0.2	0.0 \pm 0.3	0.0 \pm 0.4
Columbia River	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.3
California	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.1	0.0 \pm 0.3

San Juan Islands and Point Roberts Commercial Chum Fisheries (Areas 7 & 7A)

Stock composition analysis of these fisheries was impossible to assess due to lack of samples except for week 42 in the San Juan Islands area 7 fisheries. The unmarked collection was composed of 50% lower Fraser River, 34% east coast Vancouver Island, 8% south mainland, and 6% north Puget Sound stock aggregates. The marked collection contained 81% lower Fraser River and 18% east coast Vancouver Island.

EVALUATION

Sampling

For the Bellingham Bay (Area 7B) commercial coho fishery, the project has obtained a four year dataset of unmarked coho tissue samples for management weeks 39 through 43. Samples have been collected in weeks 37, 38, and 44 in two or three of the four years. In particular for 2008, the 200 sample objective was closely met for weeks 37 and 38. Even though the 200 sample objective was not always met, the largest weekly fisheries sample collections run four weeks consecutively and usually coinciding with peak fishery landings for all four years.

Over the four years, coho bycatch sampling objectives were never met for the San Juan Islands / Point Roberts (Area 7/7A) commercial chum fisheries with the one exception of 213 samples taken in the San Juan fishery (area 7) for week 42 in 2005. These fisheries remain a difficult challenge to sample. The only landings of coho bycatch are in the treaty and non-treaty reef net fisheries. The non-treaty seine and gillnet fisheries cannot retain their coho catch due to Washington State fishery regulations. Another problem was access to the fish because some of the retained bycatch never makes it to market. The WDFW Observer Program effort has helped in obtaining live samples from the non-treaty purse seine fisheries though this is a volunteer effort plus the crews are only present in the area during the first few weeks of the fisheries. A research vessel directed to sample catch during the fisheries may be the only answer to resolve the sampling problem though this may not be cost effective considering the indicated low bycatch numbers.

A subset of marked coho tissue samples were collected for the first time in 2008. Marked coho are adipose clipped and or coded wire tagged fish representing the hatchery production portion of the run. On average two-thirds of the landings are marked coho for the Bellingham Bay commercial coho fisheries. Consequently, sampling opportunities are greater for this segment of the catch. In the Bellingham Bay fisheries, sampling objectives were met for the first five consecutive weeks. Collecting this subset of samples in the San Juan Islands and Point Roberts fisheries were just as difficult for all the above mentioned reasons.

An analysis of sample size requirements may be explored by fishery managers as it relates to the southern coho baseline and stock aggregates employed. The dataset would be used as a guide to generate known sample stock proportions to identify sample size accuracy.

Stock Identification Analysis

In the 2008 Bellingham Bay commercial coho fisheries, additional marked coho samples were collected. Collection of these samples served two purposes, to assess the stock composition of the hatchery production portion of the fisheries catch and to reaffirm the non-presence of Thompson River Coho in this segment of the fisheries. As expected, Thompson River Coho stocks were not recovered in the landed catch. Thompson River Coho are primarily a wild stock component of the coho run in the Fraser River drainage. Puget Sound stocks comprised most of

the production (marked) sampled catch at 97% or greater for any given week. In particular, Nooksack hatchery releases contributed significantly to the weekly proportions.

A consecutive four year dataset has been developed assessing the coho stock composition of the wild component of the Bellingham Bay commercial coho fisheries including the 2008 unmarked sample collection. Specifically, four years of data were collected for management weeks 39 through 43. In reviewing the 4 years of data, Washington stocks represented at least 76% of the stock composition per week during this time frame. Columbia River and California stock aggregates were not detected in the fisheries over the 4 years. The Hood Canal stock aggregate was only detected in the 2007 fishery in week 39 at 1%.

The major Canadian stock aggregate contributions were south Mainland, east coast Vancouver Island, and lower Fraser River. These stocks were present in the Bellingham Bay commercial coho fisheries in any given week when considering the full 4 years of data from 2005 to 2008. There was one exception for week 41 where the south Mainland stock aggregate was not recovered in any of the 4 years. No trend in abundance was observed with any of the above mentioned stocks. The west coast Vancouver Island, mid-Fraser River, and Fraser Canyon stocks showed little to no presence in the fisheries. The west coast Vancouver Island stock aggregate was recovered in only four weekly sample collections over the four year period. The mid-Fraser River stock aggregate was only recovered in weeks 37 and 38 for 2007, plus week 44 in 2006. The Fraser Canyon stock was detected in only one week in each of three collection years 2005 through 2007 and not beyond week 39.

The major objective of the project was to separate out stock proportions of Thompson River coho in the fisheries. The Thompson stock aggregate was consistently detected in the first two weeks of the Bellingham Bay commercial coho fisheries over the four year sampling period. The largest contribution was seen in 2007 in management weeks 37 and 38 at 11% and 13%, respectively from the unmarked coho sample collection. Some level of presence can be detected in weeks fished over the four years combined though contributions were 1% to zero in weeks 39 to 44 with the exception of a 4% contribution in week 39 in the 2005 fisheries collection and zero recoveries in week 43 for all four years. The Thompson River stock aggregate is made up of three population segments north Thompson, south Thompson, and lower Thompson. The lower Thompson population segment appeared in the fisheries in 2007 only in weeks 37 and 38 at 3% and 1%, respectively over the four years.

Benefits from the Project

This study demonstrated that Thompson River coho stock contribution to north Puget Sound fisheries can be assessed using Microsatellite DNA techniques. The revised baseline appears to have increased stock proportion accuracy. The cBayes approach appears to be the preferred model for stock composition assessment in these fisheries.

In reviewing the 2005, 2006, and 2007 data where both the cBayes Bayesian estimator program and SPAM (version 3.7; Debevec et al. 2000) a statistical analysis of mixtures software program were used to estimate stock composition of each sample group, the cBayes model typically delivers larger Puget Sound stock aggregate contributions. The (SPAM) maximum likelihood technique gives higher loadings to lower Fraser River and east coast Vancouver Island stocks.

From a known sample analysis conducted by the DFO genetics lab running six populations independent of the baseline of known proportions, the cBayes model results were closer to the true values compared to the SPAM model results (Kirby 2007). Both models performed comparably in separating out Thompson River coho stocks from the fishery samples for all three years.

The nine Washington stocks collected in 2007 and added to the revised baseline did generate closer results between the two stock composition models when comparing the re-analyzed 2006 fishery samples with the original baseline results (Kirby 2008). In particular, the SPAM model results computed Puget Sound aggregate increases for all management weeks. These results suggest some of the additional baseline stocks collected are contributing to the fisheries and the lack of their presence in the original baseline were contributing to some stock proportion bias errors. It also suggests that the cBayes model does not need as robust a baseline as the SPAM model. The body of literature suggests greater accuracy with cBayes. Further analysis of model performance may be warranted to meet the necessary confidence of fishery resource managers.

The four year dataset gives a clearer picture of stock composition in the Bellingham Bay commercial coho fisheries. Further analysis of the data will increase accuracy for abundance, optimize harvest rates, and help maintain escapement goals for natural and hatchery stocks. Furthermore, fishery stock composition based migration timing curves will serve as a conservation tool to adjust management regimes when it is necessary to reduce catch of weak stocks such as Thompson River coho. Finally, the data will help resolve Thompson River coho exploitation rate concerns.

A published report is planned to develop estimated Thompson River Coho catch in the Bellingham Bay commercial coho fisheries using weighted landed catch averages.

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APPENDICES

Appendix 1. Management Weeks

2008 Management Weeks (Sunday - Saturday)

Mon	Week No.	Calendar Dates		Julian Dates		
		Start	End	Start	End	
Jan	1	1-Jan	5-Jan	1	5	
	2	6-Jan	12-Jan	6	12	
	1	3	13-Jan	19-Jan	13	19
		4	20-Jan	26-Jan	20	26
		5	27-Jan	2-Feb	27	33
Feb	6	3-Feb	9-Feb	34	40	
	7	10-Feb	16-Feb	41	47	
	2	8	17-Feb	23-Feb	48	54
		9	24-Feb	1-Mar	55	61
Mar	10	2-Mar	8-Mar	62	68	
	11	9-Mar	15-Mar	69	75	
	3	12	16-Mar	22-Mar	76	82
		13	23-Mar	29-Mar	83	89
Apr	14	30-Mar	5-Apr	90	96	
	15	6-Apr	12-Apr	97	103	
	4	16	13-Apr	19-Apr	104	110
		17	20-Apr	26-Apr	111	117
		18	27-Apr	3-May	118	124
May	19	4-May	10-May	125	131	
	20	11-May	17-May	132	138	
	5	21	18-May	24-May	139	145
		22	25-May	31-May	146	152
June	23	1-Jun	7-Jun	153	159	
	24	8-Jun	14-Jun	160	166	
	6	25	15-Jun	21-Jun	167	173
		26	22-Jun	28-Jun	174	180

Mon	Week No.	Calendar Dates		Julian Dates		
		Start	End	Start	End	
Jul	27	29-Jun	5-Jul	181	187	
	28	6-Jul	12-Jul	188	194	
	7	29	13-Jul	19-Jul	195	201
		30	20-Jul	26-Jul	202	208
		31	27-Jul	2-Aug	209	215
Aug	32	3-Aug	9-Aug	216	222	
	33	10-Aug	16-Aug	223	229	
	8	34	17-Aug	23-Aug	230	236
		35	24-Aug	30-Aug	237	243
Sep	36	31-Aug	6-Sep	244	250	
	37	7-Sep	13-Sep	251	257	
	9	38	14-Sep	20-Sep	258	264
		39	21-Sep	27-Sep	265	271
Oct	40	28-Sep	4-Oct	272	278	
	41	5-Oct	11-Oct	279	285	
	10	42	12-Oct	18-Oct	286	292
		43	19-Oct	25-Oct	293	299
		44	26-Oct	1-Nov	300	306
Nov	45	2-Nov	8-Nov	307	313	
	46	9-Nov	15-Nov	314	320	
	11	47	16-Nov	22-Nov	321	327
		48	23-Nov	29-Nov	328	334
Dec	49	30-Nov	6-Dec	335	341	
	50	7-Dec	13-Dec	342	348	
	12	51	14-Dec	20-Dec	349	355
		52	21-Dec	27-Dec	356	362
		53	28-Dec	31-Dec	363	366

Appendix 2. Standard abbreviations of corresponding loci screened in DNA microsatellite analysis with corresponding source references.

STANDARD LOCI ABBREVIATION

Ots2
Ots3
Ots101
Ots103
Oki1
Oki10
Oki100
Oki101
Ogo2
One111
Ssa407
OtsG253b
Omy325

SOURCE REFERENCES

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Smith et al. 1998
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Olsen et al. 1998
Olsen et al. 2000
Cairney et al. 2000
Williamson et al. 2002
O’Connell et al. 1997

Major Histocompatibility Complex exons

α 1
 α 2

MHC-Onki-A gene

Miller and Withler 1998
Miller and Withler 1998

Appendix 3. Baseline coho stocks included in the stock composition analysis of the Bellingham Bay coho commercial fisheries (Catch Area 7B) and coho bycatch in the San Juan Islands and Point Roberts commercial chum fisheries (Catch Areas 7 & 7A).

Region

Stock

A15-16-28 B.C. south Mainland	Ashlu Capilano Chapman Lang Mamquam Seymour_mark Sliammon Tenderfoot
A14-18 East Coast Vancouver Island	Big_Qualicum Black_clip Chase Chemainus Cowichan Goldstream Kirby Nanaimo Puntledge Rosewall_Creek Roy_Creek Shawnigan
A19-26 West Coast Vancouver Island	Conuma Cypre Kennedy Kootowis Maggie_River Nitinat Pachena Robertson San_Juan Sarita Sooke Thornton_Creek Tranquil

Appendix 3 (continued). Baseline coho stocks included in the stock composition analysis of the Bellingham Bay coho commercial fisheries (Catch Area 7B) and coho bycatch in the San Juan Islands and Point Roberts commercial chum fisheries (Catch Areas 7 & 7A).

<u>Region</u>	<u>Stock</u>
Lower Fraser River	Alouette
	Birkenhead
	Chehalis
	Chilliwack
	Inch
	Kanaka
	Nicomén
	Norrish
	Poole_Cr
	Salmon_LF
	Stave
Upper_Pitt	
Middle Fraser River	Bridge
	Gates_Creek
	Mckinley
	Seton_Creek
North Thompson River	Avola
	Barriere
	Birch_Island
	Blue_River
	Dunn
	Fennell
	Lemieux
	Lion
	Louis
	Mann
	Pig_Channel
	Raft
	Reg_Christie

Appendix 3 (continued). Baseline coho stocks included in the stock composition analysis of the Bellingham Bay coho commercial fisheries (Catch Area 7B) and coho bycatch in the San Juan Islands and Point Roberts commercial chum fisheries (Catch Areas 7 & 7A).

<u>Region</u>	<u>Stock</u>	<u>Watershed</u>
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South Thompson River	Bessette	
	Danforth	
	Duteau_Shwp	
	Eagle	
	Harris_Cr	
	LangChan_Shwp	
	McMomee	
	Mid_Shuswap	
	Momich	
	Salmon_SA	
	Senn	
	Sinmax	
	Wap_Cr	
Lower Thompson river	Bonaparte	
	Coldwater	
	Deadman	
	Spius	
Fraser Canyon	Nahatlatch	
North Puget Sound	N.F. Nooksack	Nooksack
	S.F. Nooksack	Nooksack
	Jones Creek	Skagit
	Sorensen Creek	Skagit
	Marblemount	Skagit
	Fortson Creek	Stillaguamish
	Skykomish River	Snohomish
	Wallace	Snohomish

Appendix 3 (continued). Baseline coho stocks included in the stock composition analysis of the Bellingham Bay coho commercial fisheries (Catch Area 7B) and coho bycatch in the San Juan Islands and Point Roberts commercial chum fisheries (Catch Areas 7 & 7A).

Region

Stock

Watershed

South-Central Puget Sound	Issaquah Creek Voight Creek White River Nisqually Minter	Lake Washington Puyallup Puyallup Nisqually Kitsap
Hood Canal	Dewatto River Quilcene	Dewatto Quilcene
Strait of Juan de Fuca	Dungeness River Elwha River	Dungeness Elwha
Washington Coast	Bingham Clearwater Queets Quillayute Shale Willapa	
Columbia River	Clackamas Cowlitz Lewis	
California	Eel_South Eel_West Mill_Smith Noyo_Cal	

