SOUTHERN STUDY AREA CHUM STOCK DISTRIBUTION ASSESSMENT IN WASHINGTON SAN JUAN ISLANDS – PT. ROBERTS AND IN BRITISH COLUMBIA SOUTHERN GULF FISHERIES

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By

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INTRODUCTION

This report represents the second year of a southern area Canada and United States trans-boundary chum stock distribution study. The objective was to collect 200 samples per week for each of the targeted 2008 chum directed fisheries, the Washington fisheries (Area 7 and 7A) and Canadian fisheries (Area 29 and 18). All samples were screened for the presence of Washington, British Columbia (non-Fraser), and Fraser River stock aggregates, using mixed stock analytical methods based on DNA techniques.

Prior to 1985, genetic stock identification (GSI) analysis had not been conducted in the targeted fisheries. From 1985 to 1995, stock composition data was collected in the Washington San Juan – Point Roberts commercial chum fisheries (Catch Areas 7 & 7A) using a starch-gel electrophoresis methodology (Aebersold et al. 1987) for GSI then run through a maximum likelihood program (MLE) (Millar 1987) to determine fisheries stock composition. The 2008 fisheries collections give fishery managers stock composition information for the second consecutive year using the more accurate and accepted DNA analysis technology.

In order to facilitate management responses to Fraser River chum stock strength in accordance with Annex IV, Chapter 6 of the Pacific Salmon Treaty (PST adopted in 2006); it is necessary to quantitatively identify stock contributions to both the Washington (Areas 7 and 7A) and Canadian (Areas 29 and 18) trans-boundary chum fisheries. This joint bilateral project will benefit both the U.S. and Canada, by developing the means toward a more effective in-season management of Southern Area Chum. It will allow the U.S. to effectively implement the current Chum Annex to the PST, to take fishery actions when the Fraser chum run is in a conservation status. The project responds to three objectives for the 'Inside Southern Chum Fisheries' to improve stock assessment information for resource managers. 1) The stock aggregate information will help in developing thresholds for Canadian Inside chum run sizes which determine Canadian and U.S. fishing opportunities pursuant to Chapter 6, Annex IV of the Pacific Salmon Treaty. 2) The stock aggregate information will help in shaping fisheries to control the harvest of Fraser chum, when required. 3) An additional benefit will be the assessment of stock component contributions to domestic and intercepting fisheries, enabling the U.S. and Canada to adjust Annex Chapter provisions to better accomplish the goals of the Treaty.

This project responds to five strategies: 1) Refine stock and fishery management objectives by developing, evaluating, and refining trend analysis of stock composition to the fisheries and risk assessment frameworks to address impacts to specific stocks of concern. 2) Develop tools and technologies for fisheries management by supplying a stock composition dataset using the new more widely accepted DNA tissue analysis to address data uncertainties. 3) Improve stock identification techniques by establishing DNA Genetic Stock Identification (GSI) bilateral datasets for southern trans-boundary chum fisheries and enhancing southern chum baseline through multi-agency collaborative effort. 4) Improve selectivity of fishing by applying mixed stock analytical methods based on DNA techniques to shape fisheries to reduce impacts on stocks of concern while creating fishing opportunities on healthy stocks. 5) Improve information sharing between the parties and agencies.

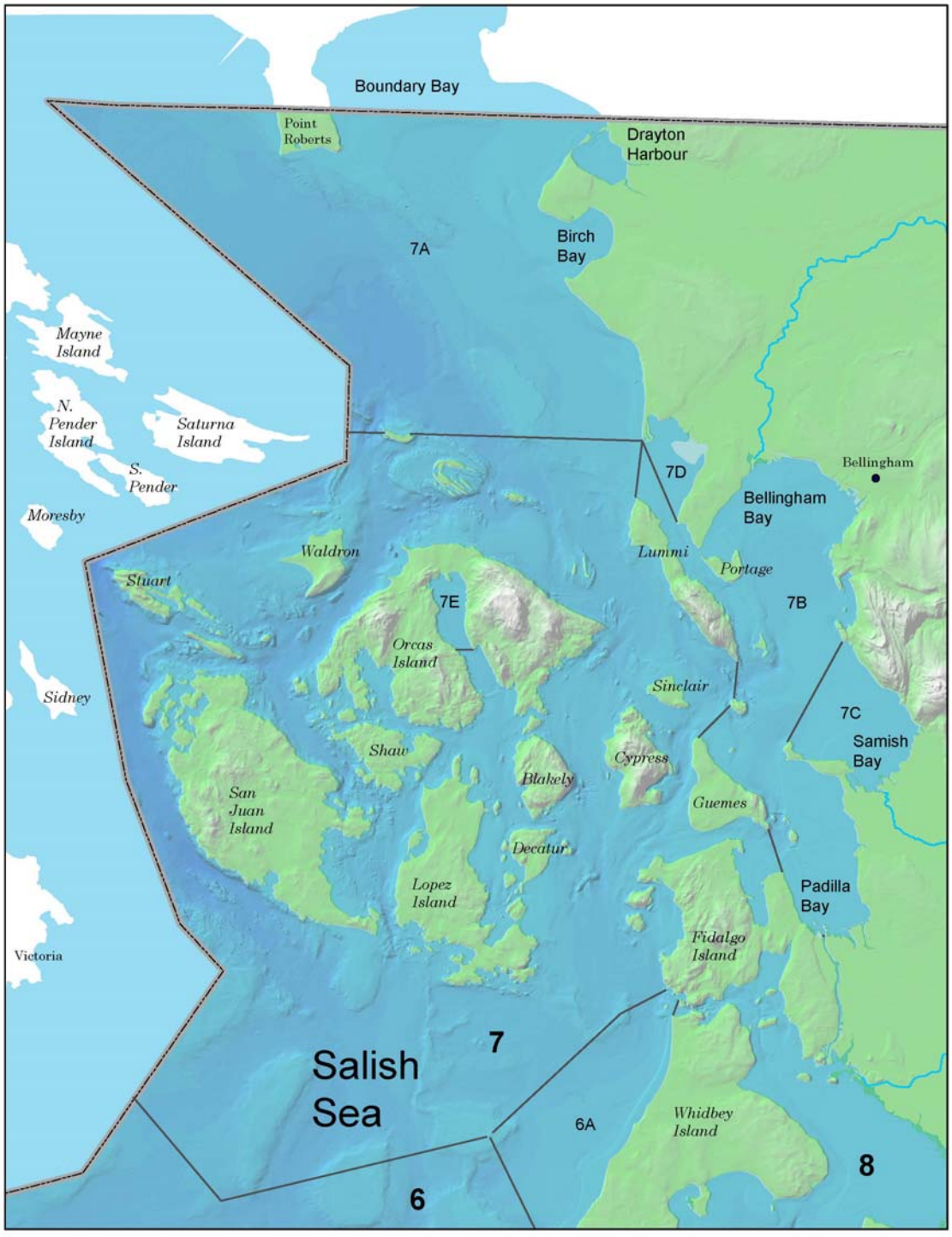

Figure 1. Washington State salmon fisheries catch areas for north Puget Sound (Map developed by Northwest Indian Fisheries Commission).

Project Objectives:

1. Sampling commercial fisheries

Collect samples of operculum tissue from chum salmon in two targeted North Puget Sound and two southern Gulf Georgia Strait commercial fisheries. Tissues will be collected from 200 randomly selected chum salmon in each catch area per week of peak fishing activity.

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 tissue samples. The resulting data will be entered into stock assessment program models, 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 non-Fraser, and Fraser River populations.

METHODS

Sampling Protocol

The sampling objective is to collect 200 Chum per week from each fishery. Without an existing North Puget Sound Chum fishery DNA dataset to analyze, the sample size was arrived at from past genetic studies. Simulations from previous Puget Sound chum genetic stock studies in the 1980s and 1990s 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 (TCCHUM 1988)**.**

For the Washington Areas 7/7A commercial chum fisheries, Northwest Indian Fisheries Commission (NWIFC) staff and Washington Department of Fish and Wildlife (WDFW) crews collected tissue samples weekly from the commercial fisheries. To the extent possible, samples were drawn from tenders or processing facilities where catches of many vessels are combined. This insured sample representation from several vessels and when necessary from different gear types. However, lack of sampling opportunities sometimes necessitated sampling from individual fishing vessels. Samplers interviewed fishing vessel operators and checked all fish sales receipts (tickets) to avoid sampling catch of mixed-area origin. Additional samples will be collected by WDFW Observer Program crews on the water during the non-treaty fisheries. For the Canadian fisheries in Areas 18 and 29, Canadian Department of Fisheries and Oceans (DFO) were to collect samples from landings. All DNA samples collected by operculum punch and preserved in 95% ethanol.

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.

Fishery Sampling Summaries

<u>San Juan Islands & Point Roberts commercial chum fisheries (Catch Areas 7 & 7A)</u>

Staff from the Northwest Indian Fisheries Commission (NWIFC) and Washington Department of Fish and Wildlife (WDFW) participated in sampling the landed catch from the San Juan Islands-

Point Roberts fishery. The landed commercial catch was sampled from treaty and non-treaty fisheries. Tissue samples were collected from combined gillnets and purse seine catch gear. The sampling objective was to collect 200 fish samples per week per sub-areas for the fisheries. In addition, WDFW Observer Program crews collected samples from the non-treaty seine fishery in week 42.

The fisheries were open for six management weeks (weeks 41 through 46) beginning October 10 annually as designated by conservation agreements. Consequently, the first management week represents a two day fishing effort. Sample collections objectives were met for the first three weeks in Area 7. For Area 7A, no samples were obtained in the first week followed by three consecutive weeks of collections closely meeting sampling objectives. There was no fishing effort in the final week of the fisheries. Peak fisheries catches occurred in week 43 for both catch areas. Catch and sampling results are shown in tables 1 and 2 for catch areas 7 and 7A, respectively. Landed catch are preliminary numbers taken from softdata.

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

Mgmt. Week	Preliminary Landed Catch			DNA Samples
	Treaty	Non-treaty	Total	
41	315	3266	3581	200
42	11318	3711	15029	264
43	18247	11553	29800	200
44	1945	579	2524	0
45	91	87	178	47
46	0	0	0	0
Totals	31916	19196	51112	711

Table 2. Commercial chum harvest and sampling summary from Area 7A in 2008

Mgmt. Week	Preliminary Landed Catch			DNA Samples
	Treaty	Non-treaty	Total	
41	0	2921	2921	0
42	2751	3514	6265	307
43	5962	5559	11521	199
44	664	1151	1815	145
45	1286	454	1740	0
46	0	0	0	0
Totals	10663	13599	24262	651

Canadian Southern Gulf Fisheries (Catch Areas 18 and 29)

In 2008 Statistical Areas 18 and 29 were not sampled due to a combination few fishery openings in open water marine areas, little effort, and low catches. All other fisheries occurring in Statistical Area 18 were targeting terminal abundances and did not occur in mixed stock areas.

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 14 microsatellite loci. The loci surveyed are listed and referenced in Appendix 2. 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. Seven Canadian chum stocks were removed from the 2007 baseline because they fall below the minimum sample size of 30 fish. The Algard population was added now considered part of the British Columbia south coast stock aggregate. Appendix 3 lists DFO's 'southern chum baseline' of 79 populations.

A cBayes statistical analysis software program developed by DFO (Neaves et al. 2005) using Bayesian estimators was used to estimate stock composition of each weekly fisheries sample (Pella and Masuda 2001). The procedure is outlined by Beacham et al. (2005a).

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 (north Puget Sound, south Puget Sound, Hood Canal, Juan de Fuca Strait, Washington Coast), southern British Columbia (south coast British Columbia, east coast Vancouver Island, west coast Vancouver Island), and the Fraser River. A genetic electrophoresis examination of adult chum population collections from 1985 to 1992 found significant allele frequency differences among the Washington chum regional population aggregate groups mentioned above and west coast Vancouver Island, Fraser River, Georgia Strait regional groups from Canada (Phelps et al. 1994). A more recent study using DNA microsatellite techniques further supports the regional population structure of British Columbia (B.C.) stock aggregates in addition to separating the Georgia Strait component into east coast Vancouver Island and south coast B.C. aggregates. Using the available chum stock baseline and the sample sizes specified in the study protocol, contributions of individual stocks or river systems may not be as accurately resolved.

STOCK COMPOSITION ESTIMATES

The cBayes Bayesian estimator model was used to assess stock composition in the 2008 fisheries. In last years report, the SPAM maximum likelihood model was also used to assess the 2007 fisheries stock composition for comparison. Both models delivered very similar proportion results from the 2007 fishery samples with few exceptions (Kirby 2008). The body of literature suggests greater accuracy with cBayes versus the SPAM model.

San Juan Islands Commercial Chum Fishery (Area 7)

The Fraser River aggregate received the largest stock proportion in the first three management weeks ranging from 49% to 64% (Table 3). Week 45 was the exception with the North Puget Sound stock aggregate comprising 77% of the sample compared to 7% for the Fraser though the low sample size probably influenced the results. The East Vancouver Island aggregate had the second highest proportion contribution over the first three weeks followed by the South Coast stock aggregate.

Table 3. The cBayes model: percent contributions (± one standard deviation) of United States and Canadian chum stock aggregates to the 2008 commercial fishery in San Juan Islands (CA 7).

Stock	Management Week			
Aggregates	41	42	43	*45
South Coast	12.2 ± 5.1	7.7 ± 4.6	7.5 ± 4.6	0.7 ± 2.4
A14-18 ECVI	14.3 ± 5.6	35.9 ± 5.5	39.2 ± 6.4	12.1 ± 8.1
A19-26 WCVI	0.4 ± 1.0	0.3 ± 0.7	0.8 ± 1.7	0.2 ± 1.2
Fraser	63.9 ± 5.1	55.1 ± 4.3	49.3 ± 5.0	7.1 ± 6.4
North Puget Sound	2.0 ± 2.9	0.9 ± 1.7	1.7 ± 2.7	77.2 ± 9.0
South Puget Sound	0.6 ± 0.8	0.1 ± 0.4	0.5 ± 0.6	0.2 ± 0.9
Hood Canal	0.0 ± 0.1	0.0 ± 0.1	0.6 ± 1.0	2.4 ± 3.4
Juan de Fuca Strait	6.6 ± 2.8	0.0 ± 0.3	0.3 ± 1.2	0.0 ± 0.4
Washington Coast	0.0 ± 0.2	0.1 ± 0.2	0.1 ± 0.5	0.0 ± 0.4

* Only 47 samples collected for week 45

Point Roberts Commercial Chum Fishery (Area 7A)

The Fraser River stock aggregate received the largest proportions over the three sampled weeks at 76%, 54%, and 81% consecutively (Table 4). The South Coast and East Coast Vancouver Island stock aggregates contributed to most of the remaining proportions. The South Coast aggregate contributed significantly in week 43 at 32%. There was little Washington stock contribution observed in this fishery.

Table 4. The cBayes model: percent contributions (± one standard deviation) of United States and Canadian chum stock aggregates to the 2008 commercial fishery in Point Roberts (CA 7A).

Stock	Management	Week	
Aggregates	42	43	44
South Coast	6.3 ± 3.5	32.2 ± 5.9	4.2 ± 3.2
A14-18 ECVI	14.7 ± 4.3	12.6 ± 5.4	9.8 ± 4.2
A19-26 WCVI	1.3 ± 2.5	1.3 ± 1.8	1.7 ± 2.0
Fraser	76.4 ± 3.9	53.5 ± 5.1	80.5 ± 4.7
North Puget Sound	1.3 ± 2.2	0.3 ± 0.8	0.4 ± 1.2
South Puget Sound	0.0 ± 0.1	0.0 ± 0.1	0.0 ± 0.2
Hood Canal	0.1 ± 0.3	0.0 ± 0.1	0.0 ± 0.2
Juan de Fuca Strait	0.0 ± 0.2	0.1 ± 0.5	3.4 ± 3.0
Washington Coast	0.0 ± 0.1	0.0 ± 0.2	0.0 ± 0.2

EVALUATION

Sampling

The two commercial chum fisheries sub-areas 7 and 7A still remain difficult to sample. With a number of commercial chum fisheries open in Puget Sound during this period, fishing vessels and buyer tenders move between catch areas depending on harvest success. Consequently, some harvest is eliminated from the sampling opportunity pool because of mixed catch landings. Even with the reduced sampling opportunities, samples were collected over three consecutive weeks during the peak period of landed catch. Samples are extremely difficult to obtain over the last two week of the fisheries as fisher effort drops and the consequential low number of landed fish. A directed research vessel catch sample could be an option used to obtain late season collections. Presently the only option available to collect samples from Canadian catch areas 18 and 29 would be a directed research vessel effort.

Stock Identification Analysis

The cBayes stock composition results were comparable to the 2007 results (Kirby 2008) where the dominate proportions were the Fraser River stock aggregate contribution. As in the previous year, Puget Sound stock aggregate contributions increased and Fraser River stock presence declined by week 45 though there appears to be no declining trend over the first four weeks as seen in the two year dataset. The small sample sizes for week 45 combined with just a two year dataset makes it difficult to determine if this is a stock migration timing trend. The data from the Puget Sound terminal area chum stock composition studies in the 1990s appears to indicate a declining trend of Fraser River stock aggregate contribution in Washington waters around week 45 (Kirby 2000).

It is difficult to assess yearly variability among the other stock aggregates with just a two year dataset though preliminary assessments can be made. The Fraser River, south coast B.C., and east coast Vancouver Island appear to be the major stock aggregate contributors over the first three to four weeks of the fisheries. The same three stock aggregates showed similar dominates from samples collected in the 2007 upper and lower Johnstone Strait fisheries as these populations migrate south (Beacham et al. 2008).

Benefits from the Project

This study demonstrated that chum stock aggregate contributions to the San Juan Islands and Point Robert commercial chum fisheries can be assessed using Microsatellite DNA techniques. Additional chum stock population samples were collected proving to contribute to the fisheries and consequently increasing baseline resolution. By running two of the science community accepted genetic stock composition models, baseline confidence was assessed to meet stock aggregate requirements though a fisheries simulation of known population proportion samples would further help assess the baseline resolution.

This report will be submitted to the PSC Chum Technical Committee for their evaluation and recommendation for further dataset expansion. The stock composition information will help in implementing the current Chum Annex to the Pacific Salmon Treaty. The data will provide additional insight to develop fishery options when the Fraser chum run is in a conservation status.

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APPENDICES

Appendix 1. Management Week Schedule for 2008 Commercial Fisheries.

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 chum salmon DNA microsatellite analysis.

STANDARD LOCI ABBREVIATION	SOURCE REFERENCES
Oke3	Buchholz et al. 2001
Ots3	Banks et al. 1999
OtsG68	Williamson et al. 2002
Ots103	Nelson and Beacham 1999
Oki2	Smith et al. 1998
Omm1070	Rexroad et al. 2001
Oki100	Beacham et al. 2001
Omy1011	Spies et al. 2005
Ssa419	Cairney et al. 2000
One101	Olsen et al. 2000
One102	Olsen et al. 2000
One104	Olsen et al. 2000
One111	Olsen et al. 2000
One114	Olsen et al. 2000

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

Region	Stock
South Coast	Algard Cheakamus Heydon Creek Homathko Indian River Kwalate Mamquam Mashiter Creek Orford Phillips Shovelnose Creek Sliammon Southgate Squamish Stawamus Theodosia Tzoonie Wortley Creek
A14-18 East Coast Vancouver Island	Big_Qualicum Campbell River Chemainus Cold Creek Cowichan Goldstream Little Qualicum Nanaimo Puntledge
A19-26 West Coast Vancouver Island	Cayeghle Colonial Demamiel Kootowis Goodspeed River Hathaway Creek Klootchlimmis Nahmint River Nitinat

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

Region	Stock
	Pegattum Creek
	Smith Creek
	Sugsaw
Fraser River	Alouette
	Alouette North
	Blaney Creek
	Chehalis
	Chilliwack
	Chilqua
	Harrison
	Harrison late
	Hicks Creek
	Hopedale Creek
	Inch
	Kanaka
	Kawakawa
	Lower Lillooet
	NorrishWorth
	Serpentine River
	Silverdale
	Squakum
	Stave
	Vedder
	Wahleach
	Widgeon Slough
	Worth Creek

Appendix 3 (continued). Baseline chum stocks included in the stock composition analysis of the San Juan Islands commercial chum fisheries (Catch Areas 7 & 7A).

Region	Stock
North Puget Sound	Nooksack
	Skagit
	County Line Ponds
	Grant Creek
	Siberia Creek
	Tulalip Hatchery
	Skykomish
South Puget Sound	Green River
	Kennedy Creek
	Minter Creek
Hood Canal	Big Quilcene
	Hoodsport
Strait of Juan de Fuca	Salmon Creek
	Elwha
Washington Coast	Bitter Creek
	Ellsworth Creek
	Quinault
	Satsop