SUMMARY OF 2009 STRAIT OF JUAN DE FUCA
Forecasts and Forecasting Methods

Species (Ref.#)	Origin	Type	Number	Mass Marked	Number Type	FRAM Model Designation
S/F Chinook (A-1)	Hoko Mixed	Primary	969		Adult Recruits[2]	Natural
	Elwha / Dungeness		2,435	0	TRS	
Pink (A-2)	Dungeness	Primary	11,360		Total Recruits	
Summer Chum (A-3)	Natural	Primary	5,198 | 5,999		Total Recruits	
Coho W. SJF (A-4)[1]	Natural	Primary	22,961		Total DA2[1] Recruits	Natural
Coho E. SJF (A-4)[1]	Natural	Primary	4,321		Total DA2[1] Recruits	Natural
	Natural	Secondary	1,033		Total DA2[1] Recruits	Hatchery
	Hatchery	Primary	8,810	8,256	Total DA2[1] Recruits	Hatchery
Fall Chum (A-5)	Natural	Primary	2,587		WA Run	

[1] See overleaf for Coho FRAM inputs.

[2.] The Hoko forecast was also expressed in terms of total recruits (12,167 Mature + Immature) and by age group. See Section A-1.3

NOTES: Summer Chum salmon, although primary, are under rehabilitation.
Forecasts for individual Strait of Juan de Fuca Management Units are:

Discovery	3,252	4,004
Sequim	943	943
Chimacum	1,003	1,053

Chinook salmon, classified as "wild and hatchery", are under rehabilitation.
Forecasts for individual Strait of Juan de Fuca Management Units are:

Dungeness River	727
Elwha River	1,708
Hoko River	969

Coho FRAM Model Inputs

Stock Name	DA2	nuFRAM Stock	nuFRAM Age 3	Marked nuFRAM	Marked %
Dungeness River Natural	761	dungew	703		
Dungeness Hatchery	6,925	dungeh	6,399	6,345	99.15%
Elwha River Natural	273	elwhaw	252		
Elwha Hatchery	1,885	elwhah	1,742	1,284	73.71%
East Juan de Fuca Misc. Natural	4,321	ejdfmw	3,993		
West Juan de Fuca Misc. Natural	22,961	wjdfmw	21,216		
Port Angeles Net Pens	0	ptangh	0		
Area 9 Misc. Natural	0	area9w	0		

A. Pre-Season Forecasting Methods

A-1. Chinook Salmon

Given the fact that the forecasted returns of the Elwha and Dungeness components of Strait of Juan de Fuca chinook salmon are being entered into the FRAM simulation model as a single population, the 2009 forecasted return of Elwha and Dungeness to the terminal areas was forecasted as a single quantity, which was then apportioned to individual populations, given their recent years' performance. This approach is believed to lessen the errors caused by summing individual stock forecasts. The forecast was made using the mean terminal area return in the last four years (2005 - 2008) and was also apportioned using the relative distribution in the same period, which may better reflect recent survival rates and the changing proportional contribution from the Dungeness stock. The resulting TRS forecast for 2009, is 2,435 for these two systems (Table A-1-a), apportioned to Elwha (1,708), and Dungeness (727) (Table A-1-b). For 2009, it became possible to enter the Hoko River forecast separately into the preseason simulation model. Therefore, the Hoko chinook were forecasted as ocean recruits to all fisheries and escapement, as outlined in Section A-1.3 of this summary.

Table A-1-a. Strait of Juan de Fuca; Elwha - Dungeness Chinook Salmon TRS

Year	Elwha	Dungeness	Strait ETRS
1986	3,159	254	3,413
1987	6,220	133	6,353
1988	8,667	372	9,039
1989	5,704	95	5,799
1990	3,606	361	3,967
1991	3,761	199	3,960
1992	4,002	154	4,156
1993	1,669	54	1,723
1994	1,580	65	1,645
1995	1,814	163	1,977
1996	1,877	183	2,060
1997	2,544	52	2,596
1998	2,462	110	2,572
1999	1,642	75	1,717
2000	1,913	218	2,131
2001	2,246	453	2,699
2002	2,416	633	3,049
2003	2,305	640	2,945
2004	3,439	1,014	4,453
2005	2,242	1,081	3,323
2006	1,931	1,543	3,474
2007	1,153	403	1,556
2008	1,157	229	1,386
2009 Forecast (2005-08 Avg.)			**2,435**

Table A-1-b. Proportional Distribution of Strait of Juan de Fuca, Elwha - Dungeness Chinook TRS

Year	Elwha	Dungeness
1986	0.926	0.074
1987	0.979	0.021
1988	0.959	0.041
1989	0.984	0.016
1990	0.909	0.091
1991	0.950	0.050
1992	0.963	0.037
1993	0.969	0.031
1994	0.960	0.040
1995	0.918	0.082
1996	0.911	0.089
1997	0.980	0.020
1998	0.957	0.043
1999	0.956	0.044
2000	0.898	0.102
2001	0.832	0.168
2002	0.792	0.208
2003	0.783	0.217
2004	0.772	0.228
2005	0.675	0.325
2006	0.556	0.444
2007	0.741	0.259
2008	0.835	0.165
2005 - 08 Avg.	0.702	0.298
2009 Forecast Distribution	1,708	727

A-1.1 Dungeness River Natural

Table A-1-c. Dungeness River Chinook Salmon Forecast Data

Return Year	Natural Escape.	Brood stock	Prespawn. Mort.	Area 6D Harvest	FW Recr. Catch	Terminal Run
1986	238			9	7	254
1987	100			4	29	133
1988	335			5	32	372
1989	88			1	6	95
1990	310			0	51	361
1991	163			19	17	199
1992	153			1	0	154
1993	43			1	10	54
1994	65			0	0	65
1995	163			0	0	163
1996	183			0	0	183
1997	50			0	2	52
1998	110			0	0	110
1999	75			0	0	75
2000	218			0	0	218
2001	453			0	0	453
2002	633			0	0	633
2003	640			0	0	640
2004	953	52	9	0	0	1,014
2005	955	113	9	2	2	1,081
2006	1,405	106	32	0	0	1,543
2007	305	88	10	0	0	403
2008	140	87	2	0	0	229

Table A-1-d. Elwha River Chinook Salmon Forecast Data.

Return Year	Extreme Terminal Run	Natural Spawning Escapement	Hatchery Broodstock	Prespawning Mortality	Terminal Harvest
1986	3,159	855	1,414	858	32
1987	6,220	1,642	1,989	2,262	327
1988	8,667	5,228	2,167	478	794
1989	5,704	3,035	1,892	560	217
1990	3,606	1,644	1,312	224	426
1991	3,761	1,642	1,719	108	292
1992	4,002	479	743	2,637	143
1993	1,669	633	929	7	100
1994	1,580	163	1,053	330	34
1995	1,814	524	626	662	2
1996	1,877	364	1,244	267	2
1997	2,544	1,585	942	10	7
1998	2,462	720	1,689	51	2
1999	1,642	903	699	23	17
2000	1,913	715	1,136	62	0
2001	2,246	655	1,553	38	0
2002	2,416	863	1,513	40	0
2003	2,305	1,045	1,182	78	0
2004	3,439	2,075	1,325	39	0
2005	2,242	835	1,396	7	4
2006	1,931	693	1,227	7	4
2007*	1,153	380	760	9	4
2008*	1,157	470	667	16	4

Harvest does not include Recreational Catch

(*) The 2007-08 estimates are preliminary and subject to revision

Note: The 1986 - 1996 values are currently under review for accuracy and may be modified

Table A-1-e. Elwha River Chinook Natural and WDFW Rearing Channel Prespawning Mortalities

Return Year	Hatchery Voluntary Escapement	Natural Spawners	In-River Gross Escapement	Gaff-Seine Removals	In-Hatchery Prespawning Mortality	In-River Prespawning Mortality
1986	1,285	855	1,842	505	376	482
1987	1,283	1,642	4,610	1,138	432	1,830
1988	2,089	5,228	5,784	506	428	50
1989	1,135	3,035	4,352	905	148	412
1990	586	1,644	2,594	886	160	64
1991	970	1,642	2,499	857	108	n/a
1992	97	479	3,762	672	26	2,611
1993	165	633	1,404	771	7	0
1994	365	163	1,181	749	61	269
1995	145	524	1,667	518	37	625
1996	214	364	1,661	1,177	147	120
1997	318	1,585	2,216	624	3	7
1998	987	720	1,422	702	51	0
1999	182	903	1,420	517	23	0
2000	404	715	1,447	732	62	0
2001	595	655	1,613	958	38	0
2002	561	863	1,815	952	40	0
2003	692	1,045	1,535	490	78	0
2004	476	2,075	2,924	849	39	0
2005	204	835	2,027	1,192	7	0
2006	366	693	1,554	861	7	0
2007	186	380	954	574	9	0
2008	89	470	1,048	578	16	0

Note: The 1986 - 1996 values are currently under review for accuracy and may be modified

In order to estimate the potential effective escapements in 2009, the forecasted return to the Elwha River was further apportioned, using the 2005-2008 mean proportions (Table A-1-e), as follows: Of the forecasted 1,708, **0.2%** (4) are expected to be harvested; **13.7%** (234) are expected to voluntarily return to the Elwha Rearing Channel, and **86.1%** (1,470) to the river. The voluntary hatchery return is expected to be reduced by **5.2%** (12), to account for average on-station pre-spawning mortality, leaving 222 effective hatchery spawners. The in-river escapement was not reduced for in-river pre-spawning mortality, based on recent years' survival. However, the 1,470 in-river escapement was reduced by **57.4%** (843) to account for broodstock removals (gaff & seine), leaving an anticipated in-river spawning escapement of 626 chinook salmon and an anticipated effective hatchery broodstock total of 1,065.

A-1.3 Hoko River (Makah)

The 2009 forecast abundance of Hoko River chinook is 969 mature ocean recruits, or 12,167 total ocean recruits. The estimate of total ocean recruits is in units suitable for input as the initial cohort size in FRAM.

Two methods were used for predicting recruits, methods which differed by age class. Age-2 recruits were predicted as the mean of the previous 5 years of Age-2 recruits. For ages 3, 4 and 5, recruits were forecasted were developed from linear regression models based on estimated sibling abundance in 2008. The regression models to forecast these age classes are based on statistically significant linear relationships ($P<0.05$) between $recruits_{age\text{-}1,\ RY\text{-}1}$ and $recruits_{age,\ RY}$. For age-6 recruits, those linear regression models were not significant; instead age-6 recruits were predicted as the mean of the previous 5 years of recruits of those ages.

Hindcasting with these regression models reveals that they perform well in predicting abundance. Excluding fish ages 2 and 6, and limiting the hindcasting to the years since after 1994, when the missing 1988 brood year was no longer present, the average error for total ocean recruits by return year is 47 fish. Historically, ages 3 through 5 have comprised 94 percent of the recruits to this stock, so errors associated with using the 5-year mean for ages 2 and 6 are not likely to make a great difference in this forecast.

The age-breakout of the forecast is shown in Table A-1-f.

Table A-1-f. Hoko R. 2009 Forecast of Chinook Salmon, by Age

Age	Total Recruits	Maturation Rate	Mature Recruits
2	9,355	0.0033	30
3	1,225	0.0979	146
4	1,289	0.3802	490
5	245	1.0000	250
6	53	1.0000	53
7	0	1.0000	0
Totals	12,167		969

Table A-1-g. Hoko R. 2008 Return Year Reconstruction

Age	Mature				Immature + Mature	
	Escape.	Esc.+Fmort[1].	Nat. Mort Factor	Total Maturing Recruits[2]	Immat. Factor[3]	Total Recruits
2	5	6	1.3594	8	280.41	2,317
3	22	26	1.3594	35	8.44	298
4	62	72	1.3594	98	2.14	212
5	394	460	1.3594	626	1.00	626
6	0	0	1.3594	0	1.00	0
Total	483	564		767		3,453
	2008 ER	0.1443				

Notes: 1: 2008 escapement + fishery mortality are estimated from escapement as Esc/(1-ER) where ER = mean of RY 2002-2006 ERs and escapement from surveys + hatchery broodstock.

2: 2008 Recruits estimate includes natural mortality that would be subtracted out by FRAM

3: Multiplier to include immatures is not exactly the same number as in the FRAM maturity schedules. The multiplier here accounts for the immature fish that are already included in the "Esc + Fmort" estimate.

Table A-1-h. Estimation of 2009 Hoko Chinook Recruitment

Age	Hatchery		Natural	Hat. + Nat.	Adjusted[5] Total Recruits	Total Mature Recruits
	Mature+ Fmort	All	All[4]	All		
2	19	5,884	3,471	9,355	9,355	30
3	92	770	454	1,224	1,225	146
4	308	871	514	1,385	1,289	490
5	158	154	91	245	245	250
6	34	34	20	54	53	53
Total	611	7,713	4,550	12,263	12,167	969

Notes: 4: Multiplier to estimate natural origin from supplemental origin Hoko chinook:0.59. This multiplier is the mean of that ratio for return years 1989-2006.

5: "Adjusted" forecast of total recruits includes change in 4 year olds, scaling them from predicted mature recruits, rather than from regression model using 2008 total ocean 3 year olds.

The 2009 forecast was developed from sibling linear regressions based on a reconstruction of the estimated 2008 recruits. Although we have conducted a coded-wire-tag based cohort reconstruction for previous brood years and return years of Hoko chinook, the 2008 CWT recovery data are not yet available. In order to estimate the 2008 recruits, therefore, we relied on the simple relationship that in any given return year, *RY*, the escapement to the spawning grounds is equal to the ocean recruits *R* times (1-exploitation rate) as shown in Equation (1).

$$Esc_{RY} = R_{RY}\left(1 - ER_{RY}\right) \quad \textbf{(1)}$$

This equation can be rearranged to estimate recruitment from escapement and exploitation rate,

$$Esc_{RY} = R_{RY}\left(1 - ER_{RY}\right) \quad \textbf{(2)}$$

as indicated in Equation (2) above.

In order to assess past years' chinook cohorts, we used CWT recovery data to estimate the exploitation rate. For the 2008 return, however, in the absence of recent-year CWT data, we estimated the exploitation rate used in this forecast as the mean exploitation rate for the five most recent years of complete CWT recovery data (2002 through 2006). These years almost correspond with the parent-years of this year's return. The mean ER was adjusted to reflect the differences between 2008 chinook catch and the 2002-2006 means chinook catch in fisheries in southeast Alaska and on the west coast of Vancouver Island. Historically, Alaskan and Canadian fisheries have accounted for over 80 percent of the harvest of Hoko chinook. No adjustments were made to the mean exploitation rate for Hoko chinook in Washington and Oregon fisheries, because the yare not major sources of mortality for Hoko chinook.

Using the preliminary estimate of 483 chinook spawners in 2008 and an estimated 2008 total ER of 0.1443, we derived an estimate of 767 mature ocean recruits, or 3,453 total ocean recruits (mature + immature) in 2008. These recruits were broken out into age classes based on scales sampled from in-river spawners and hatchery broodstock in the Hoko in 2008. All scales were read by the WDFW scale lab.

Ocean recruits in 2008 were predicted by age group (for ages 3 through 5) using sibling linear regression models based on CWT- reconstructed recruit estimates from return years 1989 through 2006. These years were used for the database because 1989 was the first year that tagged 4-year-olds returned to the Hoko, and 2006 was the most recent year for which complete CWT recovery data are available. In these sibling regression models, 3-year-olds in 2008 are forecasted from 2-year-olds in 2007, and so on for each age group, except as mentioned previously, for ages 2 and 6.

Ages 2 and 6 recruits were forecasted as the mean of the most recent five reconstructed years of recruit abundance. Because there were no recoveries of age-1 siblings in 2008, the forecast of age-2 was taken as the mean of the estimated age-2 recruits for the years 2001 through 2005. There is considerably more error in predicting age-2 recruits than in predicting the other age classes, but since most 2-year-olds (over 99 percent) are considered immature in FRAM, this error should not make a great difference in modeling exploitation rates or spawning escapement. Six-year olds were also forecasted as the 5-year mean of 6-year-old recruits.

All age classes, from 2 through 6, were forecasted in two "units of fish". The first, termed "Mature Recruits" is in terms of natural mortality + fishery mortality + escapement, and can be considered the run size that we have to work with in 2009. The second estimate includes the mature recruits, plus immature fish (*i.e.*, fish that may contribute to the 2009 harvest but will not contribute to escapements). These were also forecasted using sibling regression models, but in these forecasts the independent variable was the 2008 recruits also estimated in terms that include immatures, using the FRAM age-specific maturity schedule for Hoko chinook. Because only a small fraction of 2- and 3-year-olds are mature under the FRAM schedule, this second forecast includes large numbers of 2- and 3-year-olds that will not contribute to the spawning escapement, or therefore to ER calculations, in 2009.

Initially, all age classes were forecasted as supplemented (*i.e.*, hatchery-origin) recruits only, because the tagged fish have all been tagged at the hatchery. These forecasts were then expanded to include natural-origin recruits by using a scalar based on the historical ratio of natural- to hatchery-origin recruits in the

Hoko. Since the Makah Tribe operates the Hoko Hatchery to supplement and sustain the natural stock (as opposed to developing a separate hatchery run for harvest) the two groups were combined, and final forecast does not distinguish between hatchery- and natural-origin recruits

A-2. Pink Salmon

A-2.1 Natural Runs

Naturally produced Puget Sound pink salmon were forecast for 2009 using cycle year return per spawner rates. The biennial nature of pink salmon returns result in three distinct groupings of brood year returns (Table A-2-a). The 2009 return of pink salmon to the Dungeness River was forecast by applying the mean Cycle 1 return rate (1.83) to the 2007 parent brood escapement (6,223). This resulted in an estimated return of 11,360 natural Dungeness pink salmon total recruits. The return-per-spawner rate from the 1961 (Cycle 2) and the 1963 and 1999 broods (Cycle 3) were excluded from the calculation of mean return rates, as outliers (Table A-2-b). A few additional recruits may return to the Elwha River, but given their occasional returns in recent years, they have not been quantified.

Table A-2-a. Corrected Pink Salmon Run Reconstruction for the Dungeness River

Run Year	Escapement	Terminal Run	Total Recruits
1959	40,000	40,000	64,603
1961	70,000	70,000	90,964
1963	**400,000**	**400,000**	**954,051**
1965	**70,000**	**75,000**	**105,640**
1967	95,000	117,400	213,494
1969	14,400	14,400	20,425
1971	46,000	46,000	63,576
1973	47,000	47,000	76,423
1975	24,500	24,900	39,618
1977	35,500	35,600	61,687
1979	50,000	57,800	130,182
1981	2,900	2,900	5,532
1983	4,888	4,888	5,630
1985	4,730	4,730	6,477
1987	1,906	1,906	2,303
1989	10,902	10,902	17,780
1991	9,895	9,895	15,017
1993	1,695	1,695	1,903
1995	8,252	8,252	10,446
1997	4,935	4,935	8,678
1999	7,306	7,306	7,393
2001	**80,344**	**80,344**	**83,832**
2003	15,116	15,245	15,861
2005	8,687	8,687	8,919
2007	6,223	6,462	6,632

Table A-2-b. Dungeness River Pink Salmon Returns per Spawner

Cycle 1 BY	Cycle 1 R/S	Cycle 2 BY	Cycle 2 R/S	Cycle 3 BY	Cycle 3 R/S
1959	2.27	**1961**	**13.63**	**1963**	**0.26**
1965	3.05	**1967**	0.22	**1969**	4.42
1971	1.66	**1973**	0.84	**1975**	2.52
1977	3.67	**1979**	0.11	**1981**	1.94
1983	1.33	**1985**	0.49	**1987**	9.33
1989	1.38	**1991**	0.19	**1993**	6.16
1995	1.05	**1997**	1.50	**1999**	**11.47**
2001	0.20	**2003**	0.59	**2005**	0.76
Average:	1.83		0.56		4.19
Std.Dev.	1.12		0.49		3.16
2009 Forecast (CY 1) Recruits					11,360

Note: The WDFW used the same forecasting method. Therefore any differences in results are likely due to differences in source reconstruction estimates.

A-3. Summer Chum Salmon

A-3.1 Natural Runs (Tribal)

The 2009 return of summer-timed chum to the Discovery, Chimacum and Sequim Management Units was forecasted as a 4 year mean (2005-2008) of the total recruitment, for the Discovery and Sequim MUs, to all fisheries and escapement, and the 2004-05 and 2007-08 for the Chimacum MU (Table A-3-a). The forecasts are 4,004 fish to the Discovery MU, 943 fish to Sequim MU and 1,053 to the Chimacum MU. The forecasts excluded the 2006 returns to the Chjmacum MU as a statistical outlier. Recruits to the Dungeness / Graywolf system are few and unquantifiable at this time.

A-3.2 Natural Runs (WDFW)

For two management units (Discovery and Chimacum), the returns of summer chum were forecast in terms of natural origin fish because after the termination of several supplementation projects, few supplementation-origin adults are expected to return to these MUs in 2009.

Supplementation and reintroduction projects were implemented in Salmon Creek from 1992 through 2003 (Discovery MU); in Chimacum Creek from 1996 through 2003 (Chimacum MU), and in Jimmycomelately Creek from 1999 through the present (Sequim MU). Summer chum fry from each project were marked and natural-origin recruits (NORs) can be distinguished from supplementation-origin recruits (SORs) upon return as adults. Fry released from each project have contributed significantly to the summer chum adult recruitment and escapements.

The projects in Salmon Creek and in Chimacum Creek were terminated, following the release from the 2003 brood and no SORs are expected from those projects in 2009. Estimates of the number of

natural-origin recruits (NORs) and supplementation-origin recruits (SORs) returning to each MU each year from 1999 through 2008 and forecasts for 2009 are shown in Table A-3-b.

Individual returns to the Discovery MU and the Chimacum MU were forecast as the mean of NOR recruits from the 2005 through 2008 return years; the resulting forecasts are 3,252 and 1,003 summer chum, respectively. The return to the Sequim MU was forecast as the mean of total (NOR + SOR) recruits from the 2005 through 2008 return years. The forecast is 943 summer chum. The total forecast for the Strait of Juan de Fuca is 5,198 summer chum (Table A-3-b). Summer chum escapements to the Dungeness River have ranged from 0 to 3 fish during the period from 2005 through 2008, therefore no forecast was made for 2009.

A-3.3 Natural Runs (Joint Approach)

The Summer Chum Salmon Conservation Initiative (SCSCI) defines Critical and Recovery abundance thresholds for each MU. The abundance thresholds are 220 (Critical) and 520 (Recovery) for the Sequim MU, 790 (Critical) and 1,560 (Recovery) for the Discovery MU. For the Chimacum MU, where summer chum were extinct and have been recently reintroduced, corresponding thresholds have not yet been established. The 2009 forecasted abundance for the returns of summer chum, under the Co-Managers' different forecasting approaches provide a range from 3,252 to 4,004 recruits for the Discovery MU, an estimate of 943 recruits for the Sequim MU, and a range from 1,003 to 1,053 recruits for the Chimacum MU. All estimates exceed the Critical threshold (where available) and exceed the Recovery threshold for the Discovery and Sequim MUs. The Co-Managers will use these ranges to conduct annual post-season abundance assessments comparing the forecasts to actual returns for each MU, as required by the SCSCI.

Table A-3-a. Summer Chum Salmon Recruits to Fisheries and Escapement

Year	Discovery	Sequim	Chimacum	Eastern Strait Total
1974	1,494	492		1,986
1975	1,374	373		1,747
1976	1,264	409		1,673
1977	1,364	446		1,810
1978	2,413	828		3,241
1979	699	201		900
1980	4,127	1,447		5,574
1981	879	261		1,140
1982	2,771	771		3,542
1983	946	272		1,218
1984	1,311	397		1,708
1985	304	108		412
1986	890	327		1,217
1987	1,673	508		2,181
1988	2,952	1,177		4,129
1989	441	355		796
1990	432	98		530
1991	253	172		425
1992	592	802		1,394
1993	520	124		644
1994	196	18		214
1995	647	234		881
1996	1,075	31		1,106
1997	923	62		985
1998	1,206	101		1,307
1999	532	7	38	577
2000	879	55	52	986
2001	2,811	262	909	3,982
2002	6,072	42	867	6,981
2003	6,004	450	563	7,017
2004	6,430	1,665	1,141	9,236
2005	7,012	1,317	1,404	9,733
2006	5,516	728	**2,035**	8,279
2007	1,726	659	933	3,318
2008*	1,760	1,066	735	3,561
2009 Tribal Forecast:	4,004	943	1,053	5,999

*The 2008 estimate is preliminary and subject to revision

Table A-2-b. Strait of Juan de Fuca Canal Summer Chum Salmon Natural and Supplemetation Origin Recruits.

Year	Discovery		Sequim		Chimacum	
	NOR	SOR	NOR	SOR	NOR	SOR
1999	141	391	7	0	0	38
2000	460	419	55	0	0	52
2001	1,230	1,581	253	9	0	909
2002	4,100	1,972	2	40	129	738
2003	4,021	1,983	69	381	229	334
2004	4,402	2,028	614	1,051	593	548
2005	4,656	2,356	496	821	894	510
2006	4,909	605	346	382	1,480	554
2007	1,684	42	659		903	30
2008	1,760	0	1,066		735	0
2009 WDFW NOR Forecast	3,252				1,003	
2009 WDFW NOR + SOR Forecast			943			
2009 WDFW Total Strait of Juan de Fuca Forecast					5,198	

A-4. Coho Salmon

A-4.1 Natural Runs

The method used to develop the 2009 forecasted return of naturally reared coho salmon, for primary units, relied on an estimate of emigrating smolts (2008 emigration), multiplied by an estimate of marine survival.

A-4.1.1 Naturally reared smolts

For primary units in the western Strait of Juan de Fuca, 46,110 smolts, representing production from five streams, that comprise 19.03% of the subregion, were expanded to 242,251 to represent the entire subregion (Table A-4-a). For primary units in the Eastern SJF the number of smolts from three production units, comprising 25.83% of the total, excluding Snow Creek, was measured and expanded to 28,673 wild smolts for the sub-region (Table A-4-a). To those, we added 16,916 smolts from the Snow Creek supplemented natural emigration, bringing the sub-region total to 45,589 smolts (Table A-4-a). The total number of estimated smolts, produced from all primary units, is estimated at 287,839 (Table A-4-a).

The number of emigrating smolts from secondary units (Elwha River and Dungeness River) was estimated, by extrapolation, using the ratio of the natural escapement of the Elwha and Dungeness River to that of all primary units in the parent brood year (2006) (Table A-4-f)

A-4.1.2 Marine Survival

Given the lag effect inherent in methods which use recent years' average survival, and the recent fluctuations in survival, we estimated marine survival from two regression models. The final estimate used the mean of the two results obtained by these models.

The first model, using the jack return rate from the Lower Elwha hatchery, predicted a marine survival rate to DA2, of 0.0491 (Table A-4-d). The second model used the May-June mean Pacific Decadal Oscillation Index (PDO) to predict a marine survival rate to DA2, of 0.14045. While the results of these two models vary widely, each model has some very important merits, as well as shortcomings, that we considered carefully when developing this year's forecast.

The jack return model is commonly used to forecast the survival rate of various coho populations in Washington. It is based on the premise that much of the success of a brood year is determined by the growth rate and survival in the early months at sea, and that these are reflected in the number of jacks returning from their first year at sea. There is a significant linear relationship between the Elwha Hatchery jack return rate and the SJF natural coho marine survival (r-sq = 0.417). The jack return to the Elwha Hatchery was very low in 2008, and the resulting estimate of marine survival rate of 0.491 percent predicted by this model results in an estimate of 14,134 DA2 recruits.

The PDO model is based on a measure of sea surface temperature patterns across the Pacific Ocean. Lower sea surface temperatures are associated with higher survival of rates SJF wild coho, during their first year at sea. Several seasonal time periods of the PDO were analyzed; the best model fit came from the average of the May-June PDO index, which had a significant linear relationship with SJF natural coho marine survival (r-sq = 0.851). The PDO was especially negative (i.e., lower temperatures) during the May-June period of 2008. This model predicted a marine survival rate of 0.14045, which would then predict a return of 40,427 DA2 recruits. This level of return would be a record return in the available data series.

The final marine survival value used, is the mean of the values produced by these models, which results in an estimate of 27,281 DA2 recruits (Table A-4-d). These were further apportioned into the Eastern and Western SJF subregions (4,321 and 22,961 respectively) on the basis of their relative smolt production from brood year 2006 (Table A-4-e).

Table A-4-a. SJF Coho Smolt Production in Small Streams

2008 Smolt Trapping	Enumerated Smolts	Enumerated Proportion of Total Potential	Estimated Total Smolts
Snow Crk. (Suppl. Nat.)	16,916		16,916
Jimmycomelately Crk	1,846		
Siebert Crk	3,172		
McDonald Crk	2,387		
East Total w/o Snow	7,405	0.25826	28,673
Salt Crk	16,309		
E. Twin R	4,932		
W. Twin R	4,417		
Deep Crk	18,376		
Johnson Crk.	2,076		
West Total	46,110	0.19034	242,251
E+W+Snow Total	70,431		287,839

Table A-4-b. Recent Years' Marine Survival

	RY 2005	RY 2006	RY 2007
Primary, Parent Escapement (RY-3)	20,117	17,042	19,755
Secondary, Parent Escapement (RY-3)	2,258	3,949	1,232
Primary Proportion	0.89908	0.81187	0.94130
Primary Smolts (RY-1)	228,996	306,419	402,005
Primary Recruits (RY)	19,294	6,075	14,984
Marine Survival	0.08425	0.01983	0.03727
Primary Escapement (RY)	10,203	3,802	7,587
Secondary Escapement (RY)	899	144	517

Table A-4-c. Natural Escapement, Smolt Production, Elwha hatchery Jack Returns, and Pacific Decadal Oscillation (PDO) Index Factors, Relating to Marine Survival

Brood Year	Escapement	Smolts	Run Year	Elwha H. Jacks (RY-1)	May-June PDO Index (RY-1)	DA2 Recruits	Marine Survival
1996	8,042	139,683	1999	943	0.55	10,085	0.07220
1997	9,533	202,431	2000	1,861	-0.98	24,511	0.12108
1998	15,550	383,322	2001	950	-0.24	42,299	0.11035
1999	7,145	328,571	2002	910	-0.38	28,255	0.08599
2000	17,547	264,724	2003	431	-0.49	28,272	0.10680
2001	29,048	287,687	2004	527	0.79	19,389	0.06740
2002	20,117	228,996	2005	680	0.47	15,877	0.06933
2003	17,042	306,419	2006	158	1.52	6,075	0.01983
2004	12,003	402,005	2007	119	0.76	11,379	0.02830
2005	10,203	390,561	2008	37	-0.01		
2006	3,802	287,839	2009	85	-1.36		
2007	7,587						

Table A-4-d. 2009 Forecast of Natural Coho DA2 Recruits and Restrospective Results of the Methods Used to Estimate marine Survival

Run Year	Marine Survival	
	Jack Index Forecast	PDO Index Forecast
1999	0.07289	0.06077
2000	0.13179	0.12745
2001	0.07753	0.09175
2002	0.09653	0.10357
2003	0.05079	0.10432
2004	0.06157	0.04928
2005	0.07134	0.06503
2006	0.07443	0.02483
2007	0.05537	0.05885
2009 Est.	0.04910	0.14045
	2009 Forecast	
Marine Survival		0.09478
DA2 Recruits		27,281

Table A-4-e. Primary Natural Management Units Summary

Primary Management Units	Measured Wild Smolts	Proportion of Total Potential Measured	Estimated Total Smolts w Snow	DA2's Using Marine Survival
East Strait	7,405	0.25826	45,589	4,321
West Strait	46,110	0.19034	242,251	22,961
SJF Summary	53,515		287,839	27,281

Table A-4-f. Secondary Management Units Summary

Secondary Management Units	2006 Natural Escapement	2006 Brood Secondary Escapement Proportion	Estimated Smolts*	Estimated DA2's
Elwha	38	0.264	2,877	273
Dungeness	106	0.736	8,025	761
Total Secondary	144	1.000	10,902	1,033

A-4.2 Hatchery Runs

The 2009 returns of Strait of Juan de Fuca hatchery coho were predicted using the estimated 2005-07 (3 years - 1 brood cycle) average smolt survival to DA2 recruits, applied to the 2008 smolt releases (Table A-4-f). More specifically, the following sources of information were selected:

Dungeness Hatchery: 2005-2007 average recruits per smolt (0.01291) (Table A-4-e). Given a release of 536,300 smolts, the 2009 forecast is 6,925 DA2 recruits.

Elwha Hatchery: 2005-2007 average recruits per smolt (0.00582) (Table A-4-e). Given a release of 323,745 smolts, the 2009 forecast is 1,885 DA2 recruits.

The total hatchery-origin pre-season forecast value of 8,810 DA2 recruits (8,141 Jan Age 3) will be used for simulation modeling and pre-season planning.

Table A-4-g. Strait of Juan de Fuca Hatchery Coho Contribution to Puget Sound Net Fisheries and Escapements

Run Year	Dungeness Hatchery			Elwha Hatchery		
	Smolts Released	DA 2 Recruits	R/Sm	Smolts Released	DA 2 Recruits	R/Sm
1979	796,100			1,387,900		
1980	399,200			837,900		
1981	679,700			1,168,700		
1982	929,400			2,845,100		
1983	106,590			2,756,200		
1984				567,800		
1985	188,000			751,000		
1986	298,000			645,400		
1987	320,000			836,000		
1988	748,600	*20,948*	*0.02798*	728,500	5,260	0.00722
1989	301,700	25,401	0.08419	240,700	15,017	0.06239
1990	359,050	*20,811*	*0.05796*	413,500	12,320	0.02979
1991	342,700	*12,102*	*0.03531*	768,600	3,522	0.00458
1992	296,400	14,058	0.04743	688,600	9,848	0.01430
1993	433,700	*9,789*	*0.02257*	755,600	4,913	0.00650
1994	340,000	8,923	0.02624	580,000	2,504	0.00432
1995	680,000	26,830	0.03946	707,700	10,250	0.01448
1996	808,700	29,804	0.03685	801,000	13,705	0.01711
1997	871,600	16,596	0.01904	722,200	11,988	0.01660
1998	774,600	12,301	0.01588	643,037	6569	0.01022
1999	877,300	6,073	0.00692	867,379	9,438	0.01088
2000	788,600	42,393	0.05376	645,856	4,962	0.00768
2001	865,700	52,851	0.06105	684,856	15,237	0.02225
2002	550,700	17,588	0.03194	494,610	12,419	0.02511
2003	565,300	26,894	0.04757	662,231	3,461	0.00523
2004	505,750	9,486	0.01876	724,594	8,713	0.01202
2005	509,300	7,821	0.01536	661,700	7,788	0.01177
2006	512,450	2,141	0.00418	175,380	642	0.00366
2007	500,000	9,603	0.01921	643,122	1,309	0.00204
2008	514,100			411,745		
2009	536,300			323,745		
Average(2004-06):			0.01291	**Average (2004-06):**		0.00582
2009 Forecast DA2's			6,925			1,885

Table A-4-h. Coho Salmon Spawning Escapements to Primary Natural Spawning Areas of the Strait of Juan de Fuca

Year	E. Strait	W. Strait	Total
1986	3,909	9,346	13,255
1987	1,769	7,600	9,369
1988	2,530	6,070	8,600
1989	3,074	9,802	12,876
1990	1,139	7,078	8,217
1991	2,381	6,662	9,043
1992	1,157	9,339	10,496
1993	776	7,594	8,370
1994	1,139	5,911	7,050
1995	1,572	10,914	12,486
1996	1,086	6,956	8,042
1997	1,551	7,982	9,533
1998	1,313	14,237	15,550
1999	1,314	5,831	7,145
2000	2,180	15,367	17,547
2001	2,539	26,509	29,048
2002	3,002	17,115	20,117
2003	3,249	13,793	17,042
2004	7,752	12,003	19,755
2005	3,426	6,777	10,203
2006	1,812	1,990	3,802
2007	3,171	4,416	7,587

Note: Escapement estimation methods changed in 1998. Estimates for earlier years were developed using relationships between index redd measurements and the results obtained from the current methods for escapement assessment.

A-5. Fall Chum Salmon

A-5.1 Natural Fall Chum Salmon Forecast (Tribal)

The 2009 return of fall-timed chum salmon to the Strait of Juan de Fuca tributaries was forecasted, in the aggregate, as the average of the natural and off-station runs observed in the years 2003 through 2007 (Table A-5-a). The resulting forecast of **1,823**, was apportioned on the basis of historical escapement survey data which resulted in the following proportions: Pysht River (46%), Dungeness River (14%), Deep Creek (14%), and miscellaneous, including Elwha R. and Lyre R. (26%). At the time the forecast was prepared, more recent run size estimates, including 2008, were not available. (Table A-5-d).

A-5.2 Natural Fall Chum Salmon Forecast (WDFW)

The 2009 return of natural fall-timed chum salmon to Strait of Juan de Fuca streams was preliminarily derived as a portion of the forecasted return of all Puget Sound natural fall-timed chum. Natural fall chum forecasts were calculated using the Puget Sound-wide recruit/spawner (R/S) method, with the regional (Strait of Juan de Fuca) forecast and terminal within region forecasts, estimated by apportioning the total according to parent escapements.

The Puget Sound forecast was initially forecast using parent brood escapements, long-term odd/even-year specific average R/S values, and long-term odd/even-year specific mean proportions returning at age for 3, 4, and 5-year old returns. For example, the 2009 three-year old forecast was derived by multiplying the 2006 natural escapement by the mean even-year brood R/S value to get a total return of 2006 brood offspring. That number was then multiplied by the mean proportion of the return at age 3 for even-year broods, yielding the 2009 age 3 return forecast. This was repeated for 4 and 5-year old components, and all three were summed to obtain a total Puget Sound forecast..

Puget Sound natural fall chum parent escapements were large during 2004 and 2006. The 2004 parent escapement (872,280) was the third largest escapement on record, and the 2006 parent escapement (792,613) was quite strong. Without some adjustment to the traditional R/S method, the 2009 forecasts would likely be over-estimates. For example, the actual return of natural-origin chum in Hood Canal and South Sound in 2006, 2007 and 2008 were about three-fourths of the predicted run size, using the traditional R/S method. To address this, we used 75% of the long-term R/S averages for the 2009 forecasts. This kept the prediction inside the bounds of the existing data and compensated for the uncertainty resulting from record escapements and apparent lower survival. This method forecast returns of 724,533 natural fall chum to Puget Sound (Table A-5-b).

The forecasted return of each age group to Puget Sound was then apportioned to the Strait of Juan de Fuca using the proportions of the parent escapement of each brood. The forecast for Strait of Juan de Fuca is 3,351 natural fall chum salmon (Table A-5-c). The forecasts for individual production units are shown in Table A-5-d.

A-5.3 Preliminary Preseason Forecast

Given the numerically small difference in the results obtained by the two methods, the have agreed to use the average of the two results, for preseason planning purposes. (Table A-5-d)

Table A-5-a. Strait of Juan de Fuca Historical Fall Chum Salmon "4B" Runs

Return Year	Fall Chum Run Size	Return Year	Fall Chum Run Size
1980	5,862	1994	2,564
1981	6,518	1995	610
1982	6,744	1996	2,162
1983	1,765	1997	3,927
1984	8,280	1998	1,535
1985	8,330	1999	1,313
1986	1,922	2000	269
1987	7,269	2001	1,737
1988	**13,962**	2002	5,198
1989	4,331	2003	1,177
1990	1,220	2004	3,232
1991	1,941	2005	2,382
1992	5,654	2006	1,567
1993	5,775	2007	757
Average (All Yrs.):			3,483
2009 Tribal Forecast (Average 2003-07):			**1,823**
Std. Dev. (03-07):			885

Table A-5-b. 2009 WDFW Puget Sound Natural Fall Chum Salmon Forecast

Parent Brood	Age	Parent Escapement	Mean R/S[1]	Adjusted R/S (.75)	Estimated R/S (all ages)	Mean Age Composition[1]	Natural Forecast
2004	5	872,280	2.51451	1.88588	1,645,016	0.04752	78,176
2005	4	286,719	3.13153	2.34865	673,402	0.56089	377,706
2006	3	792,613	2.51451	1.88588	1,494,773	0.17973	268,651
						Total	724,532

Note: Uses odd or even brood year average, depending on brood year

Table A-5-c. 2009 WDFW Strait of Juan de Fuca Natural Fall Chum Salmon Forecasts

	Puget Sound Forecast	SJF Parent Escapement Proportion	SJF Forecast by Age
Age 3 (2006 Brood) Forecast	268,651	0.00160	431
Age 4 (2005 Brood) Forecast	377,706	0.00709	2,677
Age 5 (2004 Brood) Forecast	78,176	0.00311	243
Total WDFW Forecast	724,532		**3,351**

Table A-5-d. Apportionment of the Strait of Juan de Fuca Natural Fall Chum Salmon Forecast

Area	Proportion	Tribal Forecast	WDFW Forecast	Average of Forecasts
Pysht R	0.458	836	1,536	1,186
Dungeness R	0.139	253	465	359
Deep Creek	0.139	253	465	359
Miscellaneous	0.264	481	884	683
Total		1,823	3,351	2,587