

Chapter 6. Nearshore Assessment: Genetic assessment of juvenile Chinook use of the nearshore central and western Strait of Juan de Fuca

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Abstract

Fifty-eight juvenile Chinook salmon were collected from nearshore areas of the central and western Strait of Juan de Fuca, west of the Elwha River, between June and September 2007. Genetic analysis documented that 43% of these fish were Puget Sound Chinook salmon (Elwha/Dungeness reporting group), with 48% representing various Columbia River populations. The remaining 9% of the Chinook salmon observed were contributed by Washington Coastal and the Klamath Falls systems. These observations have important management implications as the National Marine Fisheries Service currently ends the Critical Habitat designation of nearshore habitat for the Puget Sound Chinook salmon population at the mouth of the Elwha River. It also supports long held belief that nearshore of the open coast of Washington is critical for salmon migration. Information supporting significant use of nearshore areas west of the Elwha River by listed Chinook salmon should result in revision of the Critical Habitat designation and boundary to accurately reflect the geographic area and nearshore habitats used by federally listed species.

Introduction

Juvenile Chinook salmon rely heavily on estuarine and nearshore habitats in Puget Sound during their early saltwater rearing (Beamer et al 2003; Brennan et al 2004; Fresh 2006; Simenstad et al 1982). As a result, the National Marine Fisheries Service (NMFS) declared the Puget Sound

nearshore environment as “Critical Habitat” for the Puget Sound Chinook Evolutionary Significant Unit (ESU) (Shared Strategy 2007), which is listed as “threatened” under the Endangered Species Act (ESA). The Puget Sound Chinook ESU includes all populations in Puget Sound, and extends into the Strait of Juan de Fuca to include the Elwha and Dungeness River populations of Chinook. NMFS chose to end the critical habitat designation of nearshore habitat at the mouth of the Elwha River.

To date there are few data to confirm that juvenile Puget Sound Chinook utilize nearshore use in the central and western Strait of Juan de Fuca, which is defined for this paper as the area from Ediz Hook to Cape Flattery (Figure 1). Additionally, the removal of two dams on the Elwha River as early as 2012 is an unprecedented effort to restore fish populations on a watershed scale. In order to fully succeed, the nearshore ecosystem upon which Elwha fish populations rely must be understood, protected, and restored where appropriate.

In 2007 a study was initiated to define fish use in the central and western Strait of Juan de Fuca. The study, currently underway, utilizes beach seining, forage fish spawning surveys, and snorkel surveys, to document juvenile fish use by geomorphic habitat type in selected locations across the central Strait of Juan de Fuca. Sample locations were identified from Dungeness Bay, west to the mouth of the Pysht River (Figure 1). The study implements one step of a multidisciplinary strategy developed to be used to define nearshore restoration priorities associated with the upcoming Elwha and Glines Canyon dam removals (Shaffer et al 2005). The project began in March 2007 and continues thru 2008.

This fish use assessment study provides an important opportunity to better understand juvenile Chinook salmon distribution along the central and western SJF. Genetic analysis allows detailed and accurate definition of fish stock origin. We therefore used genetic methods to estimate the population-of-origin for individual smolts from a mixture collected from nearshore localities. These methods are based on a procedure described by Rannala and Mountain (1997), which computes the probability that the source of a multilocus genotype (i.e., a genetic fingerprint from an individual fish) is an individual stock in the genetic baseline (one probability for each stock in

the baseline). Others have used the basic methods developed by Rannala and Mountain (1997) to provide population-of-origin assignments of unknown individuals (Hauser et al. 2006, Taylor and Costello 2006, and Waples and Gaggiotti 2006). We used the Chinook coastwide microsatellite DNA baseline developed by the Genetic Analysis of Pacific Salmonids (GAPS) consortium (including nine laboratories from the Western United States). This consortium was established to standardize protocols for the collection and reporting of microsatellite data. The current GAPS baseline dataset for Chinook salmon (GAPS v2.1, release date August 25, 2006) consists of 13 microsatellite loci for 165 Chinook stocks, categorized into 44 regional reporting units by the Pacific Salmon Commission (PSC) (Seeb et al. 2007). An additional 36 stocks from WA State have been analyzed by the WDFW Molecular Genetics Laboratory and added to the GAPS v2.1 dataset (identified as v.2.1+). Evaluation of the smolts with this baseline allowed us to determine the population-of-origin for each smolt that was captured nearshore in the Strait of Juan de Fuca.

Methods and Materials

Survey Sample Design

Beach seining was utilized to examine fish species composition in selected locations from the Dungeness Bay west to the Pysht River (Figure 1). Seining locations were selected based upon geomorphic habitat types typical of the Strait of Juan de Fuca. Habitat types represented can be broadly described as sandy shorelines, spits, rocky shorelines, estuarine areas, stable bluffs, and eroding bluffs. A total of 15 locations were sampled (Table 1), eight of which were located west of the Elwha River. Sample sites were non-randomly selected, based upon accessibility and a qualitative assessment of the representative nature of the site. The number of sample locations was scaled to be achievable by a four person crew visiting the sites on a weekly basis. Weekly sampling began in March 2007 and continued through September 2007 after which time monthly sampling was conducted thru March 2008. Weather conditions prevented some weekly sampling at some sites. However, a minimum of 16 seine hauls were made at every location west of the Elwha River equaling approximately one sample every two weeks.

Table 1. Nearshore central Strait of Juan de Fuca sampling sites by geomorphic habitat type (blue font indicates Elwha nearshore)

Site	Embayed shoreline	Spits	Lower River/Estuarine Areas	Bluffs
Dungeness Spit		X		
Dungeness Bluffs				X
Ediz Hook		X		
Elwha Bluffs				X
Elwha River			X	
Freshwater Bay	X			
Salt Creek			X	
Crescent Bay	X			
Twin River Lower river			X	
Twin River Shoreline	X			
Pysht River Lower River			X	
Pysht Shoreline	X			

Beach seining was conducted utilizing standard protocols developed by the Puget Sound Action Team (Puget Sound Protocol 2005). Seines were deployed by a small row boat, with one end of the seine anchored to the shoreline. Two separate beach seines were utilized. The first seine was larger, and more suited to open water and sandy bottom areas. This net was 38 m in length, and was divided into two wings connected by a collection bag. Each wing consisted of two panels that were 9 m each. The outer panel was 1.0 m high at the edge and tapered to 1.4 m. The second panel was 1.4 m at the edge and tapered to 2.0 m at the bag. The collection bag was 2.0 m x 2.0 m x 2.0 m. Wing mesh is approximately 0.6 cm. Bag mesh is approximately 0.3 cm.

The smaller beach seine was approximately 24 m in length and was divided into two wings connected by a collection bag. Each wing consisted of a single panel which was approximately 11 meters in length and 1.8 m in depth. The mesh size for each panel was 0.3 cm. The collection bag was 1.8 m x 1.8 m x 1.8 m, with a bag mesh of approximately 0.3 cm.

Genetic Tissue Sampling

Genetic tissue samples of juvenile Chinook were collected from nearshore sampling seining stations from the Elwha River estuary west to the Pysht River (Figure 1). Tissue was collected using methodology provided by Kurt Fresh and Anna Kagley (NOAA) (pers. com) Tissue samples were collected from up to ten fish per day from each sample location west of the Elwha River mouth. Fish were measured (fork and total length), checked for adipose fin clips and scanned for coded wire tags utilizing an electronic wand (description needed). Genetic samples were taken by clipping a small quantity of tissue from either the dorsal fin or one lobe of the caudal fin. No more than 30 percent of the fin was clipped. Each clipping was placed in individual vials with lab grade ethyl alcohol, and the vial labeled with unique identification number. The identification label and sample vial were placed in individual plastic bags. Record of fish size, sample number, date, and location were made.

Genomic DNA was extracted for all samples by digesting a small piece of fin tissue using silica membrane based kits obtained from Macherey-Nagel (Bethlehem, PA, USA) following the manufacturers recommendations. Thirteen microsatellite loci combined into five multiplexes were screened for this study. Descriptions of the loci and PCR conditions are given in Table 2. PCR reactions were conducted with a thermal profile as follows: an initial denaturation step of 2 min at 94 C^o, 40 cycles of denaturation at 94 C^o for 15 s, 30 s at the appropriate temperature for each multiplex, and 1 min at 72°C, plus a final extension at 72 C^o for 10 min and final holding step at 10 C^o. Genotypes were visualized using an ABI-3730 DNA Analyzer (Applied Biosystems, Foster City, CA, USA) with internal size standards (GS500LIZ 3730) and GENEMAPPER 3.7 software. Standardization of genetic data to GAPS allele standards was conducted following Seeb et al. (2007).

Table 2. Microsatellite DNA locus information (annealing temperature, the number of cycles used for the PCR reaction, number alleles/locus, and allele size range) for multiplexed loci used in the analysis of Chinook smolts collected in the Strait of Juan de Fuca. Number of alleles per locus and allele size range per locus is shown for the 63 Chinook samples analyzed from the Strait of Juan de Fuca.

Multiplex	Locus	Annealing temp C ^o	# Cycles	# Alleles/Locus	Allele Size	Citation
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					Range (bp)	
Ots-M	<i>Oki-100</i>	50	40	31	208 – 325	Unpublished
	<i>Ots-201b</i>	50	40	31	153 – 306	Unpublished
	<i>Ots-208b</i>	50	40	22	158 – 266	Greig et al. 2003
	<i>Ssa-408</i>	50	40	17	184 – 272	Cairney et al. 2000
Ots-N	<i>Ogo-2</i>	50	40	11	214 – 236	Olsen et al. 1998
Ots-O	<i>Ogo-4</i>	56	40	13	132 – 170	Olsen et al. 1998
	<i>Ots-213</i>	56	40	33	206 – 358	Greig et al. 2003
	<i>Ots-G474</i>	56	40	10	152 – 192	Williamson et al. 2002
Ots-R	<i>Omm-1080</i>	53	40	36	162 – 342	Rexroad et al. 2001
	<i>Ots-3M</i>	53	40	11	130 – 160	Banks et al. 1999
Ots-S	<i>Ots-211</i>	60	40	23	204 – 296	Greig et al. 2003
	<i>Ots-212</i>	60	40	23	131 – 227	Greig et al. 2003
	<i>Ots-9</i>	60	40	6	99 – 109	Banks et al. 1999

The origin of the Chinook salmon smolts collected in the Strait of Juan de Fuca was explored by assigning them with a program written by K. Warheit (WDFW Molecular Genetics Laboratory, unpublished) in MATLAB R2007a (The Mathworks 2006). This program uses a partial Bayesian procedure based on Rannala and Mountain (1997) probabilities (see above) and the expectation-maximization (EM) algorithm to calculate the stock-source probabilities (posterior probabilities) for each smolt. We used the GAPS v2.1+ baseline to define the allele frequencies for baseline stocks. A more detailed description of the methods used by this program is in Blankenship et al. (2007).

Results

A total of 58 juvenile Chinook were collected from nearshore areas west of the Elwha River, with an additional five Chinook also sampled from a side-channel in the Elwha River. For the purposes of this paper, the Elwha River samples were not included in the analysis, as that area was already designated as Critical Habitat. Chinook were observed in seine catches as early as

May 8th, but tissue collection did not begin until June 22. Chinook continued to be observed in the catches through September, with the last samples being collected on September 12.

Genetic analysis revealed that, of the fish analyzed, 43% of the juvenile Chinook collected from these sites were from Elwha Dungeness reporting group, 48% were from the Columbia River reporting group (including the L_Columbia_R._fall, U_Columbia_R._summer/fall, and Mid_Columbia_R._tule_fall reporting groups), and 9% were from the Washington Coastal and Klamath reporting groups (Figure 2). Distribution analysis of the 53 fish of this study revealed that Chinook salmon distribution in the Strait of Juan de Fuca west of the Elwha River appears to be strongly associated with specific habitat types, as the majority of Chinook were found at Pysht, Crescent Bay, and Freshwater Bay. Chinook were also collected from the Salt Creek main and side channels prior to the initiation of this study, an area also worthy of further sampling.

Table 3. Total number of seine hauls, by site, from March to September, 2007.

Location	# of Seine Hauls	# of Chinook Captured
Freshwater Bay	16	442
Salt Creek Side and Main Channels	72	99
Crescent Bay	26	207
Twin River	21	0
Twin River Nearshore	23	0
Pysht River Side and Main Channels	44	0
Pysht Bay	20	6
Total	222	754

Size of collected Chinook ranged from 72-146 mm fork length (Figure 4). Surprisingly, size distribution appeared to be bimodal, with larger fish being encountered both early in the year (July) and later in the year (September). This observation may be partially explained by changes in stock composition over the course of the summer (Figure 5). Fourteen discrete populations of Chinook salmon were identified during this study – three from Puget Sound, one from the

Washington Coast, one from the Klamath River, and the remainder from the Columbia River system.

Discussion

The documentation of Puget Sound Chinook stocks using the central and western Strait, while not surprising, is important for habitat and stock management and restoration. Shorelines of the central and western Strait are remote, and suffer from a variety of anthropogenic stressors (NOPL strategy 2005). Prior to this study these areas were deemed outside the Puget Sound Chinook recovery area and so given a lower priority for restoration funding. These results clearly provide the need to include these nearshore areas as priority for ESA listed recovery. These results also clearly provide the first justification for more detailed assessment of western Strait watershed linkages and the role these watersheds play in both ESA recovery and ecosystem health.

The documentation of Columbia River and Klamath stocks in the Elwha nearshore are equally important. Adult Columbia River fish are intercepted regularly in Alaska waters. The importance of Washington coastal nearshore is clearly important for vulnerable juvenile Chinook life history stages. More detailed assessment of this use is clearly warranted.

Conclusion

This is the first genetic documentation of Puget Sound and Columbia River Chinook salmon smolts using nearshore areas of the central and western Strait of Juan de Fuca. This documentation is an important piece of information for future habitat management of Puget Sound Chinook, and should provide the basis for redefinition of the current federal critical habitat boundary designated by the TRT in 2005 (cite here).

Unfortunately we were not able to document fish that were resident to the Pysht or Salt Creek systems. This may be due to low sample size, and theorized extremely low numbers of resident

fish in these systems (McHenry, 1996; McHenry 2004). Further sampling should be conducted in future years to provide more detail on the role nearshore of the central and western Strait for salmon, including federally listed stocks of Puget Sound Chinook, steelhead, and bull trout

Acknowledgements

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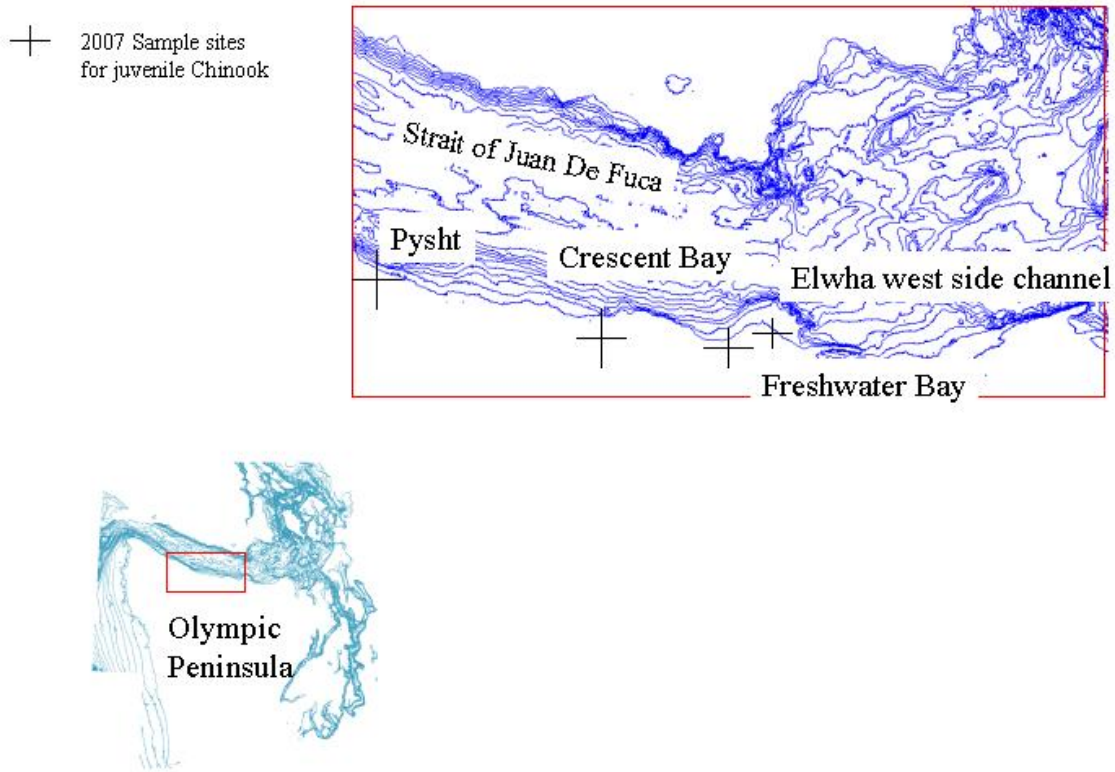


Figure 1. Sampling sites for 2007 Nearshore assessment of the central Strait of Juan de Fuca WDFW. [Note: Need to provide a different location map to match text]

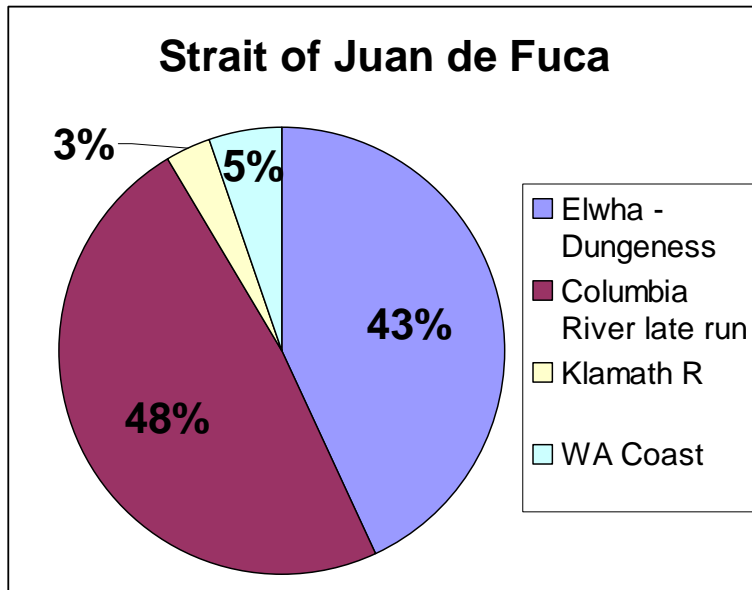


Figure 2. Chinook stock composition from the Central and Western Strait of Juan de Fuca.

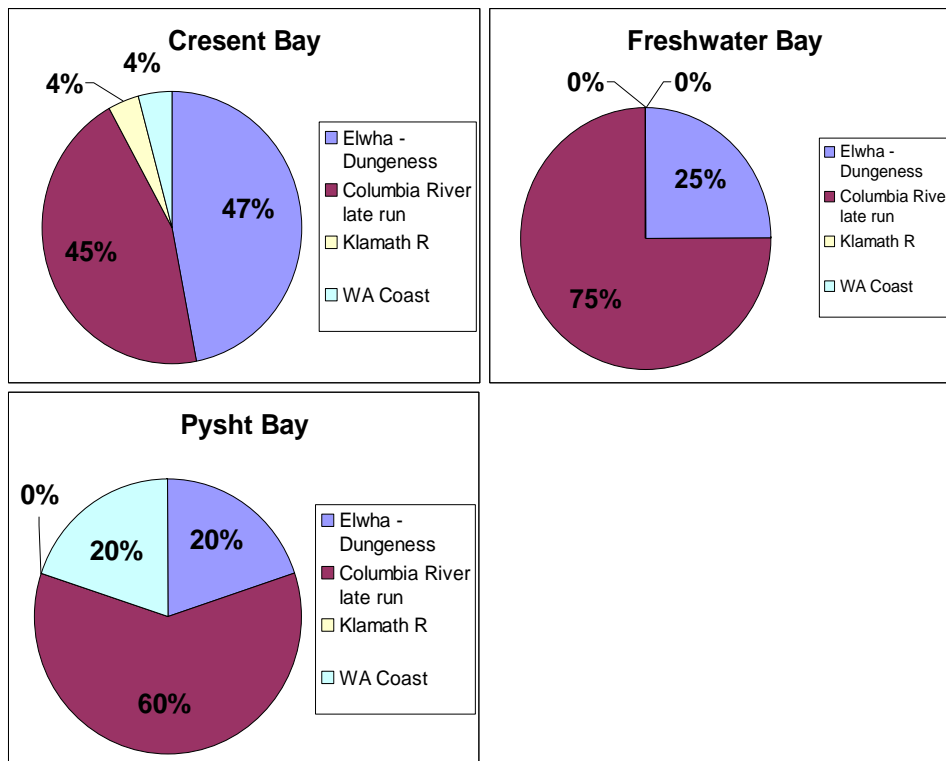


Figure3. Site specific stock composition.

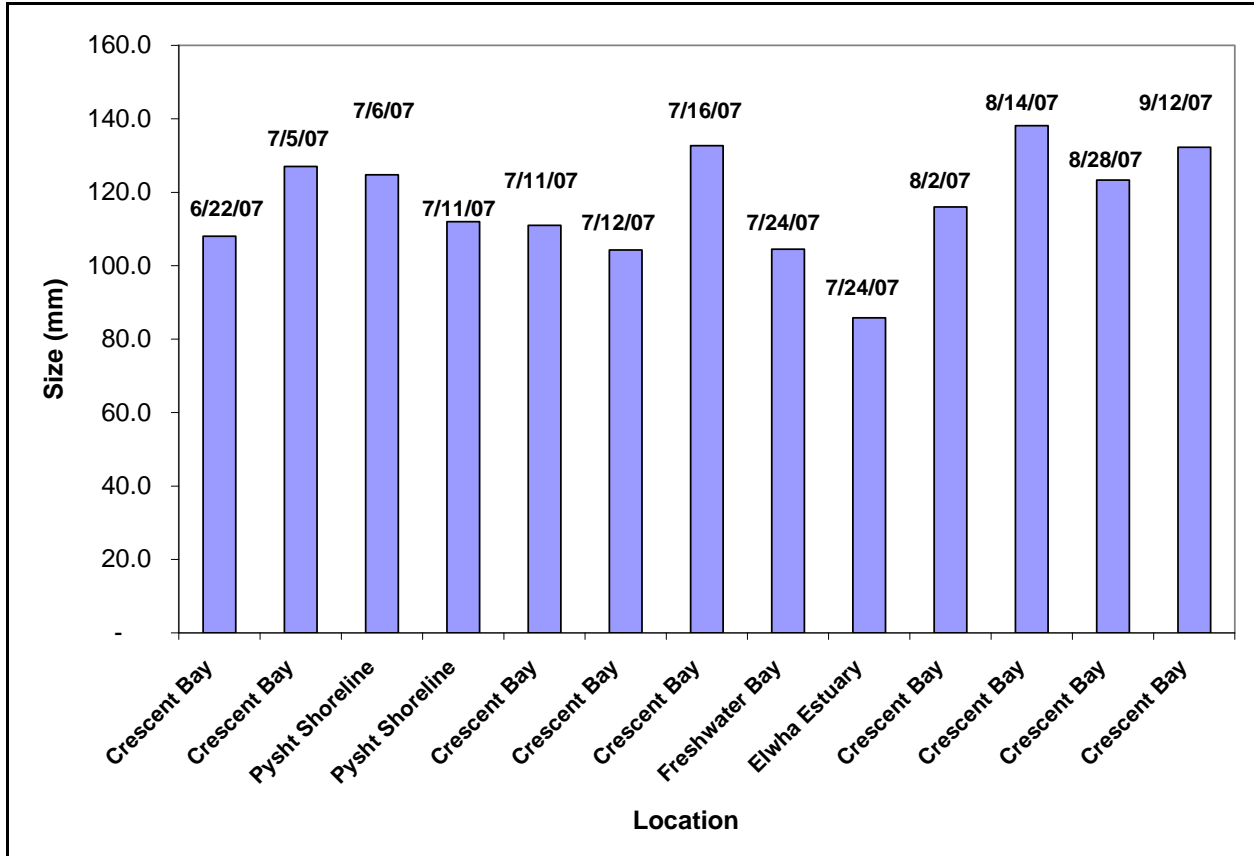


Figure 4. Chinook salmon size composition over time, by sample location.

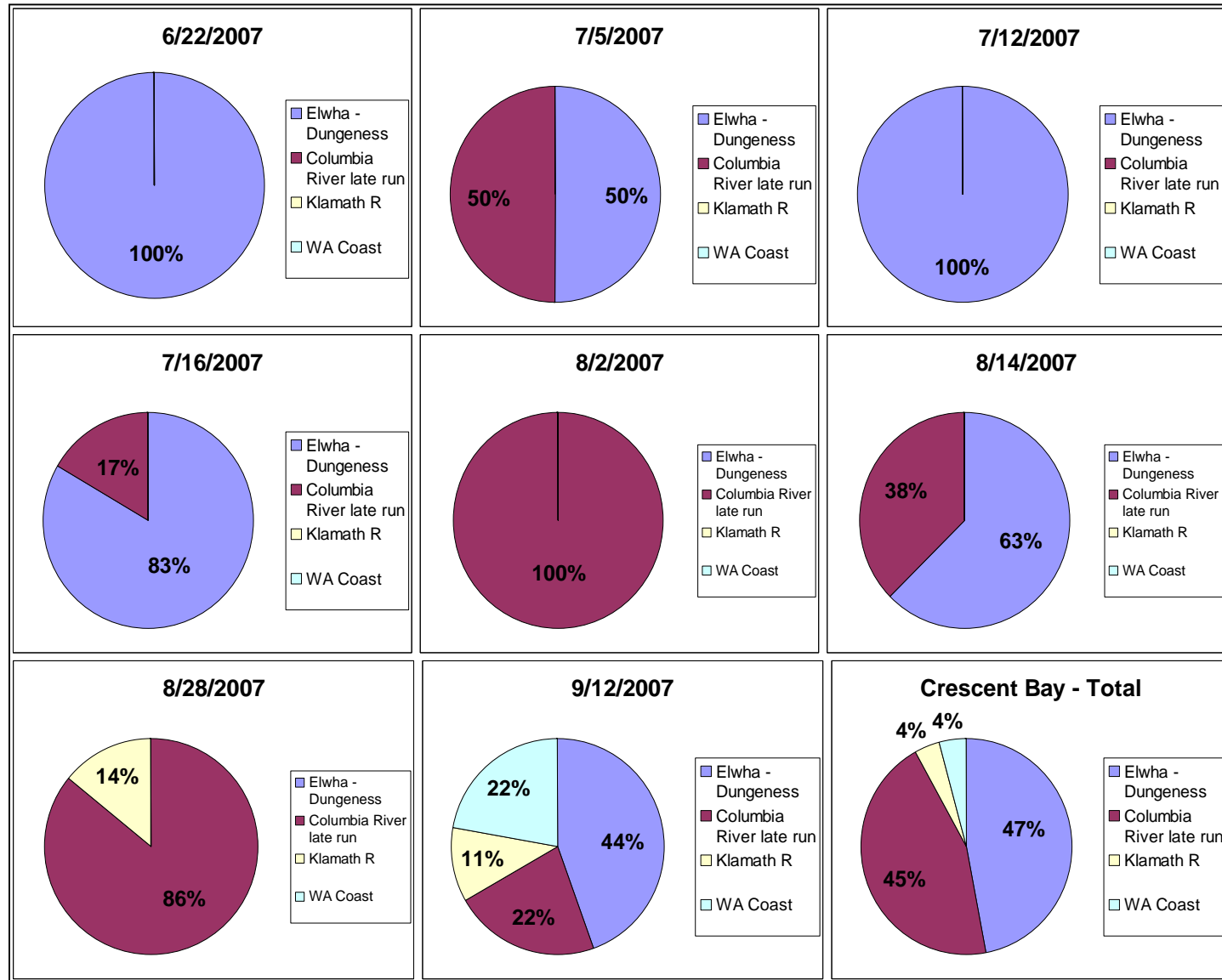


Figure 5. Crescent Bay Chinook stock composition.

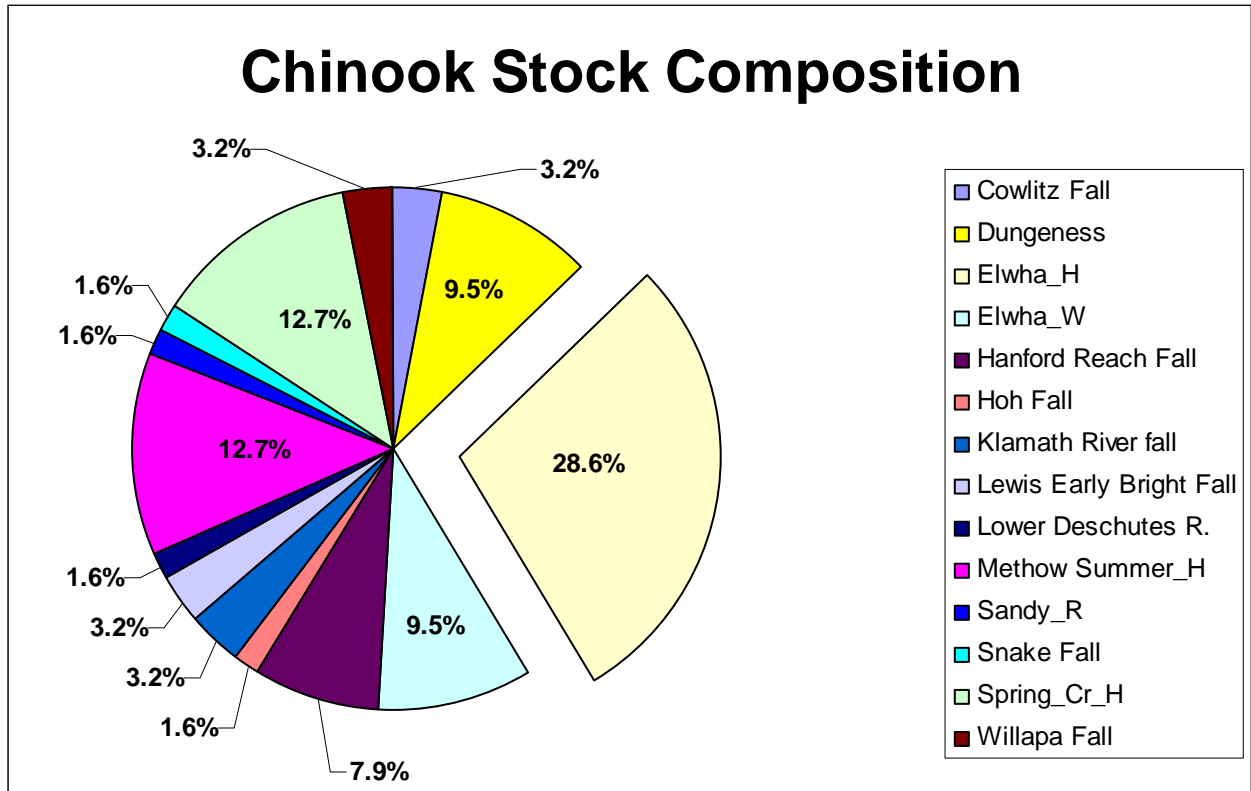


Figure 6. Federally listed populations represented

Table x. Summary of genetic analysis of juvenile Chinook samples collected from the central and western Strait of Juan de Fuca March-September 2007.

Individual	Collection Location	Collection Date	Size (mm)	Reporting Group	#1 Assignment	#1 PostProb	#2 Assignment	#2 PostProb	#3 Assignment	#3 PostProb
07IX0011	Cresecnt Bay	07/16/07	128	Elwha - Dungeness	Dungeness	0.779	Elwha_H	0.1335	Elwha_W	0.0874
07IX0012	Cresecnt Bay	07/16/07	131	Elwha - Dungeness	Elwha_H	0.954	Elwha_W	0.0456	Dungeness	0.0002
07IX0013	Cresecnt Bay	07/16/07	134	Elwha - Dungeness	Dungeness	0.431	Elwha_W	0.4275	Elwha_H	0.1418
07IX0014	Cresecnt Bay	07/16/07	146	Columbia River late run	Spring_Cr_H	0.738	Cowlitz Fall	0.0858	Hanford Reach Fall	0.0585
07IX0015	Cresecnt Bay	07/16/07	127	Elwha - Dungeness	Elwha_H	0.571	Elwha_W	0.3347	Dungeness	0.0945
07IX0016	Cresecnt Bay	07/16/07	130	Elwha - Dungeness	Elwha_H	0.639	Elwha_W	0.3601	Dungeness	0.0006
07IX0018	Freshwater Bay	07/24/07	112	Elwha - Dungeness	Dungeness	0.998	Elwha_H	0.0022	Elwha_W	1E-04
07IX0019	Freshwater Bay	07/24/07	116	Columbia River late run	Hanford Reach Fall	0.544	Methow Summer_H	0.4515	Snake Fall	0.0042
07IX0020	Freshwater Bay	07/24/07	94	Columbia River late run	Methow Summer_H	0.586	Hanford Reach Fall	0.4089	Lower Deschutes R.	0.0028
07IX0021	Freshwater Bay	07/24/07	96	Columbia River late run	Lewis Early Bright Fall	0.92	Sandy_R	0.0488	Hanford Reach Fall	0.0297
07IX0023	Elwha West Side Channel	07/24/07	101	Elwha - Dungeness	Elwha_W	0.657	Elwha_H	0.2039	Dungeness	0.1391
07IX0024	Elwha West Side Channel	07/24/07	85	Elwha - Dungeness	Elwha_H	0.969	Elwha_W	0.031	Dungeness	0.0001
07IX0025	Elwha West Side Channel	07/24/07	81	Elwha - Dungeness	Elwha_H	0.532	Elwha_W	0.3852	Dungeness	0.0829
07IX0026	Elwha West Side Channel	07/24/07	90	Elwha - Dungeness	Dungeness	0.446	Elwha_H	0.3907	Elwha_W	0.1631
07IX0027	Elwha West Side Channel	07/24/07	72	Elwha - Dungeness	Elwha_H	0.8	Elwha_W	0.2002	Dungeness	4E-05
07IX0028	Crescent Bay	08/02/07	110	Columbia River late run	Methow Summer_H	0.947	Hanford Reach Fall	0.052	Snake Fall	0.0008
07IX0029	Crescent Bay	08/02/07	112	Columbia River late run	Cowlitz Fall	0.998	Spring_Cr_H	0.0018	Lewis Early Bright Fall	0.0005
07IX0030	Crescent Bay	08/02/07	122	Columbia River late run	Sandy_R	0.597	Cowlitz Fall	0.2387	Hanford Reach Fall	0.1411
07IX0031	Crescent Bay	08/02/07	131	Columbia River late run	Spring_Cr_H	1	Cowlitz Fall	8E-05	Sandy_R	3E-06
07IX0032	Crescent Bay	08/02/07	117	Columbia River late run	Methow Summer_H	0.497	Lewis Early Bright Fall	0.4771	Cowlitz Fall	0.0192
07IX0033	Crescent Bay	08/02/07	110	Columbia River late run	Methow Summer_H	0.451	Hanford Reach Fall	0.3482	Snake Fall	0.1288
07IX0034	Crescent Bay	08/02/07	110	Columbia River late run	Lewis Early Bright Fall	0.672	Cowlitz Fall	0.1714	Spring_Cr_H	0.1168
07IX0035	Crescent Bay	08/02/07	116	Columbia River late run	Spring_Cr_H	0.991	Cowlitz Fall	0.0086	Lewis Early Bright Fall	3E-07
07IX0036	Crescent Bay	06/22/07	109	Elwha - Dungeness	Elwha_W	0.839	Elwha_H	0.1425	Dungeness	0.0179
07IX0037	Crescent Bay	06/22/07	107	Elwha - Dungeness	Elwha_H	0.513	Elwha_W	0.4871	Methow Summer_H	2E-06
07IX0071	Crescent Bay	07/05/07	121	Elwha - Dungeness	Elwha_W	0.856	Elwha_H	0.1414	Dungeness	0.0027
07IX0072	Crescent Bay	07/05/07	116	Elwha - Dungeness	Elwha_H	0.609	Elwha_W	0.3911	Dungeness	0.0001
07IX0074	Crescent Bay	07/05/07	127	Columbia River late run	Spring_Cr_H	0.999	Cowlitz Fall	0.0011	Sandy_R	3E-07
07IX0075	Crescent Bay	07/05/07	144	Columbia River late run	Spring_Cr_H	0.999	Elwha_W	0.0012	Elwha_H	0.0001
07IX0077	Pysht Shoreline	07/06/07	125	Elwha - Dungeness	Elwha_H	0.638	Elwha_W	0.362	Dungeness	3E-05
07IX0078	Pysht Shoreline	07/06/07	135	Columbia River late run	Cowlitz Fall	0.93	Sandy_R	0.0581	Spring_Cr_H	0.012

07IX0079	Pysht Shoreline	07/06/07	109	Columbia River late run	Methow Summer_H	0.981	Lower Deschutes R.	0.0109	Hanford Reach Fall	0.006
07IX0081	Pysht Shoreline	07/06/07	130	Columbia River late run	Spring_Cr_H	1	Hanford Reach Fall	0.0002	Lewis Early Bright Fall	9E-05
07IX0082	Pysht Shoreline	07/11/07	112	WA Coast	Hoh Fall	1	Hanford Reach Fall	3E-05	Willapa Fall	2E-05
07IX0083	Crescent Bay	07/11/07	111	Elwha - Dungeness	Elwha_H	0.824	Elwha_W	0.1754	Dungeness	0.0001
07IX0084	Crescent Bay	07/12/07	100	Elwha - Dungeness	Elwha_H	0.466	Elwha_W	0.2677	Puyallup	0.2314
07IX0085	Crescent Bay	07/12/07	116	Elwha - Dungeness	Elwha_H	0.997	Elwha_W	0.0028	Dungeness	2E-06
07IX0086	Crescent Bay	07/12/07	113	Elwha - Dungeness	Dungeness	0.952	Elwha_H	0.034	Elwha_W	0.0142
07IX0087	Crescent Bay	07/12/07	88	Elwha - Dungeness	Elwha_W	0.88	Elwha_H	0.1071	Dungeness	0.0131
07IX0106	Crescent Bay	08/14/07	113	Columbia River late run	Lower Deschutes R.	0.837	Hanford Reach Fall	0.1476	Methow Summer_H	0.0149
07IX0107	Crescent Bay	08/14/07	147	Elwha - Dungeness	Dungeness	0.56	Elwha_H	0.3691	Elwha_W	0.0707
07IX0108	Crescent Bay	08/14/07	111	Columbia River late run	Hanford Reach Fall	0.534	Methow Summer_H	0.4568	Snake Fall	0.0053
07IX0109	Crescent Bay	08/14/07	147	Elwha - Dungeness	Elwha_H	0.487	Dungeness	0.3431	Elwha_W	0.1702
07IX0110	Crescent Bay	08/14/07	128	Columbia River late run	Hanford Reach Fall	0.948	Lower Deschutes R.	0.0338	Methow Summer_H	0.0183
07IX0111	Crescent Bay	08/14/07	156	Elwha - Dungeness	Elwha_W	0.811	Elwha_H	0.1395	Dungeness	0.0498
07IX0112	Crescent Bay	08/14/07	157	Elwha - Dungeness	Elwha_H	0.56	Elwha_W	0.4317	Dungeness	0.0084
07IX0115	Crescent Bay	08/14/07	146	Elwha - Dungeness	Elwha_H	0.918	Elwha_W	0.082	Dungeness	4E-06
07IX0116	Crescent Bay	08/28/07	130	Columbia River late run	Spring_Cr_H	0.989	Cowlitz Fall	0.0098	Sandy_R	0.0004
07IX0117	Crescent Bay	08/28/07	119	Columbia River late run	Hanford Reach Fall	0.973	Snake Fall	0.0232	Lower Deschutes R.	0.0028
07IX0118	Crescent Bay	08/28/07	113	Klamath R	Klamath River fall	0.997	Hanford Reach Fall	0.0017	Snake Fall	0.0013
07IX0119	Crescent Bay	08/28/07	108	Columbia River late run	Snake Fall	0.885	Hanford Reach Fall	0.0949	Lower Deschutes R.	0.0194
07IX0121	Crescent Bay	08/28/07	89	Columbia River late run	Methow Summer_H	0.931	Hanford Reach Fall	0.0431	Snake Fall	0.017
07IX0122	Crescent Bay	08/28/07	122	Columbia River late run	Methow Summer_H	0.66	Hanford Reach Fall	0.3289	Lower Deschutes R.	0.0107
07IX0123	Crescent Bay	08/28/07	182	Columbia River late run	Spring_Cr_H	1	Cowlitz Fall	6E-05	Sandy_R	1E-05
07IX0124	Crescent Bay	09/12/07	123	Elwha - Dungeness	Elwha_W	0.404	Elwha_H	0.3485	Dungeness	0.2473
07IX0125	Crescent Bay	09/12/07	142	Elwha - Dungeness	Elwha_H	0.997	Dungeness	0.002	Elwha_W	0.0007
07IX0126	Crescent Bay	09/12/07	110	Elwha - Dungeness	Elwha_H	0.886	Elwha_W	0.1119	Dungeness	0.0024
07IX0127	Crescent Bay	09/12/07	122	Elwha - Dungeness	Elwha_H	0.985	Elwha_W	0.0149	Dungeness	5E-05
07IX0129	Crescent Bay	09/12/07	125	Klamath R	Klamath River fall	1	Willapa Fall	3E-07	Lewis Early Bright Fall	2E-07
07IX0130	Crescent Bay	09/12/07	139	Columbia River late run	Hanford Reach Fall	0.579	Snake Fall	0.3585	Methow Summer_H	0.0628
07IX0131	Crescent Bay	09/12/07	144	Columbia River late run	Methow Summer_H	0.761	Hanford Reach Fall	0.1831	Lower Deschutes R.	0.0332
07IX0132	Crescent Bay	09/12/07	140	WA Coast	Willapa Fall	0.977	Hoh Fall	0.0211	Hanford Reach Fall	0.0024
07IX0133	Crescent Bay	09/12/07	145	WA Coast	Willapa Fall	1	Spring_Cr_H	0.0001	Lewis Early Bright Fall	5E-05

