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Draft Final Report

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Introduction

The nearshore environment of the Elwha River provides critical habitat for salmonids and other species a like (Shaffer et al 2008, 2009). Despite degradation through anthropogenic influences such as sediment starvation (Childers et al 2000) , development, roads, diking, and riprapping (Shaffer et al 2008; Duda et al 2008), fish utilize this nearshore habitat year round maximizing usage during late spring and minimizing usage during the winter months (Shaffer et al 2010). Dam removal is anticipated to begin in 2011, marking the single largest watershed restoration in our nation (Winter and Crain 2008). The project will involve the release of over 10 million cubic yards of sediment to the nearshore resulting in a complex, partial, and poorly understood restoration response of the nearshore (Draut et al 2007, Randle 2004; Shaffer et al 2008).

To better understand the complex nearshore ecology of the central Strait of Juan de Fuca, including the Elwha estuary, beach seining has been vital in data collection capturing the temporal and spatial utilization by the ichthyofauna of these environments. Seining efforts are led and coordinated by the Coastal Watershed Institute, with partnership of the Washington Department of Fish and Wildlife, Peninsula College, Western Washington University, and local citizen groups including Sierra Club and Coastal Conservation Association (CCA). Sampling is based on the Elwha nearshore restoration strategy developed by Shaffer et al in 2004 (see Shaffer et al 2008). Long term trends in ecological indices including fish species composition, diversity, and individual species metrics are assessed for the Elwha and comparative areas. These metrics will be used to detect baseline conditions as well as ecological changes during and after dam removal with the intent of defining additional long term restoration actions to achieve full ecosystem restoration. The Salt Creek estuary is a comparative estuary for the Elwha west estuary. Nearhore fish use of the Salt Creek and Elwha west estuary sampling has been conducted since 2007, making this the single longest data set for juvenile fish use of the nearshore central Strait of Juan de Fuca.

Twenty six species have been recorded since 2007, five of which, (Puget Sound Chinook, (*Oncorhynchus tshawytscha),* Strait of Juan de Fuca/Hood Canal summer chum, (*O. keta),* bull trout, (*Salvelinus confluentus),* and steelhead (*O. mykiss),* and eulachon, (*Thaleichthys pacificus*) are federally protected under the ESA (Shaffer et al 2010).

The data collected will help serve as a baseline reference for post dam removal research (Shaffer et al 2009; Duda et al 2008, Underwood 1994) to help track how sediment recruitment, large woody debris recruitment, natural flow and flooding, and normal levels of water quality in the presence of anthropogenic influences such as temperature, dissolved oxygen, salinity, and pH will impact species composition spatially, temporally, and abundance.

Materials and Methods

Nine students worked on the study in 2010-2011: Justin Brown, Tony Duarte, Ian Franco, Joseph Gonze, Anthony Grimm, Rebecca Lucas, Brandon Massey, Tara Morrow, and Becca Yucha (Figure 9). They participated in all sampling, data transcribing and archiving, and maintenance of sampling gear. All but three presented to the Clallam MRC. Of this year's student cohort, four students have graduated from the PC Fisheries program (including the report author whom is now enrolled in the Fisheries program at UW); two will be graduating from the WWU Huxley program next week; and one will be graduating from the WWU program in Fall 2011.

Sampling frequency is one day, generally during the first week of each consecutive month. Two sites are sampled at both the west estuary of the Elwha and main channel of the Salt Creek estuary (Figure 1; Table 1.).

The seine net that's used is a standard 'small' PSWQA protocol net: 80 ft. long by 6 ft. deep, with standard cork and lead lines, and spreader rods at each end (PSWQA 1996; Shaffer et al 2010). A knotless mesh of ¼ inch makes up the wings, and mesh size of 1/8 inch makes up the bag. The bag is 6 ft^2 and located in the bunt of seine. A 12 ft skiff is used to deploy seine parallel to bank at maximum distance. When the net is in place it is retrieved by members pulling ends toward bank while working specimens toward the center making sure the cod end is fully submerged at all times and that the lead line maintains contact with substrate. Immediately upon net retrieval, the bag is placed in the center of a 4' by 4' floating ring and moved to waist deep water for specimen sampling.

Sampling consists of identifying all specimens to lowest taxa, enumerating, and collecting total and fork lengths for all species. The first 20 specimens representing the same taxon are measured, and additional specimens are only enumerated and released. Salmonids were measured for both fork and total length and received preference during data collection due to being the main species of concern as well as the quickest to succumb to mortality in the high stress environment of the cod end. Diligence is practiced as to reduce stress on specimens by quickly sampling and returning them to the water minimizing casualties to near zero percent. All fish were released unharmed after data collection, and none were subjected to tranquilizers such Tricaine mesylate (MS 222).

Water quality such as dissolved oxygen % and mg/l, salinity, pH, conductivity, and degrees Celsius, was collected by standard YSI. Latitude and longitude were taken using a portable GPS, and all sampling was conducted during daylight in the morning and early afternoon hours.

Table 1. Sampling site locations designated by GPS points.

	Latitude	Longitude
Elwha River West Estuary	**48.13196**	**123.56822**
	48.14584	**123.56738**
Salt Creek Estuary (Main Channel)	**48.16168**	**123.76538**
	48.14641	**123.56797**

The total catch per unit of effort (CPUE) was used to compare monthly trends and mean CPUE data was used to show annual variation in species abundance over time. CPUE data was standardized by finding the ratio of the monthly mean $PUE/net\ m^3$, and transformed to logarithms, $(ln(X+1))$ prior to analysis. Using these CPUE ratios for the months March-May over the years 2007-2011, a two way ANOVA without replication was used to show variation in mean CPUE for the Elwha West Estuary with a significance set at $P \leq 0.05$. From May, 2010-May, 2011 total monthly CPUE's were evaluated for both Elwha and Salt Creek to show seasonal flux in fish fauna abundance and percent of individual species composition. Total lengths were also measured of all species and were averaged and standard deviations calculated monthly over the same interval.

Results

The ichthyofauna that utilize the estuaries of the Elwha River and Salt Creek nearshore systems show wide ranges of diversity and abundance throughout the season. From May, 2010 – May, 2011, there were 26 species collected and identified in a total of n=51 seine hauls, with a total abundance of 24,195 fish (Elwha 18,814, and Salt Creek 5,381). The annual total catch for the Elwha was dominated by Chinook at 74%, coho at 1%, chum at $< 1\%$. The annual total catch for Salt Creek nearshore consisted of Chinook at 0%, coho at 9%, chum at 1%, and shiner perch making up 55% (Figure 2 and 3).

We used a two way ANOVA to examine annual mean CPUE trends at both sites for the months of March-May from 2007-2011. Statistical results show that there is significant variation between month and corresponding year sampled ($P = 0.03,\ F = 4.46$), and results also show that there is a significant difference between years ($P = 0.03,\ F = 3.84$) when looking at the natural logs of the standardized mean CPUE data. The mean CPUE for 2009 and 2010 are substantially larger than 2007, 2008 or 2011 for the month of May.

Table 2. Transformed CPUE for the Elwha River west estuary

	2007	2008	2009	2010	2011
March	**0.18**	**0.08**	**0.26**	**0.20**	**0.18**
April	**0.20**	**0.38**	**1.26**	**1.08**	**0.31**
May	**0.32**	**0.29**	**1.44**	**0.87**	**0.35**

The annual peak rate of occurrence for both systems lies between May and September (Figure 4), with the months between January and March showing the lowest numbers in overall abundance. Chinook, only present in the Elwha, started utilizing the Elwha west estuary in early April, and by September they fully migrated out. Coho follow the same migration pattern as the Chinook although they start utilizing the estuary in early March. Chum start showing up in January and by the end of May they have all migrated. Coho salmon in Salt Creek estuary inhabit the estuary year round, and by the end of May, the smolts have migrated out. Chums appear in March, and they too have fully migrated out by the end of May (Figure 2 and 3).

The Chinook that utilize the Elwha west estuary average $53 \pm 5.92\ mm$ total length in April, and by August they have doubled in length averaging $103 \pm 6.59\ mm$ total length (Figure 2). Coho average $41 \pm 2.52\ mm$ total length in March, and in September $105 \pm 9.35\ mm$ total length, more than doubling their total length (Figure 5). The coho that utilize Salt Creek estuary show average total lengths for young of year (YOY) and smolts at $84 \pm 42.0\ mm$ total length for during May (Figure 6). From June ($52.7 \pm 8.6\ mm$) through January ($115 \pm 11.7\ mm$), the total length of YOY show consistent growth. They then turn to 1+ fish and start mixing with the next generation's cohort. Salt Creek's chum show little growth at $40.5 \pm 3.3\ mm$ in March, and in May $46.3 \pm 10.1\ mm$ as their estuary residence window is strictly for acclimation to sea water as opposed to rearing (Figure 6).

Discussion

The importance of these habitats is becoming better understood with long term studies such as this. When looking at mean total lengths for salmonids, we see large increases in growth: a more than doubling the total mean length. This shows a strong connection between juvenile salmon and these estuaries as not only habitat for acclimation to sea water but for rearing purposes. This dependence has regional importance. Genetic studies in 2008 revealed juvenile Chinook and coho from as far away as Columbia and Kalamath systems using the central Strait shoreline (Shaffer et al in review). Beirnes et al (unpublished data) found intriguing shifts in prey utilization by juvenile Chinook salmon in the Elwha estuary. Further long term monitoring and more detailed research is warranted to define food availability for juvenile salmonids in the Elwha west estuary, as well as long term research in figuring the genetic compostion and total percentage of salmonids that utilize the Elwha west, east, and impounded estuary (Shaffer 2009). Water quality studies to define nutrient loading in the impounded west estuary, and larger scale

planning to promote the restoration of the degraded estuary are also a priority (Elwha Nearshore Consortium 2011).

The composition of fish fauna that inhabit the nearshore waters of these systems is diverse temporally and spatially. With the expected high rates of siltation interim and post dam removal, these estuarine habitats of the Elwha will provide habitat that may be the only refuge for fish trying to avoid elevated rates of siltation (Childers et al 2000). We expect that future sampling will intercept higher rates of fish in the Elwha west estuary if they are able to survive the flushing of sediment as the dams begin to be dismantled.

With the need of refuge from unnaturally silted water, the biological effects from the Place Rd. levy may become greater, as it disconnects a large portion of previous estuary from being utilized as refuge habitat (Shaffer 2009). The levy currently serves multiple private properties, and provides public beach access. The levy's function for flood protection has been the focus of much debate for over four decades. Scientists and managers have developed an Elwha nearshore ecosystem restoration plan proposal that lists the lower Elwha river and estuary as a top priority for restoration planning and implementation (Shaffer and D'hemcourt 2010). This plan, including the priorities for the Elwha estuary, needs to be implemented immediately if ecosystem restoration of the Elwha nearshore is to occur.

The results from May-10 through May-11 compare modestly with previous years data. Individual species composition percentages and lengths seem to be consistent with previous data as well.

This continued long term monitoring will provide the sole set of valuable and accurate nearshore fish use data for dam removal adaptive management, and nearshore ecosystem assessment and restoration planning. It provides a powerful tool for partnering and dialoging with shoreline landowners and citizens that are the stewards of our nearshore ecosystem. It also provides invaluable hands on learning experience for the next generation of resource managers and scientists. To date, 50 undergraduate students from Peninsula College, WWU, UI, Seattle Pacific University, UW, and graduate students from University of Chicago and Duke university have been an integral part of the nearshore study. It is a rare and valuable collaboration that the MRC should be very proud to be a part of.

Acknowledgments

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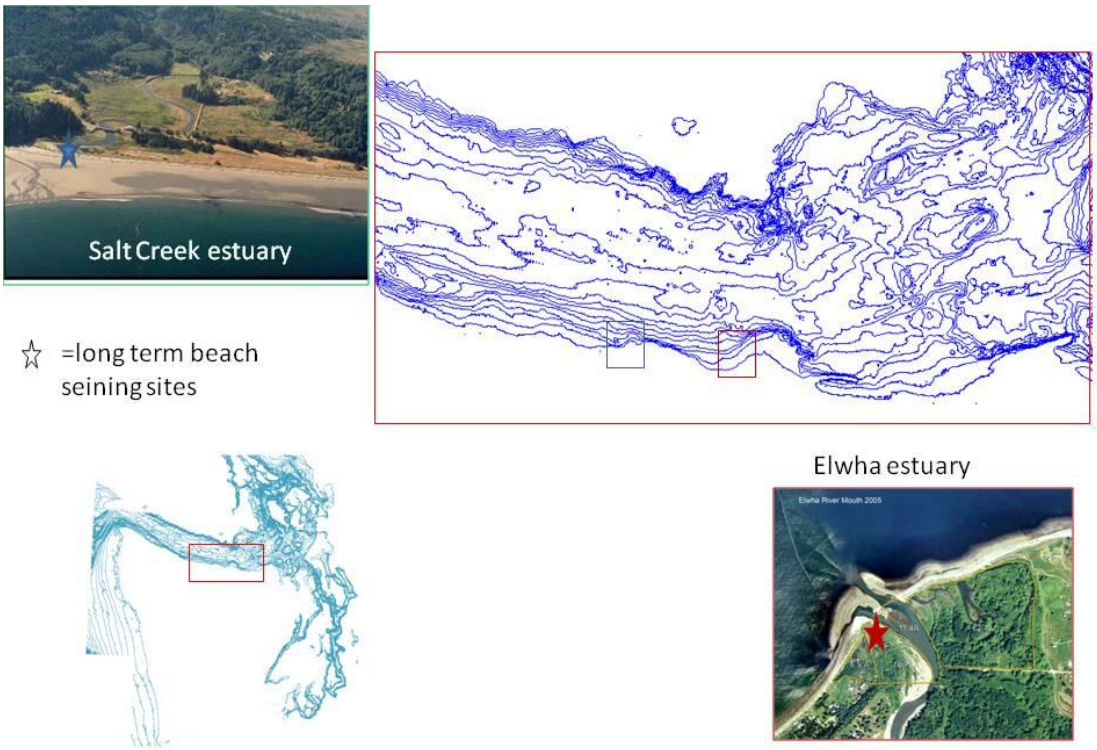

Figure 1. Long term nearshore monitoring nearshore study sites

Figure 2. Species composition as a percent of total CPUE per month for the Elwha west estuary May 2010-2011. All specimens intercepted are counted as individuals.

Common Name	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Total Annual Catch	Annual % Composition
Chinook	51.36%	99.82%	50.52%	7.43%	0	0	3.13%	0	0	0	0	50.78%	2.72%	13,863	73.68%
Coho	33.82%	0.08%	0	4.77%	1.25%	0	0	0	0	1.61%	2.70%	0	19.05%	278	1.48%
Chum	1.88%	0	0	0	0	0	0	0	2.04%	16.13%	5.41%	7.03%	13.61%	51	0.27%
Smelt (adult = >120)	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Smelt (juv = 50-120)	0	0	0	0	0	0	0	0	2.04%	0	0	0	0	1	0.01%
Smelt (pl = <50)	0	0	0	0	0	0	0	0		0	0	0	0	-	-
Herring (juv = 50-120)	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Sticleback(<30)	0	0	0	51.47%	72.43%	83.17%	87.50%	94.19%	61.22%	24.19%	8.11%	0.78%	1.36%	3,008	15.99%
Starry Flounder	0.84%	0	0	0.37%		0.55%	3.13%	0.83%	4.08%	4.84%	0	6.25%	5.44%	37	0.20%
Crescent gunnel	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Saddleback gunnel	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Penpoint gunnel	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Tubesnout	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
3-Spine stickleback	1.46%	0.05%	27.77%	23.30%	21.10%	6.42%	0	2.90%	6.12%	12.90%	32.43%	3.13%	14.29%	918	4.88%
Shiner perch	0	0	0	0	0	8.08%	0	0	0	0	0	0	0	73	0.39%
Staghorn sculpin	9.19%	0.06%	14.41%	3.39%	4.95%	1.77%	6.25%	1.24%	10.20%	22.58%	45.95%	22.66%	19.05%	367	1.95%
Cottids Unknown	0	0	0	0	0	0	0	0.41%	0	0	0	0	0	1	0.01%
Buffalo Sculpin	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Cottids <30mm	1.04%	0	4.38%	0.09%	0	0	0		12.24%	16.13%	5.41%	9.38%	24.49%	93	0.49%
Cutthroat	0.21%	0	0	0	0	0	0	0	0	1.61%	0	0	0	2	0.01%
Unkown trout	0	0	2.30%	3.58%	0.10%	0	0			0	0	0	0	52	0.28%
Steelhead	0.21%	0	0	0	0	0	0	0.41%	2.04%	0	0	0	0	3	0.02%
Prickley Sculpin	0	0	0.63%	5.60%	0	0	0	0	0	0	0	0	0	64	0.34%
Arrow Goby	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Northern Anchovie (Adult)	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
N. Shad	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Fluffy Sculpin	0	0	0	0	0.16%	0	0	0	0	0	0	0	0	3	0.02%
Sardine	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Total CPUE	479	13,248	479	1,090	1,919	903	32	241	49	62	37	128	147	18,814	

Figure 3. Species composition as a percent of total CPUE per month for the Salt Creek estuary May 2010-2011. All specimens intercepted are counted as individuals.

Common Name	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Total Annual Catch	Annual % Composition
Chinook	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Coho	47.62%	14.78%	2.62%	4.84%	6.46%	9.63%	0.95%	0	25.93%	2.94%	2.06%	9.43%	38.92%	474	8.81%
Chum	32.38%	0	0	0	0	0	0	0	0	0	19.59%	7.55%	1.23%	62	1.15%
Smelt (adult = >120)	0	0	0	0	0	0	0	0	0	2.94%	0	0	5.67%	24	0.45%
Smelt (juv = 50-120)	0	0	0	0	0	0	0	0	0	8.82%	1.03%	0	0.25%	5	0.09%
Smelt (pl = <50)	0	0	0	0	0	0	0	0	0	5.88%	0	0	0	2	0.04%
Herring (juv = 50-120)	0	0	0	0	0	0	0	0	0	0	0	0	0.25%	1	0.02%
Sticleback(<30)	0	0	0	0.20%	1.25%	2.63%	0	0	0	0	5.15%	0	0.25%	32	0.59%
Starry Flounder	0	1.85%	0.20%	0.87%	1.47%	4.16%	0.32%	0	7.41%	5.88%	6.19%	7.55%	0.74%	73	1.36%
Crescent gunnel	0	0	0.40%	0.40%	0	0	0	0	0	0	0	0	0.25%	9	0.17%
Saddleback gunnel	0	1.58%	7.04%	7.59%	4.87%	7.22%	0.21%	0	0	0	0	0	0	232	4.31%
Penpoint gunnel	0	0	2.82%	0.47%	0	0	0	0	0	0	0	0	0	21	0.39%
Tubesnout	0	0	0	0.07%	0	0.22%	0.11%	0	0	0	0	0	0	3	0.06%
3-Spine stickleback	0.95%	42.74%	0	2.15%	0.34%	0.22%	0	0	0	2.94%	1.03%	0	0.74%	204	3.79%
Shiner perch	2.86%	27.70%	80.28%	47.72%	75.20%	36.76%	97.05%	0	0	0	0	0	0.74%	2973	55.25%
Staghorn sculpin	0.95%	9.50%	6.04%	24.46%	10.08%	38.73%	0.53%	100%	44.44%	29.41%	9.28%	45.28%	43.84%	941	17.49%
Cottids Unknown	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Buffalo Sculpin	0	0	0	0%	0	0	0	0	0	0	0	0	0	1	0.02%
Cottids <30mm	2.86%	0	0	0.07%	0	0	0	0	22.22%	41.18%	51.55%	30.19%	7.14%	119	2.21%
Cutthroat	0	0.53%	0.40%	0.20%	0.34%	0.44%	0.74%	0	0	0	4.12%	0	0	23	0.43%
Unkown trout	0	0	0.20%	0.07%	0	0	0	0	0	0	0	0	0	2	0.04%
Steelhead	12.38%	0	0	0	0	0	0	0	0	0	0	0	0	13	0.24%
Prickley Sculpin	0	0	0	0.07%	0	0	0	0	0	0	0	0	0	1	0.02%
Arrow Goby	0	0.53%	0	0	0	0	0	0	0	0	0	0	0	2	0.04%
Northern Anchovie (Adult)	0	0	0	10.75%	0	0	0	0	0	0	0	0	0	160	2.97%
N. Shad	0	0	0	0	0	0	0.11%	0	0	0	0	0	0	1	0.02%
Fluffy Sculpin	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-
Sardine	0	0.79%	0	0	0	0	0	0	0	0	0	0	0	3	0.06%
Total CPUE	105	379	497	1488	883	457	949	6	27	34	97	53	406	5381	

Figure 4. Transformed CPUE's for Elwha River west estuary and Salt Creek estuary, May 2010- May 2011. Values represent the $Ln\ (Stardized\ Mean\ CPUE\ + 1)$. Peak abundance of the Elwha River for June 2010 reached 13,248 fish. This abnormal peak is the result of hatchery propagated fish interception.

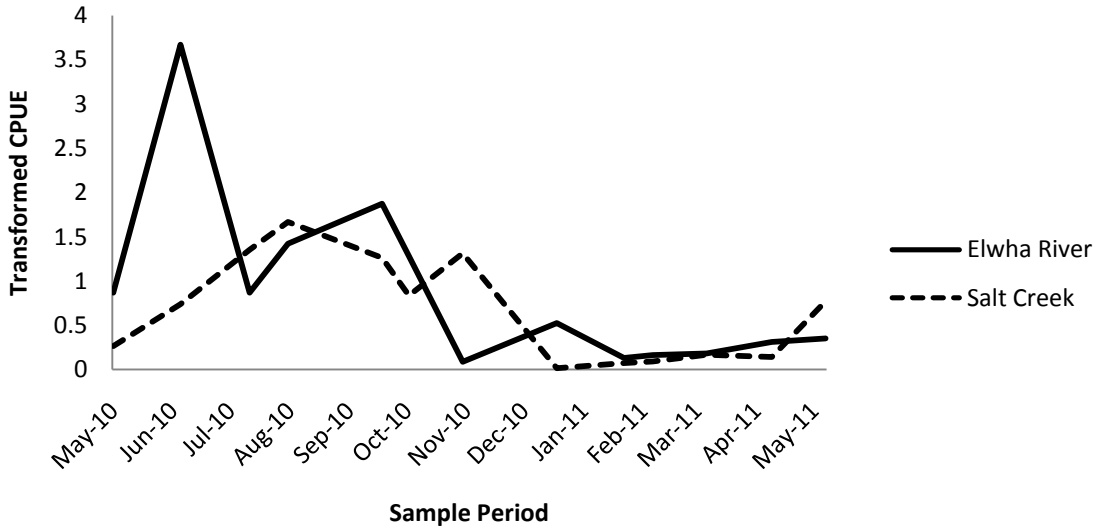

Figure 5. Mean monthly total length of the first 20 intercepted fish representing individual species for the Elwha River West estuary. Lengths are in mm.

	May-10		Jun-10		Jul-10		Aug-10		Sep-10		Oct-10		Nov-10		Dec-10		Jan-11		Feb-11		Mar-11		Apr-11		May-11	
	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD
Chinook_tot	64.36	7.61	98.38	10.88	93.16	6.15	103.10	6.59	0.00	0.00	0.00	0.00	111.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	52.80	5.92	65.75	4.99
Chinook_fork	60.11	7.19	92.13	10.58	85.77	6.44	94.97	5.70	0.00	0.00	0.00	0.00	109.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	49.57	5.79	60.33	6.03
Coho_tot	89.59	43.83	113.25	30.21	0.00	0.00	100.13	9.94	105.13	9.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	98.00	0.00	41.67	2.52	0.00	0.00	59.89	11.90
Coho_fork	83.15	40.21	107.75	28.52	0.00	0.00	92.43	8.70	96.50	8.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	90.00	0.00	39.00	2.65	0.00	0.00	56.29	11.28
Chum_tot	42.89	2.76	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	40.00	0.00	41.00	1.76	41.35	5.58	45.50	4.34	42.95	3.99
Chum_fork	40.22	2.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	37.00	0.00	37.70	2.31	39.00	5.60	42.75	4.10	40.05	4.35
Smelt (adult = >120)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Smelt (juv = 50-120)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	78.00	0.00	0.00	0.00	85.00	0.00	0.00	0.00	0.00	0.00
Smelt (pl = <50)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Herring (juv = 50-120)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Starry Flounder	150.25	17.35	0.00	0.00	0.00	0.00	74.75	6.50	74.50	12.02	64.20	32.55	67.00	0.00	53.00	2.83	76.50	2.12	75.67	13.20	84.00	23.39	95.13	21.62	106.25	22.73
Crescent gunnel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Saddleback gunnel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Penpoint gunnel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tubesnout	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3-Spine stickleback	50.71	3.95	56.40	3.91	56.00	8.07	51.48	8.57	44.73	16.35	41.50	9.33	0.00	0.00	42.57	6.08	33.67	1.53	33.63	3.20	40.54	7.78	47.50	6.03	44.43	7.78
Shiner perch	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Staghorn sculpin	92.76	42.59	95.67	16.35	84.43	28.71	96.11	28.30	100.35	27.01	101.78	36.28	54.00	0.00	72.00	22.63	55.20	14.18	42.57	12.25	50.84	17.17	58.14	24.20	64.61	30.91
cottids unknown	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	114.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Buffalo Sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cutthroat_tot	168.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	275.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cutthroat_fork	160.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	252.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unkown Trout_tot	0.00	0.00	0.00	0.00	35.73	7.39	47.90	9.70	71.00	14.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unkown trout_fork	0.00	0.00	0.00	0.00	34.64	7.10	45.50	9.27	66.00	14.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Steelhead_tot	220.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	650.00	0.00	750.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Steelhead_fork	210.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	620.00	0.00	740.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Prickley Sculpin	0.00	0.00	0.00	0.00	79.67	12.01	71.35	27.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Arrow Goby	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Northern Anchovie (ac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N. Shad	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fluffy Sculpin	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	84.00	20.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 6. Mean monthly total lengths of the first 20 intercepted fish representing individual species for the estuary of Salt Creek. Lengths are in mm.

	May-10		Jun-10		Jul-10		Aug-10		Sep-10		Oct-10		Nov-10		Dec-10		Jan-11		Feb-11		Mar-11		Apr-11		May-11	
	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD	AVE	STD
Chinook_tot	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chinook_fork	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Coho_tot	125.3	37.5	52.7	8.6	73.3	4.8	76.3	8.2	97.1	8.2	101.8	8.2	103.1	12.2	0.0	0.0	115.0	11.7	63.0	0.0	0.0	0.0	87.8	6.8	84.1	42.0
Coho_fork	116.8	35.4	49.0	8.2	67.9	4.7	70.8	8.2	90.3	8.0	93.3	7.1	94.4	10.3	0.0	0.0	104.3	8.4	59.0	0.0	0.0	0.0	82.2	8.1	78.7	39.4
Chum_tot	46.3	10.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.5	3.3	42.3	7.5	39.4	2.8
Chum_fork	43.7	9.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	38.0	3.8	39.3	6.8	37.8	1.9
Smelt (adult = >120)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	139.0	0.0	0.0	0.0	0.0	0.0	164.7	9.9
Smelt (juv = 50-120)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	104.0	7.9	0.0	0.0	0.0	0.0	78.0	0.0
Smelt (pl = <50)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.5	3.5	0.0	0.0	0.0	0.0	0.0	0.0
Herring (juv = 50-120)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	110.0	0.0
Starry Flounder	0.0	0.0	99.6	23.1	142.0	0.0	80.3	32.0	89.5	24.7	97.5	17.7	84.0	10.8	0.0	0.0	146.5	75.7	83.5	7.8	85.3	12.7	123.8	64.4	74.7	28.4
Crescent gunnel	0.0	0.0	0.0	0.0	113.5	2.1	80.0	10.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	76.0	0.0
Saddleback gunnel	0.0	0.0	108.5	15.5	79.7	22.3	80.3	18.9	88.4	14.4	81.2	13.9	86.5	20.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Penpoint gunnel	0.0	0.0	0.0	0.0	61.9	6.5	71.4	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tubesnout	0.0	0.0	0.0	0.0	0.0	0.0	226.0	0.0	0.0	0.0	246.0	0.0	212.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3-Spine stickleback	40.0	0.0	47.9	4.6	0.0	0.0	55.8	8.1	39.7	15.0	40.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.0	0.0	0.0	0.0	0.0	0.0	36.3	3.2
Shiner perch	109.0	18.5	113.2	14.4	116.8	14.1	61.9	26.1	75.3	4.5	80.0	4.1	105.5	19.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	93.5	9.2
Staghorn sculpin	65.0	0.0	60.8	19.0	127.4	28.4	101.7	19.0	112.2	19.7	108.6	21.6	87.7	75.2	40.0	2.7	46.8	15.6	56.5	24.8	39.9	9.6	44.3	13.3	50.9	14.2
cottids unknown	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Buffalo Sculpin	0.0	0.0	0.0	0.0	0.0	0.0	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cutthroat_tot	0.0	0.0	320.0	0.0	204.0	65.1	177.3	16.0	209.7	70.9	233.0	15.6	314.3	44.3	0.0	0.0	0.0	0.0	0.0	0.0	301.3	4.8	0.0	0.0	0.0	0.0
Cutthroat_fork	0.0	0.0	312.5	3.5	199.5	64.3	168.0	18.3	161.5	36.1	223.5	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	288.8	9.5	0.0	0.0	0.0	0.0
Unkown Trout_tot	0.0	0.0	0.0	0.0	32.0	0.0	82.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unkown trout_fork	0.0	0.0	0.0	0.0	31.0	0.0	76.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Steelhead_tot	199.2	11.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Steelhead_fork	189.9	11.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prickley Sculpin	0.0	0.0	0.0	0.0	0.0	0.0	81.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Arrow Goby	0.0	0.0	42.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Northern Anchovie (ac	0.0	0.0	0.0	0.0	0.0	0.0	115.2	5.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
N. Shad	0.0	0.0	0.0	0.0	0.0	0.0	139.0	7.0	0.0	0.0	0.0	0.0	170.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fluffy Sculpin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 7. Transformed annual CPUE's for the Elwha west estuary and Salt Creek. Values represent $Ln\ (standardized\ mean\ CPUE\ +\ 1)$. Unfilled data represents periods without sampling.

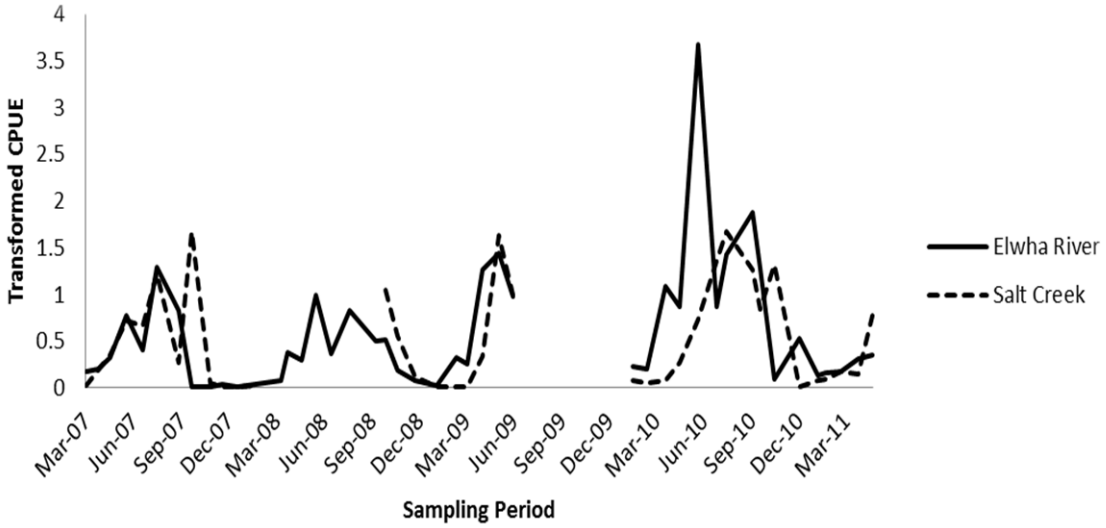

Figure 9. 2010-2011 sampling photos: A. Intern Becca Yucha collecting water quality data, Elwha west estuary north; B. Biologists Anne Shaffer (CWI), Chris Byrne (DFW) and Peninsula College students Justin Brown, Joseph Gonce, and Ian Franco sample fish from Elwha west estuary south; C. WWU students Tara Morrow, Tony Duarte, Tony Grimm, Sierra Club member Norm Baker, WDFW biologist Chris Byrnes, and now UW student Justin Brown sample the Elwha west estuary south. Duke University students watch from bank prior to joining sampling effort.