Fish use of shoreline habitats of the central and western Strait of Juan de Fuca

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This report provides a summary of beach seining results from March 2007-August 2008 for embayed shoreline, spit, and bluff sites, collectively called 'shoreline sites', of nearshore central and western Strait of Juan de Fuca, and highlights of interannual long term monitoring results observed to date at two embayed shoreline sites. While this report provides a detailed discussion of results from this portion of the Strait nearshore, the reader is also referred to individual watershed chapters for Pysht, Twins, Salt Creek, as well as the Chinook genetic report, forage fish use, kelp snorkeling surveys, and nearshore water quality reports.

Methods and Materials.

Seining was conducted using the large PSAMP protocol nets (;Figure 1) deployed by boat from shore.

All shoreline sites were intended for sampling from March 2007-March 2008. Sites were to be sampled at a minimum of weekly from March-September 2007, and then monthly from October 2007 to March 2008. Two shoreline sites, Freshwater Bay and Crescent Bay, continue to be sampled for long term monitoring, and have been sampled monthly from March-September 2008. On average two seines were conducted at each site and sampling day. For each seine all fish identified to lowest taxa possible, counted, and 25 of each species were measured to nearest mm. When observed, five Chinook were sampled for genetic analysis (see genetic report for methods). We opportunistically collected up to 100 fish of each forage fish species for biomass evaluation. These fish were preserved in 70 percent ETOH, returned to the lab, weighed, measured, and assessed for sexual maturity.

Fish densities were calculated to fish per cubic meter x 1000. Species richness and diversity were calculated for each site in the study.

Results.

A total of 181 seines were sampled from all shoreline sites from March 2007-March 2008. Sixty three percent of these were conducted between March and September 2007. Chronically limited agency boat resources and challenging sampling conditions of swell and fog severely limited our ability to sample Dungeness Bluffs, Dungeness Spit, Ediz Hook, and Elwha Bluffs, which are accessed only by boat. These sites were therefore sampled only from May thru October 2007. Due to further constraints of run time only one seine was done at spit and bluff sites.

The majority of seines were at embayed (131 seines) sites followed by bluff (29 seines) and spit (25 seines) sites Overall, shoreline sites had the highest percentage of total fish caught over the year sampling period. The one exception was Ediz Hook, which had the second lowest percent of fish collected of all sites sampled over the entire period (Table 1).

Forage fish, specifically smelt, anchovy, sand lance, and herring, were the most abundant fish collected along all the shoreline sites (Table 1), and comprised well over 40% of total fish collected during the year sampling period. Bluff and spits had the highest weekly averages of total smelt (the majority of which were surf smelt see appendix for individual species). Smelt did show strong seasonal variation in weekly densities for all live histories (adults, juveniles, and post larval stages).

Continued monitoring of Freshwater and Crescent bay indicates that there is strong interannual variation in smelt and lingcod density. Total smelt densities at each site decreased by over 80% in 2008 compared to 2007, and percent compostion by life history shifted from adult smelt in 2007 to juvenile smelt in 2008. (Figure 3g-h; Table 2&3.) Length of mature adult smelt did not vary appreciably between site. Maturity and weight however did show site differences (Figure 3e). Mature herring were not as frequently encountered, and most mature herring were not sexually mature or gravid (Figure 3f). Only one site in the Dungeness drift cell was observed to have sexually mature herring throughout the 13 month study.

For salmonid use of the nearshore, salmon were present at all the shoreline sites. The Twins nearshore had the lowest density of salmon, with only two coho collected from the Twins nearshore in December 2007. The Elwha drift cell, including Freshwater Bay, Elwha Bluffs, and Ediz Hook, had the highest density of Chinook and coho salmon (Figure 4). Genetic analysis of juvenile Chinook salmon collected during this survey revealed that a significant proportion of juvenile Chinook were from ESA listed stocks of both Puget Sound and Columbia river (see Figure xxx and genetic chapter for details).

Discussion

Comparing diversity of shoreline sites, embayments, spits, and bluffs, indicates both trends and differences in ecological function. All sites had significant seasonal differences in diversity. Within embayments, Crescent Beach, Twins, Pysht all have higher diversity than Freshwater Bay, which is degraded due to sediment starvation from Elwha river dams. Comparing between geomorphic habitat types, the embayed sites had consistently higher diversity than spits and bluffs. Finally, the Elwha drift cell embayed, spit, and bluff sites had consistently lower diversity than comparative shoreline sites within the comparative Dungeness drift cell (Figure xxx).

It is also important to note that, while the Elwha drift cell appears to be functioning at a lower level ecologically it is supporting the highest density of salmon, and in particular, Chinook salmon. In the genetic portion of this study we documented the majority of Chinook found along the central and western Strait shoreline to be from a number of listed stocks, including from Elwha Dungeness and Columbia river stocks(see chapter xxxx this report). Mapping of forage fish spawn from the Elwha drift cell has revealed that only Freshwater Bay supports surf smelt spawning.

Eelgrass mapping of the Elwha and comparative nearshore indicates remnant eelgrass beds in the Ediz Hook area, and extremely high use of understory kelp beds by juvenile forage fish

(Norris et al 2007). This juxtaposition of current ecological fitness, current fish density and presence of numerous stocks of ESA listed priority recovery salmon species and forage fish spawning, leads us to conclude that the Elwha drift cell, including embayed, spit, and bluff sites, is a top priority for nearshore restoration.

Restoration of the Elwha drift cell will be complex and require modeling analysis. The Elwha drift cell is defined as extending from the western edge of Freshwater Bay to the tip of Ediz Hook. Sediment processes are the dominant limiting factor for the Elwha nearshore, and have played a significant role in nearshore habitat form (Warrick et al 2008). Historically the feeder bluffs east of the river mouth provided over 70% of sediment to the Elwha littoral system (Randall et al 2004; Shaffer et al 2008). The Elwha river provided the rest. The feeder bluffs east of the rivermouth of the Elwha have been bulkheaded for over 100 years. Feeder bluffs in the lower river have been actively feeding since the dams were installed (Draut et al 2008). We therefore hypothesize that nearshore sediment starvation, and concomitant functional impacts, increase in Elwha nearshore with distance from the river mouth. This is supported by the documentation of surf smelt spawning, which requires a fine sand gravel substrate, only along the Elwha drift cell in immediate proximity to the Elwha river mouth.

Upcoming dam removals, which will partially restore Elwha nearshore sediment delivery, will have two phases. The first will be the restoration response, and is anticipated to deliver 10mcy of sediment to the nearshore within five years of dam removal (see Randle et al 2004; Stolnack and Naimann 2005; and Shaffer et al 2008). The second will be the post dam removal annual rate of sediment delivery, estimated to be approximately 200,00cy per year. Sediment contribution from the feeder bluffs, which, prior to armoring were estimated, to provide over 70% of sediment to the Elwha drift cell will continue to be disrupted. Every effort should therefore be made to optimize this high volume but short interval upcoming sediment delivery to the Elwha bluffs and Ediz Hook from the dam removals.

Additional specific modeling to define sediment fate in the Elwha nearshore and anticipated habitat response, in particular for predicting the proportion and fate of grain size that will be suitable for forage fish spawning and eelgrass recolonization, will be needed if the restoration actions are to be the most effective and successful.

The high diversity and richness of the embayed shorelines, and Crescent Bay in particular, make it, Freshwater Bay, and the Twins shoreline top priorities for long term preservation. The majority of these properties are privately owned. Acquisition and conservation easements of Crescent Bay and Freshwater Bay are therefore the appropriate and top priority actions for shoreline restoration.

The Twins shoreline is intriguing in that it has high diversity, but salmon use was not heavily documented in this study. This despite heavy salmon use of the watershed documented by Roni et al. We theorize that salmon use of the Twins nearshore, both shoreline and lower river, is much different than other nearshore areas of the central and western Strait. Additional monitoring is recommended to understand salmonid use of the Twins nearshore. The high diversity and species richness of the area, and high smelt use for both spawning and migration, leads us to recommend the Twins as a priorty for restoration and aquistion. The Twins is a mixture of private and public ownership. Acquisition/conservation easement of private properties is a priority.

The Pysht shoreline also exhibited high species diversity and richness, as well as salmon use, including both Puget Sound and Columbia river ESA listed stocks. This area is the site of a large conservation easement. Every effort should be made to keep the Pysht shoreline intact. All development of this shoreline should be avoided.

Finally, preliminary results from ongoing long term sampling of two of the embayed sites indicates a large seasonal and interannual variation in fish use of the nearshore central Strait, with large differences in both total numbers of fish, and fish distribution in the nearshore. For example, between 30-60% fewer smelt were observed in Crescent and Freshwater Bay shoreline sites in 2008 relative to 2007 sampling, and the life history composition of smelt changed dramatically with year. This strong interannual variation may reflect a cyclic nature for smelt use of the Strait, and partially explain large interannual differences in spawn that is characteristic of Strait smelt spawning beaches. Also, in Crescent Bay 2008 we observed a strong and sustained recruitment of greenlings, primarily lingcod. This was not observed in 2007, but noted by WDFW biologists that worked in this area in the early 1980’s (Doty, WDFW, pers comm.). This strong interannual variation makes it necessary to continue long term sampling of the nearshore central Strait so we can clearly define current fish use of the nearshore, as well as changes in fish use that may occur due to restoration actions.

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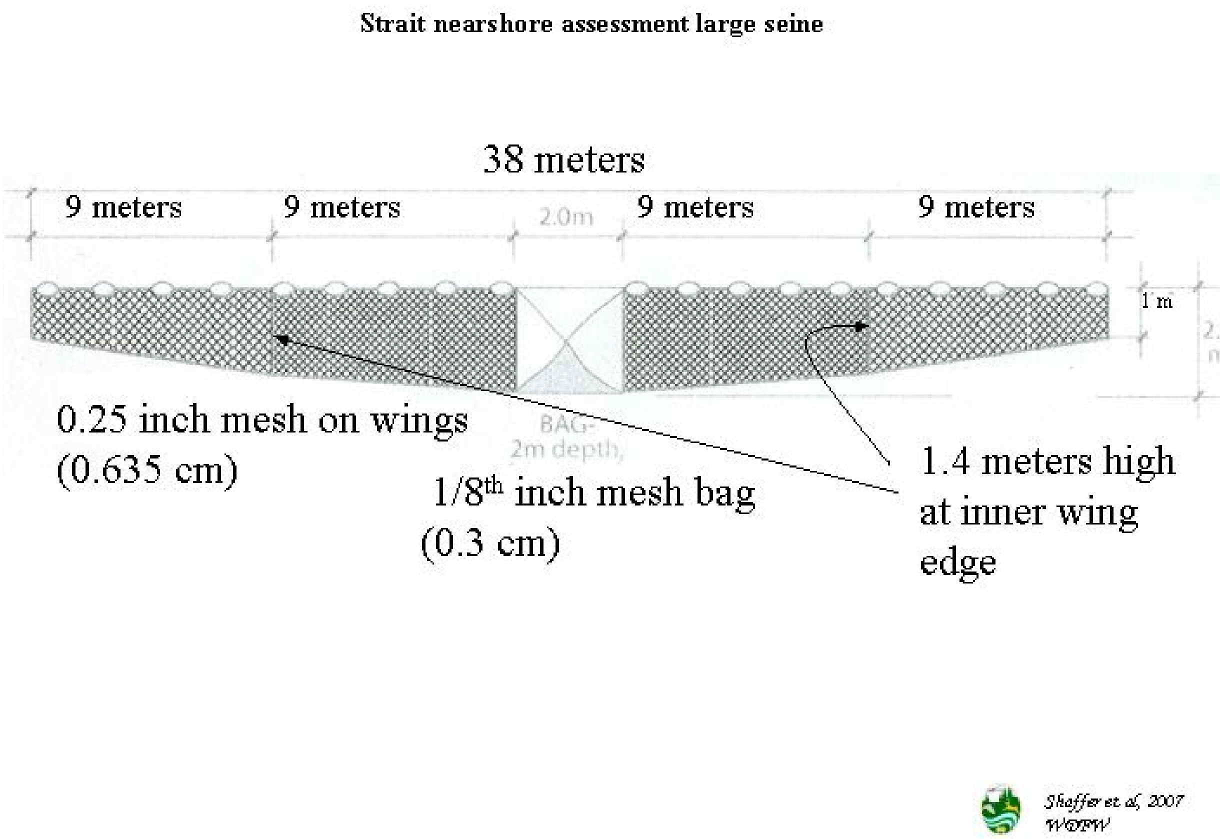
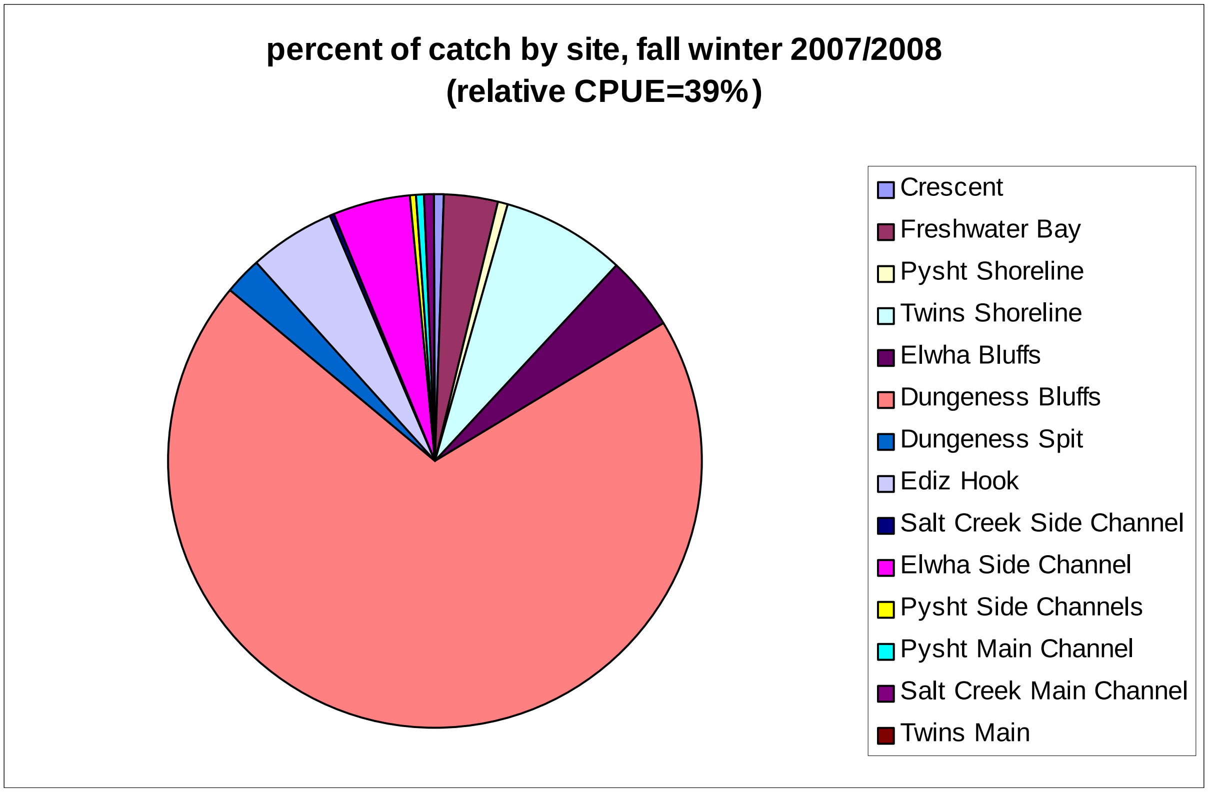


Figure 1. Strait nearshore assessment seine design provided by Christensen nets.

Table 1. Results. Percent of total fish and dominant species at each site, march 2007-march 2008.

Site	Total seines	Total Fish	% of all fish	Chinook	Coho	Chum	Smelt (adult = >120)	Smelt (juv = 50-120)	Smelt (pl = <50)	Herring (juv = 50-120)	Northern Anchovy	Sand lance (juv = 50-120)	3-Spine stickle back	Shiner perch	Stag horn scul pin	Cottids	Cutthr oat	Prickley Sculpin
Crescent Bay	41	11563	6	2	2	2	**42**	**14**	0	4	0	**21**	1	1	3	0	0	0
Dungeness Bluffs	16	24960	13	0	0	0	1	6	**90**	2	0	0	0	0	0	0	0	0
Dungeness Spit	12	5049	3	0	0	6	4	**54**	**14**	**11**	0	8	0	0	0	0	0	0
Ediz Hook	9	3101	2	6	0	3	5	**20**	1	**51**	0	**12**	0	0	0	0	0	0
Elwha Bluffs	13	5518	3	10	1	9	1	**43**	**15**	**20**	0	1	0	0	0	0	0	0
Elwha W Estuary	52	16258	9	**12**	2	1	0	0	0	0	0	0	**70**	0	4	5	0	1
Freshwater Bay	28	12259	6	4	0	1	**14**	6	9	**56**	1	7	0	1	0	0	0	0
Pysht Shoreline	30	31720	17	0	0	0	**11**	**79**	0	2	0	0	0	0	3	0	0	0
Pysht Main Channel	44	9553	5	0	1	1	0	7	0	0	0	0	1	0	7	**79**	0	0
Pysht Side Channels	36	15586	8	0	0	0	0	0	0	0	0	0	**49**	**26**	**19**	3	0	0
Salt Creek Main Channel	66	18731	10	0	2	3	0	0	0	0	0	0	5	**68**	**14**	6	0	0
Salt Creek Side Channel	52	13947	7	0	1	2	0	0	0	0	0	0	**12**	**54**	**22**	7	0	0
W.Twins River	26	1477	1	0	0	1	0	0	0	0	0	0	0	0	5	**48**	6	**33**
W. Twins Shoreline	32	19810	10	0	0	0	**10**	**17**	4	**19**	**30**	0	0	0	0	20	0	0
Total	459* *63% of which were March - September 07	189532	100															


percent of catch by site, fall winter 2007/2008
(relative CPUE=39%)
Crescent
Freshwater Bay
Pysht Shoreline
Twins Shoreline
Elwha Bluffs
Dungeness Bluffs
Dungeness Spit
Ediz Hook
Salt Creek Side Channel
Elwha Side Channel
Pysht Side Channels
Pysht Main Channel
Salt Creek Main Channel
Twins Main

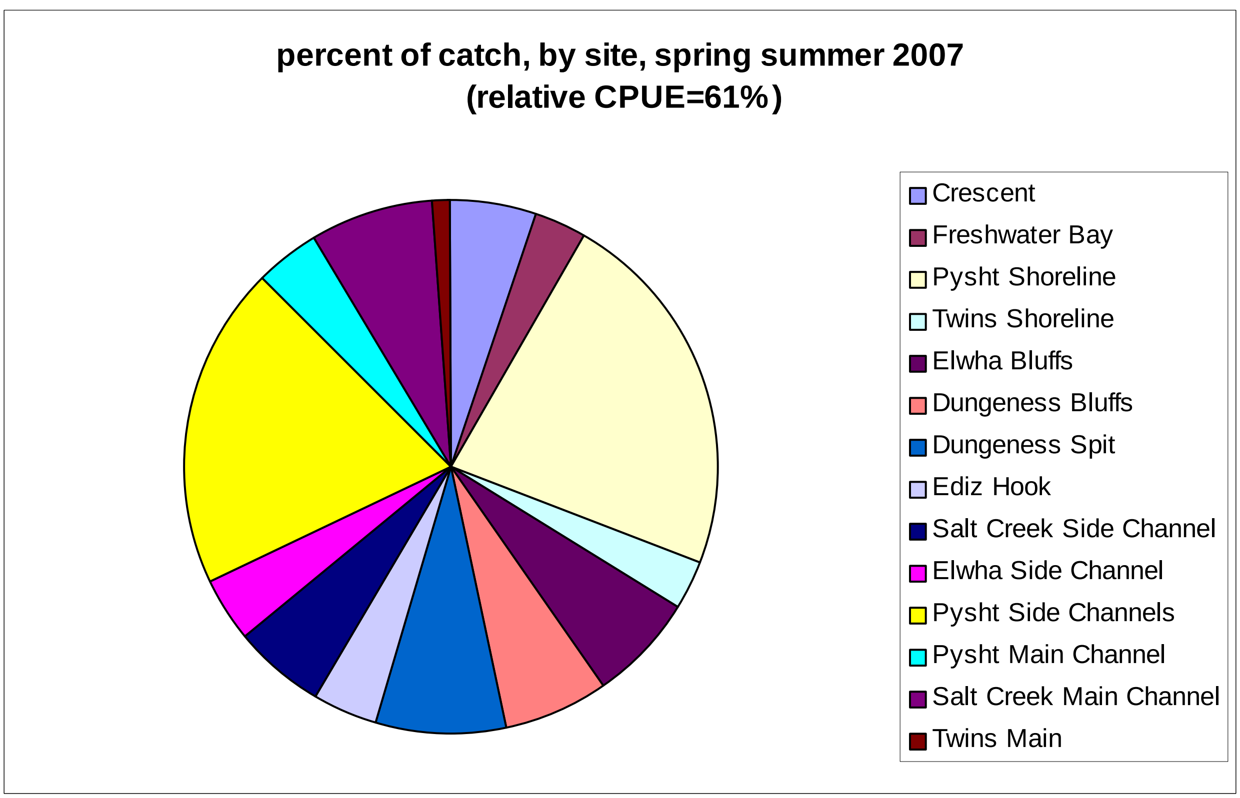

percent of catch, by site, spring summer 2007
(relative CPUE=61%)
Crescent
Freshwater Bay
Pysht Shoreline
Twins Shoreline
Elwha Bluffs
Dungeness Bluffs
Dungeness Spit
Ediz Hook
Salt Creek Side Channel
Elwha Side Channel
Pysht Side Channels
Pysht Main Channel
Salt Creek Main Channel
Twins Main

Figure 2 Percent of total fish collected by site by site for 2007-2008

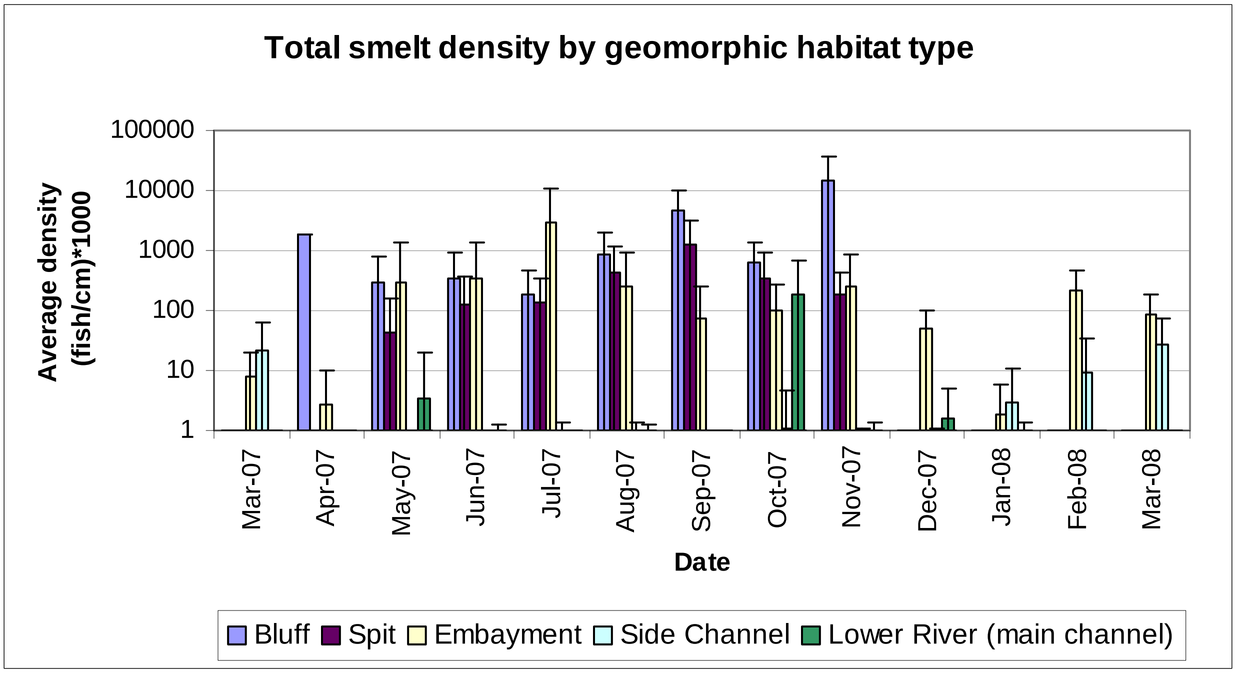


Figure 3a. Average weekly total smelt density by geomorphic habitat type (fish per cubic meter) x1000.

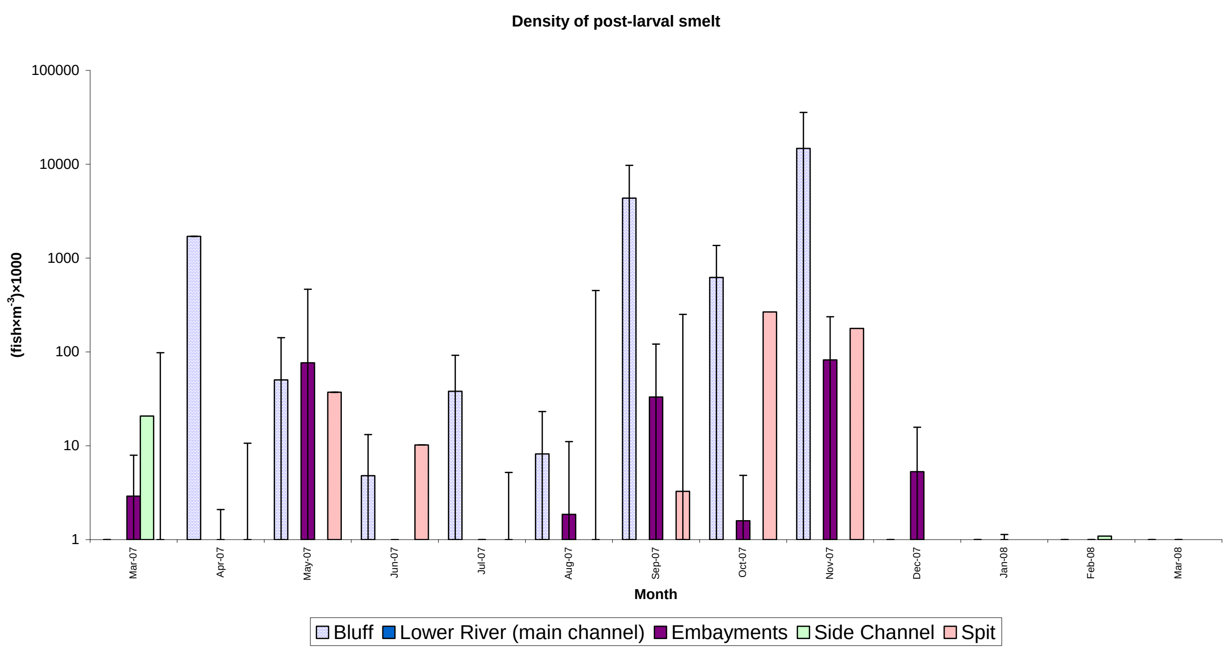


Figure 3b. Average weekly post larval smelt density by geomorphic habitat type (fish per cubic meter) x1000.

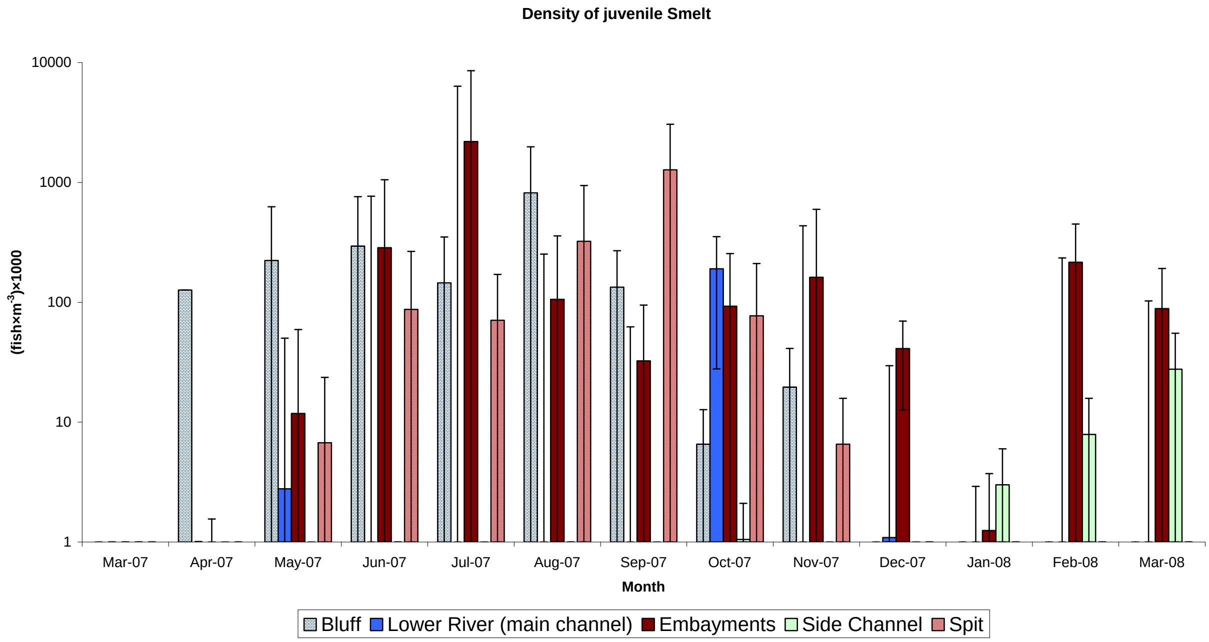


Figure 3c. Average weekly juvenile smelt density by geomorphic habitat type (fish per cubic meter) x1000.

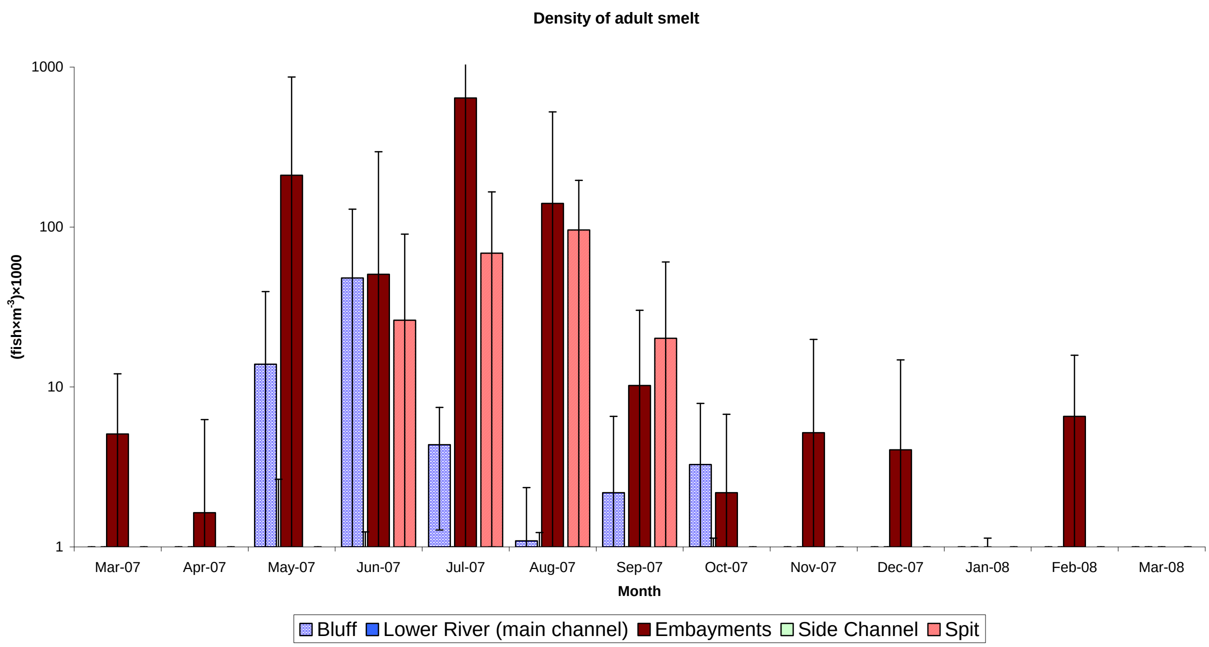


Figure 3d. Average weekly adult smelt density by geomorphic habitat type (fish per cubic meter) x1000.

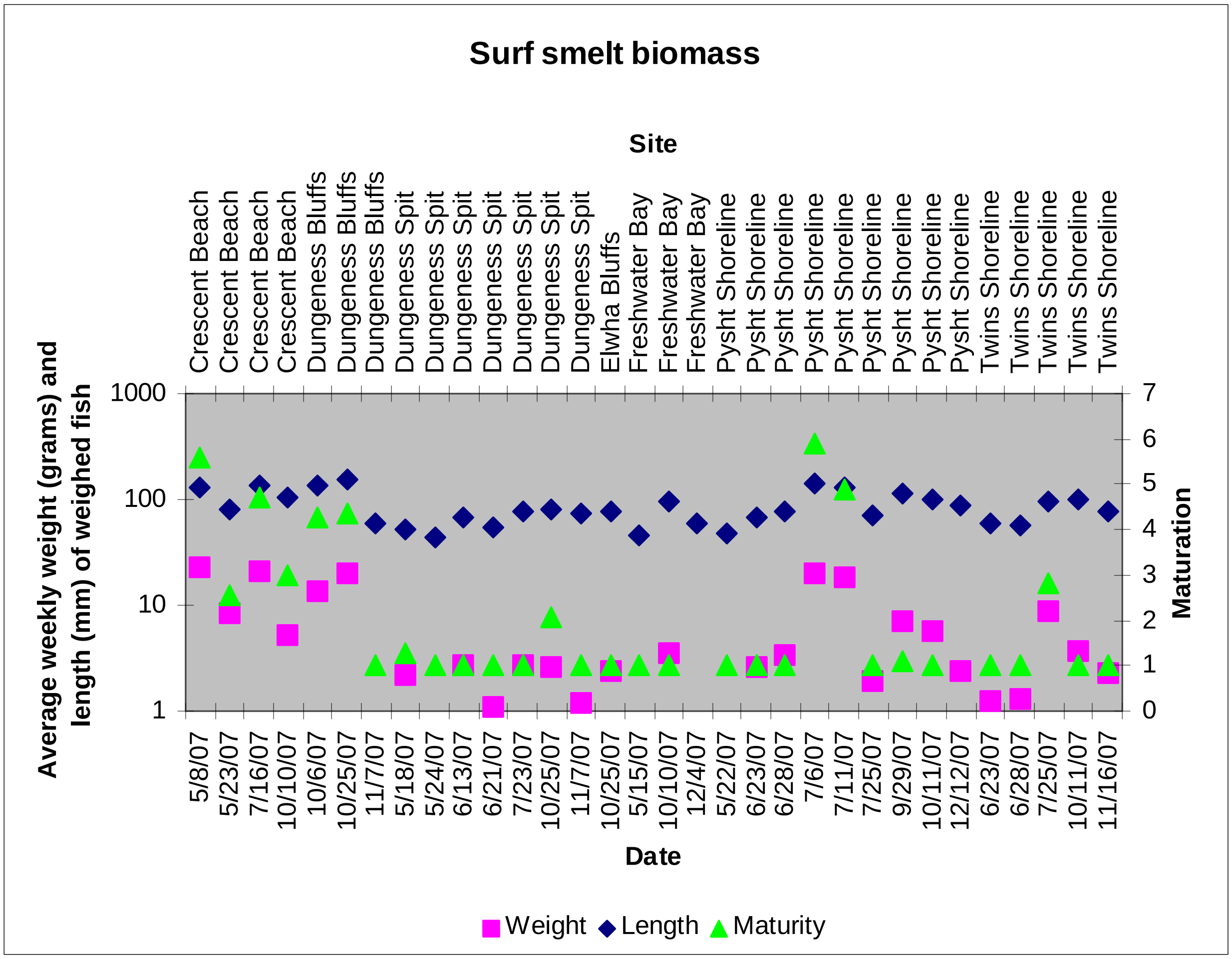


Figure 3e. Weight, length and maturity of weighed adult smelt collected from shoreline sites. Maturity 1=Immature, 2=Starting, 3=Developing, 4=Maturing, 5=Mature, 6=Ripe, 7=Spent, 8=Recovering, 0=Juvenile

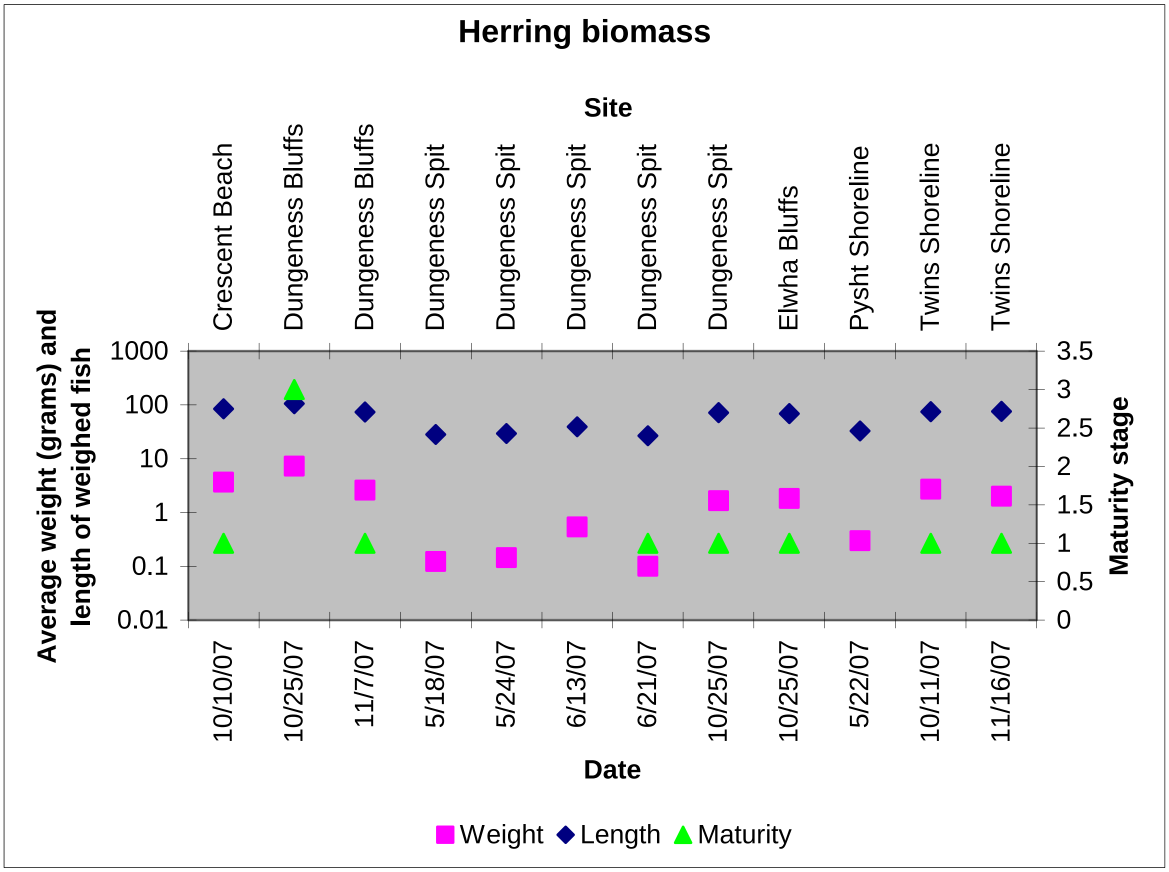


Figure 3f. Weight, length and maturity of weighed adult herring collected from shoreline sites. Maturity 1=Immature, 2=Starting, 3=Developing, 4=Maturing, 5=Mature, 6=Ripe, 7=Spent, 8=Recovering, 0=Juvenile

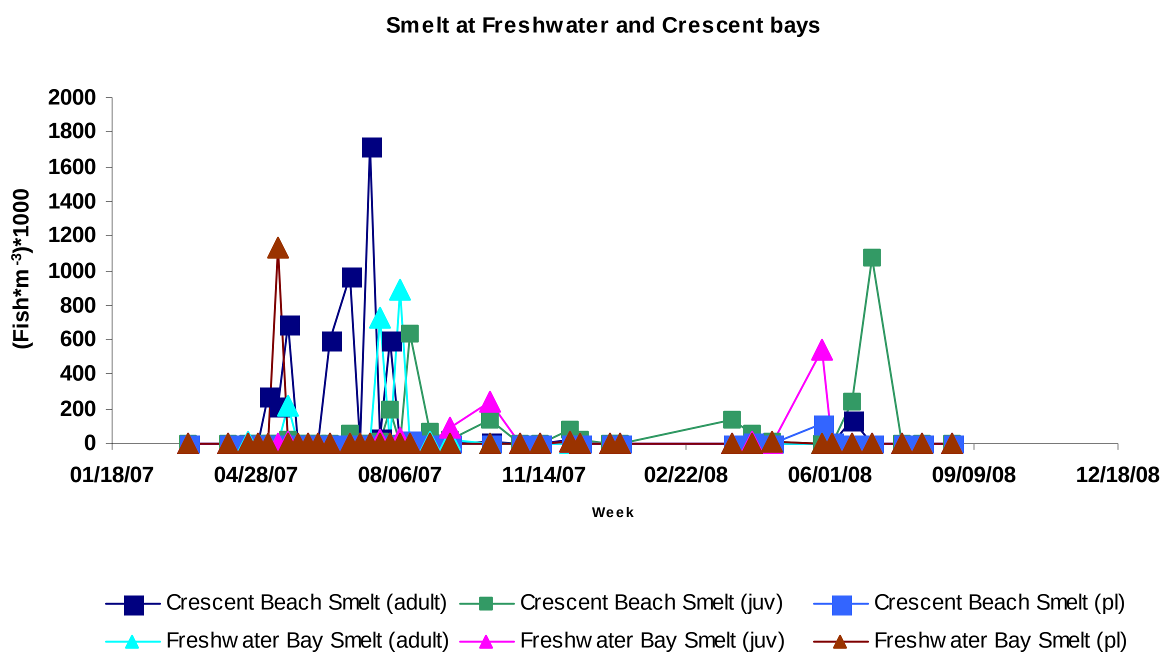


Figure 3g. Long term monitoring results for average smelt densities Freshwater and Crescent Bays.

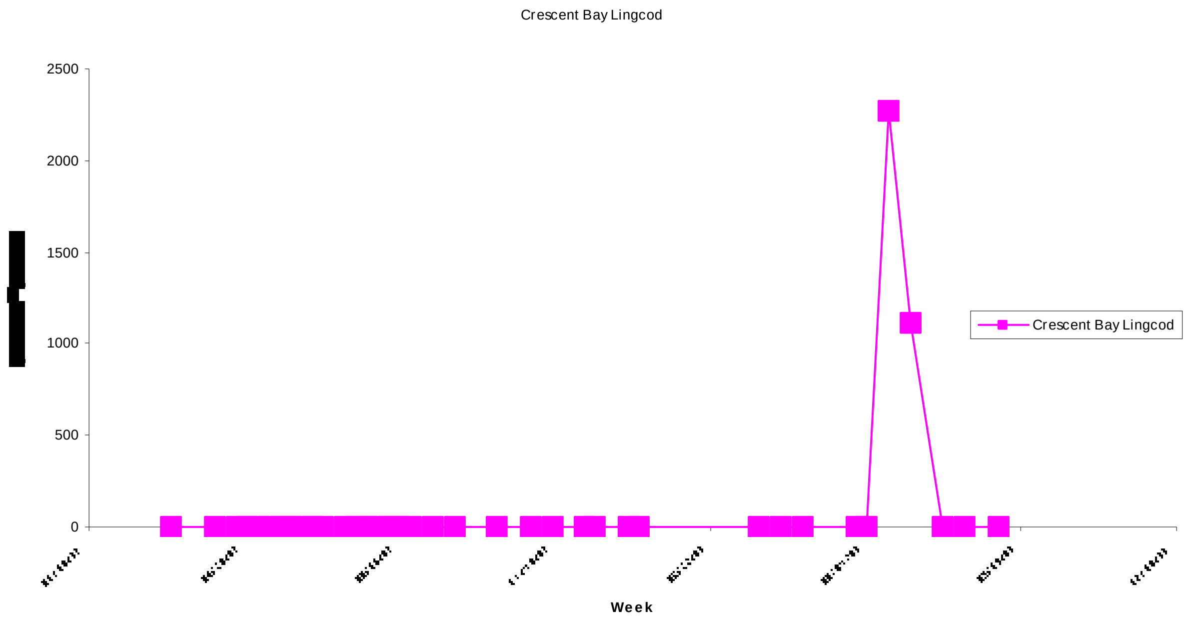


Figure 3h. Long term monitoring result, ling cod densities, Crescent Bay.

Table 2. Percent of total smelt for each year by life history. Total smelt % change based on CPUE.

Site	**20007**			**2008**			
	Adult	Juvenile	Post larval	Adult	Juvenile	Post larval	Percent Change in total smelt
Crescent	80	19	0	8	85	7	-32
Freshwater Bay	54	12	33	0	98	2	-60

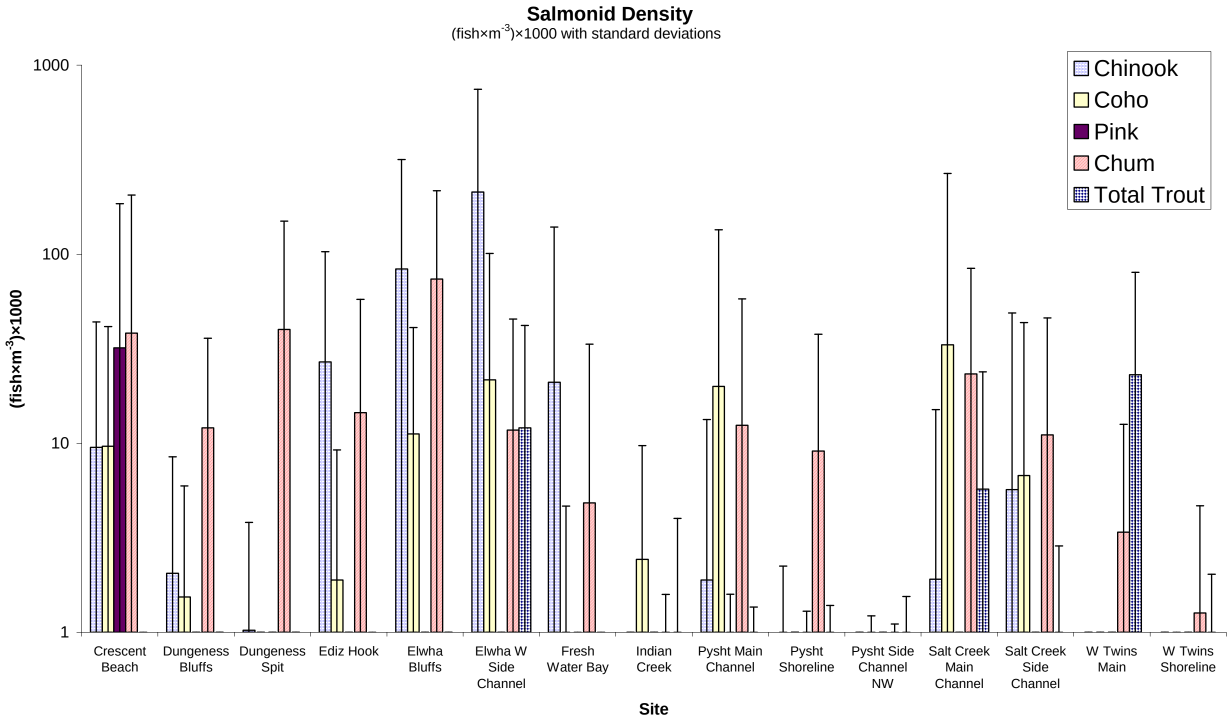
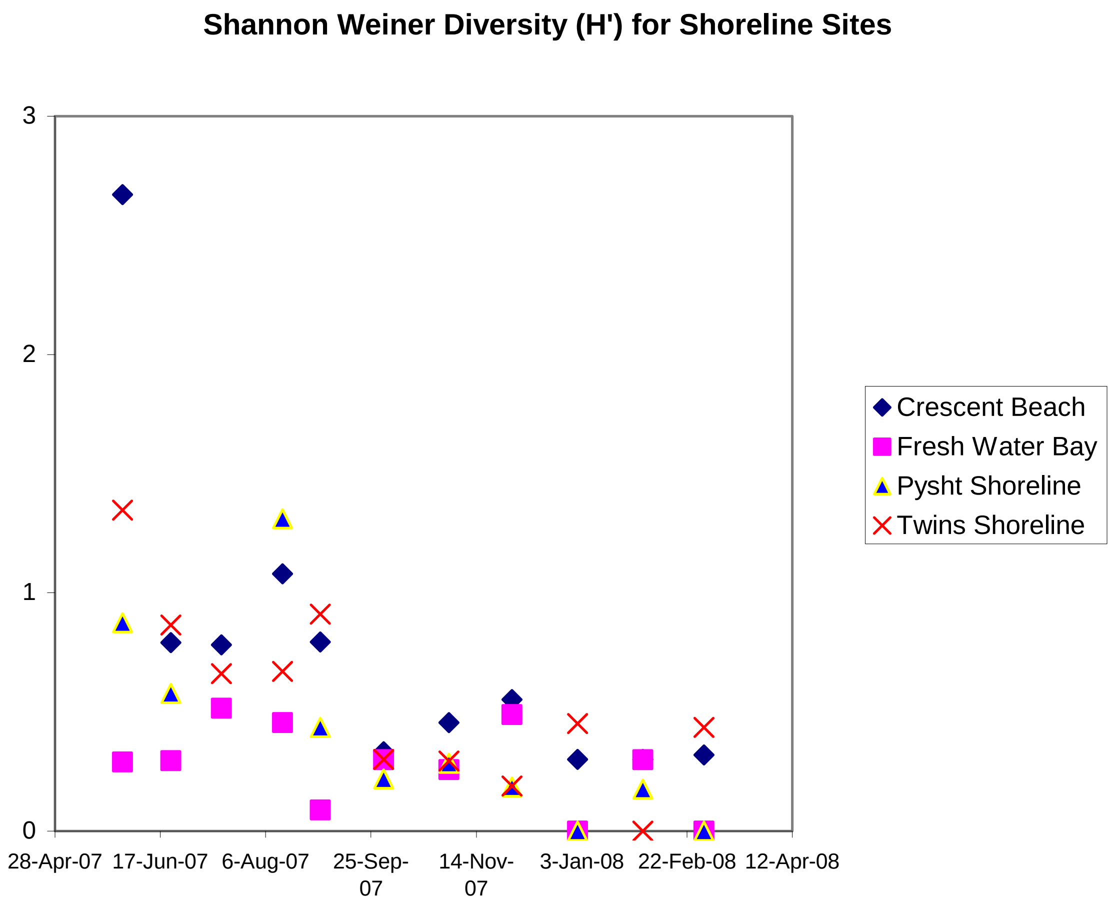
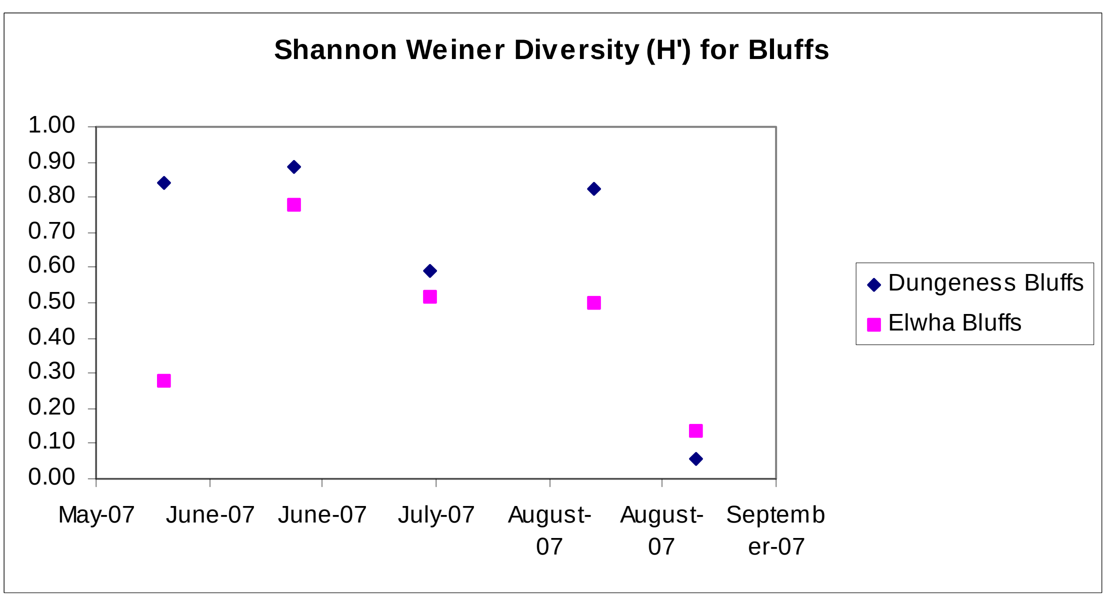
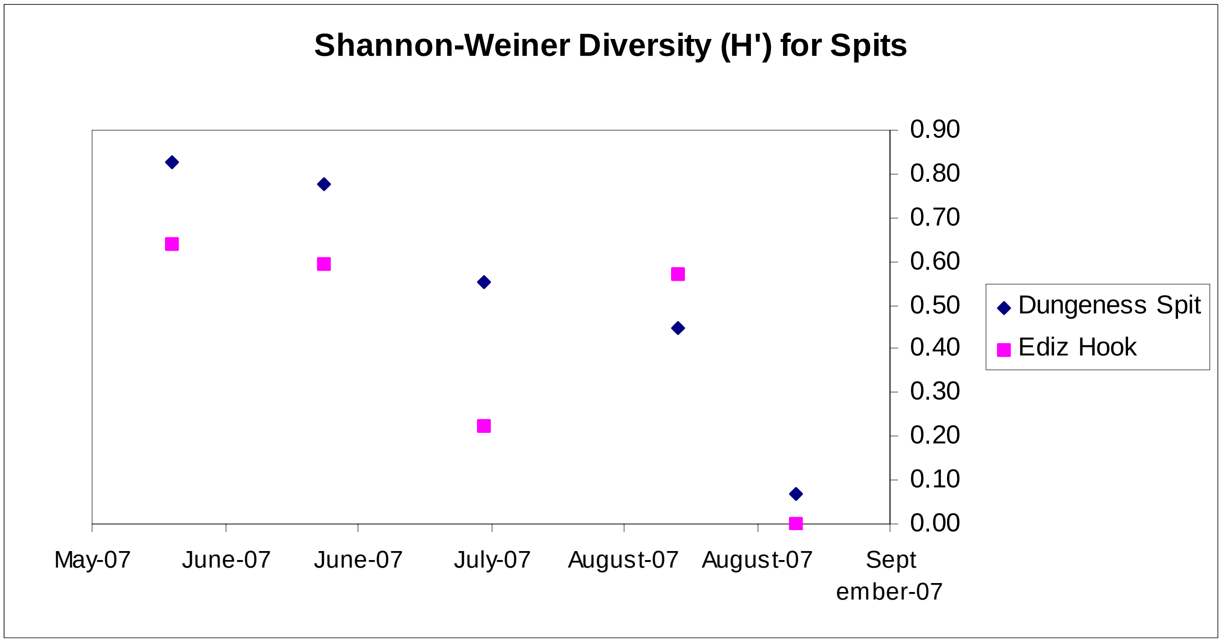


Figure 4. Salmon density by site and species, March-September 2007.


Shannon Weiner Diversity (H') for Shoreline Sites
3
2
1
0
28-Apr-07
17-Jun-07
6-Aug-07
25-Sep-07
14-Nov-07
3-Jan-08
22-Feb-08
12-Apr-08
Crescent Beach
Fresh Water Bay
Pysht Shoreline
Twins Shoreline


Shannon Weiner Diversity (H') for Bluffs
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
May-07
June-07
June-07
July-07
August-07
August-07
September-07
Dungeness Bluffs
Elwha Bluffs


Shannon-Weiner Diversity (H') for Spits
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
May-07
June-07
June-07
July-07
August-07
August-07
Sept ember-07
Dungeness Spit
Ediz Hook