Eulachon Distribution in the Taku River, Juneau, Alaska, 2008.

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Introduction

The Tulsequah Chief mine is located in British Columbia, Canada on the Tulsequah River, which is a tributary to the Taku River approximately 10km from the US/Canada border. Currently the only means of transportation into the mine are by air and water. Traditional access to the mine site was provided by conventional barging operations which are only possible in summer months depending on river flow. Concern about impacts to fishery resources has lead to a need for more information on eulachon (*Thaleichthys pacificus*) spawning in the Taku River.

Eulachon (*Thaleichthys pacificus*) are a short lived anadromous smelt found from Northern California to the southern Bering Sea (Hart 1973, Mecklenburg et al. 2002). During the spawning event, eulachon play an important ecological role as a seasonally available high lipid prey item affecting the movement of predators including: bird aggregations, marine mammals and fish (Womble 2005). Spawning typically occurs in the spring in river systems associated with a freshet (Hay and McCarter 2000).

In Southeast Alaska inside waters, there are at least twenty-eight rivers with known eulachon spawning, including the Taku River (Womble 2005, Wilson 2006). Eulachon spawning in the Taku River typically occurs in early April (E. Jones and L. Parisian, pers.comm.). In April 2006 before ice break up, harbor seals (*Phoca vitulina*) were hauled out on river ice, while eulachon schools were observed up river, indicating the fish moved underneath the ice access spawning grounds (E. Jones, pers.comm.).

Eggs are spawned demersally and adhere to coarse sand or small gravel substrate via a sticky stalk, which forms from the outer membrane of the egg (Smith and Saalfield 1955, Parente and Snyder 1970). The number of eggs produced increases with length and age, and can range from 8,500 to 67,500 eggs with an average of 26,000 (Spangler, 2002). Hatching duration varies throughout the range of eulachon spawning, lasting from 188 accumulated thermal units (ATU) in the Columbia River in the southern part of their range (Smith and Saalfeld 1955) to 242 ATU in the Kemano River (Triton 1990), 258 ATU in the Kitimat River (Pedersen et al. 1995), ~340 ATU in the Bella Coola River (Moody 2004) and 303 ATU in the Twentymile River in Alaska (Spangler, 2002). Hatching

appears to be related to temperature and accumulated thermal units (ATU), as the highest densities of drift occur when water temperatures are stable and change less than 2.8^{o}C (Smith and Saalfeld 1955, Hart 1973, Spangler 2002). Hatching typically begins between three and five weeks after spawning, but tends to occur four to six weeks after spawning in SE Alaska (Andrew Eller, University of Alaska Fairbanks, pers. comm.).

Once hatched the 4-5 mm larvae rely on river currents to carry them to the estuary. The presence of larval eulachon in estuaries and marine waters adjacent to rivers is a strong indication that a river is used by eulachon for spawning (McCarter & Hay 2003). The highest densities of larval eulachon are found near the bottom of the water column (Spangler 2002) with peak larval drift occurring at night (Spangler 2002). Larval movement into the estuary after hatching is rapid. Larval eulachon distribution in estuaries indicates a residence, lasting anywhere from weeks to possibly months (McCarter and Hay 1999).

In many rivers, the spawning reach is more or less limited to the part of the river that is influenced by tides (Lewis et al. 2002) owing to them being relatively weak swimmers. In other systems, eulachon ascend well beyond the tidal influence eg. eulachon are reported to go as far as 80 km up the Susitna River (Barrett et al. 1984; Vincent-Lang and Queral 1984). The Taku River receives tidal influence just past the Taku Lodge, 35km up river from the mouth of Taku Inlet (Randy Host, USGS pers comm.). This study focused on a reach between river kilometer 31 and 57 to determine the upper limit of eulachon spawning in 2008 (Figure 1). Ichthyoplankton surveys in this study were designed to detect the furthest upstream spawning distribution of eulachon larvae in the Taku River.

Study Objectives

- Collect baseline information on the emergence timing and distribution of larval eulachon (*Thaleichthys pacificus*) on the Taku River.
- Locate and map the upper limit of adult spawner migration ie. the furthest distance upstream that is reached by spawning eulachon.

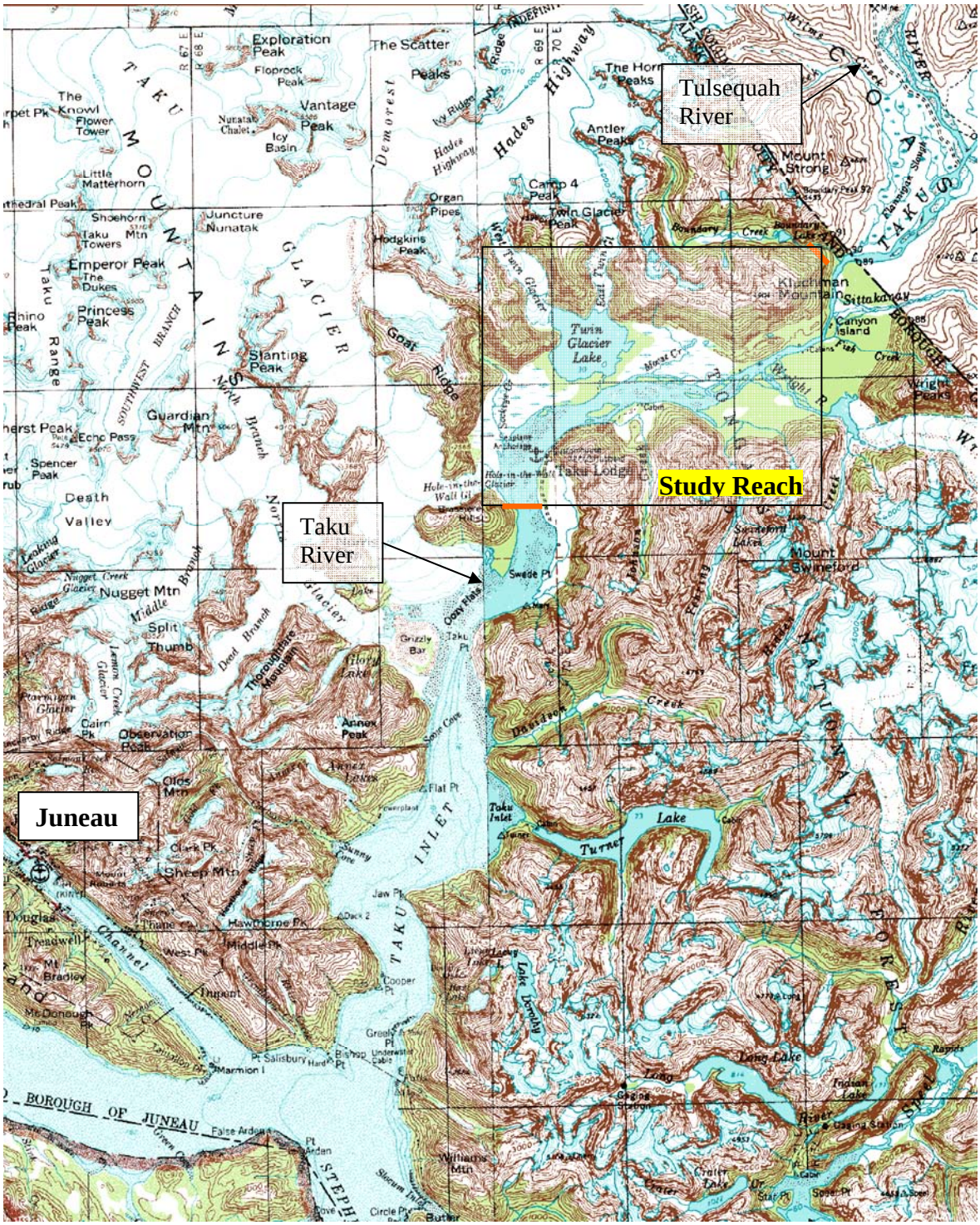

Figure 1: Location Map with study reach.

Methods

Adult eulachon were not targeted for this study owing to their potential ability to swim upstream underneath river ice undetected. The study focused on locating larvae moving downstream back to the ocean using the methods of McCarter and Hay 2003. Larvae are believed to hatch four to six weeks after spawning (Andrew Eller pers.comm.), so the distribution and timing of spawning can be determined from larval density in the water column.

Ichthyoplankton were collected from a boat at various sites along the Taku River. Two 350μm plankton nets with 20cm (8 inch) diameter openings were attached to a bongo frame and lowered from the winch of a 22ft skiff or 18ft jet boat according to location (Figures 2-3). A temperature data logger was placed in the river on the first sampling occasion to record water temperature every 15 minutes throughout the course of the study. The first sampling station was chosen 4 km below the Taku Lodge where congregations of seals and birds had been observed in April suggesting the presence of eulachon (Don Thomas pers. comm.). Stations were spaced 300m to 4 km apart with the aim of determining the upstream limit of distribution. Distances between stations were measured using Garmin "Mapsource" software.

At each station, surface water temperature, water depth and GPS co-ordinates were recorded. A General Oceanics flow meter attached to the bongo frame measured water flowing through the net allowing sample volume to be calculated. The boat was anchored or held stationary under power at the sampling site while the nets were lowered over the side and held just off the river bottom for three to eight minutes. Sampling time was recorded as the full time the nets were submersed in the water.

The contents of both left and right cod-end buckets from each plankton net were combined and flushed into a plastic sorting tray. After examination for larvae, the sample was transferred to a 1 liter bottle containing 70% ethanol for later examination with a microscope.

Sampling was conducted at low tide to avoid larval being displaced upstream by tidal action. Daily mean discharge rates of the Taku River were obtained from the USGS gage station at Canyon Island. Sampling was repeated weekly for four weeks. After the

first week, additional stations were added until the furthest upstream point that larval eulachon were found was established. More frequent samples were collected at the furthest downstream station to examine changes in eulachon density and determine peak spawning time.

Larval eulachon were positively identified by having an average ventral melanophore (pigment) count of 12 and gut length greater than three-fourths the body length (Hearne 1983, Young, 1984). Figure 4 shows the difference between coast-range sculpin larvae (top two larvae in photo) and eulachon larvae (bottom larvae). Andrew Eller (University of Alaska Fairbanks) identified eulachon larvae and Andrew Whiteley (University of Alaska Fairbanks) provided assistance in the identification of larval cottids (sculpins).

Larval eulachon density (D) measurements (number/m^3) were determined for each sampling station by calculating the quotient of the laboratory count (N) and the corresponding volume (V) of seawater (m^3) filtered through the plankton net:

$$D = N / V \quad (1)$$

The volume of water filtered through the net is determined using a General Oceanics® equation:

$$V = (A.F.K) / 999{,}999 \quad (2)$$

where:

V = volume of water filtered through the plankton net

A = area of net opening (m2)

F = number of revolutions recorded by a General Oceanics® model 2030R flow meter

K = rotor constant

and high speed rotor constant = 26,873 (7.0 cm rotor),

20 cm bongo net opening = 0.0283 m^2 or 0.0566 m^2 for both nets.

Figure 2: The plankton nets attached to the bongo frame.

Figure 3: 18ft jet boat and 22 ft skiff used to collect ichthyoplankton.

Figure 4: The top two larvae are coast-range sculpin; the larvae on the bottom is a eulachon. Larvae are approximately 5mm.

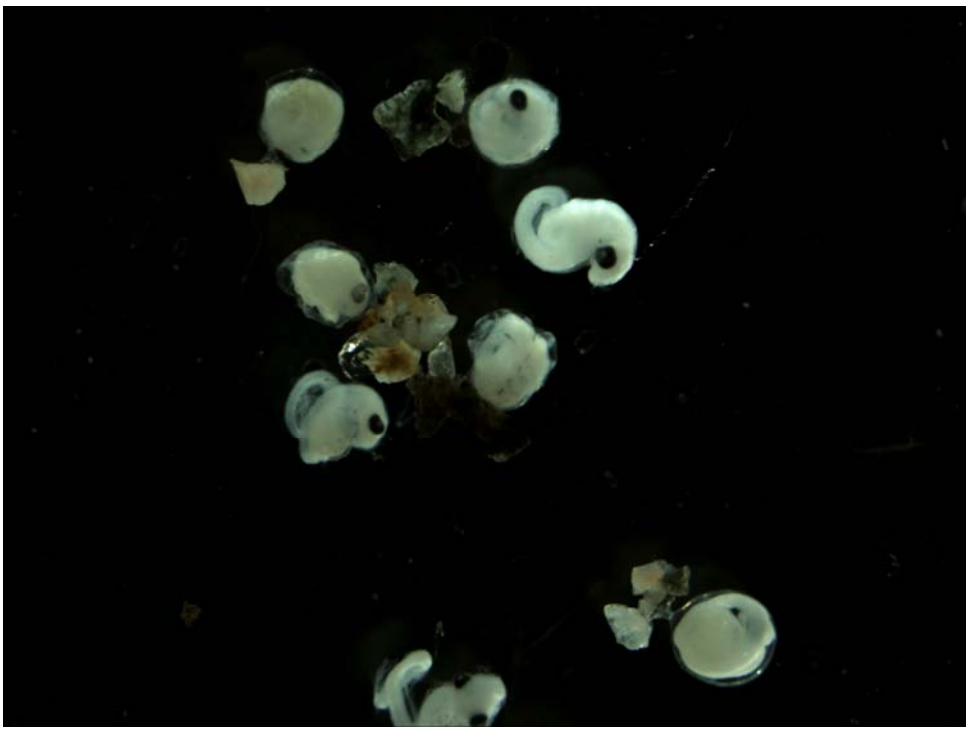

Figure 5: Eulachon eggs (1mm diameter) attached to sand particles.

Results

Four sampling trips were conducted between May 24 and June 12, 2008 to collect ichthyoplankton from 22 stations spaced along 26km of the Taku River. Two surveys were conducted during day trips to the site while an additional two surveys were conducted over a two day period to increase sampling frequency. Not all stations were surveyed on each occasion. River flow was low during the first survey restricting sampling sites to a narrow channel. Additional samples were collected at Station 1 on May 25, 27 and June 2, 10, 18 and 24. A total of 58 samples were collected and examined for larvae. Sampling depth varied from 0.8m at Station 4 to 6.6m at Station 12.

Larval eulachon were caught throughout the sampling period, but were not found at all stations. The furthest upstream location that larval eulachon (n=3) were encountered during the sampling period was Station 9, 1.4km from Yehring Creek and 12.6km upstream from the start of the survey reach (river kilometer 43.6). Table 1 gives the distances between stations as well as the density of larvae on each sampling occasion. Figure 7 shows changes in density of eulachon larvae, eggs and sculpin larvae during the course of the study. Density of eulachon larvae generally decreased upstream from station 1 to 9, although densities were slightly higher at Stations 4 and 5 than lower stations during May. Densities were much higher at Stations 1-5 (0-5km upstream from the start of the survey reach) compared to upstream stations (Stations 6 to 14). Densities declined steeply between Stations 5 and 9 (between river kilometer 36 and 43.6).

Densities of eulachon eggs decreased over the survey period with the highest density occurring during the first survey at the end of May. Sculpin larvae were found at all stations and densities increased over the survey period.

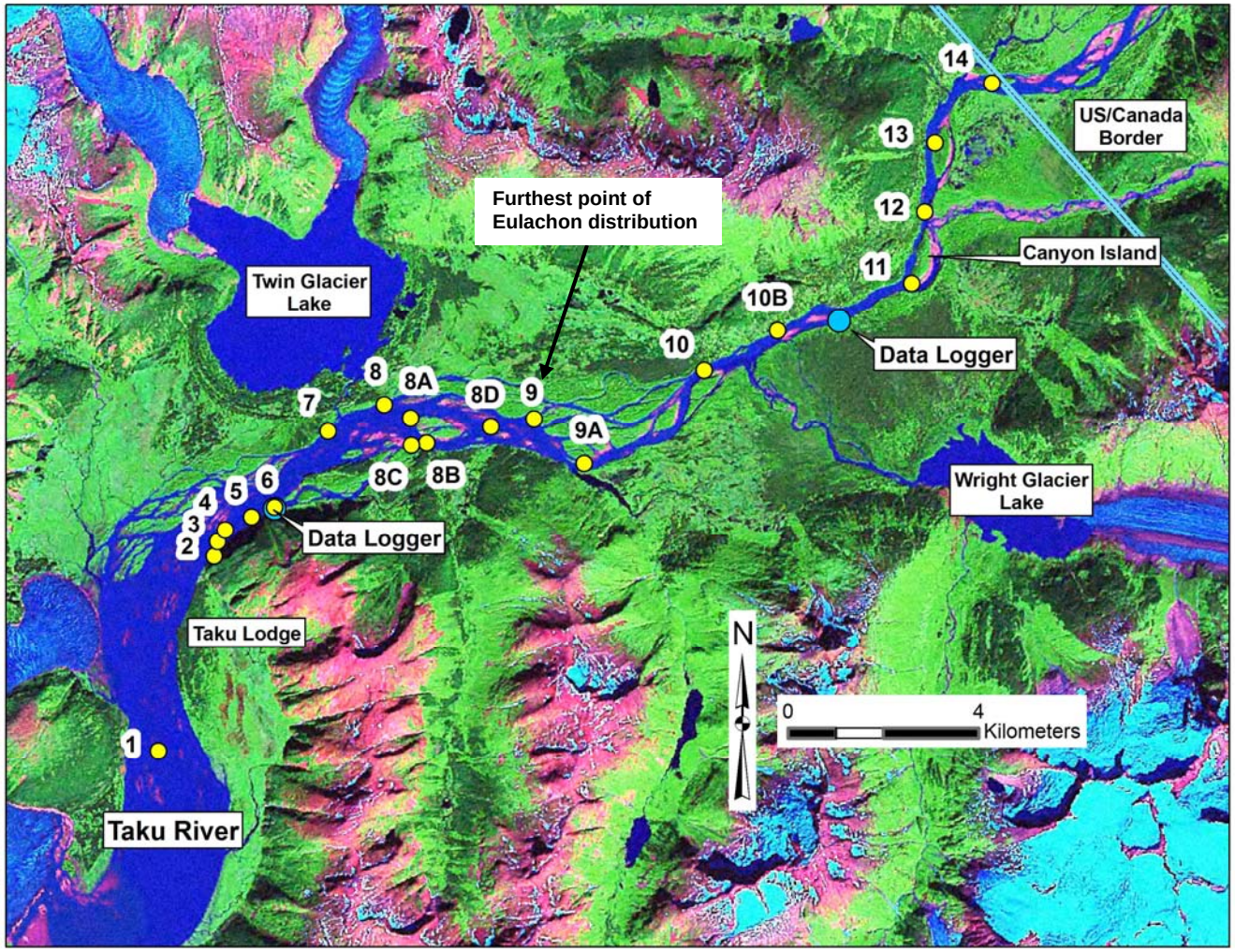

Figure 6. Sampling stations on the Taku River. Eulachon larvae were found at decreasing density from Stations 1 through 9

Table 1. Sample locations and density of Eulachon larvae of the Taku River 2008.

Station	GPS N	GPS W	Description	Distance Upstream (km)	Distance between stations (km)	Number of eulachon per cubic meter water			
						24-May	May29-30	June 5-6	12-Jun
1	58.45801	133.95720		**0.0**	**0.0**	5.74	7.12	11.79	12.32
2	58.49472	133.93604	**Taku Lodge**	**4.3**	**4.3**	0.34	0.48	14.24	4.77
3	58.49741	133.93471		**4.6**	**0.3**	0.76	ns	ns	ns
4	58.49958	133.93187		**4.9**	**0.3**	8.40	ns	ns	ns
5	58.50195	133.92233		**5.2**	**0.3**	0.53	8.03	6.55	ns
6	58.50373	133.91399	**Johnson Creek**	**5.7**	**0.5**	0.31	0.31	0.79	4.16
7	58.51801	133.89427	**Twin Glacier**	**7.7**	**2.0**	0.33	0.78	0.52	ns
8	58.52282	133.87393		**9.0**	**1.3**	0.18	0.12	1.44	0.64
8a	58.52022	133.86438	**Moose Creek**	**9.6**	**0.6**	ns	ns	3.56	ns
8b	58.51544	133.85880		**10.2**	**0.6**	ns	ns	0.29	0.17
8c	58.51505	133.86438		**10.8**	**0.6**	ns	ns	3.16	ns
8d	58.51837	133.83560		**11.6**	**0.8**	ns	ns	0.94	0.04
8e	58.52005	133.82776		**12.1**	**0.5**	ns	ns	ns	0
9	58.51968	133.81992		**12.6**	**0.5**	0	0.09	0	0
9a	58.51104	133.80225	**Yehring Creek**	**14.0**	**1.4**	ns	ns	0	0
9b	58.51311	133.79283		**14.4**	**0.4**	ns	ns	ns	0
10	58.52822	133.75835	**Wright River**	**17.0**	**2.6**	0	0	0	0
10B	58.53545	133.73166		**18.8**	**1.8**	ns	0	0	0
11	58.54379	133.68294	**Canyon Island**	**21.8**	**3.0**	0	0	ns	ns
12	58.55730	133.67773	**Sittakanay River**	**23.3**	**1.5**	ns	0	ns	ns
13	58.57030	133.67349		**24.8**	**1.5**	ns	0	ns	ns
14	58.58131	133.65259	**Boundary Creek**	**26.5**	**1.7**	ns	0	ns	ns

ns = not sampled

Additional sampling dates for Station 1 include: 5/25, 5/27, 6/2, 6/10, 6/18, 6/24

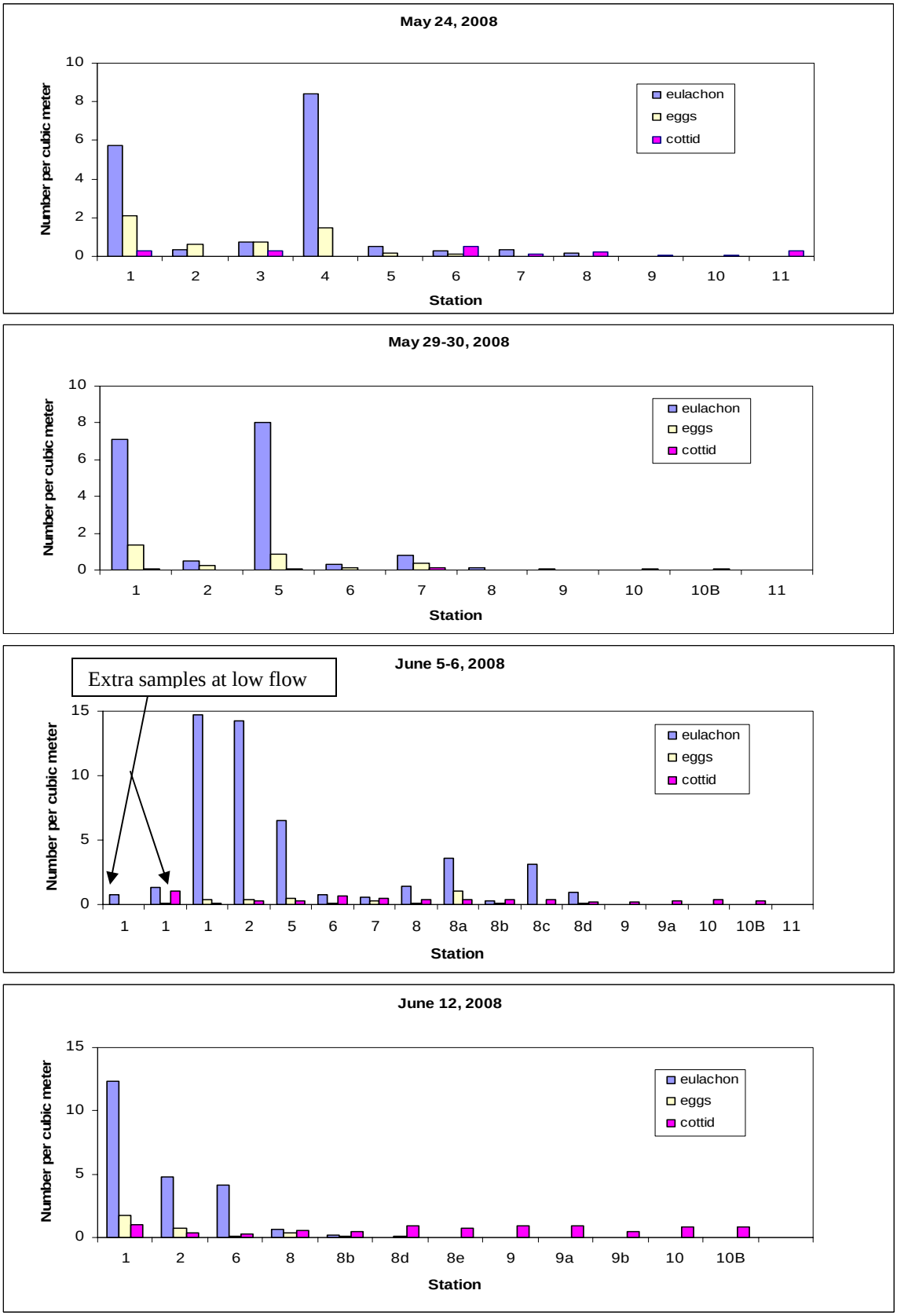

Figure 7: Density of eulachon larvae and eggs and cottid (sculpin) larvae at each station.

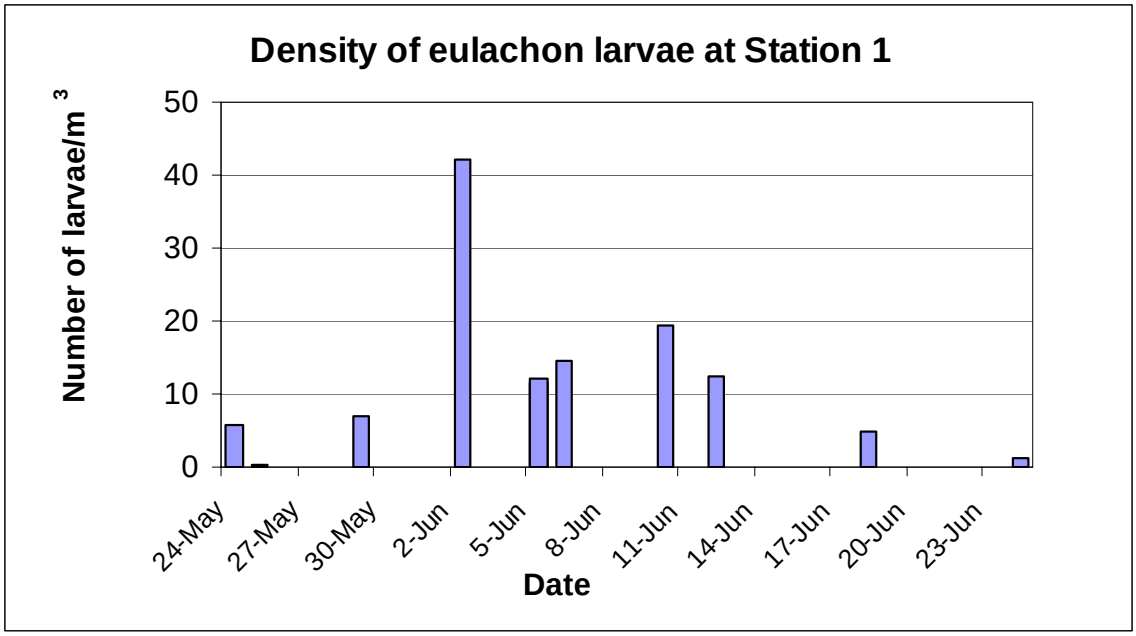

Figure 8: Change in density of eulachon larvae at Station 1 over the study period.

Figure 8 shows the change in density of larval eulachon at Station 1. The estimated peak emergence was determined by the highest count and density of larval eulachon at Station 1 and occurred on June 2 (n = 591, estimated 42 larvae/m^3). The volume of this sample had to be estimated due to a flow meter malfunction. Peak emergence occurred around the time of peak river discharge for the sampling period (Figure 9) and after water temperatures had exceeded 47°F. Changes in water temperature recorded every 15 minutes are shown in Figure 10. Water temperature increased during the last week of May, then remained steady until June 7 when temperatures dipped again.

Across all sites, a total of 2,625 larval eulachon, 356 eulachon eggs, 332 coast-range sculpin larvae (*Cottus aleuticus*), 12 coast-range sculpin eggs and 106 unidentifiable larvae were collected (Table 2).

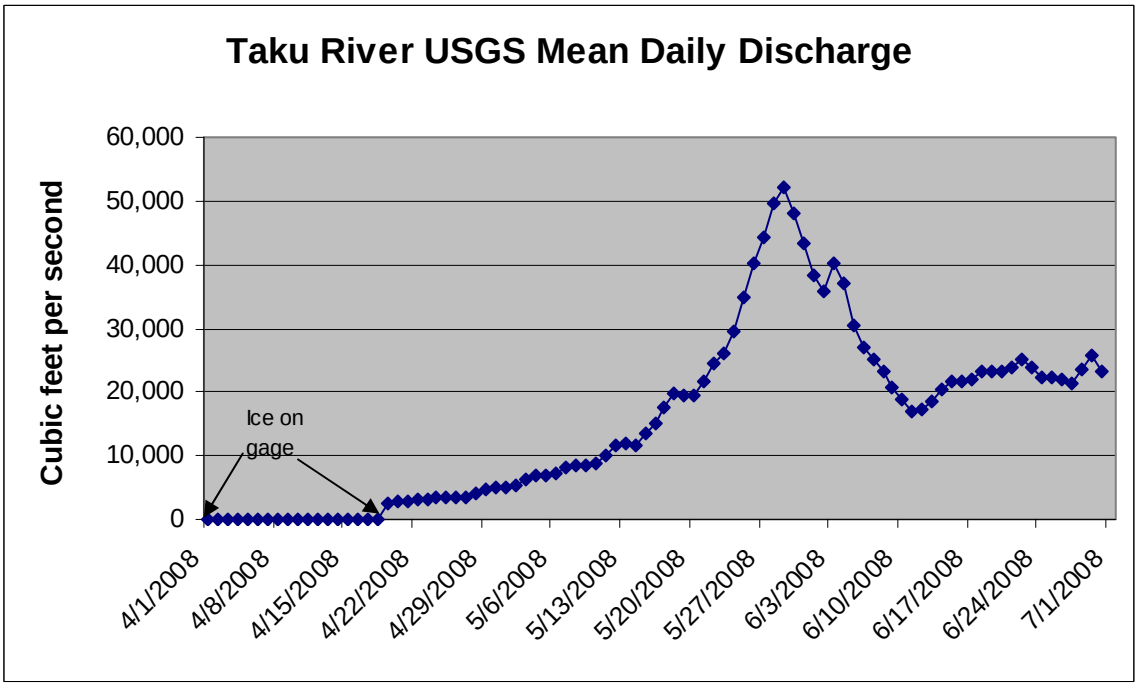

Figure 9: Daily mean discharge (cfs) at the USGS stream gaging station, Canyon Island. Provisional data from USGS.

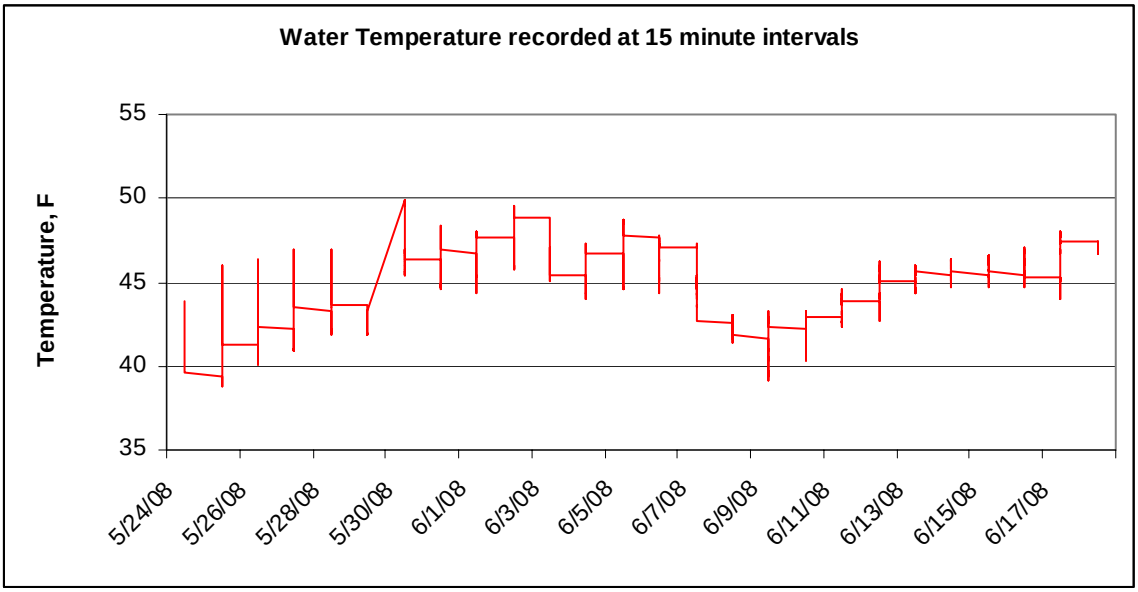

Figure 10: Records from a temperature logger positioned at Station 6 from May 24-29 and thereafter positioned between Station 10B and 11.

Table 2. Counts of eulachon (*T. pacificus*), coast-range sculpin (*C. aleuticus*) and unidentifiable larvae from the Taku River 2008.

Station	Date	Depth	Eulachon larvae	Eulachon eggs	Cottid	Cottid egg	Unidentified
1	5/24/08	1.5	97	36	5	0	0
	5/25/08	0.9	45	39	3	3	1
	5/27/08	0.76	19	11	0	0	0
	5/29/08	1.7	100	19	1	0	13
	6/2/08		591	19	5	0	4
	6/5/08	1.5	62	4	0	0	0
	6/5/08	1.5	109	12	1	0	0
	6/6/08	1.2	141	4	1	0	2
	6/10/08		266	24	3	0	0
	6/12/08	1.1	120	17	10	0	0
	6/18/08		48	23	7	0	0
	6/24/08		20	19	8	0	1
2	5/24/08	2.9	4	7	0	0	1
	5/29/08	3.1	11	6	0	0	8
	6/5/08	3	281	8	5	0	7
	6/12/08	2.4	56	9	4	0	0
3	5/24/08	2.1	10	10	4	0	1
4	5/24/08	0.8	52	9	0	0	0
5	5/24/08	4.5	9	3	0	1	1
	5/30/08	3.8	191	20	1	0	4
	6/6/08	4.3	117	9	5	0	2
6	5/24/08	1.9	3	1	5	0	0
	5/29/08	2.3	3	1	0	0	0
	6/5/08	1.7	6	1	5	0	0
	6/12/08	3.9	32	1	2	0	0
7	5/24/08	4.8	3	0	1	0	6
	5/30/08	5	25	12	4	0	3
	6/6/08	4.1	13	6	12	0	4
8	5/24/08	3.8	5	0	6	1	1
	5/29/08	4.2	3	0	0	0	1
	6/5/08	5	26	2	6	0	1
	6/12/08	3.3	10	6	9	0	1
8a	6/6/08	2.9	30	9	3	0	11
8b	6/5/08	3.5	3	1	4	0	0
	6/12/08	4.2	3	2	8	0	0
8c	6/6/08	1.8	83	0	11	0	12
8d	6/5/08	2.5	24	2	4	0	9
	6/12/08	2.8	1	3	26	0	1
8e	6/12/08	3.5	0	0	14	0	0
9	5/24/08	2.1	0	1	2	4	5
	5/30/08	3	3	0	1	0	0
	6/6/08	2.4	0	0	4	0	2
	6/12/08	2.3	0	0	25	0	0
9a	6/5/08	3	0	0	9	0	2
9a	6/12/08	2.5	0	0	25	0	0
9b	6/12/08	2.5	0	0	16	0	0
10	5/24/08	4.2	0	0	3	2	0
10	5/29/08	5.7	0	0	1	1	2
10	6/6/08	2.4	0	0	10	0	0
10	6/12/08	4	0	0	19	0	0
10B	5/29/08	2.1	0	0	1	0	0
10B	6/5/08	3.5	0	0	6	0	0
10B	6/12/08	3	0	0	18	0	0
11	5/24/08	1.6	0	0	5	0	0
11	5/30/08	2.1	0	0	0	0	0
12	5/30/08	6.6	0	0	3	0	0
13	5/30/08	2.5	0	0	1	0	0
14	5/29/08	2.6	0	0	0	0	0
			2625	**356**	**332**	**12**	**106**

Discussion

Ichthyoplankton surveys were selected for this study over other methods due to their ability to detect small spawning runs that might be missed by conventional fishing techniques (gill nets or seine nets) on adults. Substantial numbers of eulachon larvae can be caught in rivers and estuaries where no (or negligible) adult spawning is observed. Furthermore, the duration of the presence of larvae in adjacent estuaries seems to occur over a number of weeks, whereas the duration of spawning may be complete within days (McCarter and Hay 2003).

The plankton net tows in the current study were confined to daylight hours for safety and logistical reasons even though there is evidence that many larvae hatch at night. The major consideration in any survey design is insuring adequate spatial and temporal sampling coverage, fully utilizing available time and resources. Over 26km of the river was sampled on four occasions to determine the upstream limit of eulachon distribution. Decreasing density of eulachon larvae in upstream samples suggest the limit was close to Station 9, which lies 1.4km downstream from the mouth of the Yehring River or at river kilometer 43.6. Only 3 larvae were found at Station 9 on one out of four sampling events. These larvae were found during the estimated peak of larval outdrift. Water temperature appeared slightly warmer, yet stable, which may have encouraged emergence. Although spawning may have occurred further upstream, density of larvae was too low to be detected at sites further upstream, suggesting only small patches of spawning could be present. The greatest densities of larvae were recorded at Stations 1 through 6, which lie between 4km downstream of the Taku Lodge and 1.4km upstream near the mouth of Johnson Creek.

Exact river spawning locations, however, are difficult to determine by plankton net surveys alone. According to McCarter and Hay (2003), the cumulative down river effect of several separate spawning events within the same time period can often obscure distribution patterns even with extensive spatial and temporal sampling coverage. The densities of eulachon larvae might be expected to be higher at down river stations than up river stations, however, up river sites can sometimes produce higher density estimates immediately after hatching and are often characterized by the capture of large numbers of embryonic eggs as well as very small, curled larvae (McCarter and Hay 2003).

Counts of eulachon larvae in other studies have generally ranged from 0 to 3,000 larvae per 6 minute tow. Ninety-nine percent of Fraser River samples collected between 1995 and 2002 produced counts between 0 and 500 larvae per 6 minute tow (McCarter and Hay 2003). The highest count of larvae in the current study was 591 during a 5 minute tow. Counts above station 5 were less than 100 on each sampling occasion. This would suggest the limit of upstream distribution was being approached at Station 9.

The furthest ever upstream distribution of eulachon in the Taku system is thought to be at Bull Slough, near the Tulsequah River in Canada, recorded during surveys conducted by Alaska Dept of Fish and Game (Kisner, 1979, Pers. comm. Parisian). Migration this far upriver was noted only during exceptionally large runs, which occurred approximately four times since 1979. Typically, spawning is focused in the lower river around the Taku River Lodge. In recent salmonid smolt trapping (minnow traps) studies, ADFG personnel have not captured eulachon adults above Canyon Island.

Eulachon embryonic egg and larval outdrift in the Taku River in 2008 appeared to begin during the middle of May, peaked during the first week of June and declined by mid-June. A small number of eggs were still being captured on June 12 suggesting a protracted spawning period at the lower sites or they may simply have failed to hatch. Given that eulachon larvae typically emerge four to six weeks after spawning in the region, spawning likely took place around mid to late April, which matches closely with the timing of marine mammal observations.

The data shows no apparent correlation between station depth and larval density. Depth is dependent of river flow and varied over time at each station. Larval density appeared more dependent on station location upstream rather than water depth, but many more sites would need to be sampled at different depths across the river at each station to reveal any correlation with spawning and depth of water. In the Fraser River, British Columbia, the deeper, swifter side margins were found to produce higher larval eulachon densities than either mid-river or shallower, slower moving sides of the river despite higher sediment loads (Hay and McCarter 2003). In BC, there is a connection between spawning eulachon and certain rivers that have strong, spring freshets that drain major glaciers or snowpacks (Hay and McCarter 2000).

Future studies would be beneficial in gathering information on the variability of eulachon spawning distribution and timing between years. Sampling coverage could be reduced as the patterns of several years of data are established and key representative sampling sites are identified. Future studies could repeat sampling at stations 1, 2, 5, 8, 8b, 8d, 9 and 9a as well as new sites between 9 and 9a to further pinpoint the upper limit of distribution, and sites upstream to determine any spawning further upstream in future. Ichthyoplankton surveys could also be designed to produce abundance estimates of spawning eulachon biomass in the Taku system. Information could also be gathered on the use of tributaries versus the main Taku River channel for eulachon spawning.

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		Eulachon		Cottid		Sample	Flow Meter						Density		
Station	Date	Larvae	Eggs	Larvae	Eggs	Time	start	end	Difference	Distance(m)	volume(20)	volume(.2)	Eulachon	eggs	cottid
1	5/24/08	97	36	5	0	6	13700	23717	10017	269.2	84524.8	16.9	5.74	2.13	0.30
2	5/24/08	4	7	0	0	4	24034	30953	6919	185.9	58383.4	11.7	0.34	0.60	0.00
3	5/24/08	10	10	4	0	4	31431	39211	7780	209.1	65648.7	13.1	0.76	0.76	0.30
4	5/24/08	52	9	0	0	4	39356	43022	3666	98.5	30934.2	6.2	8.40	1.45	0.00
5	5/24/08	9	3	0	1	4	43461	53531	10070	270.6	84972.0	17.0	0.53	0.18	0.00
6	5/24/08	3	1	5	0	6	53691	59399	5708	153.4	48164.8	9.6	0.31	0.10	0.52
7	5/24/08	3	0	1	0	6	59582	64953	5371	144.3	45321.2	9.1	0.33	0.00	0.11
8	5/24/08	5	0	6	1	5.4	65433	81493	16060	431.6	135516.4	27.1	0.18	0.00	0.22
9	5/24/08	0	1	2	4	6	82042	103751	21709	583.4	183183.4	36.6	0.00	0.03	0.05
10	5/24/08	0	0	3	2	5.2	104358	127855	23497	631.4	198270.8	39.7	0.00	0.00	0.08
11	5/24/08	0	0	5	0	10	133290	143189	9899	266.0	83529.1	16.7	0.00	0.00	0.30
1	05/29/08	100	19	1	0	5	175191	183512	8321	223.6	70213.7	14.0	7.12	1.35	0.07
2	05/29/08	11	6	0	0	5	184033	197630	13597	365.4	114733.3	22.9	0.48	0.26	0.00
5	05/30/08	191	20	1	0	5.3	346395	360485	14090	378.6	118893.3	23.8	8.03	0.84	0.04
6	05/29/08	3	1	0	0	5	197807	203563	5756	154.7	48569.9	9.7	0.31	0.10	0.00
7	05/30/08	25	12	4	0	5	327334	346331	18997	510.5	160299.2	32.1	0.78	0.37	0.12
8	05/29/08	3	0	0	0	5	204258	219714	15456	415.3	130419.7	26.1	0.12	0.00	0.00
9	05/30/08	3	0	1	0	5	298702	318351	19649	528.0	165800.8	33.2	0.09	0.00	0.03
10	05/29/08	0	0	1	1	4.3	218650	236115	17465	469.3	147371.9	29.5	0.00	0.00	0.03
10B	05/29/08	0	0	1	0	8	236115	248693	12578	338.0	106134.8	21.2	0.00	0.00	0.05
11	05/30/08	0	0	0	0	5	294816	298702	3886	104.4	32790.6	6.6	0.00	0.00	0.00
12	05/30/08	0	0	3	0	6.3	278185	294634	16449	442.0	138798.8	27.8	0.00	0.00	0.11
13	05/30/08	0	0	1	0	5	264743	278184	13441	361.2	113416.9	22.7	0.00	0.00	0.04
14	05/29/08	0	0	0	0	6	248813	261820	13007	349.5	109754.8	22.0	0.00	0.00	0.00

Appendix 1: Number of eulachon and cottid larvae and eggs with flow meter data and calculation of density (numbers/m^3).

		Eulachon		Cottid		Sample	Flow Meter						Density		
Station	Date	Larvae	Eggs	Larvae	Eggs	Time	start	end	Difference	Distance(m)	volume(20)	volume(.2)	Eulachon	eggs	cottid
1	06/05/08	62	4	0	0	3	369372	372601	3229	86.8	27246.7	5.4	11.38	0.73	0.00
1	06/05/08	109	12	1	0	5	372601	377891	5290	142.2	44637.7	8.9	12.21	1.34	0.11
1	06/06/08	141	4	1	0	3	542211	547901	5690	152.9	48013.0	9.6	14.68	0.42	0.10
2	06/05/08	281	8	5	0	5	381498	393191	11693	314.2	98667.1	19.7	14.24	0.41	0.25
5	06/06/08	117	9	5	0	5	531498	542076	10578	284.3	89258.5	17.9	6.55	0.50	0.28
6	06/05/08	6	1	5	0	5	393784	398262	4478	120.3	37785.9	7.6	0.79	0.13	0.66
7	06/06/08	13	6	12	0	5	516601	531292	14691	394.8	123964.6	24.8	0.52	0.24	0.48
8	06/05/08	26	2	6	0	5	398552	409240	10688	287.2	90186.7	18.0	1.44	0.11	0.33
8a	06/06/08	30	9	3	0	5	510197	515188	4991	134.1	42114.7	8.4	3.56	1.07	0.36
8b	06/05/08	3	1	4	0	5	409314	415474	6160	165.5	51978.9	10.4	0.29	0.10	0.38
8c	06/06/08	83	0	11	0	5	494095	509664	15569	418.4	131373.3	26.3	3.16	0.00	0.42
8d	06/05/08	24	2	4	0	5	415848	431054	15206	408.6	128310.2	25.7	0.94	0.08	0.16
9	06/06/08	0	0	4	0	5	477510	493212	15702	422.0	132495.5	26.5	0.00	0.00	0.15
9a	06/05/08	0	0	9	0	5	432663	452991	20328	546.3	171530.3	34.3	0.00	0.00	0.26
10	06/06/08	0	0	10	0	5	477510	493212	15702	422.0	132495.5	26.5	0.00	0.00	0.38
10B	06/05/08	0	0	6	0	5	453301	464547	11246	302.2	94895.2	19.0	0.00	0.00	0.32
1	06/12/08	120	17	10	0	4	556517	562290	5773	155.1	48713.3	9.7	12.32	1.74	1.03
2	06/12/08	56	9	4	0	4	562301	569263	6962	187.1	58746.3	11.7	4.77	0.77	0.34
6	06/12/08	32	1	2	0	4	569832	574395	4563	122.6	38503.2	7.7	4.16	0.13	0.26
8	06/12/08	10	6	9	0	5	574801	583990	9189	246.9	77538.0	15.5	0.64	0.39	0.58
8b	06/12/08	3	2	8	0	5	584483	594659	10176	273.5	85866.4	17.2	0.17	0.12	0.47
8d	06/12/08	1	3	26	0	5	595201	611550	16349	439.3	137955.0	27.6	0.04	0.11	0.94
8e	06/12/08	0	0	14	0	5	612367	623835	11468	308.2	96768.5	19.4	0.00	0.00	0.72
9	06/12/08	0	0	25	0	6	625432	640810	15378	413.3	129761.6	26.0	0.00	0.00	0.96
9a	06/12/08	0	0	25	0	6.17	641993	658773	16780	450.9	141591.8	28.3	0.00	0.00	0.88
9b	06/12/08	0	0	16	0	6	660114	680742	20628	554.3	174061.8	34.8	0.00	0.00	0.46
10	06/12/08	0	0	19	0	6.15	681413	695615	14202	381.7	119838.3	24.0	0.00	0.00	0.79
10B	06/12/08	0	0	18	0	5.4	696314	709561	13247	356.0	111779.9	22.4	0.00	0.00	0.81
1	5/25/08	45	39	3	3	8	43302	155662	112360	3019.5	948108.3	189.6	0.24	0.21	0.02
1	5/27/08	19	11	0	0	8	44849	165592	120743	3244.7	1018845.2	203.8	0.09	0.05	0.00
1	06/02/08	591	19	5	0	5	259681	258009	1672	44.9	14108.6	2.8	209.45	6.73	1.77
1	06/10/08	266	24	3	0	4	547923	556008	8085	217.3	68222.3	13.6	19.50	1.76	0.22
1	06/18/08	48	23	7	0										
1	06/24/08	20	19	8	0	8	716853	727001	10148	272.7	85630.1	17.1	1.17	1.11	0.47

Appendix 1 continued.