

Fish And Flow Measurements And General
Observations For Lobos Creek, San Francisco,
California, Spring 1998

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PURPOSE

A survey was undertaken to:

- 1) Determine the distribution and relative abundance of threespine stickleback (*Gasterosteus aculeatus*) in lower Lobos Creek below Lincoln Boulevard during Spring 1998.
- 2) Determine potential impacts to sensitive life stages of the threespine stickleback downstream of diversion point.
- 3) Estimate total flows at a couple points during spring of 1998.

METHODS

Fish sampling. Three sample sites were selected downstream of Lincoln Boulevard. These sites include: main channel pool downstream of the Squirrel Cage, a main channel pool site 59 m below Squirrel Cage, and a flatwater site 131 m below Squirrel Cage (Figure 1). The main channel pool above Lincoln Boulevard was also sampled. Two-pass electrofishing was conducted with a Smith-Root Model 12B electrofishing units. Sampled habitat units were netted on the upstream and downstream sides to prevent movement of fish during sampling activities. Fish were identified to species, counted, and standard length measured.

Flow measurements. On May 7th and 12th, 1998, flow measurements were made at 3 locations along Lobos Creek: 1) Baker Beach outfall (5.1 m below cement wall facing), 2) Above Achuck culvert (approx 3-5 m), and 3) Below Squirrel Cage (2 m below culvert). Three other flow measurements were taken on March 20, 23, and 24th at the Squirrel Cage site. Discharge measurements were taken using a Swoffer 2100 meter. Generally, ten measurements were taken across a channel cross-section, such that no one measurement represented more than 10% of the total flow for that section. Discharge estimates were computed using the U.S.G.S.'s midsection method (Buchanan and Somers 1969). Reported Swoffer meter readings in the field were adjusted upward by 8% to correct for instrument measurement bias (as determined in pool tests). Concurrently, pump rate data was obtained for Lobos Creek at the water treatment plant. When pump rates are stable over long periods of time, total streamflow is the sum of the instream flow plus the pump rate. Under different flow regimes, we also noted whether habitats were connected or disconnected under the different streamflow rates.

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RESULTS and DISCUSSION

General Fish Habitat Characteristics

Suitable habitat for threespine stickleback exists both upstream and downstream of Lincoln Boulevard. Stickleback are common in low gradient portions (generally, the lower part of streams) where slow water habitats such as pools predominate. For example, in Redwood Creek, Marin Co., stickleback are most abundant in the Big Lagoon area-- the downstream most portion of Redwood Creek. Here, threespine stickleback are closely associated with the emergent vegetation occurring in the shallow margins of the lagoon. Lobos Creek is characterized by low stream gradient, extensive slow water and emergent vegetation areas, and consistent year-round flows upstream of diversion point. Male threespine stickleback constructs nests on a variety of substrates (sand, mud, rock, and detritus) (Whoriskey and FitzGerald 1994) and use vegetation and sand grains for construction of nests (McGinnis 1984)- reproductive requirements that are easily satisfied throughout Lobos Creek.

As previously noted, three sites downstream of the diversion point and one upstream site were sampled for fish. Although the sampled sites were not selected randomly, they appear representative of the downstream area. Table 1 lists physical habitat features of the sampled sites.

Table 1: Physical habitat characteristics at threespine stickleback sampling sites on Lobos Creek, San Francisco, March 23-24, 1998

Station	Above Lincoln Blvd	Below Squirrel Cage	Below Squirrel Cage (59 m below)	Below Squirrel Cage (131 m below)
Date	3/24/98	3/23/9	3/23/98	3/24/98
Habitat type	Pool (MC)	Pool (MC,BW)	Pool (MC)	FW
Mean width (m)	5.8	4.9	4.9	1.9
Mean depth (m)	0.32	0.08	0.10	0.13
Length (m)	32.0	12.5	10.7	9.2
Area (m ²)	184.0	61.3	52.4	17.6
Max depth (m)	0.80	0.30	0.30	
Min depth (m)	0.80	0.18	0.25	
Residual pool depth (m)	0.00	0.12	0.05	
Cover type (% cover)	EV (30)	OV (5), EV (10)	EV (15)	EV (10)

Note: EV-emergent vegetation, OV-overhanging vegetation, FW-flatwater, MC-main channel, BW-backwater

Fish Population Characteristics

Only threespine stickleback were found at the four sites. Fish densities ranged from 22 to 560 fish/ 100m (Table 2). These abundance estimates should only be viewed as the minimum number present. The high water conductivity and small fish size hampered electrofishing efforts. Water conductivity was approximately 600 $\mu\text{S}/\text{cm}$. Electrofishing is most effective when water conductivities are similar to fish conductivity (approximately 100 $\mu\text{S}/\text{cm}$). When water conductivity greatly exceeds fish conductivity, increased power is needed to elicit a response in the fish. Many fish swam away from the probe during electrofishing activities, apparently unaffected by the electric field. Rather than using removal-depletion estimation models, we summed the total number of captured fish from 2 consecutive passes to estimate fish abundance.

Table 2: Fish density estimates at four sites in Lobos Creek (Golden Gate National Recreation Area) associated with electrofishing activities.

Sampling Sites	# stickleback/100 m
Above Lincoln Blvd	69
Below Squirrel Cage	560
Below Squirrel Cage (59 m)	159
Below Squirrel Cage (131 m)	22

Based on published length-age information for stream-dwelling threespine stickleback, most captured fish downstream of Lincoln Boulevard are probably 1-year old or younger. A large percentage of the fish captured above Lincoln Boulevard were between 50-65 mm and are probably older than 1 year. The standard lengths for one-year old stream-dwelling threespine stickleback range from 34 to 50 mm with a mean of 43.8 mm (Baker 1994). Mean standard length of fish by sampled site is provided in Table 3.

Table 3: Mean standard length of threespine stickleback, Lobos Creek, CA, March 1998.

	Above Lincoln Blvd	Below Squirrel Cage	Below Squirrel Cage (59 m below)	Below Squirrel Cage (131 m below)
n	22	32	17	1
Mean (mm)	46.4	35.3	39.4	33
Std. Dev.	± 14.8	± 6.9	± 9.5	NA

Instream flows and Pumping Rates

Instream flows downstream of the diversion point (Squirrel Cage) are provided in Table 4.

Table 4: Instream flows and pumping rates for Lobos Creek, San Francisco, California, 1998.

<i>Location</i>	<i>Date</i>	<i>Time (2400hr)</i>	<i>Instream Flows cfs (MGD)</i>	<i>Pump Rate GPM (MGD)</i>	<i>Start of Pump Rate</i>
At Baker Beach	7 May 1998	1007	1.04 (0.67)	700 (1.01)	0816
	7 May 1998	1213	0.09 (0.05)	1100 (1.58)	1124
Above Achuck culvert	7 May 1998	0941	0.92 (0.59)	700 (1.01)	0816
	7 May 1998	1158	0.09 (0.05)	1100 (1.58)	1124
Below Squirrel Cage	20 Mar 1998	1800	3.49 (2.26)	0	1600
	23 Mar 1998	0810	1.16 (0.75)	700 (1.01)	0700
	24 Mar 1998	1410	1.18 (0.76)	700 (1.01)	1100
	7 May 1998	0900	1.03 (0.66)	700 (1.01)	0816
	7 May 1998	1042	Damp-No flow	1300 (1.87)	1043
	7 May 1998	1134	<0.01 (<0.01)	1100 (1.58)	1124
	12 May 1998	0715	2.11 (1.36)	0	*
	12 May 1998	1627	2.16 (1.39)	0	**
	11 June 1998	0850	1.85 (1.20)	0	****

Note: cfs-cubic feet per second, MGD-million gallons per day

*Stopped pumping on 11 May 1998 @1630HR. **Stopped pumping on 12 May 1998 @1330HR.

***Stopped pumping on 11 June 1998 @0800HR.

Physical Habitat Changes

Changes in flow rates resulted in changes in the cross-sectional area. Because of time limitations, no transects were established at sites other than the discharge measurement locations. We followed the decrease in channel width as pumping rates increased through placement of wire flags and photographs (Figure 2).

In the absence of pumping, the cross-sectional area of the site just downstream of the diversion point was 0.26 sq. meters (Figure 3). Under a pumping rate of 700 gallons per minute (gpm) (or 1.01 MGD), this cross-section experienced a loss of 43% of its area. Under the highest pumping rate (1300 gpm or 1.87 MGD), a 99% loss of cross-sectional area occurred. However, it should be noted that these changes are based on measurements taken at the tail of a pool. Riffles and pool tails are sites most adversely affected by pumping changes. To quantify habitat changes under different flow regimes, cross-section should be established along the length of the channel within various stream habitat types (riffle, pool, and flatwater).

Influence of Habitat Changes on Fish Populations

A review of existing literature on habitat characteristics and its influence on threespine sticklebacks is currently being conducted. In general, it appears that the juveniles and eggs are the critical stickleback lifestages that could be most adversely affected by fluctuating flows. However, no information is currently available about the seasonal breeding patterns in this region. In southern California, reproduction of the endangered unarmored threespine stickleback (*G.a. williamsoni*) occurs mostly in the spring, about March, with lower levels throughout the summer and fall (USFWS 1985). Much of the information provided below are *potential* effects of habitat changes on the ecology of stickleback from studies conducted elsewhere.

1. Increased rates of cannibalism through loss of habitat. Adult male sticklebacks are efficient predators on juveniles from 5 to 15 mm SL (Baker 1994). Small juvenile fish inhabit vegetated areas until they are large enough so that they are less vulnerable to predation (Whoriskey and FitzGerald 1994). Most of the emergent vegetation used for cover are located along the margins of the main channel. These areas are typically dewatered when pumping occurs. This is evident when we observed the decrease in channel width under the higher pumping rates. Therefore it is likely that pumping could increase predation risk for juveniles.

2. Increased rates of avian predation. Threespine stickleback are the only fish within the creek. Predators on juvenile fish include certain invertebrates (e.g., dragonfly nymphs) and adult stickleback. However, predators on adults are likely fish-eating birds. Great egrets have been observed foraging in open areas downstream of the diversion structure. Much of the protective cover for fish occur along the margins of the channel where overhanging vegetation is abundant or emergent vegetation is present. As water recedes, adult sticklebacks will be more susceptible to avian predators (away from cover).

3. Potential for nest failure. Nests built in shallow water near the margins of the channel are vulnerable to fluctuations in water level (Whoriskey and FitzGerald 1994).

4. Reduction in food base. Continuous fluctuations in the area and volume of aquatic habitat will likely impact the abundance of aquatic insects-- some which are food sources for sticklebacks.

Lobos Creek Connection to the Ocean.

A well-defined channel between the Ocean and Lobos Creek Outfall was present (Figure 4). It is likely that the channel banks and bottom elevation are maintained by the higher flows occurring at night when pumps are inoperative. On May 12th, when no pumping was occurring, the wetted channel was at the edge of the defined banks. On May 7th, under the various pumping rates, the wetted channel was well within the defined banks.

Under the range of short-term discharges observed at Baker Beach, the stream was connected to the ocean. Under the lowest discharge (0.09 cfs), flows were confined to a shallow channel about 0.9 m wide at its confluence with the Ocean (Figure 5). When no pumping was occurring, flows (1.64 MGD) were spread across a shallow, but wide channel of 8.5 m wide.

Calculation of total flows.

Total flows could only be calculated when the pumps were not operational. Total flows on a sampling event in March was 2.26 MGD and 1.32 MGD on a sampling event in May. We couldn't add instantaneous pump rates and streamflow at the Squirrel Cage to determine total flows. For example, pump rates of 1100-1300 gallons per minute (1.58-1.87 MGD) from 1040 to 1230 HR appropriated more water than the creek was producing on a sustained basis at the time. The wet well was not stabilized under these pump rates and was continually dropping.

There was a lag time between changes in pump rates and response in streamflow in downstream locations. The discharge point closest to the intake structure (Squirrel cage), during pump rates of 1100-1300 gpm, had flows ranging from 0 to <0.01cfs and responded within minutes of pump rate changes. However, points downstream had reduced flows under the higher pumps, but changes were not instantaneous.

Monthly variation in flows.

Unfortunately, flow measurements in the absence of pumping have not been taken consistently throughout the year. On March 20th, May 12th, and June 11th, stream flows were measured when the pumps were off. Flows declined successively on each sampling occasion (Table 4). During March 20th measurements, flows were approximately 47% higher than flows taken on June 11th. Further declines in flows may limit the amount of water for appropriation.

MITIGATION

The Council of Environmental Quality regulations for implementing the National Environmental Policy Act define mitigation to include: 1) avoiding the impact; 2) minimizing the impact; 3) rectifying the impact; 4) reducing or eliminating the impact over time; and 5) compensating for impacts.

The FINAL GENERAL PLAN AMENDMENT-- PRESIDIO OF SAN FRANCISCO has the following water resource management objective: "*Manage onsite water resources to protect ground and surface water resources and natural wetland and riparian values and to efficiently supply water to the Presidio community.*" Therefore, under the assumption that some amount of flows must be diverted to comply with the General Plan Amendment's requirement for water supply, it would seem that some level of biological

impacts are unavoidable. Pumping rates can be altered to minimize biological impacts. However, even with impact minimization, loss of habitat will always occur under any pumping regime. To compensate for such impacts, a flexible mitigation and monitoring plan should be required. Under Policy and Objectives for Aquatic Habitat Protection and Management, NPS-77 clearly states that "with respect to aquatic habitats, the NPS seeks to: ...limit effects and mitigate damage if impacts are unavoidable."

Components of this mitigation plan should include the following **long-term elements**:

1. Using the U.S. Fish and Wildlife's mitigation planning goals by resource category, the creek habitats and associated emergent wetland habitats should be classified as Resource Category 2 with a Mitigation Goal of No Net Loss of In-Kind Habitat Value.

Attainment of this goal is only possible by maintaining natural hydrology throughout the downstream sites affected by the diversion. The restoration plan proposed in the Environmental Assessment (Harding Lawson Associates) resolves this issue by calling for the relocation of the diversion structure to a downstream location.

Components of this mitigation plan should include the following **short-term elements** for aquatic resource protection:

1. Maintain average 0.5 MGD on a daily basis. Flexibility in pump rates should allow plant operators to pump at rates during the day that leave less than 0.5 MGD, but maintain visible flows into pools.

1a. Maintain sufficient instream flows by reducing Presidio demand through a variety of actions, including water conservation.

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Figure 1: Threespine stickleback sampling sites on Lobos Creek, San Francisco CA (March 23-24, 1998)

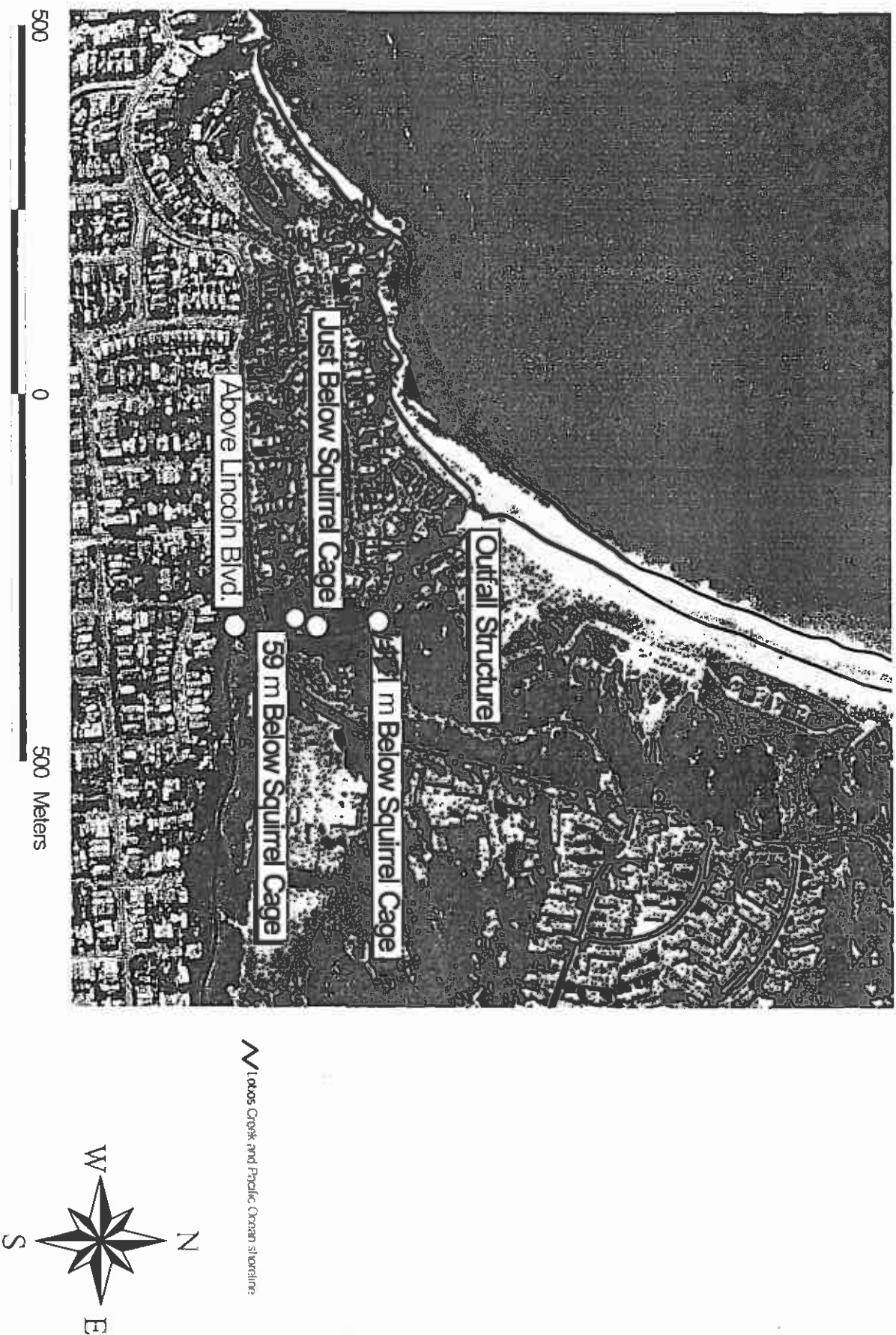




Figure 2: Lobos Creek channel : wire flags marking (circled) wetted perimeter under different flow regimes on May 7, 1998.



Figure 4: Lobos Creek at Baker Beach outfall in absence of pumping on May 12, 1998

Figure 3: Channel cross-section under different flows at Lobos Creek, downstream of Squirrel Cage, 1998.

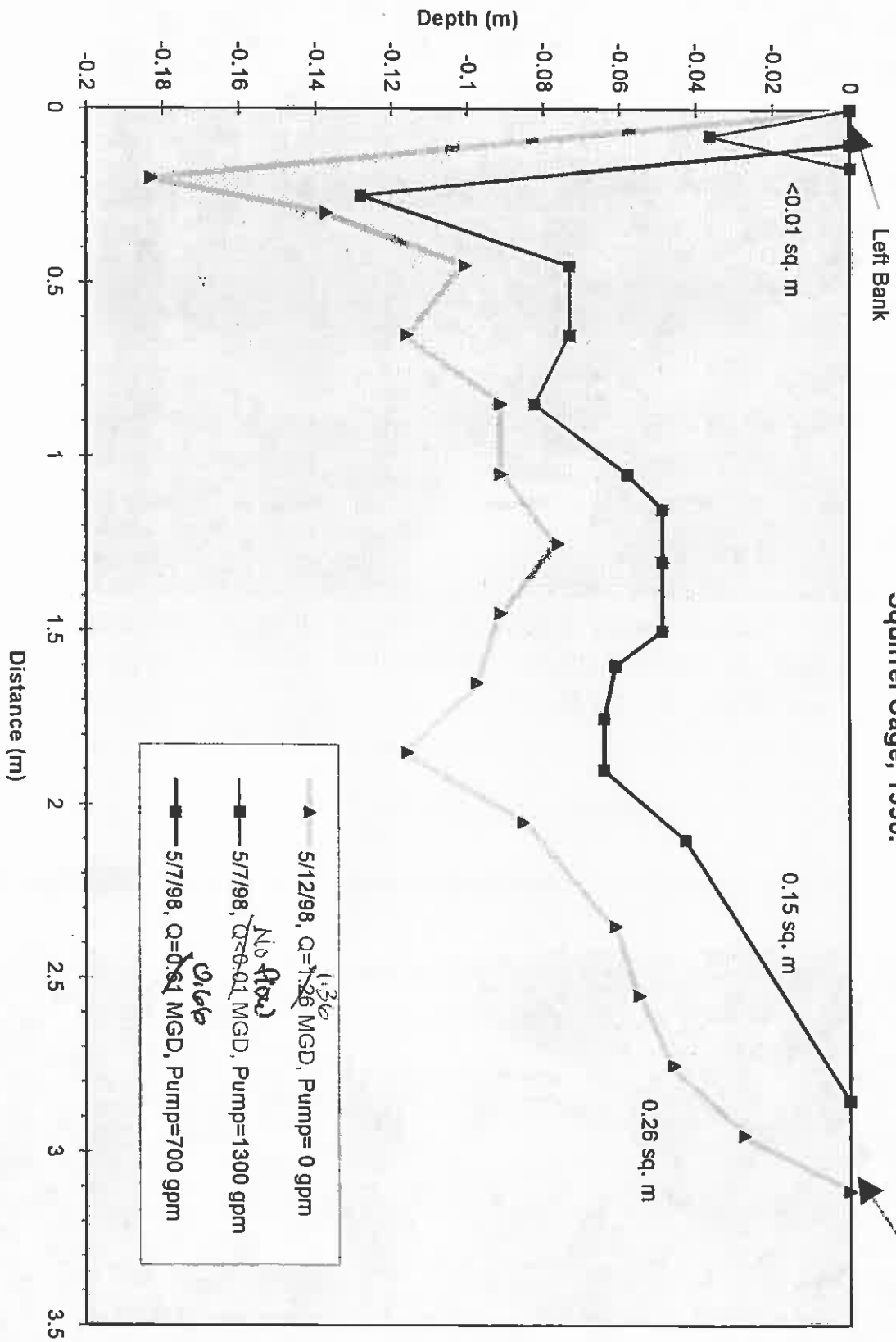




Figure 5: Lobos Creek Confluence with
Pacific Ocean at approx 0.1 cfs flows
on May 7, 1998,

Appendix I: Raw Electrofishing Data For Lobos Creek, San Francisco, CA

Date	Location	Pass	Number	Std Length (mm)
23-Mar-98	Below Squirrel Cage	1	1	44
23-Mar-98	Below Squirrel Cage	1	1	29
23-Mar-98	Below Squirrel Cage	1	1	30
23-Mar-98	Below Squirrel Cage	1	1	42
23-Mar-98	Below Squirrel Cage	1	1	45
23-Mar-98	Below Squirrel Cage	1	1	40
23-Mar-98	Below Squirrel Cage	1	1	44
23-Mar-98	Below Squirrel Cage	1	1	31
23-Mar-98	Below Squirrel Cage	1	1	30
23-Mar-98	Below Squirrel Cage	1	1	30
23-Mar-98	Below Squirrel Cage	1	1	25
23-Mar-98	Below Squirrel Cage	1	1	39
23-Mar-98	Below Squirrel Cage	1	1	31
23-Mar-98	Below Squirrel Cage	1	1	27
23-Mar-98	Below Squirrel Cage	1	1	41
23-Mar-98	Below Squirrel Cage	1	1	50
23-Mar-98	Below Squirrel Cage	1	1	43
23-Mar-98	Below Squirrel Cage	1	1	33
23-Mar-98	Below Squirrel Cage	1	1	30
23-Mar-98	Below Squirrel Cage	1	1	36
23-Mar-98	Below Squirrel Cage	1	1	42
23-Mar-98	Below Squirrel Cage	1	1	32
23-Mar-98	Below Squirrel Cage	1	1	43
23-Mar-98	Below Squirrel Cage	1	1	42
23-Mar-98	Below Squirrel Cage	1	1	29
23-Mar-98	Below Squirrel Cage	1	1	26
23-Mar-98	Below Squirrel Cage	1	1	26
23-Mar-98	Below Squirrel Cage	1	1	31
23-Mar-98	Below Squirrel Cage	1	1	31
23-Mar-98	Below Squirrel Cage	1	1	29
23-Mar-98	Below Squirrel Cage	1	1	40
23-Mar-98	Below Squirrel Cage	1	1	39
23-Mar-98	Below Squirrel Cage	1	14	
23-Mar-98	Below Squirrel Cage	2	24	
23-Mar-98	Below Squirrel Cage (59 m)	1	1	31
23-Mar-98	Below Squirrel Cage (59 m)	1	1	39
23-Mar-98	Below Squirrel Cage (59 m)	1	1	53
23-Mar-98	Below Squirrel Cage (59 m)	1	1	35
23-Mar-98	Below Squirrel Cage (59 m)	1	1	39
23-Mar-98	Below Squirrel Cage (59 m)	1	1	40
23-Mar-98	Below Squirrel Cage (59 m)	1	1	27
23-Mar-98	Below Squirrel Cage (59 m)	1	1	47
23-Mar-98	Below Squirrel Cage (59 m)	1	1	38
23-Mar-98	Below Squirrel Cage (59 m)	1	1	57
23-Mar-98	Below Squirrel Cage (59 m)	1	1	56
23-Mar-98	Below Squirrel Cage (59 m)	1	1	33
23-Mar-98	Below Squirrel Cage (59 m)	1	1	46
23-Mar-98	Below Squirrel Cage (59 m)	1	1	30
23-Mar-98	Below Squirrel Cage (59 m)	2	1	40
23-Mar-98	Below Squirrel Cage (59 m)	2	1	31

Appendix I: Raw Electrofishing Data For Lobos Creek, San Francisco, CA

Date	Location	Pass	Number	Std Length (mm)
23-Mar-98	Below Squirrel Cage (59 m)	2	1	28
24-Mar-98	Below Squirrel Cage (131 m)	3	0	
24-Mar-98	Above Lincoln Blvd	1	1	60
24-Mar-98	Above Lincoln Blvd	1	1	53
24-Mar-98	Above Lincoln Blvd	1	1	60
24-Mar-98	Above Lincoln Blvd	1	1	55
24-Mar-98	Above Lincoln Blvd	1	1	56
24-Mar-98	Above Lincoln Blvd	1	1	54
24-Mar-98	Above Lincoln Blvd	1	1	44
24-Mar-98	Above Lincoln Blvd	1	1	40
24-Mar-98	Above Lincoln Blvd	1	1	55
24-Mar-98	Above Lincoln Blvd	1	1	45
24-Mar-98	Above Lincoln Blvd	1	1	58
24-Mar-98	Above Lincoln Blvd	2	1	50
24-Mar-98	Above Lincoln Blvd	2	1	40
24-Mar-98	Above Lincoln Blvd	2	1	62
24-Mar-98	Above Lincoln Blvd	2	1	62
24-Mar-98	Above Lincoln Blvd	2	1	58
24-Mar-98	Above Lincoln Blvd	2	1	50
24-Mar-98	Above Lincoln Blvd	2	1	36
24-Mar-98	Above Lincoln Blvd	2	1	32
24-Mar-98	Above Lincoln Blvd	2	1	13
24-Mar-98	Above Lincoln Blvd	2	1	19
24-Mar-98	Above Lincoln Blvd	2	1	18
24-Mar-98	Below Squirrel Cage (131 m)	1	1	33
24-Mar-98	Below Squirrel Cage (131 m)	2	1	