
TECHNICAL MEMORANDUM

TO: Chris Berry
City of Santa Cruz Water Department

FROM: Jeff Hagar
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DATE: November 15, 2013

PROJECT: City of Santa Cruz Habitat Conservation Plan, Lagoon Fish Population Sampling 2012

Fish population and steelhead (*O. mykiss*) rearing were assessed in Laguna Creek lagoon and the San Lorenzo River lagoon during the summer of 2012 by the City of Santa Cruz Water Department and Hagar Environmental Science (HES). Surveys were conducted in the early summer and again in the fall using large seines. Mark-recapture abundance estimates for *O. mykiss* were completed using PIT tags in both lagoons during both the June and October sampling periods. Fish were tagged one day and recaptured the next day in Laguna Creek lagoon. In the larger San Lorenzo River lagoon, fish were captured and tagged on two consecutive days and recaptured during a subsequent two-day period (in the San Lorenzo lagoon there were two days between the mark and the recapture period). In Laguna Creek lagoon a 100 foot long by 6 foot deep seine with a bag and ¼ inch mesh was used. In the San Lorenzo River lagoon we used both the 100 foot seine and a 150 foot long by 8 foot deep seine with ¼ inch mesh. The larger seine was used in deeper water and at higher lagoon stages. A summary of the results of the survey follows.

Laguna Creek

Summary

Laguna lagoon was still open during the June survey in 2012 with tidal conditions and low stage (Figure 1). The lagoon typically closes by mid-May and remains closed into the fall but, similar to 2011, the mouth did not close until the second half of July (2nd Nature 2012). It is possible that reduced spring diversions by the City, in place on an experimental basis as part of the Habitat Conservation Planning process, are contributing to later closing of the mouth of Laguna Creek. In June, the small, shallow lagoon supported primarily young-of-year *O. mykiss* with only a few older fish captured. In spite of these conditions, by September the lagoon supported a relatively high abundance of smolt-sized *O. mykiss* (150mm FL or more) as well as smaller individuals (60mm-140mm). The presence of smaller size classes of *O. mykiss* (less than ~140mm FL) in the lagoon in fall is atypical of past surveys, previously observed only in 2008. The lagoon did not breach until November 29.

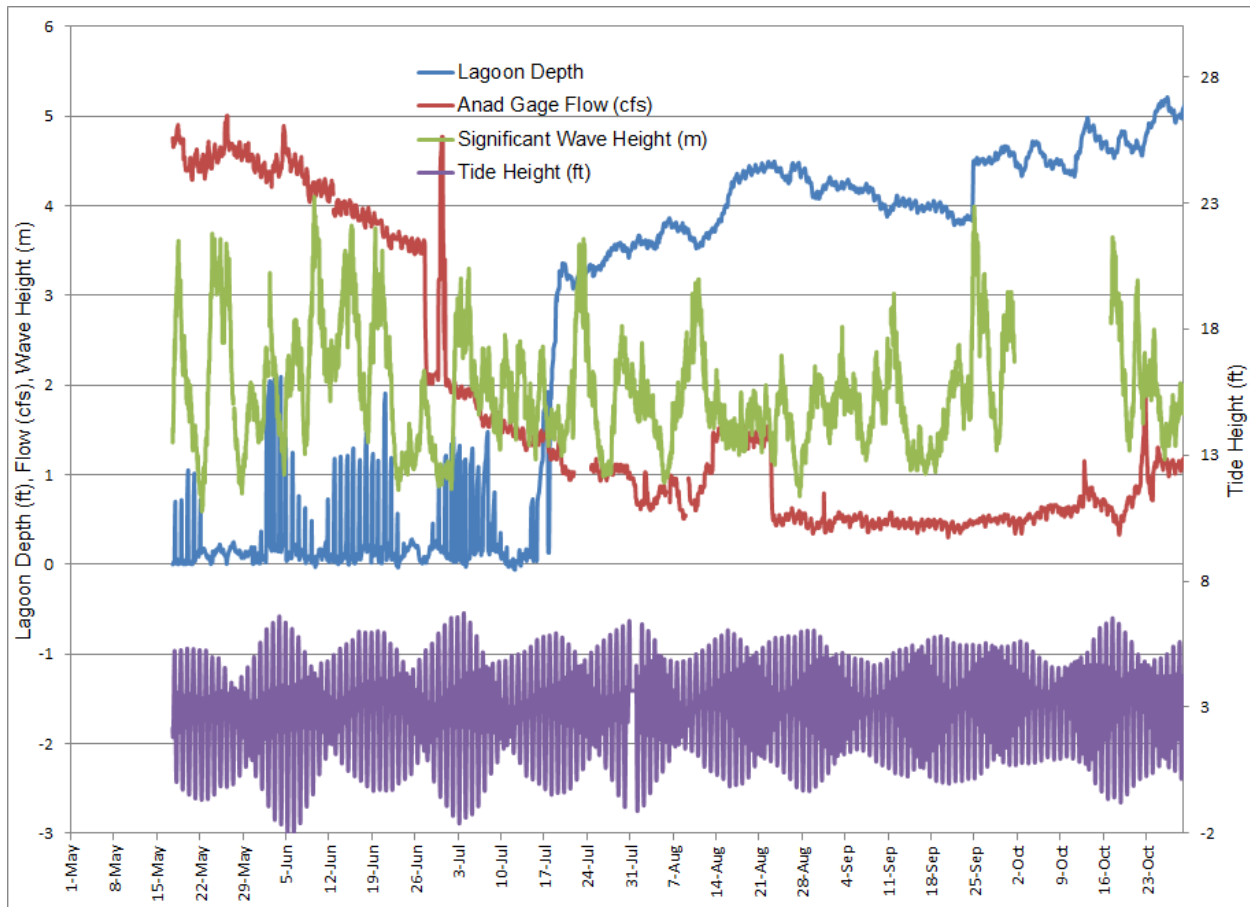


Figure 1. Laguna Lagoon stage, streamflow, wave height, and tides 2012 (Source: lagoon stage from 2ND Nature, streamflow from Balance Hydrologics, wave and tide data from NOAA).

Spring (June 5-6)

Spring Site Conditions

- Mouth open, lagoon stage very low (Figures 2-4). Lagoon had been tidal since the water quality monitoring gage was installed on May 17 (Figure 1).
- Relatively high inflow from Laguna Creek at 4-4.5 cfs.
- Maximum depth to 2-3 feet, most of lagoon much shallower (1 foot or less).
- Indication of recent higher stage on bedrock near mouth (Figure 2).
- Appeared to be minimal tidal action in lagoon during sampling; sinuous outlet configuration with invert perched above low tide level.
- Salinity less than 2 ppt, temperature 12-14°C, dissolved oxygen 10 mg/l or more (saturation 95% to over 100%)
- The water column was clear.
- The overwash pond was full



Figure 2. Laguna Lagoon, June 5, 2012.



Figure 3. Laguna lagoon, June 6, 2012 near Station 2.



Figure 4. Laguna lagoon, June 5, 2012, Station 2 and Station 3.

Spring Survey Results

- *O. mykiss* were captured and tagged on June 5. On June 6 the lagoon was re-sampled and the proportion of re-captured fish was recorded.
- Thirteen seine hauls were completed between the beach and the willows upstream of the water quality monitoring location (LA-4) (Table 1).
- The majority of *O. mykiss* captured (97%) were young-of-year at 50mm FL or less (Figure 5). A few were in the 90mm to 149mm range (most likely age 1+, see Table 2), and one fish of 356 mm was captured (age 3+ ocean return). This is greatest abundance of y-o-y *O. mykiss* observed in the lagoon, probably related to the open lagoon condition and the riverine nature of what is usually lagoon. Y-o-y were also numerous in 2011 when the lagoon was open late but the lagoon was higher and y-o-y not as numerous as 2012.
- Only 5 of the 147 *O. mykiss* captured were greater than 70mm in length.
- Many tidewater goby (TWG) were captured in spite of the fact that the gear used is not very effective for goby (mesh-size too large).
- The backwater pond was not sampled.

Table 1. Fish catch in Laguna Creek lagoon, June 2012.

Species	LA-1	LA-1.5	LA-2	LA-3	LA-4	Grand Total
	June 5 and 6					
<i># Hauls</i>	4	3	3	1	2	13
<i>O. mykiss</i>	1	36	31	13	66	147
Threespine stickleback		130	24	24	388	566
Prickly sculpin		1	7	6	21	35
Staghorn sculpin	14	24	6		8	52
Tidewater goby		100	25	2	37	164
<i>O. mykiss CPUE</i>	0.25	12	10.3	13	33	11.3

Note: See Figures at end of document for sample station locations.

Spring *O. mykiss* Population Estimate

- Insufficient numbers of *O. mykiss* 50 mm FL or larger were captured to enable a mark-recapture population estimate.
- Two steelhead were tagged during the mark period. Neither was recaptured during the subsequent recapture period.

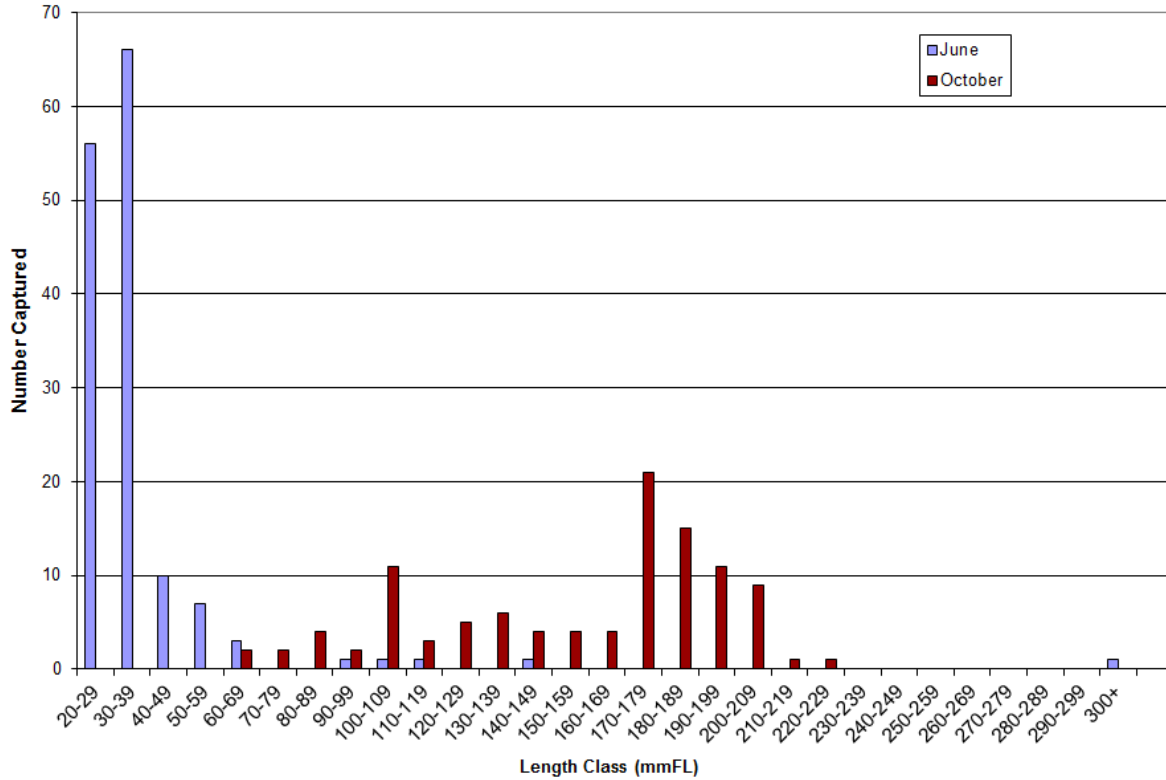


Figure 5. *O. mykiss* length classes in Laguna Creek Lagoon.

Table 2. Results of Age Determination of Juvenile *O. mykiss* in Laguna Creek Lagoon, 2012 (courtesy of Michelle Leicester, CDFG).

Date	Length (mm FL)	Age	Length at Annulus 1	Length at Annulus 2	Length at Annulus 3
5-Jun	356	3+	115	173	280
6-Jun	97	1+	91		
6-Jun	108	1+	87		
6-Jun	112	1+	92		
12-Sep	118	0+			
12-Sep	148	0+			
11-Sep	169	0+			
11-Sep	180	1+	70 ¹		
11-Sep	196	1+	80		
12-Sep	203	1+	93		
12-Sep	227	1+	88		

¹ Regenerated scale, same fish captured June 6 at 97mm

Fall (September 11-12)

Fall Site Conditions

- Mouth closed, stage high (Figures 6 and 7)
- Following the spring sample on June 5 and 6, the lagoon remained open until about July 17. Lagoon stage climbed rapidly to over 3 feet by July 19 (Figure 1). The lagoon remained closed through at least mid-November, with generally increasing stage throughout the summer and fall (Figure 1). Stage was at about 4 feet during the fall survey.
- At time of survey the lagoon was fresh, un-stratified; well-oxygenated at 8.0 to 9.3 mg/l through water column; temperature was 16.1°C to 18.4°C.

Fall Survey Results

- *O. mykiss* were captured and marked on September 11. On September 12 the lagoon was re-sampled and the proportion of re-captured fish was recorded.
- Six seine hauls were completed on September 11 and 5 hauls on September 12 between the beach (LA-1) and water quality monitoring location (LA-3) (Table 3).
- Overall abundance of *O. mykiss* based on number caught per seine haul (catch per unit effort or CPUE) was relatively high compared to previous years surveys (Table 4). *O. mykiss* CPUE was comparable to that in June.
- *O. mykiss* ranged in size from 60mm to 230mm (FL). About 63% were between 150mm and 230mm (Figure 5).
- The majority of *O. mykiss* in size classes of 130mm or larger were at the silvery parr stage, while most below 130mm were parr (Figure 8). None of the *O. mykiss* were characterized as smolts.
- Analysis of scales indicated that at least two age classes were present. Scales indicating age 0+ *O. mykiss* were taken from individuals between 118 and 169 mm FL and scales indicating age 1+ from individuals of 180 to 227 mm FL (Table 2).
- The average length of age 1+ *O. mykiss* in the fall (202 mm FL) was 96 mm greater than the average length of age 1+ *O. mykiss* in June (106 mm FL). This change is close to the growth of one individual (83 mm or 0.86 mm/day) captured both in June and September.
- Very few tidewater goby were captured compared to the spring survey. It is possible that they are less susceptible to capture at the higher lagoon stage encountered in the fall.
- The backwater pond was not sampled.



Figure 6. Laguna Creek Lagoon, September 11, 2012.



Figure 7. Laguna Creek Lagoon, September 11, 2012.

Table 3. Fish catch in Laguna Creek lagoon, September 2012.

Species	LA-1	LA-1.5	LA-2	LA-3	Grand Total
# Hauls	4	5	1	1	11
<i>O. mykiss</i>		63	18	32	113
threespine stickleback	many	many			Many
Staghorn sculpin		2			2
tidewater goby	1				1
<i>O. mykiss</i> CPUE	0	12.6	18	32	10.3

Table 4. *O. mykiss* and coho salmon catch per seine haul in Laguna Creek lagoon at consistently sampled stations (data from HES 2005, HES 2009, HES 2010, HES 2011, and HES 2012).

	<i>O. mykiss</i> Catch per Haul				Coho Catch per Haul			
	Jun	Jul	Sep	Oct	Jun	Jul	Sep	Oct
2004		2.4	0			0	0	
2008	11		6		0		0	
2009	7		19		0		0	
2010	13			1.7	0			0
2011	19.8			0.1	0			0
2012	11.3		10.3		0		0	

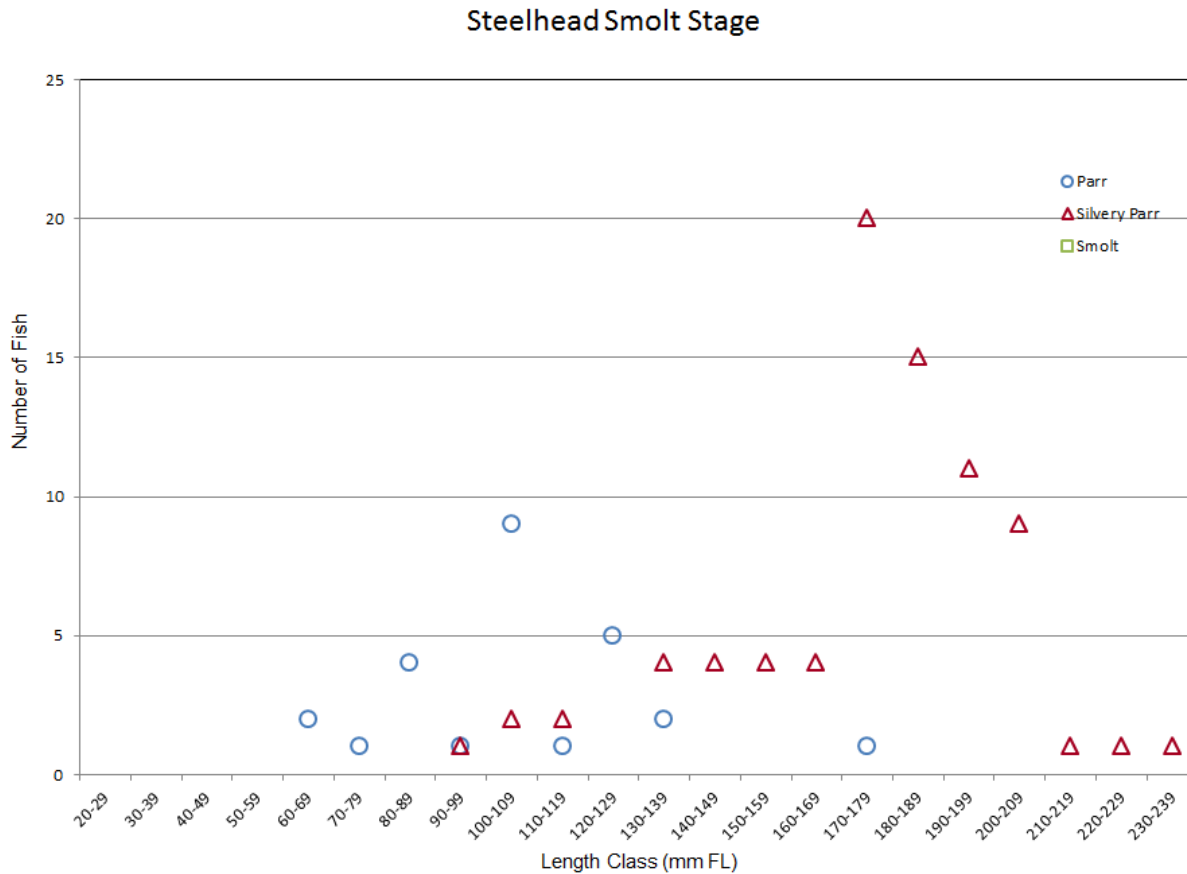


Figure 8. *O. mykiss* smolt stage by length class, Laguna Lagoon, September 2012.

Fall *O. mykiss* Population Estimate

- All *O. mykiss* captured on September 11 were larger than 50 mm FL and all were marked by insertion of a PIT tag in the abdominal cavity (fish smaller than 50 mm FL are too small to mark). A total of 31 *O. mykiss* were marked.
- On September 12, a total of 80 *O. mykiss*, all larger than 50 mm FL, were captured. Of these, 6 had been marked on September 12.
- Population estimate using the Petersen method (Ricker 1975) is 370 *O. mykiss* larger than 50mm in the lagoon on September 12. The 95% confidence limits for this estimate are 184 and 694.
- One *O. mykiss* marked in the spring (June 6) was recaptured September 11. This fish was originally captured at Station 4 and was recaptured at Station 1.5. It had grown from 97 mm FL in June to 180 mm FL in September, an average growth rate of 0.86 mm per day. Recapture rate for *O. mykiss* tagged in September was 6 out of 31 tagged or about 19%. Since only 2 *O. mykiss* were tagged in June, this recapture suggests good survival rates for *O. mykiss* in Laguna lagoon during the summer of 2012.

San Lorenzo River

Summary

Late-season storms in late-March and April resulted in inflows to the lagoon of over 30 cfs into June. The lagoon was open and tidal through mid-July then entered a period of closures with several “fill and spill” cycles lasting seven to ten days at a time (Figure 9). These “fill and spill” cycles were punctuated by periods with open, tidal conditions through at least late-October. The size distribution of *O. mykiss* in the lagoon was atypical in both June and September with large numbers of very large individuals. Typically, few fish over 230 mm are captured in June; in 2012 half the catch was between 230 and 510 mm.

In the fall there was a relatively large part of the size distribution (40 % of the catch) from 150-210 mm that appeared to be primarily age 0+ based on scale analysis. These fish must have entered the lagoon after June since very few age 0+ *O. mykiss* were captured in June. There were also large numbers of larger fish up to 460 mm FL. Of 261 *O. mykiss* examined for presence of adipose fin, 15 were clipped. All except 2 of those with clipped adipose were over 320 mm FL. At least two of the large *O. mykiss* were from other watersheds (San Vicente and Soquel) and had entered the San Lorenzo after spending an unknown amount of time in the ocean. This is known from PIT tags the fish were carrying (see results below).

The population estimate was higher in September than in June (945 vs. 60). Many of the fish captured in September may have entered the lagoon after it breached on the night of September 13/14. Catch per unit effort increased after the 13th and adult chinook salmon appeared in the catch on the 17th. CPUE at stations near the mouth was 3.8 on the 13th and 34.5 on the 17th. This may have been at least partially a result of lower lagoon stage on the 17th. CPUE has generally been lower at high lagoon stages when the mouth is closed.

Fall recaptures of 5 fish tagged in June indicated good growth rates (0.58 mm/day to 0.84 mm/day) over the summer. This is relatively high recovery rate of tagged fish since only 18 *O. mykiss* were tagged in June. Of 49 *O. mykiss* tagged on September 13 and 14, 10 were recovered on September 17 and 18 for a recovery rate of 20%. If all 18 *O. mykiss* tagged in June were present in September, and recovery rates for these fish were the same as for fish tagged in September (20%), we would have expected to catch 4 of them. Although the numbers involved are relatively low to be statistically valid, this analysis suggests that most, if not all the *O. mykiss* present in June could have still been present in the lagoon in September.

Spring (June 7-8, 11-12)

Spring Site Conditions

- Lagoon open, tidal; flow at Santa Cruz gage 28 cfs on June 7 and 8 and 25 cfs on the 11th and 12th.
- Lagoon stage relatively low at lower tides, ample beach for seining between RR and WQ Stations and around Riverside Bridge (Figures 10, 11)
- Salinity 1.1-5.1 ppt at surface and 29.9-32.5 at the bottom depending on tidal stage;
- Surface temperature 13.5-18.8°C, bottom temperature 13.4-17.7;
- Surface DO ranged from 6.7 to 9.7 mg/l and bottom DO was from 4.1 to 8.8 mg/l.

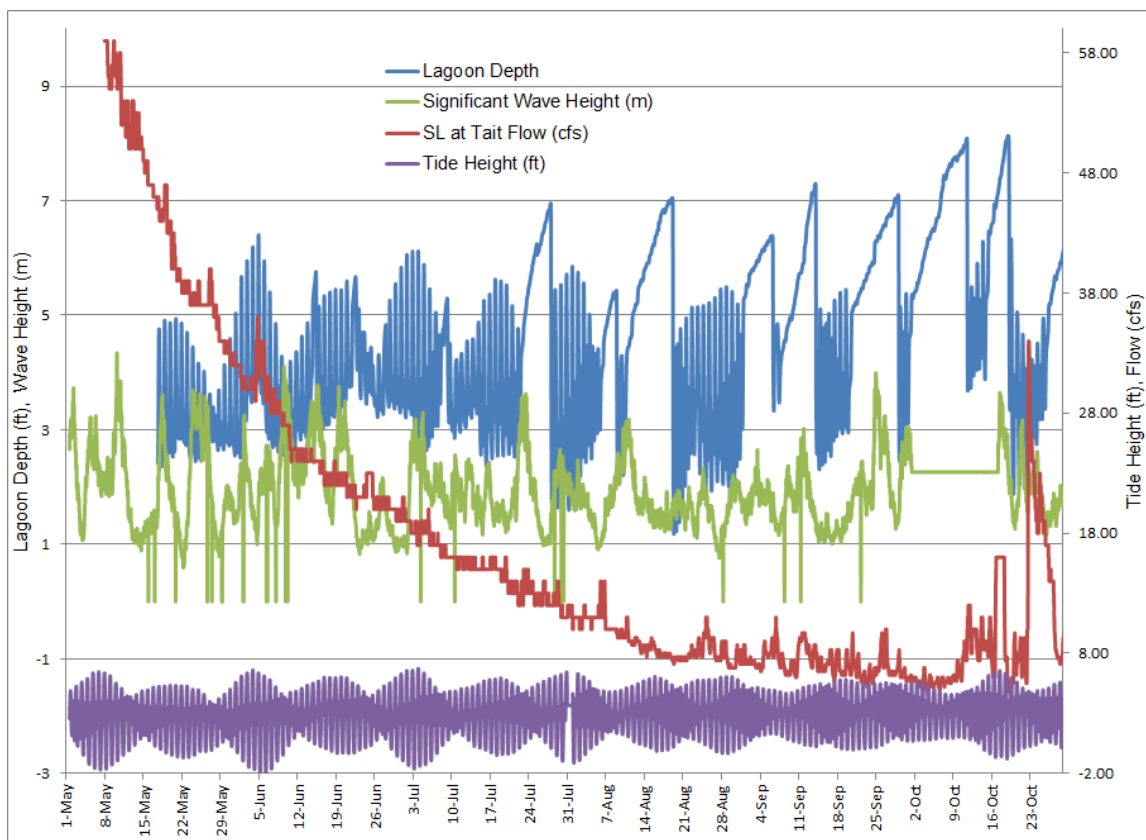


Figure 9. San Lorenzo Lagoon stage, streamflow, wave height, and tides 2012 (Source: lagoon stage from 2ND Nature, streamflow from Balance Hydrologics, wave and tide data from NOAA).



Figure 10. San Lorenzo River lagoon between trestle and water quality buoy, June 7, 2012.



Figure 11. San Lorenzo River lagoon at Riverside Bridge, June 8, 2012.

Spring Survey Results

- *O. mykiss* were captured and marked on June 7 and 8 and the lagoon was resampled on June 11 and 12. Untagged *O. mykiss* captured on June 11 and 12 were also tagged for over-summer information.
- Completed 31 hauls between the beach and the bend upstream of Riverside Bridge.
- *O. mykiss* were most abundant between the railroad bridge and the water quality monitoring site (Table 5).
- Relatively low abundance with high proportion of large fish. In previous surveys few fish were over 230 mm; in 2012 half the catch was between 230 and 510 mm (Figure 12).
- Twenty-three percent of the June catch were characterized as smolts. Most of the smolts were 160-190mm in length though a few were 240-300 mm in length (Figure 13). Twenty-one percent of the June catch were characterized as parr (70-180mm FL), 23% were silvery parr (140-400 mm FL), and 33% had the appearance of ocean or adult fish (280-509 mm FL).
- Three out of 42 *O. mykiss* examined had no adipose fin, indicating they were of hatchery origin.
- Based on analysis of scales, *O. mykiss* captured in June were a mix of mostly age 1+ and 2+ (Table 6) with a few older individuals. Scales from age 1+ fish were from individuals of 126 to 207 mm FL while scales from age 2+ fish were from individuals of 228 to 330 mm FL.
- Water quality parameters at stations where *O. mykiss* were captured included low surface salinity (2-5.1 ppt) and high bottom salinity (29.9-32.5 ppt), moderate surface temperature (13.5-18.8C), cool bottom temperature (13.4-16.2), adequate surface DO (7.1-8.0 mg/l), and low to adequate bottom DO (4.1 to 8.8 mg/l)

Table 5. Fish catch in San Lorenzo River lagoon, June 2012.

Species	Around Trestle (2)	Between Trestle and WQ site (3)	Marsh Outlet (4)	Upstream of Riverside Bridge (5)	Bend near Laurel Ave. (6)	Grand Total
<i># Hauls</i>	9	6	2	6	8	31
Pacific herring	5					5
<i>O. mykiss</i>	47	5			1	53
Topsmelt	1328	52	5		1	1386
Stickleback	1	1				2
Bay pipefish	5	2	1			8
Prickly sculpin		1		1	1	3
Irish lord	1					1
Staghorn sculpin	93	16	6	8		123
Surfperch	3					3
Shiner surfperch	33	25				58
Starry flounder	2	2	2	1		7
Crab	1	3				4
<i>O. mykiss CPUE</i>	5.2	0.8	0	0	0.1	1.7

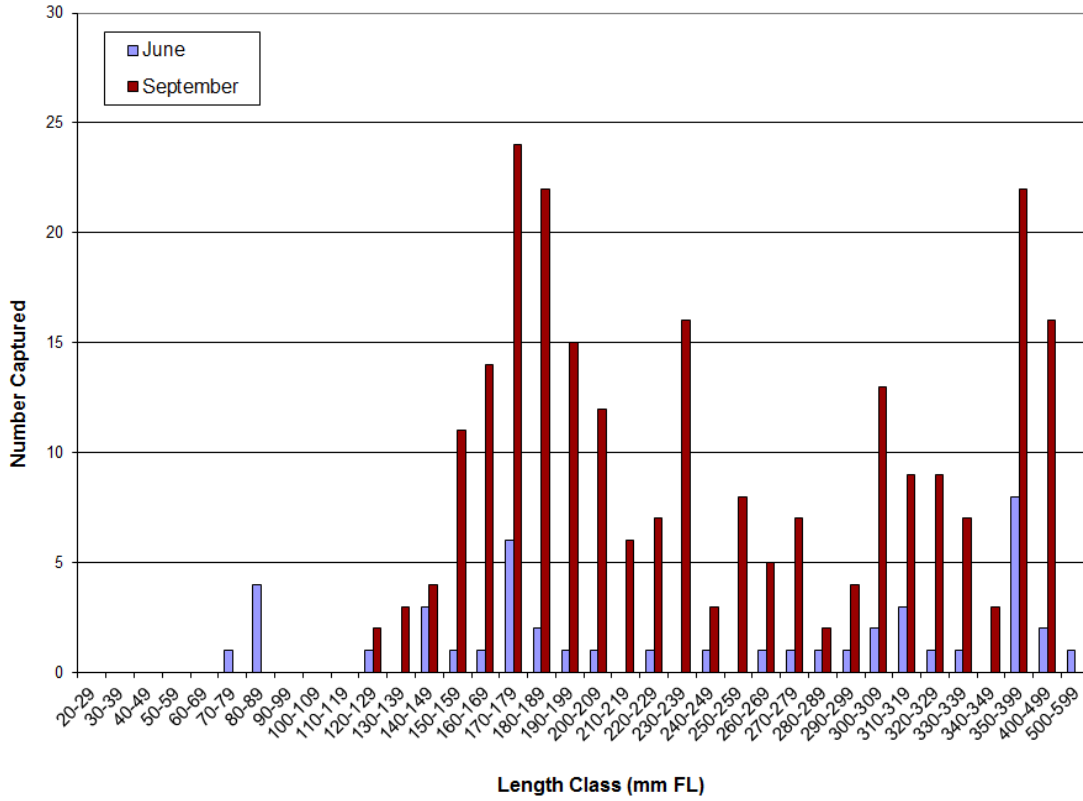


Figure 12. *O. mykiss* length classes in San Lorenzo Lagoon, 2012.

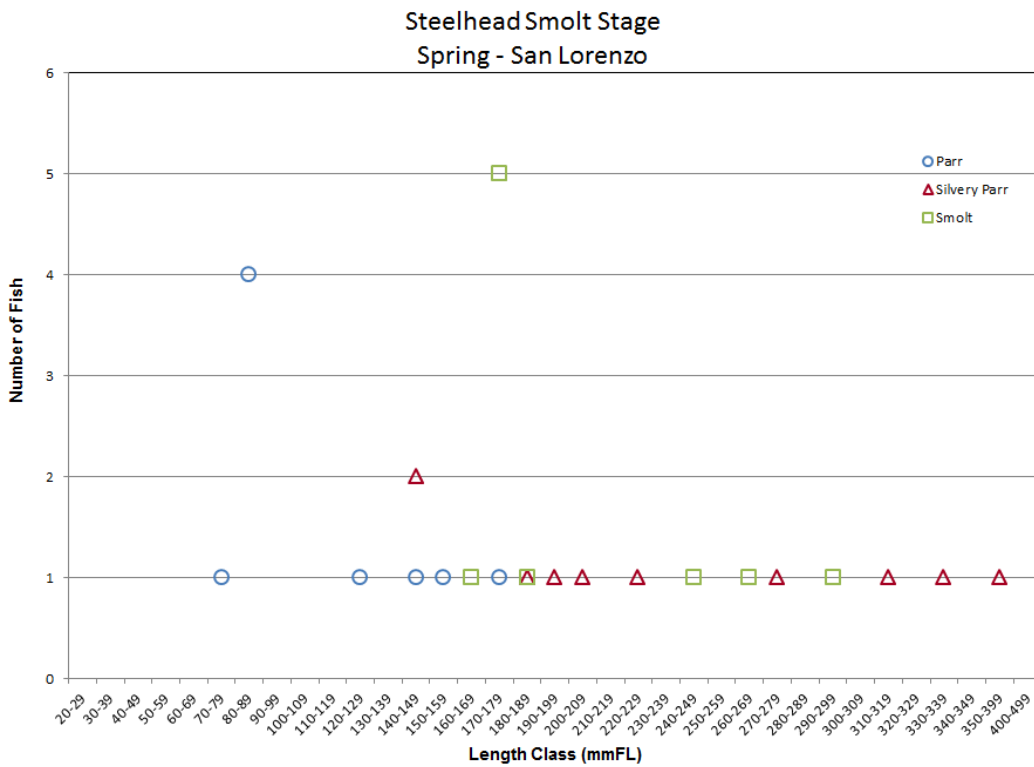


Figure 13. *O. mykiss* smolt stage by length class, San Lorenzo Lagoon, June 2012.

Table 6. Results of Age Determination of Juvenile *O. mykiss* in San Lorenzo Lagoon, June 2012
(courtesy of Michelle Leicester, CDFG).

Date	Length (mm FL)	Age	Length at Annulus 1	Length at Annulus 2	Length at Annulus 3	Adipose Fin
12-Jun	126	1+	108			Y
7-Jun	146	1+	93			Y
7-Jun	163	1+	88			Y
7-Jun	170	1+	96			Y
7-Jun	171	1+	103			Y
7-Jun	177	1+	108			Y
7-Jun	178	1+	106			Y
12-Jun	194	1+	100			Y
12-Jun	207	1+	113			Y
7-Jun	228	2+	120	188		N
7-Jun	241	2+	104	192		Y
12-Jun	277	2+	115	221		Y
7-Jun	283	2+	85	240		Y
7-Jun	312	2+	96	268		Y
7-Jun	315	2+	90	234		Y
7-Jun	316	3+	94	203	302	Y
11-Jun	330	2+	110	282		Y

Spring *O. mykiss* Population Estimate

- A total of 18 *O. mykiss* were marked with PIT tags on June 7 and 8. Eight *O. mykiss* captured during the marking period were over 320 mm FL and were not tagged since they may have been kelts. Three marked *O. mykiss* were recaptured during the marking period. There was one mortality, not marked. No *O. mykiss* were smaller than the minimum 50 mm size for marking.
- On June 11 and 12, a total of 23 *O. mykiss* were captured of which 5 had been marked on June 7-8. Five of the 23 *O. mykiss* captured were 320 mm FL or larger and were omitted from the analysis since larger fish were not tagged.
- Population estimate using the Petersen method (Ricker 1975) is 60 *O. mykiss* larger than 50mm FL in the lagoon in June. This does not include *O. mykiss* larger than 320 mm FL. The 95% confidence limits for this estimate are 28 and 116.
- *O. mykiss* appeared to be congregated at Stations 2 and 3 in June. Only one was captured upstream of Station 3 on all four sample dates (at Station 6 above Riverside Bridge).

Fall (September 13-14 and 17-18)

Fall Site Conditions

- Lagoon was closed during sampling on the 13th and water level was high. Lagoon breached the night of 13th (Figures 14, 15). Had been closed previously from August 30 to September 4, August 9-19, August 5-7, and July 22-28 (Figure 9). Breached previously on September 6. Muted tidal conditions occurred during sampling after the breach.
- Too warm to sample at Riverside on afternoon of 14th.
- During the fish census period, no samples had bottom salinity less than 31 ppt, and surface salinity ranged from 3.1 to 29.6 ppt.
- Surface temperature 16.4-20.6°C, bottom temperature 15.2-21.9°C.
- Surface DO ranged from 6.8-10.0 mg/l and bottom DO measurements were 0.7-10.7 mg/l.
- Visibility was good with bottom visible at most locations in water as deep as 2 meters.



Figure 14. San Lorenzo River Mouth, afternoon of September 13, 2012.



Figure 15. San Lorenzo River Mouth, morning of September 14, 2012.

Fall Survey Results

- *O. mykiss* were captured and marked on September 13 and 14 and the lagoon was resampled on September 17 and 18 to recapture marked fish.
- Completed 20 hauls between beach and bend upstream of Riverside Bridge.
- Too warm to sample at Riverside Bridge on September 14, delayed start downstream of YSI site due to warm temperature after breach, cooled as tide came in.
- Some tidewater goby (*Eucyclogobius newberryi*) were stranded near the boardwalk on morning of September 14 after the breach.
- Twenty adult chinook salmon (*Oncorhynchus tshawytscha*) were captured Sept 17 and 18, 15 examined for presence of adipose fin were all missing the adipose fin.
- Species diversity was relatively low compared to past years (Table 7).
- *O. mykiss* were captured at all Stations but most abundant along the steep bank between the water quality monitoring site and railroad bridge (Table 7). Fish were so abundant in one haul that a number had to be released without measuring or checking for tags.
- CPUE for *O. mykiss* higher than June, intermediate between fall 2010 and fall 2011 (Table 8).
- *O. mykiss* were large, ranging from 120 to 460 mm FL (Figure 12). One mode in the size distribution was from 120 to about 230 mm. Approximately 50% of the *O. mykiss* catch was larger than 230 mm FL. This was unusual compared to past surveys.
- Scale analysis indicates that the 120 mm to 230 mm size class present in the fall were primarily age 0+ (Table 9). These fish must have entered the lagoon after June since very few age 0+ were captured in the June survey. Scales from age 1+ *O. mykiss* were from fish of 226 to 355 mm FL although the largest had no adipose fin, indicating hatchery origin (Table 9) (this fish had a significantly greater size at first annulus compared to the other fish, consistent with hatchery origin). Some larger individuals (400 mm FL and up) were difficult to age and may have been age 2+ or 3+.
- Of 261 *O. mykiss* examined for presence of adipose fin, 15 were clipped. All except 2 of those with clipped adipose were over 320 mm FL.
- Five *O. mykiss* tagged in June were recaptured in September (one was captured twice) (Table 10). Growth rates for these fish ranged from 0.58 mm/day to 0.84 mm/day (average 0.72 mm/day) with the smallest fish growing fastest. These are good growth rates and consistent with previously measured growth rates of 0.40-0.90 mm/day measured in 2005 (2NDNATURE 2006), and growth estimates of 0.5 mm/day to 0.7 mm/day for 2011 (HES 2012).
- Two *O. mykiss* captured in September had been tagged in other studies in other watersheds. A 353 mm FL fish captured in the San Lorenzo lagoon on September 14, 2012 (982000143464607) was tagged in San Vicente Creek (near the mouth) on 9/7/2011 at a size of 112 mm FL, 16.0g. It was recaptured at the same site on 12/5/2011, at a size of 119 mm and 20.4g. The other was a 266 mm FL fish captured September 14, 2012 (2982000088071952) that was tagged on 9/26/2011 in Soquel

Creek at a site within the Soquel Demonstration State Forest. It was 83 mm FL and 7.0 g when tagged (Susan Sogard, NOAA Fisheries, personal communication, September 25, 2012). Both fish were captured in the same seine haul in the San Lorenzo River.

- All *O. mykiss* were characterized as silvery parr or ocean/adult appearance.
- There were no obvious associations of *O. mykiss* catch with any of the water quality parameters. *O. mykiss* were caught across the full range of surface salinity (3.1 ppt to 29.6 ppt). Most were captured where surface salinity was between 20 ppt and 26 ppt. Surface DO was at least 6.8 mg/l at all sample sites and ranged from 7.6 mg/l to 10.0 mg/l at Stations 2 and 3 where the majority of *O. mykiss* were captured. Maximum surface temperature was 17°C to 20.6°C with highest values recorded at Stations 2 and 3.

Table 7. Fish catch in San Lorenzo River lagoon, September 2012 (including both mark and recapture periods).

Species	West of Trestle (1)	Around Trestle (2)	Between Trestle and WQ site (3)	Upstream of Riverside Bridge (5)	Bend near Laurel Ave. (6)	Grand Total
# Hauls	1	9	4	4	2	20
<i>O. mykiss</i>	1	192	70	14	10	287
Chinook salmon	11	5	2	1	1	20
Topsmelt ^A	48	1367	410	1132	300	3257
Bay pipefish		1				1
Prickly sculpin				1		1
Staghorn sculpin		1				1
Starry flounder		2				2
<i>O. mykiss</i> CPUE	1	21.3 ^B	17.5	3.5	5	14.4

^A Estimated

^B Includes 24 *O. mykiss* released without measuring or checking for tags.

Table 8. *O. mykiss* catch per haul for the San Lorenzo River lagoon during recent sampling events (data from H.T. Harvey and Associates 2003, 2NDNATURE 2006, Ellen Freund (NOAA Fisheries), HES 2005, HES 2009, HES 2010, and HES 2011).

Station	Location	<i>O. mykiss</i> Catch per Haul					
2002						1 Oct	20 Nov
SL-2	RR Trestle						0.0
SL-3	Near YSI Site					5.5	
SL-4	Below Riverside						
SL-5	Riverside Drive						9.0
SL-7	Laurel St.						1.0
SL-8	Soquel Ave.					20.0	0.3
2004			6 July		21 Sep	29 Sep	
SL-1	Near Mouth				0.0	0.0	
SL-2	RR Trestle		24.5			0.5	
SL-3	Near YSI Site		20.0				
SL-4	Below Riverside		0.0				
SL-5	Riverside Drive		62.0		0.0	0.0	
SL-6	U/S Bank Restoration		3.0			0.0	
SL-7	Laurel St.		3.0				
SL-8	Soquel Ave.				0.0	0.0	
2005		14 Jun	14 Jul	16 Aug		5 Oct	
SL-1	Near Mouth	0.0	0.0	1.7		0.0	
SL-2	RR Trestle	28.0	5.3	179.5		0.0	
SL-5	Riverside Drive	0.0	12.3	10.7		62.7	
SL-8	Soquel Ave.	7.7	1.0	0.0		0.0	
2008		8, 19 Jun				7-8 Oct	
SL-1	Near Mouth	0				0	
SL-2	RR Trestle	9				0.25	
SL-3	Near YSI Site	0				0	
SL-5	Riverside Drive	0				0	
SL-6	U/S Bank Restoration	0				0	
SL-8	Soquel Ave.	0				0	
	Overall	2.6				0.1	
2009		10-11 Jun			16 Sep	21 Oct	
SL-2	RR Trestle	0.75			1.0	0.25	
SL-3	Near YSI Site	0.25					
SL-5	Riverside Drive	0				0	
SL-6	U/S Bank Restoration	0				1.5	
	Overall	0.3			1.0	0.5	
2010		22-23 Jun	17 Jul			Oct	
SL-1	Near Mouth	0.0				0	
SL-2	RR Trestle	11.7	0.5			31.3	
SL-3	Near YSI Site		42.5			0	
SL-5	Riverside Drive	0.0				9.0	
SL-6	U/S Bank Restoration	9.0				80.0	
	Overall	8.3	21.5			28.25	
2011		9-14 Jun				Oct	
SL-2	RR Trestle	11.7				1.7	
SL-3	Near YSI Site	7.8				5.7	
SL-4	Near Marsh Outlet	16.0				1.0	
SL-5	Riverside Drive	48.5				2.2	
SL-6	U/S Bank Restoration	0.5				0.3	
	Overall	13				2.5	

Table 8 (continued).

Station	Location	<i>O. mykiss</i> Catch per Haul				
		7-12 Jun			Sep 13-18	
2012						
SL-2	RR Trestle	5.2			21.3	
SL-3	Near YSI Site	0.8			17.5	
SL-4	Near Marsh Outlet	0				
SL-5	Riverside Drive	0			3.5	
SL-6	U/S Bank Restoration	0.1			5.0	
	Overall	1.7			14.4	

Table 9. Results of Age Determination of Juvenile *O.mykiss* in San Lorenzo Lagoon, September 2012 (courtesy of Michelle Leicester, CDFG).

Date	Length (mm FL)	Age	Length at Annulus 1	Length at Annulus 2	Length at Annulus 3	Adipose Fin
13-Sep	123	0+				Y
17-Sep	158	0+				Y
13-Sep	170	0+				Y
14-Sep	179	0+				Y
14-Sep	209	0+				Y
17-Sep	226	1+	99			Y
13-Sep	231	1+	119			Y
14-Sep	266	1+	98	142 ²		Y
13-Sep	279	1+	144 ³			Y
13-Sep	306	1+	133	159 ⁴		Y
14-Sep	353	1+/2+? ⁵	145	166		Y
14-Sep	355	1+	216			N
14-Sep	408	2+	97	217 ⁶		Y
14-Sep	432	2+/3+	82	193	279 ⁷	Y

² Transition to lagoon

³ Regenerated, spacing may be off

⁴ Transition to lagoon

⁵ Regenerated; transition to lagoon

⁶ May have gone to lagoon in winter

⁷ May be false annulus

Table 10. *O. mykiss* tagged in June and recaptured in September.

Length in June	Length in September	Growth Rate (mm/day)	Original Capture Location	Recapture location
184	259	0.77	2	2
330	-	-	3	2
241	310	0.68	2	3
277	333	0.58	2	3
178	265	0.84	2	5

Fall *O. mykiss* Population Estimate

- *O. mykiss* captured were marked on September 13 and 14 by PIT tag. Fish larger than 320mm FL were not marked. All fish captured and marked were 75 mm FL or larger.
- There were a total of 49 marked *O. mykiss* in the lagoon following the marking period, including two marked as part of another study.
- On September 17 and 18, a total of 156 *O. mykiss* less than 320mm FL were captured (51 *O. mykiss* larger than 320 mm were also captured). Ten of these fish had been marked on September 13 and 14.
- Population estimate using the Petersen method (Ricker 1975) is 714 *O. mykiss* larger than 50mm FL and smaller than 320 mm FL in the lagoon in September. The 95% confidence limits for this estimate are 404 and 1223.
- The assumption of no gains or losses from the population between the mark period and the recapture period, inherent in this analysis, may have been violated during this study. Catch per unit effort increased after the lagoon breached on the 13th and adult chinook salmon appeared in the catch on the 17th. CPUE was 3.8 on the 13th, 12.3 on the 14th, and 34.5 on the 17th.
- Population estimates for 2011 and 2012 were compared with catch-per-unit-effort (CPUE) data from the same surveys to assess validity of past CPUE data as a measure of population abundance. Surveys to date show a strong correlation between the two parameters (Figure 16).

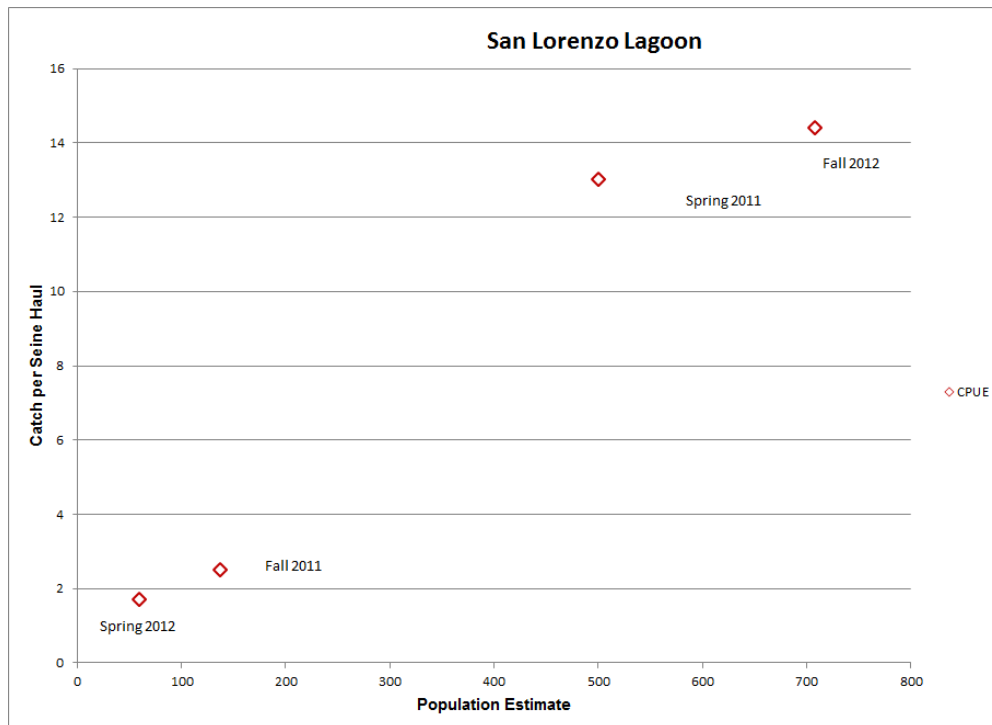
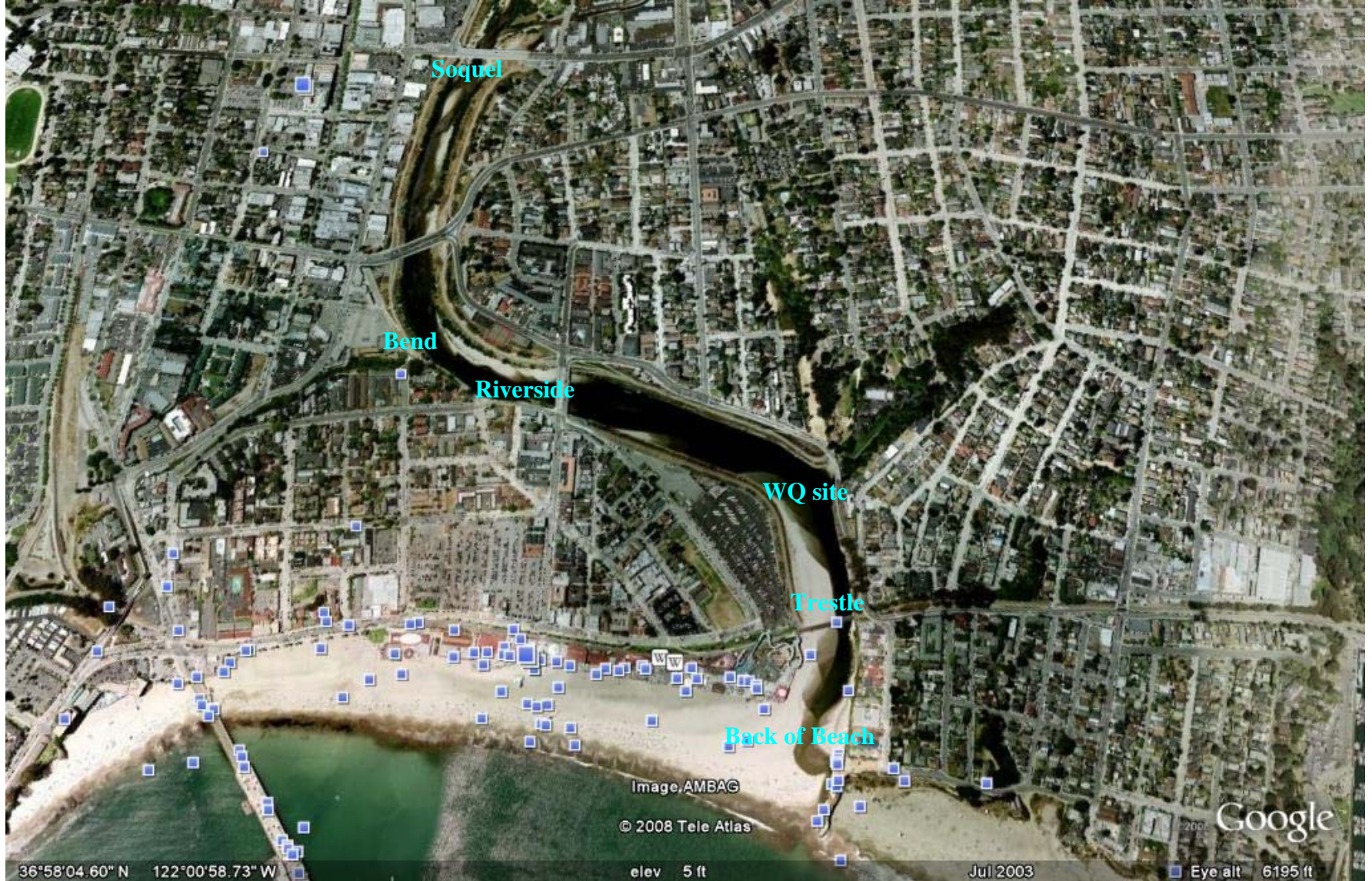


Figure 16. Relationship between *O.mykiss* population estimate and CPUE in the San Lorenzo River.



Laguna Creek Lagoon sampling stations.



San Lorenzo River lagoon sampling stations.

Literature Citations

- 2NDNATURE 2006. Comparative Lagoon Ecological Assessment Project (CLEAP) Santa Cruz County, California. Client: Santa Cruz County Resource Conservation District. Funder: California Coastal Conservancy. October 2006. Draft Final Report.
- 2NDNATURE 2012. 2011. San Lorenzo and Laguna Lagoon Annual Water Quality Progress Report, Santa Cruz, California. Final Report. Submitted to the City of Santa Cruz Water Department. May 21, 2012.
- H.T. Harvey & Associates, 2003b. San Lorenzo Lagoon Steelhead Monitoring Feasibility Study. Prepared by H.T. Harvey & Associates and Scott Cressey. Prepared for: City of Santa Cruz. February 18, 2003.
- HES. 2005. DRAFT CLEAP Fish Sampling in San Lorenzo and Laguna Creek Lagoons 2004. Prepared for: California Coastal Conservancy and Santa Cruz County. February 9, 2005.
- HES. 2009. City of Santa Cruz Habitat Conservation Plan, Lagoon Fish Population Sampling. Technical Memorandum, January 5, 2009.
- HES. 2010. City of Santa Cruz Habitat Conservation Plan, Lagoon Fish Population Sampling. Technical Memorandum, January 15, 2010.
- HES. 2011. City of Santa Cruz Habitat Conservation Plan, Lagoon Fish Population Sampling 2010. Technical Memorandum, September 30, 2011.
- HES. 2012. City of Santa Cruz Habitat Conservation Plan, Lagoon Fish Population Sampling 2011. Technical Memorandum, December 11, 2012.
- Ricker, W.E. 1975. Computation and Interpretation of Biological Statistics of fish Populations. Bulletin of the Fisheries Research Board of Canada. Bulletin 191. Department of the Environment, Fisheries and Marine Service. Ottawa, Canada 1975.