D.W. ALLEY & Associates aquatic biology

Soquel Lagoon Monitoring Report- 2011

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SOQUEL CREEK LAGOON MONITORING REPORT, 2011

ACKNOWLEDGMENTS

The Capitola Public Works Department did well in creating and maintaining the lagoon in 2011. We appreciated their efforts to maintain the sandbar during the early June rain, though it eventually had to be breached. The flume was sealed well to prevent seepage along the flume throughout the summer. We appreciated that Ed Morrison and staff again lashed floating logs together under the bridge to create fish cover. Matt Kotila, as heavy equipment operator, and Ed Morrison, as Field Supervisor, teamed to daily observe the lagoon and adjust to its needs. Every year is different, and we are grateful for their attentiveness.

Regarding the Begonia Festival, the organizers and volunteers effectively dismantled the floats and removed flowers by boat after the Begonia Festival. We thank Nels and Susan Westman again for the loan of their boat for fish censusing. The lagoon inhabitants (wildlife and humans alike) benefitted greatly from Ed Morrison's daily attention to managing the flume inlet as streamflow lessened through the summer We greatly appreciated the close monitoring of weather conditions, rainfall patterns and lagoon level by Steve Jesberg, Public Works Director, as he teamed with his staff. He was there with Morrison and Kotila for the emergency sandbar breach in early October.

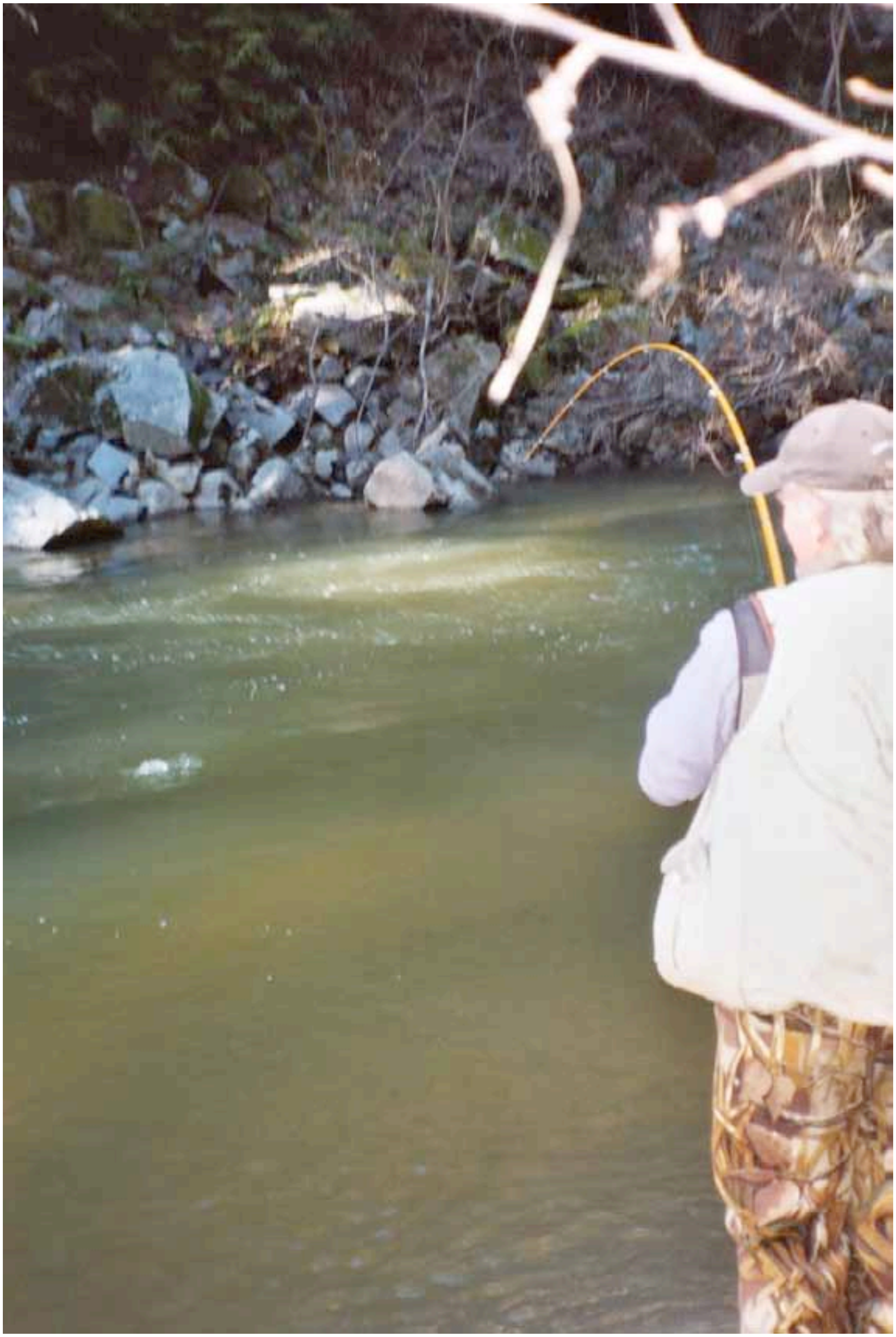
We were grateful to the volunteers who assisted in the annual fish censusing at the lagoon. There were local residents and an especially large turnout of volunteers from the Coastal Watershed Council and UCSC students under the tutelage of Walter Heady, as well as local high school students (community services credits). Biologists Inger-Marie Laurson and Josie Moss also provided their positive energies. The regulars, Chad Steiner and Walter Heady, rounded out the fish-crew. Kristen Heady brought young Quincy again this year to see his father work with the fish and ride in the boat.

Volunteers are greatly appreciated and always very welcome on typically the first two Sunday mornings in October. Seining usually ends by 1:00 pm, in time for other afternoon activities.

I am sorry to report that this was the last year for Ed Morrison as a full-time employee, though he will continue to supervise sandbar construction as a contractor. Ed and I have worked positively together for 21 years and shared many lagoon and life experiences. We are happy that he will continue to be involved with future lagoon management. We trust that Matt, Steve Jesberg and the remaining Public Works staff will continue the day to day lagoon observations to fill in for Ed while he is off hunting or fishing in some other beautiful place. Good luck, Ed!

Ed Morrison and Cary Oyama spreading a little sand during the initial sandbar closure, 2011.

Ed Morrison, guiding Matt Kotila on the bull-dozer during the second sandbar closure, 2011.



Ed Morrison, doing what he enjoys almost as much as moving sand around.

Ed Morrison, momentarily holding a prized steelhead during its spawning migration in the San Lorenzo River.

REPORT SUMMARY

Sandbar Construction. After the second wet winter following 3 previous years of below-average rainfall, sandbar construction began on 23 May, prior to Memorial Day weekend. Sandbar construction has been permitted by the California Department of Fish and Game (1600-2003-0357-3), the Army Corps of Engineers (25714-0S) and under the National Marine Sanctuary Permit MBNMS-2004-033-A1. After large spring stormflows and flooding of Capitola Village, the Creek flowed laterally across the beach at approximately 23 cubic feet per second (cfs) and emptied into the Monterey Bay at the jetty. The flume had been mostly cleared of sand the previous week. The lateral channel was seined immediately after it was blocked off to allow fish rescue. The overflow from the lagoon ran through a narrow channel cut adjacent to but not immediately alongside the flume. Cary Oyama and Ed Morrison of the Capitola Public Works Department assisted Don Alley in the fish relocation. Nearly all fish were localized in the upper lateral channel. Water quality was apparently good, with no oxygen stress evident in the captured fish. Fish captured included 49 staghorn sculpins (*Leptocottus armatus*) and 7 adult threespine sticklebacks (*Gasterosteus aculeatus*). No other fish species were detected in the lateral channel. Rescued fish were relocated to the main lagoon/ estuary. There were no mortalities. The estuary's western margin adjacent to Venetian Court was steep and did not require seining.

The estuary thalweg was not well-defined, and the estuary width was wider than the previous year, although the western margin was mostly steep. A small area near the Venetian Court wall was more flat above water line where tidal overwash had occurred earlier. The lower estuary remained wide during the construction activities. A redwood trunk with rootwad (55 feet long and 4 feet dbh) lay laterally in the channel, upstream of the trestle. It likely diverted streamflow to the western bank under the trestle along the bedrock outcrop. The biologist went upstream to look for late steelhead spawning redds that could be inundated by the lagoon. None were observed.

As required in the permit, a fisheries biologist was present during all activities that could affect the fish habitat in the lagoon/estuary during sandbar construction. This was our 21th year of monitoring and assisting in activities associated with sandbar construction at Soquel Creek Lagoon. Annual monitoring reports for the first 20 years are available at the City (**Alley 1991-2010**). As stated in the Soquel Lagoon Management and Enhancement Plan (**1990**) and 2004 Soquel Creek Lagoon Management and Enhancement Plan Update (**2004**), all instream removal of kelp, sea grass and other organic debris was to be accomplished without the use of heavy equipment in the stream channel except within 25 feet of the flume. The bulldozer/tractor could traverse the area adjacent to the flume.

The sandbar was closed hopefully for the season on 26 May. However, a late stormflow reaching 673 cfs on 4 June required emergency breaching of the sandbar to prevent flooding. The sandbar was again constructed on 20 June after the Public Works staff and the biologist raked approximately 60% of the decomposing kelp and seagrass out of the estuary. The estuary channel had been maintained near the flume since 4 June, and no fish relocations were necessary.

Sandbar Breaching. An emergency breaching that was required in the early morning of 5

October, which was early compared to the past 21 years of monitoring. By 0215 hr the water level was within 1 foot of the lower piling bolt and rising quickly, with the Soquel gage reading 37 cfs. The suspected capacity of the flume is approximately 30 cfs. Kotilla breached the surfside berm soon after with the tractor. At 0245 hr, Kotilla breached the final berm at the lagoon margin with the water level rising fast and approximately 4 inches below the lower piling bolt (Soquel gage reading of 59 cfs). The estuary continued to rise for approximately 30 minutes and peaked 2 inches above the bottom piling bolt before the swath through the beach had widened sufficiently to take the entire streamflow. Streamflow peaked at the Soquel gage at 0315 hr at 123 cfs. The estuary water surface dropped below the lower piling bolt at 0320 hr. Matt Kotila and Frank DiFalco determined that the estuary level rose maximally to within 4 inches of the top of the bulkhead along the lagoon path near the trestle.

Stream Inflow to the Lagoon. Stream inflow to the 2011 lagoon followed an above average winter rainfall amount with a significant stormflow on 24 March (6000+ cfs) that resulted in flooding of Capitola. Baseflow at the time of the first sandbar closure was approximately 25 cfs (compared to 14 cfs in 2010) and approximately 20 cfs during the second sandbar closure on 20 June (**Table 9; Figures 23 and 24**). 2011 had the third highest baseflow on 1 June for the past 21 years, with 1995 and 1996 only slightly less. By 1 September, prior to any fall rainfall, 2011streamflow had declined to 5.8 cfs at the Soquel Village USGS gage, compared to 3.4 cfs in 2010, 1.2 cfs in 2009, 0.7 cfs in 2008, 1.3 cfs in 2007 and 6.6 cfs in 2006. The 1 September 2011 baseflow was the third highest in the last 21 years. The first relatively small stormflow that peaked at about 130cfs, but exceeded the capacity of the flume, necessitated an emergency breach of the sandbar on 5 October. Only two smaller November stormflows peaking about 30 cfs occurred between then and 20 December (**Figure 25**). The sandbar has periodically closed for short periods during high tides between 5 October and 20 December at a baseflow of between 5 and 8 cfs but never remained closed through an entire tidal cycle (**Ed Morrison, personal communication**). On 27 December the sandbar was open with an estuary as deep as it was with the sandbar closed, having a gage height of 2.30.

Water Temperature. As in past years, no stratification or lagoon thermocline (with its warm, well-mixed, oxygen-rich epilimnion above the thermocline and a cool, non-circulated, oxygen-poor hypolimnion below) was detected in 2011 by the data loggers at the deep area near the trestle or at any of the 4, two-week monitoring stations (**Figures 4a-l; 6a-1 and 6a-2**). Lagoon water temperature was slightly warmer near the surface than near the bottom, as seasonal maxima and minima of temperatures and 7-day rolling averages indicated (**Table 4**). As in past years, lagoon water temperatures in 2011 closely reflected those of the stream inflow (**Figures 4a-l; 5a-b**).

The 2011 lagoon met the steelhead management goal of maintaining early morning minimum temperature below 20°C near the bottom throughout the season (**Figure 4a**). The lagoon management goal for steelhead of maintaining maximum daily water temperature below 22ºC (71.6°F) was met in 2011 when water temperature did not rise above 21°C (**Figures 4a and 4k**).

The coho management goal of maintaining maximum water temperatures below 20ºC (68ºF) near the bottom in the presence of steelhead was actually met in 2011 under the coolest conditions measured in 21 years. It was not met on 6% of the days measured (7 of 127 days) in 2010 compared to 57% of the days measured (75 of 131 days) in 2009. Coho salmon may have survived in the 2010 lagoon if present, although they prefer water temperatures below 16°C.

At the creek site near Nob Hill in 2011, the stream management goal was met for steelhead of *no more than 4 hours a day at greater than 20ºC (68ºF)* (**Figures 5a**). The Soquel Creek water temperature goal for coho salmon in stream habitat is *average weekly temperature (7-day rolling average) of16.7º C (62º F) or cooler*. In 2011 the management goal was not met 23 days (25%) in July of the 93-day lagoon period (**Figure 5a**), with it reaching a maximum of 17.3°C. In 2010 the goal was met except for 7 days (6% of the days) consisting of 3 days in early June and 4 days in mid-July (**Figure 5c**). Coho salmon may have survived in the 2010 and 2011 stream habitat near the lagoon if present. However, in all other past monitoring years, considerably more stream shading and streamflow would be required to make lower Soquel Creek habitable for this species.

Lagoon water temperatures in 2010 and 2011 were the coolest in the past 21 years of monitoring. The cooler water temperatures were consistent with cooler air temperatures consistently measured during two week monitorings (**Figure 3f**). In 2011, water temperatures near the lagoon bottom in the morning were rated "good" at all stations throughout the lagoon season except under the railroad trestle on 1 October, where it was rated poor. The warmest afternoon water temperatures recorded near the bottom at the monitoring stations during two-week monitoring was 19.5°C in late July.

As in most years when no saline layer develops later in the summer from tidal overwash, water temperature at dawn within 0.25 m of the bottom of the lagoon became warmer as the monitoring stations progressed down the lagoon from Noble Gulch to the flume (**Figure 3g**). With cooler water emptying in from Noble Gulch, Station 4 was always cooler than the other 3 stations. Water temperature of the stream inflow was cooler in the morning than the lagoon, with fluctuations in lagoon inflow temperature mirrored in early-morning lagoon temperatures (**Figure 3g**). The correspondence between inflow fluctuations and lagoon temperature fluctuations indicated that the inflow temperature influenced the lagoon temperature in 2011 as in previous years. Stream inflow temperatures were typically 1-3° C cooler in the morning than lagoon water temperature at the 3 lower lagoon stations.

In analyzing temperature data from the 6 continuous data loggers throughout the water column just downstream of the railroad trestle, results were consistent with temperature data collected at 2-week intervals through the water column at monitoring stations over the past 21 years. Daily temperature *minima* in the lagoon were consistently warmer near the bottom than the stream inflow in 1999-2011 (**Table 4**). In 2011, the 7-day rolling average temperature was 1.3 – 1.5° C cooler in the stream than near the lagoon bottom near the trestle, as substantiated by seasonal minima (15.4° C vs. 16.2°C) and maxima (17.3° C vs. 18.2°C) (**Table 4**). The average 7-day rolling average of 16.4°C in the stream was 0.8°C less than 17.2°C at 0.5 feet from the lagoon bottom. Stream inflow temperature in 2011 was generally about 1°C cooler than near the lagoon bottom in the morning and afternoon, with much reduced daily fluctuation in both the stream and the lagoon in September and October (**Figures 4a and 5a**). The difference in the 7-day rolling averages was also approximately 1°Cbetween the stream inflow and the lagoon near the bottom. We see from comparisons of 7-day rolling averages for 2011 and 2010 near the bottom that it fluctuated less in 2011 and was similar between years until late August and September when it was usually approximately 1°C cooler in 2011. The lagoon in both years was much cooler than in 2009, however. The 2011 lagoon's rolling average near the bottom was 2-4°C cooler than in 2009 and 2-3°C cooler near the surface for all but the latter half of September when 2011 was 1°C cooler, consistent with cooler inflow temperatures (**Figures 4a, 4k, 4m-p; 5a-b**).

Aquatic Vegetation. There was less bottom algae by itself in the 2011 lagoon compared to previous years, likely due to the late date of the second sandbar closure and the cool water temperatures that slowed metabolic activities and was a result of overcast with less sun to stimulate photosynthesis. Bottom algae thickness in the 2011 lagoon was less than in 2010 or 2009. In 2011, bottom algae thickness at in Reaches 1−3 and at the mouth of Noble Gulch averaged 0.6 ft, 0.6 ft, 0.3 ft and 1.1 ft, respectively (**Table 5**). This was compared to 2010 averages of 0.8 ft, 0.8 ft, 0.8 ft and 2.2 ft, respectively, and 2009 averages of 1.7 ft, 1.2 ft, 0.9 ft and 1.4 ft, respectively (**Tables 6 and 7**). Filamentous algae was first noted in late July compared to mid-June in 2010 and 2009. Pondweed was not detected until early September 2011 and was not very prominent, it reaching 5% of the lagoon bottom coverage in Reach 2 in mid-September and 1 October.

Evidence of nutrient inputs from Noble Gulch was expressed its the mouth in the lagoon by sporadic high amounts of surface algae and relatively thick bottom algae in 2011 as occurred in 2009 and 2010, as well as the thick, persistent plankton bloom in 2011. Very turbid gray/brown water oozed from the mouth on 4 of 7 two week monitorings at levels exceeding many past years.

Oxygen Levels. In 2011, oxygen levels for steelhead were "good" (greater than 7 mg/l at dawn) *near the bottom at dawn* at all stations during the 7 two-week monitorings and on Begonia Festival Day except a "poor" rating at Station 3 (Railroad trestle) on 1 October (**Tables 2 and 3, Figure 6a-1 and Appendix A**).

Generally, oxygen levels were higher in the afternoon than morning in 2011 as in most years. However, in 2011 with its reduced algal production, oxygen levels were less in the afternoon in early July at Station 1 and late July at Station 2 and nearly same at Station 2 in late August (**Figures 6b-6e**).

Salinity Monitoring. In 2011, saline conditions were only detected a short time after the first sandbar closure (31 May) in the deeper lagoon area along the wall at Venetian Court (**Appendix A**). This resulted from a small amount of saltwater being trapped in the lagoon at the time of sandbar closure on 27 May. Shrouds were not installed on the sandbar inlet at that time because it was assumed that the high stream inflow would soon force the saltwater out through the sandbar. On 10 July Public Works staff observed tidal overwash and installed the flume inlet shrouds to evacuate the saltwater. By the next two-week monitoring time, no saltwater remained. It was hypothesized that beachgoers had breached the berm around the lagoon near Venetian Courts to drain a surface pool of ocean water after the high tidal event, thus introducing saline water to the lagoon.

Begonia Festival Observations and Water Quality Findings. The City's fishery biologist (Donald Alley) was present before, during and after the Begonia Festival parade in 2011. The day of the parade, 4 September, was initially cool and overcast until 1400 hr, after which it was sunny, though cool, for the remainder of the day. Water temperatures were cooler in the morning than 2 weeks previous, and oxygen levels were similar and in the "good" range. The lagoon depth was maintained at an excellent gage height of 2.51 ft during the nautical parade. There were 6 floats in the parade and 20other boats (mostly kayaks) and 6 standing surfboarders in the water. In conformance with the permit requirements from the California Department of Fish and Game, no floats were set up to be propelled by waders. Means of propulsion included electric motor with paddlers on board and by kayaks with draw ropes. Thus, the lagoon bottom was undisturbed. Conductivity near the bottom increased very slightly at the Stockton Avenue Bridge from 634 before to 650 umhos after the parade. Conductivity at the mouth of Noble Gulch was 624 umhos near the bottom before the procession and 641 afterwards (**Appendix A**). The measured levels of conductivity were not stressful to steelhead. There was no odor of hydrogen sulfide, and no fish mortality was observed. Begonia petals were cleaned up the following week and no evidence was detected of oxygen depletion that may be caused by decomposing flowers.

Fish Sampling. Our steelhead population estimate based on mark and recapture for fall 2011was 678 compared to 1,174 in 2010 (**Table 10**) (methods in **Ricker 1971**). This was the 7th lowest estimate and below our 19-year average of 1,667 juveniles. Four especially productive years inflated the average. The other species captured in fall 2011 were threespine sticklebacks and staghorn sculpins. No tidewater gobies were captured. The 2011 lagoon population size was small likely because young-of-the-year (YOY) steelhead numbers were low throughout the watershed (**Alley 2012**) and ample stormflows were available to spawning adults to migrate high into the watershed to spawn , away from the lagoon. The large stormflow on 24 March (6,000+ cfs) likely destroyed steelhead nests and washed recently emerged YOY out of the drainage, thus providing few YOY afterwards to filter into the lagoon to rear.

Though we do not have a 2011 steelhead population estimate for the entire Soquel Creek watershed, the lagoon population of larger smolt-sized fish was likely a significant percent of the total watershed population, based on data from years when watershed estimates were possible. Thus, the lagoon provides valuable steelhead nursery habitat through proper management.

Pollution Sources. The lagoon near the beach was closed to human contact due to bacterial levels above the maximum acceptable level. The gulls are a primary source of pollution, both for bio-stimulating nutrients and bacteria. They forage through the human refuge left on the beach. They bathe and defecate in the lagoon. They roost and defecate on the buildings surrounding the lagoon. Reducing the gull population at Soquel Creek Lagoon would be a major step in reducing pollution. The use of gull sweeps has been observed to be successful in other locales to prevent gull roosting. The parallel wires strung across the roof of the Paradise Grill have been effective in discouraging roosting on that restaurant. All of the refuse cans on the beach were equipped with gull-proof lids since 2006 (**Ed Morrison, pers. comm.**). The City had received funding to deter gull use on restaurant roofs, to redirect restaurant gutter systems away from the lagoon and to provide waste cans with gull-proof lids. However, attempts at partnership between the City and Esplanade restaurants for adding gull deterrents to their roofs has, thus far, been unsuccessful. However, conditions of future remodeling will require addition of roof deterrents (**Steve Jesberg, Public Works Director, pers. comm.**). Rock doves (pigeons) are another source of bird pollution as they circulate between the wharf and the railroad trestle over Soquel Creek Lagoon. As stated in the original Management Plan, the trestle could be screened to eliminate pigeon roosting areas.

Regarding pollution from urban runoff, installation and maintenance of silt and grease traps on storm drains is critical to reducing pollution by petro-chemicals. All new drainage systems from new development and parking lots should be installed with effective traps and percolation basins to encourage winter percolation of storm runoff. The City redirected dry-weather runoff to the constructed wetland on the west side of the Stockton Avenue Bridge (just upstream) from the drain on the east side of Stockton Avenue Bridge (just upstream) and the drains at the pier and Venetian Court. Water quality measurements taken at the outlet of the wetland in 2010 indicated only slight differences compared to those taken at the Stockton Bridge, with no impact to steelhead habitat conditions (**Appendix A**). In 2010, water temperatures were slightly cooler at the wetland outlet, while oxygen levels at dawn were slightly higher on 3 of 6 monitorings and slightly lower on 3. After conversations with Bruce Arthur regarding construction of the wetland and the amount of water being pumped into it compared to the amount leaving the outlet pipe, it appeared that significant leakage was occurring under the wetland.

Ideally, all storm drains leading to the lagoon should be re-directed away from the lagoon in summer. Included in these is the culvert that drains Noble Gulch. Significant quantities of gray water and oily slicks have consistently emptied into the lagoon from Noble Gulch until 2001, and again in 2005 and 2006 (**Alley 1995; 1996b; 1997-2000; 2005; 2006**). There was improvement noted in 2008 with no gray water observations and in 2007 with only one instance. By comparison, these plumes were observed on 8 of 12, two-week monitorings in 2006. This improvement may have resulted from replacement of sewage pipes along Riverview Road in the vicinity of Noble Gulch in fall of 2006. Conditions deteriorated in 2010 and 2011, however. In 2010, gray water was observed at Noble Gulch on 3 of 10 two-week monitorings and in 2011 at 4 of 7 monitorings. High levels of surface and bottom algae were observed near the Gulch mouth than elsewhere in both years, and surface algae was commonly higher downstream of Noble Gulch than upstream (**Tables 5 and 6**). Therefore, Noble Gulch continues to be a pollution source to the summer lagoon.

There has been a pollution problem and high flashiness in streamflow in the past during the first small storms of the fall. At times, the lagoon required breaching prematurely because the flume could not accept all of the stormflow, and flooding was imminent. Retrofitting of storm drainage systems with holding tanks or percolation basins could reduce the sudden increase in street runoff and pollution during early storms. Drains leading from Wharf Road (across the Rispin property), the Auto Plaza and 41st Avenue businesses north of Highway 1 are some of the sources of this problem.

New and Continuing Recommendations and Those Not Yet Fully Implemented

1. Continue to repair the cracked flume. Its integrity is jeopardized, and the beach sinkholes created by flume underflow are a safety hazard.

2. Make sure the flume is completely open to the Bay before the work-day has ended during all sandbar construction activities. This includes during sandbar re-construction activities late in the smolt out-migration period. Do not use manhole cover spacers to flush sand out of the flume during darkness when the entire outflow from the lagoon must exit through the flume and there is a chance that smolts are still exiting.

3. If stranded fish are detected as a result of sandbar closure or flume clearing, alert the monitoring biologist to discuss the appropriate relocation method for fish, and have the biologist capture and relocate the fish with assistance from Public Works staff. The biologist should be present during all sandbar closure and flume clearing activities when fish may be present (not when the flume is being cleared the week prior to sandbar construction and streamflow is still flowing through the beach). However, if fish become stranded due to unforeseen circumstances unassociated with sandbar closure/ flume clearing and insufficient time is available for the biologist to reach the site, as occurred on 21 June 2011, Public works staff should consult with the biologist prior to any response. Then Morrison and Oyama of the Public Works staff should capture and relocate the fish with available dip nets or seine and buckets filled with fresh estuary/ lagoon water, after consultation with the biologist, because of their experience in handling fish. (Other public works staff should be given experience in relocating fish from the lateral channel in the future or during fall sampling so that they may fill in if Morrison or Oyama are unavailable.) If the biologist is unavailable during emergency cases, relocate fish to the main body of the estuary or lagoon near the pilings and boulders adjacent to the restaurants, where cover and good water depth are available.

4. Closing the sandbar in late May is better than mid-June or later because streamflow is sufficient to rapidly fill the lagoon in most years, and the juvenile steelhead most likely to be present in the lagoon in May are out-migrating smolts. Late May is prior to down-migration of most YOY steelhead from spawning sites above the lagoon. Small steelhead fry remain in the vicinity of spawning sites before moving down into the lagoon. Down-migrant trapping on the nearby San Lorenzo River in 1987 and 1988 by Don Alley and Stafford Lehr (now with CDFG) indicated that a few YOY steelhead were down-migrating in May, but the number greatly increased in June.

5. The management solution for minimizing the time required for sandbar construction is for the City to remain flexible on timing of the work. If rain is in the forecast within two days after the intended starting date for sandbar construction, Public Works should postpone construction until clear weather is forecasted. If 4-5 working days are set aside to construct the sandbar, the sandbar construction may be delayed as late as 4-5 days before the Memorial Day weekend and may still satisfy the tradition of lagoon formation before then.

6. Continue to rake as much kelp and sea grass out of the lagoon as possible before final closure, from the Stockton Avenue Bridge downstream, including plant material trapped under the restaurants and in depressions around the bridge piers. Discontinue raking if juvenile steelhead are observed near the water surface. It is best to minimize time required to stockpile sand, rake out the decomposing organic material and prepare the flume inlet for fish passage. This will minimize the number of instances of artificial fluctuation of lagoon water level. Sufficient City staff should be assigned to be ready to enter the estuary at the earliest opportunity each day and quickly rake out decomposing kelp and to clear the sand-filled flume.

7. Dispose of kelp in the Bay rather than bury it in the sandbar. Disperse it up and down the beach. Continue to include this in the Fish and Game permit for sandbar construction. County Environmental Health approved of this method so long as kelp is spread over a

wide area (**J. Ricker, personal communication cited in the original 1990 Soquel Creek Lagoon Management and Enhancement Plan**).

8. To provide cover for juvenile fishes, continue to leave any large woody material deposited in the lagoon from winter storms. Allow a clear path from under the bridge to the beach at Venetian Courts to enable seining for juvenile steelhead during fall censusing.

9. Annually evaluate the structural integrity of the flume and its supports. Continue to repair cracks and supports as necessary. This will prevent sinkholes from forming and reduce water leaking from the lagoon along the flume.

10. Repair the flume at a time that does not obstruct fish passage or require lowering of the lagoon water level.

11. During sandbar construction, continue to close the lagoon each day before the incoming tide can wash salt water and kelp into the lagoon. Re-open the sandbar and unplug the flume, if necessary, each morning to facilitate kelp and sea grass removal.

12. Continue to search under the Stockton Avenue Bridge and in Reaches 2 and 3 for stranded fish to rescue as the lagoon drains each day during raking. It is best to minimize the number of days to construct the sandbar and rake out the decomposing organic material. This will minimize the artificial fluctuation of lagoon water level. Having a maximum number of personnel to rake decomposing organic material into the bay and to clear the flume of sand will minimize the days needed to prepare the lagoon for the summer.

13. Take special care to pack sand under the flume, between the pilings, during final sandbar closure in order to prevent seepage under the flume after closure.

14. Maintain an underwater portal in the flume intake for out-migration of adult steelhead until June 15, while maintaining a notched top plank for out-migration of smolts until 1 July. However, in dry years such as 2007−2009, when stream inflow is insufficient to fill an underwater portal and allow lagoon filling, opt for a larger notch in the upper boards to accommodate adult kelts and smolts instead of a deeper underwater portal for kelts.

15. Maintain the 1-foot high baffle inside the flume until July 1 for safe entrance of out-migrating steelhead smolts into the flume inlet before they enter the Monterey Bay.

16. Continue to cover the visquine around the flume inlet with manually shoveled sand instead of tractor shoveled sand. This will prevent the tractor from displacing the visquine. Clear visquine is preferable to black. Key the visquine into the lagoon margin to encourage its retention when the sandbar breaches in the fall.

17. Retrieve visquine from around the flume inlet before or immediately after the fall sandbar breach, if possible.

18. Require that Margaritaville staff not wash the patio and adjacent walkway (containing refuse dumpsters) off into the lagoon.

19. Seek volunteers to re-establish tules in the alcoves under the railroad trestle, near the Golino property and beside Margaritaville.

20. During sandbar construction, continue to lash floating logs together under the bridge to create fish cover if they are present and time allows.

21. Restrict the number/weight of float participants allowed to ride on the floats to a safe level.

22. Continue to disallow wading to propel floats during the Begonia Festival's parade.

23. Recommend to the Begonia Festival organizers that floats be safely maneuvered downstream of Stockton Avenue, with a water marshal present to direct floats around buoys in a circular direction along the periphery of the lagoon after they clear the bridge.

24. Support the ban on alcohol consumption by float participants and rowdy behavior on their floats.

25. Continue to use wedges or plywood on the flume inlet boards to prevent their dislodgment from vandals and back-flushing from the tide, especially in the fall when the beach becomes eroded.

26. If sufficient turbidity occurs after the first small storms of the season to prevent light from penetrating to the bottom of the intact lagoon for more than one day, continue to reduce lagoon depth temporarily to insure that light reaches the bottom. This will prevent death of aquatic vegetation and increased biological oxygen demand, with the associated loss of oxygen production that would have occurred from photosynthesis. Thus, anoxic conditions will be prevented. When the lagoon clears up, re-establish the maximum lagoon depth.

27. If the sandbar is in place after November 15, maintain an opening in the flume inlet to allow early spawning adults to pass through the flume from the bay during early storms.

28. Continue to use gull-proof lids on refuse cans on the beach and around the lagoon. Use enough refuse containers to satisfy the demand for refuse disposal.

29. Look into installing gull sweeps on restaurant roofs. The stringing of wire above roofs as observed over the Paradise Grill Restaurant should continue and be expanded to other restaurants to successfully prevent gull roosting there.

30. Look into screening the railroad trestle to discourage roosting and nesting by rock doves.

31. As stated in previous reports, if the streamflow in Soquel Creek in the vicinity of Soquel Village approaches the point of losing surface flow, notify Tiedemann Nursery and the Fish and Game Department so that direct water pumping from the stream may be reduced or discontinued until flow returns. Loss of surface flow should be prevented.

32. Continue to retain large woody material in the lagoon for fish cover.

33. During daily artificial breaching during sandbar construction, continue to maintain water depth in the estuary such that no isolated pools and backwaters form at the margins to strand fish. Blocking of the sandbar may be required to maintain sufficient depth. Check the estuary margins to prevent stranding of fish.

34. As stated in the Management Plan (**1990**), make sure that parking lots and streets draining into the lagoon are cleaned before the rainy season. This will reduce the pollutants entering the lagoon during the first storm of the season that are lethal to fish. Street sweepers with water and suction may be necessary. In addition, roadwork such as repaving and application of fresh petrochemicals should be done in the early summer to allow sufficient time for penetration and drying before the rainy season.

35. Notch the sandbar diagonally across the beach (instead of straight out along the flume as before) to minimize the gradient of the notch, to slow the evacuation of water through the beach and too minimize beach erosion *in order to maximize the residual estuary depth after the emergency breach.*

36. The notch in the sandbar should be cut slightly lower than the piling bolt. *Continue to* m*ake the notch at least 30 feet wide across the beach to also maximize the possibility of maintaining an estuary with some depth after the breach.* The City may have to periodically re-establish the notch if it does not rain or high tides obliterate it. If a storm is predicted, the sandbar needs a notch as preparation. Continue to maintain an outer berm near the surf and an inner berm near the lagoon margin with the wide notch in between.

37. Just as the first storm of the fall season begins, remove boards from each side of the flume if a small storm is anticipated. The number of boards removed will be dictated by the anticipated size of the storm. Remove two boards from either side if a large storm is anticipated. Clear the exit to the flume by removing the plate from one side of the exit. After the stormflow subsides, replace the cover until the next storm.

38. As stated in the 1993 monitoring report, management options to delay sandbar breaching include installation of a perimeter fence around the flume inlet to collect algae. Replace the boards after the stormflow subsides, removing them for each succeeding storm until the sandbar is eventually breached during later, larger storms usually occurring after Thanksgiving. There is now a grated opening on top of the flume inlet.

39. After the first storm of the season with the sandbar still intact, lower the lagoon level to a point where light may penetrate to the lagoon bottom. In doing so, the plant life in the lagoon may continue to photosynthesize and is kept viable. Thus, vegetation mortality and stressfully low oxygen levels are prevented until the water clarity is re-established. Re-install boards to increase lagoon depth after the lagoon clears up.

40. Continue to notify the California Department of Fish and Game 12 hours before the possibility of a sandbar breach and immediately after the breach occurs.

41. If the sandbar breaches early in the rainy season, followed by a period of 2-4 weeks of a reformed sandbar that prevents water exchange with the ocean, attempt to pull the

decomposing kelp out of the stagnating lagoon. Open the flume and encourage streamflow out with the shroud installed.

42. If a stagnant, kelp-filled lagoon forms in fall after an early breach and a dry period, do not empty the lagoon by breaching the sandbar. Instead, use the flume and shrouds to pull salt water out. Breaching of the lagoon will increase the opportunity for more kelp to enter and probably will not empty the entire lagoon anyway. Fish passage need not be maintained through the flume because it should be discouraged until sufficient stormflows develop to provide passage up the Creek. If adult salmonids enter too early, they will become stranded and unable to migrate upstream because of insufficient streamflow.

43. The City should encourage and influence planners, architects and property owners through the permit process to maximize water percolation and to filter out and collect surface runoff pollutants from new and existing development in the City and upstream.

44. The City should request from the flood control district that sediment and grease traps be installed, inspected and cleaned on drains leading into lower Soquel Creek.

45. The City should continue to fund activities to remove Arundo from lagoon-side residences and other non-native plants in the riparian corridor between Highway 1 and the lagoon.

46. Continue to census the juvenile steelhead in the fall to monitor the use of the lagoon as an important nursery area under varying management scenarios and restoration efforts.

LAGOON AND ESTUARY FORMATION

Results of Fish Seining Prior to Construction Activities

23 May 2011. The Creek flowed laterally across the beach at approximately 27 cubic feet per second (cfs) and emptied into the Monterey Bay at the jetty. The flume had been mostly cleared of sand the previous week. The lateral channel was seined immediately after it was blocked off at 0755 hr. The channel was blocked off to allow fish rescue. The overflow from the lagoon ran through a narrow channel cut adjacent to but not immediately alongside the flume. Sixteen seine hauls were made in the lateral channel from 0800 to 1005 hr with a beach seine that was 30 ft x 4 feet with 1/8-inch mesh. No steelhead (*Oncorhynchus mykiss*) or tidewater goby (*Eucyclogobius newberryi*) were captured in the lateral channel, and no fish were captured on the last two seine hauls. The lateral channel was mostly free of kelp and seagrass, allowing effective seine hauling. The lateral channel was wide (approximately 25 feet wide) and flat downstream to a large redwood stump that had washed out of the estuary. It had been in the summer lagoon for several years before washing out. The stump created a hydraulic control, and the gradient of the lateral channel increased downstream of it. Cary Oyama, Ed Morrison of the Capitola Public Works Department assisted Don Alley in the fish relocation. All fish were localized in the upper lateral channel, above the redwood stump. Water quality was apparently good, with no oxygen stress evident in the captured fish. Fish captured included 49 staghorn sculpins (*Leptocottus armatus*) and 7 adult threespine sticklebacks (*Gasterosteus aculeatus*). No other fish species were detected in the lateral channel. Rescued fish were relocated to the main lagoon/ estuary. There were no mortalities. The estuary's western margin adjacent to Venetian Court was steep and did not require seining.

As required in the permit, a fisheries biologist was present during all activities that could affect the fish habitat in the lagoon/estuary during sandbar construction. This was our 21st year of monitoring and assisting in activities associated with sandbar construction at Soquel Creek Lagoon. Annual monitoring reports for the first 20 years are available at the City (**Alley 1991-2010**). As stated in the Soquel Lagoon Management and Enhancement Plan (**1990**) and 2004 Soquel Creek Lagoon Management and Enhancement Plan Update (**2004**), all instream removal of kelp, sea grass and other organic debris was to be accomplished without the use of heavy equipment in the stream channel except within 25 feet of the flume. The bulldozer/tractor could traverse the area adjacent to the flume.

Monitoring of Flume Maintenance and Sandbar Construction

Sandbar construction was initially done prior to and after Memorial Day weekend. The winter storms had been above median, and streamflow had declined steadily to 26 cfs on 24 May. Rain had been light in April and May, allowing considerable sand to build up on the beach. Kelp and seagrass were localized in the lower estuary, adjacent to the Esplanade restaurants. Therefore, raking was focused on the lower lagoon within approximately 50 meters of the flume inlet, initially. Then isolated clumps of decomposing material were raked from further upstream to near the Stockton Bridge. No raking occurred upstream of the Stockton Bridge. Like in most years, the thalweg of the lower lagoon below Stockton Bridge was on the east side (Esplanade side) near the restaurants. Low tide during the period prior to Memorial Day came in mid- to late morning, allowing considerable time of raking and later sandbar closures before saltwater influx might occur. Approximately 90% of the plant material was removed from Reach 1 below Stockton Avenue Bridge. One large redwood root mass remained in Reach 1, adjacent to the Esplanade restaurants. A 55-foot redwood trunk with rootwad was present upstream of the railroad trestle.

23 May 2011. The fishery biologist arrived at 0615 hr. Sand grading on the beach began this day. As in most years, Soquel Creek was flowing out to the Monterey Bay in a channel that laterally crossed the beach to the eastern jetty. The flume had been mostly cleared of sand the previous week by Public Works staff, with adequate screening of the intake hose for water pumped into the flume. On 23 May, a narrow channel was cut through the beach adjacent to the flume, but not immediately alongside, to bypass flow after the lateral channel was blocked off for fish rescue. The sand from the auxiliary channel was used to block off the lateral channel. The fish removal from the lateral channel began at approximately 0800 hr (when the lateral channel was blocked off) and ended at approximately 1005 hr. The lateral channel became pool-like upstream of the redwood stump in the lateral channel and continued to flow past the redwood stump until after the fish rescue was completed. Fish were relocated to the main estuary/lagoon. Flume boards on the eastern restaurant side of the flume inlet were removed except for the lowermost one. The estuary was drawn down approximately 2 feet during the day's activities. The estuary thalweg was not well-defined, and the estuary width was wider than the previous year, although the western margin was mostly steep. A small area near the Venetian Court wall was more flat above water line where tidal overwash had occurred earlier. The lower estuary remained wide during the construction activities. The biologist walked upstream from 1030 to 1130 hr, looking for any fish stranded in side pools No side pools were present and no fish were observed. The channel ranged from 30 to 100 feet width, averaging 50−60 feet. Three mergansers were observed. A redwood trunk with rootwad (55 feet long and 4 feet dbh) lay laterally in the channel, upstream of the trestle. It likely diverted streamflow to the western bank under the trestle along the bedrock outcrop. The biologist went upstream to look for late steelhead spawning redds that could be inundated by the lagoon. None were observed. At approximately 1200 hr, all boards in the wide portion of one side of the flume outlet. The biologist observed a western pond turtle was observed around submerged rip-rap next to the restaurants at 1345 hr. The auxiliary channel was closed with a berm at 1355 hr before the incoming tide. Some sand was packed around the flume inlet because it had been undercut during winter stormflows. No raking occurred this day. The lateral channel was covered over after the fish relocation was completed. All tractor work was performed above the tidal action.

24 May 2011. The biologist arrived at 0630 hr. The equipment operator was stockpiling sand on the beach and adding sand over the former lateral channel. The lagoon had filled to within 3 inches of the top of the flume. Flow was passing out the flume outlet, insuring smolt access to the Monterey Bay. The sandbar was opened at 0730 hr. Seven public works staff and the biologist raked kelp/sea grass for approximately 3 hours (0835 – 1145 hr) adjacent to the Esplanade restaurants until the tide changed. The biologist walked upstream (0935−1030 hr). No fish or piscivorous birds were observed. Water depth along the bedrock in Reach 2 was 4 feet deep with the estuary drawn down, offering adequate depth for any fish present. Morrison observed the western pond turtle again this morning adjacent to the restaurants. The biologist and others observed an adult steelhead adjacent to the restaurants at 1220 hr after raking was completed.

Kotila dammed off the auxiliary channel at 1350 hr. Morrison and Kotila observed considerable leakage from the flume in the downstream 1/3 of the flume where layers of the flume exterior had become eroded away through the years.

25 May 2011. The fishery biologist arrived at 0635 hr. Flow was passing out the auxiliary channel. According to Kotila (equipment operator), the estuary had partially filled overnight before the berm had eroded away from underflow beneath the flume. The seal around the flume inlet had failed, and considerable sand was lost when the auxiliary channel opened. Fish access through the flume occurred through the night. Then the estuary flowed out through the auxiliary channel sometime prior to Kotila's arrivial. Sand had partially filled the flume outlet by 0635 hr. Seven staff and the biologist raked kelp and seagrass from 0900 to 1200 hr. The biologist walked upstream 0935 hr to 1100 hr. The auxiliary channel was bermed at 1415 hr.

26 May 2011. The fishery biologist arrived at 0625 hr. The berm had held overnight, and the water level was within 3 inches of the top of the flume. The gage height was 2.11 feet. The berm across the auxiliary channel was opened at 0915 hr. Eight public works staff and the biologist raked kelp and seagrass from 1015 to 1200 hr. The biologist walked upstream 1030−1130 hr. YOY stickleback were observed at the upper end of the estuary, but no fish were stranded. An adult steelhead was observed about 25 feet from the flume inlet on the restaurant side of the estuary at 1200 hr, just as the raking ended. Consultants crawled through the flume, locating and documenting cracks in the flume during the morning. They said the flume's floor looked good, while cracks were observed in several locations in the flume walls. A worker from Granite Construction attempted to patch the largest cracks from the inside in the downstream end of the flume. Kotila prepared a pad around the flume inlet, and staff secured visquine around the inlet with sandbags. Then sand was hand-shoveled over the visquine and sandbags. The sand was packed around the flume to prevent water seepage. The auxiliary channel was closed at 1420 hr.

27 May 2011. The fishery biologist arrived in late morning to inspect the sandbar and flume inlet/outlet. Both sides of the flume inlet were screened with 2"x 3" mesh that allowed smolt passage through. The lagoon water level was within 4 inches of the top of the flume. The sandbar was in place with the auxiliary channel filled with sand. The screening on the east (restaurant) side had an 8"x 8" underwater portal for adult fish access to the flume. The screen was painted white, and the border of the portal was flagged with yellow flagging for easy visibility, as requested by the biologist.

31 May 2011. Water quality was measured at 1600 hr to detect any saline water still present in the lagoon. None was detected under the Stockton Bridge. A small 2 x 2 meter area with partly saline water (10 ppt) along the bottom was located adjacent to the Venetian Court wall at 3 meters depth was detected. This was a deep pocket. With the continued streamflow at approximately 20 cfs and low salinity of the deep pocket, it was not recommended that shrouds be put on the flume inlet. Oxygen levels were above 10 mg/L through most of the water column, with it just 0.3 mg/L in the deep saline pocket. Water temperature was between 13.6 and 14.1°C through the water column.

4 June 2011. Rain occurred this day. The fishery biologist was notified at approximately 0230 hr by Morrison that an emergency breach of the sandbar was likely to occur to prevent flooding. It was raining steadily in the Santa Cruz Mountains. The biologist reached the lagoon at 0330 hr. A notch had been cut in the sandbar through the beach, with a berm remaining at the lagoon margin to prevent breaching. The water level was above the top of the flume, with streamflow emptying through the flume. It rained steadily through the night, with the streamflow remaining below 40 cfs at the gage as the water level slowly increased about 1 inch per hour (40 cfs reading at Soquel Village USGS gage at 0800 hr) until approximately 0830 hr. Then the lagoon level began to rise more rapidly as rain intensified. The gage reading at 0900 hr was 48 cfs. At 0915 hr, the berm at the lagoon margin was breached with a shovel and streamflow began to flow across the beach. By 0915 hr the lagoon level had risen to within 3 inches of the piling bolt which indicated where bulkhead flooding became problematic. The gage reading at 0915 hr was 53 cfs. At 0931 hr the lagoon water level had risen to within 2 inches of the bulkhead flooding bolt (gage reading at 0930 hr was 63 cfs). The biologist's observations along the bulkhead at 0940 hr indicated that the lagoon level was equal to the elevation of puddles on the margins of the lagoon behind the permeable bulkheads. Streamflow at the gage exceeded 650 cfs later in the day (673 cfs @ 1645 hr). Breaching could not have been avoided.

20 June 2011. Streamflow had receded enough by this day to allow re-construction of the sandbar. The fishery biologist arrived at the site at 0625 hr. The outlet channel from the estuary was adjacent to the flume and had been open to the Monterey Bay since the breaching of the lagoon on 4 June. At low tide, the lower estuary downstream of Stockton Bridge was ponded and averaged approximately 2.5 feet deep (0.7 meters). The area on the west side of the estuary above Stockton Bridge was also ponded and somewhat deeper. The redwood stump near the Esplanade restaurants had moved further out into the center of the estuary. More kelp and seagrass appeared to be present in the estuary than when the sandbar was constructed in May. Seven Public Works staff and the biologist raked approximately 60% of the kelp and seagrass present downstream of the Stockton Bridge out the outlet channel. A smaller than usual visquine sheet was secured around the flume inlet and keyed into the lagoon margin with sandbags and a trench. The sandbar was closed by equipment operator, Kotila, at 1157 hr.

Approximately the last 40 feet of the flume was blocked with sand when the sandbar was closed. Sand was excavated from the flume from the last two manholes before the flume exit. Daylight could be seen along the ceiling of the flume from the second-to-the-last manhole opening to the flume inlet. In order to facilitate flushing of sand from the flume, Morrison directed that the last two manhole covers be secured with openings maintained by 2" x 4" spacers so that some water could exit through the manhole covers while the flume was flushed out by streamflow through the flume.

The biologist did not request for the flume to be completely free of sand before work was completed on 20 June because he assumed the smolt migration was essentially over and because Morrison was certain, based on experience, that the flume would flush itself of sand during the night. The biologist assumed that if any steelhead smolts were still present in the estuary, they would exit the flume after it completely opened. The biologist failed to foresee that smolts would exit the flume through the spaces in the manhole covers and become trapped before entering the bay and before the flume would be flushed of sand.

21 June 2011. The flume opened completely during the night, with a bathtub ring around the periphery of the lagoon indicating that the surface had receded after complete flume opening. Morrison directed Public Works staff to seal the last 2 manhole covers that had been spaced the day before. While inspecting these manhole covers in the morning, Public Works staff, Cary

Oyama, discovered a small pool (4 ft x 8 ft by 1 foot deep maximum) adjacent to the flume at the second to last manhole cover, with a pocket of water slightly under the flume. The pool was isolated from the surf, and he observed fish in it. He immediately contacted Ed Morrison. Upon reaching the pool, Morrison identified steelhead in the pool. He instructed Oyama to obtain dip nets and a clean bucket from the wharf fishing concession. After obtaining the nets, Morrison and Oyama captured 7 juvenile steelhead from the pool (4−5 inches long by Morrison's estimation) and relocated them with the clean bucket and fresh lagoon water to the lagoon in the shaded portion adjacent to the restaurant pilings. Cover was available under the restaurants. There were no steelhead mortalities, and all steelhead were rescued. This occurred at approximately 0900 hr. There was concern for steelhead mortality in the small pool from potential gull predation and increasing water temperature if the fish were not rescued quickly. Morrison notified Alley, the fish biologist, at 0914 hr, after the fish relocation was completed.

Morrison rescued the fish in an appropriate manner and relocated them to the proper location, in our judgment. We must assume that the steelhead were smolts due to their size and behavior and that they were ready to enter saline water. However, they typically migrate under protection of darkness and may have been subjected to high risk of predation if placed in the surf during daylight hours. Being placed in the lagoon, they would have the opportunity to exit the flume the following night.

Apparently, until the flume became completely flushed of sand during the night, water exited through the second-to-last manhole that had been propped open with spacers the afternoon before. The fish stranded in the pool beside the flume must have exited the flume through the manhole under low tidal conditions when the pool was isolated. During high tide, the manhole was underwater, Morrison stated, and there was evidence that the pool had been connected to the Monterey Bay earlier.

24 June 2011. Water quality was measured at 1237 hr to detect any saline water still present in the lagoon. None was detected. The inlet shrouds were unneeded. Water temperature varied between 16.4° and 17.5°C in the water column, while oxygen concentration ranged between 9.50 and 10.97 mg/L at the deepest spot adjacent to the Venetian Court Wall. Salinity was 0.3 ppt throughout the water column, indicating freshwater conditions. Public Works staff had lashed logs together under the Venetian side of the Stockton Bridge to create fish cover.

27 June 2011. Morrison notified the biologist that he would be removing boards from the flume inlet in anticipation of a chance of rain on 28 June. He predicted that the lagoon depth would be reduced approximately one foot from a level one inch from the top of the flume. He stated that he would notify Fish and Game about this adjustment.

28 June 2011. Rain occurred this day. When the lagoon water surface increased to above the top of the flume, Morrison had Kotila notch the sandbar in preparation for another emergency breach. However, streamflow at the Soquel Village gage topped out at 28 cfs, and no emergency breach was required. The water surface rose to 4 inches above the top of the flume before receding. Streamflow out of the flume had been hampered by a high tide.

Effect of Sandbar Construction on Tidewater Gobies in 2011

It was likely that most tidewater gobies, if they were present, used habitat upstream of the construction area, where there was less tidal fluctuation and salinity. No tidewater gobies were detected after a heavier than median rainfall season. However, artificial water level fluctuations were created during sandbar construction activities. Four sandbar breaches were required during sandbar preparation in 2011 (including the emergency breach on 4 June), with 3 breaches allowed by the permit without regulatory consultation. Morrison consulted with CDFG prior to the emergency breach. The initial 3 breaches closely mimicked normal tidal fluctuations of an estuary. The 4th artificial breach which occurred on 4 June had no ultimate impact on estuary dynamics because the 600+ cfs stormflow that followed overshadowed it and would have naturally breached the sandbar.

With each lowering of the water in the estuary during the first sandbar construction, tidewater gobies would have to retreat to deeper water in the upper estuary as water surface receded in the upper estuary. A well defined, bathtub-like margin existed in the upper estuary in 2011, allowing easy retreat to deeper water.

The second sandbar construction on 20 June did not require artificial breaching of the sandbar and would have no impact on tidewater gobies. The sandbar was re-constructed in the morning before the tide turned. The outlet channel that was blocked had been stream-like without backwaters that could have provided tidewater goby habitat.

The channel in lower Soquel Creek lacks sheltered backwaters for gobies to escape high water velocity during high stormflows, and the population that reoccurred during the dry years of 2008 and 2009 may have been transitory.

Effect of Sandbar Construction on Steelhead in 2011

No juvenile steelhead were detected in the lateral channel before it was covered over in May. The flume outlet was open during the entire period of sandbar construction in May, and smolts had access to the ocean nightly. It was beneficial to promote lagoon filling each night. No juvenile steelhead were observed during the initial sandbar construction, indicating that the smolt migration was essentially over. The 6,000+ cfs stormflow at the end of March likely encouraged many smolts to exit at that time.

However, it would seem that the late spring stormflow of 4 June encouraged more juvenile steelhead of adequate size to smolt (likely fast-growing YOY from the previous year and now yearlings that had experienced high spring flows and good feeding conditions), extending the typical smolt season into late June. Negative impacts to steelhead smolts were detected during the sandbar re-construction on 20 June. The flume was not completely open to the Bay when darkness came and probably did not open until early morning nighttime hours. Presumably steelhead smolts became trapped in an isolated side pool adjacent to the second-from-the-end manhole, having apparently exited the flume through the propped open manhole cover. Steelhead found in the pool at 0900 hr on 21 June were relocated to the lagoon without mortality. However, some predation may have occurred prior to their detection.

The seasonal effect of removing organic material and constructing the sandbar is to create good summer rearing habitat for steelhead and tidewater goby. Compared to allowing natural lagoon formation, a lagoon is created with cooler, deeper, freshwater conditions, with reduced potential for eutrophication and associated increased biological oxygen demand from plant decomposition and nighttime respiration by live algae. Kelp and sea grass removal and sandbar closure create better fish habitat for tidewater goby and steelhead than if the sandbar was allowed to close naturally. Natural sandbar formation would allow considerable kelp and sea grass to become trapped in the lagoon to decompose. Under natural sandbar conditions, a much shallower lagoon would have formed with much more saltwater trapped to create an unmixed, anoxic lagoon bottom, which would collect heat and raise lagoon water temperature. The naturally formed sandbar would be lower in stature, allowing more tidal overwash of saltwater during especially high tides. Increased tidal overwash would further elevate water temperature, making the lagoon less hospitable for steelhead.

Recommendations for Lagoon Preparation and Sandbar Construction

1. Make sure the flume is completely open to the Bay before the work-day has ended during all sandbar construction activities. This includes during sandbar re-construction activities late in the smolt out-migration period. Do not use manhole cover spacers to flush sand out of the flume during darkness when the entire outflow from the lagoon must exit through the flume and there is a chance that smolts are still exiting.

2. If stranded fish are detected as a result of sandbar closure or flume clearing, alert the monitoring biologist to discuss the appropriate relocation method for fish, and have the biologist capture and relocate the fish with assistance from Public Works staff. The biologist should be present during all sandbar closure and flume clearing activities when fish may be present (not when the flume is being cleared the week prior to sandbar construction and streamflow is still flowing through the beach). However, if fish become stranded due to unforeseen circumstances unassociated with sandbar closure/ flume clearing and insufficient time is available for the biologist to reach the site, as occurred on 21 June 2011, Public works staff should consult with the biologist prior to any response. Then Morrison and Oyama of the Public Works staff should capture and relocate the fish with available dip nets or seine and buckets filled with fresh estuary/ lagoon water, after consultation with the biologist, because of their experience in handling fish. (Other public works staff should be given experience in relocating fish from the lateral channel in the future or during fall sampling so that they may fill in if Morrison or Oyama are unavailable.) If the biologist is unavailable during emergency cases, relocate fish to the main body of the estuary or lagoon near the pilings and boulders adjacent to the restaurants, where cover and good water depth are available.

3. Closing the sandbar in late May is better than mid-June or later because streamflow is sufficient to rapidly fill the lagoon in most years, and the juvenile steelhead most likely to be present in the lagoon are out-migrating smolts. Late May is prior to down-migration of most YOY steelhead from spawning sites above the lagoon. Small steelhead fry remain in the vicinity of spawning sites before moving down into the lagoon. Down-migrant trapping on the nearby San Lorenzo River in 1987 and 1988 by Don Alley and Stafford Lehr (now

with CDFG) indicated that a few YOY steelhead were down-migrating in May, but the number greatly increased in June.

4. The management solution for minimizing the time required for sandbar construction is for the City to remain flexible on timing of the work. If rain is in the forecast within two days after the intended starting date for sandbar construction, Public Works should postpone construction until clear weather is forecasted. If 4-5 working days are set aside to construct the sandbar, the sandbar construction may be delayed as late as 4-5 days before the Memorial Day weekend and may still satisfy the tradition of lagoon formation before then.

5. Continue to rake as much kelp and sea grass out of the lagoon as possible before final closure, from the Stockton Avenue Bridge downstream, including plant material trapped under the restaurants and in depressions around the bridge piers. Discontinue raking if juvenile steelhead are observed near the water surface. It is best to minimize time required to stockpile sand, rake out the decomposing organic material and prepare the flume inlet for fish passage. This will minimize the number of instances of artificial fluctuation of lagoon water level. Sufficient City staff should be assigned to be ready to enter the estuary at the earliest opportunity each day and quickly rake out decomposing kelp and to clear the sand-filled flume.

6. Dispose of kelp in the Bay rather than bury it in the sandbar. Disperse it up and down the beach. Continue to include this in the Fish and Game permit for sandbar construction. County Environmental Health approved of this method so long as kelp is spread over a wide area (**J. Ricker, personal communication cited in the original 1990 Soquel Creek Lagoon Management and Enhancement Plan**).

7. To provide cover for juvenile fishes, continue to leave any large woody material deposited in the lagoon from winter storms. Allow a clear path from under the bridge to the beach at Venetian Courts to enable seining for juvenile steelhead during fall censusing.

8. Annually evaluate the structural integrity of the flume and its supports. Continue to repair cracks and supports as necessary. This will prevent sinkholes from forming and reduce water leaking from the lagoon along the flume.

9. Repair the flume at a time that does not obstruct fish passage or require lowering of the lagoon water level.

10. During sandbar construction, continue to close the lagoon each day before the incoming tide can wash salt water and kelp into the lagoon. Re-open the sandbar and unplug the flume, if necessary, each morning to facilitate kelp and sea grass removal.

11. Search under the Stockton Avenue Bridge and in Reaches 2 and 3 for stranded fish to rescue as the lagoon drains each day during raking. It is best to minimize the number of days required to construct the sandbar and rake out the decomposing organic material. This will minimize the artificial fluctuation of lagoon water level. Having a maximum number of personnel to rake decomposing organic material into the bay and to clear the flume of sand will minimize the days needed to prepare the lagoon for the summer.

12. Maintain an underwater portal in the flume intake for out-migration of adult steelhead until June 15, while maintaining a notched top plank for out-migration of smolts until 1 July. However, in dry years such as 2007−2009, when stream inflow is insufficient to fill an underwater portal and allow lagoon filling, opt for a larger notch in the upper boards to accommodate adult kelts and smolts instead of a deeper underwater portal for kelts.

13. Maintain the 1-foot high baffle inside the flume until July 1 for safe entrance of out-migrating steelhead smolts into the flume inlet before they enter the Monterey Bay.

14. Continue to cover the visquine around the flume inlet with manually shoveled sand instead of tractor shoveled sand. This will prevent the tractor from displacing the visquine. Clear visquine is preferable to black. Key the visquine into the lagoon margin to encourage its retention when the sandbar breaches in the fall.

15. Retrieve visquine from around the flume inlet before or immediately after the fall sandbar breach, if possible.

Procedure for Emergency Sandbar Breaching at Soquel Lagoon by the City of Capitola

In 1990, a bolt was set into a wooden piling adjacent to the restaurants at the lagoon. The bolt's elevation was surveyed to coincide with the water surface elevation at which flooding was imminent. The bolt is 1.77 feet above the elevation of the top of the flume inlet. It allowed 1 foot of freeboard at the residence where flooding was identified as a problem. Since then, another low point has been located near the railroad trestle, which will have flooding problems approximately 0.5 feet above the bolt. Another bolt is present on a piling to indicate this elevation. The management goal is to pass stormflow through the flume from the first small storm events in the fall while keeping the lagoon surface below the original bolt. This is done by the City removing boards from the flume inlet prior to and during increased stormflow. Water also flows through the top grate that was constructed in the flume inlet in 2003.

A tractor is used in the fall to cut a notch approximately 30 feet wide in the sandbar adjacent to the flume. A berm is left along the lagoon margin between the notch and the lagoon. An additional berm is constructed across the notch near the surf to prevent wave action at the beach from entering the notch. The intent is to prepare the sandbar so that it will breach at the proper time to prevent flooding. The City cuts the sandbar notch at the elevation of the piling bolt. However, the notch fills in from foot-traffic on the beach as time goes on. If, despite efforts to pass all of the stormflow through the flume, the water surface reaches the elevation of the piling bolt, then the City is to facilitate sandbar breaching. A tractor is used to re-cut the sandbar notch and breach the two berms across the notch so that the entire sandbar breaches prior to flooding. If the flume is able to receive all of the stormflow and flooding does not become a threat, boards are replaced in the flume inlet after the stormflow has passed.

Sandbar Breaching During the 2011-2012 Rainy Season.

4-5 October 2011. The sandbar had been prepared with a notch approximately 30 feet wide and two elevated berms at the surfside and lagoon margin in place. Five to 6 4x4-inch boards had been removed from both sides of the flume entrance prior to the storm. Rain started at 2300 hr on 4 October with streamflow at the Soquel gage reading 6 cfs. By 2400 hr, streamflow was 11 cfs. Jesberg went to the lagoon at 0015 hr, and Kotila and DiFalco were already present. Flow at 0100 hr on 5 October was 13 cfs. Alley was called at 0130 hr and arrived at 0215 hr. Flow at the Soquel gage had reached 28 cfs by 0200 hr, with the water level 18 inches below the lower piling bolt. By 0215 hr the water level was within 1 foot of the lower piling bolt and rising quickly, with the Soquel gage reading 37 cfs. The suspected capacity of the flume is approximately 30 cfs. Kotilla breached the surfside berm soon after with the tractor. At 0245 hr, Kotilla breached the final berm at the lagoon margin with the water level rising fast and approximately 4 inches below the lower piling bolt (Soquel gage reading of 59 cfs). The estuary continued to rise for approximately 30 minutes and peaked 2 inches above the bottom piling bolt before the swath through the beach had widened sufficiently to take the entire streamflow. Streamflow peaked at the Soquel gage at 0315 hr at 123 cfs. The estuary water surface dropped below the lower piling bolt at 0320 hr. Kotila and DiFalco determined that the estuary level rose maximally to within 4 inches of the top of the bulkhead along the lagoon path near the trestle.

Recommendations Regarding Sandbar Breaching

1. As stated in the Management Plan (**1990**), make sure that parking lots and streets draining into the lagoon are cleaned before the rainy season. This will reduce the pollutants entering the lagoon during the first storm of the season that are lethal to fish. Street sweepers with water and suction may be necessary. In addition, roadwork such as repaving and application of fresh petrochemicals should be done in the early summer to allow sufficient time for penetration and drying before the rainy season.

2. *Notch the sandbar diagonally across the beach* (instead of straight out along the flume as before) to minimize the gradient of the notch, to slow the evacuation of water through the beach and too minimize beach erosion *in order to maximize the residual estuary depth after the emergency breach.*

3. The notch in the sandbar should be cut slightly lower than the piling bolt. *Make the notch at least 30 feet wide across the beach to also maximize the possibility of maintaining an estuary with some depth after the breach.* The City may have to periodically re-establish the notch if it does not rain or high tides obliterate it. If a storm is predicted, the sandbar needs a notch as preparation. Continue to maintain an outer berm near the surf and an inner berm near the lagoon margin with the wide notch in between.

4. Just as the first storm of the fall season begins, remove boards from each side of the flume if a small storm is anticipated. The number of boards removed will be dictated by the anticipated size of the storm. Remove two boards from either side if a large storm is anticipated. Clear the exit to the flume by removing the plate from one side of the exit. After the stormflow subsides, replace the cover until the next storm.

5. As stated in the 1993 monitoring report, management options to delay sandbar breaching include installation of a perimeter fence around the flume inlet to collect algae. Replace the boards after the stormflow subsides, removing them for each succeeding storm until the

sandbar is eventually breached during later, larger storms usually occurring after Thanksgiving. There is now a grated opening on top of the flume inlet.

6. After the first storm of the season with the sandbar still intact, lower the lagoon level to a point where light may penetrate to the lagoon bottom. In doing so, the plant life in the lagoon may continue to photosynthesize and is kept viable. Thus, vegetation mortality and stressfully low oxygen levels are prevented until the water clarity is re-established. Re-install boards to increase lagoon depth after the lagoon clears up.

7. Notify the California Department of Fish and Game 12 hours before the possibility of a sandbar breach and immediately after the breach occurs.

8. If the sandbar breaches early in the rainy season, followed by a period of 2-4 weeks of a reformed sandbar that prevents water exchange with the ocean, attempt to pull the decomposing kelp out of the stagnating lagoon. Open the flume and encourage streamflow out with the shroud installed.

9. If a stagnant, kelp-filled lagoon forms in fall after an early breach and a dry period, do not empty the lagoon by breaching the sandbar. Instead, use the flume and shrouds to pull salt water out. Breaching of the lagoon will increase the opportunity for more kelp to enter and probably will not empty the entire lagoon anyway. Fish passage need not be maintained through the flume because it should be discouraged until sufficient stormflows develop to provide passage up the Creek. If adult salmonids enter too early, they will become stranded and unable to migrate upstream because of insufficient streamflow.

WATER QUALITY MONITORING IN 2011

Rating Criteria

Water quality parameters were rated according to the tolerances of steelhead. This was because they are least tolerant of low oxygen, higher salinity and higher temperatures of the resident lagoon fishes. Stress to freshwater acclimatized steelhead would probably not occur until conductivity levels reach 12,000 to 15,000 umhos, associated with sudden increases in salinity to 10 − 12 parts per thousand. Water temperatures above 22º C (72º F) (**Table 1**) and oxygen levels below 5 parts per million (mg/L) are thought to stress steelhead. Bjornn and Reiser (1991) state that growth, food conversion efficiency, and swimming performance are adversely affected when dissolved oxygen concentrations are <5 mg/L. However, steelhead have been found surviving in pools in the Carmel River at 1-2 mg/L for 1-2 hours at dawn (**David Dettman, personal observation**) and in San Simeon Lagoon near Cambria at oxygen concentrations less than 2 mg/l on repeated occasions (**Alley 1995b; 2006b**). Based on 1988 monitoring, steelhead appear to survive in Soquel Lagoon at water temperatures of 23-25º C for 1-2 hours in late afternoon or early evening (**Habitat Restoration Group 1990**). Water temperature may rise as much as 3-5º C from a morning minimum, after a sunny, fog-less day.

Oxygen levels critical to steelhead survival were classified as those measured in the lower 0.25 meters from the bottom, where steelhead would inhabit. Early Morning oxygen levels below 2 mg/l were rated "critical" (**Table 2**). Those levels between 2 and 5 mg/l were rated "poor." Early morning oxygen levels of 5 to 7 mg/l were rated "fair" with above 7 mg/l rated as "good." Early morning water temperatures in the lower 0.25 meters of the water column of less than 20º C were rated "good" while those 20 − 21.5º C were rated "fair." Temperatures between 21.5 and 23º C were rated "poor," while those greater than 23º C at dawn were rated "critical." High levels of dissolved carbon dioxide in water will inhibit absorption of oxygen by fish. However, in the alkaline conditions of Soquel Creek Lagoon, carbon dioxide is poorly dissolved and is not a problem (**J. Smith, personal comm**.). Therefore, its monitoring was unnecessary.

Lagoon water level was monitored with the staff gage on the eastern bulkhead, upstream of the Stockton Avenue Bridge (**Figure 1.**) Readings below 1.5 feet were rated "critical" while readings between 1.5 and 1.85 were rated poor (**Table 2**). Readings between 1.85 and 2.2 were rated "fair." Readings above 2.2 were rated "good." These criteria were somewhat arbitrary, being based on an as yet poorly defined relationship between lagoon depth and associated fish cover, water temperature and algal growth. If the upper lagoon becomes too shallow, steelhead habitat is eliminated and algae growth may be stimulated. An important factor not directly under control by the City is change in streambed elevation resulting from winter scour or fill in the estuary.

Locations and Timing of Water Quality Monitoring

As required under the CDFG permit for 2011, water quality was monitored in late afternoon, as well as in the early morning near first light. Prior to 2003, water quality had been measured only in the early morning after dawn because the most limiting factor, oxygen concentration, is usually a minimum at that time. Water quality was monitored at four lagoon stations and one stream station. Station 1 was at the flume inlet (**Figure 1**). Station 2 was on the downstream side of the

Stockton Avenue Bridge in the deepest thalweg area. Station 3 was just downstream of the railroad trestle on the east side. Station 4 was at the mouth of Noble Gulch. Station 5 was monitored in the morning and afternoon in Soquel Creek near the Nob Hill shopping center, just upstream of the lagoon. The stream data were compared to lagoon conditions of water temperature and oxygen levels in early morning.

In 2011, as required by the CDFG permit, 6 HOBO temperature loggers were launched on 30 June 2011 just downstream of the railroad trestle in Reach 2 (as in 2008−2010) at 1-foot intervals through the water column, beginning at 0.5 feet above the bottom and ending 5.5 feet from the bottom. The previously used location, just upstream of the trestle had filled in at least a foot over the 2007-2008 winter. The 2008 monitoring location was shifted downstream from the 2007 location because it was deeper, and this location was used again in 2011. Another logger was placed in Soquel Creek near the Nob Hill Shopping Center. All 7 loggers were removed on 2 October 2011, prior to any forecasted rain.

Water quality in terms of oxygen concentration, temperature, conductivity and salinity was measured at each lagoon station at two-week intervals after the sandbar was constructed until the sandbar breached in the fall. Prior to the first full monitoring, salinity was measured in deeper portions of the lagoon to determine if saltwater had been trapped during sandbar construction. Saltwater was not detected in 2011 after the second sandbar closure, and no inlet shroud was needed.

Table 1. Temperature Equivalents for Degrees Celsius and Degrees Fahrenheit.

Degrees Celsius	Degrees Fahrenheit
10	50.0
11	51.8
12	53.6
13	55.4
14	57.2
15	59.0
16	60.8
17	62.6
18	64.4
19	66.2
20	68.0
21	69.8
22	71.6
23	73.4
24	75.2
25	77.0
26	78.8
27	80.6
28	82.4
29	84.2
30	86.0

Table 2. Criteria for Rating Water Quality Measurements within 0.25 Meters of the Bottom and for Rating Gage Height Readings.

MORNING RATING	MORNING TEMPERATURE (Celsius)	OXYGEN (mg/L)	GAGE HEIGHT (ft)
Good	< 20	> 7	> 2.20
Fair	20-21.5	5-7	1.85-2.20
Poor	21.5-23	2-5	1.50-1.85
Critical	> 23	< 2	< 1.50

Water Temperature Goals for Soquel Creek and Lagoon

Regarding Soquel Creek Lagoon in summer, where food is more abundant than upstream, a management goal for steelhead should be to maintain water temperature below 20ºC (68ºF) at dawn within 0.25 m of the bottom and the afternoon maximum below 22ºC (71.6ºF) near the bottom. This early morning goal coincides with a "good" rating at monitoring sites (**Table 2**). This lagoon management goal is somewhat higher than the enhancement goal we established for Soquel Creek upstream, where the goal was to maintain water temperature below 20ºC. Maximum daily water temperature in the lagoon should not reach 26.5ºC (79.5ºF). Although Coche (**1967, cited in Kubicek and Price 1976**) determined that temperatures between 20 and 24ºC were responsible for high maintenance requirements and low conversion efficiency of food into growth for his stock of juvenile steelhead, our annual sampling of juvenile steelhead in Soquel Lagoon indicates that growth rate in the lagoon has been greater than in the upstream stream reaches (**Alley 2008a; 2008b**), with nearly all young-of-the-year juveniles rearing in the lagoon reaching smolt size the first summer each year. This indicates that higher water temperature has not prevented relatively rapid growth of juveniles in the lagoon, where food is abundant.

Water temperatures above 20ºC (68ºF) are considered limiting to juvenile coho salmon in the presence of steelhead (depending on food abundance), and lagoon temperatures below 16ºC (60.8ºF) are preferred (**J. Smith, personal communication**). Therefore, the management target for making Soquel Creek Lagoon habitable for coho should be to maintain summer water temperature below 20ºC (68ºF). The 2010 lagoon was the coolest in the last 20 years, with temperatures near the bottom exceeding 20° C only for a 3-day period in early June and a 4-day period in mid-July. However, we do not believe that Soquel Creek Lagoon may be cooled sufficiently to support juvenile coho salmon in most years.

The management goal for water temperature in stream habitat upstream of the lagoon should be maintenance below 20ºC (68ºF) in April and May when baseflow still remains above summer low-flow and juvenile salmonids are feeding and growing rapidly. From June1 to September 1, the water temperature should not rise above 20ºC (68ºF) more than 4 hours a day (15% of the month) and preferably the maximum daily temperature, averaged weekly, should not rise above 21ºC (70ºF). These goals are based on literature review of physiological relationships between fish metabolic rate and water temperature (**Kubicek and Price (1976); Brett (1959, cited in Kubicek and Price 1976); and Snyder and Blahm (1971, cited in Kubicek and Price 1976)**).

The temperature optimum is a moving target, increasing and decreasing with food supply. According to Moyle (**2002**), Baltz et al. (**1987**) reported that optimal temperatures for growth of rainbow trout (not steelhead) to be around 15-18ºC, a range that corresponded to temperatures selected in Sierran streams when possible. According to Moyle (**2002**), regarding temperature optima, "The optimal temperatures for growth of rainbow trout are around 15-18ºC, a range that corresponds to temperatures selected in the field when possible. Thus, in a section of the Pit River containing a thermal plume from an inflowing cold tributary, rainbow trout selected temperatures of 16-18ºC. However, many factors affect choice of temperatures by trout (if they have a choice), including the availability of food." The Santa Ynez River Technical Advisory Committee (SYRTAC) proposed guidelines with upper limits of 20ºC average daily temperature and 25ºC daily maximum as providing acceptable habitat conditions for steelhead in the Santa Ynez River (**SYRTAC 2000**), much further south of Soquel Creek and the Santa Maria River and in the southern ESU for steelhead. The SYRTAC (**2000**) decided that a mean daily temperature of 22ºC may be the threshold between acceptable and unsuitable from a long-term perspective. This was based on studies by Hokanson et al. (**1977;** Cited in Santa Ynez River Technical Advisory Committee 2000), who concluded that the highest constant temperature at which the effects of growth and mortality balance out was 23ºC.

The management goal regarding water temperature prior to re-introduction of coho salmon to Soquel Creek should be that water temperature in specified reaches meet the criteria that average daily water temperature (averaged weekly) during summer/fall months (June 1 to October 1) be 16.7ºC (62ºF) or less in the warmest week and that the weekly maximum temperature be 18.0ºC (64ºF) or less during the warmest week (**Welsh et al. 2001**). The targeted stream segments include 1) the mainstem Reaches 7-9 (Moores Gulch confluence to Hinckley Creek confluence on the East Branch), 2) Reaches 11 and 12A (Soquel Demonstration State Forest between the Soquel Creek Water District Weir at the lower end of the canyon and the gradient increase below the Fern Gulch confluence) and 3) Reaches 13 and 14a on the West Branch (downstream of the lowermost Girl Scout Falls I. Coho salmon juveniles were detected by NOAA Fisheries biologists and D.W. ALLEY & Associates in Reach 9 of the East Branch in Fall 2008, supporting the potential for coho recovery in Soquel Creek.

Results of Lagoon Water Quality Monitoring After Sandbar Closure

Lagoon Level. **Appendix A** provides detailed water quality data. **Table 3** rates habitat conditions. The lagoon level was maintained mostly in the good range for the summer and during the Begonia Festival, except in the fair range in late May after the first sandbar closure and late June and early July after the second sandbar closure. The sandbar was open 4−20 June due to an early June storm after the first sandbar closure. The lagoon level was monitored 9 times in 1 to 2-week intervals from 31 May to 1October 2011, plus on 4 September, the day of the Begonia Festival. For 2011, the measurements of lagoon level as measured on the staff gage were rated "good" (**Table 2**) on 7 occasions and "fair" on 3 occasions (**Table 3; Figure 2a**). On 4 October, 5 to 6 boards were removed from each side of the flume inlet in anticipation of a storm that occurred on 5 October. Unfortunately, the first fall storm was large enough to breach the sandbar in 2011.

Maintenance of lagoon gage height was relatively high from mid-July through September 2011 and typically higher than in 2010 despite the high lagoon inflow. Typically, it is more difficult for the City to maintain the highest water surface elevation during wetter years. But this was not the case in 2011 despite high lagoon inflow. No saltwater was trapped in the lagoon near the Venetian Court wall at the time of sandbar closure, and shroud installation was not required.

No vandalism of the flume inlet was detected in 2011. Plywood protects against both back-pressure and vandalism for most of the lagoon season. However, with early, small storms, the plywood is not used between storms. While the wedges discourage all but the most determined vandals and prevent dislodging of boards, they do not allow easy removal of boards when surface algae and debris near the flume needs to be drained out or when sandbar breaching is to be prevented by increasing the volume through the flume. The grated hole in the top of the flume alleviates the need for rapid board removal and replacement during small stormflows.

Flume Passability. According to the Management Plans (**1990; 2004**), steelhead smolt passage is to be maintained until July 1. A flume depth of 12 inches or deeper was desired at the entrance until July 1. The flume was cleared of sand prior to sandbar construction in 2011. With the high baseflows (>20 cfs), the lagoon filled sufficiently each night during the first sandbar construction period (23-26 May) to provide smolt passage through the flume each night. Once sandbar construction was complete, both sides of the flume inlet were screened with 2"x 3" mesh that allowed smolt passage through. The screening on the east (restaurant) side had an 8"x 8" underwater portal for adult fish access to the flume. The screen was painted white, and the border of the portal was flagged with yellow flagging for easy visibility, as requested by the biologist. The lagoon level was in the "fair" range on 31 May, 4 days after the first sandbar closure.

With the stormflow of 4-5 June, the sandbar was breached to prevent flooding. The sandbar remained open until 20 June when it was reconstructed. At the time of sandbar closure, approximately the last 40 feet of the flume was blocked with sand when the sandbar was closed. Sand was excavated from the flume from the last two manholes before the flume exit. Daylight could be seen along the ceiling of the flume from the second-to-the-last manhole opening to the flume inlet. In order to facilitate flushing of sand from the flume, Morrison directed that the last two manhole covers be secured with openings maintained by 2" x 4" spacers so that some water could exit through the manhole covers while the flume was flushed out by streamflow through the flume. The biologist did not request for the flume to be completely free of sand before work was completed on 20 June because he assumed the smolt migration was essentially over and because Morrison was certain, based on experience, that the flume would flush itself of sand during the night. The biologist assumed that if any steelhead smolts were still present in the estuary, they would exit the flume after it completely opened. The biologist failed to foresee that smolts would exit the flume through the spaces in the manhole covers and become trapped before entering the bay and before the flume would be flushed of sand.

The flume opened completely during the night, with a bathtub ring visible around the periphery of the lagoon on 21 June, indicating that the surface had receded after complete flume opening. Morrison directed Public Works staff to seal the last 2 manhole covers that had been spaced the day before. While inspecting these manhole covers in the morning, Public Works staff, Cary Oyama, discovered a small pool (4 ft x 8 ft by 1 foot deep maximum) adjacent to the flume at the second to last manhole cover, with a pocket of water slightly under the flume. The pool was isolated from the surf, and he observed fish in it. He immediately contacted Ed Morrison. Upon reaching the pool, Morrison identified steelhead in the pool. He instructed Oyama to obtain dip nets and a clean bucket from the wharf fishing concession. After obtaining the nets, Morrison and Oyama captured 7 juvenile steelhead from the pool (4−5 inches long by Morrison's estimation) and relocated them with the clean bucket and fresh lagoon water to the lagoon in the shaded portion adjacent to the restaurant pilings. Cover was available under the restaurants. There were no steelhead mortalities, and all steelhead were rescued. This occurred at approximately 0900 hr. There was concern for steelhead mortality in the small pool from potential gull predation and increasing water temperature if the fish were not rescued quickly. Morrison notified Alley, the fish biologist, at 0914 hr, after the fish relocation was completed.

Morrison rescued the fish in an appropriate manner and relocated them to the proper location, in our judgment. We must assume that the steelhead were smolts due to their size and behavior and that they were ready to enter saline water. However, they typically migrate under protection of darkness and may have been subjected to high risk of predation if placed in the surf during daylight hours. Being placed in the lagoon, they would have the opportunity to exit the flume the following night.

Apparently, until the flume became completely flushed of sand during the night, water exited through the second-to-last manhole that had been propped open with spacers the afternoon before. The fish stranded in the pool beside the flume must have exited the flume through the manhole under low tidal conditions when the pool was isolated. During high tide, the manhole was underwater, Morrison stated, and there was evidence that the pool had been connected to the Monterey Bay earlier.

An 8 inch x 8 inch portal was provided for adult steelhead passage in the flume inlet on 20 June, and half screens were in place above, which were passable to juvenile steelhead. The underwater portal was removed prior to the 10 August monitoring, insuring adult steelhead passage well into July. The lagoon level was in the "fair" range on 10 July, approximately two weeks after the second sandbar closure and remained in the good range after 19 July for the remainder of the summer. The flume was passable for steelhead smolts during the entire summer.

The sandbar was emergency breached to prevent flooding on 5 October during the first stormflow of the season, which reached 123 cfs at its highest. This stormflow would have breached the sandbar soon after without facilitation, though flooding would have occurred. The sandbar remained open for the fall and winter after that.

Water Temperature Results from Two-Week Monitoring. In 2011, the lagoon was similar to or slightly cooler near the bottom in the morning and afternoon compared to 2010 except at Site 3 under the trestle where afternoon temperatures were warmer in 20011 on 5 of 7 monitorings (**Table 3, Figures 3a-d; Appendix A**). This was the coolest lagoon in the past 21 years of monitoring and much cooler than the 2009 lagoon (**Alley 2010b**). Lagoon inflow water temperatures were similarly cool with 2010 and cooler than the 3 previous summers (**Figure 3e**). The cooler water temperatures in 2011 corresponded with the consistent cool air temperatures measured at the lagoon compared to previous years that showed considerable fluctuation (**Figure 3f**). The warmest water temperature measured near the bottom in the morning was 19.0°C (66.2°F) on 26 July at the Flume. In 2011, water temperatures near the lagoon bottom in the morning were rated "good" at all stations throughout the lagoon season. The warmest afternoon water temperatures recorded near the bottom at the monitoring stations during two-week monitoring was 19.4°C on 26 July compared to 19.6°C in mid-July 2010, 21.9° C in late August 2009 and 24.6° C under the Stockton Bridge in early July 2008.

At the mouth of Noble Gulch in 2011, the water layer near the bottom was usually not cooler than above at dawn, unlike previous years, but was noticeably cooler in the afternoon. In 2010 a slightly cooler layer of water was detected near the bottom in early morning as in 2009, and the largest decrease in water temperature of all the monitoring stations was detected there on afternoon monitorings (**Appendix A**). This resulted from slightly cooler water entering from Noble Gulch during the lagoon period. For example, on the warmest water temperature monitoring days in 2011 (26 July), the surface and bottom temperature readings near dawn were 17.6 and 17.4° C, respectively (**Appendix A**). In the afternoon at 1505 hr they were 20.8 and 18.4° C, respectively.

Table 3. 2011 Morning Water Quality Ratings in Soquel Creek Lagoon, Within 0.25 m of Bottom.

Date	Flume Passage	Gage Height	Water Temperature	Oxygen	Salin-ity	Lagoon In-flow Esti-mated from Soquel Gage Readings (cfs)
31May11	open (afternoon)	2.04 fair	- good - -	- good - -	- good - -	22 cfs
24June11	open (afternoon)	2.05 fair	- good - -	- good - -	- good - -	16.5 cfs
10Jul11	open	2.00 fair	good	good	good	12.5 cfs
26Jul11	open	2.37 Good	good	good	good	9 cfs
10Aug11	open	2.49 good	good	good	good	6.8 cfs
23Aug11	open	2.45 good	good	good	good	5.7 cfs
04Sep11 Begonia Festival	open (morning)	2.51 good	good	good	good	4.6 cfs
04Sep11	open (afternoon)	2.51 good	- good good good	- good good good	- good good good	
05Sep11	open	2.51 good	good	good	good	4.5 cfs
18Sep11	open	2.38 good	good	good	good	4.5 cfs
01Oct11	open	2.35 good	good	good	good	4 cfs

* Four ratings refer to Monitoring Sites 1-4. One rating represents all sites.

As in most years when no saline layer develops later in the summer from overwash, water temperature at dawn within 0.25 m of the bottom of the lagoon became warmer as the monitoring stations progressed down the lagoon from Noble Gulch to the flume (**Figure 3g**). With cooler water emptying in from Noble Gulch, Station 4 was always cooler than the other 3 stations. Water temperature of the stream inflow was cooler in the morning than the lagoon, with fluctuations in lagoon inflow temperature mirrored in early-morning lagoon temperatures (**Figure 3g**). The correspondence between inflow fluctuations and lagoon temperature fluctuations indicated that the inflow temperature influenced the lagoon temperature in 2011 as in previous years. Stream inflow temperatures were typically 1-2° C cooler in the morning than lagoon water temperature at the 3 lower lagoon stations. The cool inflow from Noble Gulch maintained substantially cooler lagoon water temperature in the morning and afternoon at Station 4 near the bottom than the other three lagoon stations (**Figures 3g and 3h**). Usually, morning water temperature was 1-1.5° C cooler at Station 4 than Station 1. In the afternoon, the difference was less or similar in 2011. Larger differences occurred in previous years. Temperature differences between stations in the cool 2011 lagoon were less than what was the case in previous summers, such as 2008 and 2009, but similar to 2007 (**Figures 3i-k**). Stratification did not occur in the water column throughout the summer lagoon, with thorough mixing of the water and cooling each night (**Appendix A**).

Water Temperature Results from Continuous Data Loggers. In analyzing temperature data from the 6 data loggers throughout the water column just downstream of the railroad trestle, results were consistent with temperature data collected at 2-week intervals through the water column at monitoring stations over the past 21 years. However, the following analysis pertains to the vicinity of these continuous data loggers only. Keep in mind that our 2-week monitoring at the 4 sites indicated that Station 4 near the mouth of Noble Gulch had cooler water temperatures near the bottom than Site 3 near the trestle, where these continuous data loggers were deployed (**Figures 3g and 3h**).

Juvenile steelhead likely spend most of their time near the bottom, except when feeding on emerging aquatic insects at dusk and dawn. This assumption is based on many years of underwater observations of salmonids. Therefore, the water temperature recorded near the lagoon bottom (0.5 feet from the bottom) has greatest relevance to assessing habitat quality.

As in past years, lagoon water temperatures in 2011 closely reflected those of the stream inflow (**Figures 4a-l; 5a-b**). Daily temperature *minima* in the lagoon were consistently warmer near the bottom than the stream inflow in 1999-2011 (**Table 4**). In 2011, the 7-day rolling average temperature was 1.3 – 1.5° C cooler in the stream than near the lagoon bottom near the trestle, as substantiated by seasonal minima (15.4° C vs. 16.2°C) and maxima (17.3° C vs. 18.2°C) (**Table 4**). The average 7-day rolling average of 16.4°C in the stream was 0.8°C less than 17.2°C at 0.5 feet from the lagoon bottom. Stream inflow temperature in 2011 was generally about 1°C cooler in the morning and afternoon than near the lagoon bottom, with much reduced daily fluctuation in both the stream and the lagoon in September and October (**Figures 4a and 5a**). The difference in the 7-day rolling averages was also approximately 1°C. We see from comparisons of 7-day rolling averages for 2011 and 2010 near the bottom that it fluctuated less in 2011 and was similar between years until late August and September when it was usually approximately 1°C cooler in 2011. Both years were much cooler than 2009, however. The 2011 lagoon's rolling average near the bottom was 2-4°C cooler than in 2009 and 2-3°C cooler near the surface for all but the latter half of September when 2011 was 1°C cooler, consistent with cooler inflow temperatures (**Figures 4a, 4k, 4m-p; 5a-c**).

Table 4. Water Temperature Statistics for Continuous Water Temperature Probes with Readings at 30-minute Intervals in Soquel Lagoon and Stream Inflow Immediately Upstream, Early June – 15 September in 2009 and 2010 and 30 June – 15 September in 2011.

Year	Statistic	Stream Inflow Temperature °C	Near-Surface Lagoon Temperature @5.5 ft from Bottom °C	Near-Bottom Lagoon Temperature @ 0.5 ft from Bottom °C
2011	Maximum Water Temperature °C	23.6	21.0	19.8
2011	Minimum Water Temperature °C	14.1	16.0	15.6
2011	Maximum 7-Day Rolling Average	17.3	19.0	18.2
2011	Minimum 7-Day Rolling Average	15.4	16.8	16.2
2011	**Average 7-Day Rolling Average**	**16.4**	**18.0**	**17.2**
2010	Maximum Water Temperature °C	19.8	21.0	20.6
2010	Minimum Water Temperature °C	13.7	15.2	15.2
2010	Maximum 7-Day Rolling Average	17.5	19.5	18.8
2010	Minimum 7-Day Rolling Average	14.8	16.7	16.3
2010	**Average 7-Day Rolling Average**	**16.0**	**17.9**	**17.4**
2009	Maximum Water Temperature °C	19.1	22.5	22.1
2009	Minimum Water Temperature °C	14.1	15.9	15.3
2009	Maximum 7-Day Rolling Average	17.5	21.5	21.0
2009	Minimum 7-Day Rolling Average	15.7	18.0	17.6
2009	**Average 7-Day Rolling Average**	**16.7**	**20.1**	**19.8**

As in past years, no stratification or lagoon thermocline (*a thermocline has a warm, well-mixed, oxygen-rich epilimnion above it and a cool, non-circulated, oxygen-poor hypolimnion below*) was detected in 2011 by the data loggers at the deep area near the trestle or at any of the 4, two-week monitoring stations (**Figures 4a-1; 6a-1 and 6a-2**). The lagoon was likely 7−8 feet deep, at most, and subject to daily inland breezes that circulated the water, surface to bottom. There was complete, diurnal (daily) mixing of the water column except in deeper pockets when a temporary, heavy and stagnant saline layer developed from tidal overwash the evening of 10 July. In this case, the saltwater had dissipated by the next 2-week monitoring. During the short period of less than two weeks, a stagnant saline layer developed in the deep hole adjacent to the Venetian Court wall.

Lagoon water temperature was slightly warmer near the surface than near the bottom, as seasonal maxima and minima of temperatures and 7-day rolling averages indicated (**Table 4**).

The greatest increase in water temperature recorded from morning to afternoon near the bottom in 2010 was **3°C** (5.4° F) on 5 July compared to **2.7°C** in 2010, **2.7° C** in 2009; **1.9° C** in 2008 and **3.0°C** in 2007 (**Figures 4a-b; 4n and 4p; Alley 2010b**). The greatest increase near the lagoon surface in 2011 was **2.7°C** (4.8°F) on 18 July compared to **3.1°C** in 2010, **4.6° C** in 2009, **2.3° C** in 2008 and **5.4°C** in 2007 (**Figures 4k-l; 4m and 4o; Alley 2010b**).

Days when lagoon water temperatures exceeded 22º C (71.6º F) near the lagoon bottom would likely be stressful for juvenile steelhead. Therefore, the lagoon management goal is to maintain water temperature below 22ºC. In 2010 and 2011, water temperature did not rise above 21°C near the bottom or the surface (**Figures 4a and 4k**). In 2009, it was above 22° C on 8 days, primarily in early August (4 successive days). In 2008, it was above 22ºC on 13 days, primarily in early July (4 successive days) and mid-July (6 successive days) related to a warm saline layer. In 2007, it was above 22º C on 20 days, primarily in mid-July (9 successive days) and early September (6 successive days). This was compared to only 4 days (22-25 July) in 2006 (**Alley 2006**). In 2005, water temperature near the bottom never reached this threshold. It only went above 22°C once (12 July) at the surface (**Alley 2005**). In 2004, the <22ºC goal near the bottom was not met for 5 days after tidal overwash on 19 July, 4 days in August and 2 days in early September (**Alley 2005**). But conditions were more stressful in 2001 when there had been two major tidal overwashes. In 2001, daily temperatures near the bottom fluctuated between approximately 23 and 26ºC (73.4–78.8ºF) for 14 days (**Alley 2003c**).

As in 2010, the 2011 lagoon met the steelhead management goal of maintaining early morning minimum temperature below 20°C near the bottom throughout the season (**Figures 4a and 4m**) compared to not meeting the goal on 16 of 131 days (12%) in 2009 (**Figure 4n**), 54 of 130 days (42%) in 2008 and 35 of 124 days (28%) in 2007 (**Alley 2010b)**. In 2005 and 2006 (after wetter winters), the management goal was reached during the lagoon season. In the 2004 lagoon, 27% of the days (34 of 125 days) failed to meet the management goal partially due to tidal overwash. This was compared to 19% in 2003 and 10% in 2002.

The coho management goal of keeping maximum water temperatures below 20ºC (68ºF) near the bottom in the presence of steelhead was met for the lagoon period in 2011 compared to not being met 6% of the days measured (7 of 127 days) in 2010 and 57% of the days measured (75 of 131 days) in 2009; 69% in 2008, 66% in 2007 and 17% in 2006. However, coho prefer temperatures below 16°C (depending on food abundance) (**J. Smith pers. communication**), and the lagoon temperature near the bottom went to 16°C or below on 26 days (28%) compared to 56 days (44%) in 2010. But the daily maximum was always above 16°C in 2011 and was above 16°C except for 5 days in early October 2010. In 2009, lagoon temperature went down to 16° C or below on 9 days but the daily maximum was always more. The 2008 lagoon failed to cool to 16°C.

At the creek site near Nob Hill in 2009−2011, the stream management goal was met for steelhead of *no more than 4 hours a day at greater than 20ºC (68ºF)* (**Figures 5a, 5c and 5d**) and failed on only 1 day (**0.8%**) in 2008 (**Figure 5e**). In 2011, water temperature reached 20°C on one day while in 2009 and 2010, water temperature did not reach 20°C. In 2007, water temperature failed to meet this management goal on **4%** of the days (**Figure 5e**) compared to **12%** in 2006 (**Figure 5f**). At the creek site in 2005, water temperature failed to meet the management goal **5%** of the days (**Alley 2005**). In 2004, **7%** of the days did not meet the goal. September was unusually cool in 2004 and 2005 (**Alley 2005**). At the Creek site in 2003, **17%** of the days failed to meet the management goal (**Alley 2005**).

The Soquel Creek water temperature goal for coho salmon in stream habitat is average weekly temperature (7-day rolling average) of16.7º C (62º F) or cooler. In 2011 the management goal was not met 23 days (25%) in July of the 93-day lagoon period (**Figure 5a**), with it reaching a maximum of 17.3°C. In 2010 the goal was met except for 7 days (6% of the days) consisting of 3 days in early June and 4 days in mid-July (**Figure 5c**). Coho salmon may have survived in the 2010 and 2011 stream habitat near the lagoon if present. However, in all other past monitoring years, considerably more stream shading and streamflow would be required to make lower Soquel Creek habitable for this species. From late May to the end of September 2009, the average weekly temperature went as high as 17.5° C and was higher than 16.7° C for a 13-day period and a separate 15-day period (**Figure 5c**). From late May to the end of September 2008, the average weekly temperature went as high as 18.2ºC (64.7ºF) on 9 July and was higher than 16.7° C for a 20-day period (**Figure 5d**).

The daily stream water temperature fluctuated more than the daily lagoon water temperature near the bottom in 2011, which was typical for previous years except 2010. The maximum daily lagoon water temperature typically occurred between 1700 and 2100 hr each day.

The 7-day rolling average for creek water temperatures were similar for 2010 and 2011, although daily fluctuations were greater in 2011. They were cooler in 2010 than 2009, cooler in 2009 than 2008, which was cooler than 2007, based on graphical representations of the 7-day rolling averages. 2011 had the highest baseflow of the last five years (**Table 10**).

Creek water temperatures in 1999-2011 were much cooler than in 1998, despite the much higher baseflow in 1998. In 1998, there was a 20-day period in which water temperature rose above 21º C (69.8º F) for several hours each day in the stream above the lagoon, with a maximum of approximately 23.5º C (74.3º F) on 3 August 1998 (**Alley 2005**). Daily maxima were still approaching 21ºC on 4 September 1998. Considerable riparian vegetation had been removed by El Niño stormflows the previous winter. Despite the warm stream temperatures, lagoon water temperatures in 1998 were relatively cool, with higher stream inflow compared to other years (**Alley 2003**).

Aquatic Vegetation Monitoring. In 2011 at the time of the second sandbar construction on 20 June, approximately 60% of the kelp and seagrass had been raked out of the lower lagoon, and the lagoon bottom was relatively firm. This was compared to 90% in 2010 and 70% in 2009. There was less bottom algae by itself in the 2011 and 2010 lagoons compared to 2009, though there was more pondweed with attached algae in 2010 (**Tables 5-7**). Evidence of nutrient inputs from Noble

Gulch was expressed by constant thick planktonic algae, sporadic high amounts of surface algae and thicker bottom algae than other sites in 2011. Pondweed was first detected in early September 2011 and was most prominent in Reach 2. Filamentous algae was first noted in late July in 2011.

Surface algae in 2011 varied between 0 and <1% in Reach 1 (0 and 1% in 2010), 0 and 25% in Reach 2 (0 and 5% in 2010), 0 and 5% in Reach 3 (0 and 8% in 2010) and 0 and 20% at the mouth of Noble Gulch (0 and 30% in 2010) (**Tables 5 and 6**). Surface algae was less prevalent in 2011 and 2010 than 2009 except sporadically it was as high at Noble Gulch. It was much more prevalent in 2009 than most years, with the average and maximum surface coverage being more than double that of 2008 in Reaches 1 and 2 and at the mouth of Noble Gulch (**Tables 7 and 8**). The average surface algae coverage for Reaches 1−3 and mouth of Noble Gulch in 2011 were 0.1%, 3.6%, 1.3% and 1%, respectively (0.1%, 1.1%, 1.6% and 7.5%, respectively in 2010 and 2%, 4%, 0.6% and 8.2% respectively in 2009). The years, 2007−2009, were dry years with minimal stream inflow to the lagoon. Surface algae coverage in 2007 and 2008 varied between 0 and 10% in the different reaches, with similar 2-week estimates between the two years except for a higher amount in mid-August 2007. In 2007, the average coverage at the mouth of Noble Gulch was similar to 2009 and 2010 due to 30% and 15% coverage mid August and early September 2007 (**Alley 2008**). Surface algae in 2006 (a relatively wet year with high stream inflow) varied between 0 and 5% coverage, with the most being present in Reach 3 and near Noble Gulch (**Alley 2007**). By contrast, surface algae in 2005 (also a wet year) varied between 0 and 20% coverage of Reach 3, with very little in the lower 2 reaches (maximum was 2%) (**Alley 2006**).

Bottom algae thickness in the 2011 lagoon was less than in 2010 or 2009. In 2011, bottom algae thickness at in Reaches 1−3 and at the mouth of Noble Gulch averaged 0.6 ft, 0.6 ft, 0.3 ft and 1.1 ft, respectively (**Table 5**). This was compared to 2010 averages of 0.8 ft, 0.8 ft, 0.8 ft and 2.2 ft, respectively, and 2009 averages of 1.7 ft, 1.2 ft, 0.9 ft and 1.4 ft, respectively (**Tables 6 and 7**).

Table 5. Visually Estimated Algae Coverage and Thickness in the 2011 Lagoon (pondweed with attached algae included).

Date	Reach 1			Reach 2			Reach 3			Mouth of Noble Gulch		
Month /Day	**Avg. Bottom Thick-ness (ft)**	**% Bottom Algae Cover**	**% Surf. Algae Cover**	**Avg. Bottom Thick-ness (ft)**	**% Bottom Algae Cover**	**% Surf. Algae Cover**	**Avg. Bottom Thick-ness (ft)**	**% Bottom Algae Cover**	**% Surf. Algae Cover**	**Avg. Bottom Thick-ness (ft)**	**% Bottom Algae Cover**	**% Surf. Algae Cover**
7-10	0	0	0	0	0	0	0	0	0	Turbid-Yellow/brown water	Turbid	0
7-26	0.6	60	0	0.5	70	0	0.3	60	0	Thick plankton bloom	Turbid	0
8-10	1.0	60	0	1.0	70	0	Dark	Dark	2% ds Noble; 5% us Noble	1.0 Thick plankton bloom	80	20 after-Noon
8-23	Dark	Dark	<1 morning	0.3	100	25 morning	0.3	80	10% ds Noble; <1% us Noble	Turbid Thick plankton bloom	Turbid	5 morning
9-5	0.5	100	<1	1.0	70 (1 pond-weed)	0	0.3	70 (1 pond-weed)	0	Thick plankton bloom/gray water	Turbid	0
9-18	0.4	100	0	0.6	100 (1 pond-weed)	0	0.4	100	0	0.8 Thick plankton bloom/gray water	100	0
10-01	1.0	90	0	0.5	100 (5 pond-weed)	0	0.5	95	0	1.5 Turbid-gray/brown Water	90	0
Avg-7-10 – 10-01	**0.6**	**68**	**0.1**	**0.6**	**73**	**3.6**	**0.3**	**68**	**1.7 ds Noble/ 0.8 us/ 1.3 total**	**1.1 (limited obs.)**	**90 (limited obs.)**	**1**

Table 6. Visually Estimated Algae Coverage and Thickness in the 2010 Lagoon (pondweed with attached algae included).

Date	Reach 1			Reach 2			Reach 3			Mouth of Noble Gulch		
Month /Day	**Avg. Bottom Thick-ness (ft)**	**% Bottom Algae Cover**	**% Surf. Algae Cover**	**Avg. Bottom Thick-ness (ft)**	**% Bottom Algae Cover**	**% Surf. Algae Cover**	**Avg. Bottom Thick-ness (ft)**	**% Bottom Algae Cover**	**% Surf. Algae Cover**	**Avg. Bottom Thick-ness (ft)**	**% Bottom Algae Cover**	**% Surf. Algae Cover**
6-19	0.3	10	0	0.3	15	0	0.3	25	0	Turbid	Turbid	0
7-04	0.3	30	0	0.3	60	0	0.3	30	0	Turbid	Turbid	0
7-19	0.8	70	<1	0.8	60	2	0.5	80 (<1 pond-weed)	20 ds Noble/<1 us/8 total	Turbid	Turbid	25
8-02	1.0	80 (1 pond-weed)	0	1.0	65	5	2.0	40 (<1 pond-weed)	15 ds Noble/ 1 us/5 total	0.5	30	5
8-15	1.0(pond-weed 3.0)	85 (15 pond-weed)	0	0.8	40	0	1.0	50 (<1 pond-weed)	0	Turbid	Turbid	0
8-29	2.0(pond-weed 4.0)	60 (10 pond-weed)	0	1.0	30	0	1.0	99	0	Turbid	Turbid	0
9-12	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0
9-26	0.5(pond-weed 2.0)	40 (20 pond-weed)	<1	0.5 (pond-weed 2.0)	85 (15 pond-weed)	3	0.5(pond-weed 3.5)	90 (10 pond-weed)	2	3.0	35	30
10-09	0.7(pond-weed 4.0)	60 (20 pond-weed)	1	2.0(pond-weed 3.0)	50 (30 pond-Weed)	1	1.0(pond-weed 3.0)	70 (20 pond-weed)	1	3.0	30	15
10-23	Turbid	Turbid	0	Turbid	Turbid	0	Turbid	Turbid	0	Turbid	Turbid	0
Avg-6-19 – 10-23	**0.8**	**53**	**0.1**	**0.8**	**51**	**1.1**	**0.8**	**97**	**3.8 ds Noble/ 0.4 us/ 1.6 total**	**2.2 (limited obs.)**	**32 (limited obs.)**	**7.5**

Table 7. Visually Estimated Algae Coverage and Thickness in the 2009 Lagoon (pondweed with attached algae included).

Date	Reach 1			Reach 2			Reach 3			Mouth of Noble Gulch		
Month /Day	**Avg. Bottom Thick-ness (ft)**	**% Bottom Algae Cover**	**% Surf. Algae Cover**	**Avg. Bottom Thick-ness (ft)**	**% Bottom Algae Cover**	**% Surf. Algae Cover**	**Avg. Bottom Thick-ness (ft)**	**% Bottom Algae Cover**	**% Surf. Algae Cover**	**Avg. Bottom Thick-ness (ft)**	**% Bottom Algae Cover**	**% Surf. Algae Cover**
6-07	—	—	5	—	—	2		—	<1	0.4	60	2
6-21	1.1	40	3	0.3	70	10	0.5	80	2	0.5	60	20
7-02	—	—	0	0.5	100	0	0.5	100	0	0.8	70	5
7-19	1.0	70	<1	1.5	100 (1 pond-weed)	25	0.5	100 (1 pond-weed)	3	1.0	95	2
8-01	2.0	100	0	2.0	100 (2 pond-weed)	<1	1.5	100 (2 pond-weed)	<1	1.2	70	25
8-15	2.0	95 (20 pond-weed)	0	0.5	90	0	1.0	100 (1 pond-weed)	0	2.0	90	1
8-29	2.0	90	5	1.5	95	3	1.0	98	<1	2.0	70	7
9-12	2.0	100	<1	2.0	80 (<1 pond-weed)	<1	1.5	100 (1 pond-weed)	1	3.0	60	20
9-26	Turbid	Turbid	0	Turbid	Turbid	0	Turbid	Turbid	<1	Turbid	Turbid	0
10-10	Dark	Dark	5	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0
Avg- 6-07 – 9-12	**1.7**	**83**	**2.0**	**1.2**	**91**	**4.0**	**0.9**	**97**	**0.6**	**1.4**	**72**	**8.2**

Table 8. Visually Estimated Algae Coverage and Thickness in the 2008 Lagoon (pondweed with attached algae included).

Date	Reach 1			Reach 2			Reach 3			Mouth of Noble Gulch		
Month /Day	Avg. Bottom Thick-ness (ft)	% Bottom Algae Cover	% Surf. Algae Cover	Avg. Bottom Thick-ness (ft)	% Bottom Algae Cover	% Surf. Algae Cover	Avg. Bottom Thick-ness (ft)	% Bottom Algae Cover	% Surf. Algae Cover	Avg. Bottom Thick-ness (ft)	% Bottom Algae Cover	% Surf. Algae Cover
6-7	0 Light Phyto-Plank-ton	0	0	0 Light Phyto-Plank-ton	0	0	0 Light Phyto-Plank-ton	0	0	0 Light Phyto-Plank ton	0	0
6-21	0.3	40	1	0.4	80	3	0.3	40	3	-	-	10
7-06	0.5	30	<1	0.4	25	<1	0.3	40	<1	0.4	50	<1
7-20	0.5	30	0	0.4	99 (1 pond-weed)	0	0.4	100	0	0.5	30	0
8-03	1.0	95 (5 pond-weed)	0	1.0	95 (5 pond-weed)	0	0.6	99	<1	0.6	60	5
8-16	2.0	95 (5 pond-weed)	0	2.0	97 (3 pond-weed)	0	2.0	100	0	0.6	70	1
8-30	3.0	95 (5 pond-weed)	0	1.75	95 (5 pond-weed)	<1	1.0	99	1	0.2	40	5
9-13	2.0	70 (20 pond-weed)	<1	2.0	93 (7 pond-weed)	2	2.0	50	2	1.0	20	2
9-28	Glare	Glare	0	2.0	95 (5 pond-weed)	0	2.0	85 (15 pond-weed)	0	Glare	Glare	0
10-13	Turbid – phyto-plank-ton Bloom	Turbid - (15 pond-weed)	0	Turbid – phyto-plank-ton Bloom	-	2	Turbid – phyto-plank-ton Bloom	-	0	Turbid – phyto-plank-ton Bloom	-	0
10-26	Turbid	-	0	Turbid	-	0	Turbid	-	0	Turbid	0	0
Avg- 6-07 – 9-13	**1.2**	**57**	**0.15**	**1.0**	**73**	**0.65**	**0.8**	**66**	**0.8**	**0.5**	**39**	**2.9**

<u>Dissolved Oxygen Results.</u> Oxygen concentration in the lagoon is lowest at dawn, or soon after, because oxygen has been depleted by cell respiration over night before plant photosynthesis can begin producing oxygen with the light. This is the time when oxygen concentrations are most importantly measured and rated. In 2011, oxygen levels for steelhead were "good" (greater than 7 mg/l at dawn) *near the bottom at dawn* at all stations during the 7 two-week monitorings and on Begonia Festival Day except a "poor" rating at Station 3 (Railroad trestle) on 1 October (**Tables 2 and 3, Figure 6a-1 and Appendix A**).

Lower oxygen concentration at dawn is usually associated with more algae present in concert with a previously cloudy/foggy day or a stagnant saline layer along the bottom that prevents the bottom layer from circulating with the surface and other oxygen-rich water. At dawn after a previously sunny day, oxygen levels are higher because the water became supersaturated with oxygen from high photosynthetic rates of the lagoon algae and pondweed the previous day. Oxygen levels in 2011 at dawn were generally similar to those in 2010 and higher than in 2006−2009 (**Figures 6a-1; 6f−i**). An explanation for the low oxygen level measured at the railroad trestle on 1 October may be that pollutants may have entered the lagoon from the stormdrain nearby to increase the biological oxygen demand and deplete the oxygen in the vicinity.

In comparing morning and afternoon oxygen levels, usually oxygen concentration was higher in the afternoon than morning, despite warmer water temperature in the afternoon which has a lower saturation point. However, in 2011 with the low algae concentrations and occurrence of overcast days, this was not always the case or oxygen was not much higher in the afternoon. At Site 1 near the flume, morning and afternoon oxygen levels were similar in July and August, with more contrast in September and early October (**Figure 6b**). At Stations 2 and 3, oxygen levels in the morning and afternoon were similar on 3 of 4 monitorings in July and August, with them higher in the morning at Site 2 in late July, which is highly unusual (**Figures 6c-d**). Oxygen concentration was also higher in the morning than in the afternoon at Station 4 in early July, higher in the afternoon the remainder of the season (**Figure 6e**). Oxygen levels on the afternoon of the Begonia Festival (5 September) were supersaturated near the bottom at Sites 2−4 despite late clearing skies that day (**Appendix A**). Oxygen levels were consistently less in the afternoon than in the morning at Site 5 above the lagoon (**Figure 6f**). This was consistent with the warmer afternoon water temperature and less algae to produce oxygen during the day in the stream than in the lagoon.

<u>Salinity Results.</u> In 2011, saline conditions were only detected a short time after the first sandbar closure (31 May) in the deeper lagoon area along the wall at Venetian Court (**Appendix A**). This resulted from a small amount of saltwater being trapped in the lagoon at the time of sandbar closure on 27 May. Shrouds were not installed on the sandbar inlet at that time because it was assumed that the high stream inflow would soon force the saltwater out through the sandbar. On 10 July Public Works staff observed tidal overwash and installed the flume inlet shrouds to evacuate the saltwater. By the next two-week monitoring time, no saltwater remained. It was hypothesized that beachgoers had breached the berm around the lagoon near Venetian Courts to drain a surface pool of ocean water after the high tidal event, thus introducing saline water to the lagoon. Unlike in 2008, there was apparently sufficient lagoon outflow through the flume in 2011 to prevent saltwater from periodically being flushed back into the lagoon through the flume on certain high tides.

Conductivity Results. Conductivity remained low throughout 2011, except in the Venetian Court's wall-hole early on when saltwater was present at the bottom. Otherwise, it ranged between 590 umhos early in the season to 675 umhos on 1 October (**Appendix A**). Conductivity was usually slightly lower near the bottom in the afternoon at Station 4 as slightly cooler water entered the lagoon from Noble Gulch. Conductivity was slightly lower at Station 5 above the lagoon than in the lagoon.

Stream In-Flow to the Lagoon. The lagoon water quality is generally best with relatively higher summer baseflow. Higher summer baseflow flushes saltwater out through the sandbar and flume more quickly than less baseflow, thus reducing the heating effects of a stagnant saline layer on the lagoon bottom. Higher baseflow causes more outflow through the flume to prevent saltwater back-flushing through the flume into the lagoon. The lagoon mixes and cools more overnight when inflow is higher. In 2008 there were repeated problems with apparent saltwater back-flushes through the flume at high tides. This was not a problem in 2009 − 2011 with higher streamflow than in 2008 (**Table 9**). The year 2001 was most affected by tidal overwash in the last 11 years (**Alley 2002a**). In recent years, the sandbar around the periphery of the lagoon has been maintained at a higher elevation to prevent tidal overwash.

With proper flume management and the new grated flume ceiling installed in 2003, it should be easier to maintain lagoon depth and prevent fluctuations in lagoon level when the summer begins with high baseflow. To maximize summer baseflow, water percolation into the aquifer during the rainy season must be maximized and surface runoff must be minimized. Summer water diversion and pumping from the underflow of the creek reduce summer baseflow and should be curtailed quickly if surface flow becomes discontinuous in lower Soquel Creek.

Stream inflow to the 2011 lagoon followed an above average winter rainfall amount with a significant stormflow on 24 March (6000+ cfs) that resulted in flooding of Capitola. 2010 was also an above average rainfall year, with 2007−2009 being below average winters for rainfall (**Figures 25−27**). Baseflow at the time of the first sandbar closure was approximately 25 cfs (compared to 14 cfs in 2010) and approximately 20 cfs during the second sandbar closure on 21 June (**Table 9; Figures 22 and 23**). 2011 had the third highest baseflow on 1 June for the past 21 years, with 1995 and 1996 only slightly less. By 1 September, prior to any fall rainfall, 2011streamflow had declined to 5.8 cfs at the Soquel Village USGS gage, compared to 3.4 cfs in 2010, 1.2 cfs in 2009, 0.7 cfs in 2008, 1.3 cfs in 2007 and 6.6 cfs in 2006. The 1 September 2011 baseflow was the third highest in the last 21 years. The first relatively small stormflow that peaked at about 130cfs, but exceeded the capacity of the flume, necessitated an emergency breach of the sandbar on 5 October. Only two smaller November stormflows peaking about 30 cfs occurred between then and 20 December (**Figure 24**). The sandbar has periodically closed for short periods during high tides between 5 October and 20 December at a baseflow of between 5 and 8 cfs but never remained closed through an entire tidal cycle (**Ed Morrison, personal communication**). On 27 December the sandbar was open with an estuary as deep as it was with the sandbar closed, having a gage height of 2.30.

Drain Line Test for Restaurants Contiguous with Soquel Creek Lagoon. The 6 restaurants, contiguous with the Soquel Creek Lagoon that had accessible plumbing systems were tested for leaks and deficiencies in plumbing connections and repaired as necessary. Confirmation is contained in **Appendix B**.

Begonia Festival Observations and Water Quality Findings. The City's fishery biologist (Donald Alley) was present before, during and after the Begonia Festival parade. The day of the parade, 4 September, was initially overcast until 1400 hr, after which it was sunny, though cool, for the remainder of the day, much like the previous year. Water temperatures were cooler in the morning than 2 weeks previous, and oxygen levels were similar and in the "good" range. The lagoon depth was maintained at an excellent gage height of 2.51 ft during the nautical parade. There were 6 floats in the nautical parade and 20other boats (mostly kayaks) and 6 standing surfboarders in the water. In conformance with the permit requirements from the California Department of Fish and Game, no floats were set up to be propelled by waders. Means of propulsion included electric motor with paddlers on board and by kayaks with draw ropes. Thus, the lagoon bottom was undisturbed. Conductivity near the bottom increased very slightly at the Stockton Avenue Bridge from 634 before to 650 umhos after the parade. Conductivity at the mouth of Noble Gulch was 624 umhos near the bottom before the procession and 641 afterwards (**Appendix A**). The measured levels of conductivity were not stressful to steelhead. There was no odor of hydrogen sulfide, and no fish mortality was observed.

Oxygen concentrations in the afternoon following the nautical parade were high, ranging between 10.66 and 15.65 mg/l near the bottom before 1435 hr (**Appendix A**). Water temperatures at this time were the coolest in 21 years near the bottom (16.7−16.8° C) and likely became somewhat warmer later in the day.

Floats were dismantled the following week, and flowers were gathered from the lagoon, using a boat. More than 90% of the petals were retrieved. Water quality measurements on 18 September detected no oxygen depletion resulting from decomposing begonias (**Figure 6a-1; Appendix A**).

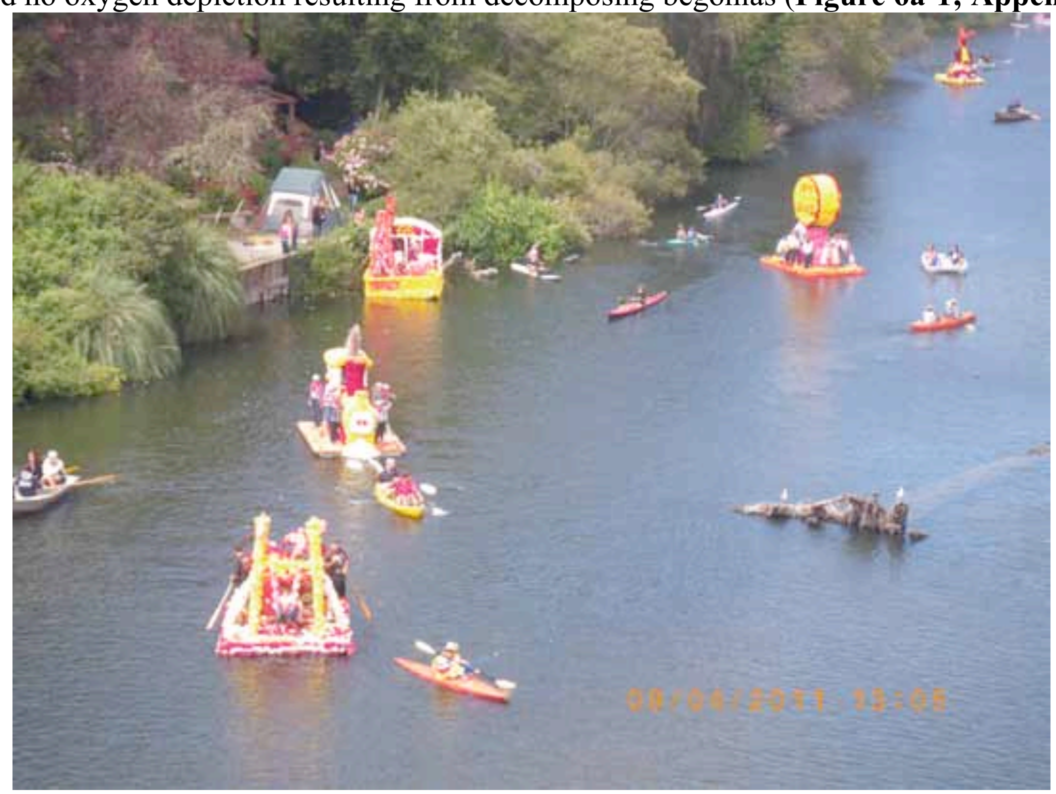



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Table 9. Daily Mean Discharge Recorded at the USGS Stream Gage (11160000) in Soquel Village, At One Month Intervals from 1 June to 1 October, 1991-2010 from Graphical Representations.

Year	1 June Streamflow (cfs)	1 July Streamflow (cfs)	1 August Streamflow (cfs)	1 September Streamflow (cfs)	1 October Streamflow (cfs)
1991	4.1	2.6	1.5	0.65	0.37
1992	4.0	4.0	0.6	0.1	0.2
1993	12	5.8	3	1.8	1.6
1994	4.2	1.3	0.7	0.2	0.05
1995	24	17	7.8	4.5	3.7
1996	23	17	8	4.6	3.6
1997	9	7.7	4.2	2.6	2.3
1998	58	22	13	9.7	7.2
1999	16	10	7.4	5.7	4.3
2000	14	9.5	6.2	4.6	7.4
2001	7.2	4.0	3.4	2.6	1.6
2002	9.1	4.9	3.3	2.8	2.2
2003	15	7.2	4	2.2	1.8
2004	5.2	3.3	2.7	1.8	1.4
2005	20	13	7.5	5.1	3.1
2006	28	17	8.7	6.6	7.1
2007	4.7	2.3	2.0	1.4	1.3
2008	3.8	2.0	1.3	0.7	1.4
2009	6.2	3.3	2.5	1.2	0.5
2010	14	7.3	5.3	3.4	2.2
2011	25	15	8.6	5.8	4.5

<u>Pollution Sources.</u> The lagoon near the beach was closed to human contact due to bacterial levels above the maximum acceptable level. The gulls are a primary source of pollution, both for bio-stimulating nutrients and bacteria. They forage through the human refuge left on the beach. They bathe and defecate in the lagoon. They roost and defecate on the buildings surrounding the lagoon. Reducing the gull population at Soquel Creek Lagoon would be a major step in reducing pollution. The use of gull sweeps has been observed to be successful in other locales to prevent gull roosting. The parallel wires strung across the roof of the Paradise Grill have been effective in discouraging roosting on that restaurant. All of the refuse cans on the beach were equipped with gull-proof lids since 2006 (**Ed Morrison, pers. comm.**). Refuse containers with gull-proof lids may reduce gull numbers. The City had received funding to deter gull use on restaurant roofs, to redirect restaurant gutter systems away from the lagoon and to provide waste cans with gull-proof lids. However, attempts at partnership between the City and Esplanade restaurants for adding gull deterrents to their roofs has, thus far, been unsuccessful. However, conditions of future remodeling will require addition of roof deterrents (**Steve Jesberg, Public Works Director, pers. comm.**). Rock doves (pigeons) are another source of bird pollution as they circulate between the wharf and the railroad trestle over Soquel Creek Lagoon. As stated in the original Management Plan, the trestle could be screened to eliminate pigeon roosting areas.

Regarding pollution from urban runoff, installation and maintenance of silt and grease traps on storm drains is critical to reducing pollution by petro-chemicals. All new drainage systems from new development and parking lots should be installed with effective traps and percolation basins to encourage winter percolation of storm runoff. The City redirected dry-weather runoff to the constructed wetland on the west side of the Stockton Avenue Bridge (just upstream) from the drain on the east side of Stockton Avenue Bridge (just upstream) and the drains at the pier and Venetian Court. Water quality measurements taken at the outlet of the wetland in 2009 and 2010 indicated only slight differences compared to those taken at the Stockton Bridge, with no impact to steelhead habitat conditions (**Alley 2010b**). In 2009, oxygen levels near dawn at the wetland outlet were usually very slightly higher than at the Stockton Bridge and water temperatures were very slightly cooler. In 2010, water temperatures were slightly cooler at the wetland outlet, but oxygen levels at dawn were slightly higher on 3 of 6 monitorings and slightly lower on 3. After speaking with Bruce Arthur regarding wetland construction and observing the small water output compared to the large input, it appeared that significant leakage occurred under the wetland.

Ideally, all storm drains leading to the lagoon should be re-directed away from the lagoon in summer. Included in these is the culvert that drains Noble Gulch. Significant quantities of gray water and oily slicks have consistently emptied into the lagoon from Noble Gulch until 2001, and again in 2005 and 2006 (**Alley 1995; 1996b; 1997-2000; 2005; 2006**). There was improvement noted in 2008 with no gray water observations and in 2007 with only one instance. By comparison, these plumes were observed on 8 of 12, two-week monitorings in 2006. This improvement may have resulted from replacement of sewage pipes along Riverview Road in the vicinity of Noble Gulch in fall of 2006. In 2010, gray water was observed at Noble Gulch on 3 of 10 two-week monitorings, with the first seen in August. In 2011, gray water was observed at Noble Gulch on 4 of 7 two-week monitorings plus on Begonia Festival Day. High levels phytoplankton bloom s near the Gulch mouth were noted on 5 of 7 monitorings, and surface algae was commonly higher at Noble Gulch and sometimes downstream (**Table 5**). Therefore, Noble Gulch continues to be a pollution source to the summer lagoon and may be worsening. When gray water was observed at the Noble Gulch culvert outlet to the lagoon, streamflow was clear in Noble

Gulch at the park when checked, before the creek went underground into the culvert.

There has been a pollution problem and high flashiness in streamflow in the past during the first small storms of the fall. At times, the lagoon required breaching prematurely because the flume could not accept all of the stormflow, and flooding was imminent. Retrofitting of storm drainage systems with holding tanks or percolation basins could reduce the sudden increase in street runoff and pollution during early storms. Drains leading from Wharf Road (across the Rispin property), the Auto Plaza and 41st Avenue businesses north of Highway 1 are some of the sources of this problem.

Discussion of Options to Improve Water Quality

All storm drains leading to the lagoon should ideally be re-directed away from the lagoon in summer. Included in these is the culvert draining Noble Gulch. Significant quantities of gray water and oily slicks have consistently emptied into the lagoon from Noble Gulch until 2001, and gain in 2005 and 2006 (**Alley 1995; 1996b; 1997-2000; 2005**). There was improvement noted in 2007 with only one instance (30 September) of an observed gray water plume issuing from Noble Gulch out of 14, 2-week monitorings. There was continued improvement in 2008 and 2009, with no gray water observed during the 2-week monitorings. By comparison, these plumes were observed on 8 of 12, 2-week monitorings in 2006. This improvement may have resulted from replacement of sewage pipes along Riverview Road in the vicinity of Noble Gulch in fall of 2006. In 2005, gray water plumes and sometimes oil slicks were observed on 7 of 13, 2-week monitorings. The gray water problem occurred particularly in late September and October in 2005 and was correlated with the highest surface algae estimates. By contrast, gray water plumes were observed in 2004 on only 1 of 11, 2-week monitorings. As further history of the problem, in 2001 and 2002, no gray water was observed during monitorings, but in 2003, the water was murky on 2 of 12 monitorings. In 2000 and 2011, gray water plumes were observed on 5 of the 7 two-week monitorings.

Stimulation of algal growth has annually occurred at the mouth of Noble Gulch, with consistently greater growth there compared to elsewhere in the lagoon in most years except 2001. Increased algal growth indicates elevated nutrient inputs probably associated with bacteria and retention of decomposing kelp and seagrass in the lagoon at the time of sandbar closure. Oxygen depletion noted at dawn has been greater at the mouth of Noble Gulch in 2002-2005, 2007 and 2011for the majority of monitorings and other years (**Alley 2010b**), with usually lower oxygen readings at that station (**Alley 2005**). However, in 2006, 2008−2010 oxygen depletion at dawn was not consistently greatest at the mouth of Noble Gulch (**Figures 6a, 6f and 6h**).

Usually, when cloudy water enters the lagoon from Noble Gulch, the water is clear upstream in Noble Gulch at the park beyond Bay Street. This indicates that pollutants enter Noble Gulch from the lower village near Soquel Creek. There are ducks living at the mobile home park up that drainage that could be removed to reduce nutrient influxes and coliform bacterial inputs. A flashboard dam could be constructed in Noble Gulch at Bay Street to impound water to be pumped out for irrigation purposes, provided that lagoon depth is adequately maintained. Coliform counts greater than 200/ 100 ml are considered a hazard to human health.

By minimizing the summer stream inflow from Noble Gulch, nutrients and bacteria entering the lagoon would be reduced. Algae production may also be reduced. However, the benefit of slight reduction in lagoon water temperature at the mouth of Noble Gulch would be eliminated. Another drain into the lagoon is situated under the railroad trestle, where slight oxygen depletion has been detected in recent years and on 1 October 2011. This drain could be capped if summer runoff was re-directed into the sewer.

The gulls are a primary source of pollution, both for bio-stimulating nutrients and bacteria. They forage through the human refuge left on the beach. They bathe in the lagoon. They roost on the buildings surrounding the lagoon. Restaurant goers and others feed them. Reducing the gull population at Soquel Creek Lagoon would be a major step in reducing pollution. It is likely that the gull population is artificially high because of the artificial food source and artificial roosting areas. If these were reduced, then the gull population would probably decline, and pollution would be reduced at Soquel Lagoon. All of the refuse cans on the beach were equipped with gull-proof lids in 2006 (**Ed Morrison, pers. comm.**). Regarding roosting, there are methods available to make buildings' roofs inhospitable to gulls. Gull sweeps are an effective option (**Yehudit Sherman, pers. comm.**). Parallel wires covered the roof of the Paradise Grill in 2006 and were effective in keeping gulls off since then. The remainder of the restaurants would benefit from this application.

Another source of bird pollution is the rock dove (pigeon) population that circulates between the wharf and the railroad trestle over the lagoon. As stated in the original management plan, the trestle could be screened so that roosting areas were eliminated and bird pollution reduced.

Regarding urban runoff, installation and maintenance of silt and grease traps on storm drains is critical to reducing pollution by petrochemicals. All existing and new drainage systems from new development and parking lots should include installation of effective traps and percolation basins to increase percolation of storm runoff. The City redirected dry-weather runoff to the constructed wetland on the west side of the Stockton Avenue Bridge (just upstream) from the drain on the east side of Stockton Avenue Bridge (just upstream) and the drains at the pier and Venetian Court.

The storm drain along the Esplanade was connected to the sewer line in 2006 for summer diversion of water in the drain to the sewer system. However, the pump was in manual mode, requiring Public Works staff to turn it on and off. Now an automatic pump switch has been connected to a float system to improve the operation.

The historical lagoon had large tule beds prior to construction of the bulkheads after the 1955 flood. Tules are commonly used in managed wetlands to remove nutrients and other pollutants from wastewater effluent. Re-establishment of tule marsh in Soquel Lagoon would reduce nutrient pollution and may reduce bacterial counts. Tule re-establishment would also provide fish habitat in Soquel Lagoon.

Recommendations to Maintain Good Water Quality and Fish Habitat in the Lagoon

1. Seek volunteers to re-establish tules in the alcoves under the railroad trestle, near the Golino property and beside Margaritaville.

2. Require that Margaritaville staff not to wash their patio and adjacent walkway (containing refuse dumpsters) off into the lagoon.

3. Restrict the number/weight of float participants allowed to ride on the floats to a safe level.

4. Enforce the ban on waders during the Begonia Festival Parade.

5. Continue to recommend to the Begonia Festival organizers that floats be safely maneuvered downstream of Stockton Avenue, with a water marshal present to direct floats around buoys in a circular direction along the periphery of the lagoon after they clear the bridge.

6. Continue to recommend to the Begonia Festival organizers to discourage alcohol consumption by float participants and rowdy behavior on their floats.

7. Continue to use gull-proof lids on refuse cans at and around the lagoon and beach. Use enough refuse containers to satisfy the demand for refuse disposal.

8. Consider screening the railroad trestle to discourage roosting and nesting by rock doves.

9. Re-install the 12-inch high wooden baffle inside the flume prior to directing water through the flume, if it was destroyed during the previous winter.

10. Maximize lagoon depth throughout the dry season, while maintaining passage through the flume for adult steelhead until June 1 and for steelhead smolts until July 1. If the lagoon level begins to drop below the notch for steelhead smolts on one side of the flume because of the hole for adult steelhead after June 1, close the underwater portal for adults. If there is plenty of flow to maintain lagoon depth with the adult portal open, leave it open throughout the summer. If adult steelhead are seen in the lagoon after June 1 and the adult portal has been closed, then open the portal for a week to allow out-migration.

11. After July 1, leave the flume exit closed once it closes, unless flooding is eminent. Install visquine or plywood on the outside of the flashboards to prevent leakage into the flume. Maximize the number of boards in the flume entrance to maximize lagoon depth.

12. Secure the flume boards at all times to prevent their lifting by vandals or bay back-flushing to drain the lagoon.

13. If the lagoon bottom becomes invisible due to turbidity after the rains that do not breach the sandbar, immediately lower the lagoon level to the point where the bottom is visible. This will allow algal growth despite the high turbidity. Plant photosynthesis will produce oxygen and prevent anoxic conditions. A previous recommendation in the original Management Plan (**1990**) should be emphasized to prevent fish mortality; parking lots and streets draining into the lagoon should be cleaned thoroughly before the first fall rains.

14. Road repaving and application of petrochemicals should be done early in the summer. This will allow chemical penetration into the pavement and drying before fall rains.

15. Do not reduce the lagoon level for the Begonia Festival’s nautical parade.

16. Regarding the nautical parade during the Begonia Festival, we continue to recommend that float propulsion by surfboard paddling or rowboat or electric outboard motor be required by the City rather than allowing pulling and pushing by waders. The latest CDFG permit prohibits wading. Allow float passage in one direction only, presumably downstream, before dismantling near the Stockton Avenue Bridge. In the past, floats were taken down the lagoon and then back up before dismantling back at the bridge.

17. Check the gage height at the lagoon once a week (preferably the same day each week) and keep a log of measurements so that the biologist may contact the City to obtain a weekly update.

18. "Gull Sweeps" sold by West Marine Products should be installed on Esplanade roofs to test their effectiveness in deterring gulls. According to the catalogue, "Powered by the slightest breeze, the Gull Sweep's motion will deter the most determined bird." These were successfully used on San Diego restaurants (**Y. Sherman, pers. communication**).

19. The City should influence planners, architects and property owners through the permit review to maximize water percolation and to filter out and collect surface runoff pollutants from new and existing land development within the City and upstream.

20. The City should request from the responsible flood control district that sediment and grease traps leading into lower Soquel Creek be annually inspected and cleaned.

21. The City should continue to fund activities to permanently remove invasive Arundo from residences along the lagoon and other non-native plants in the riparian corridor between Highway 1 and the lagoon in order to maximize stream shading, minimize water temperature of inflow water and protect aquatic and wildlife habitat.

FISH CENSUSING

Steelhead Plantings. No steelhead were planted in Soquel Creek in 2011, as was the case in 2003–2010. CDFG allowed juvenile planting of smolts in spring only in streams where planted juveniles were descendents of captured adult steelhead brood stock from those streams (San Lorenzo River and Scott Creek). No adult steelhead were captured from Soquel Creek for hatchery propagation. Therefore, no juveniles were planted there.

Fish Sampling Results. Fall sampling for steelhead occurred on 2 and 16 October 2011, from just upstream of the Stockton Avenue Bridge, downstream. Two weeks passed between samplings, and the sandbar was emergency breached on 5 October between samplings. The population estimate was considered valid because it was assumed that the probability was the same for marked and unmarked steelhead to either enter the bay or move upstream of the estuary after the sandbar breached. A bag-seine with dimensions 106 feet long by 6 feet high by 3/8-inch mesh was used. The seine was set perpendicular to shore, parallel to the Stockton Avenue Bridge and just upstream of it. Juvenile steelhead congregate in the shade under the bridge. The seine was pulled to the beach in front of Venetian Court. With this larger, coarser-meshed seine, no tidewater gobies were captured. A total of 197 juvenile steelhead were captured and clipped on 2 October after 5 seine hauls. There were no mortalities. 86 juvenile steelhead were captured on 16 October after 3 seine hauls, with 25 recaptures and no mortalities. The median size of juvenile steelhead captured the first day in 2011 was 155-159 mm SL compared to 160-164 mm SL on the second day (**Figure 8**), 115-119 mm SL in 2010 (**Figure 9**), in 2009 (**Figure 10**), 115-119 mm SL in 2008 (**Figure 11**), 125-129 mm SL in 2007 (**Figure 12**) and 155-159 mm SL in 2006 (**Figure 13**). The median size of captured steelhead on 10 October 2010 was again 115-119 mm SL. A bimodal histogram was evident in 2011, as was the case in 2009. The same bimodal pattern was observed in steelhead captured in Aptos Lagoon/Estuary in 2011 (**Alley 2012**). It could be that the lagoon population consisted more of larger yearlings and fewer YOY in 2009 and 2011 than in other years.

On 2October 2011, 6 seine hauls were made for tidewater gobies with a 30-foot x 4-foot x 1/8-inch mesh beach seine in lower Soquel Lagoon near the beach. No tidewater gobies were captured. They were last captured in 2008 and 2009 after dry winters. Fish captured with the small seine included threespine sticklebacks in moderate abundance and 8 staghorn sculpins. The low number of tidewater gobies captured in 1992-1997, and their absence since the El Niño stormflows in winter 1997-98 until 2008 and 2009, probably indicated a lack of backwater areas to be used as refuges during high winter stormflows. This species was plentiful in Soquel Lagoon during the previous drought of the late 1980's and early 1990's and reappeared during the recent, less severe 3-year drought (2007-2009). Tidewater gobies have been reported in recent years in adjacent lagoons (Moran Lake and Aptos) by Jerry Smith (**pers. communication**). Tidewater gobies from up-coastal-current in Moran Lake likely re-colonized Soquel Lagoon in 2008, when Soquel Creek had experienced two mild winters in a row. Two tidewater gobies were captured in Aptos Lagoon in 2011 (**Alley 2012**).

Our steelhead population estimate based on mark and recapture for fall 2011was 678 compared to 1,174 in 2010 (**Table 10**) (methods in **Ricker 1971**). This was the 7th lowest estimate in 19 years.

Table 10. Estimates of Juvenile Steelhead Numbers in Soquel Creek Lagoon for the Years 1988 and 1992-2011.

Year	Steelhead Population Estimate for Soquel Creek Lagoon
1988-	Rough estimate of a few hundred. No mark/recapture activity done. 157 juveniles captured in 5 seine hauls.
1992-	Rough estimate of a few hundred. No mark/recapture activity was done. 60 juveniles captured in 4 seine hauls.
1993-	2,787 +/- 306 (standard error). 1,046 fish marked from two seine hauls.
1994-	1,140 +/- 368 (standard error). 76 fish were marked from two seine hauls.
1995-	360 +/- 60 (standard error). 59 fish were marked from 4 seine hauls.
1996-	255 +/- 20 (standard error). 105 fish were marked from 3 seine hauls.
1997-	560 +/- 182 (standard error). 53 fish were marked from 3 effective seine hauls.
1998-	671 +/- 74 (standard error). 164 fish were marked from 3 effective and one snagged seine haul.
1999-	928 +/- 55 (standard error). 397 fish were marked in 4 effective seine hauls.
2000-	875 +/-156 (standard error).185 fish were marked in 4 effective seine hauls.
2001-	454 +/- 27 (standard error). 186 fish were marked in 4 effective seine hauls.
2002-	1,042 +/-84 (standard error). 363 fish were marked in 4 effective seine hauls.
2003-	849 +/-198 (standard error). 109 fish were marked in 5 effective seine hauls.
2004-	3,869 +/-1,009 (standard error). 281 fish were marked in 4 effective seine hauls.
2005-	1,454 +/-347 (standard error). 212 fish were marked in 5 effective seine hauls and one with rope tangled around one pole.
2006-	992 +/- 125 (standard error). 178 fish were marked in 5 effective seine hauls.
2007-	6,064 +/- 1,671 (standard error). 226 fish were marked in 5 effective seine hauls
2008 -	7,071 +/- 1,574 (standard error). 551 fish were marked in 2 effective seine hauls
2009 -	449 +/- 87 (standard error). 114 fish were marked in 6 effective seine hauls.
2010-	1,174+/- 111 (standard error). 318 fish marked in 2 effective seine hauls.
2011-	678 +/- 107 (standard error). 197 fish marked in 5 effective seine hauls.

Less juveniles were expected to use the lagoon in 2010 and 2011 than 2007–2009 because of higher adult passage flows in 2010 and 2011 and lower adult passage flows late in the spawning season in 2007–2009 (**Figures 21, 24 and 25; Alley 2010b**). Higher winter flow in 2011 encouraged more spawning in the upper creek in 2011 with easier access, assumedly seeding the lagoon less with young-of-the-year steelhead than the previously dry years of 2007−2009. This expectation was realized when comparing lagoon population size to those in 2007 and 2008 but not 2009, which had the smallest population size of the last 5 years (**Table 10; Figure 7a**). The 2008-2009 winter was the wettest of the three previous dry years, encouraging more spawning in the upper watershed. However, it is likely that the low 2009 lagoon population size was a result of generally low adult returns and spawning throughout the Santa Cruz Mountains over the previous winter. Findings indicated that juvenile densities sampled by us at stream sites in 2009 in 4 watersheds, including Soquel Creek, were less than half those detected in 2008. The likely poor adult returns in 2009 would have resulted from three consecutive years of poor food conditions in the ocean (**Jerry Smith, pers. comm**.). The relatively smaller 2011 lagoon population estimate was also likely a result of poor egg and YOY survival during the large 24 March stormflow. Stream sampling of sites in the San Lorenzo, Soquel and Aptos watersheds in 2011 indicated low YOY densities throughout. The stormflow exceeded 6,000 cfs.

Past calculations indicated that lagoon production represented nearly 1/3 of the smolt-sized steelhead production in the lower 7.2 miles of mainstem Soquel Creek in both 1999 and 2000. In 1993, the lagoon production estimate of nearly 2,800 fish represented 10% of the smolt production in the 16.6 miles of steelhead habitat in the mainstem, East and West Branches. The 2004 lagoon population estimate of 3,900 fish represented an estimated 47% of the smolt production for the 16.6 miles of stream and lagoon habitat. Though we do not have 2007–2011 population estimates for the entire Soquel Creek watershed, the lagoon population of larger smolt-sized fish was likely a significant percentage of the total watershed population in both of these dry years. The lagoon provides valuable habitat through proper management.

Even with a freshwater lagoon created by the City of Capitola, the water temperature sometimes approaches the upper tolerance limit of steelhead for 1-2 hours per day when fog is absent and stream inflow is warm. If sufficient saltwater were present in the lagoon, water temperatures could become lethal for steelhead. Although tidal overwash occurred in 2001 and 2004, it was

In this report, two factors that may influence the size of juvenile steelhead at the time of fall sampling were examined. Those were population size and the time of lagoon closure prior to sampling. A summary table was prepared for the years, 1998−2011 corresponding to scatter plots of the data (**Table 11**). Scatter plots of median juvenile size versus weeks of sandbar closure and versus population size done for data in 1998−2010, indicated no strong relationship between these factors when considered separately (**Figures 7b-c)**. One would predict that if the population was large, then competition for food would be high and juvenile size would be less. One would expect that since the lagoon is a very food-productive habitat, then juvenile size would be larger with longer the lagoon growth periods. The population estimates may not be entirely precise but likely are accurate in reflecting relative annual differences in actual population size. The proportion of larger yearlings may also vary between years, but usually the lagoon population is overwhelmingly dominated by young-of-the-year steelhead, based on past scale analysis.

Table 11. Summary of Annual Fish Sampling Dates, Population Estimates, Steelhead Size and Lagoon Growth Period Prior to Sampling, 1998−2011.

Year	Sandbar Closure Date	Fish Sampling Dates	Weeks of Sandbar Closure Prior to Final Fish Measurements	Days of Sandbar Closure Prior to Final Sampling	Steelhead Population Estimate	Median Size Grouping of Captured Fish (mm SL)
1998	9 July	4/11 Oct	13.1	92	671	115-119 First Day
1999	18 May	3/10 Oct	20.6	144	928	120-124 First Day
2000	7 June	1/8 Oct	17.4	122	875	135-139 First Day
2001	14 June	7/14 Oct	17.3	121	454	125-129
2002	23 May	6/13 Oct	20.3	142	1,042	105-109 First Day
2003	22 May	5/12 Oct	20.3	142	849	110-114 First Day
2004	26 May	3/10 Oct	19.4	136	3,869	115-119 First day
2005	9 June	2/9 Oct	18.1	127	1,454	105-109& 110-114
2006	14 June	30Sep/8 Oct	16.4	115	992	150-154 & 145-149
2007	23 May	7/14 Oct	20.4	143	6,064	125-129 Both days
2008	22 May	27Sep/ 11 Oct (no lengths)	18.1	127	7,071	115-119 First day
2009	21 May	4/11 Oct	20.3	142	449	155-159 Both days
2010	2 June	3/10 Oct	18.4	129	1,174	115-119 Both days
2011	20 June	2/16 Oct	15.3+1.6 estuary	106+11 days estuary	678	155-159 & 160-164

We suspect from the size distributions of juveniles captured, that steelhead grew faster in 2006 and 2009 than either 2007 or 2008 because of less competition for food with much smaller juvenile populations 2006 and 2009 (**Table 9; Figure 7a-b**). The food-rich lagoon was in place nearly 3 weeks less in 2006 than in 2007 and 2008 before sampling, and the steelhead still grew faster in 2006 (**Figure 7c**). We see that with similarly low population sizes in 1998, 2001 and 2009, as the growth period increased, the median size also increased, respectively. However, in years like 1999 and 2003 that had similar population size to 2000 and 2006, growth rate remained relatively slower despite longer growth periods (**Figures 7b-c**). So, other factors influence growth rate.

Other factors that may strongly influence growth rate are water temperature and food production. The density of aquatic vegetation, which may be an indirect indication of food availability, may vary considerably between years. Also, pondweed with attached algae may provide more invertebrate food than just filamentous algae alone. So, the density of pondweed is also important. Consideration must be given to potentially diminished water quality (oxygen levels at the end of the night) and/or fish foraging efficiency if aquatic vegetation becomes too dense.

Cooler lagoons reduce fish metabolic rate and encourage faster growth. However, cooler lagoons may have reduced production of aquatic vegetation. The cooler lagoon in 2011 promoted relatively larger juvenile steelhead with a relatively small population size, although the growth period prior to sampling was relatively short (**Table 10**). Aquatic plant production was less in 2011 than in the warmer lagoons of 2008 and 2009 (**Tables 6–8**). Oxygen levels at dawn were also high in 2011 than 2008 and 2009, although they were adequate for steelhead in all years (**Figures 6a-1, 6h and 6i**). As stated earlier, the lagoon population in 2011 may have had a higher proportion of larger yearlings than some years due to overall low YOY survival in the watershed.

In 2011, prior to sandbar closure, the flume was inspected for cracks, and some of the major ones were patched. Matt Kotila reported that sink holes in the beach were somewhat reduced as a result, indicating that the patches made some improvement. Seepage of water and sand under the flume at the flume inlet did not appear to be a problem in 2011, allowing relatively high gage heights to be maintained. In addition, Reach 1 was especially deep in 2011 due to scour during the previous winter. This likely provided more productive habitat in the 2011 lagoon.

In order to maintain good steelhead nursery habitat in Soquel Creek Lagoon, the sediment input from the watershed must be reduced. Stream shading must be increased to provide cooler stream inflow. The City must maintain the water level as high as possible throughout the summer until sandbar breaching, without large fluctuations. It is potentially easier to maintain good water quality and water depth when there is higher streamflow into the lagoon in summer (known as summer baseflow). The ceiling grate constructed in 2003 makes it easier to maximize lagoon depth because a portion of the flow can spill over the boards into the ceiling opening with all of the flashboards in place. However, even with the grate, it was difficult to maximize lagoon depth in 2006 because of the seepage of water and sand under the flume (**Figure 2**). Seepage again occurred in 2009 as previously, and sandbags were piled into the hole that developed in front of the flume inlet. Seepage was prevented in 2007, and lagoon depth was maintained. After the seepage was stopped, the 2009 lagoon level increased in mid July and August and early September. However, the lagoon level was lowered after the 13-14 September storm, and was not raised to maximal levels until early October. With the turbidity remaining for an extended period due to low stream inflow, water depth could not be raised above a gage height of about 2.0 for 3+ weeks (14 September – 10 October).

Predation may be a factor in size distribution of juvenile steelhead. If bird predation rate was heavier, smaller steelhead would be most vulnerable because swimming speed increases with size. Heavy predation could increase the size distribution of juveniles surviving until fall sampling.

In 2011, piscivorous birds seemed less common than in previous years. Only 4 merganser were observed during only one monitoring on 1 October (**Appendix A**). That day was unusual in that 4 common egrets were observed on 1 October Noble Gulch, which was the most ever observed at one time. Black crowned night heron was observed on two monitorings. Only 1 pied-billed grebe was observed on one monitoring- 1 October. Two or 3 pied-billed grebes were usually observed each monitoring in past years. Piscivorous western pond turtles regularly basked on the instream cottonwood log and additional logs further downstream adjacent to the Golino Property. As many as 3 pond turtles were observed at one time on the cottonwood log and the nearby log. Maintenance of lagoon depth is important to make feeding more difficult for these animals. Other bird species that utilized the lagoon included mallard (as many as 25), coots (as many as 5) and gulls (as many as 75). Approximately 5 domestic ducks (two were white) and one goose were present. The goose was determined to be a female, as she sat on an egg on a redwood stump near the restaurants during sandbar construction in May. There was an additional redwood log with rootmass located in Reach 3, offering additional roosting area for birds. It was heavily utilized, including by two gulls on 5 September. The redwood log moved downstream 50-75 feet during the summer, as observed on 5 September.

If the lagoon becomes too shallow, steelhead habitat in the upper lagoon is lost. This is another reason to keep the lagoon as deep as possible during summer. The flume's flashboards must be secured against vandal's who are intent on draining the lagoon and against tidal backpressure that may dislodge the boards.

Maintenance of the lagoon in the fall after the first small storms is important. If the sandbar opens with the first small stormflows and closes again, kelp and seagrass may become trapped to rot and create an anoxic lagoon leading to a fish kill. Although the sandbar remained mostly open after the relatively early breaching on 5 October 2011, the sandbar reformed repeatedly at some high tides with lagoon filling and then breaching again during each tidal cycle until at least 21 December (inflow of 5 cfs) at this writing (**Ed Morrison, personal communication**). Minimization of pollutant input from early fall storms is also important for reducing biological oxygen demand and avoiding fish kills.

Recommendations Regarding Fish Management

1. Seek volunteers to re-establish tules in the alcoves under the railroad trestle, near the Golino property and beside Margaritaville.

2. If the streamflow in Soquel Creek in the vicinity of Soquel Village approaches the point of losing surface flow, notify nurseries having surface diversions upstream and the Fish and Game Department of the streamflow conditions so that direct water diversion of surface flow may be reduced or discontinued until flow returns. Pumping by the Soquel Creek Water District from the Main Street well may also need to be curtailed. Complete loss of surface flow should be avoided.

3. Maximize lagoon depth by maximizing the number of flashboards in the flume inlet as streamflow declines and by sealing the boards with visquine and/or

plywood, as was done in the past.

4. Secure the flume boards at all times so that vandals cannot pry them up and drain the lagoon. This will prevent tidal surges through the flume from dislodging boards and doing the same thing. Installation of a louver system on one side of the flume inlet would eliminate the need to deal with boards all summer. The design and installation of a louver system is recommended.

5. Do not unplug the flume exit after 1 July unless flooding is eminent.

6. Do not remove flume boards for the Begonia Festival's nautical parade or prior to taking fall vacation time.

7. Remove flume boards as the first small storms begin in fall and replace the boards after the stormflow has subsided while maintaining light penetration to the lagoon bottom. The effort should be to minimize lagoon fluctuation until the sandbar actually breaches for the winter. Many forecasts for rain and storm intensities are incorrect in the early fall. It is harmful to steelhead to drop the lagoon level in anticipation of a storm that fails to develop, followed by failure to re-install the flume board afterwards.

8. Maintain the lagoon in fall until streamflow has increased enough (20-25 cfs) to prevent stranding of spawning adult steelhead or coho salmon and to prevent osmotic stress to lagoon-inhabiting steelhead. If necessary, install a perimeter fence with 2"x 4" mesh and with 6-foot panels around the flume entrance by October to prevent plugging of the flume's screen with aquatic vegetation during the first minor storms. Maintain the lagoon until approximately Thanksgiving in late November, before allowing stormflow to breach the sandbar. By this time, the winter storm pattern has usually developed to keep the sandbar open.

9. If sufficient turbidity occurs after the first small storms of the season to prevent light from penetrating to the bottom of the intact lagoon for more than one day, reduce lagoon depth temporarily to insure that light reaches the bottom. This will prevent death of aquatic vegetation and increased biological oxygen demand, with the associated loss of oxygen production that would have occurred from photosynthesis. Thus, anoxic conditions will be prevented. When the lagoon clears up, re-establish the maximum lagoon depth.

10. If the sandbar is still in place after November 15, maintain an opening in the flume inlet to allow early spawning adults to pass through the flume from the Monterey Bay.

11. Continue to census the juvenile steelhead in the fall to monitor the use of the lagoon as an important nursery area under varying management scenarios and restoration efforts.

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Soquel Lagoon Post-Venetian Court Construction- Older Stockton Avenue Bridge and prior to expanded development on eastern margin of the Lagoon, above and below the Railroad Trestle; circa 1931
(Courtesy of the Capitola Historical Museum)

Post-World War II Soquel Creek Estuary at very low tide- present-day Stockton Bridge with flume exposed on the beach after the December 1955 flood. Riparian corridor re-established on west side above Stockton Bridge; circa 1955-56 after the flood
(Courtesy of the Capitola Historical Museum)

FIGURES

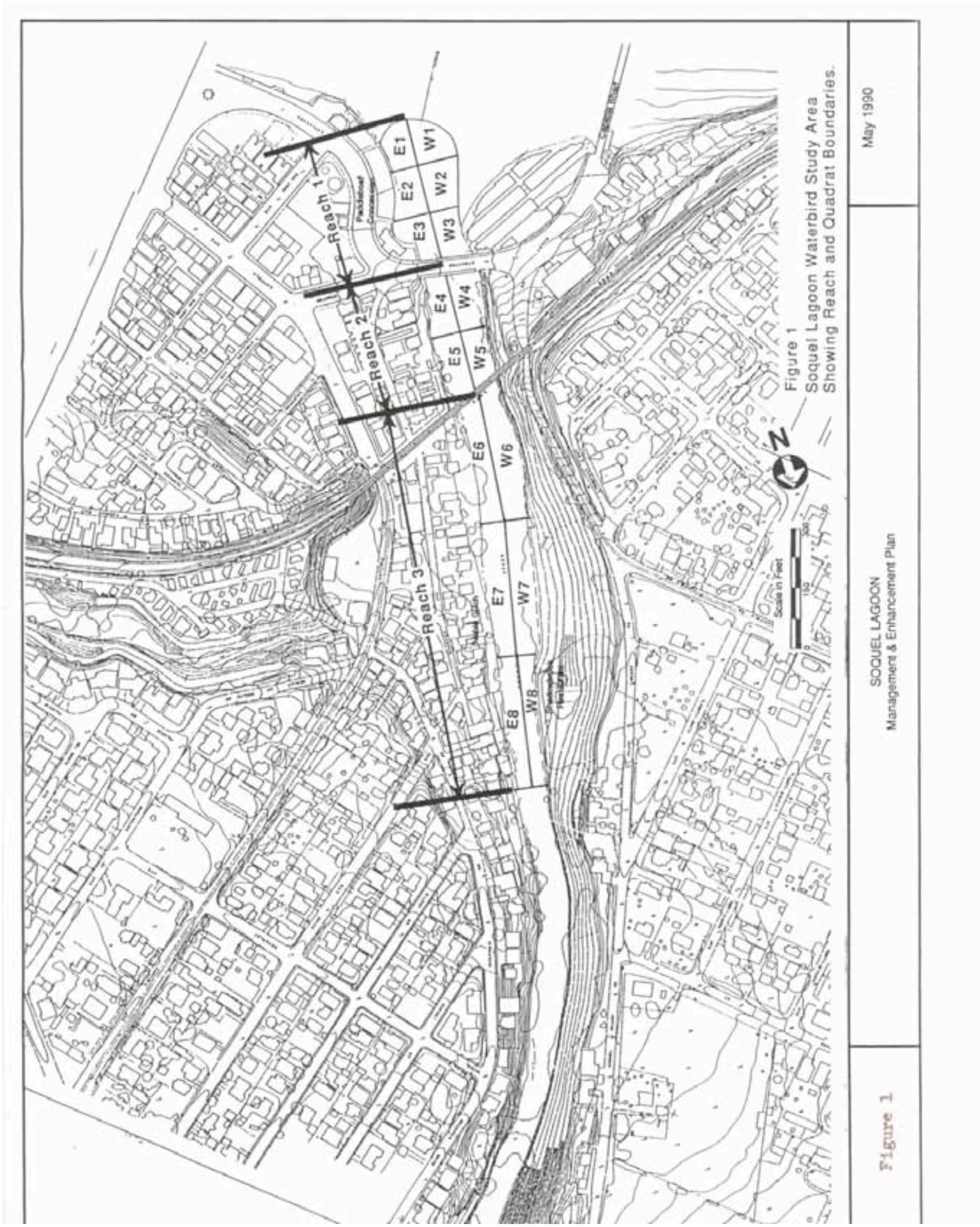


Figure 1
Soquel Lagoon Waterbird Study Area
Showing Reach and Quadrat Boundaries.
May 1990
SOQUEL LAGOON
Management & Enhancement Plan
Scale in Feet
Reach 1
Reach 2
Reach 3
E1
E2
E3
E4
E5
E6
E7
E8
W1
W2
W3
W4
W5
W6
W7
W8
N
Figure 1

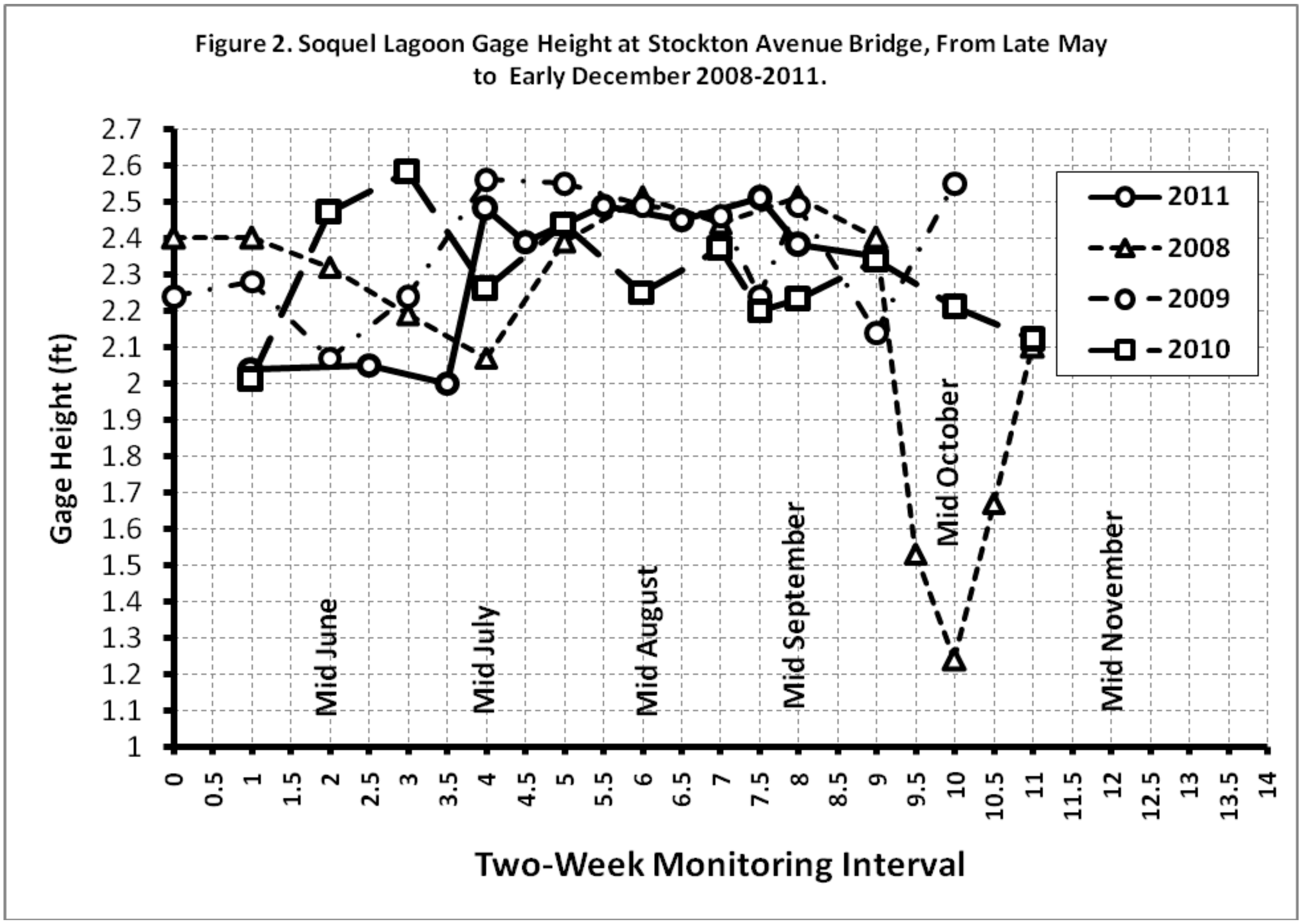


Figure 2. Soquel Lagoon Gage Height at Stockton Avenue Bridge, From Late May to Early December 2008-2011.
Gage Height (ft)
Two-Week Monitoring Interval
2011
2008
2009
2010
Mid June
Mid July
Mid August
Mid September
Mid October
Mid November

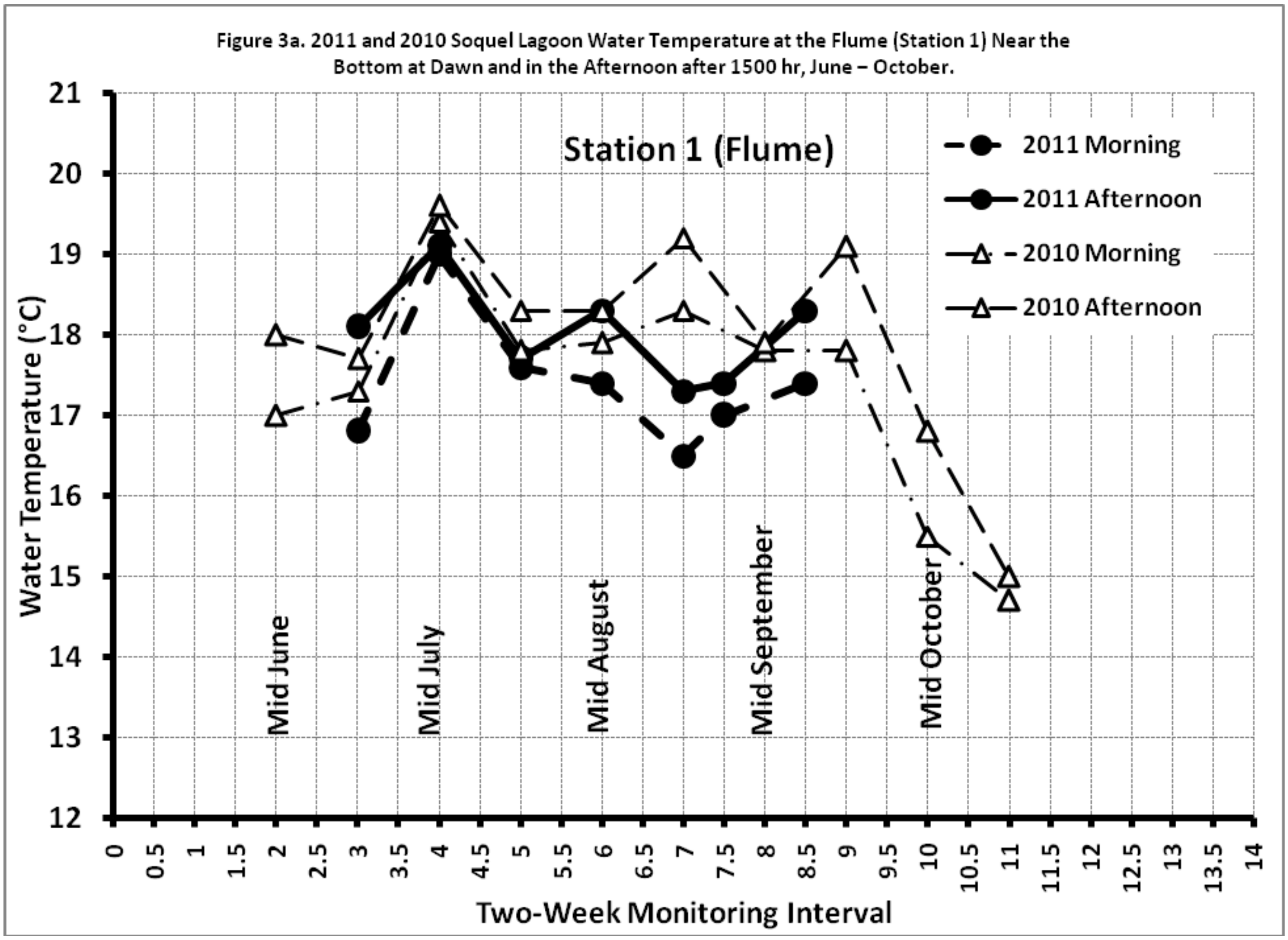


Figure 3a. 2011 and 2010 Soquel Lagoon Water Temperature at the Flume (Station 1) Near the Bottom at Dawn and in the Afternoon after 1500 hr, June – October.
Station 1 (Flume)
2011 Morning
2011 Afternoon
2010 Morning
2010 Afternoon
Water Temperature (°C)
Two-Week Monitoring Interval
Mid June
Mid July
Mid August
Mid September
Mid October

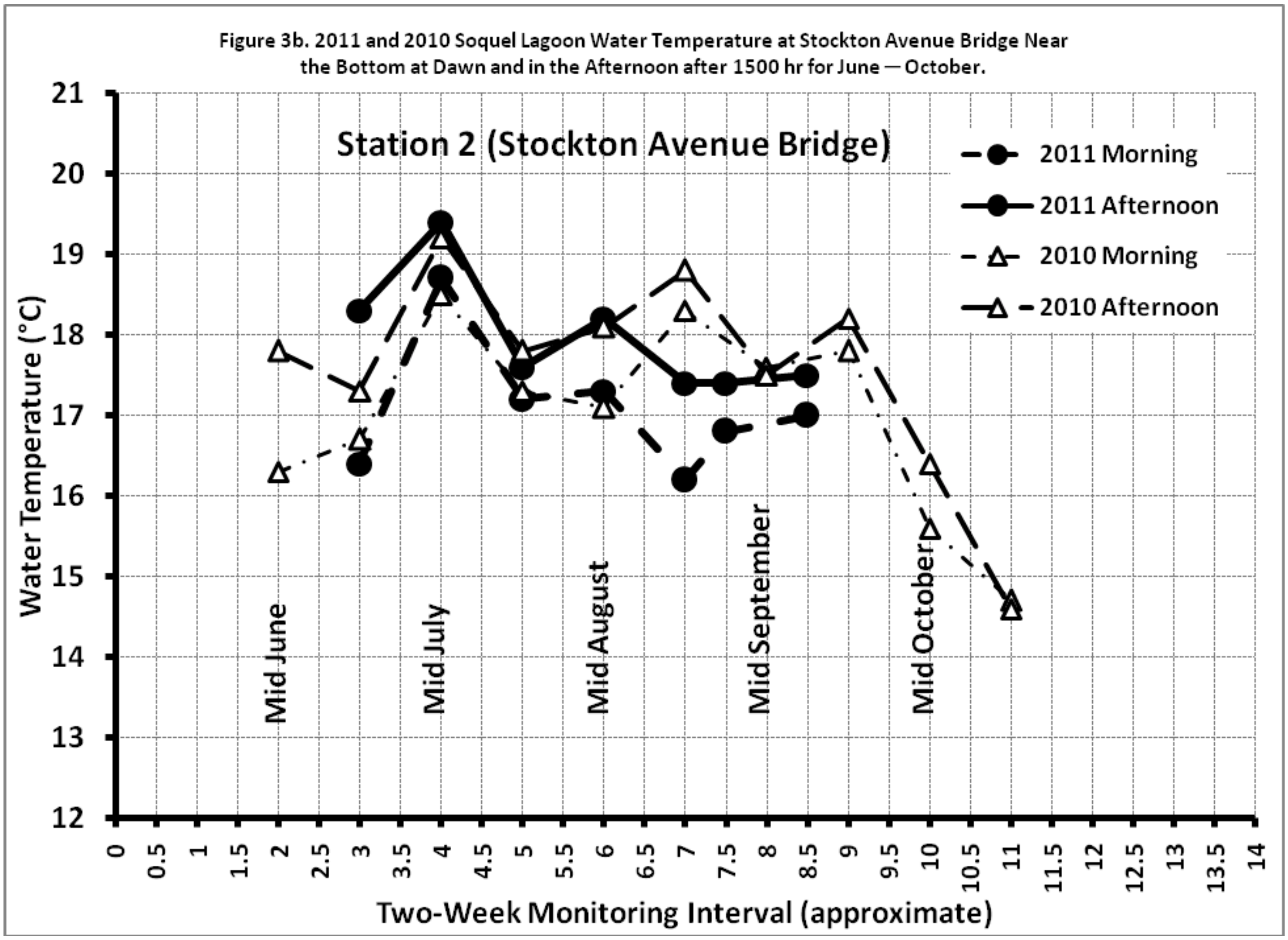


Figure 3b. 2011 and 2010 Soquel Lagoon Water Temperature at Stockton Avenue Bridge Near the Bottom at Dawn and in the Afternoon after 1500 hr for June — October.
Station 2 (Stockton Avenue Bridge)
2011 Morning
2011 Afternoon
2010 Morning
2010 Afternoon
Water Temperature (°C)
Two-Week Monitoring Interval (approximate)
Mid June
Mid July
Mid August
Mid September
Mid October
21
20
19
18
17
16
15
14
13
12
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14

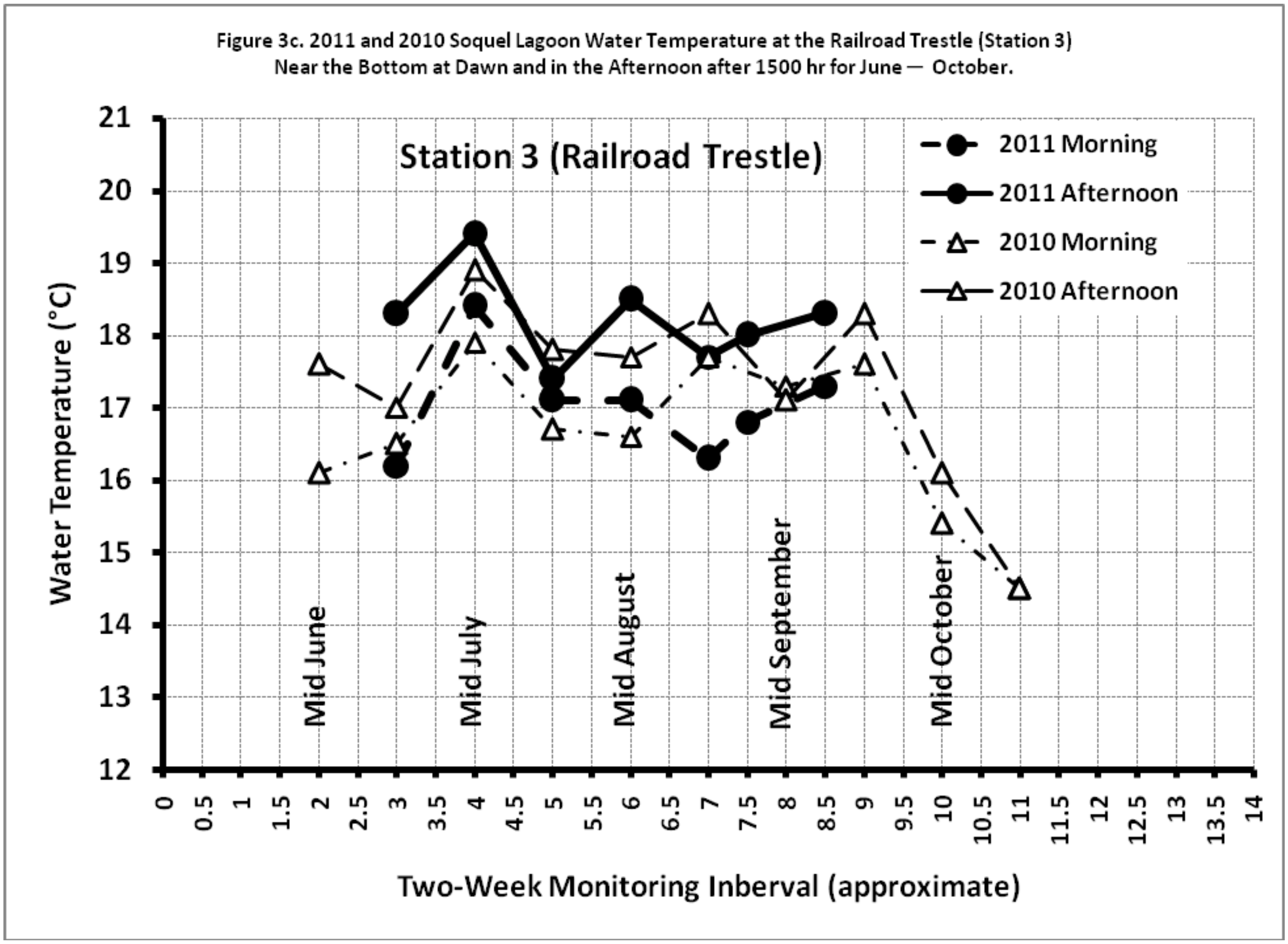


Figure 3c. 2011 and 2010 Soquel Lagoon Water Temperature at the Railroad Trestle (Station 3)
Near the Bottom at Dawn and in the Afternoon after 1500 hr for June — October.
Station 3 (Railroad Trestle)
2011 Morning
2011 Afternoon
2010 Morning
2010 Afternoon
Water Temperature (°C)
21
20
19
18
17
16
15
14
13
12
Mid June
Mid July
Mid August
Mid September
Mid October
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14
Two-Week Monitoring Inberval (approximate)

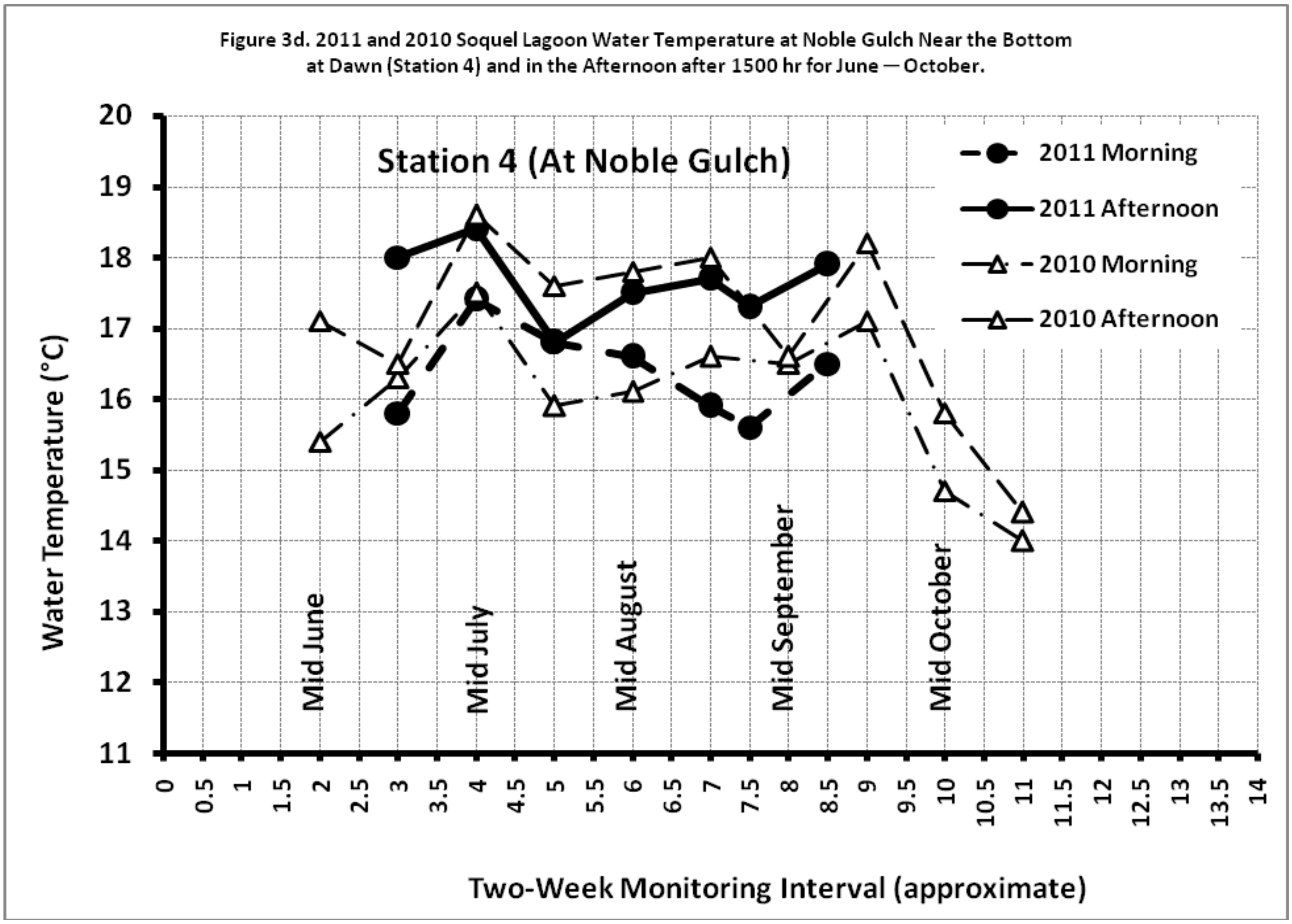


Figure 3d. 2011 and 2010 Soquel Lagoon Water Temperature at Noble Gulch Near the Bottom
at Dawn (Station 4) and in the Afternoon after 1500 hr for June — October.
Station 4 (At Noble Gulch)
2011 Morning
2011 Afternoon
2010 Morning
2010 Afternoon
Water Temperature (°C)
Two-Week Monitoring Interval (approximate)
Mid June
Mid July
Mid August
Mid September
Mid October

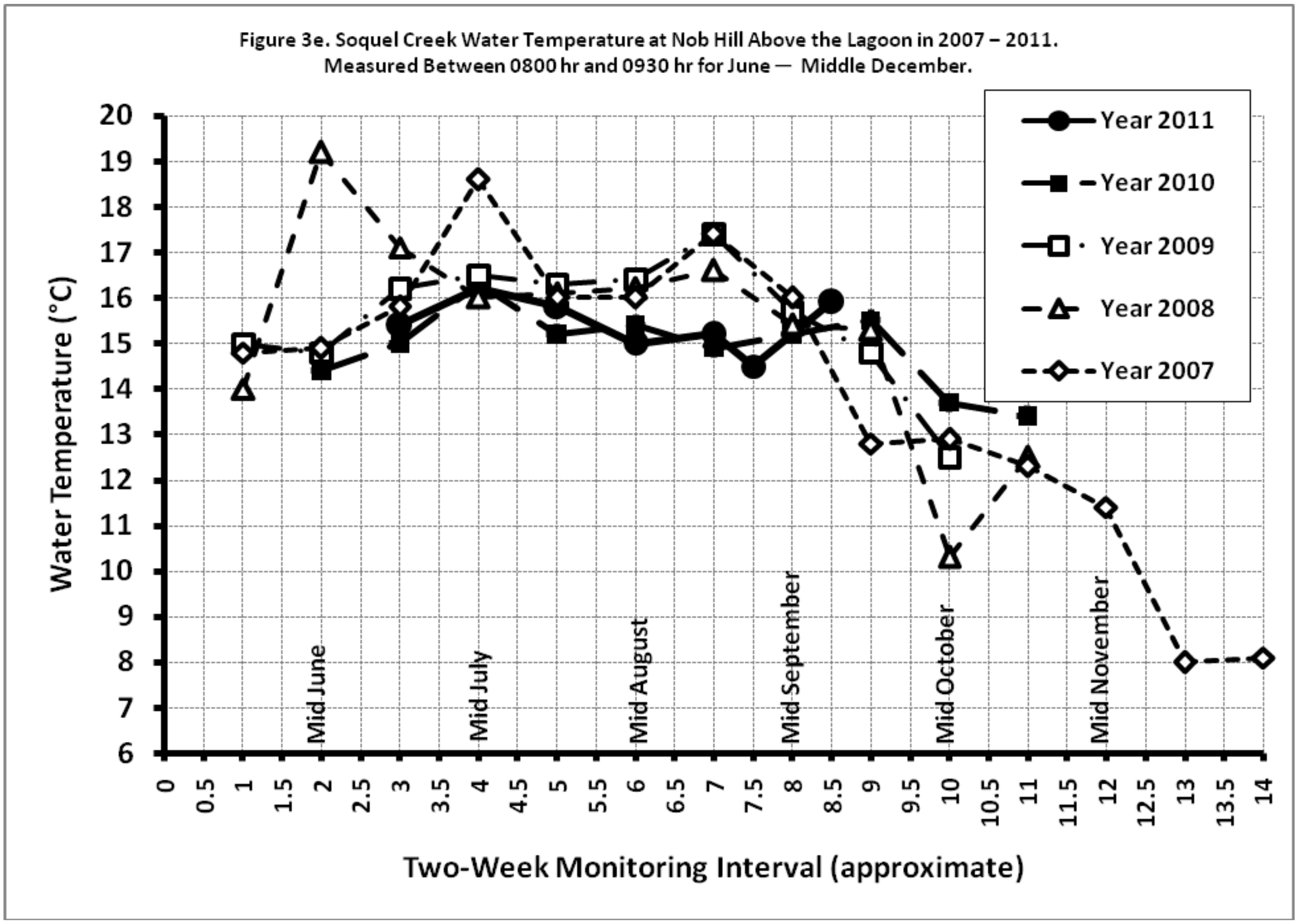


Figure 3e. Soquel Creek Water Temperature at Nob Hill Above the Lagoon in 2007 – 2011.
Measured Between 0800 hr and 0930 hr for June — Middle December.
Water Temperature (°C)
Two-Week Monitoring Interval (approximate)
Year 2011
Year 2010
Year 2009
Year 2008
Year 2007
Mid June
Mid July
Mid August
Mid September
Mid October
Mid November

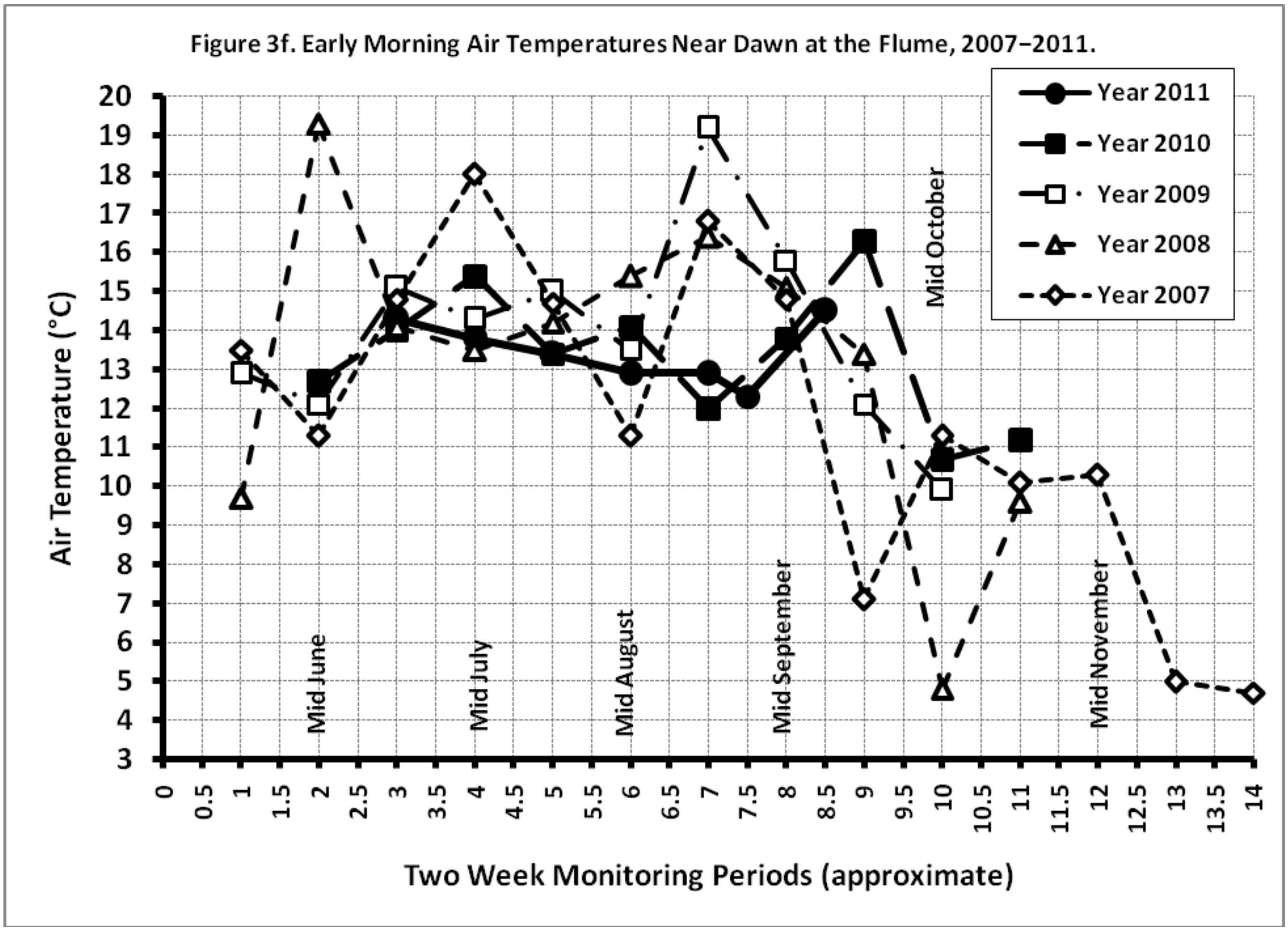


Figure 3f. Early Morning Air Temperatures Near Dawn at the Flume, 2007–2011.
Year 2011
Year 2010
Year 2009
Year 2008
Year 2007
Air Temperature (°C)
Two Week Monitoring Periods (approximate)
Mid June
Mid July
Mid August
Mid September
Mid October
Mid November

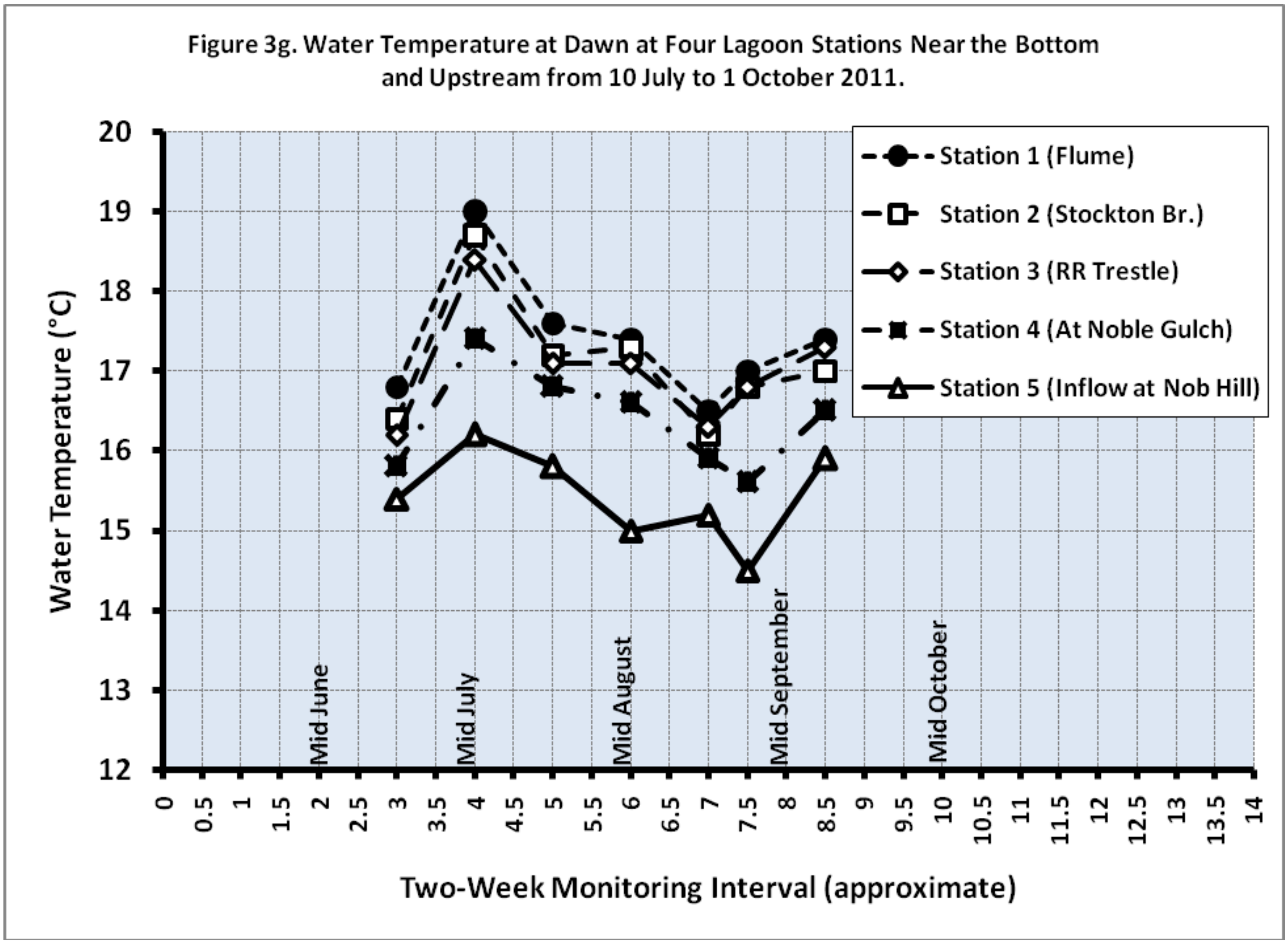


Figure 3g. Water Temperature at Dawn at Four Lagoon Stations Near the Bottom and Upstream from 10 July to 1 October 2011.
Water Temperature (°C)
Two-Week Monitoring Interval (approximate)
Station 1 (Flume)
Station 2 (Stockton Br.)
Station 3 (RR Trestle)
Station 4 (At Noble Gulch)
Station 5 (Inflow at Nob Hill)
Mid June
Mid July
Mid August
Mid September
Mid October
20
19
18
17
16
15
14
13
12
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14

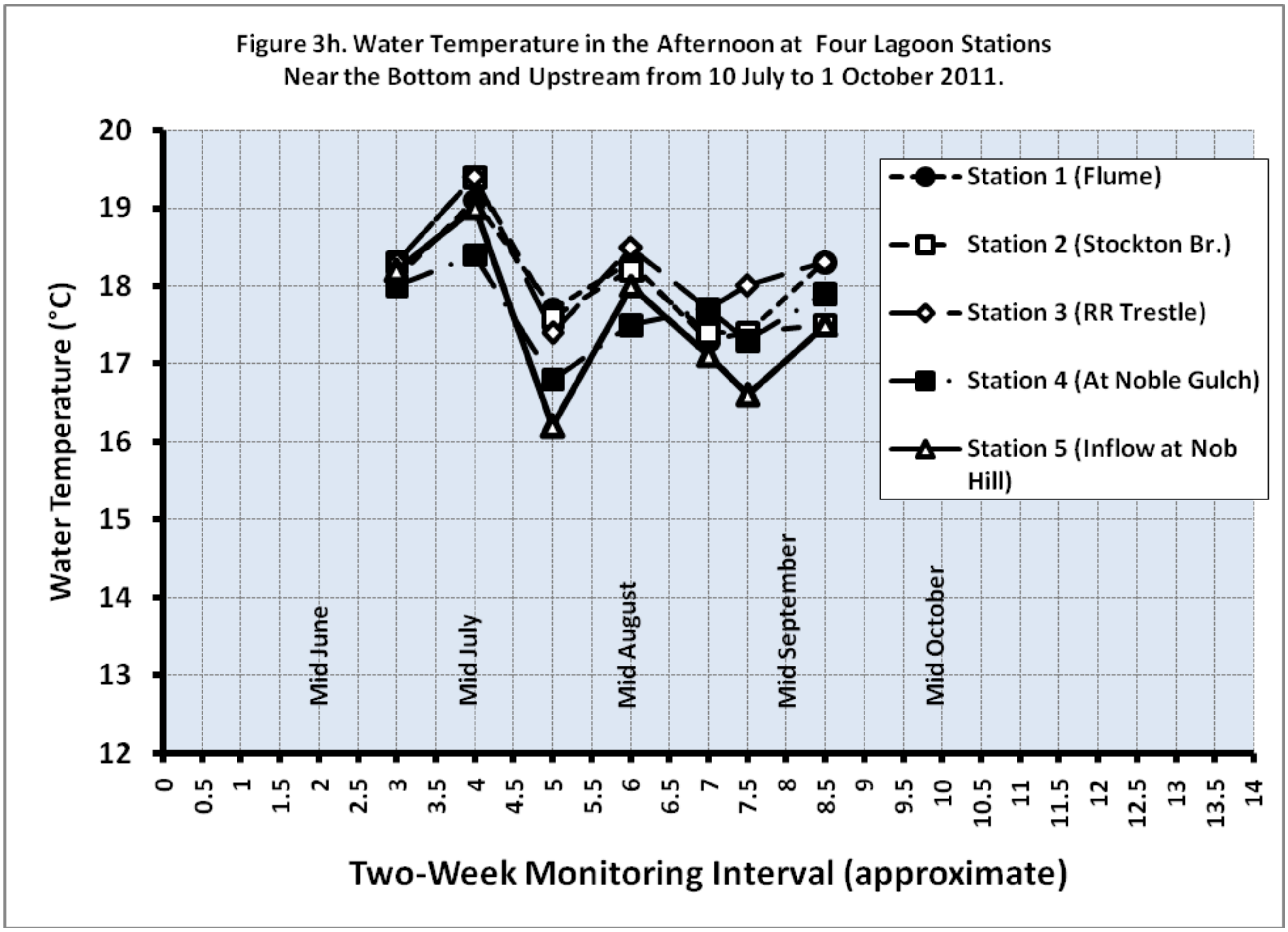


Figure 3h. Water Temperature in the Afternoon at Four Lagoon Stations
Near the Bottom and Upstream from 10 July to 1 October 2011.
Water Temperature (°C)
20
19
18
17
16
15
14
13
12
Mid June
Mid July
Mid August
Mid September
Mid October
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14
Two-Week Monitoring Interval (approximate)
Station 1 (Flume)
Station 2 (Stockton Br.)
Station 3 (RR Trestle)
Station 4 (At Noble Gulch)
Station 5 (Inflow at Nob Hill)

Figure 3i. Water Temperature in the Afternoon at Four Lagoon Stations Near the Bottom and Upstream in Soquel Creek from 19 June to 23 October 2010.

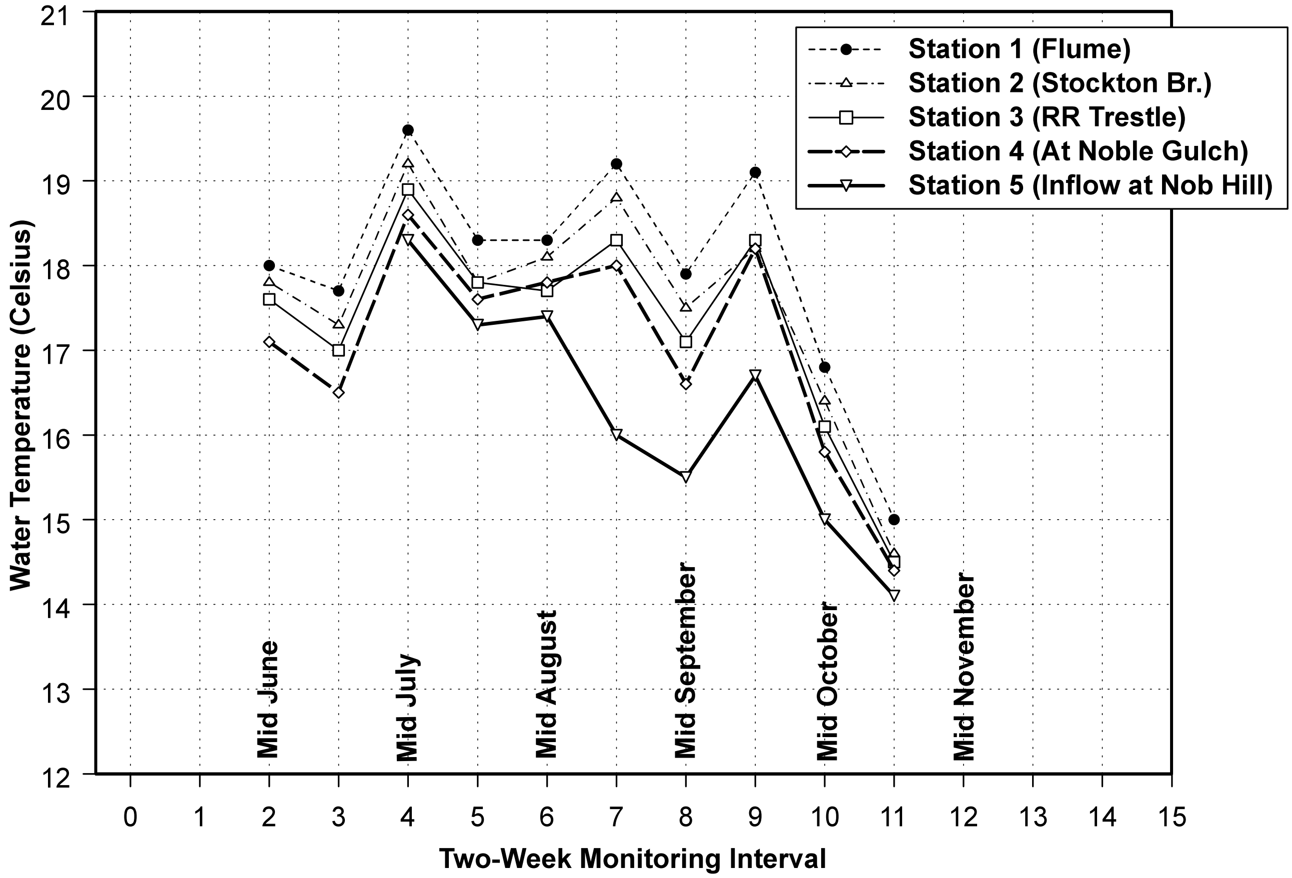


Figure 3j. Water Temperature in the Afternoon at 4 Lagoon Stations Near the Bottom Between 1430 hr and 1630 hr from 7 June to 10 October 2009.

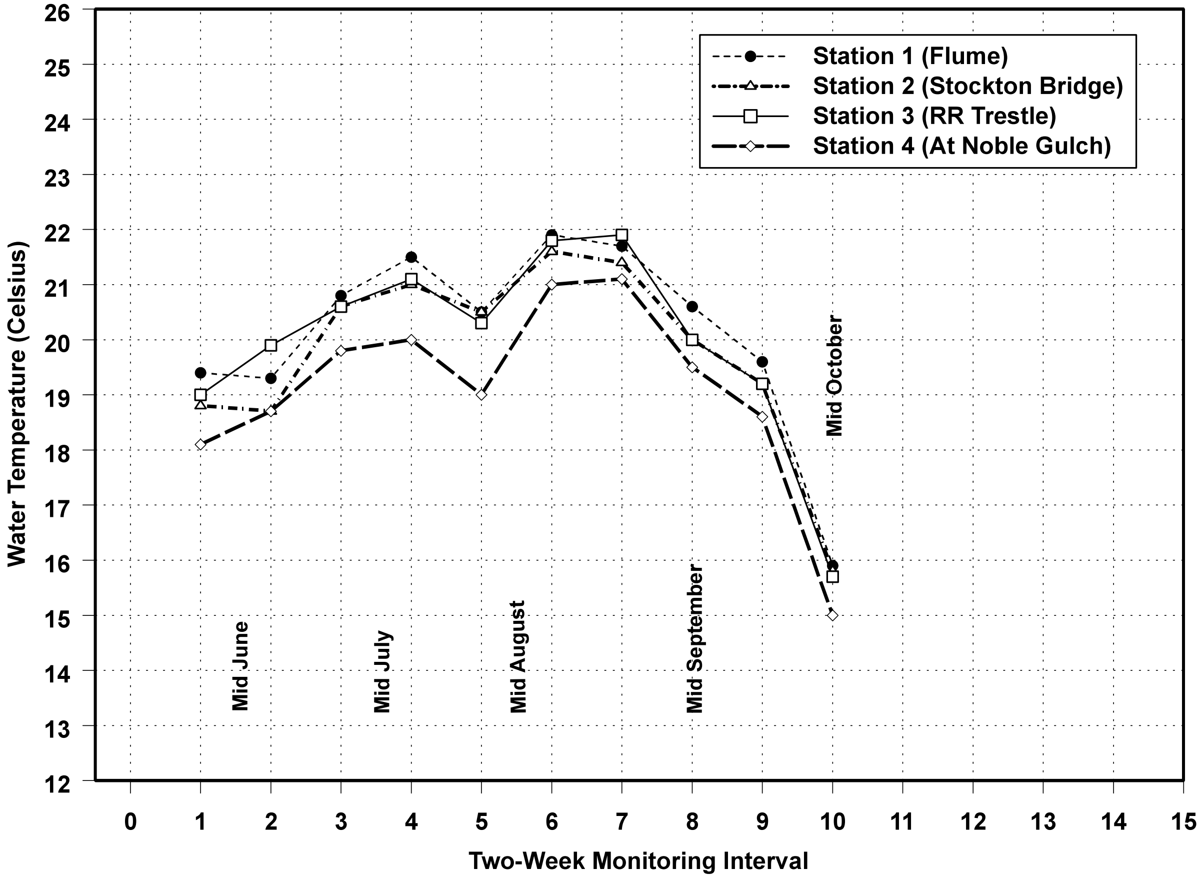


Figure 3k. Water Temperature in the Afternoon at 4 Lagoon Stations Near the Bottom Between 1430 hr and 1630 hr from 7 June to 26 October 2008.

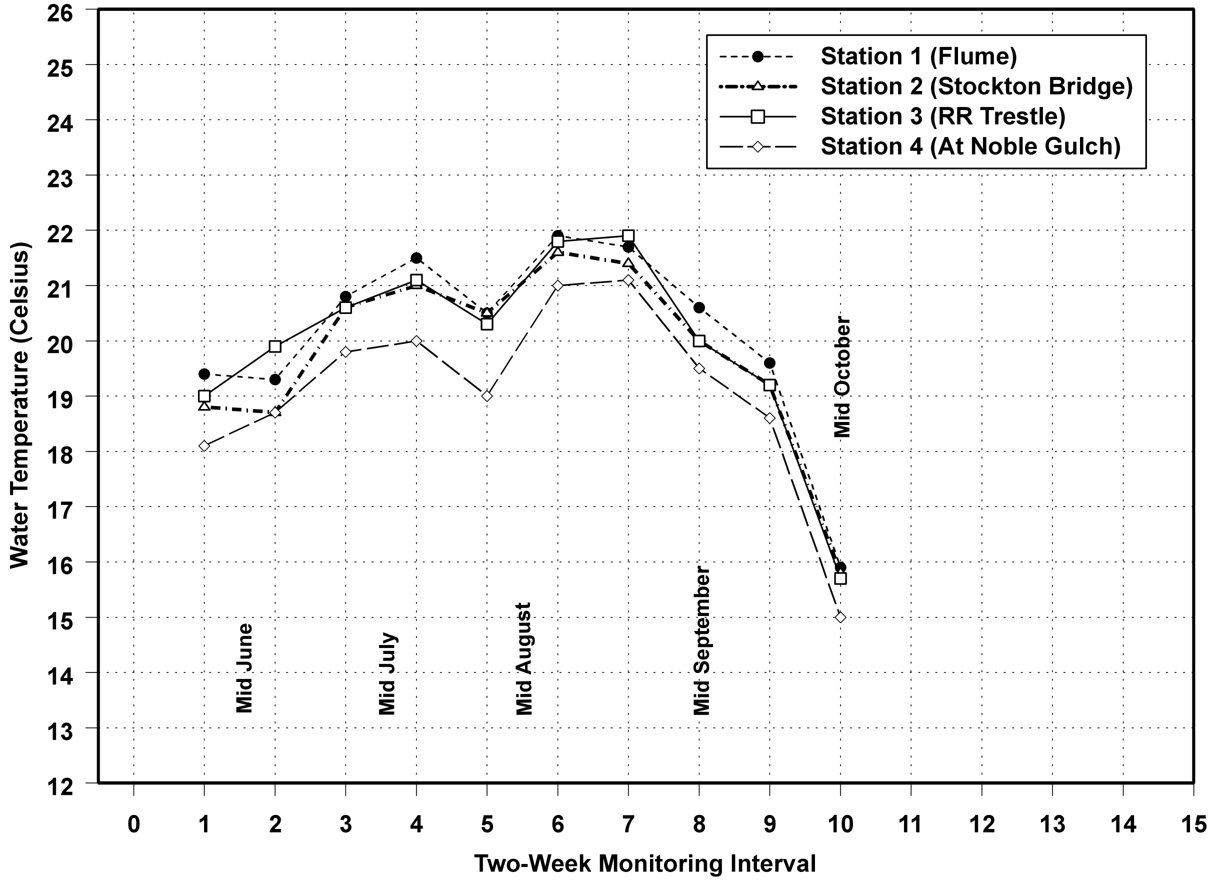


Figure 3l. Water Temperature in the Afternoon at 4 Lagoon Stations Near the Bottom Between 1500 and 1630 hr from 10 June to 8 December 2007.

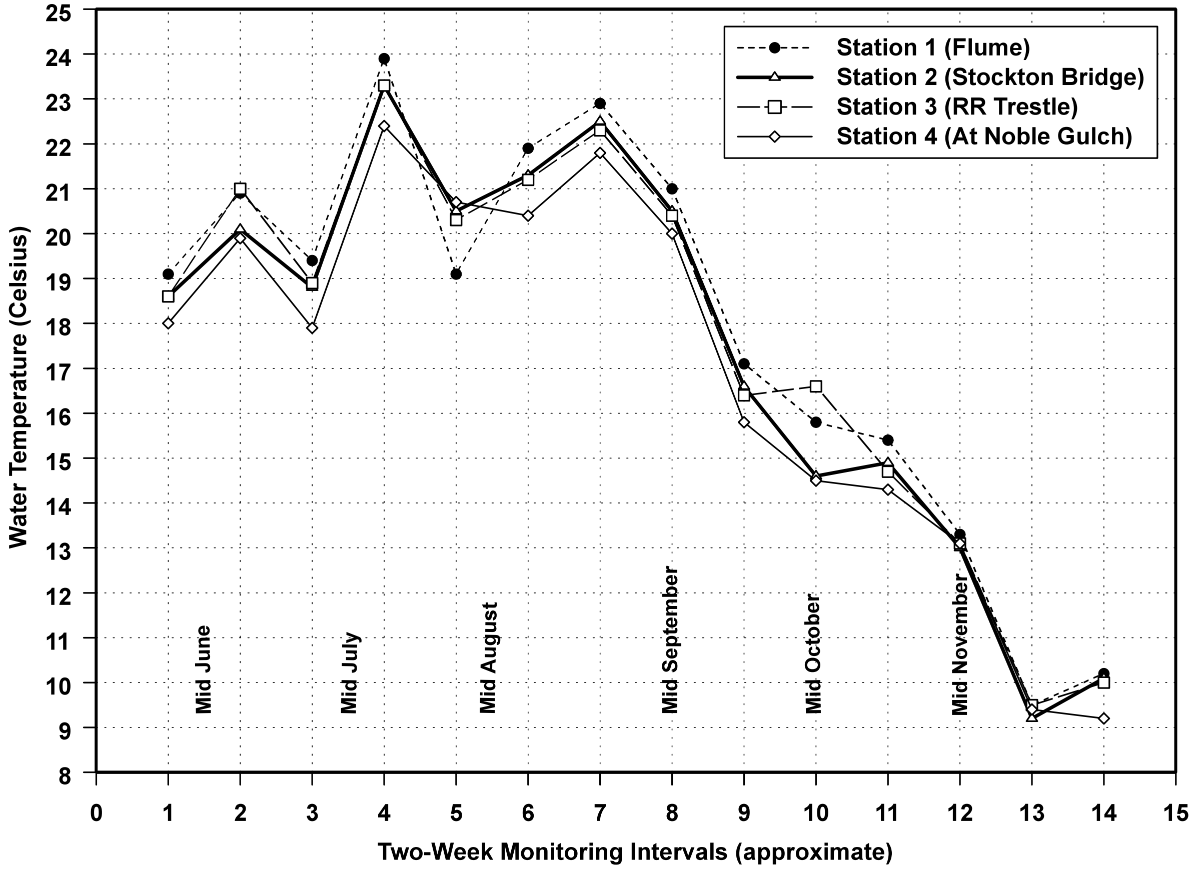


Figure 4a. Water Temperature (°C) Down from Trestle, 0.5 ft from Bottom, 30 June – 2 October 2011 (30-minute interval).

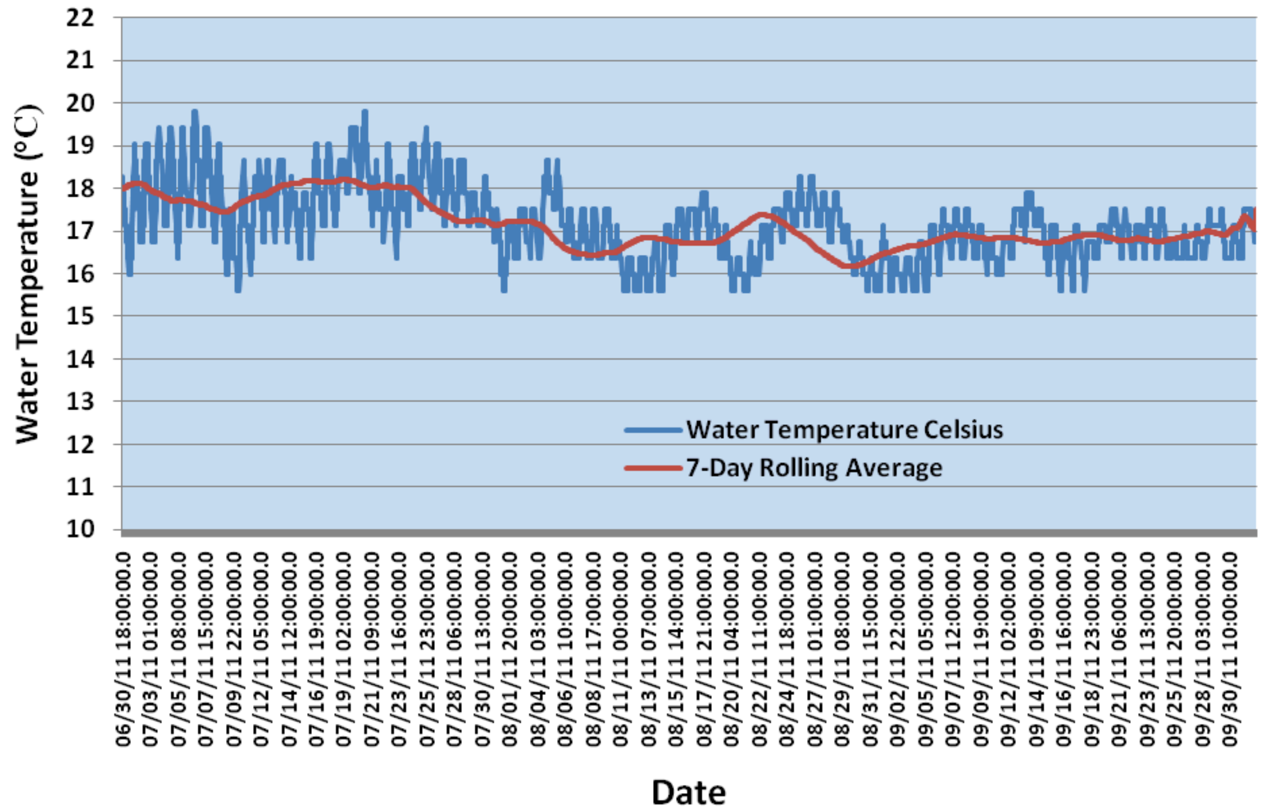
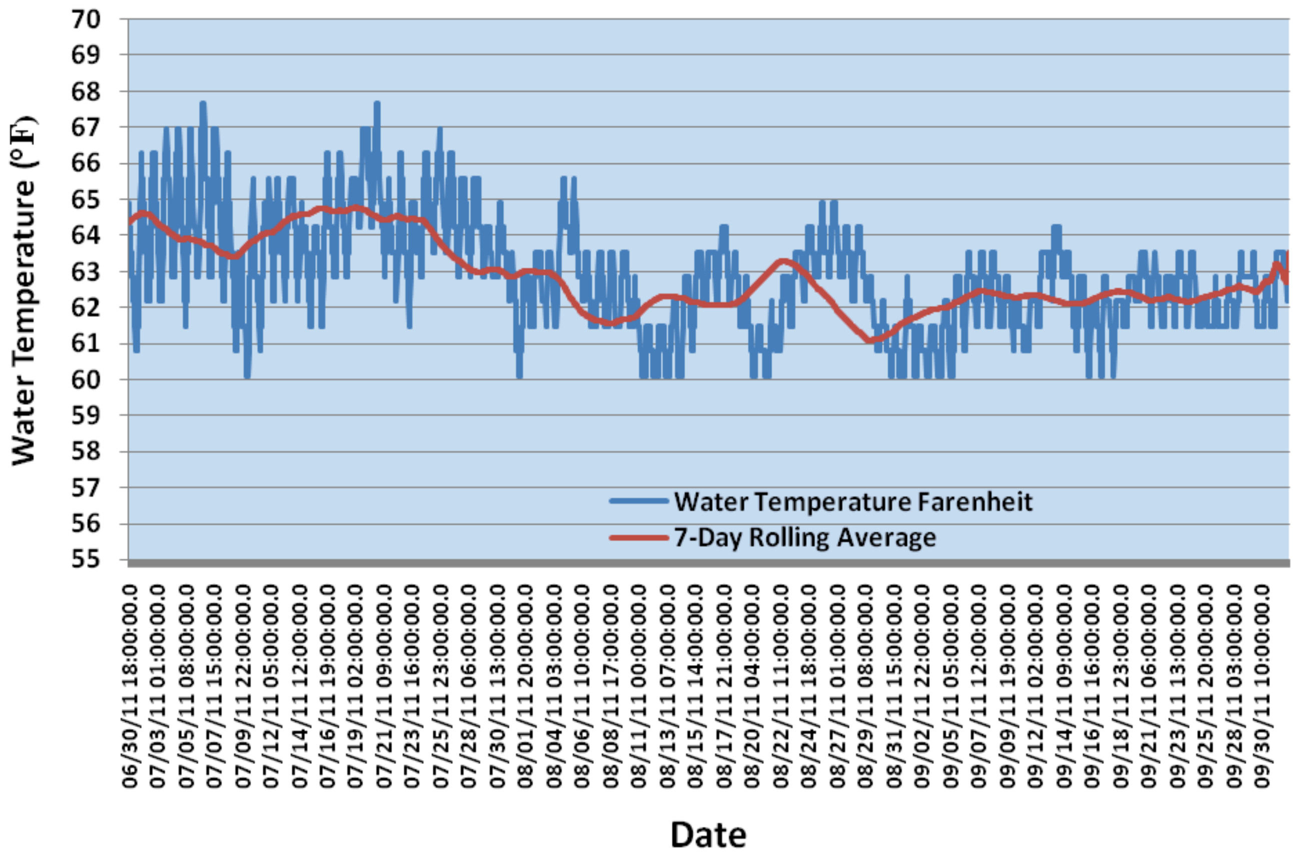


Figure 4b. Water Temperature (°F) Down from Trestle, 0.5 ft from Bottom, 30 June – 2 October 2011 (30-minute interval).



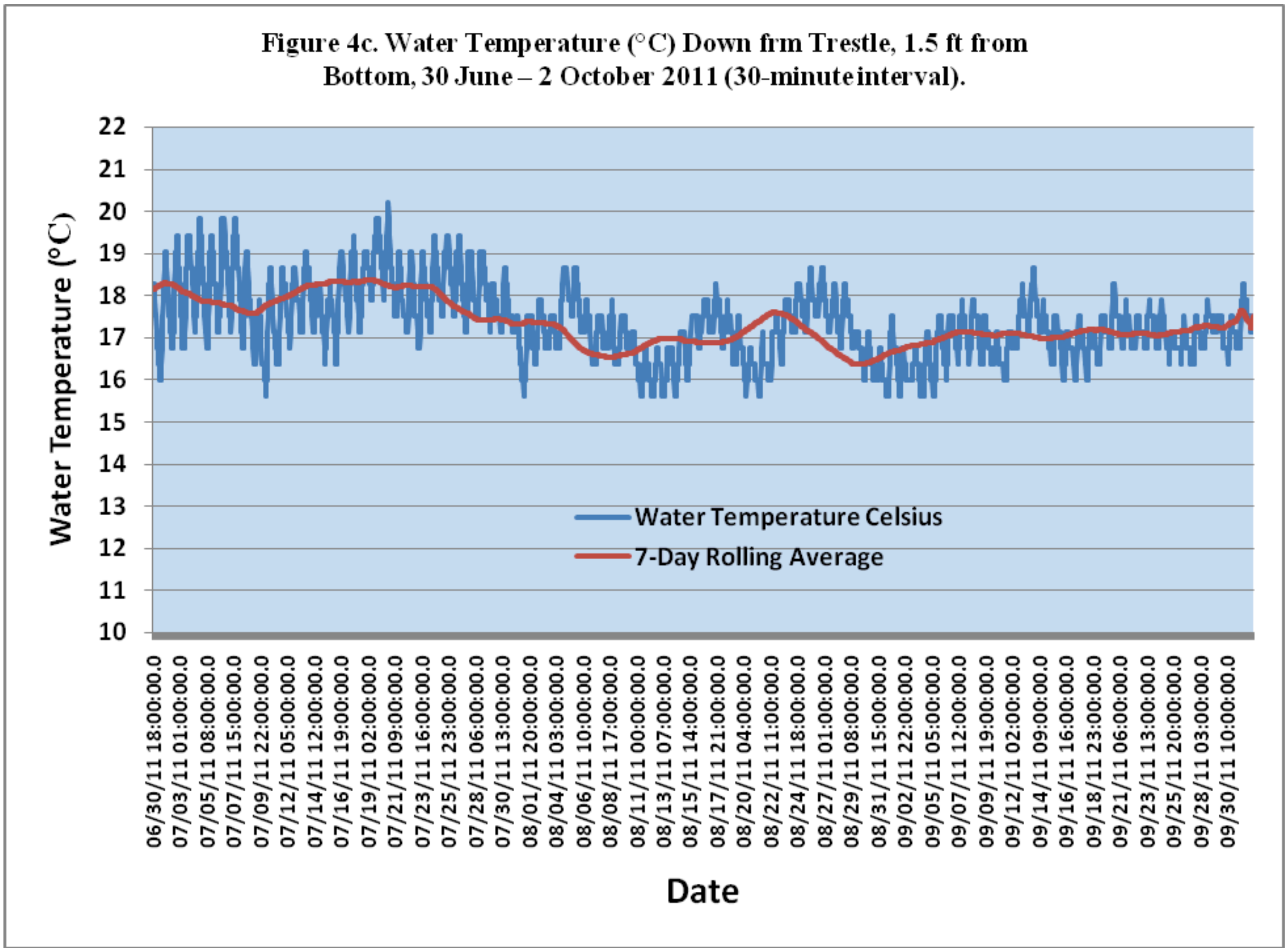


Figure 4c. Water Temperature (°C) Down frm Trestle, 1.5 ft from Bottom, 30 June – 2 October 2011 (30-minute interval).
Water Temperature (°C)
Water Temperature Celsius
7-Day Rolling Average
Date

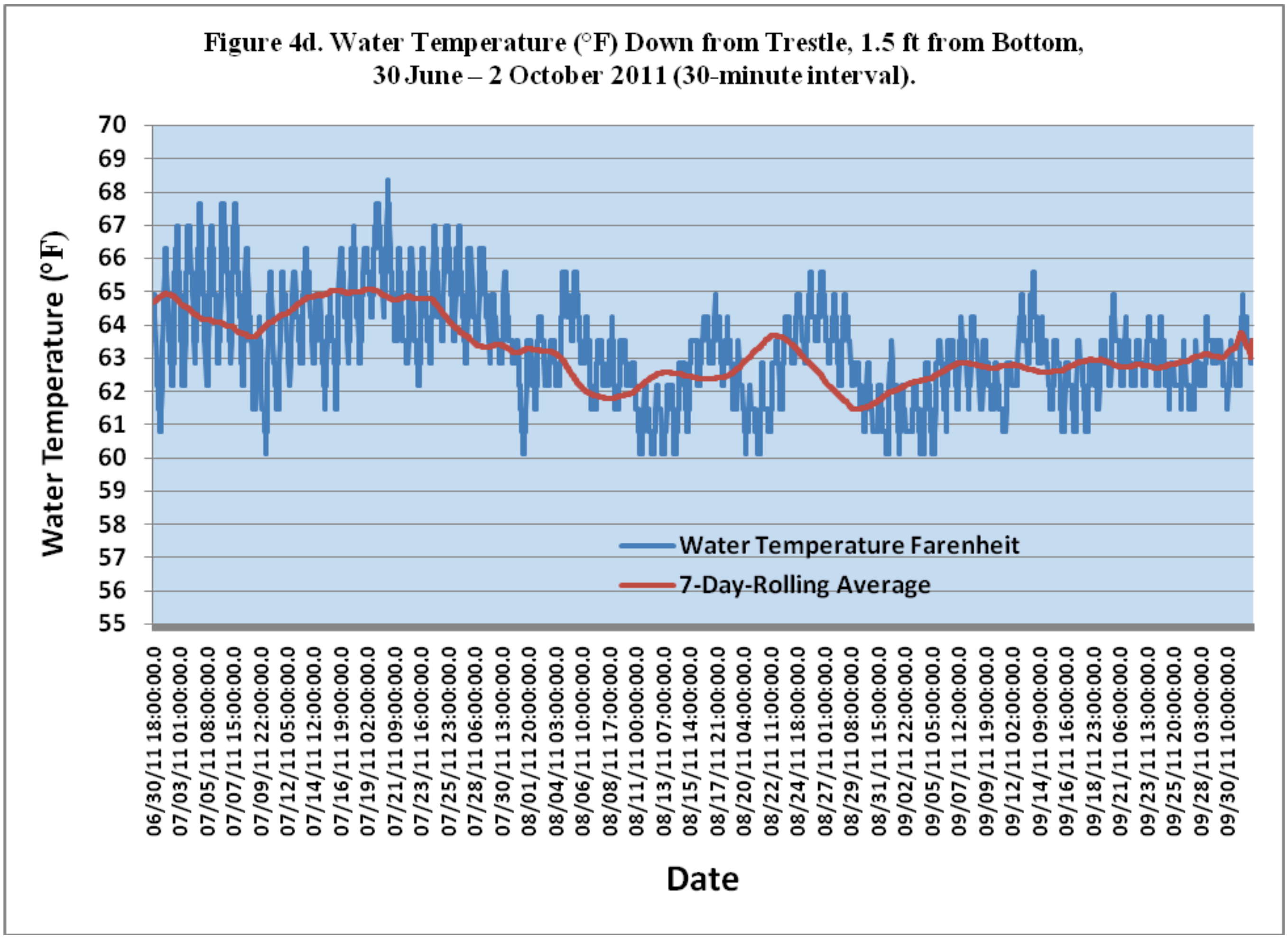


Figure 4d. Water Temperature (°F) Down from Trestle, 1.5 ft from Bottom,
30 June – 2 October 2011 (30-minute interval).
Water Temperature (°F)
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
Water Temperature Farenheit
7-Day-Rolling Average
06/30/11 18:00:00.0
07/03/11 01:00:00.0
07/05/11 08:00:00.0
07/07/11 15:00:00.0
07/09/11 22:00:00.0
07/12/11 05:00:00.0
07/14/11 12:00:00.0
07/16/11 19:00:00.0
07/19/11 02:00:00.0
07/21/11 09:00:00.0
07/23/11 16:00:00.0
07/25/11 23:00:00.0
07/28/11 06:00:00.0
07/30/11 13:00:00.0
08/01/11 20:00:00.0
08/04/11 03:00:00.0
08/06/11 10:00:00.0
08/08/11 17:00:00.0
08/11/11 00:00:00.0
08/13/11 07:00:00.0
08/15/11 14:00:00.0
08/17/11 21:00:00.0
08/20/11 04:00:00.0
08/22/11 11:00:00.0
08/24/11 18:00:00.0
08/27/11 01:00:00.0
08/29/11 08:00:00.0
08/31/11 15:00:00.0
09/02/11 22:00:00.0
09/05/11 05:00:00.0
09/07/11 12:00:00.0
09/09/11 19:00:00.0
09/12/11 02:00:00.0
09/14/11 09:00:00.0
09/16/11 16:00:00.0
09/18/11 23:00:00.0
09/21/11 06:00:00.0
09/23/11 13:00:00.0
09/25/11 20:00:00.0
09/28/11 03:00:00.0
09/30/11 10:00:00.0
Date

Figure 4e. Water Temperature (°C) Down from Trestle, 2.5 ft from Bottom, 30 June – 2 October 2011 (30-minute interval).

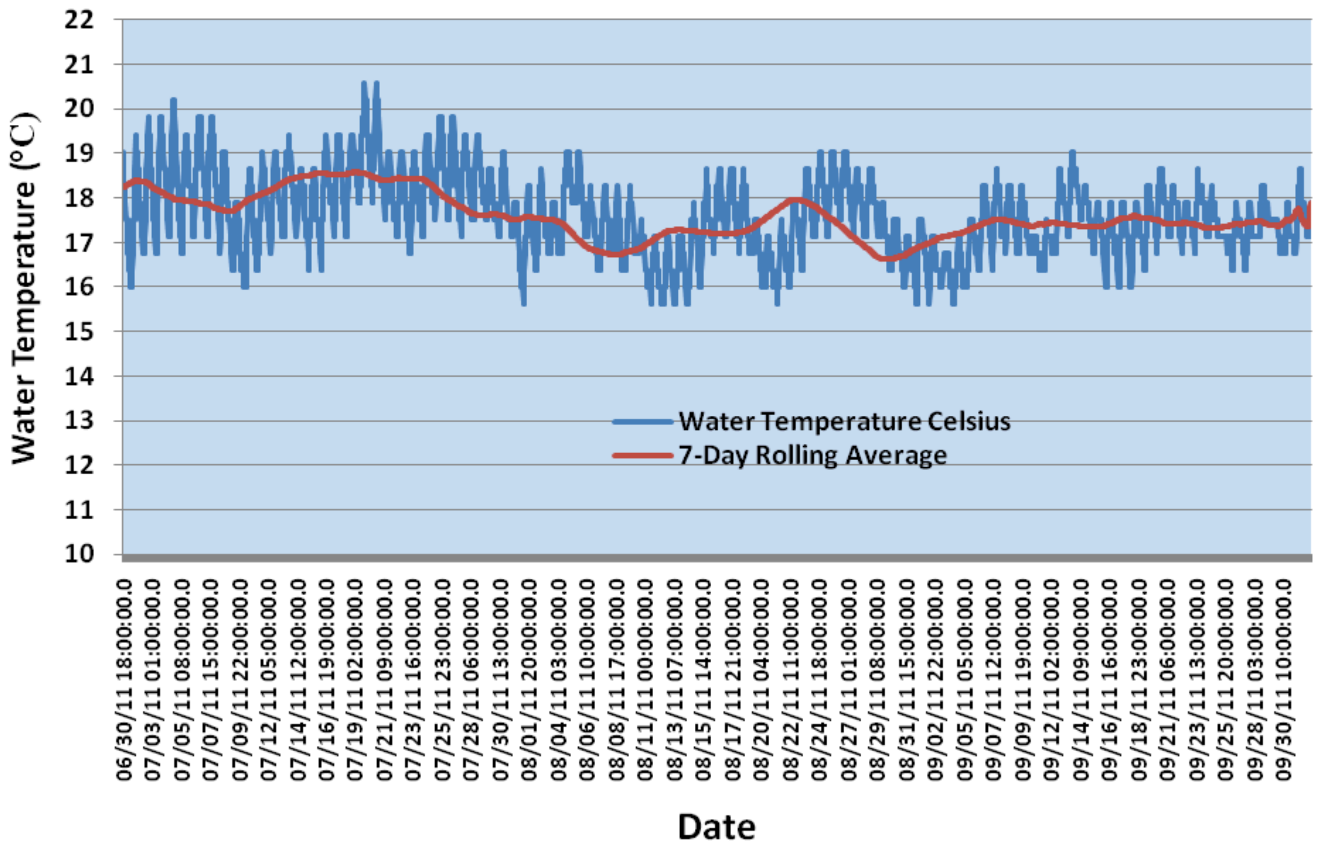


Figure 4f. Water Temperature (°F) Down from Trestle, 2.5 ft from Bottom, 30 June – 2 October 2011 (30-minute interval).

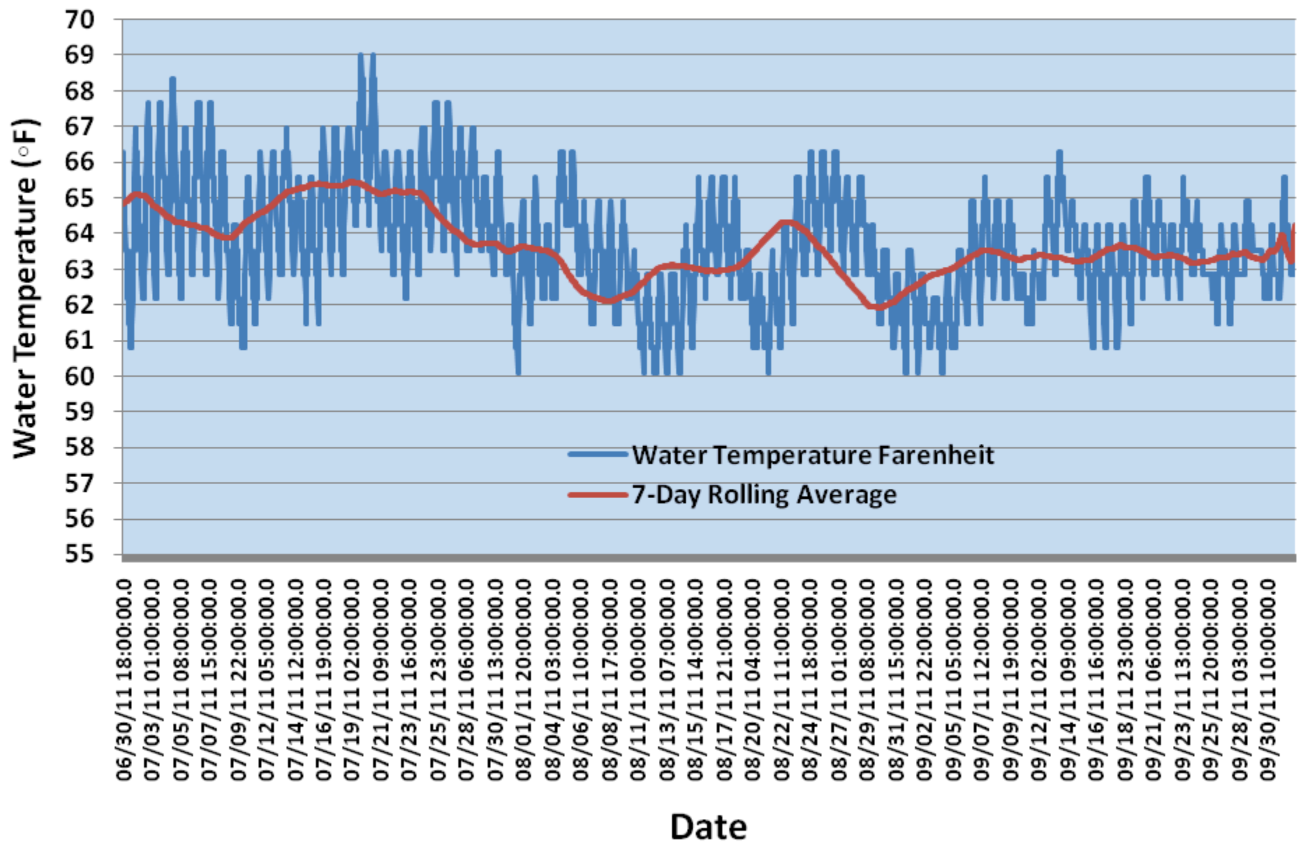
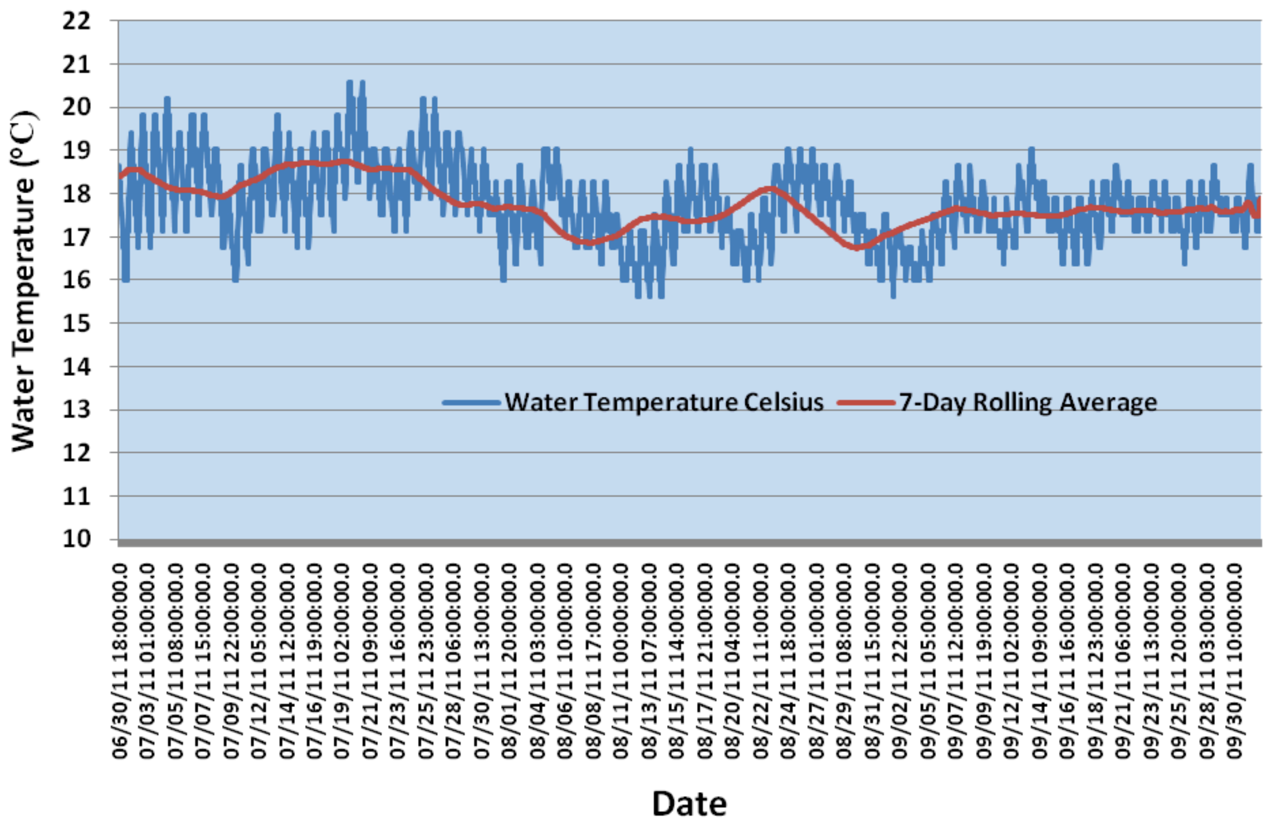


Figure 4g. Water Temperature (◦C) Down From Trestle, 3.5 ft from Bottom, 30 June – 2 October 2011 (30-minute interval).



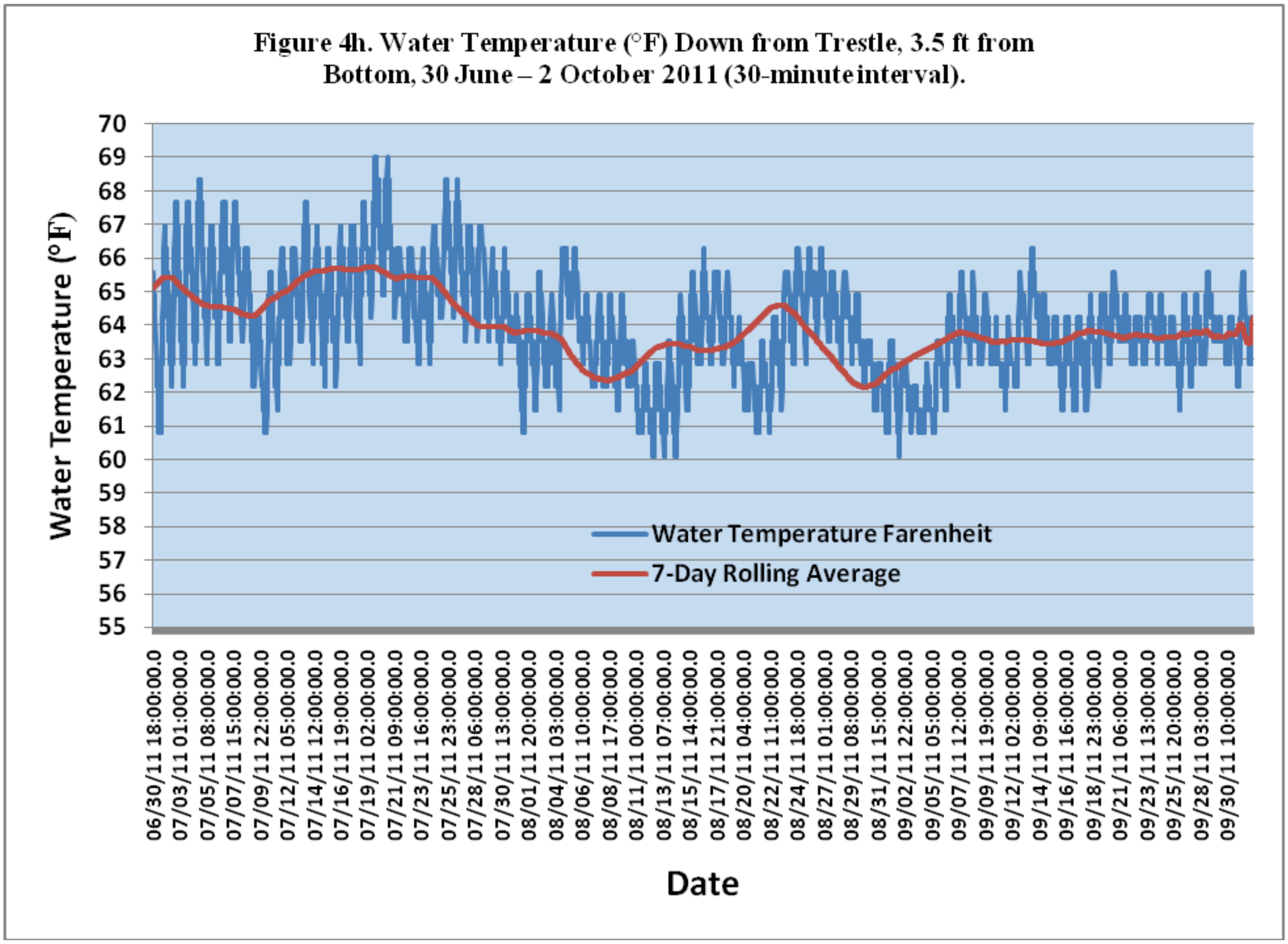


Figure 4h. Water Temperature (°F) Down from Trestle, 3.5 ft from Bottom, 30 June – 2 October 2011 (30-minute interval).
Water Temperature (°F)
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
Water Temperature Farenheit
7-Day Rolling Average
Date

Figure 4i. Water Temperature (°C) Down from Trestle, 4.5 ft from Bottom, 30 June – 2 October 2011 (30-minute interval).

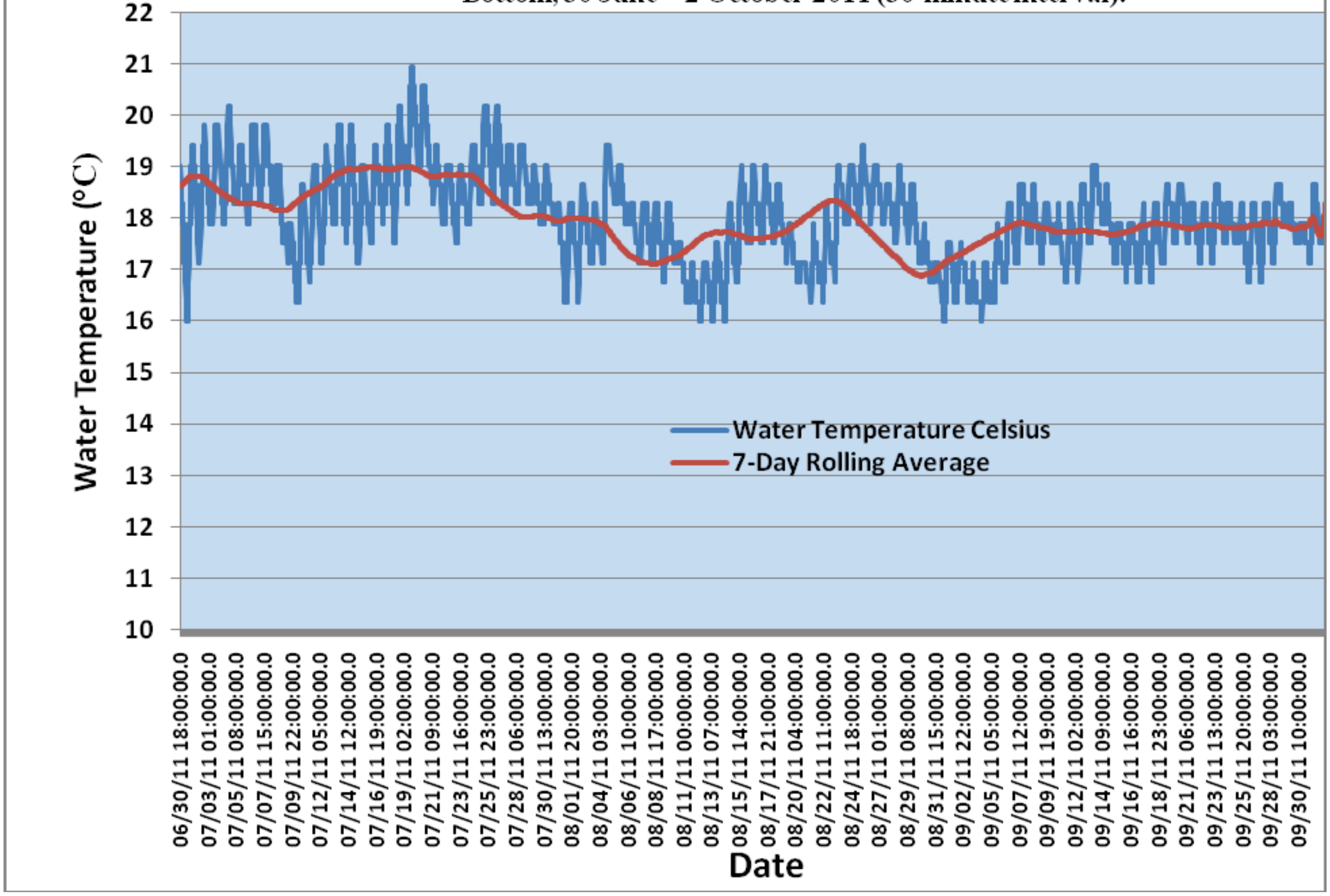


Figure 4j. Water Temperature (°F) Down from Trestle, 4.5 ft from Bottom, 30 June – 2 October 2011 (30-minute interval).

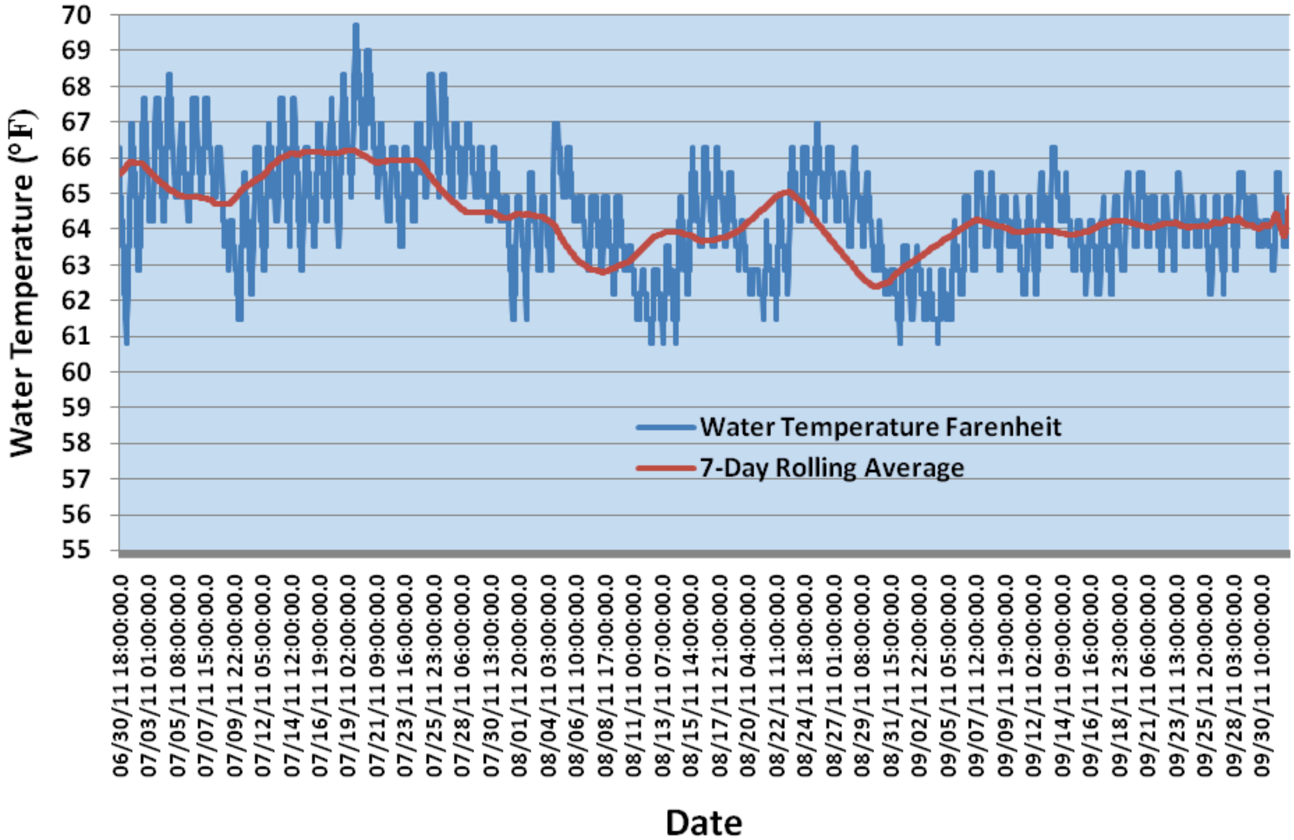


Figure 4k. Water Temperature (°C) Down from Trestle, 5.5 ft from Bottom, 30 June – 2 October 2011 (30-minute interval).

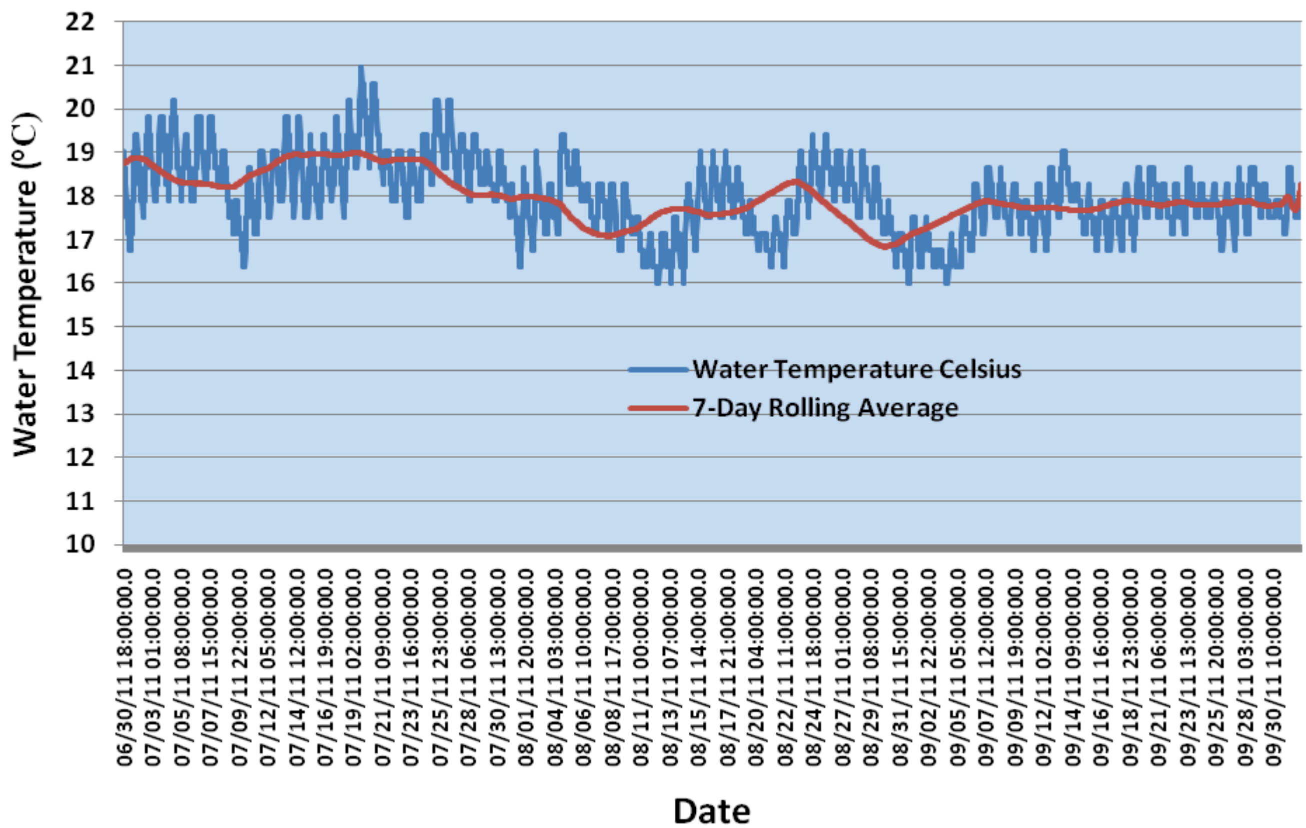


Figure 4l. Water Temperature (°F) Down from Trestle, 5.5 ft from Bottom, 30 June – 2 October 2011 (30-minute interval).

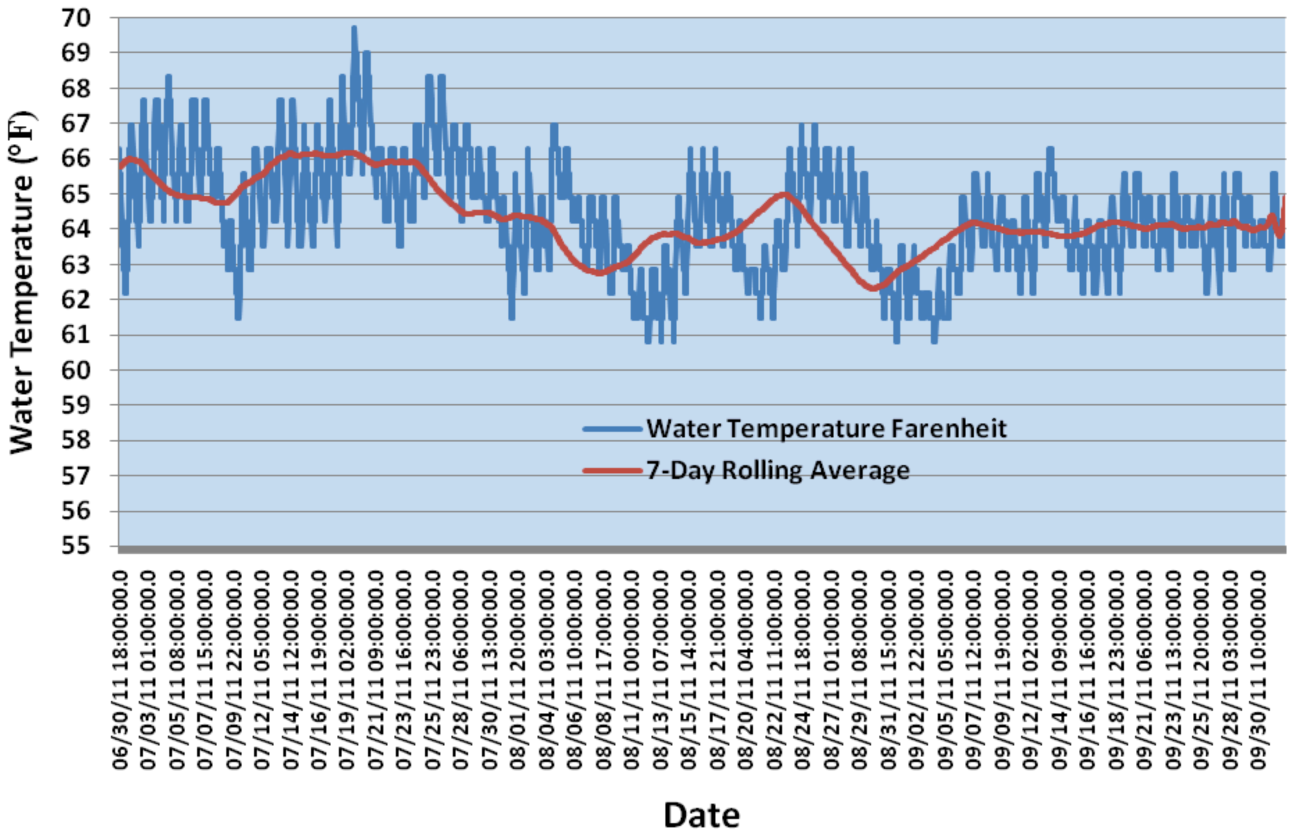
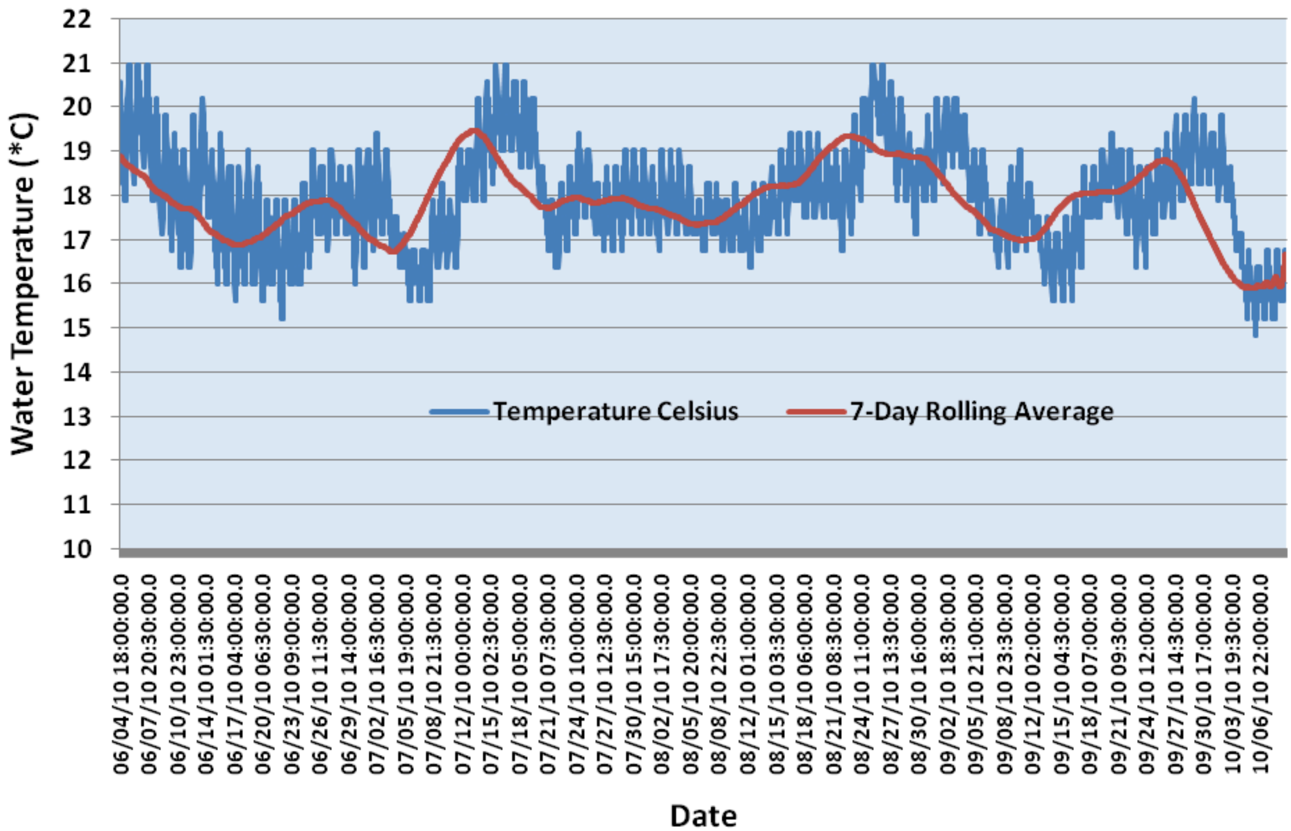


Figure 4m. Water Temperature (*C) Down from Trestle, 5.5 ft from Bottom, 4 June - 9 October 2010 (30-minute interval).



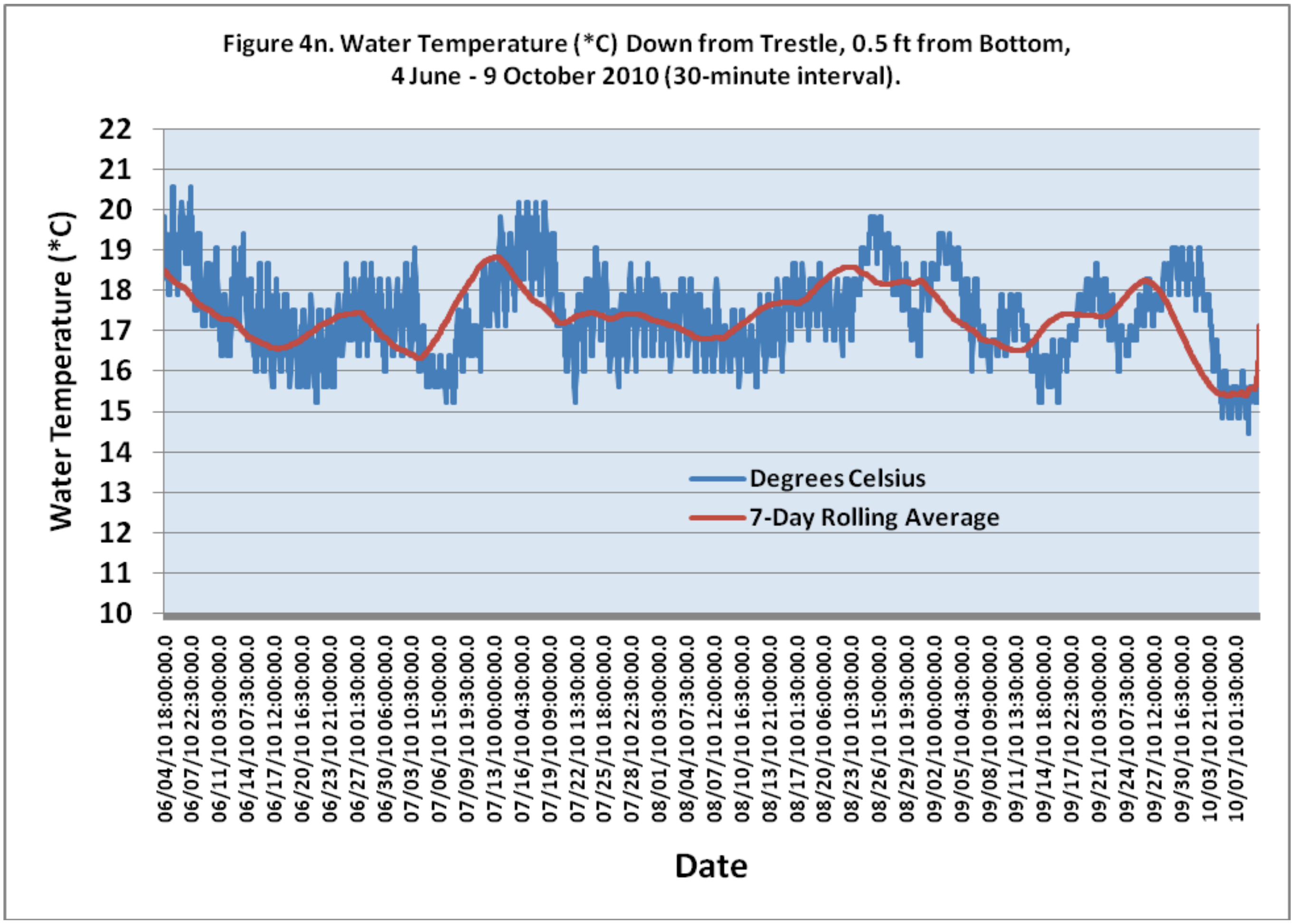


Figure 4n. Water Temperature (*C) Down from Trestle, 0.5 ft from Bottom,
4 June - 9 October 2010 (30-minute interval).
Water Temperature (*C)
22
21
20
19
18
17
16
15
14
13
12
11
10
Degrees Celsius
7-Day Rolling Average
Date

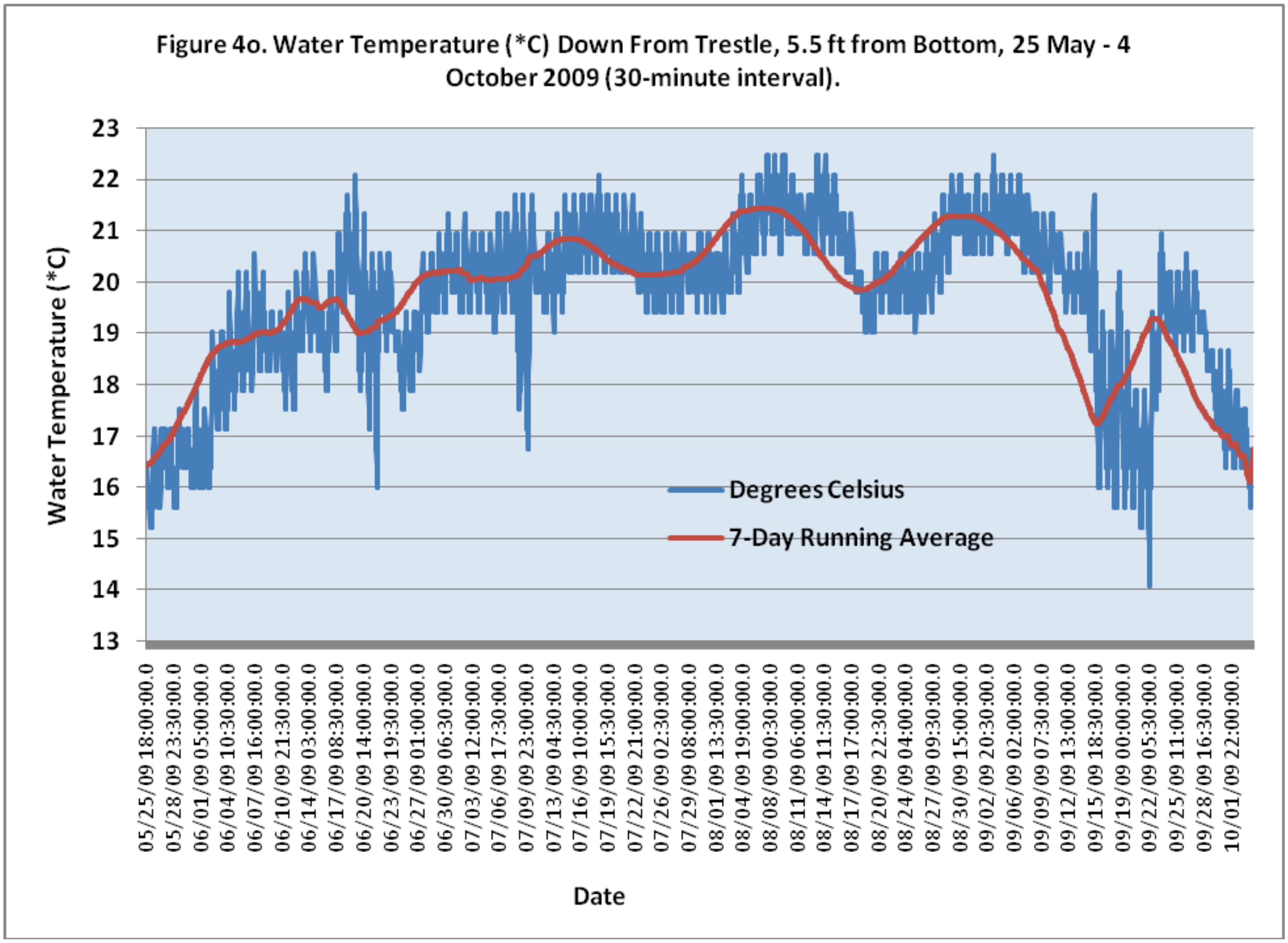


Figure 4o. Water Temperature (*C) Down From Trestle, 5.5 ft from Bottom, 25 May - 4 October 2009 (30-minute interval).
Water Temperature (*C)
23
22
21
20
19
18
17
16
15
14
13
Degrees Celsius
7-Day Running Average
05/25/09 18:00:00.0
05/28/09 23:30:00.0
06/01/09 05:00:00.0
06/04/09 10:30:00.0
06/07/09 16:00:00.0
06/10/09 21:30:00.0
06/14/09 03:00:00.0
06/17/09 08:30:00.0
06/20/09 14:00:00.0
06/23/09 19:30:00.0
06/27/09 01:00:00.0
06/30/09 06:30:00.0
07/03/09 12:00:00.0
07/06/09 17:30:00.0
07/09/09 23:00:00.0
07/13/09 04:30:00.0
07/16/09 10:00:00.0
07/19/09 15:30:00.0
07/22/09 21:00:00.0
07/26/09 02:30:00.0
07/29/09 08:00:00.0
08/01/09 13:30:00.0
08/04/09 19:00:00.0
08/08/09 00:30:00.0
08/11/09 06:00:00.0
08/14/09 11:30:00.0
08/17/09 17:00:00.0
08/20/09 22:30:00.0
08/24/09 04:00:00.0
08/27/09 09:30:00.0
08/30/09 15:00:00.0
09/02/09 20:30:00.0
09/06/09 02:00:00.0
09/09/09 07:30:00.0
09/12/09 13:00:00.0
09/15/09 18:30:00.0
09/19/09 00:00:00.0
09/22/09 05:30:00.0
09/25/09 11:00:00.0
09/28/09 16:30:00.0
10/01/09 22:00:00.0
Date

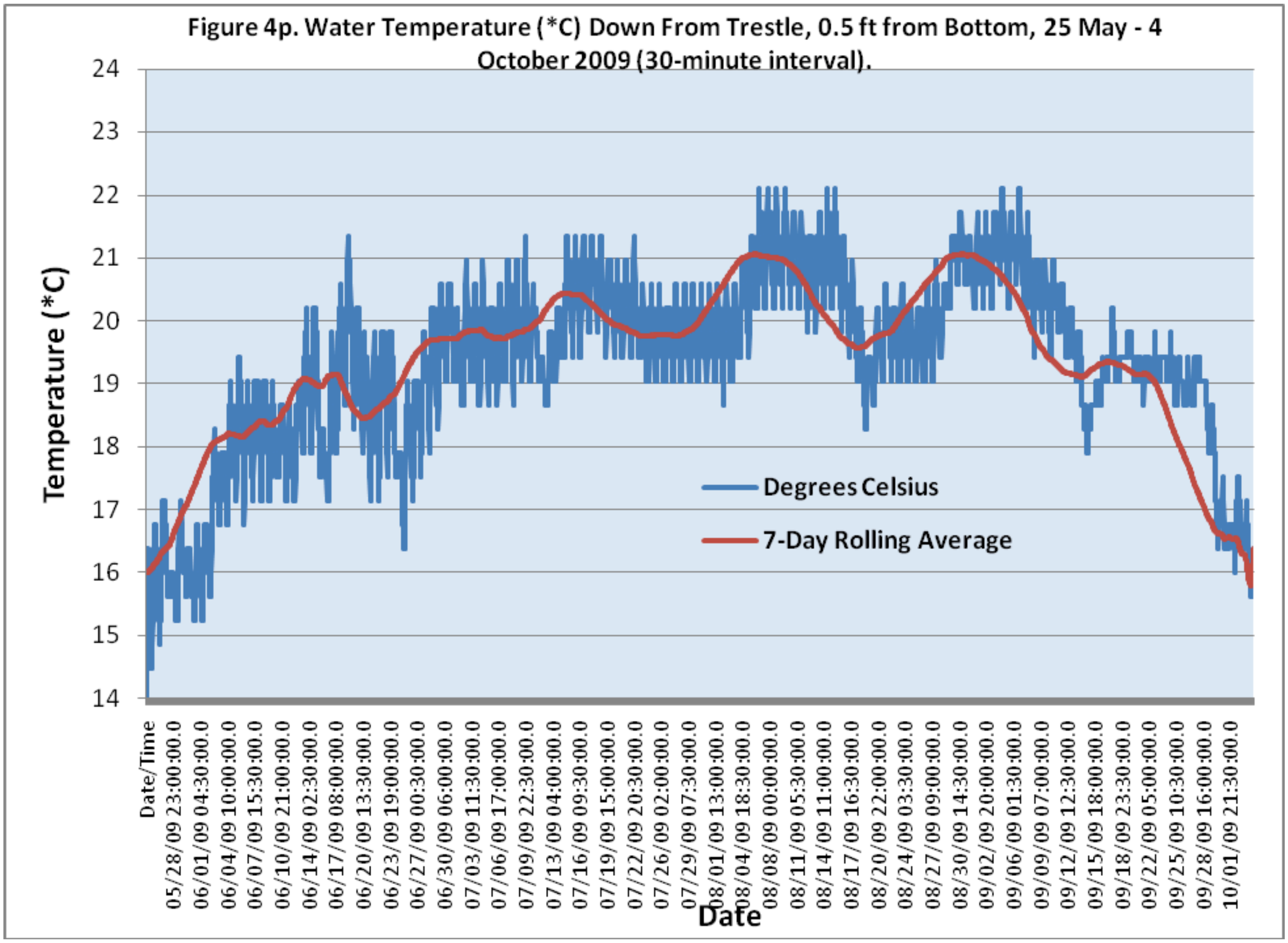


Figure 4p. Water Temperature (*C) Down From Trestle, 0.5 ft from Bottom, 25 May - 4 October 2009 (30-minute interval).

Figure 5a. Water Temperature (°C) Above the Lagoon (Nob Hill) in Soquel Creek, 30 June – 2 October 2011 (30-minute interval).

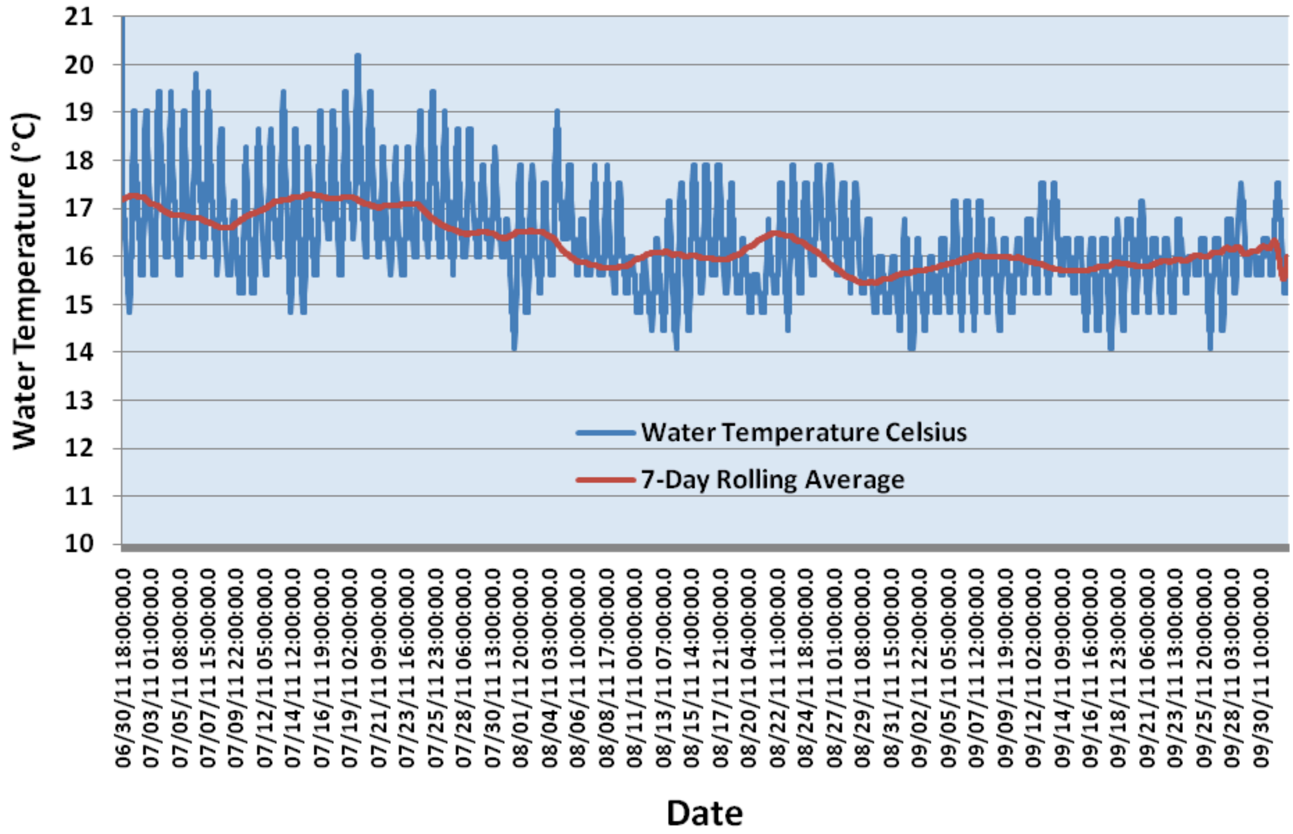
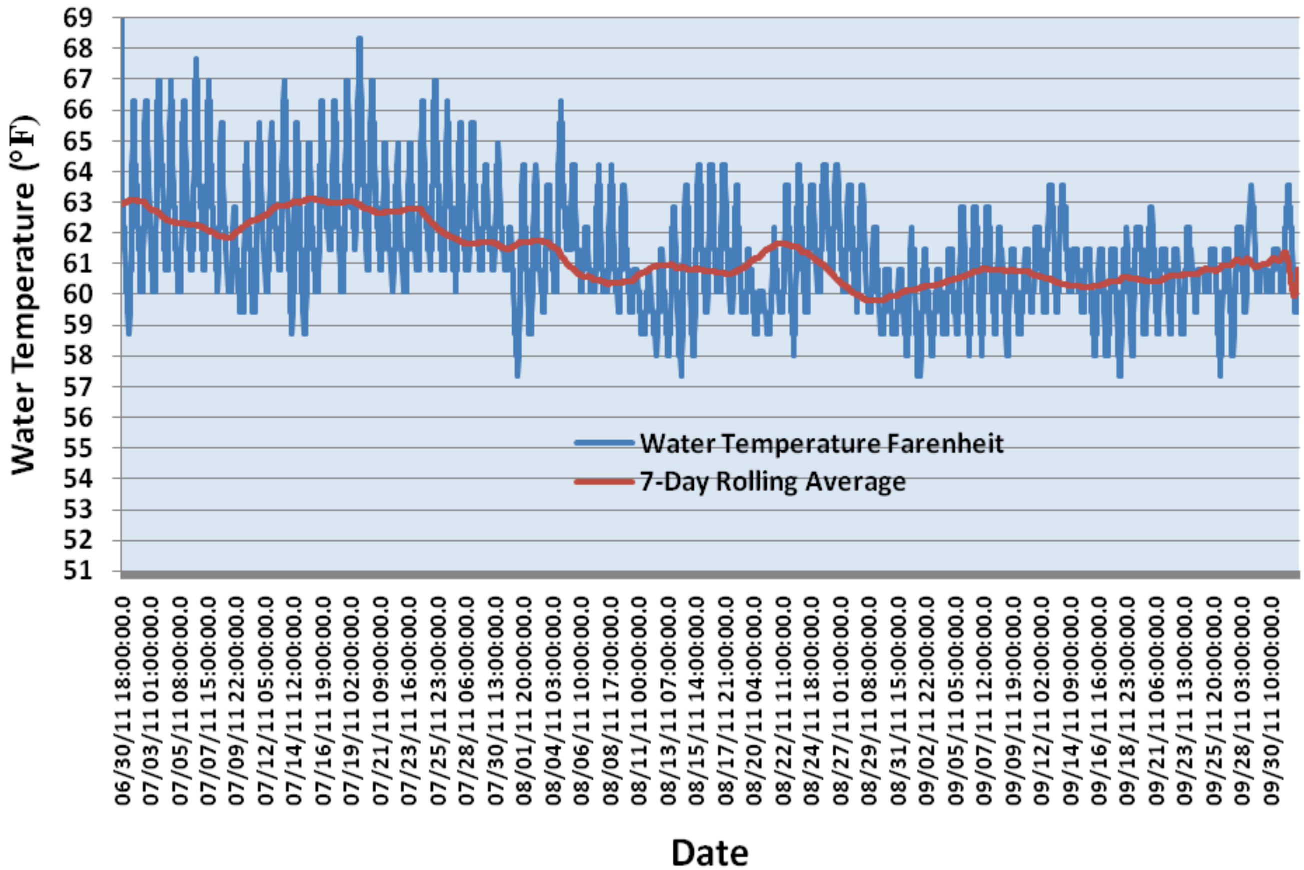


Figure 5b. Water Temperature (°F) Above the Lagoon (Nob Hill) in Soquel Creek, 30 June – 2 October 2011 (30-minute interval).



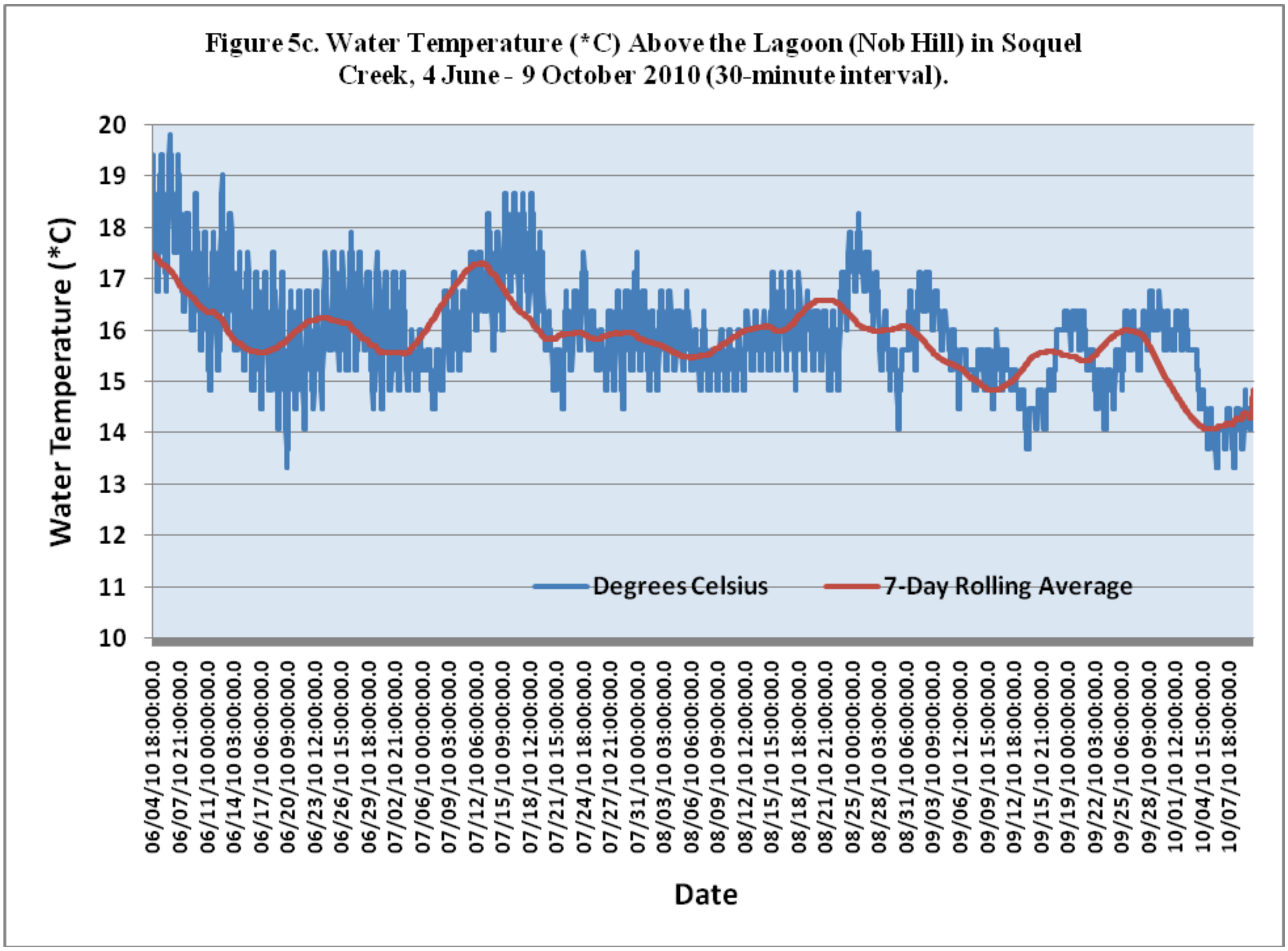
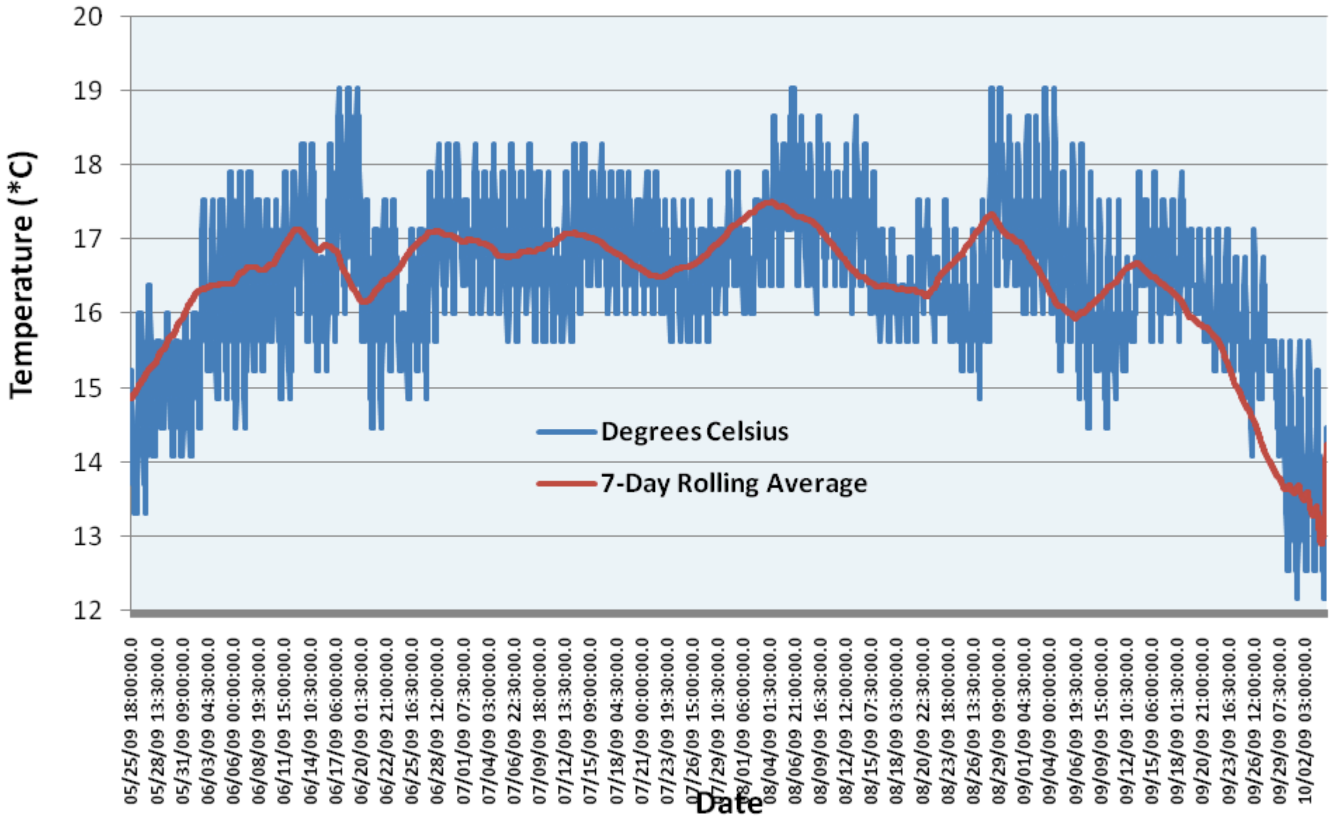


Figure 5c. Water Temperature (*C) Above the Lagoon (Nob Hill) in Soquel Creek, 4 June - 9 October 2010 (30-minute interval).
Water Temperature (*C)
Date
Degrees Celsius
7-Day Rolling Average

Figure 5d. Water Temperature (*C) Above the Lagoon (Nob Hill) in Soquel Creek, 25 May - 4 October 2009 (30-minute interval).



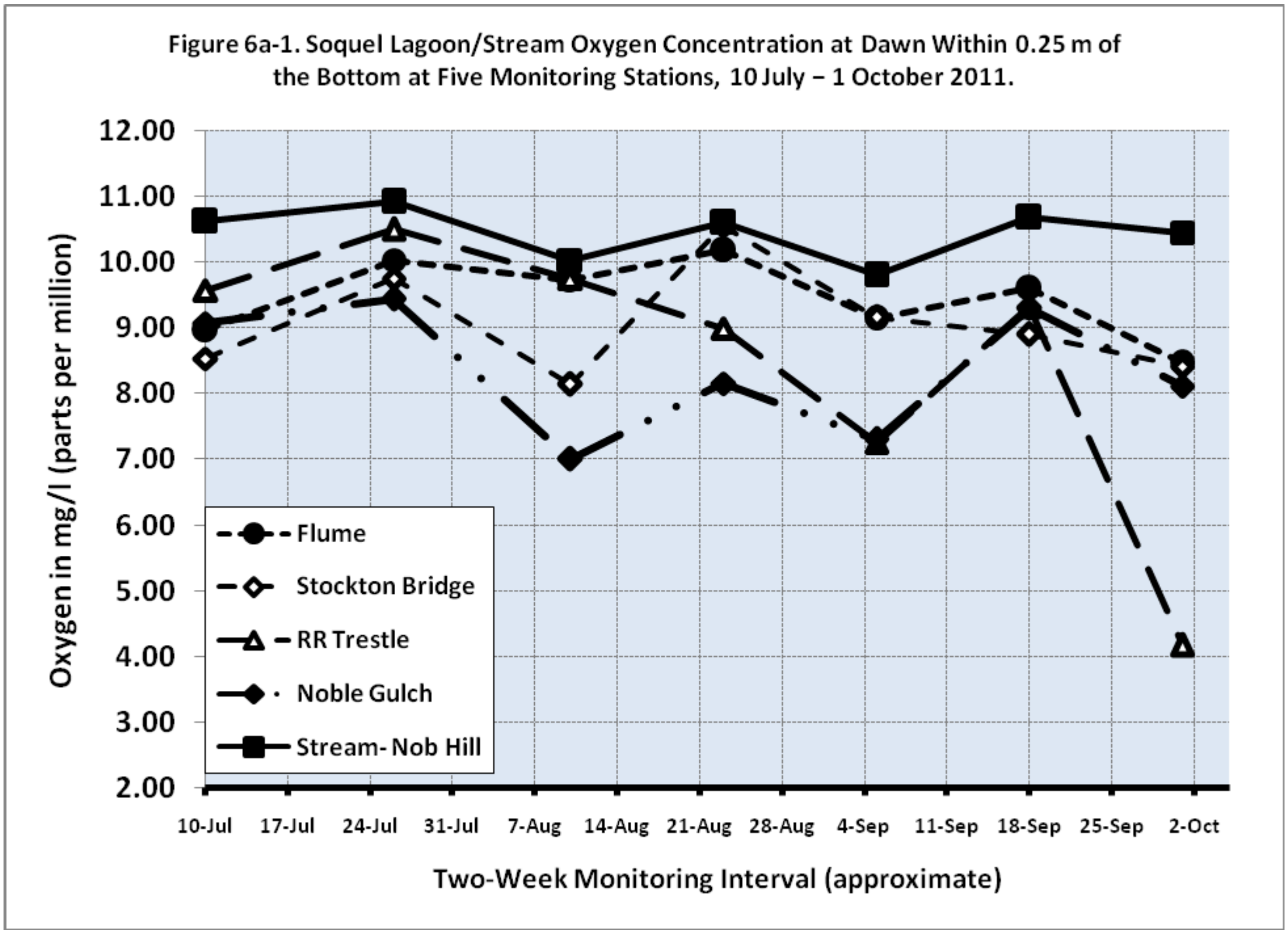


Figure 6a-1. Soquel Lagoon/Stream Oxygen Concentration at Dawn Within 0.25 m of the Bottom at Five Monitoring Stations, 10 July – 1 October 2011.
Oxygen in mg/l (parts per million)
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
Flume
Stockton Bridge
RR Trestle
Noble Gulch
Stream- Nob Hill
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep
2-Oct
Two-Week Monitoring Interval (approximate)

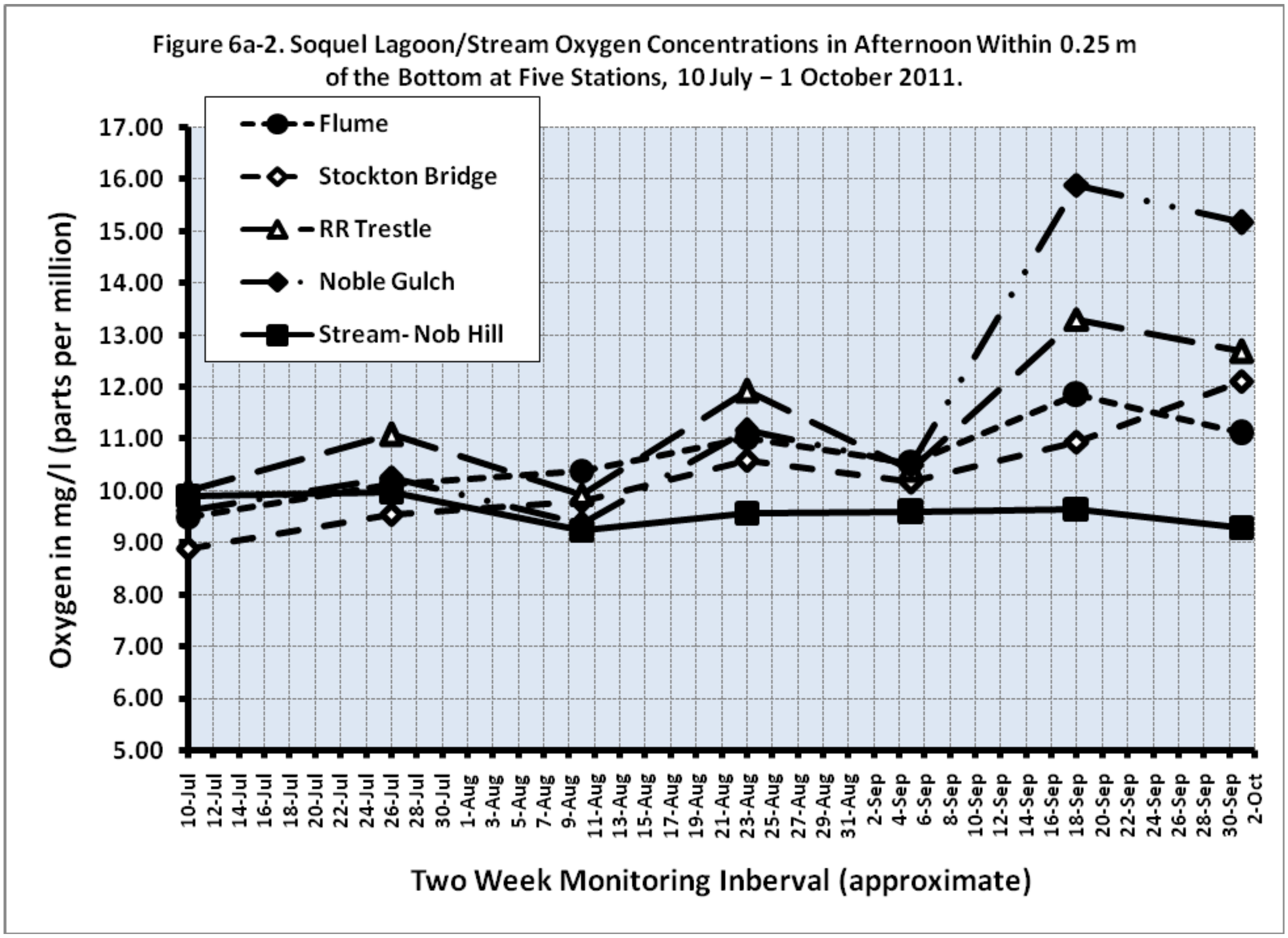
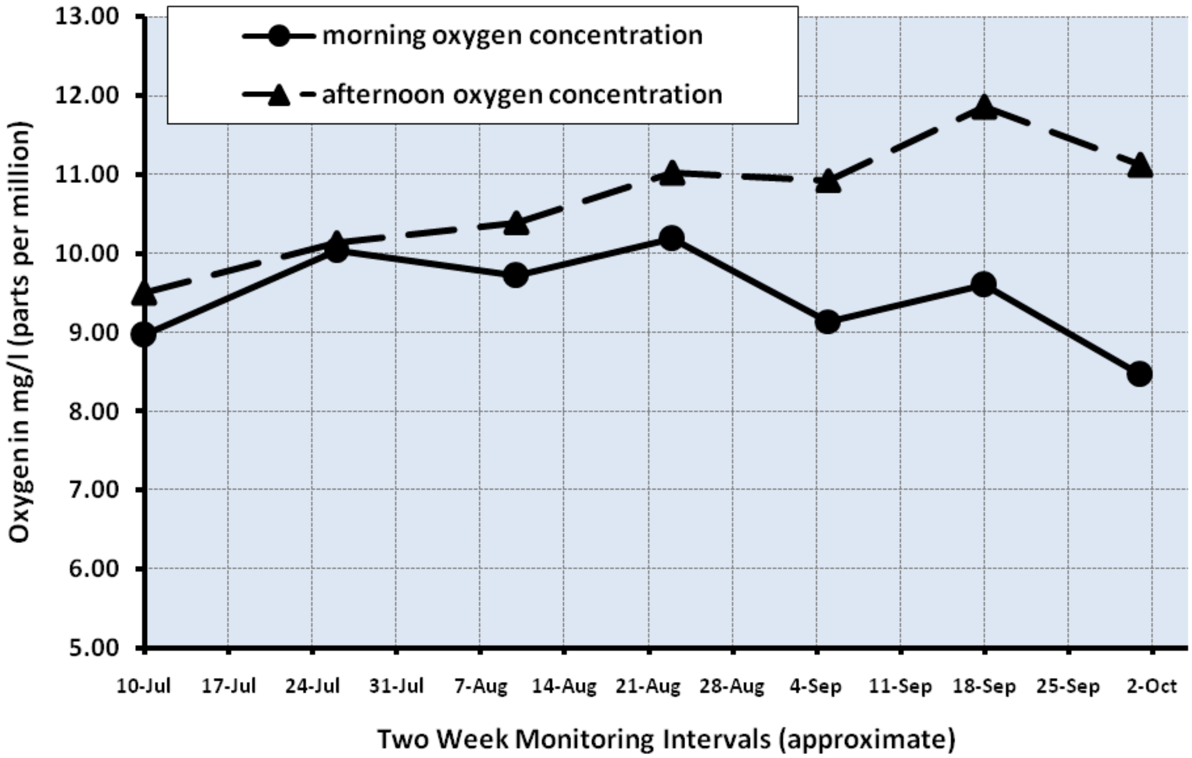


Figure 6a-2. Soquel Lagoon/Stream Oxygen Concentrations in Afternoon Within 0.25 m
of the Bottom at Five Stations, 10 July – 1 October 2011.
Flume
Stockton Bridge
RR Trestle
Noble Gulch
Stream- Nob Hill
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
Oxygen in mg/l (parts per million)
10-Jul
12-Jul
14-Jul
16-Jul
18-Jul
20-Jul
22-Jul
24-Jul
26-Jul
28-Jul
30-Jul
1-Aug
3-Aug
5-Aug
7-Aug
9-Aug
11-Aug
13-Aug
15-Aug
17-Aug
19-Aug
21-Aug
23-Aug
25-Aug
27-Aug
29-Aug
31-Aug
2-Sep
4-Sep
6-Sep
8-Sep
10-Sep
12-Sep
14-Sep
16-Sep
18-Sep
20-Sep
22-Sep
24-Sep
26-Sep
28-Sep
30-Sep
2-Oct
Two Week Monitoring Inberval (approximate)

Figure 6b. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 m of the Bottom at Station 1, the Flume, 10 July – 1 October 2011.



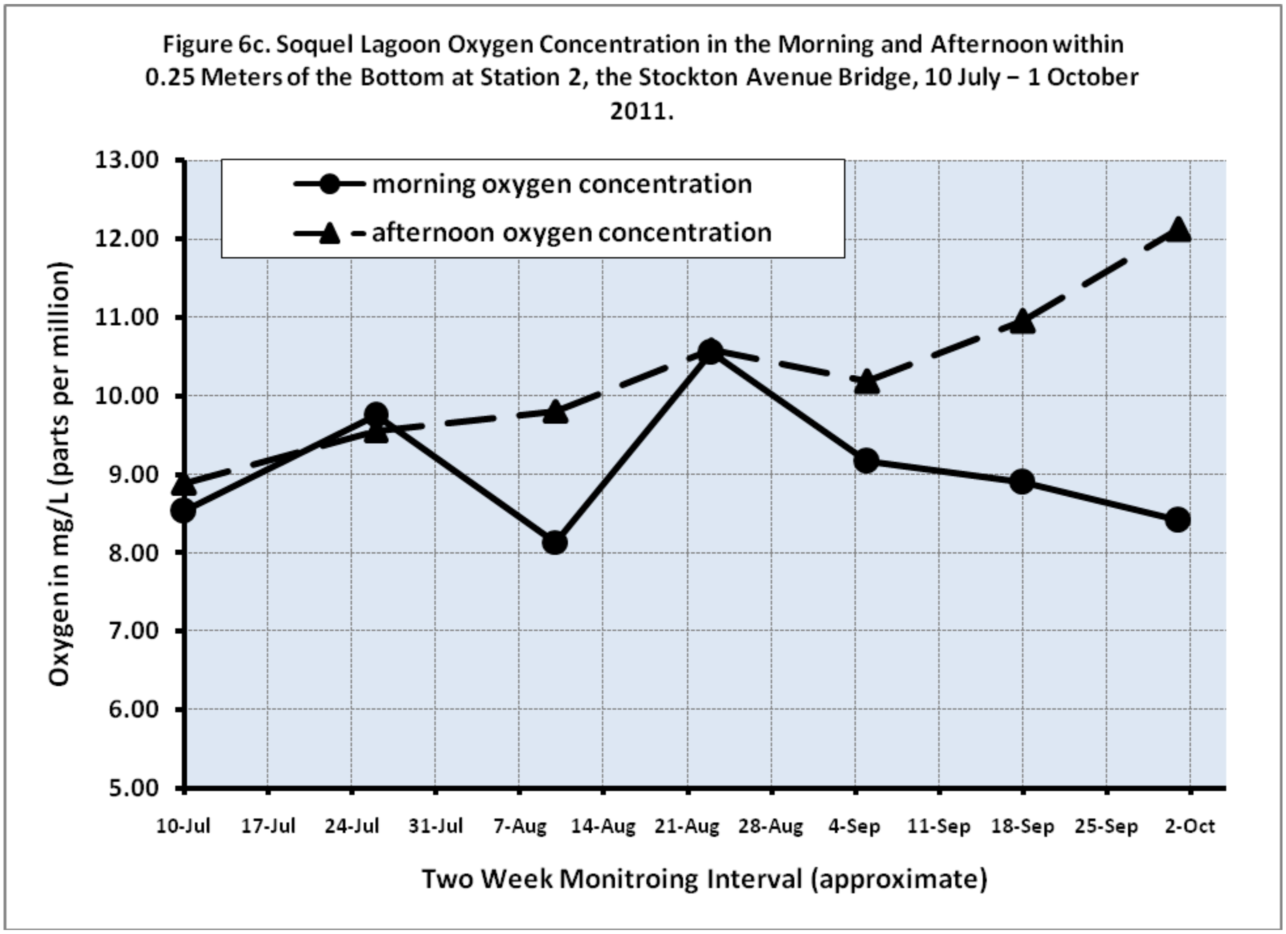


Figure 6c. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 2, the Stockton Avenue Bridge, 10 July – 1 October 2011.
morning oxygen concentration
afternoon oxygen concentration
Oxygen in mg/L (parts per million)
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep
2-Oct
Two Week Monitroing Interval (approximate)

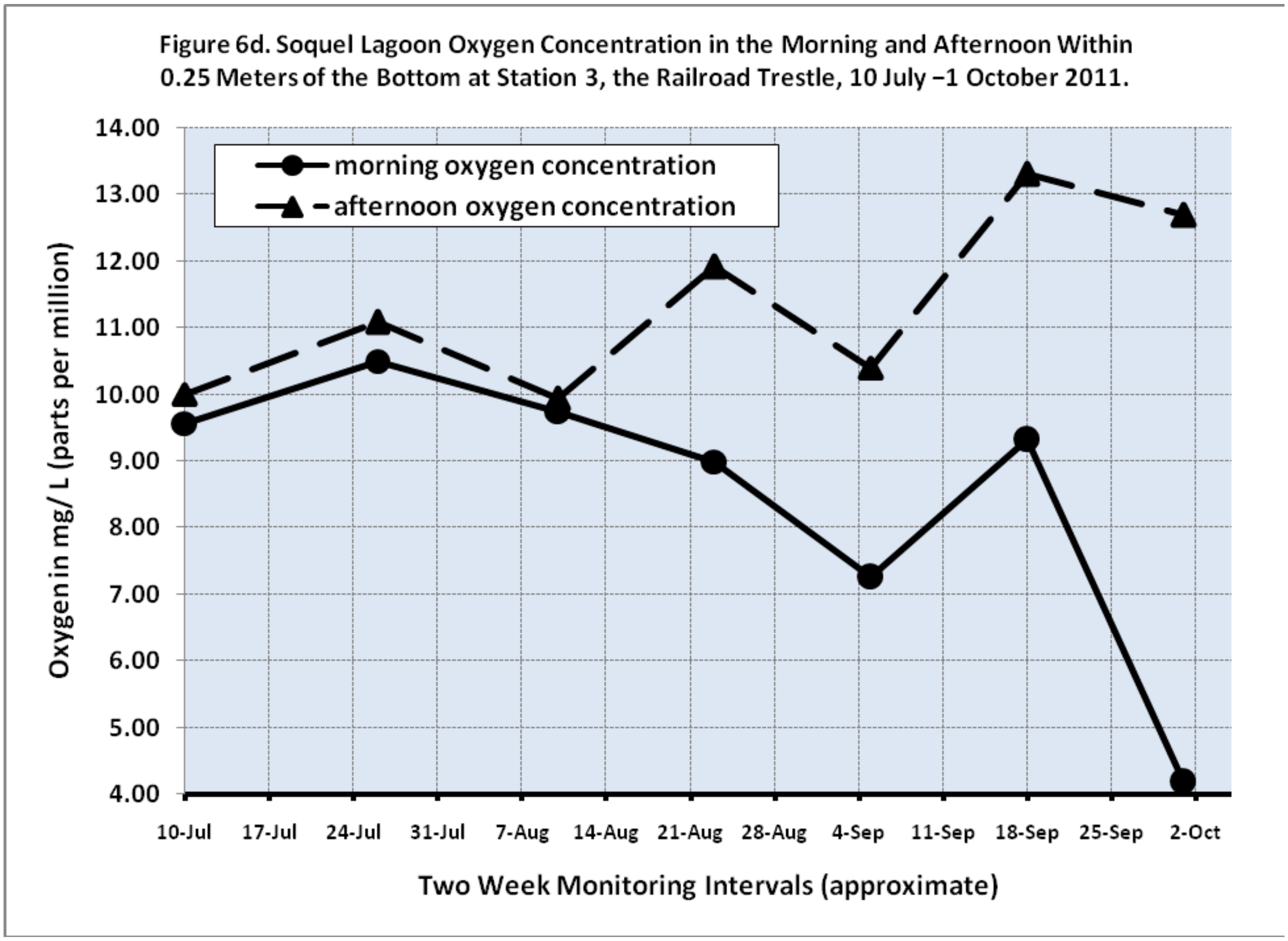


Figure 6d. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon Within 0.25 Meters of the Bottom at Station 3, the Railroad Trestle, 10 July –1 October 2011.
morning oxygen concentration
afternoon oxygen concentration
Oxygen in mg/ L (parts per million)
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep
2-Oct
Two Week Monitoring Intervals (approximate)

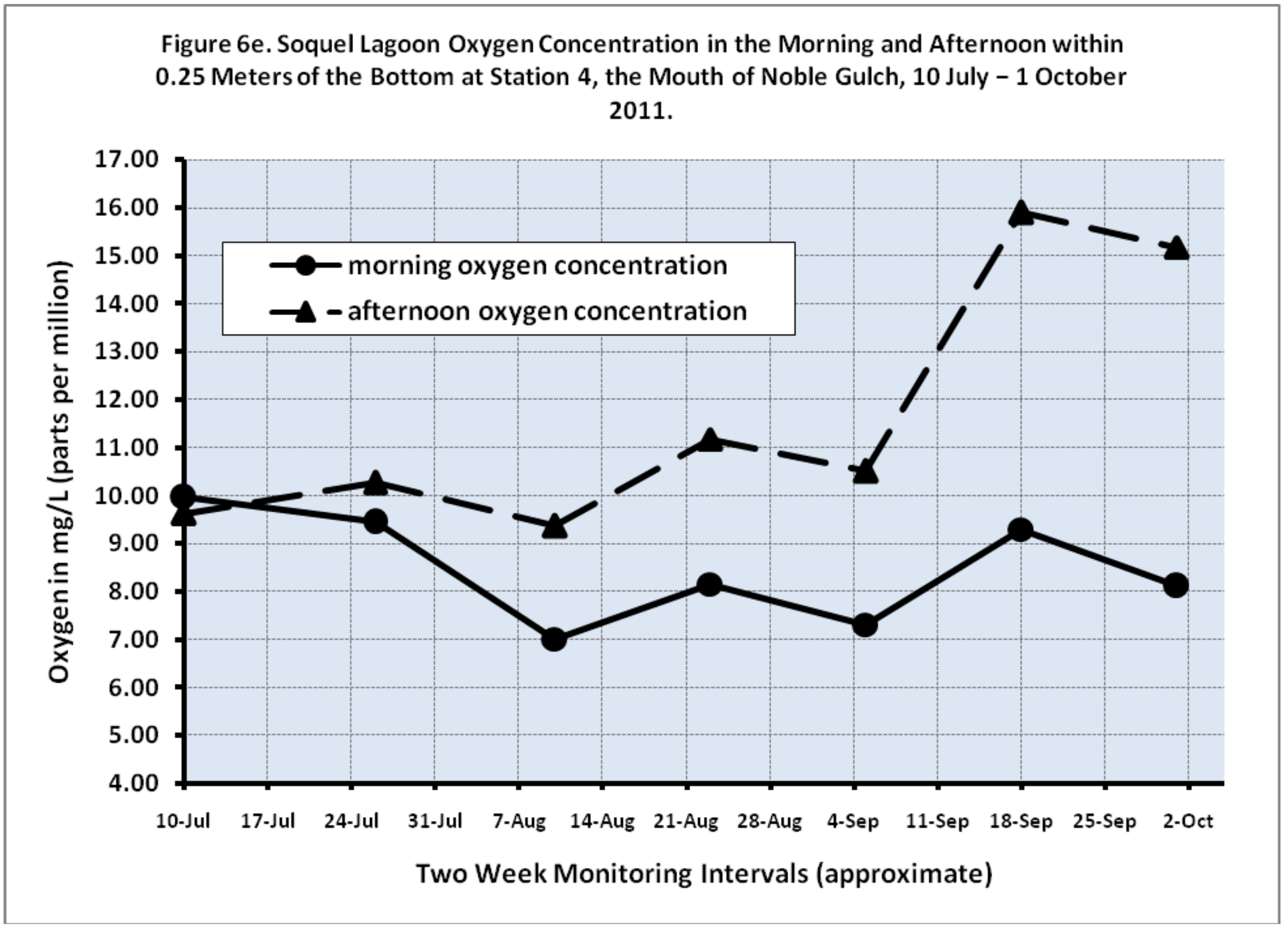


Figure 6e. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 4, the Mouth of Noble Gulch, 10 July – 1 October 2011.
morning oxygen concentration
afternoon oxygen concentration
Oxygen in mg/L (parts per million)
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep
2-Oct
Two Week Monitoring Intervals (approximate)

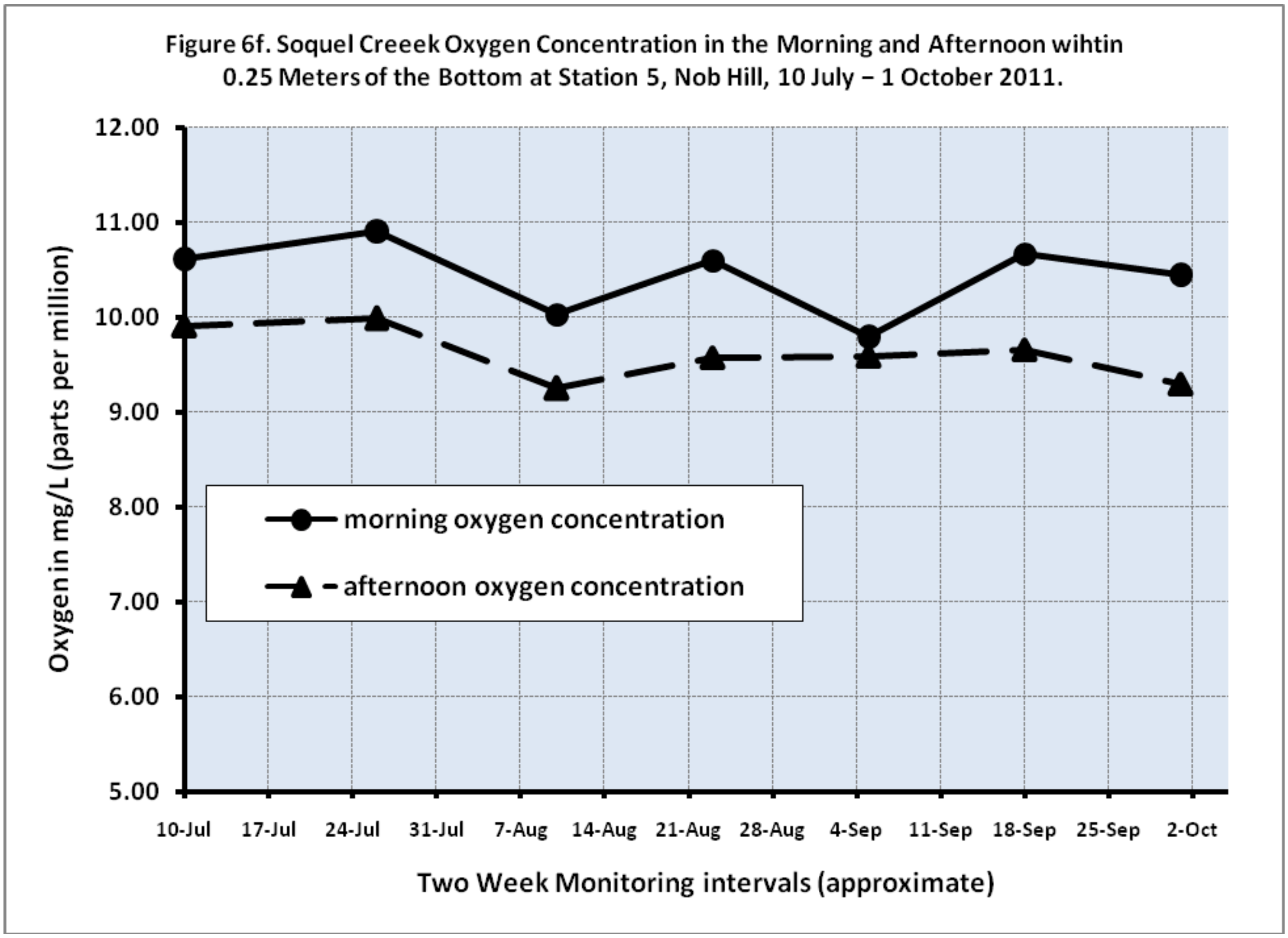


Figure 6f. Soquel Creeek Oxygen Concentration in the Morning and Afternoon wihtin 0.25 Meters of the Bottom at Station 5, Nob Hill, 10 July – 1 October 2011.
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
Oxygen in mg/L (parts per million)
morning oxygen concentration
afternoon oxygen concentration
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep
2-Oct
Two Week Monitoring intervals (approximate)

Figure 6g. Soquel Lagoon/Stream Oxygen Concentrations at Dawn within 0.25 Meters of the Bottom at Five Stations, June 10 - December 8, 2007.

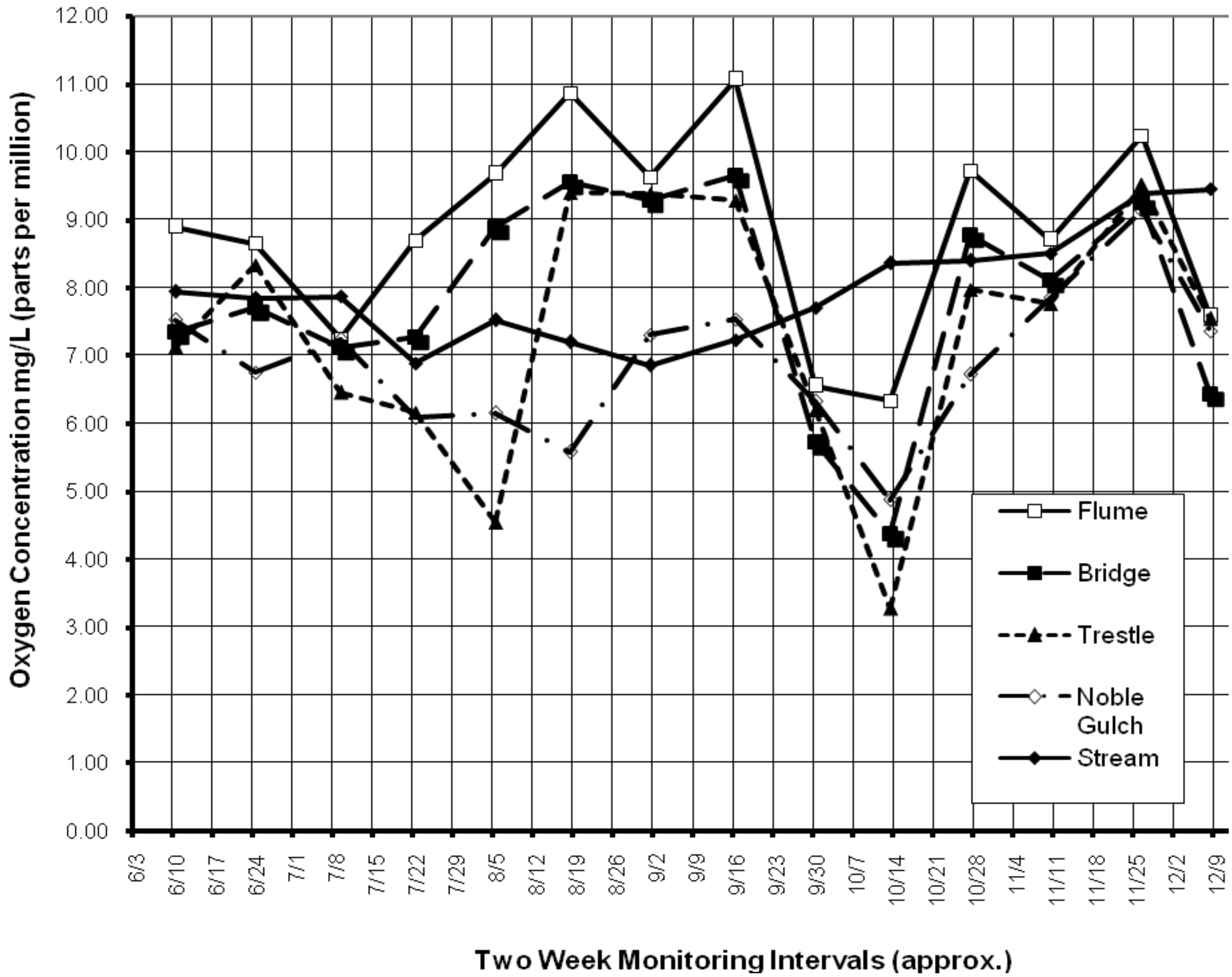
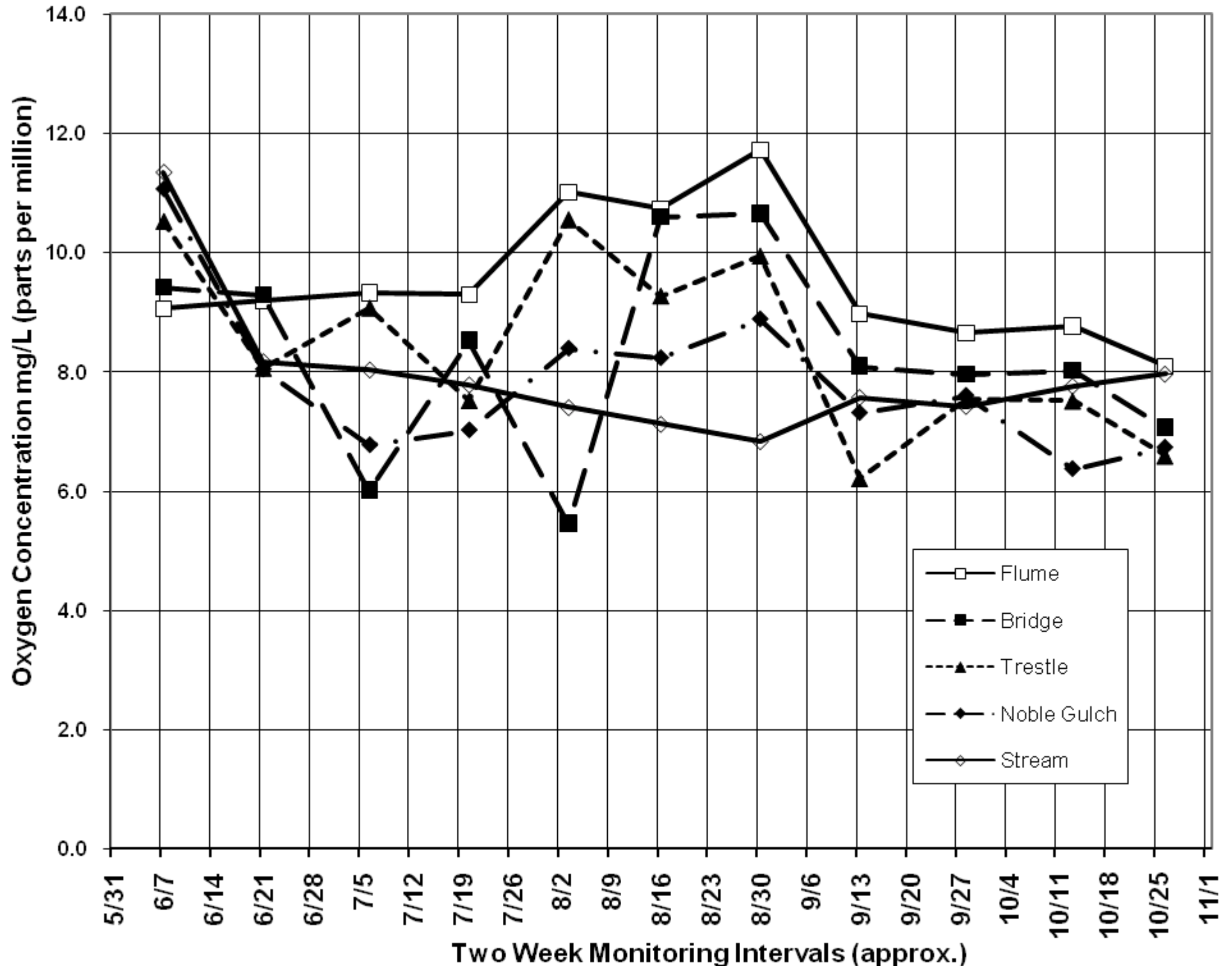


Figure 6h. Soquel Lagoon/Stream Oxygen Concentrations at Dawn Within 0.25 Meters of the Bottom at Five Monitoring Stations, 7 June - 26 October 2008.



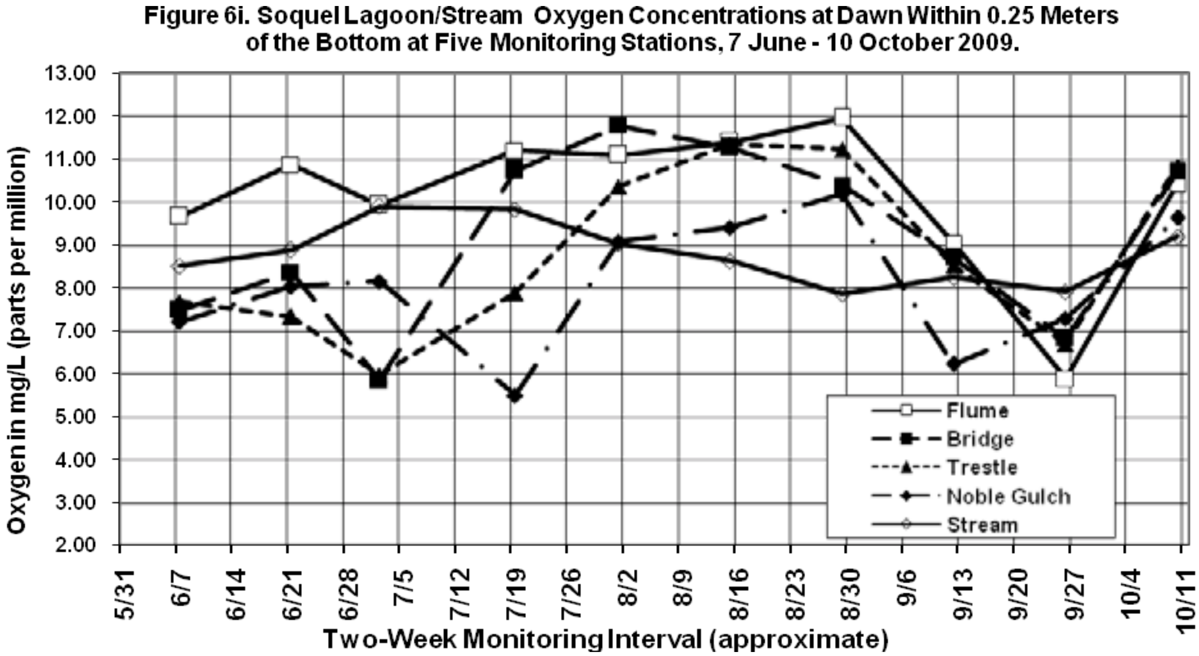


Figure 6i. Soquel Lagoon/Stream Oxygen Concentrations at Dawn Within 0.25 Meters of the Bottom at Five Monitoring Stations, 7 June - 10 October 2009.
Oxygen in mg/L (parts per million)
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
5/31
6/7
6/14
6/21
6/28
7/5
7/12
7/19
7/26
8/2
8/9
8/16
8/23
8/30
9/6
9/13
9/20
9/27
10/4
10/11
Two-Week Monitoring Interval (approximate)
Flume
Bridge
Trestle
Noble Gulch
Stream

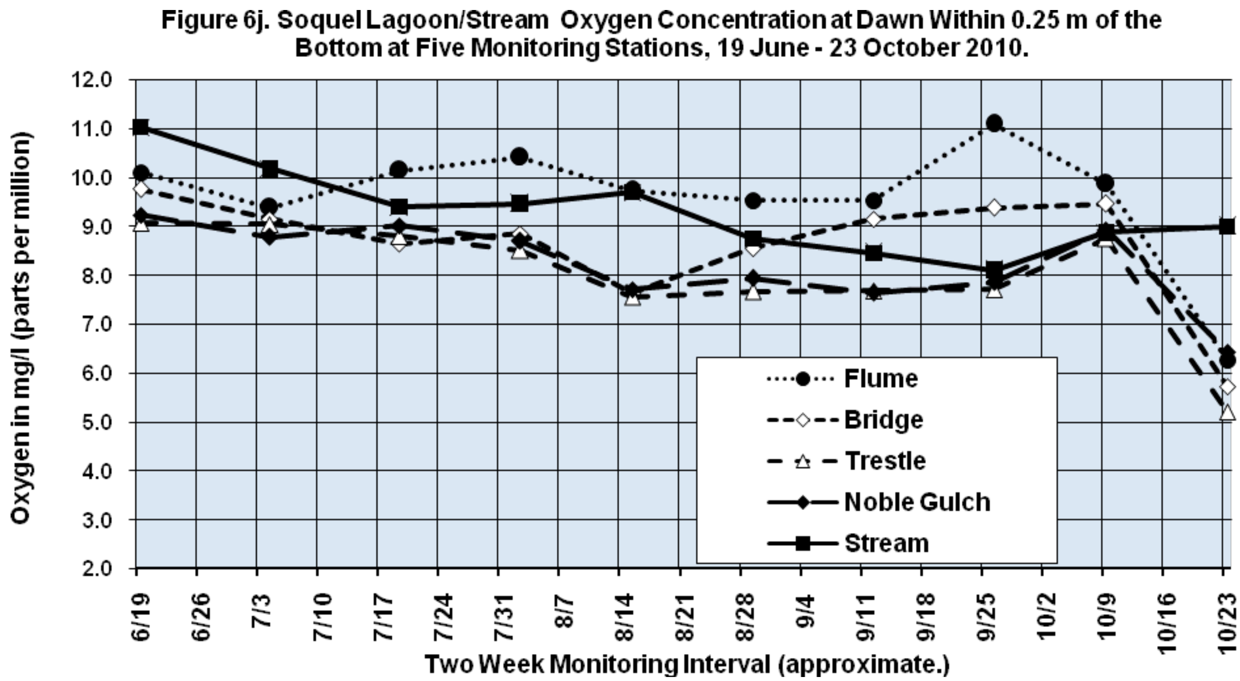


Figure 6j. Soquel Lagoon/Stream Oxygen Concentration at Dawn Within 0.25 m of the Bottom at Five Monitoring Stations, 19 June - 23 October 2010.
Oxygen in mg/l (parts per million)
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
6/19
6/26
7/3
7/10
7/17
7/24
7/31
8/7
8/14
8/21
8/28
9/4
9/11
9/18
9/25
10/2
10/9
10/16
10/23
Two Week Monitoring Interval (approximate.)
Flume
Bridge
Trestle
Noble Gulch
Stream

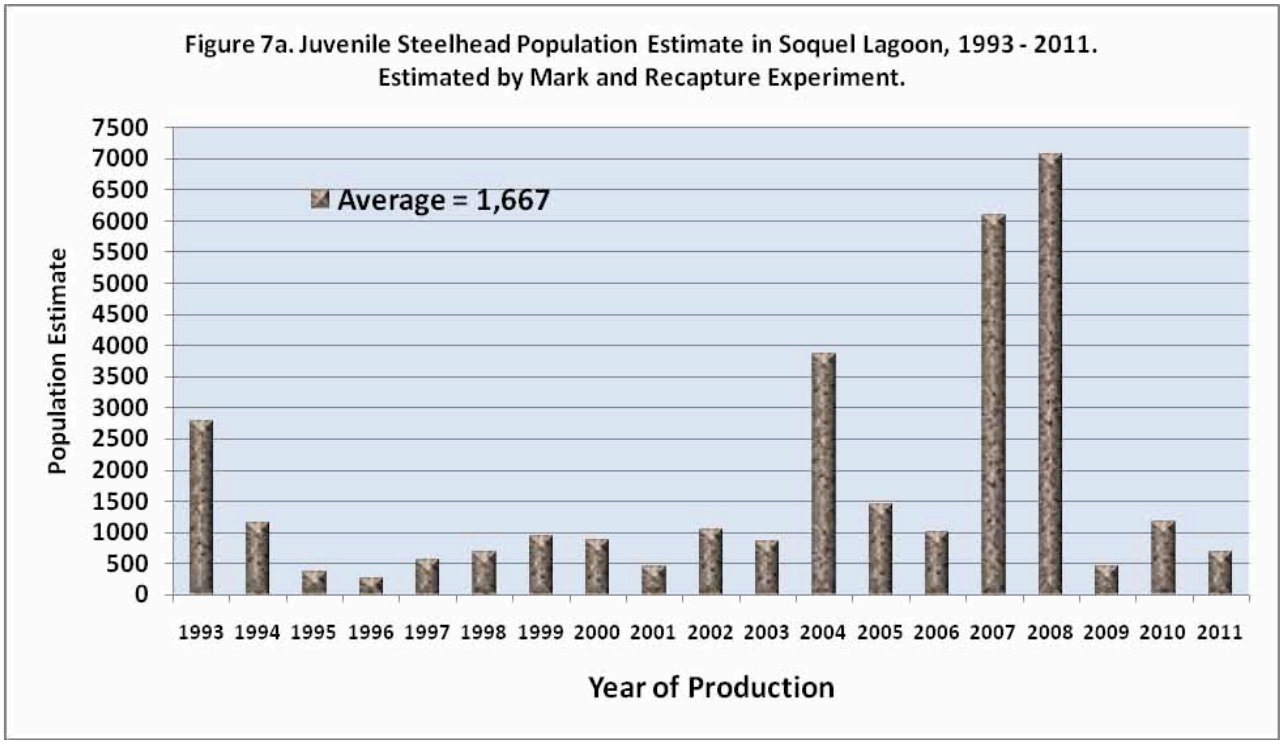


Figure 7a. Juvenile Steelhead Population Estimate in Soquel Lagoon, 1993 - 2011.
Estimated by Mark and Recapture Experiment.
Average = 1,667
Population Estimate
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011
Year of Production

Figure 7b. Steelhead Median Standard Length Versus Lagoon Population Size, 1998-2010.

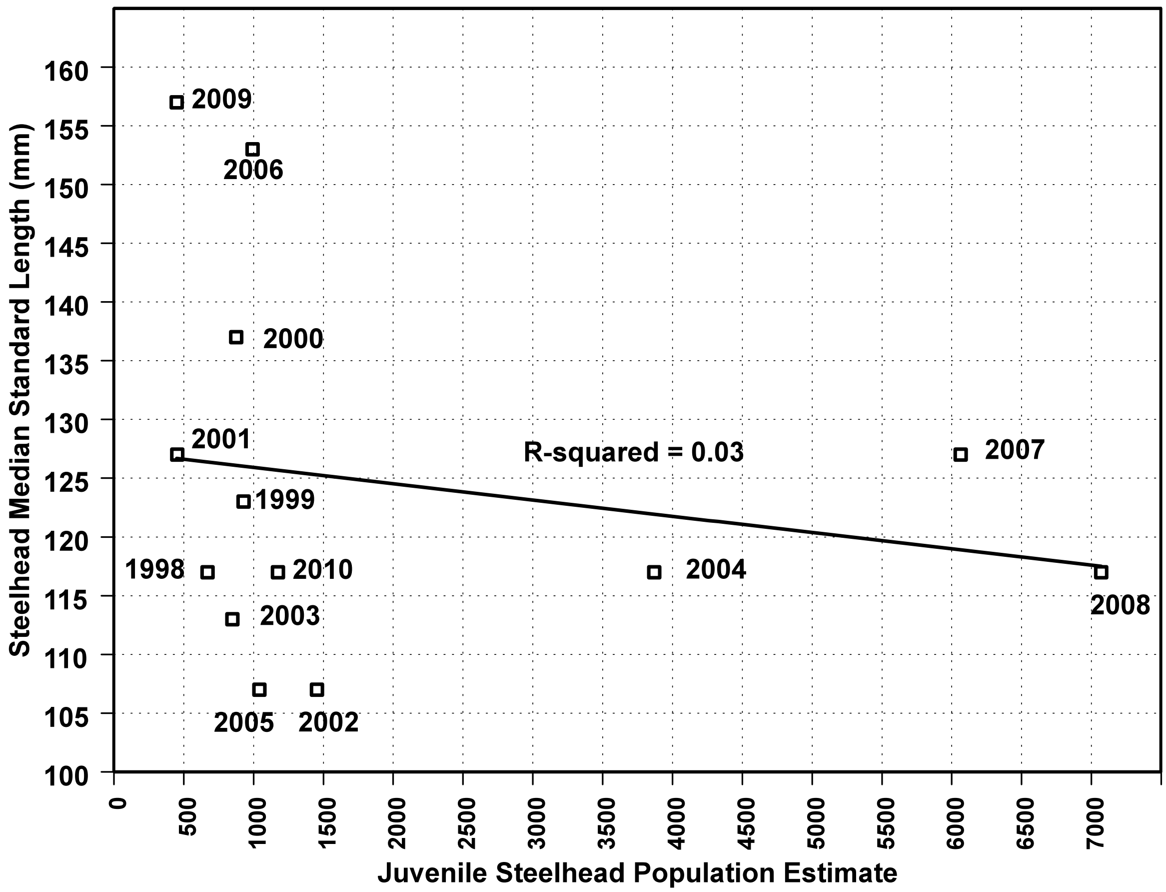
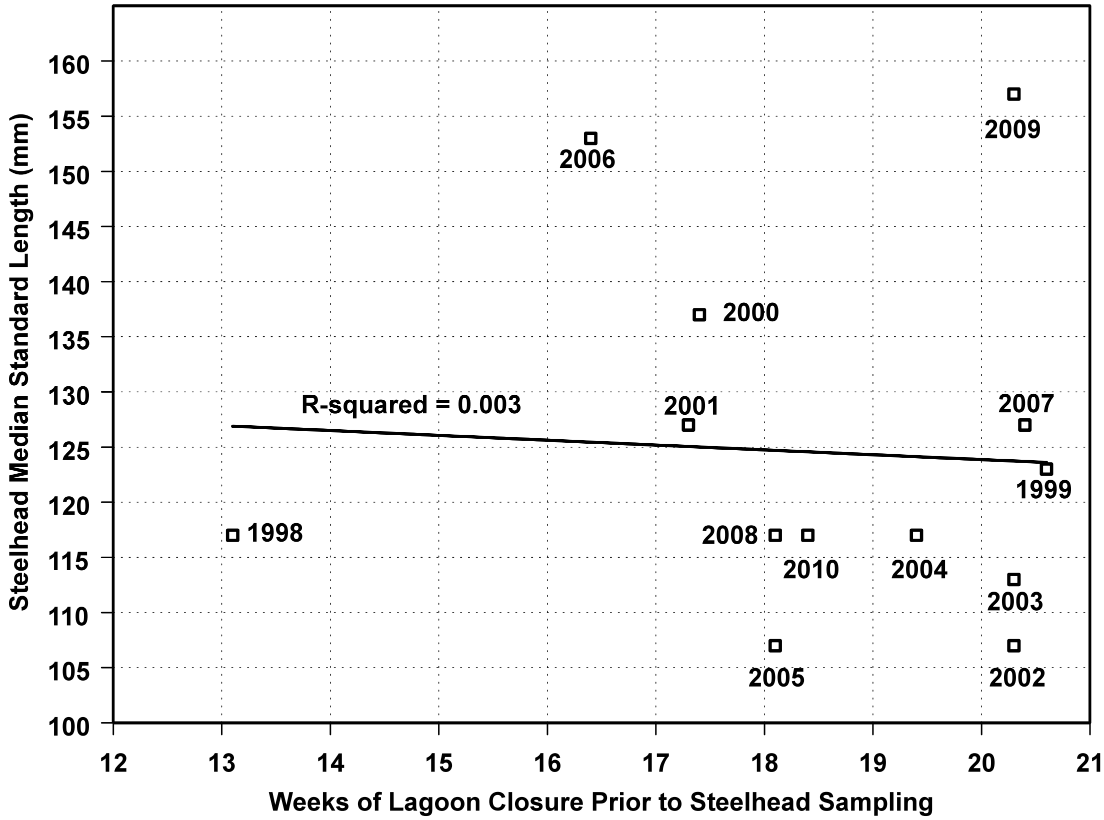


Figure 7c. Steelhead Median Standard Length Versus Weeks of Lagoon Closure Prior to Steelhead Sampling, 1998 - 2010.



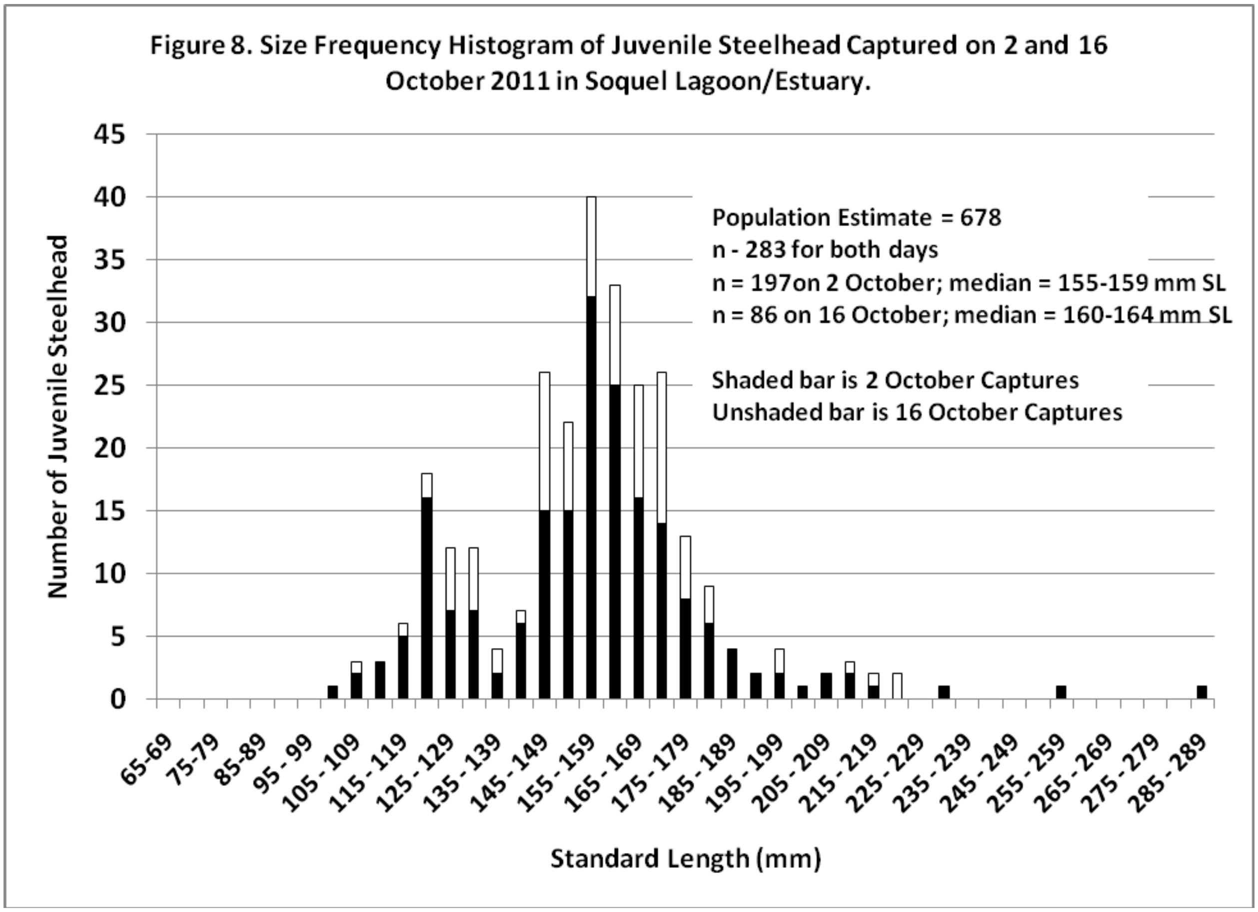


Figure 8. Size Frequency Histogram of Juvenile Steelhead Captured on 2 and 16 October 2011 in Soquel Lagoon/Estuary.
Population Estimate = 678
n - 283 for both days
n = 197on 2 October; median = 155-159 mm SL
n = 86 on 16 October; median = 160-164 mm SL
Shaded bar is 2 October Captures
Unshaded bar is 16 October Captures
Number of Juvenile Steelhead
Standard Length (mm)
0
5
10
15
20
25
30
35
40
45
65-69
75-79
85-89
95 - 99
105 - 109
115 - 119
125 - 129
135 - 139
145 - 149
155 - 159
165 - 169
175 - 179
185 - 189
195 - 199
205 - 209
215 - 219
225 - 229
235 - 239
245 - 249
255 - 259
265 - 269
275 - 279
285 - 289

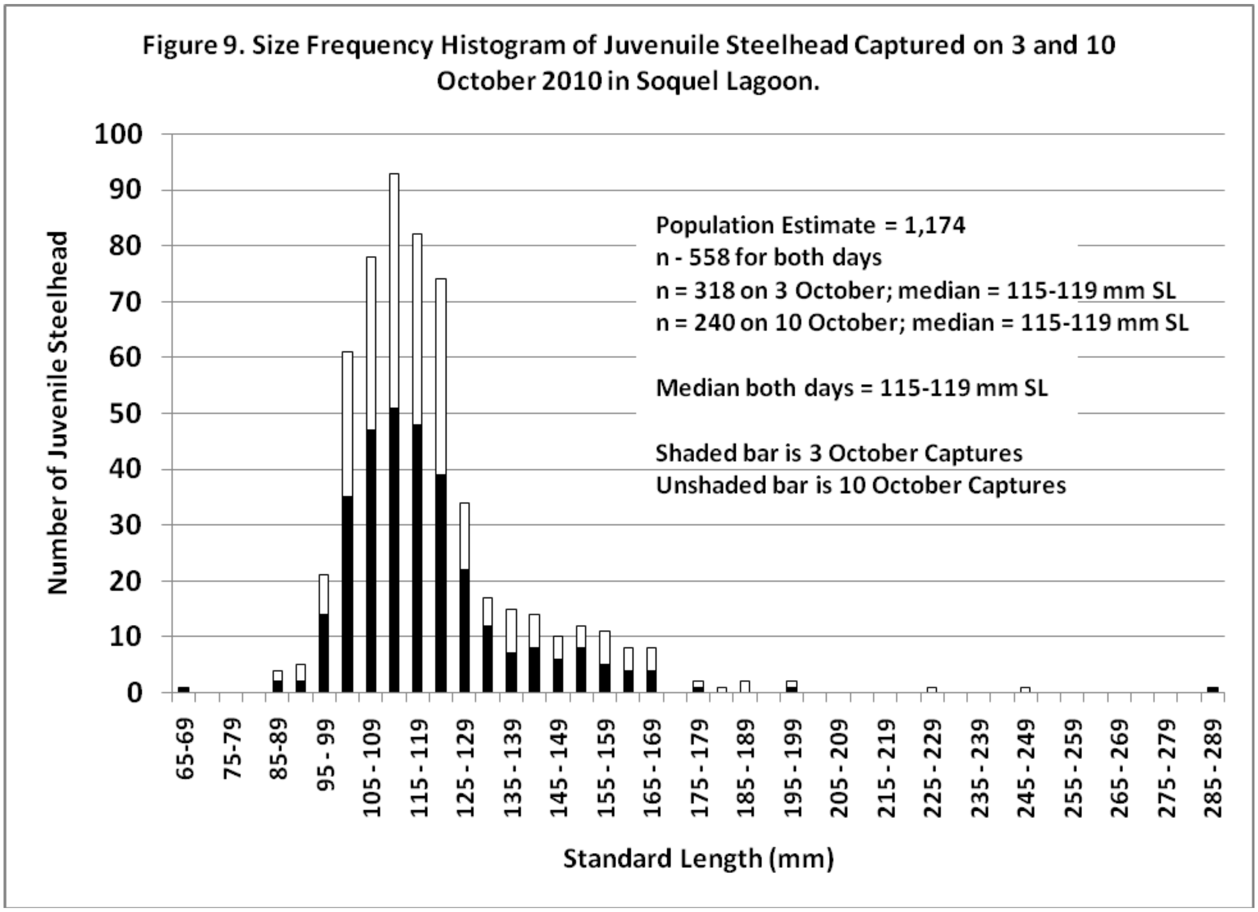


Figure 9. Size Frequency Histogram of Juvenuile Steelhead Captured on 3 and 10 October 2010 in Soquel Lagoon.
Population Estimate = 1,174
n - 558 for both days
n = 318 on 3 October; median = 115-119 mm SL
n = 240 on 10 October; median = 115-119 mm SL
Median both days = 115-119 mm SL
Shaded bar is 3 October Captures
Unshaded bar is 10 October Captures
Number of Juvenile Steelhead
Standard Length (mm)
0
10
20
30
40
50
60
70
80
90
100
65-69
75-79
85-89
95 - 99
105 - 109
115 - 119
125 - 129
135 - 139
145 - 149
155 - 159
165 - 169
175 - 179
185 - 189
195 - 199
205 - 209
215 - 219
225 - 229
235 - 239
245 - 249
255 - 259
265 - 269
275 - 279
285 - 289

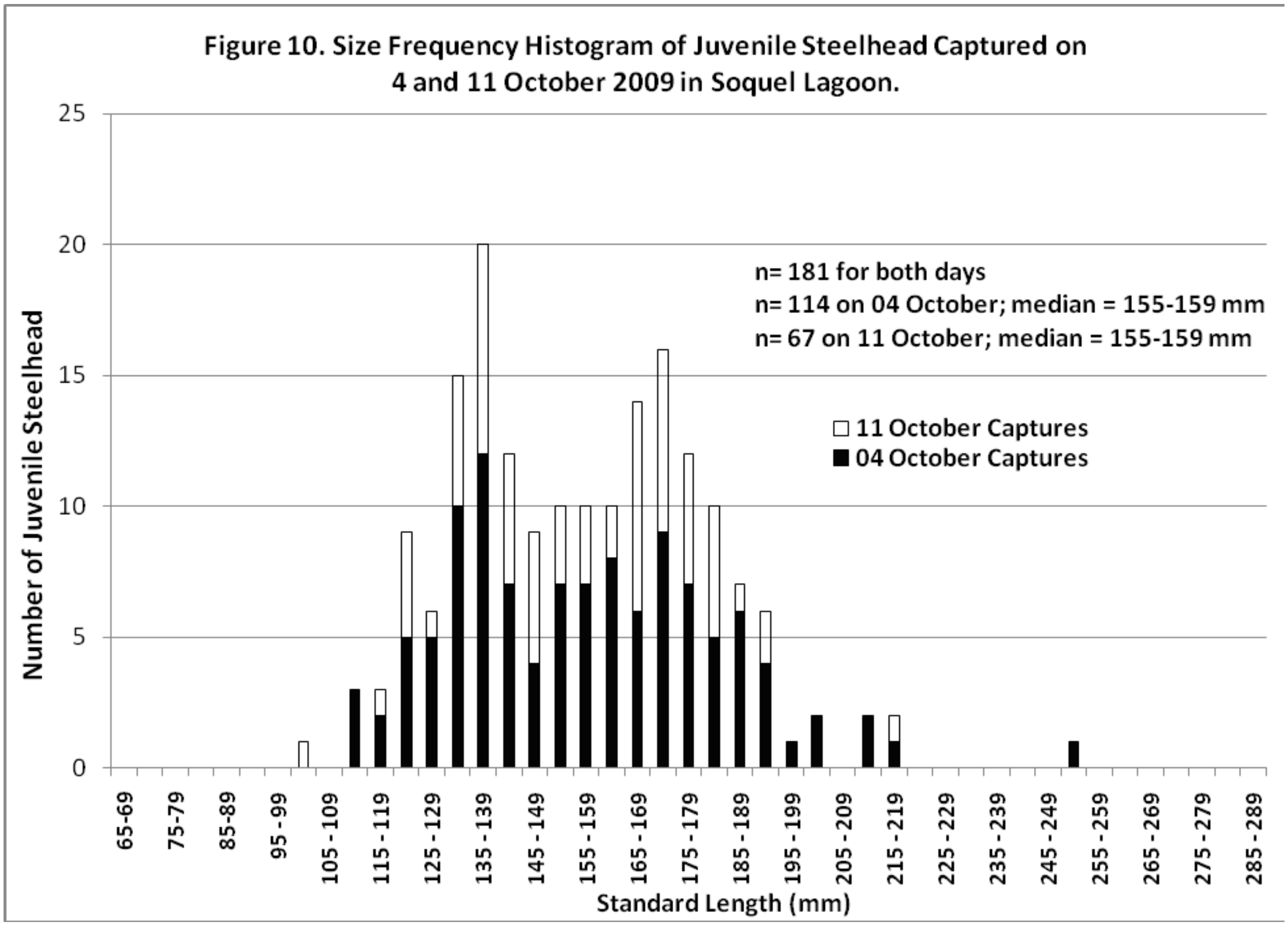


Figure 10. Size Frequency Histogram of Juvenile Steelhead Captured on
4 and 11 October 2009 in Soquel Lagoon.
Number of Juvenile Steelhead
n= 181 for both days
n= 114 on 04 October; median = 155-159 mm
n= 67 on 11 October; median = 155-159 mm
11 October Captures
04 October Captures
Standard Length (mm)

Figure 11. Size Frequency Histogram of Juvenile Steelhead Captured on 27 September 2008 in the Soquel Lagoon.

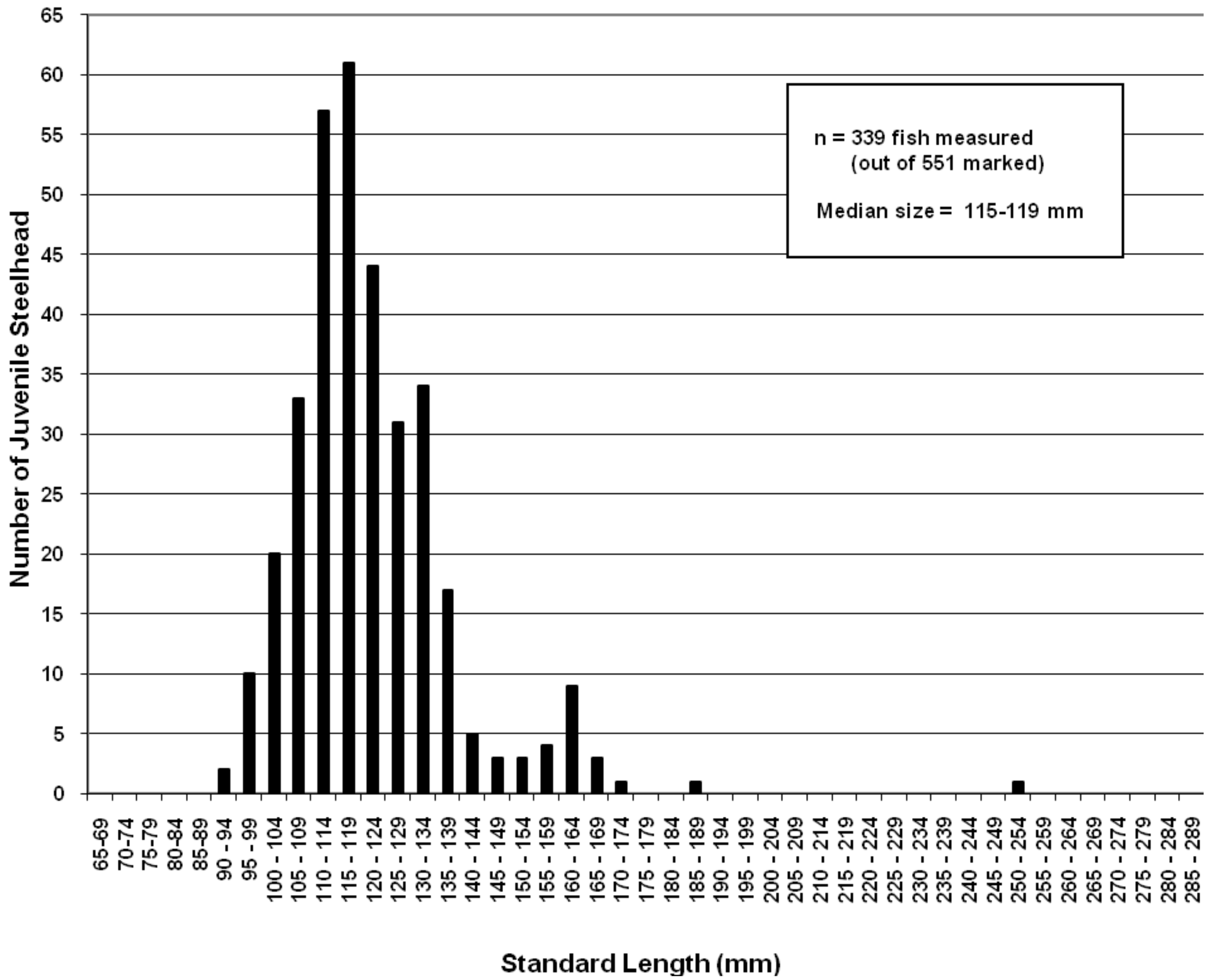


Figure 12. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 7 & 14 October 2007 in the Soquel Lagoon

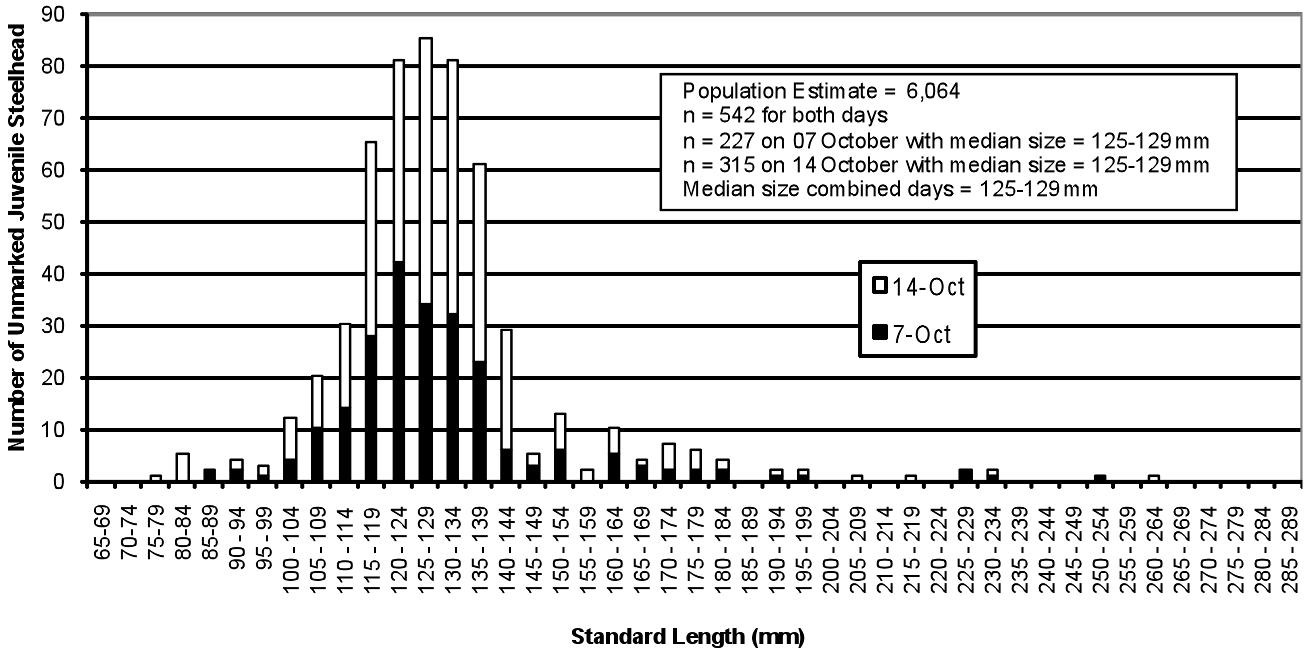


Figure 13. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 30 September and 8 October 2006 in Soquel Lagoon.

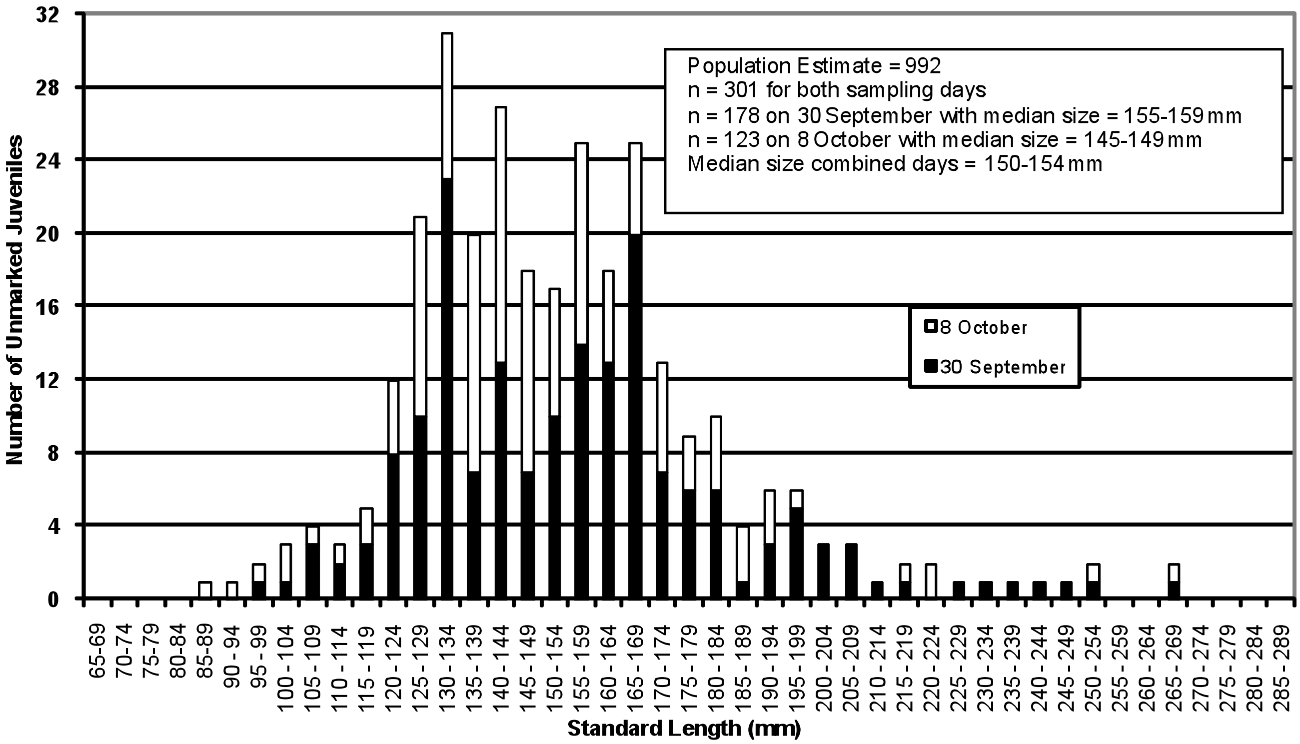


Figure 14. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 2 and 9 October 2005 in Soquel Lagoon.

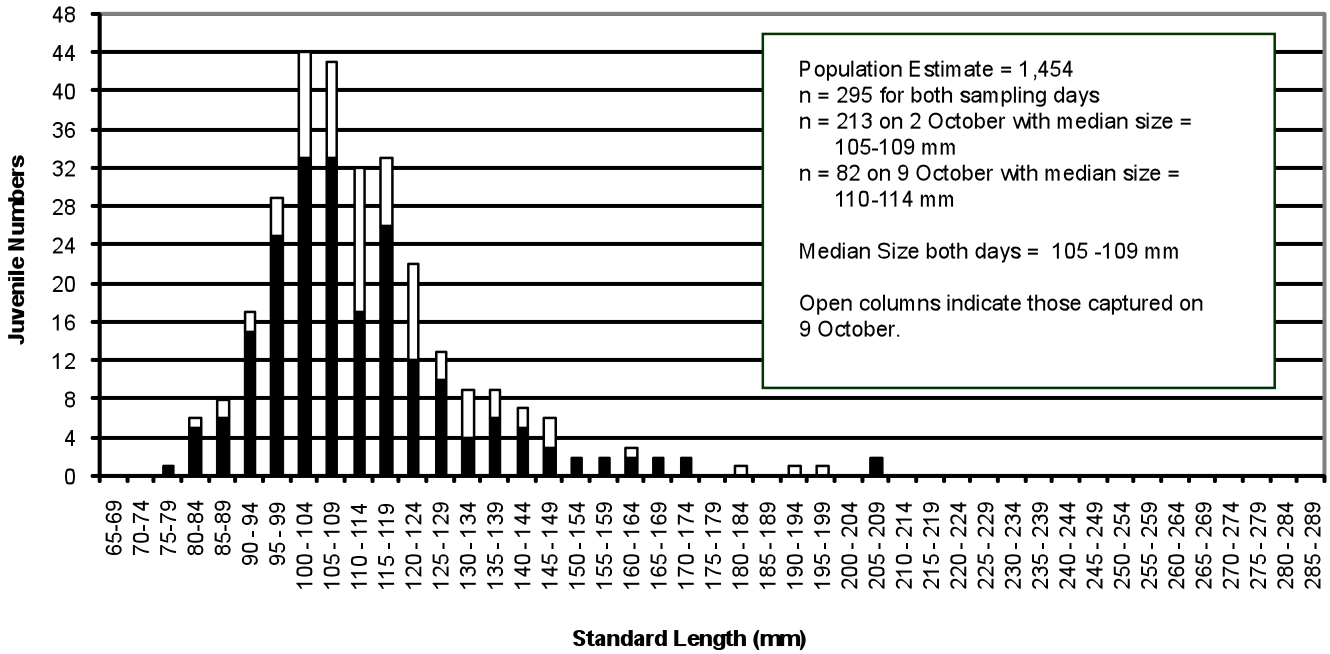
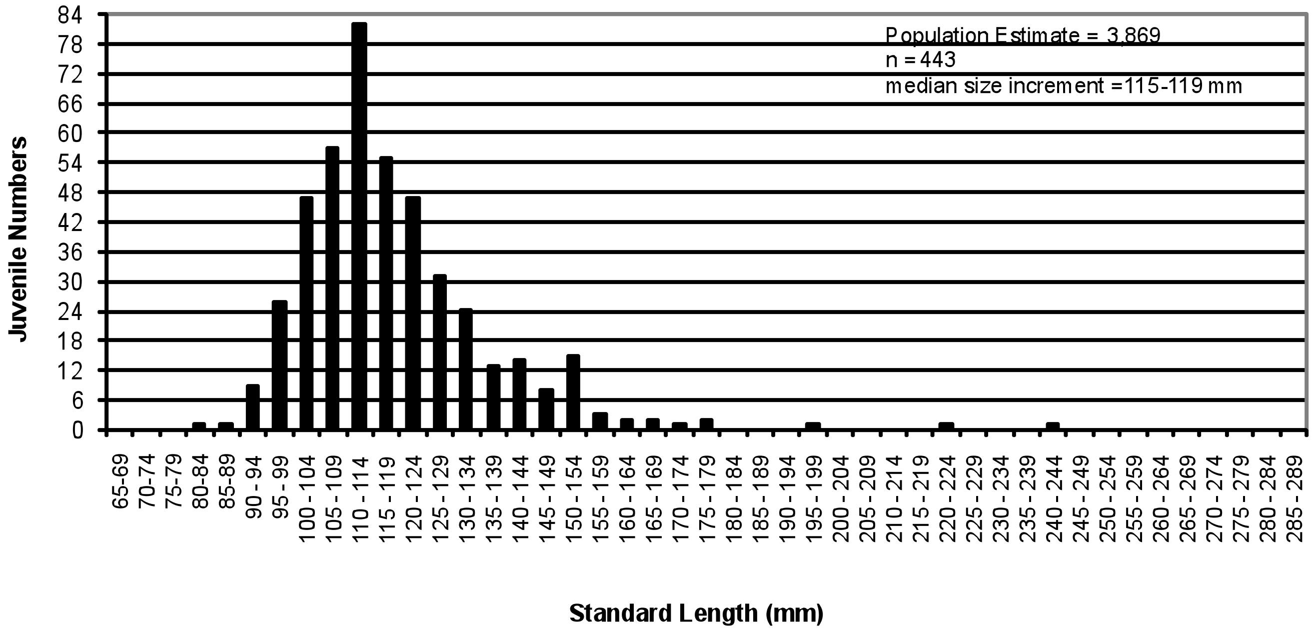


Figure 15. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 and 12 October 2004 in Soquel Lagoon.



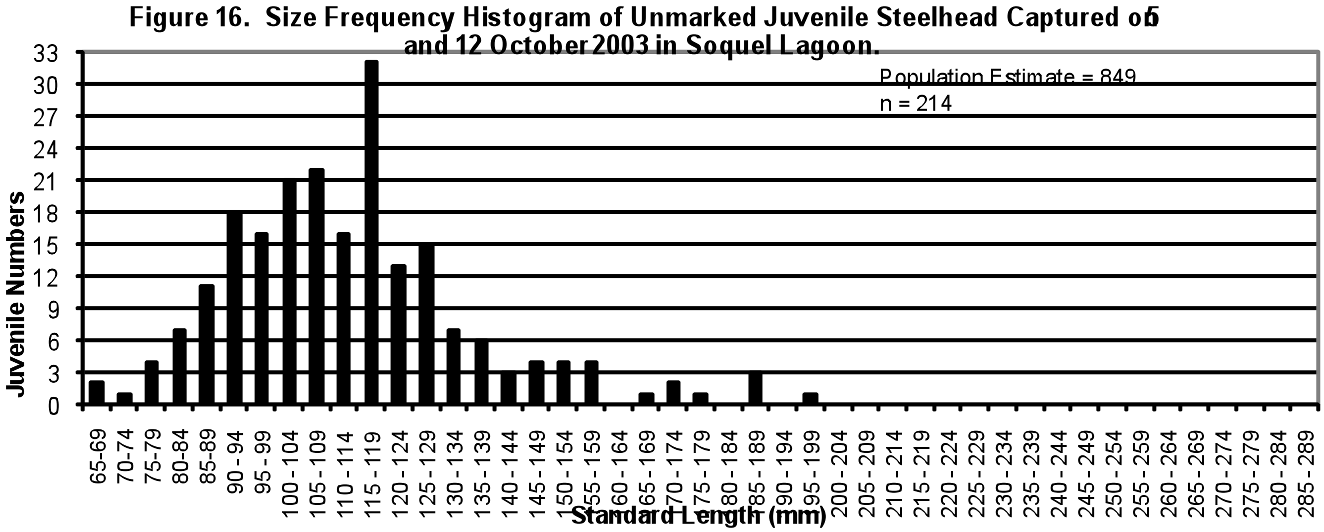


Figure 16. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 5 and 12 October 2003 in Soquel Lagoon.
Population Estimate = 849
n = 214
Juvenile Numbers
Standard Length (mm)

Figure 17. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 6 and 13 October 2002 in Soquel Lagoon.

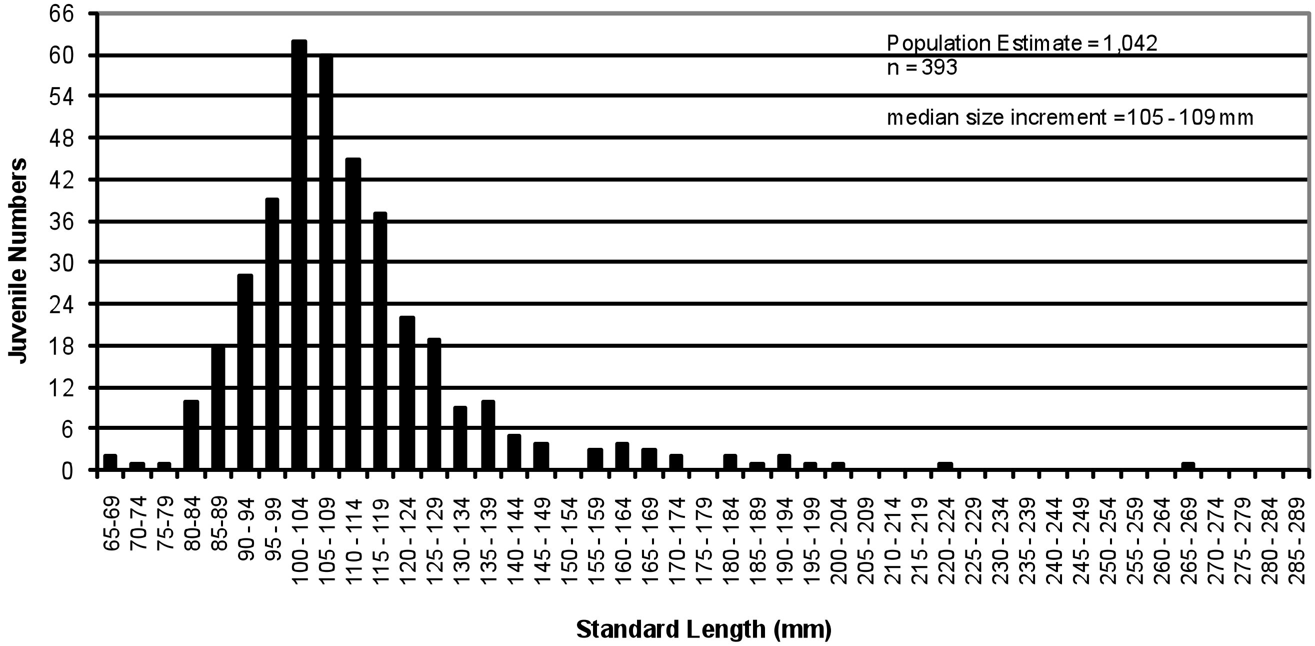


Figure 18. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 7 and 14 October 2001 in Soquel Lagoon.

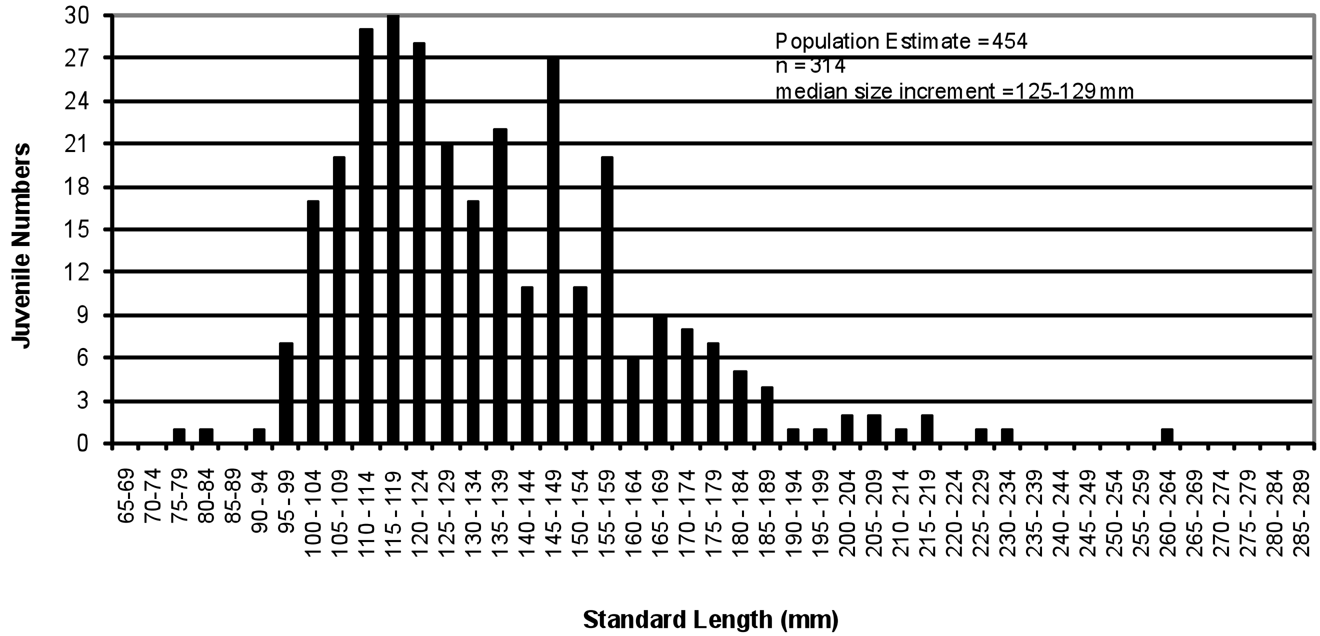


Figure 19. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 1 and 8 October 2000 in Soquel Lagoon.

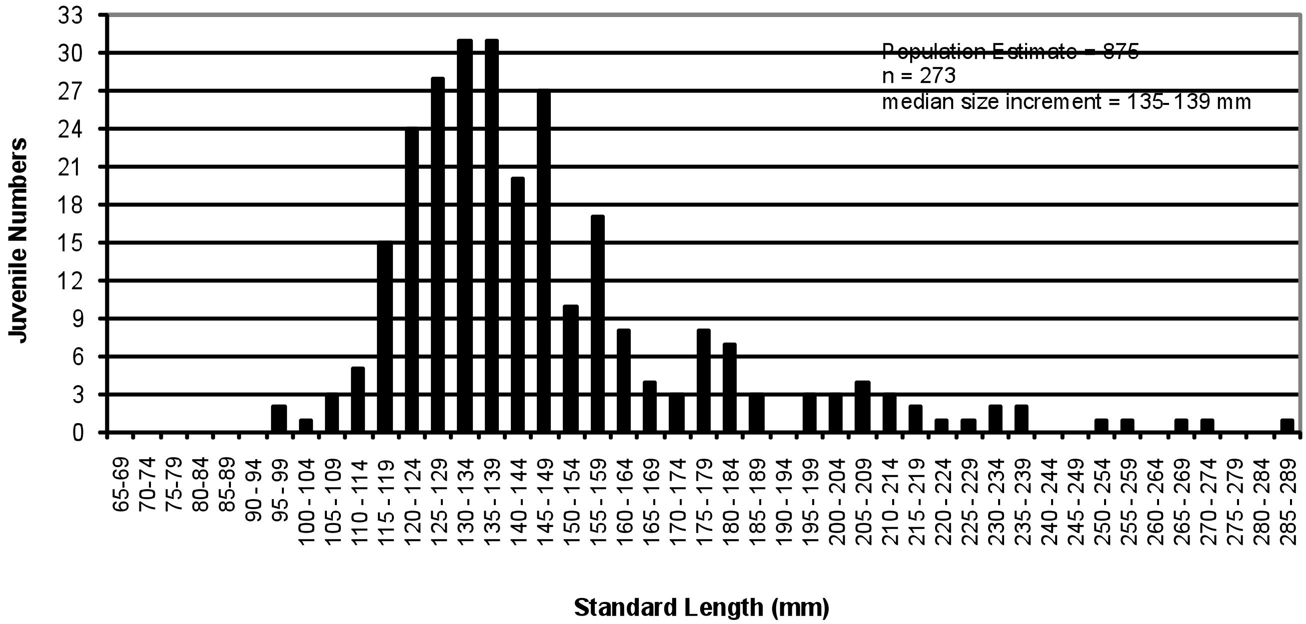


Figure 20. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 October 1999 (only) in Soquel Lagoon.

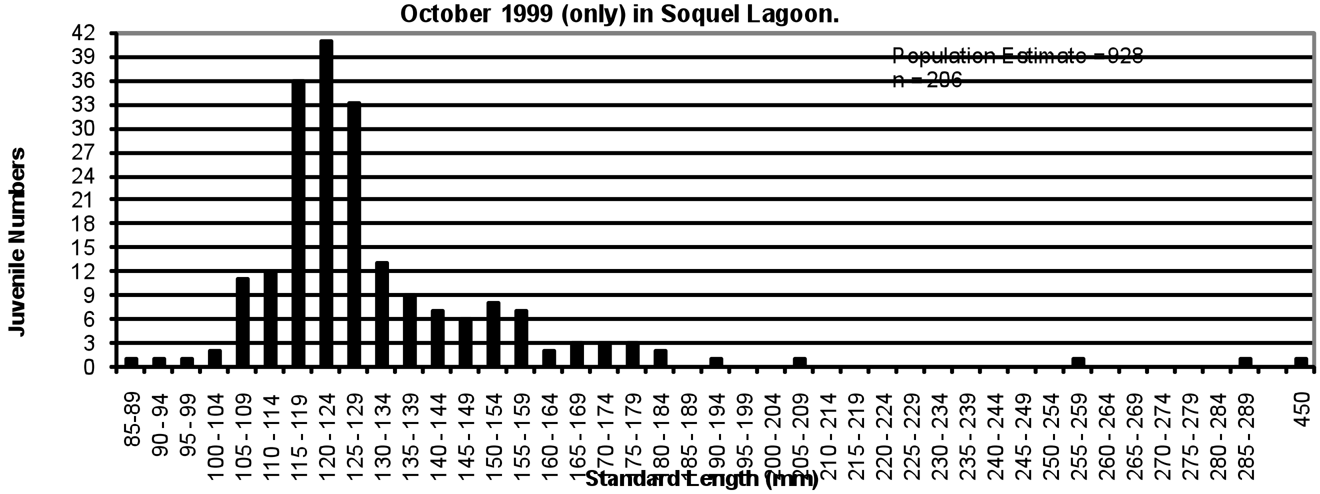


Figure 21. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 4 and 11 October 1998 in Soquel Lagoon.

Population Estimate = 671.

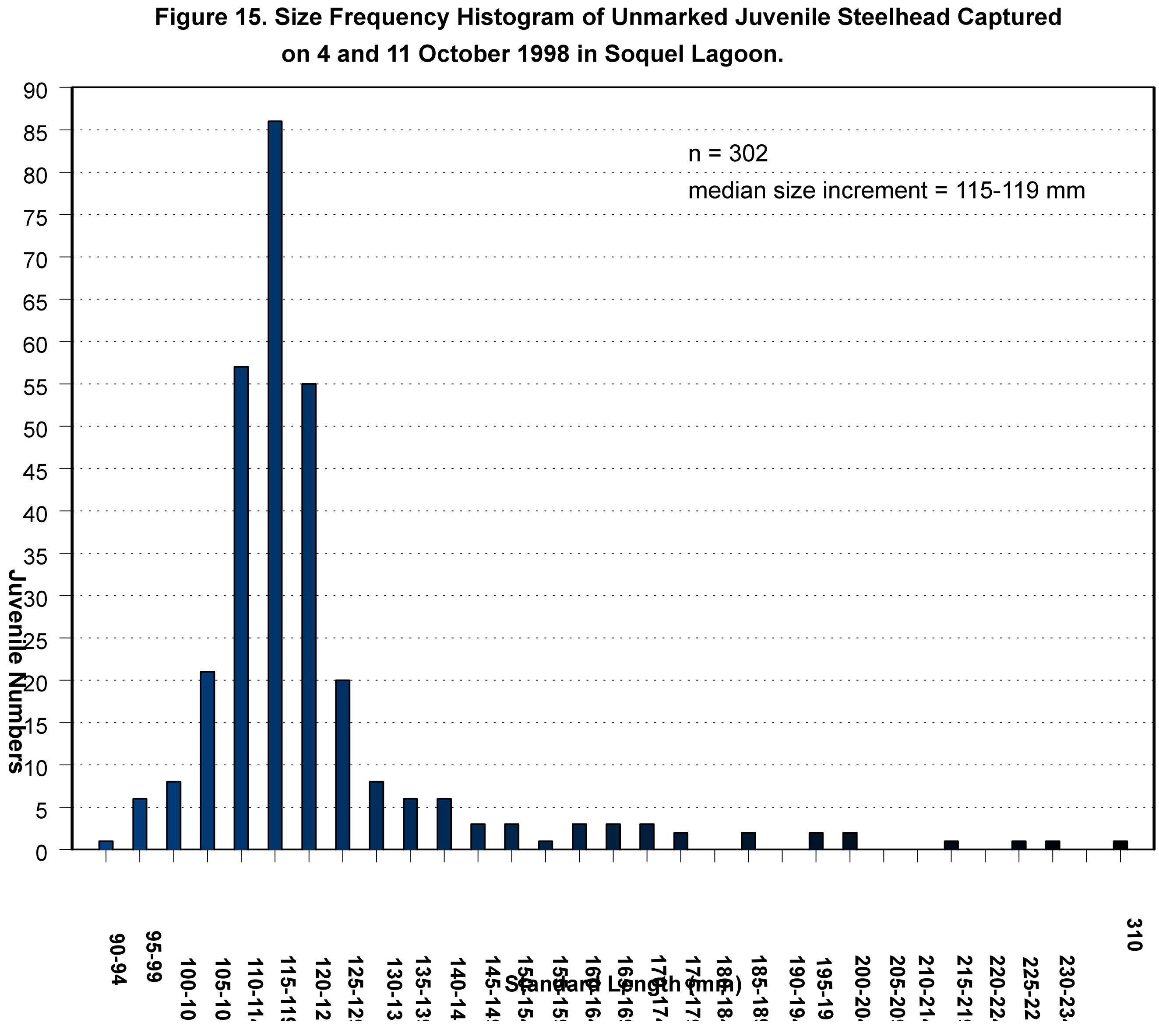


Figure 22. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 1 October 2010 – 30 September 2011.

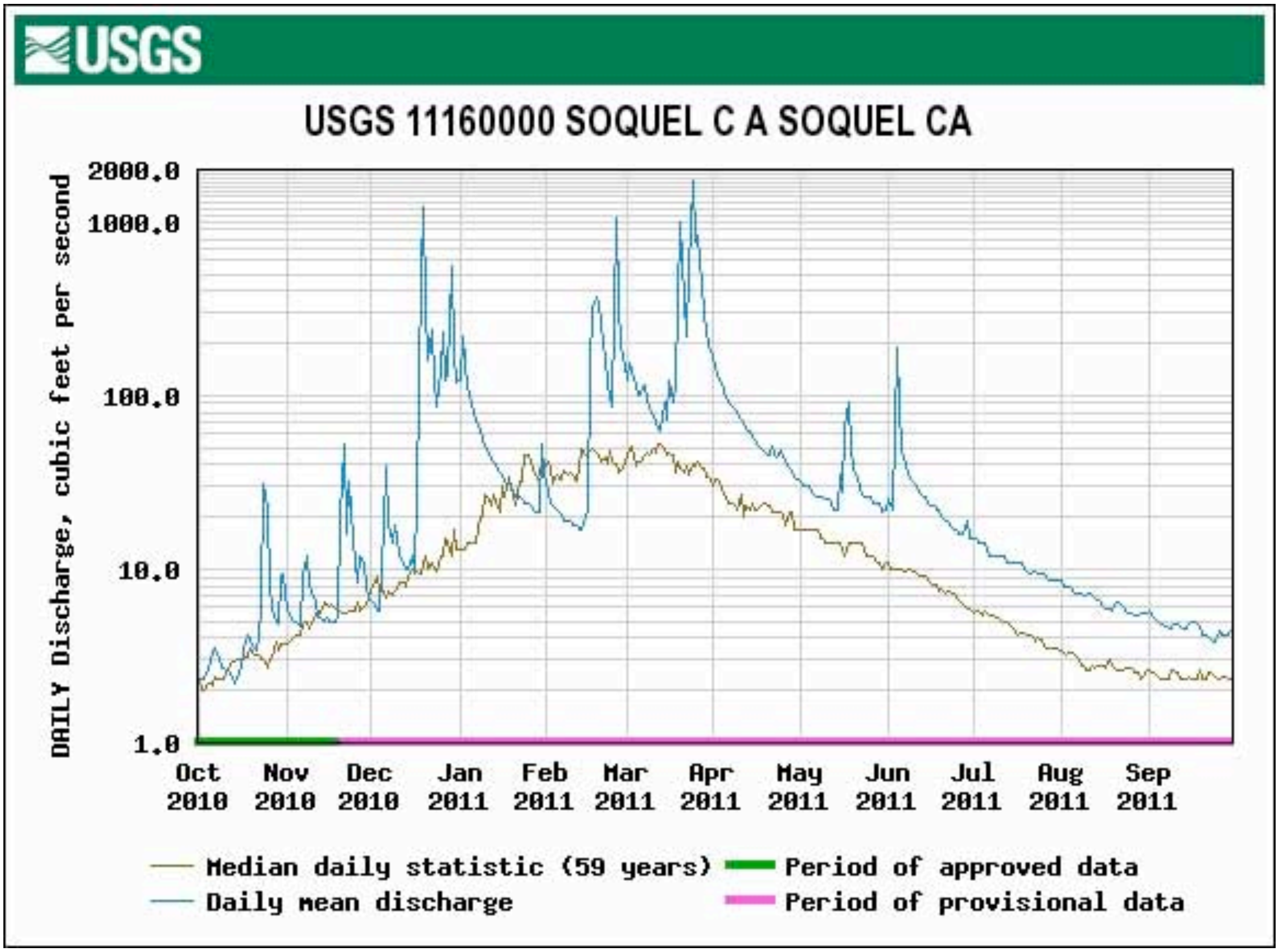


Figure 23. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 15 May 2011 – 21 December 2011.

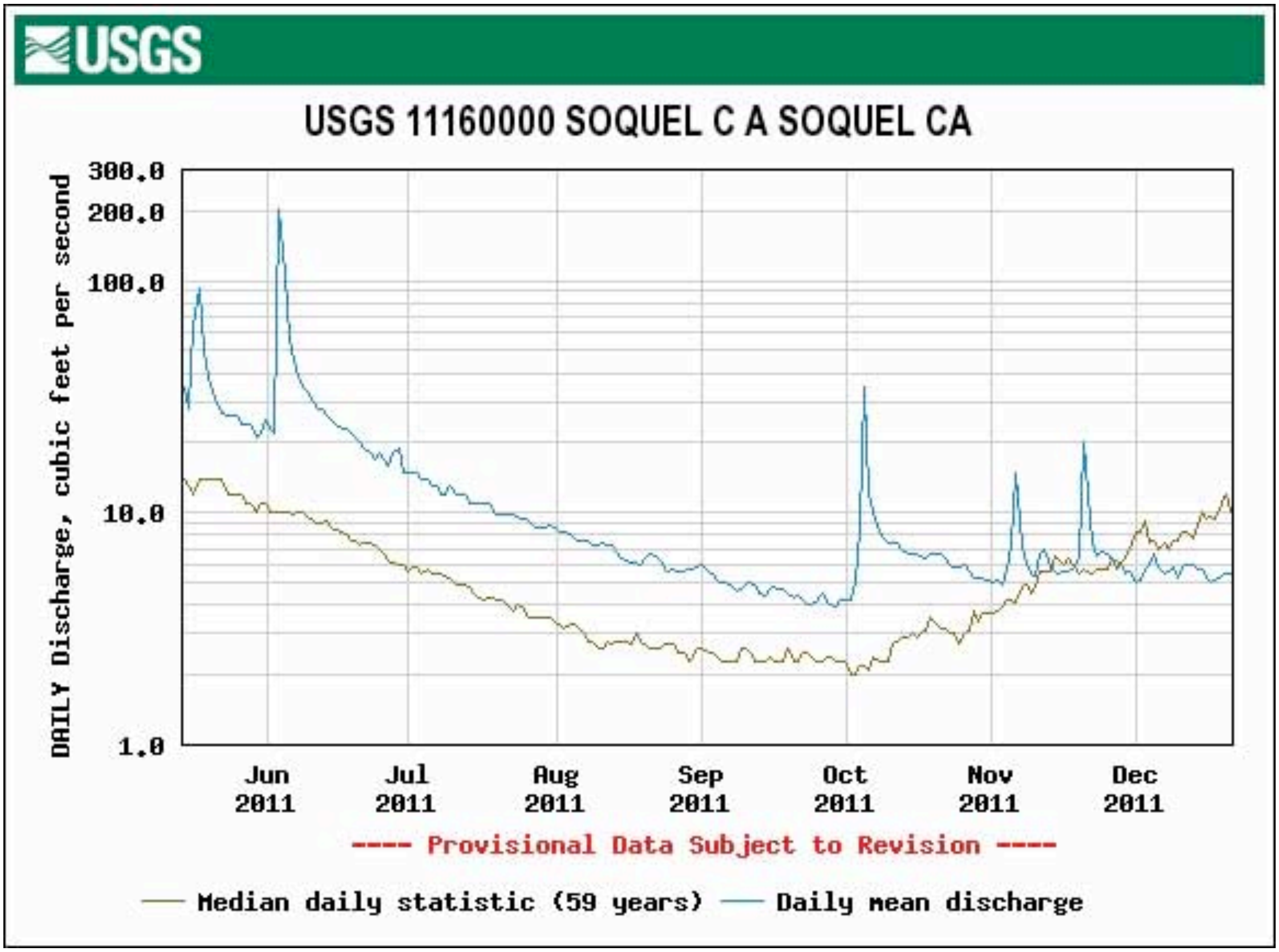


Figure 24. Soquel Creek Real-Time Streamflow at the USGS Gage in Soquel, CA, 1 October 2011 – 21 December 2011.

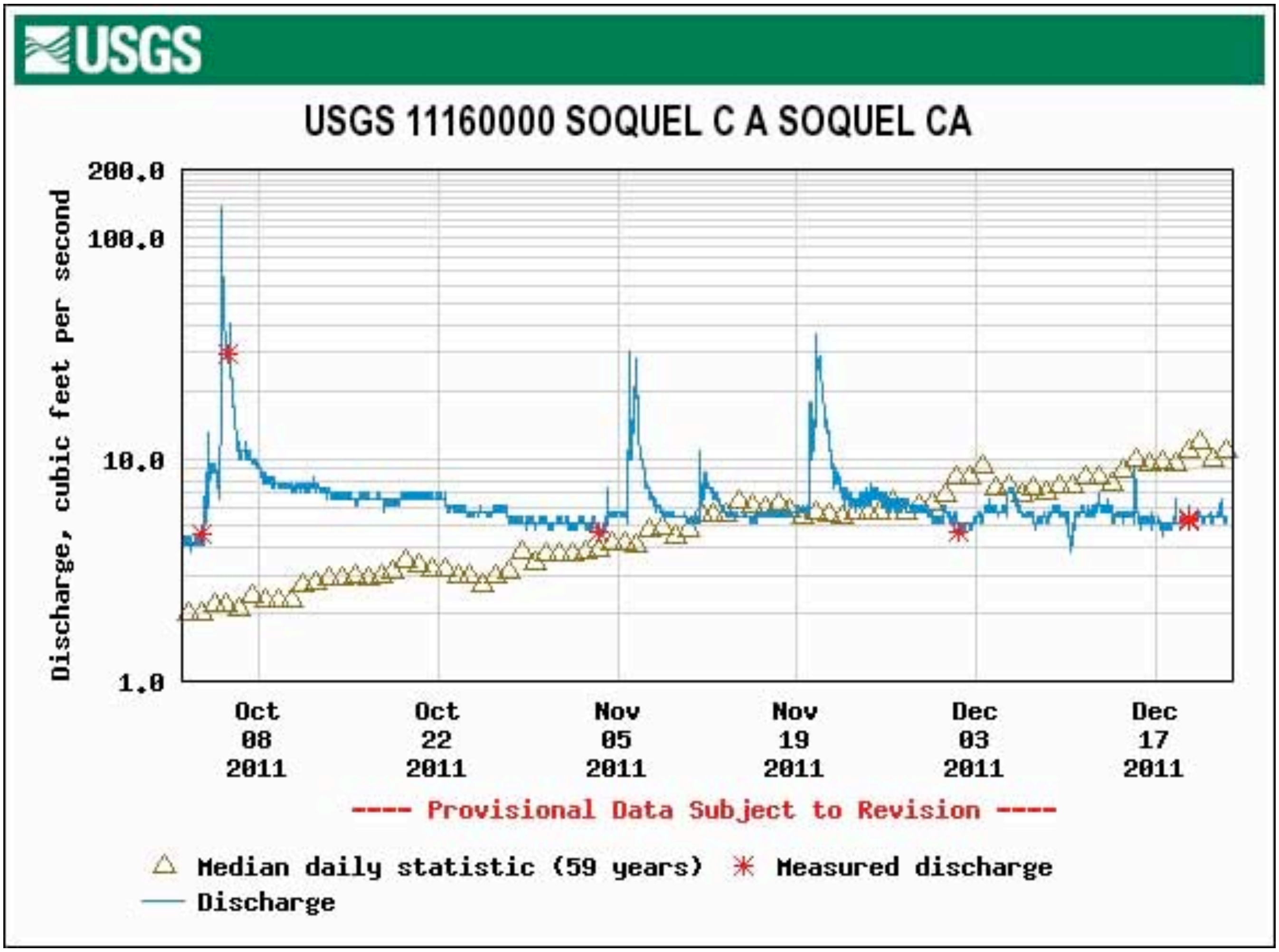


Figure 25. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 1 October 2009 – 30 September 2010.

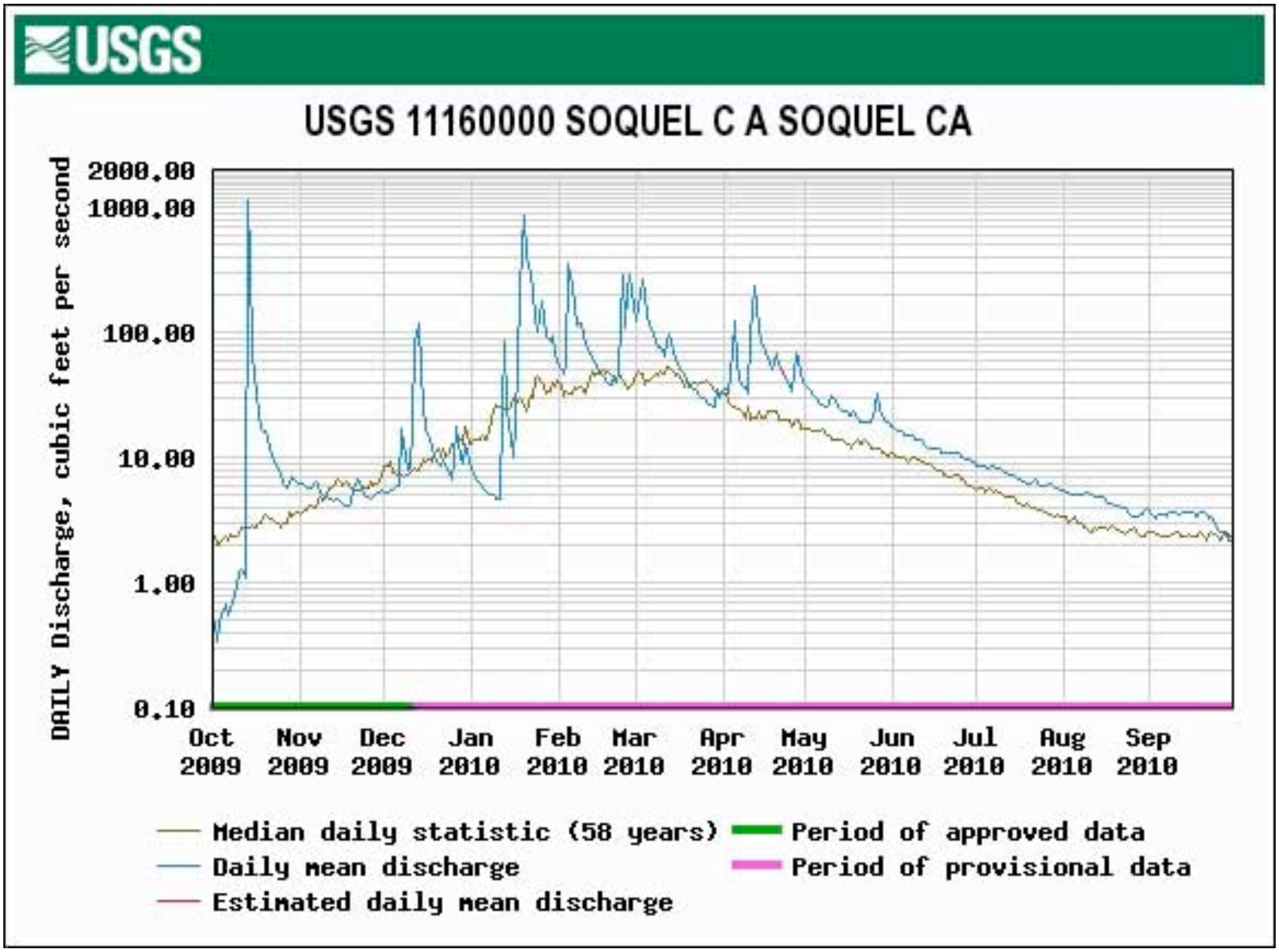


Figure 26. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 1 October 2008 – 30 September 2009.

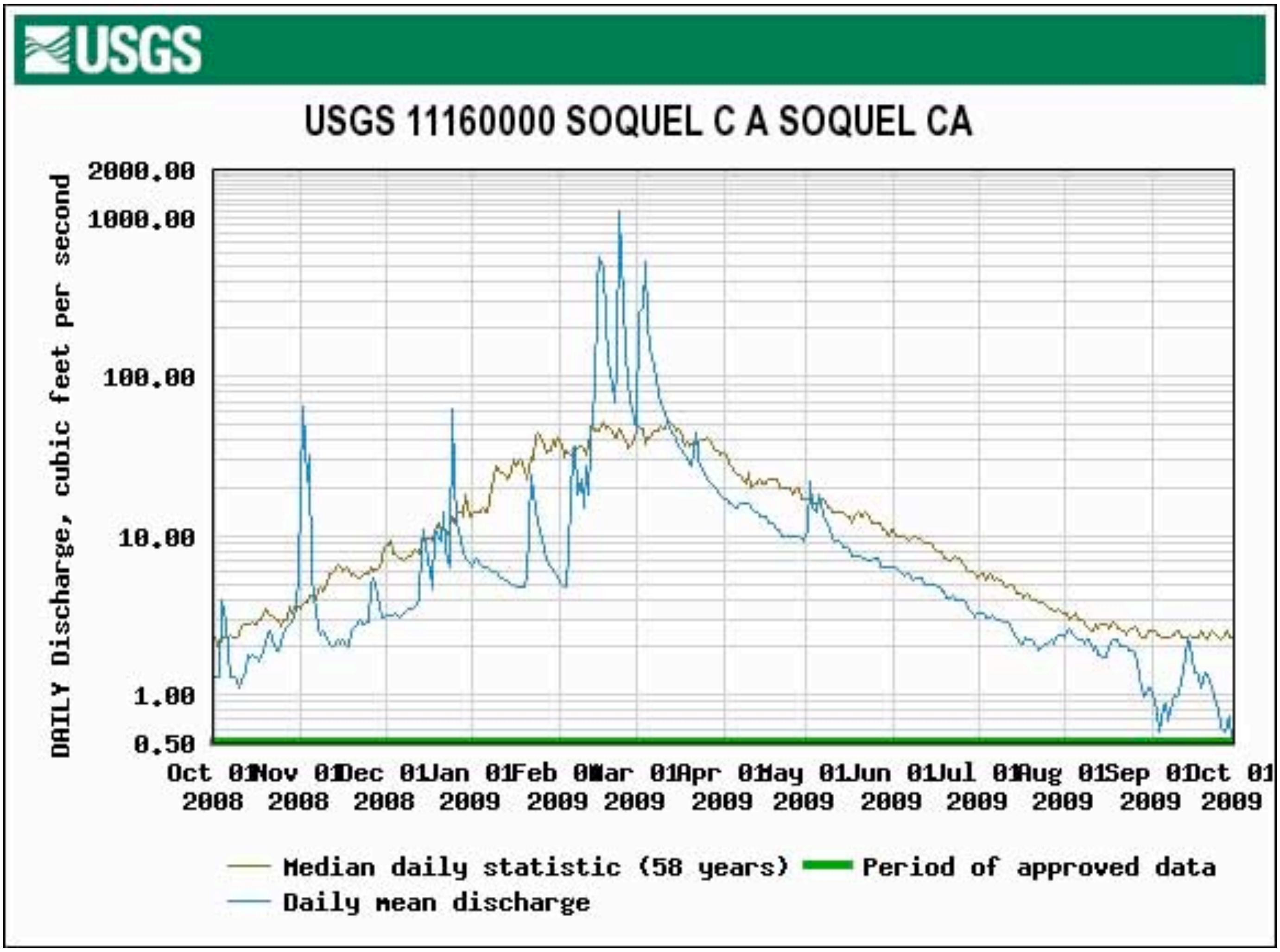
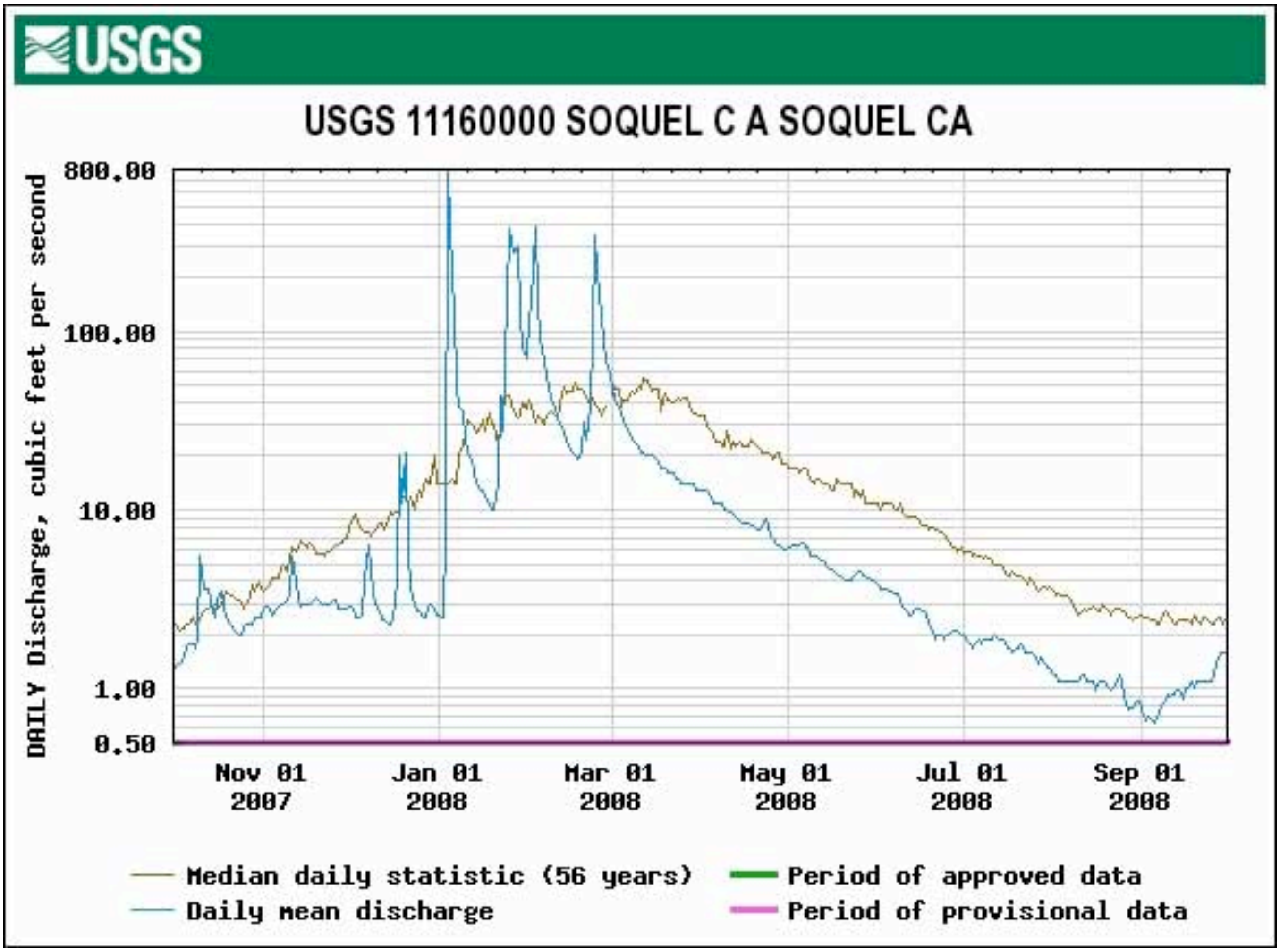


Figure 27. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 1 October 2007 – 30 September 2008.



APPENDIX A.

WATER QUALITY DATA AND GENERAL OBSERVATIONS OF BIRDS AND AQUATIC VEGETATION
31 MAY – 16 OCTOBER 2011.

<u>31 May 2011.</u> The sandbar had been closed since 26 May. Gage height = 2.04. Air temperature = 13.2 C. Partly cloudy. Saltwater was present in the deeper hole adjacent to the Venetian Court wall (5 ft x 5 ft pocket). Did not recommend to Morrison that shrouds be placed on flume inlet. Rain was forecasted later in the week. Screens were out of flume inlet. All boards in the wide portion of flume inlet had been removed. Plan was to notch the sandbar if forecast for Friday night rain continued. Esplanade sidewalk grates closed with plates.

			31-May-11					
	Venetian Wall 1735 hr				**Stockton Ave Bridge Thalweg**			1722 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00					14.1	0.3	10.48	503
0.25					14.1	0.3	10.49	503
0.50					14.0	0.3	10.53	502
0.75					14.0	0.3	10.48	502
1.00					13.9	0.3	10.41	501
1.25					13.8	0.3	10.27	501
1.50					13.8	0.3	10.46	499
1.75					13.6	0.3	10.49	498
1.87 bott.					13.6	0.3	3.70	498
3.00 bott.	13.7	10.0	0.30	13390				
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00								
0.25								
0.50								
0.75								
1.00								
1.25								
1.50								

24 June 2011. The sandbar was breached due to a late storm on 4 June. The sandbar was closed a second time for the season on 20 June. Gage height = 2.05. Clear and breezy. The water quality probe was moved all along the Venetian Court wall near the bottom to detect any saltwater. None was found.

			24-Jun-11					
	Flume Inlet				**Venetian Court Wall-** 1237 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00					17.5	0.3	9.40	583
0.25					17.5	0.3	9.51	581
0.50					17.2	0.3	9.74	581
0.75					17.2	0.3	10.40	573
1.00					17.1	0.3	9.78	574
1.25					16.9	0.3	9.64	576
1.50					16.8	0.3	9.87	576
1.75					16.5	0.3	9.67	575
2.00					16.4	0.3	9.47	576
2.15 b.					16.4	0.3	10.97	574

	Railroad Trestle				**Mouth of Noble Gulch**			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00								
0.25								
0.50								
0.75								
1.00								
1.25								
1.50								
1.75								

28 June 2011. Ran on 28 June resulted in a stormflow maximum of 28 cfs. With all boards and screens removed from both flume inlets and both outlets open, the sandbar held. It had been notched in preparation of a potential breach.

			10-July 11					
	Flume		0709 hr		**Stockton Avenue Bridge**			0753 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.0	0.3	9.37	597	16.8	0.3	9.25	594
0.25	17.0	0.3	9.20	596	16.8	0.3	9.09	596
0.50	17.0	0.3	9.05	596	16.8	0.3	9.23	595
0.75	16.9	0.3	9.14	594	16.8	0.3	9.11	594
1.00	16.8	0.3	8.96	594	16.7	0.3	9.04	590
1.20b	16.8	0.3	8.52	594				
1.25					16.4	0.3	8.53	587
1.45b					16.3	0.3	7.81	588
1.50								
	Railroad Trestle			0809 hr	**Mouth of Noble Gulch**			0820 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	16.7	0.3	10.45	594	15.8	0.3	10.22	580
0.25	16.7	0.3	10.22	594	15.8	0.3	10.02	580
0.50	16.7	0.3	10.22	592	15.8	0.3	9.94	580
0.75	16.2	0.3	9.57	588	15.8	0.3	9.97	579
0.95b					15.8	0.3	7.82	580
1.00b	16.2	0.3	8.72	587				
1.25								
1.50								
1.75								
2.00								

10 July 2011. Gage height of 2.00 in morning. Overcast. Half screens on flume inlet with underwater portal. Surf scoter on downed cottonwood on day of temperature probe launch. Tidal overwash in evening of 10-11 July. Shroud installed 11 July. People at Venetian Court may be notching lagoon berm to eliminate ponding of seawater and allowing it to enter the lagoon.
Station 1: Flume at 0709 hr. Reach 1- 15 gulls bathing, 1 mallard, 3 mallards on Venetian Court beach near lagoon margin. Air temp. 16.3 C. No surface algae.
Station 2: Stockton Avenue Bridge at 0753 hr. Secchi depth to bottom. Reach 2-no birds. Swallows active. Batteries in water quality equipment required replacement and caused delay.
Station 3: Railroad Trestle at 0809 hr. Reach 3- one mother mallard and 2 ducklings, another mallard and 2 white domestic ducks in water near downed cottonwood. 3 mallards, 3 domestic ducks and 1 goose on downed redwood tree. No surface algae.
Station 4: Mouth of Noble Gulch at 0820 hr. 10 mallards on downed cottonwood. Yellow-brown water coming out of Noble Gulch.
Station 5: Nob Hill at 0847 hr. Water temp.= 15.4 C. Oxygen= 10.62 mg/L. cond.= 572 umhos, salinity= 0.3 ppt. Streamflow 16 cfs.

			10-July 11					
	Flume		1600 hr		**Stockton Avenue Bridge**			1549 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.3	0.3	9.59	616	18.5	0.3	9.24	621
0.25	18.2	0.3	9.55	616	18.5	0.3	9.18	621
0.50	18.1	0.3	9.54	615	18.4	0.3	9.09	620
0.75	18.1	0.3	9.52	613	18.4	0.3	9.25	619
1.00	18.1	0.3	9.50	613	18.3	0.3	9.11	619
1.25b	18.1	0.3	6.31	613	18.3	0.3	8.89	618
1.45b					18.2	0.3	6.84	618
1.50								
1.75								
	Railroad Trestle			1535 hr	**Mouth of Noble Gulch**			1500 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.5	0.3	10.04	616	18.4	0.3	9.79	610
0.25	18.5	0.3	9.96	616	18.3	0.3	9.70	610
0.50	18.5	0.3	9.98	615	18.1	0.3	9.83	609
0.75	18.5	0.3	10.00	614	18.0	0.3	9.62	609
1.00b	18.5	0.3	8.22	614	18.2	0.3	7.79	611
1.25								
1.50								

10 July 2011. Gage height of 1.99 in afternoon. Sunny.
Station 1: Flume at 1600 hr. Air temp. 17.2 C. No surface algae.
Station 2: Stockton Avenue Bridge at 1549 hr. Secchi depth to bottom. No surface algae. Reach 2- no birds.
Station 3: Railroad Trestle at 1535 hr. Reach 3- 21 mallards with 2 ducklings and 3 domestic ducks in water. No surface algae. Goose on downed redwood.
Station 4: Mouth of Noble Gulch at 1500 hr. Only 2 western pond turtles on cottonwood. No gray water.
Station 5: Nob Hill at 1628 hr. Water temp. =18.2. Oxygen= 9.91 mg/L. cond. = 607 umhos. Salinity =0.3 ppt.

			19-July-11					
	Flume				**Venetian Court Wall** 0956hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00					19.3	0.4		
0.25					19.2	0.4		
0.50					19.1	0.4		
0.75					19.1	0.4		
1.00					`8.5	0.4		
1.25					18.6	0.4		
1.50					18.4	0.4		
1.75					18.3	0.4		
2.00					18.3	0.4		
2.25					18.3	0.4		
2.50b					18.3	0.4		
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00								
0.25								
0.50								
0.75								
1.00								
1.20b								
1.25								
1.45b								

<u>19 July 2011.</u> Gage height of 2.48 in morning. Sunny. Checking for saline water after tidal overwash on 10-11 July. Also checked for salinity all along the Venetian Court wall. Found none. Recommended to Morrison that the shrouds could be removed.

			26-July-11					
	Flume 0709 hr				**Stockton Avenue Bridge** 0725hr			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 umhos**
0.00	18.7	0.4	9.45	637	18.8	0.4	10.98	638
0.25	18.9	0.4	9.87	638	19.0	0.4	10.90	638
0.50	19.0	0.4	9.86	637	19.0	0.4	10.96	638
0.75	19.0	0.4	9.92	637	19.0	0.4	10.98	637
1.00	19.0	0.4	9.99	637	19.0	0.4	10.73	636
1.25	19.0	0.4	10.03	637	18.7	0.4	9.75	632
1.45b	19.0	0.4	8.70	636				
1.50b					18.5	0.4	7.28	631
1.75								
2.00								
2.25								
	Railroad Trestle 0741hr				**Mouth of Noble Gulch**			0753hr
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	18.6	0.4	10.98	634	17.6	0.4	9.42	619
0.25	18.6	0.4	10.94	634	17.6	0.4	9.47	618
0.50	18.5	0.4	10.51	631	17.5	0.4	9.56	618
0.75	18.4	0.4	10.58	631	17.5	0.4	9.62	618
1.00	18.4	0.4	10.50	631	17.4	0.4	9.44	618
1.05b					17.4	0.4	7.44	618
1.20b	18.5	0.4	7.00	632				
1.25								
1.45b								

<u>26 July 2011.</u> Gage height of 2.37 in morning. Overcast. Air temperature of 13.8°C at 0709 hr. Shrouds still in place. No sand depression around flume inlet, indicating that no water was leaking under flume.

Station 1: Flume 0709 hr. Reach 1- 11 gulls bathing. Surface algae<1%.
Station 2: Stockton Bridge 0725 hr. Reach 2-6 mallards; no surface algae.
Station 3: Railroad trestle 0741 hr. Reach 3- 16 adult mallards and 2 ducklings and 1 comestic duck in water. No surface algae.
Station 4: Noble Gulch 0753 hr. 3 mallards and 1 goose roosting on emergent wood. No gray water.
Station 5: Nob Hill at 0823 hr. Water temperature 16.2°C. Conductivity 599 umhos. Salinity 0.4 ppt. Oxygen 10.91 mg/l.

			26-July-2011					
	Flume			1601 hr	**Stockton Avenue Bridge**			1543 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	20.0	0.4	9.72	650	20.2	0.4	9.45	658
0.25	20.0	0.4	9.85	650	20.3	0.4	9.13	656
0.50	19.9	0.4	9.66	646	20.1	0.4	9.12	654
0.75	19.9	0.4	9.76	639	20.0	0.4	9.13	653
1.00	19.2	0.4	10.07	638	19.8	0.4	8.97	652
1.25	19.1	0.4	10.14	638	19.4	0.4	9.56	639
1.37b	19.1	0.4	8.49	638				
1.50b					19.1	0.4	7.58	641
1.75								
	Railroad Trestle			1528 hr	**Mouth of Noble Gulch**			1505 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	21.0	0.4	9.70	663	20.8	0.4	9.08	663
0.25	20.8	0.4	9.55	661	20.7	0.4	9.01	656
0.50	20.6	0.4	9.48	659	19.8	0.4	8.98	646
0.75	20.4	0.4	9.48	653	18.5	0.4	10.19	631
1.00	19.5	0.4	11.09	639	18.4	0.4	10.26	631
1.13b					18.5	0.4	8.20	633
1.20b	19.4	0.4	8.61	639				
1.25								
1.50								

<u>26 July 2011</u>. Gage height of 2.40 in afternoon. Sunny. Air temperature of 16.7°C at 1601 hr. Flume inlet approx. 1.5 ft depth. Flume exit depth 1.3 ft. Shrouds removed.
Station 1: Flume at 1601 hr. Reach 1- Bottom algae 60% coverage, 0.3-1.0 ft thick; avg. 0.6 ft. Remainder film. No surface algae. Slight plankton bloom. 33 gulls bathing.
Station 2: Stockton Avenue Bridge at 1543 hr. Secchi depth to bottom. Reach 2- No surface algae, 70% of bottom covered with algae, 0.3- 1.0 ft thick, averaging 0.5 ft. Remainder film. Slight algal bloom. No birds.
Station 3: Railroad Trestle at 1528 hr. Reach 3- No surface algae, 60% of bottom covered with algae. 0.2-0.7 ft thick, averaging 0.3 ft. Remainder film. Slight algal bloom. 22 mallards, 3 domestic ducks, 1 goose and 2 white domestic ducks in water.
Station 4: Mouth of Noble Gulch at 1505 hr. No gray water was entering lagoon from Noble Gulch. 3 mallards roosting on downed cottonwood. Thick phytoplankton bloom. Bottom invisible.
Station 5: Nob Hill at 1638 hr. Water temperature 19.0°C. Conductivity 633 umhos. Salinity 0.4 ppt. Oxygen 9.99 mg/l.

			10-August-11					
	Flume 0600 hr				**Stockton Avenue Bridge** 0639 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	17.6	0.4	9.96	630	17.4	0.4	11.06	629
0.25	17.6	0.4	10.15	630	17.5	0.4	11.12	629
0.50	17.7	0.4	10.18	630	17.5	0.4	11.06	629
0.75	17.7	0.4	10.21	630	17.5	0.4	11.04	628
1.00	17.6	0.4	9.91	630	17.5	0.4	10.95	628
1.25	17.6	0.4	9.72	630	17.3	0.4	10.47	628
1.50b	17.6	0.4	8.30	630	17.2	0.4	8.14	624
1.55b					17.2	0.4	7.52	624
1.75								
2.00								
			10-August-11					
	Railroad Trestle 0613 hr				**Mouth of Noble Gulch**			0623 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	17.5	0.4	10.30	630	17.0	0.4	9.42	622
0.25	17.5	0.4	10.30	630	17.0	0.4	9.23	622
0.50	17.5	0.4	10.25	630	17.0	0.4	9.24	621
0.75	17.3	0.4	9.82	628	17.0	0.4	9.27	621
1.00	17.1	0.4	9.75	626	16.8	0.4	7.01	617
1.20b	17.2	0.4	7.55	627	16.7	0.4	5.70	618
1.25								
1.50								

10 August 2011. Gage height of 2.49 in morning. Overcast. Air temperature of 13.4°C at 0600 hr. Flume still sealed at lagoon bottom.
Station 1: Flume at 0600 hr. Reach 1- 41gulls and 1 pelican on margin. 10 steelhead strikes on the surface/ min. No surface algae.
Station 2: Stockton Avenue Bridge at 0639 hr. Secchi depth to bottom. Reach 2- No birds or surface algae.
Station 3: Railroad Trestle at 0613 hr. Reach 3- 2 mallards in water. Surface algae 7% below Noble Gulch and 1% above.
Station 4: Mouth of Noble Gulch at 0623 hr. No gray water. 6 mallards and 1 black crown night heron on downed cottonwood and willow. Thick phytoplankton bloom with 2% surface algae.
Station 5: Nob Hill at 0700 hr. Water temperature 15.8° C. Conductivity 604 umhos. Oxygen 10.03 mg/l. Salinity 0.4 ppt. 8 mallards in creek.

			10-August-11					
	Flume 1950 hr				**Stockton Avenue Bridge** 1935 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	17.6	0.4	10.27	629	17.6	0.4	9.85	631
0.25	17.6	0.4	10.27	629	17.6	0.4	9.79	631
0.50	17.7	0.4	10.28	629	17.6	0.4	9.77	630
0.75	17.7	0.4	10.26	629	17.6	0.4	9.72	630
1.00	17.7	0.4	10.43	629	17.6	0.4	9.79	630
1.25	17.1	0.4	10.39	629	17.6	0.4	9.74	631
1.50	17.1	0.4	8.39	629	17.6	0.4	9.81	630
1.55b					17.6	0.4	7.69	630
1.75								
2.00								

			10-August-11					
	Railroad Trestle 1925 hr				**Mouth of Noble Gulch** 1910 hr			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	17.5	0.4	9.86	629	17.1	0.4	8.82	619
0.25	17.6	0.4	9.81	629	17.1	0.4	8.66	619
0.50	17.5	0.4	9.85	629	17.0	0.4	8.68	617
0.75	17.4	0.4	9.85	627	16.7	0.4	9.36	617
1.00	17.4	0.4	9.94	627	16.7	0.4	9.37	617
1.20b	17.4	0.4	7.89	627	16.8	0.4	8.67	617
1.25								
1.50								

10 August 2011. Gage height of 2.50 in evening. Overcast. Overcast the entire day and most of the week. Air temperature of 14.6^{o} C at 1950 hr.
Station 1: Flume at 1950 hr. Reach 1- 13 gulls bathing. No surface algae. 60% of bottom covered with algae 0.3 – 2.0 ft thick, averaging 1.0 ft.
Station 2: Stockton Avenue Bridge at 1935 hr. Secchi depth to bottom. Reach 2- No surface algae. 70% of the bottom algae 0.5 – 2.0 ft thick, averaging 1.0 ft. No waterfowl.
Station 3: Railroad Trestle at 1925 hr. Reach 3- 2% surface algae below Noble Gulch and 5% above. 10 mallards and 3 domestic ducks in water.
Station 4: Mouth of Noble Gulch at 1910 hr. 80% bottom algae coverage, 0.3-2 ft thick; averaging 1.0 ft. 20% surface algae.
Station 5: Nob Hill at 2020 hr. Water temperature 16.2 ^{o} C. Conductivity 606 umhos. Oxygen 9.25 mg/l. Salinity 0.4 ppt.

			23-Aug-11					
	Flume 0702 hr				**Stockton Avenue Bridge** 0715 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.2	0.4	9.74	638	17.1	0.4	10.69	636
0.25	17.3	0.4	9.96	638	17.2	0.4	10.70	636
0.50	17.4	0.4	10.02	639	17.3	0.4	10.71	636
0.75	17.4	0.4	10.08	639	17.3	0.4	10.58	636
1.00	17.4	0.4	10.09	639	17.3	0.4	10.67	636
1.25	17.4	0.4	10.18	638	17.3	0.4	10.55	636
1.45b	17.4	0.4	9.52	637				
1.50b					17.3	0.4	3.60	636
1.75								
2.00								
			23-Aug-11					
	Railroad Trestle 0731 hr				**Mouth of Noble Gulch** 0744 hr			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.1	0.4	9.73	639	16.6	0.4	9.30	631
0.25	17.1	0.4	9.78	639	16.6	0.4	9.28	631
0.50	17.1	0.4	9.61	639	16.6	0.4	9.22	632
0.75	17.1	0.4	9.05	639	16.6	0.4	9.09	632
1.00	17.1	0.4	8.99	639	16.6	0.4	8.15	631
1.10b					16.6	0.4	2.61	632
1.20b	17.1	0.4	6.22	641				
1.25								
1.50								

23 August 2011. Gage height of 2.45 (morning) and 2.45 (afternoon). Clear at 0702 hr with air temperature of 12.9 °C. Air temperature 14.4º C at 1610 hr and clear. Flume inlet 1.2 ft. Flume outlet 2.0 ft in afternoon with incoming tide.

Station 1: Flume at 0702 hr. Reach 1- 8 gulls bathing. Surface algae<1%.
Station 2: Stockton Avenue Bridge at 0715 hr. Secchi depth to the bottom. Reach 2- no birds; 25% surface algae.
Station 3: Railroad trestle at 0731 hr. Reach 3- No waterfowl in water. 3 mallards on redwood log and 2 mallards on downed cottonwood. 10% surface algae between trestle and Noble Gulch. <1% surface algae upstream of the Gulch.
Station 4: Mouth of Noble Gulch at 0744 hr. 5% surface algae and no gray water at Noble Gulch.
Station 5: Nob Hill at 0807 hr. Water temperature at 15.0°C. Conductivity 602 umhos, Oxygen 10.60 mg/l. Salinity 0.4 ppt.

1610 hr			23-Aug-11					1556 hr
	Flume				**Stockton Avenue Bridge**			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	18.7	0.4	10.76	658	19.0	0.4	10.36	665
0.25	18.7	0.4	10.96	658	19.0	0.4	10.36	665
0.50	18.4	0.4	11.21	653	19.0	0.4	10.21	664
0.75	18.4	0.4	11.31	649	18.9	0.4	10.12	662
1.00	18.3	0.4	11.11	650	18.8	0.4	10.15	657
1.25	18.3	0.4	11.02	649	18.2	0.4	10.59	651
1.50b	18.3	0.4	8.72	649	18.1	0.4	10.34	651
1.75								
2.00								
1546hr			23-Aug-11					1515 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	20.0	0.4	10.31	678	20.3	0.4	8.88	678
0.25	19.9	0.4	10.22	677	20.1	0.4	8.84	675
0.50	19.5	0.4	10.34	671	19.4	0.4	8.49	660
0.75	19.2	0.4	10.81	663	17.6	0.4	10.98	638
1.00	18.5	0.4	11.92	654	17.5	0.4	11.17	635
1.10b					17.7	0.4	13.07	632
1.20b	18.4	0.4	9.25	655				

Station 1: Flume at 1610 hr. Reach 1- 1% bright green algae just below surface. Bottom invisible (too dark). 60 gulls and one brown pelican bathing. Terns flying overhead.
Station 2: Stockton Avenue Bridge at 1556 hr. Secchi depth to the bottom. Reach 2- 5% bright green tufts of algae just below surface. 100% of bottom covered by algae 0.1 – 2 ft thick, averaging 0.3 ft. 1 goose in water.
Station 3: Railroad trestle at 1546 hr. Reach 3- Surface algae 2% below Noble Gulch and 1% above. 50% of bottom covered by algae 0.1- 2 ft thick, averaging 0.3 ft, remainder film. 9 mallards dabbling. 10 mallards on downed cottonwood with 1 pond turtle. 1 pond turtle on other downed wood adjacent Golino property.
Station 4: Mouth of Noble Gulch at 1515 hr. Thick photoplankton bloom continues. 2% surface algae. 100% of bottom covered by algae 0.2 - 3 ft thick, averaging 1.5 ft. One black crowned night heron in willows across from Gulch. No gray water.
Station 5: Nob Hill at 1704 hr. Water temperature at 18°C. Conductivity 646 umhos, Oxygen 9.58 mg/l. Salinity 0.4 ppt.

0859 hr	Begonia	Festival	04-Sep-11		Begonia	Festival		0914 hr
	Flume				**Stockton Avenue Bridge**			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	16.4	0.4	9.39	657	16.4	0.4	10.26	643
0.25	16.5	0.4	9.38	657	16.4	0.4	10.20	643
0.50	16.5	0.4	9.18	659	16.5	0.4	10.23	643
0.75	16.4	0.4	9.16	664	16.5	0.4	10.17	642
1.00	16.4	0.4	9.12	671	16.5	0.4	10.23	641
1.25	16.3	0.4	9.03	671	16.3	0.4	9.81	634
1.50b	16.4	0.4	8.60	674	16.0	0.4	6.90	634
1.75								
			04-Sep-11					
0933 hr	**Railroad Trestle**				**Mouth of Noble Gulch**			0947 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	16.4	0.4	10.07	638	15.7	0.4	9.54	622
0.25	16.4	0.4	10.03	638	15.7	0.4	9.37	622
0.50	16.4	0.4	9.99	638	15.7	0.4	9.32	623
0.75	16.4	0.4	9.65	637	15.7	0.4	9.25	623
1.00	16.1	0.4	8.62	637	15.7	0.4	9.28	624
1.25b	16.1	0.4	6.61	636	15.7	0.4	8.70	624
1.50								
			4-Sep-11					1406 hr
	Flume				**Stockton Avenue Bridge**			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00					16.8	0.4	10.47	649
0.25					16.9	0.4	10.41	649
0.50					16.9	0.4	10.37	651
0.75					16.9	0.4	10.35	651
1.00					16.9	0.4	10.45	652
1.25					16.9	0.4	10.48	652
1.50					16.8	0.4	10.66	650
1.60b					16.9	0.4	10.12	651
1.75								

			4-Sep-11					
	Railroad Trestle			1422 hr	**Mouth of Noble Gulch**			1434 hr
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 Umhos**
0.00	16.8	0.4	12.08	645	17.0	0.4	10.95	644
0.25	16.8	0.4	11.94	645	16.9	0.4	11.00	643
0.50	16.8	0.4	12.05	645	16.8	0.4	10.98	642
0.75	16.7	0.4	11.97	645	16.7	0.4	11.05	641
1.00	16.7	0.4	12.13	645	16.7	0.4	15.65	641
1.15b					16.9	0.4	15.97	639
1.25b	16.8	0.4	9.83	645				

04 September 2011. Begonia Festival Day. Gage height of 2.51 (morning) and 2.51 (afternoon). Overcast in morning at 1000 hr and stayed that way until shortly before 1400 hr. Air temp. morning 13.7°C. Air temp. afternoon 15.4°C. The day of the parade, 4 September, was initially overcast until 1400 hr, after which it was sunny, though cool, for the remainder of the day, much like the previous year. Water temperatures were cooler in the morning than 2 weeks previous, and oxygen levels were similar and in the "good" range. The lagoon depth was maintained at an excellent gage height of 2.51 ft during the nautical parade. There were 6 floats in the nautical parade and 20 other boats (mostly kayaks) and 6 standing surfboarders in the water. In conformance with the permit requirements from the California Department of Fish and Game, no floats were set up to be propelled by waders. Means of propulsion included electric motor with paddlers on board and by kayaks with draw ropes. Thus, the lagoon bottom was undisturbed. Conductivity near the bottom increased very slightly at the Stockton Avenue Bridge from 634 before to 650 umhos after the parade. Conductivity at the mouth of Noble Gulch was 624 umhos near the bottom before the procession and 641 afterwards. The measured levels of conductivity were not stressful to steelhead. There was no odor of hydrogen sulfide, and no fish mortality was observed. Oxygen concentrations in the afternoon following the nautical parade were high, ranging between 10.66 and 15.65 mg/l near the bottom before 1435 hr. Water temperatures at this time were the coolest in 21 years near the bottom (16.7–16.8° C) and likely became somewhat warmer later in the day. The secchi depth (water clarity) was to the lagoon bottom after the float procession. Flower petals were collected by Begonia Festival staff and volunteers the following week, and there were fewer than usual left by the parade of floats.

			5-Sep-11					
	Flume			0703hr	**Stockton Avenue Bridge**			0715hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	16.7	0.4	9.67	646	16.6	0.4	10.36	648
0.25	16.7	0.4	9.64	645	16.6	0.4	10.32	649
0.50	16.7	0.4	9.54	645	16.7	0.4	10.24	648
0.75	16.5	0.4	9.17	644	16.7	0.4	10.31	647
1.00	16.5	0.4	9.14	642	16.7	0.4	10.07	646
1.25	16.5	0.4	9.14	642	16.6	0.4	10.10	645
1.50b	16.5	0.4	7.56	642	16.2	0.4	9.16	636
1.60b					16.1	0.4	7.01	636
1.75								
2.00								
			5-Sep-11					
	Railroad Trestle			0739hr	**Mouth of Noble Gulch**			0753hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	16.5	0.4	9.91	642	15.8	0.4	10.58	628
0.25	16.5	0.4	9.75	642	15.8	0.4	10.30	629
0.50	16.5	0.4	9.73	642	15.9	0.4	9.91	629
0.75	16.5	0.4	9.69	641	15.9	0.4	9.80	629
1.00	16.3	0.4	7.26	641	15.9	0.4	7.31	630
1.13b					15.9	0.4	5.29	632
1.25b	16.3	0.4	5.30	641				

5 September 2011. Gage height of 2.51 (morning) and 2.51 (afternoon). Overcast in morning and sunny in afternoon. Air temperature of 12.9ºC at 0703 hr and 16.5ºC at 1553 hr.

Station 1: Flume at 0703 hr. Reach 1- 53 gulls and 2 mallards bathing. Air temp. 12.9 C. Flume at 1553 hr. Reach 1- 39 gulls bathing with 1 cormorant perched on redwood stump. Bright green algal tufts <1% at surface. 100% of bottom with algae 0.2-2.0 ft thick, averaging 0.5 ft thick; No pondweed observed.

Station 2: Stockton Avenue Bridge at 0715 hr. Reach 2- no birds or surface algae. Reach 2 at 1531 hr. Secchi depth to bottom. No surface algae. 70% of bottom covered with algae 0.2 – 2.0 ft thick, averaging 1 ft. algae + pondweed = 1%. Remainder of bottom a thick algal film.

Station 3: Railroad trestle at 0739 hr. Reach 3- 4 mallards dabbling. Two mallards roosting on small emergent logs. No surface algae. At 1508 hr, 5 mallards and 4 domestic ducks (one white) dabbling in water near Noble Gulch. 2 gulls perched on redwood log above trestle, which had moved downstream about 50 feet from previous monitoring. No surface algae. 70% of bottom covered with algae 0.2-0.6 ft thick, averaging 0.3 ft. Algae + pondweed <1% and 1 ft thick. Remainder of bottom with algal film.

Station 4: Mouth of Noble Gulch at 0753 hr. Thick gray water from Noble Gulch. Plume extending 25 ft out from mouth. No birds on cottonwood or redwood log, downstream. At 1459 hr- 2 pond turtles on cottonwood.

Station 5: Nob Hill at 0825 hr. Water temperature at 15.2°C. Conductivity 615 umhos, Oxygen 9.98

mg/l. Salinity 0.4 ppt. Nob Hill at 1512 hr. Water temperature 17.1° C. Oxygen 9.59 mg/l. Conductivity 641 umhos. Salinity 0.4 ppt.

			18-Sep-11					
	Flume			1609 hr	**Stockton Avenue Bridge**			1547 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.9	0.4	11.29	672	18.2	0.4	9.97	684
0.25	17.8	0.4	11.44	669	18.2	0.4	9.92	685
0.50	17.6	0.4	11.63	667	18.2	0.4	9.99	684
0.75	17.6	0.4	11.43	667	18.1	0.4	9.87	685
1.00	17.5	0.4	11.62	664	18.1	0.4	10.22	683
1.25	17.4	0.4	11.85	666	17.6	0.4	11.10	681
1.50b	17.3	0.4	9.33	666	17.4	0.4	10.95	672
1.55b					17.3	0.4	10.70	669
1.75								
2.00								
			18-Sep-11					
	Railroad Trestle			1530hr	**Mouth of Noble Gulch**			1512hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.8	0.4	10.41	694	19.7	0.4	9.07	703
0.25	19.1	0.4	10.45	692	19.4	0.4	8.86	690
0.50	18.9	0.4	10.36	681	19.0	0.4	9.30	677
0.75	18.5	0.4	11.72	670	17.1	0.4	11.08	663
1.00	18.0	0.4	13.31	661	17.3	0.4	15.90	662
1.05b					17.3	0.4	14.48	656
1.20b	17.8	0.4	10.97	660				
1.25								
1.50								

			18-Sep-11				
	Flume			0712hr	**Stockton Avenue Bridge**		0729hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.0	0.4	9.44	653	16.9	0.4	9.87	653
0.25	17.0	0.4	9.53	653	17.0	0.4	10.10	653
0.50	17.1	0.4	9.63	653	17.0	0.4	10.16	653
0.75	17.1	0.4	9.66	653	17.0	0.4	10.08	653
1.00	17.0	0.4	9.58	652	17.0	0.4	10.14	653
1.25	17.0	0.4	9.60	652	17.0	0.4	9.91	653

1.45b	17.0	0.4	8.85	652				
1.50					16.8	0.4	8.90	653
1.55b					16.8	0.4	7.57	653
1.75								
2.00								
			18-Sep-11					
	Railroad Trestle			0752hr	**Mouth of Noble Gulch**			0804hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	16.8	0.4	9.64	654	15.6	0.4	9.55	642
0.25	16.7	0.4	9.56	654	15.6	0.4	9.46	641
0.50	16.7	0.4	9.48	654	15.6	0.4	9.41	641
0.75	16.7	0.4	9.43	654	15.6	0.4	9.39	641
1.00	16.8	0.4	9.32	654	15.6	0.4	9.30	645
1.05b					15.8	0.4	2.54	674
1.12b	16.8	0.4	6.77	654				
1.25								

<u>18 September 2011.</u> Gage height of 2.38 (morning) and 2.38 (afternoon). Clear in morning and sunny in afternoon. Air temperature of 12.3ºC at 0712 hr and 16.4ºC at 1609 hr.
Station 1: Flume at 0712 hr. Reach 1- 25 gulls bathing. No surface algae. Gage height 2.38. Air temp. 12.3 C. Flume at 1609 hr. Gage height 2.38. Reach 1- 75+ gulls bathing. No surface algae. 100% of bottom with algae 0.4-1.0 ft thick, averaging 0.4 ft thick; No pondweed observed.
Station 2: Stockton Avenue Bridge at 0729 hr. Reach 2- no birds or surface algae. Reach 2 at 1528 hr. Secchi depth to bottom. Surface algae<1%. 95% of bottom covered with algae 0.4 – 1.5 ft thick, averaging 0.6 ft.
Station 3: Railroad trestle at 0752 hr. Reach 3- 4 mallards dabbling. At 1530 hr, lady feeding ducks at Noble Gulch- 10 wild mallards, 3 domestic ducks, 1 goose and 3 gulls. She is a routine bird feeder and unreceptive to education. Reach 3- No surface algae; 99% of bottom covered with algae 0.2 - 1.0 ft thick, averaging 0.4 ft; 1% pondweed with algae 1.5 ft thick and under trestle.
Station 4: Mouth of Noble Gulch at 0804 hr. Gray water from Noble Gulch. At 1512 hr- one pond turtle on cottonwood and 1 pond turtle on other wood adjacent Golino property. 100% of bottom covered with algae 0.2-1.0 ft thick; averaging 0.4 ft. No surface algae but phytoplankton bloom present.
Station 5: Nob Hill at 0825 hr. Water temperature at 14.5°C. Conductivity 620 umhos, Oxygen 10.67 mg/l. Salinity 0.4 ppt. Nob Hill at 1512 hr. Water temperature 16.6º C. Oxygen 9.66 mg/l. Conductivity 652 umhos. Salinity 0.4 ppt.

			18-Sep-11					
	Flume			1609 hr	**Stockton Avenue Bridge**			1547 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.9	0.4	11.29	672	18.2	0.4	9.97	684
0.25	17.8	0.4	11.44	669	18.2	0.4	9.92	685
0.50	17.6	0.4	11.63	667	18.2	0.4	9.99	684
0.75	17.6	0.4	11.43	667	18.1	0.4	9.87	685

1.00	17.5	0.4	11.62	664	18.1	0.4	10.22	683
1.25	17.4	0.4	11.85	666	17.6	0.4	11.10	681
1.50b	17.3	0.4	9.33	666	17.4	0.4	10.95	672
1.55b					17.3	0.4	10.70	669
1.75								
2.00								
			18-Sep-11					
	Railroad Trestle			1530hr	**Mouth of Noble Gulch**			1512hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.8	0.4	10.41	694	19.7	0.4	9.07	703
0.25	19.1	0.4	10.45	692	19.4	0.4	8.86	690
0.50	18.9	0.4	10.36	681	19.0	0.4	9.30	677
0.75	18.5	0.4	11.72	670	17.1	0.4	11.08	663
1.00	18.0	0.4	13.31	661	17.3	0.4	15.90	662
1.05b					17.3	0.4	14.48	656
1.20b	17.8	0.4	10.97	660				
1.25								
1.50								

0717 hr			1-Oct-11					0732 hr
	Flume				**Stockton Avenue Bridge**			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.5	0.4	9.37	668	17.5	0.4	9.81	674
0.25	17.5	0.4	9.34	669	17.5	0.4	9.77	674
0.50	17.5	0.4	9.26	670	17.5	0.4	9.73	674
0.75	17,5	0.4	9.18	671	17.5	0.4	9.77	674
1.00	17.4	0.4	8.51	671	17.5	0.4	9.49	674
1.25	17.4	0.4	8.46	672	17.4	0.4	9.17	669
1.50b	17.4	0.4	6.89	672	17.0	0.4	8.41	669
1.70b					17.1	0.4	4.47	669
0750 hr			1-Oct-11					0804 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.4	0.4	8.43	685	16.9	0.4	10.22	659
0.25	17.7	0.4	8.15	685	16.8	0.4	10.08	646
0.50	17.5	0.4	8.47	683	16.7	0.4	8.26	666
0.75	17.5	0.4	8.84	683	16.5	0.4	8.58	664
1.00	17.3	0.4	4.18	687	16.5	0.4	8.11	666
1.05b					16.6	0.4	4.03	669
1.18b	17.2	0.4	3.17	687				
1.25								

1 October 2011. Gage height of 2.35 (morning) and 2.40 (afternoon). Overcast in morning and sunny in afternoon. Air temperature of 14.5º C at 0717 hr and 17.4ºC at 1545 hr.
Station 1: Flume at 0717 hr. Reach 1- 15 gulls bathing. No surface algae. Flume at 1545 hr. Reach 1- No surface algae. 90% of bottom with algae 0.5 – 3.5 ft thick, averaging 1 ft. No pondweed observed. 59 gulls bathing.
Station 2: Stockton Avenue Bridge at 0732 hr. Reach 2- No surface algae; 8 mallards and 5 coots. Reach 2 at 1526 hr. No surface algae. 95% of bottom covered with algae 0.5 – 1.5 ft thick, averaging 0.5 ft. 5% of bottom algae + pondweed 1-4 ft thick, averaging 2.5 ft thick. No waterfowl.
Station 3: Railroad trestle at 0750 hr. Reach 3- No surface algae; 12 mallards, 1 pied-billed grebes and 1 goose in water (goose and 3 of the mallards near Noble Gulch). 2 common egrets and 3 domestic ducks roosting on wood. At 1510 hr, Reach 3- No surface algae; 95% bottom covered with algae 0.3- 4.0 ft, avg. = 0.5 ft. 10 mallards and 2 domestic ducks dabbling, 1 pied-billed grebe. On redwood log nearer trestle- 3 mergansers. On emergent wood downstream adjacent to Golino property- 2 common egrets roosting.
Station 4: Mouth of Noble Gulch at 0804 hr. No surface algae and thick, concentrated gray-brown

water oozing from Noble Gulch. At 1445 hr. No surface algae. 90% of the bottom with algae 0.5-4 ft thick, averaging 1.5 ft. On cottonwood- 3 mallards, 1 domestic duck, 1 common egret, 1 goose and 2 pond turtles. 1 common egret and 1 merganser on emergent willow branches.

Station 5: Nob Hill at 0837 hr. Water temperature 15.9° C. Oxygen 10.45 mg/l. Conductivity 648 umhos. Salinity 0.4 ppt. Nob Hill at 1614 hr. Water temperature 17.5° C. Oxygen 9.30 mg/l. Conductivity 672 umhos. Salinity 0.4 ppt.

1545 hr			1-Oct-11					1526 hr
	Flume				**Stockton Avenue Bridge**			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.6	0.4	11.37	692	18.8	0.4	10.07	701
0.25	18.5	0.4	11.17	691	18.8	0.4	9.96	700
0.50	18.4	0.4	10.99	690	18.7	0.4	9.98	697
0.75	18.5	0.4	10.93	690	18.6	0.4	9.87	696
1.00	18.4	0.4	11.06	689	18.5	0.4	10.36	688
1.25	18.3	0.4	11.12	688	17.8	0.4	11.91	680
1.50b	18.0	0.4	8.27	687	17.7	0.4	11.76	676
1.75					17.5	0.4	12.12	674
1.80b					17.5	0.4	12.65	674
1510 hr			1-Oct-11					1445 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.9	0.4	10.60	697	19.2	0.4	8.82	696
0.25	18.8	0.4	10.55	697	19.1	0.4	8.87	694
0.50	18.8	0.4	10.55	696	18.9	0.4	8.78	686
0.75	18.7	0.4	10.66	692	17.9	0.4	11.39	671
1.00	18.3	0.4	12.69	680	17.9	0.4	15.17	671
1.05b					17.9	0.4	11.61	668
1.20b	18.2	0.4	10.52	679				

			16-Oct-11					0806 hr
	Flume				**Stockton Avenue Bridge**			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00					16.4	2.4	7.70	4037
0.25					17.3	21.58	5.68	22590
0.50					17.8	23.7	5.70	31970
0.75					17.3	27.5	5.52	36560
1.00b					17.2	28.5	0.53	37444
1.25					Sandbar	Open		
1.50								
1.75								
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00								
0.25								
0.50								
0.75								
1.00								
1.25								
1.50								

Appendix B.

2011 Drain Line Test for Restaurants Contiguous with Soquel Creek Lagoon.

2011 DRAIN LINE TEST FOR RESTAURANTS CONTIGUOUS WITH SOQUEL CREEK				
RESTAURANT	**INITIAL CONTACT**	**TEST DATE**	**COMMENTS**	**SIGN OFF**
MY THAI BEACH 207 ESPLANADE		5/26/2011		5/26/2011
BAY BAR 209 ESPLANADE		5/20/2011		5/20/2011
PIZZA MY HEART 209-A ESPLANDE		5/20/2011		5/20/2011
FOG BANK 211 ESPLANDE		5.10.2011		5/10/2011
PARADISE BAR & GRILL 215 ESPLANADE		5.10.2011	Failed, numerous leaks at grease and sanitary systems Jimmy Smith Plmb	5/20/2011
ZELDA'S 201 ESPLANADE		5.10.2011	Passed Jimmy Smith Plmb	5.10.2011