Soquel Lagoon Monitoring Report- 2010

Capitola's Summer Lagoon

Dick and Anita Arthurs' Summer Garden Along the Lagoon

Prepared by D.W. ALLEY & Associates, Aquatic Biology

CITY OF CAPITOLA
420 Capitola Avenue
Capitola, California 95010

December 2010 **Project # 106-20**

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Soquel Creek Mouth; circa 1853
(Courtesy of the Bache Collection; University of California at Santa Cruz)

SOQUEL CREEK LAGOON MONITORING REPORT, 2010

ACKNOWLEDGMENTS

The Capitola Public Works Department did well in creating and maintaining the lagoon in 2010. The sandbar around the flume was sealed nicely to prevent seepage along the flume throughout the summer. We appreciate that Ed Morrison and staff 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.

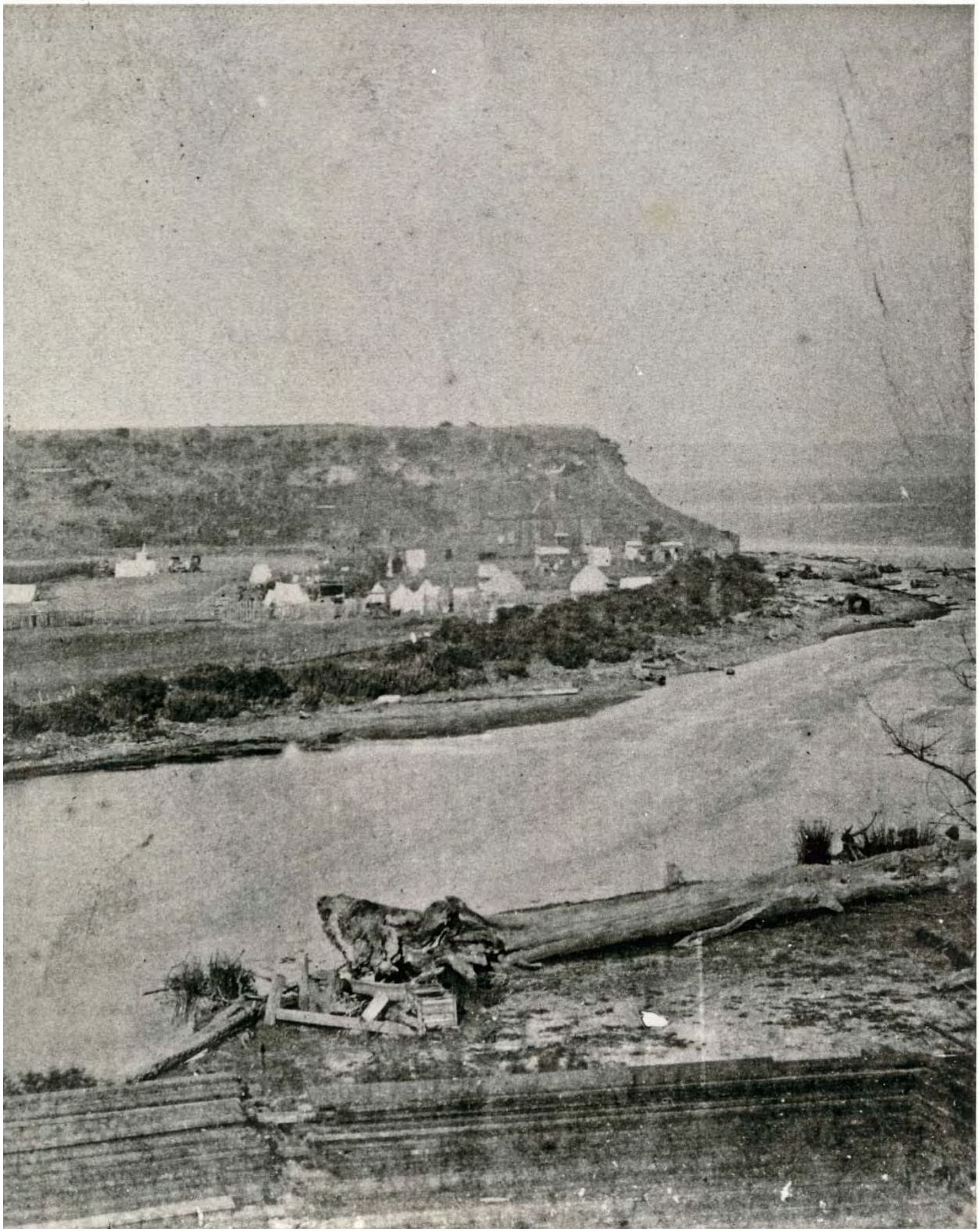
We thank John Getzschmann for sharing his recollections of the Soquel Lagoon and his boyhood fishing experiences with coho salmon in the watershed in the 1930's and 1940's. We thank Carolyn Swift of the Capitola Historical Museum, the Bache Collection at UC Santa Cruz and the Polhemus Family Photographs, Edith C. Smith Collection, Sourisseau Academy, San Jose State University for use of their historical photographs. Cary Oyama helped us again to relocate fish by seining prior to sandbar closure and was a pleasure to work with. We appreciated Gary Quail's continuing help and good humor in censusing the fish. Regarding the Begonia Festival, the organizers, volunteers and students 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 and their lagoon observations. We greatly benefitted from the observations and hospitality of lagoon-side residents, Dick and Anita Arthur. 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 late 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 students from UCSC, Cabrillo and local high schools (community services credits). Residents of the Laguna Creek watershed helped. Biologists from NOAA Fisheries also helped sample on both weekends, looking for tagged fish from their study. The Friends of Soquel Creek were represented (Steve Leinau). Biologists Inger-Marie Laurson, Jessica Wheeler, Carla Moss 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 to see his father work with the fish for the first time.

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

And finally, Daniel Kostelec has retired after many years with the City of Capitola. We are grateful for his 20 years of inspecting the plumbing under the Esplanade restaurants for leaks and providing to us his drain line reports (**Appendix B**).

John Getzschmann Standing on Left at Christmas Time, 2008−
Longtime Watershed Angler and Resident of Soquel Village



Soquel Creek Mouth; circa 1875
(Courtesy of the Capitola Historical Museum)

REPORT SUMMARY

Sandbar Construction. After the first wet winter following 3previous years of below-average rainfall, sandbar construction began on 24 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. The Creek flowed laterally across the beach at approximately 16 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 0645 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. Fourteen seine hauls were made in the lateral channel from 0645 to 1000 hr with a beach seine that was 30 ft x 4 feet with 1/8-inch mesh. There was kelp near the entrance to the lateral channel, making seining problematic in that area, as is sometimes the case. The kelp and deep pockets around boulder riprap were agitated by foot and seine pole to flush fish into more open water where they could be seined. The lateral channel was wide (approximately 25 feet wide) and flat. Cary Oyama 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. Unlike in most previous years, juvenile steelhead were present in the upper lateral channel. Fish captured included 12 steelhead (*Oncorhynchus mykiss*) (11 young-of-the-year and 1 yearling smolt), 9 staghorn sculpins (*Leptocottus armatus*) and approximately 61 adult threespine sticklebacks (*Gasterosteus aculeatus*). No other fish species were detected in the lateral channel. No steelhead were captured in the last 3 seine hauls, and no fish were captured on the last seine haul. Rescued fish were relocated to the main lagoon/ estuary. There were no mortalities. The estuary's western margin adjacent to Venetian Court was very 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 20th year of monitoring and assisting in activities associated with sandbar construction at Soquel Creek Lagoon. Annual monitoring reports for the first 19 years are available at the City (**Alley 1991-2009**). 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.

Sandbar Breaching. An emergency breaching that was required on Sunday, 23 October, which was relatively early for the past 20 years of monitoring. Morrison checked lagoon conditions at 0900 hr on Sunday. Lagoon level had risen to 1 foot above the flume the previous night. When the gage readings resumed, it showed that flow had reached a maximum of 31 cfs at 0515 hr. At 0800 the level was 8 inches over the flume. At 1000 hr the level was still 6 inches over the flume. Morrison removed 4 more boards to make a 24-inch gap blow the top of the flume. More rain was forecasted. Morrison returned to the lagoon at 1330 hr, noting the lagoon level had dropped 4 inches. But the rain was starting to pick up at that time with gage readings up to 43 cfs at 1345 hr. Steve Jesberg checked the lagoon at 1500 hr and found that it was on the rise again. He called

Morrison who headed down to the lagoon. Streamflow at the gage peaked at 79 cfs by 1615 hr. It was about that time that Kotilla and the tractor arrived on the beach and began the assisted, emergency breach. Lagoon levels had come up to the lower benchmark bolt on our indicator piling, meaning that it was approaching the height where it would overtop the bulkhead near the trestle. The breach occurred at 1646 hr with the lagoon still continuing to rise to a crest of 3 inches over the lower benchmark bolt at approximately 1715 hr.

Stream Inflow to the Lagoon. Stream inflow to the 2010 lagoon followed a more normal, above average winter rainfall amount, with 3 previous below average winters. Baseflow at the time of sandbar closure was approximately 14 cfs, with a small storm occurring during the sandbar construction period (**Table 8; Figures 21 and 22**). Eight of the last 20 years had higher baseflow on 1 June. By 1 September, prior to any fall rainfall, streamflow had declined to 3.4 cfs at the Soquel Village USGS gage. The 1 September 2010 baseflow was the 8th highest in the last 20 years. A relatively small stormflow that peaked at about 80 cfs but that exceeded the capacity of the flume required an emergency breach of the sandbar on 24 October. The next significant rainfall causing more than 20 cfs of stormflow did not occur until almost a month later on 20-21 November (**Figure 23**). The sandbar remained open after the original 24 October breach, however.

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 2010 by the data loggers at the deep area near the trestle or at any of the 4, two-week monitoring stations (**Figures 3k-n**). 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 5**). The 2010 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 2010 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 not met 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 2010, the stream management goal was met for steelhead of *no more than 4 hours a day at greater than 20ºC (68ºF)* (**Figures 5a**). The water temperature goal for coho salmon in stream habitat is *average weekly temperature* (7-day rolling average) of16.7º C (62º F) or cooler. This 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 5a**). Coho salmon may have survived in the 2010 stream habitat near the lagoon if present. However, in all other past monitoring years, considerably more stream shading and streamflow would have be required to make lower Soquel Creek habitable for this species.

In 2010, the lagoon was substantially cooler (2 to 3° C) near the bottom in morning and afternoon than in 2009 at all monitoring times throughout the summer until the two monitorings in October (**Table 3, Figures 3a-d; Appendix A**). This was the coolest lagoon in the past 20 years of monitoring. The cooler water temperatures were consistent with cooler air temperatures in July

and August at the Watsonville Airport (**Table 4**), although air temperatures appeared similar in June and September between years. Unfortunately, Capitola air temperatures were not available in 2009. The cooler water temperatures in 2010 were also consistent with cooler 2010 inflow to the lagoon than in 2009 for June – September (**Figure 3e**). In 2010, 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 19.6°C in mid-July.

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, at least for June and July (**Figure 3f**). However in late September through October monitoring, morning water temperatures were very similar at Stations 1-3. 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 3f**). The correspondence between inflow fluctuations and lagoon temperature fluctuations indicated that the inflow temperature influenced the lagoon temperature in 2010 as in previous years. Stream inflow temperatures were typically 2-3° 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 3f and 3g**).

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 20 years. Daily temperature *minima* in the lagoon were consistently warmer near the bottom than the stream inflow in 1999-2010 (**Table 5**). In 2010, 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 (14.8° C vs. 16.3°C) and maxima (17.5° C vs. 18.8°C) (**Table 5**). The average 7-day rolling average of 16°C in the stream was 1.4°C less than 17.4°C at 0.5 feet from the lagoon bottom. Stream inflow temperature in 2010 was generally about 0.5°C cooler in the morning and 1°C cooler in the afternoon than near the lagoon bottom. We see from comparisons of 7-day rolling averages for 2010 and 2009 that the 2010 lagoon's running average was 1-4°C cooler near the bottom and 1-2°C cooler near the surface for all but early June, consistent with cooler inflow temperatures (**Figures 4a, 4k, 4m-n; 5a-c**).

Aquatic Vegetation. There was less bottom algae by itself in the 2010 lagoon compared to 2009, though there was more pondweed with attached algae in 2010 (**Tables 6 and 7**). Evidence of nutrient inputs from Noble Gulch was expressed by sporadic high amounts of surface algae in 2010 as occurred in 2009. Pondweed was first detected in early August 2010 and was most prominent in Reach 1 until early October, when it was fairly evenly distributed in all three reaches, especially in the deep thalweg. Filamentous algae was first noted in mid-June in 2010, as was the case in 2009. Surface algae in 2010 varied between 0 and 1% in Reach 1 (0 and 5% in 2009), 0 and 5% in Reach 2 (0 and 25% in 2009), 0 and 8% in Reach 3 (0 and 3% in 2009) and 0 and 30% at the mouth of Noble Gulch (0 and 25% in 2009) (**Tables 6 and 7**). Surface algae was less prevalent in 2010 than 2009 except in Reach 3 and at the mouth of Noble Gulch.

Oxygen Levels. In 2010, oxygen levels for steelhead were either "good" (greater than 7 mg/l on 10 of 12 monitorings) or "fair" (between 5 and 7 mg/l on 2 of 12 monitorings with one on Begonia Festival Day) *near the bottom at dawn* at all stations during two-week monitorings (**Tables 2 and 3, Figure 6a-1 and Appendix A**). After a mid-October storm that caused turbidity that restricted light penetration, the lagoon depth was reduced quickly to allow light to penetrate through the entire water column. This encouraged photosynthesis and oxygen production. On 23 October, oxygen was still slightly depressed, but not stressful for steelhead, after an 18 October storm. It was in the 5-6 mg/l range near the bottom in the morning and later in the afternoon during a cloudy, misting day (**Appendix A**).

On all monitoring days except 23 October at the trestle (Station 3) and Noble Gulch (Station 4) (which was an overcast and misty day), the oxygen concentration near the bottom and throughout the water column was higher in the afternoon than in the morning at all stations, despite warmer afternoon temperatures (**Figures 6b-6e**).

Salinity Monitoring. In 2010, saline conditions were only detected for a short time after sandbar closure on 4 June 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 2 June. Shrouds were installed on the sandbar inlet to draw the heavier saltwater off the bottom early on, as was recommended in the original lagoon management plan and update (**Alley et. al 2004a**). By our first 2-week monitoring on 19 June, saltwater had dissipated from this location through the flume and sandbar. Then the shrouds were removed.

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, 5 September, was initially overcast until 1300 hr, after which it was sunny, though cool, for the remainder of the day. Water temperatures were very slightly warmer in the morning than the previous week, but oxygen levels were lower, having dropped into the "fair" range at Stations 2 and 3 near the bottom. The lagoon depth was maintained at an adequate gage height of 2.20–2.22 ft. There were 10 floats in the nautical parade and 17 other boats, canoes and rafts 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, pedal kayaks, surfboard paddlers and pole. However, the surfboard paddler float could not be controlled initially, and a wader entered the lagoon and pulled a tow rope a certain distance. Thus, the lagoon bottom was disturbed in the vicinity of the railroad trestle, which increased turbidity slightly in that vicinity. Conductivity near the bottom increased very slightly at the Stockton Avenue Bridge from 701 before to 703 umhos after the parade. Conductivity at the mouth of Noble Gulch was 687 umhos near the bottom after the procession (**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 9.61 to 10.85 mg/l near the bottom before 1430 hr (**Appendix A**). Water temperatures were moderate (17.4−18.8° C) near the bottom at this time at both monitored sites and likely became warmer later in the day. The following week, floats were dismantled and flowers were gathered. More than 90% of the petals were retrieved. Water quality measurements on 12 September detected no oxygen depletion resulting from decomposing begonias (**Figure 6a-1; Appendix A**).

Fish Sampling. Our steelhead population estimate based on mark and recapture for fall 2010 was 1,174, compared to 449 in 2009, 7,071 in 2008, to 6,064 in 2007, 992 juveniles in 2006 and 1,454 juveniles in 2005 (**Table 9, Figure 7a-b**) (methods in **Ricker 1971**). This was the sixth highest estimate and below our 18-year average of 1,723 juveniles. Four especially productive years inflated the average. The other species captured in fall 2010 were threespine sticklebacks, starry flounders and staghorn sculpins. No tidewater gobies were captured. No NOAA Fisheries PIT-tagged juveniles the upper watershed were captured.

Though we do not have a 2010 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 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. In 2010, gray water was observed at Noble Gulch on 3 of 10 two-week monitorings, with the first seen in August. High levels of surface algae were observed near the Gulch mouth on 3 of 10 monitorings, and surface algae was commonly higher downstream of Noble Gulch than upstream (**Table 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. Repair the cracked flume. Its integrity is jeopardized, and the beach sinkholes created by flume underflow are a safety hazard.

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

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

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

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

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

7. Recommend to the Begonia Festival organizers that floats be more 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.

8. Recommend to the Begonia Festival organizers to discourage alcohol consumption by float participants and rowdy behavior on their floats.

9. Contact the USGS and request that they update the streamflow measurements at their Soquel Village gage (11160000) regularly during storms and preferably every 15 minutes.

10. Use wedges 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.

11. 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.

12. 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.

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

14. 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.

15. 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.

16. 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.

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

18. 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.

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

20. 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.

21. In anticipation of a sandbar breach in the fall, the notch in the sandbar should be cut slightly lower than the piling bolt. *Continue to make the notch a 20-30 foot wide swath across the beach to maximize the possibility of maintaining an estuary with some depth after the breach.* Continue to place secondary berms near the flume exit and entrance to prevent tidal overwash through this swath. 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.

22. 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.

23. 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.

24. 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.

25. 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.

26. 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.

Later Wooden Stockton Avenue Bridge with adjacent Trolley car bridge and wider lagoon under western bridge portion and in later Venetian Court location (Railroad Trestle free-spanning the stream channel further upstream); circa 1910
(Courtesy of the Capitola Historical Museum)

LAGOON AND ESTUARY FORMATION

Results of Fish Seining Prior to Construction Activities

24 May 2010. The Creek flowed laterally across the beach at approximately 16 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 0645 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. Fourteen seine hauls were made in the lateral channel from 0645 to 1000 hr with a beach seine that was 30 ft x 4 feet with 1/8-inch mesh. There was kelp near the entrance to the lateral channel, making seining problematic in that area, as is sometimes the case. The kelp and deep pockets around boulder riprap were agitated by foot and seine pole to flush fish into more open water where they could be seined. The lateral channel was wide (approximately 25 feet wide) and flat. Cary Oyama 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. Unlike in most previous years, juvenile steelhead were present in the upper lateral channel. Fish captured included 12 steelhead (*Oncorhynchus mykiss*) (11 young-of-the-year and 1 yearling smolt), 9 staghorn sculpins (*Leptocottus armatus*) and approximately 61 adult threespine sticklebacks (*Gasterosteus aculeatus*). No other fish species were detected in the lateral channel. No steelhead were captured in the last 3 seine hauls, and no fish were captured on the last seine haul. Rescued fish were relocated to the main lagoon/ estuary. There were no mortalities. The estuary's western margin adjacent to Venetian Court was very 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 20th year of monitoring and assisting in activities associated with sandbar construction at Soquel Creek Lagoon. Annual monitoring reports for the first 19 years are available at the City (**Alley 1991-2009**). 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 done prior to and after Memorial Day weekend. The winter storms had been above median, and streamflow had declined steadily to 16 cfs on 24 May. Winter wave action had pushed considerable sand across the beach on the west side, making the estuary narrower than usual. Rain occurred during the night of 26-27 May, increasing flow to 27 cfs maximum. The City was unable to finalize sandbar construction until after Memorial Day weekend, 2 June, with a total of 3 artificial breaches. The estuary bottom was firmer than previous dry years. 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. 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 early in the day, restricting the time of raking and necessitating early artificial sandbar closure each day. Approximately 90% of the plant material was removed from Reach 1 below Stockton Avenue Bridge. The two large redwood root masses that had been in the lagoon in 2008−2009, remained.

24 May 2010. The fishery biologist arrived at 0610 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 24 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 0645 hr (when the lateral channel was blocked off) and ended at approximately 1000 hr. There was no concern for the lateral channel becoming dewatered because the tide was incoming. The lateral channel was wider by the end of the fish relocation than before. The estuary was already filling with the incoming tide. 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 well-defined, and the estuary width was approximately half of usual due to more sand than usual accumulated along the west margin. The lower estuary narrowed approximately 10-15 feet during the construction activities. The auxiliary channel was left open overnight. 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 and water contact was avoided. The biologist went upstream to look for late steelhead spawning redds that could be inundated by the lagoon. None were observed.

25 May 2010. The estuary had partially filled overnight and flowed through the flume for fish passability. The fishery biologist arrived at 0610 hr, and the estuary was emptying out the auxiliary channel. Six public works staff and the biologist raked kelp/sea grass for approximately 2 hours adjacent to the Esplanade restaurants until the tide changed. The biologist walked upstream at 0726 hr to look for isolated side-pools and fish. No side-pools were found. No fish were observed. One greenback heron was observed. The estuary remained 3-4 feet deep on the west side between Stockton Avenue Bridge and the railroad trestle at low tide.

A low dam was placed across the auxiliary channel in mid-morning to keep kelp from washing in. There was a 50% chance of light rain forecasted overnight. The boards had been removed from the east side of the flume outlet. Both sides of the flume outlet had been opened.

26 May 2010. The fishery biologist arrived at 0610 hr, with flow passing through the auxiliary channel, which was approximately 25 feet wide. The low dam had remained intact until 0530 a.m., when it was breached by the equipment operator. Overnight, flow passed through the flume. Streamflow at the Soquel Village gage peaked in the morning at 45 cfs at 0700 hr, with the flow the previous midnight being 30 cfs. By 1900 hr on 26 May it had declined to 27 cfs. The flume had passed the entire stormflow overnight, allowing steelhead passage through the flume. Six staff and Don Alley raked kelp/seagrass from the lower estuary. The biologist walked up the creek

channel at 0730 hr to check the side pools. Two small puddles (3 ft x 5 ft) were found adjacent to the Shadowbrook restaurant, but no fish were found in them. Birds observed included 1 greenback heron, 1 merganser, 1 goose and 8 mallards. Kotilla dammed the auxiliary channel in late morning.

27 May 2010. The fishery biologist arrived at 0642 hr, anticipating a later lagoon opening. The sandbar was opened at 0700 hr after the streamflow had emptied through the flume overnight, offering fish passability. No raking occurred this day because at least 90% of the kelp and seagrass had been raked out of the lower lagoon, and the lagoon bottom was relatively firm. The higher flows in 2010 facilitated the raking effectiveness. Alley and Morrison walked upstream at 0730 hr to check for side-pools. Two puddles existed adjacent to the Shadowbrook restaurant. Approximately 20-30 small larval fishes were rescued from them. These were likely threespine stickleback. No larger fish were present. Further upstream, the location of the winter landsliding was observed. No steelhead redds were observed. The auxiliary channel was dammed at 0900 hr and would remain intact through the Memorial Day weekend. Kotilla graded the western margin of the lagoon, above the water line. Boards with a 2-foot screened upper opening were placed in the flume inlet to allow the lagoon to partially fill over the Memorial Day weekend. Streamflow continued to empty through the flume during this period, allowing fish passability.

2 June 2010. The fishery biologist arrived at 0600 hr, prior to breaching of the auxiliary channel at 0625 hr. The lagoon level had reached the top of the flume with 13-14 cfs being measured at the Soquel Village gage. A female mallard, drake and 4 large ducklings were dabbling near the flume inlet prior to breaching. The biologist walked upstream at 0725 hr, looking for side-pools. Under the Stockton Bridge on the west side the previous day, Morrison and Oyama from Public Works had created fish cover by lashing together floating logs collected from the beach and under the restaurants. Two small puddles were found upstream, adjacent to the Shadowbrook restaurant. Approximately 10 larval fishes were removed from the one puddle that had fish. No larger fish were present. In preparation for sandbar closure, Kotilla flattened and compacted the sand around the flume inlet. This flat pad was covered with visquine that was secured with sandbags. Sandbags lined the base of the flume inlet to secure the visquine to the flume. The clear visquine was covered with a layer of sand by hand. Sand was shoveled by hand into the cracks between the pilings and the flume and tamped by foot to help prevent seepage. The baffle was intact inside the flume. Plywood was placed in the lower flume inlet to prevent water leaks through the lower flashboards. One side of the flume inlet was left screened for the upper 2 feet of height, with an underwater portal cut, 8”x10”, in the screen for adult/ juvenile steelhead passage. Kotilla contoured the western margin of the estuary downstream of Stockton Bridge and above the waterline with the tractor, deepening it before sandbar closure. The sandbar was closed for the season at 1029 hr. He packed more sand into the crevices along the flume with the tractor to minimize lagoon seepage under the flume. Ed Morrison lashed floating logs together under the bridge to create fish cover.

4 June 2010. The fishery biologist installed temperature probes in the lagoon and Creek. Streamflow was 13 cfs at the Soquel Village USGS gage. The lower lagoon was checked for salinity in the deep location adjacent to the Venetian Court wall. Saline water was detected in a 0.25 meter layer along the bottom, with 12.2 ppt at the bottom of this layer and 3.2 ppt at the top. The saline layer was not warmer than upper layers yet, but oxygen levels were less than 1 mg/l in this layer due to the lack of circulation. Elsewhere in the water column, oxygen concentration was

good at more than 8 mg/l at 1530 hr. The sheet metal covers had been installed under the Esplanade sidewalk storm grates. Ed Morrison was informed and instructed to install a baffle on the flume on Monday, 7 June, to facilitate removal of the saline layer.

Effect of Sandbar Construction on Tidewater Gobies in 2010

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. Three sandbar breaches were required during sandbar preparation in 2010, with 3 breaches allowed by the permit without regulatory consultation. The 3 breaches closely mimicked normal tidal fluctuations of an estuary. With each lowering of the water in the estuary, 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 2010, allowing easy retreat to deeper water. The channel 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 2010

No negative impacts to steelhead were detected in 2010. We were satisfied that all juvenile steelhead were relocated from the lateral channel before it was covered over. The flume outlet was open during the entire period of sandbar construction, and smolts had access to the ocean nightly. Only one smolt was observed during estuary relocation and upstream surveys, indicating that smolt emigration was mostly over. It was beneficial to promote lagoon filling each night.

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. Annually evaluate the structural integrity of the flume and its supports. Repair cracks and supports as necessary. This will prevent sinkholes from forming and reduce water leaking from the lagoon along the flume. Repair the flume when it neither obstructs fish passage nor requires lower lagoon water level.

2. Sandbar closure 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 near spawning sites before moving into the lagoon. Down-migrant trapping on the San Lorenzo River in 1987 and 1988 by Don Alley and Stafford Lehr (CDFG) indicated that a few YOY steelhead down-migrated in May to inhabit the summer lagoon, but the number greatly increased in June.

3. 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.

4. 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.

5. 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**).

6. 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.

7. 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.

8. 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.

9. 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.

10. 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.

11. 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.

12. Continue to lash floating logs together under the bridge to create fish cover if they are present and time allows.

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 2010-2011 Rainy Season.

17 October 2010. Prior to a small storm on 18 October, Morrison removed the screen with a 4-inch opening from the flume inlet, which had been in place for much of the summer, and replaced it with a flashboard. This left an 8-inch opening in preparation for the stormflow. This 8-inch opening was maintained until 24 October.

23 October 2010. 23 October was on a Saturday. Morrison had notified CDFG the previous day that the lagoon may need to be breached over the weekend. Morrison checked flume and lagoon at noon. Lagoon level was 6 inches below top of flume. Streamflow was 5 cfs at the Soquel Village gage. Considerable rain was forecasted overnight. Morrison was closely monitoring streamflow at the gage. Unfortunately, it stopped providing readings at 2100 hr at a streamflow of 12 cfs.

24 October 2010. Morrison checked lagoon conditions at 0900 hr on Sunday. Lagoon level had risen to 1 foot above the flume the previous night. When the gage readings resumed, it showed that flow had reached a maximum of 31 cfs at 0515 hr. At 0800 the level was 8 inches over the flume. At 1000 hr the level was still 6 inches over the flume. Morrison removed 4 more boards to make a 24-inch gap below the top of the flume. More rain was forecasted.

Morrison returned to the lagoon at 1330 hr, noting the lagoon level had dropped 4 inches. But the rain was starting to pick up at that time with gage readings up to 43 cfs at 1345 hr. Steve Jesberg checked the lagoon at 1500 hr and found that it was on the rise again. He called Morrison who headed down to the lagoon. Morrison contacted the biologist, Don Alley, leaving a message on his cell phone. Alley's cell phone did not ring and he missed the call. He called Morrison at approximately 1700 hr to check on conditions and learned that the sandbar had already breached. Streamflow at the gage peaked at 79 cfs by 1615 hr. It was about that time that Kotilla and the tractor arrived on the beach and began the assisted, emergency breach. Lagoon levels had come up to the lower benchmark bolt on our indicator piling, meaning that it was approaching the height where it would overtop the bulkhead near the trestle. The breach occurred at 1646 hr with the lagoon still continuing to rise to a crest of 3 inches over the lower benchmark bolt at approximately 1715 hr. Jesberg provided photos of the breaching to Alley.

25 October 2010. The lagoon continued to drain overnight, with dropping to 28 cfs by 0700 hr. Rain was again in the forecast for later in the week. Alley observed the breached sandbar and took photographs. As Ed Morrison stated, "Another year in the books."

20-21 November 2010. The next significant stormflow occurred, with the sandbar remaining open from the emergency breach until this storm.

Recommendations Regarding Sandbar Breaching

1. Contact the USGS and request that they update the streamflow measurements at their Soquel Village gage (11160000) regularly and preferably every 15 minutes. Updating was interrupted at 2100 hr on 23 October just as a storm period began and the streamflow measurements were most needed. Measurements were not available until the next afternoon, making it difficult to predict the fluctuation of lagoon level during stormflow.

2. 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.

3. The notch in the sandbar should be cut slightly lower than the piling bolt. *Make the notch at least 20-30 foot wide across the beach to 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 2010

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. 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 2010, water quality was monitored in late afternoon, as well as in the early morning near first light. Water quality was monitored at four lagoon stations. 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 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 2010, as required by the CDFG permit, 6 HOBO temperature loggers were launched on 4 June 2010 just downstream of the railroad trestle in Reach 2 (as in 2008 and 2009) 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 2010. Another logger was placed in Soquel Creek near the Nob Hill Shopping Center. All 7 loggers were removed on 9 October 2010, 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 detected in 2010, and a shroud was placed on the flume inlet to draw the heavier saltwater off the lagoon bottom to hasten the freshwater conversion in the lagoon. In 2010, the CDFG permit required that monitoring occur in the early morning and late afternoon. Prior to 2003, water quality had been measured only in the early morning after dawn because the most limiting factor, oxygen concentration, is at a minimum at that time.

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**), further south of Soquel Creek. 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 early June after sandbar closure and late October just prior to sandbar breaching. The lagoon level was monitored 11 times in 1 to 2-week intervals from 4 June to 23 October 2010, plus on 5 September, the day of the Begonia Festival. For 2010, the measurements of lagoon level as measured on the staff gage were rated "good" (**Table 2**) on 10 occasions and "fair" on 2 occasions (**Table 3; Figure 2a**). On 15 October, two boards were removed in anticipation of a storm that occurred on 18 October. A tea-colored turbidity developed after the storm and persisted until the sandbar was breached on 24 October. Boards were restored to the flume inlet on 21 October, prior to the 23 October monitoring.

Maintenance of lagoon gage height was relatively high from mid-June to early July 2010 compared to the three previous low flow years, but lower than those years for the remainder of the summer until the sandbar breach (**Figure 2**). However, gage height remained in the good range until late October. Typically, it is more difficult for the City to maintain the highest water surface elevation during wetter years. Saltwater was trapped in the lagoon in deep pockets near the Venetian Court wall at the time of sandbar closure, requiring shroud installation on the flume inlet. This saltwater was flushed through the sandbar within two weeks.

No vandalism of the flume inlet was detected in 2010. The plywood protected 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 2010. Both sides of the flume outlet were opened on the first day of sandbar construction, and one board was left in the flume inlet on the eastern side the first night to allow some lagoon filling. Water spilled over the inlet board the first night (24-25 May), allowing steelhead smolt access to the Bay. A storm came overnight the second night (25-26 May) with the flume taking the entire flow 30+ cfs and providing fish passage. Streamflow emptied through the flume the third night (26-27 May) to provide fish passability. Boards with a 2-foot screened upper opening were placed in the flume inlet to allow the lagoon to partially fill over the Memorial Day weekend until 2 June, with streamflow entering the flume over the top board to allow fish passability. On 2 June, an underwater portal was cut for adult steelhead passage while a two-foot screened opening was maintained above the flume boards at the final sandbar closure. The baffle near the flume inlet remained from 2009. The underwater portal was removed prior to the 19 July monitoring. The lagoon level was in the "fair" range by 4 June, 2 days after sandbar closure and was in the "good" range by the first two-week monitoring on 19 June.

Prior to the 18 October storm, 2 boards were removed from the Esplanade side of the flume inlet.

This created a gap at the top of the flume inlet. No screens were in place. Both boards were added back on 21 October after lagoon conditions cleared sufficiently to allow light penetration to the bottom. The sandbar was breached on 23 October during an 80 cfs stormflow and remained open to adult steelhead passage for the winter.

Water Temperature Results from Two-Week Monitoring. In 2010, the lagoon was substantially cooler (2 to 3° C) near the bottom in morning and afternoon than in 2009 at all monitoring times throughout the summer until the two monitorings in October (**Table 3, Figures 3a-d; Appendix A**). This was the coolest lagoon in the past 20 years of monitoring. The cooler water temperatures in 2010 were consistent with cooler air temperatures in July and August at the Watsonville Airport (**Table 4**), although air temperatures appeared similar in June and September between years. Unfortunately, Capitola air temperatures were not available in 2009. The cooler water temperatures in 2010 were also consistent with cooler 2010 inflow to the lagoon than in 2009 for June – September (**Figure 3e**). The warmest water temperature measured near the bottom in the morning was 18.3°C (65°F) on 29 August at the Stockton Bridge. In 2010, 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 19.6°C in mid-July compared to 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 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 2010 (19 July), the surface and bottom temperature readings near dawn were 17.7 and 17.3° C, respectively (**Appendix A**). In the afternoon at 1515 hr they were 21.0 and 18.2° C, respectively.

Table 3. 2010 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)
04June10	open (afternoon)	2.01 fair	- good - -	- good - -	- good - -	13 cfs
19June10	open	2.47 good	good	good	good	9 cfs
04Jul10	open	2.58 good	good	good	good	6.5 cfs
19Jul10	open	2.26 Good	good	good	good	5 cfs
02Aug10	open	2.44 good	good	good	good	4.5 cfs
15Aug10	open	2.25 good	good	good	good	3.5 cfs
29Aug10	open	2.37 good	good	good	good	2.8 cfs
05Sep10 Begonia Festival	open (morning)	2.20 good	good	good fair fair good	good	2.5 cfs
05Sep10	open (afternoon)	2.22 good	good - - good	good - - good	good - - good	
12Sep10	open	2.23 good	good	good	good	2.8 cfs
26Sep10	open	2.36 good	good	good	good	2 cfs
09Oct10	open	2.21 good	good	good	good	2 cfs
23Oct10	open	2.12 fair	good	fair	good	3 cfs

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

Table 4. Monthly Statistics for Air Temperature in Capitola in 2007 and at the Watsonville Airport in July through September in 2007–2010.

Month/ Year	Max. Temp. ˚ F Capitola	Avg. Temp. ˚ F Capitola	Min. Temp. ˚ F Capitola	Avg. Daily Max. Temp. ˚ F Watson-ville	Avg. Daily Min. Temp. ˚ F Watson-ville	Avg. Temp. ◦F Watson-ville
June 2007	85.3	58.8	44.5	NA	NA	NA
June 2008	99.4	58.7	43.2	74	53.4	61.8
June 2009	NA	NA	NA	70.9	51.9	61.4
June 2010	**93.2 12 Jun**	**59.3**	**44.8 20 Jun**	**71**	**51**	**62**
July 2007	80.9	61.4	48.3	65	54	NA
July 2008	74.0	60.2	48.8	71.9	53.4	62.6
July 2009	NA	NA	NA	72.6	51.9	62.2
July 2010	**79.4 15 Jul**	**58.6**	**48.0 1 Jul**	**68**	**53**	**61**
August 2007	83.2	61.3	49.2	66	55	NA
August 2008	81.4	60.5	49.2	73	53.2	63.1
August 2009	NA	NA	NA	75.3	53.7	64.5
August 2010	**96.3 24 Aug**	**59.2**	**46.5 28 Aug**	**71**	**52**	**62**
September 2007	89.9	61.5	44.8	69	54	NA
September 2008	92.3	60.2	46.2	75.4	52.1	63.8
September 2009	NA	NA	NA	77.7	52.4	65
September 2010	**94.7 25 Sep**	**60.4**	**46.1 14 Sep**	**77**	**52**	**65**

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, at least for June and July (**Figure 3f**). However in late September through October monitoring, morning water temperatures were very similar at Stations 1-3. 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 3f**). The correspondence between inflow fluctuations and lagoon temperature fluctuations indicated that the inflow temperature influenced the lagoon temperature in 2010 as in previous years. Stream inflow temperatures were typically 2-3° 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 3f and 3g**). Usually, morning water temperature was 1-2° C cooler at Station 4 than Station 1. In the afternoon, the difference was usually 0.5-1.5° C. Temperature differences between stations in the cool 2010 lagoon were less than what was the case in previous summers, such as 2008 and 2009, but similar to 2007 (**Figures 3h-j**). Stratification did not occur in the water column throughout the summer (as indicated on 19 June and 19 July), with thorough mixing of the water and cooling each night (**Figures 3k-n**).

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 20 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 3f and 3g**).

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 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 2010 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 1999-2010 (**Table 5**). In 2010, 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 (14.8° C vs. 16.3°C) and maxima (17.5° C vs. 18.8°C) (**Table 5**). The average 7-day rolling average of 16°C in the stream was 1.4°C less than 17.4°C at 0.5 feet from the lagoon bottom. Stream inflow temperature in 2010 was generally about 0.5°C cooler in the morning and 1°C cooler in the afternoon than near the lagoon bottom, with much reduced daily fluctuation in both the stream and the lagoon in September and October. We see from comparisons of 7-day rolling averages for 2010 and 2009 that the 2010 lagoon's average was 1-4°C cooler near the bottom and 1-2°C cooler near the surface for all but early June, consistent with cooler inflow temperatures (**Figures 4a, 4k, 4m-n; 5a-c**).

Table 5. Water Temperature Statistics for Continuous Water Temperature Probes with Readings at 30-minute Intervals in Soquel Lagoon and Stream Inflow Immediately Upstream, 1 June – 15 September.

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
2010	MaximumWater 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	MaximumWater 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**
2008	MaximumWater Temperature °C	21.0	23.3	22.8
2008	Minimum Water Temperature °C	15.6	17.5	17.2
2008	Maximum 7-Day Rolling Average	18.2	21.7	22.4
2008	Minimum 7-Day Rolling Average	15.3	18.7	17.9
2008	**Average 7-Day Rolling Average**	**16.6**	**20.4**	**20.2**

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 2010 by the data loggers at the deep area near the trestle or at any of the 4, two-week monitoring stations (**Figures 3k-n**). 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. During the short period of less than two weeks after sandbar closure 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 5**).

The greatest increase in water temperature recorded from morning to afternoon near the bottom in 2010 was **2.7°C** (4.8° F) on 5 June and 11 July compared to **2.7° C** (4.8° F) on 18 June 2009; compared to **1.9° C** (3.4° F) on 1 June in 2008 and **3.0°C** (5.5°F) on 20 June 2007 (**Figures 4a-b; 4n and 4p**). The greatest increase near the lagoon surface in 2010 was **3.1°C** (5.6°F) on 5 June and 30 June compared to **4.6° C** (8.2° F) in 2009; compared to **2.3° C** (4.1° F) on 6 June in 2008 and **5.4°C** (9.7°F) on 16 August in 2007 (**Figures 4k-l; 4m and 4o**).

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, 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**).

The 2010 lagoon met the steelhead management goal of maintaining early morning minimum temperature below 20°C near the bottom throughout the season (**Figure 4a**) compared to not meeting the goal on 16 of 131 days (12%) in 2009 (**Figure 4n**), 54 of 130 days (42%) in 2008 (**Figure 4p**) and 35 of 124 days (28%) in 2007 (**Alley 2010)**. 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 not met 6% of the days measured (7 of 127 days) in 2010 compared to 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 56 days (44%) but the daily maximum was above 16°C except for 5 days in early October. 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 and 2010, the stream management goal was met for

steelhead of *no more than 4 hours a day at greater than 20ºC (68ºF)* (**Figures 5a and 5c**) and failed on only 1 day (**0.8%**) in 2008 (**Figure 5d**). 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 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 5a**). Coho salmon may have survived in the 2010 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**).

Water temperatures in the lagoon closely reflected temperatures in the stream inflow in 2003-2010. Daily *minima* in the lagoon near the bottom were consistently warmer than the stream above in 1999-2010 (0.5-2°C warmer in 2010 and 2-3° C warmer in 2008 and 2009) (**Figures 4a-b, 4m, 5a-e and Alley 2006**). The daily *maxima* near the bottom of the lagoon were also warmer than in the stream in 2010 (1-1.5ºC) (**Figures 4aand 5a**). The daily stream water temperature fluctuated more than the daily lagoon water temperature near the bottom in June but not afterwards in 2010, while stream fluctuations were typically greater than in the lagoon the entire season in previous years. The maximum daily lagoon water temperature typically occurred between 1700 and 2100 hr each day.

Creek water temperatures 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. 2010 had the highest baseflow of the last four years (**Table 11**). Air temperatures were cooler in July and August but not June and September compared to 2009 at the Watsonville airport, which may or may not be representative of Capitola air temperatures (**Table 4; Figures 5a-c**). Unfortunately, no Capitola air temperatures were available in 2009. Average air temperature in Capitola in July and August was cooler than in 2007 and 2008 and consistently warmer than at the Watsonville Airport for all summer months.

Creek water temperatures in 1999-2010 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 2010 at the time of sandbar construction, at least 90% of the kelp and seagrass had been raked out of the lower lagoon, and the lagoon bottom was relatively firm. The higher flows in 2010 facilitated the raking effectiveness, and most of the vegetative deposits were in the deep thalweg near the restaurants and at the beginning of the lateral channel that passed the streamflow through the beach. This had been the case in 2009. But in 2009 only about 40% of the area downstream of Stockton Bridge, and nearest the flume, was raked out. Approximately 70% of the decaying plant material was removed from the area downstream of Stockton Bridge prior to sandbar closure in 2009. Thus, there was more decaying material left in the 2009 lagoon than many previous years and 2010. This decaying material had provided considerable nutrients for future algae production in the summer lagoon in 2009. There was less bottom algae by itself in the 2010 lagoon compared to 2009, though there was more pondweed with attached algae in 2010 (**Tables 6 and 7**). Evidence of nutrient inputs from Noble Gulch was expressed by sporadic high amounts of surface algae in 2010 as occurred in 2009. Pondweed was first detected in early August 2010 and was most prominent in Reach 1 until early October, when it was fairly evenly distributed in all three reaches, especially in the deep thalweg. Filamentous algae was first noted in mid-June in 2010, as was the case in 2009.

Surface algae in 2010 varied between 0 and 1% in Reach 1 (0 and 5% in 2009), 0 and 5% in Reach 2 (0 and 25% in 2009), 0 and 8% in Reach 3 (0 and 3% in 2009) and 0 and 30% at the mouth of Noble Gulch (0 and 25% in 2009) (**Tables 6 and 7**). Surface algae was less prevalent in 2010 than 2009 except in Reach 3 and 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 2010 were 0.1%, 1.1%, 1.6% and 7.5%, respectively (2%, 4%, 0.6% and 8.2% in 2009, respectively). 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 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 varied between 0 and 20% coverage of Reach 3, with very little in the lower 2 reaches (maximum was 2%) (**Alley 2006**).

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**

Dissolved Oxygen Results. 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 2010, oxygen levels for steelhead were either "good" (greater than 7 mg/l on 10 of 12 monitorings) or "fair" (between 5 and 7 mg/l on 2 of 12 monitorings with one on Begonia Festival Day) *near the bottom at dawn* at all stations during two-week monitorings (**Tables 2 and 3, Figure 6a-1 and Appendix A**). After a mid-October storm that caused turbidity that restricted light penetration, the lagoon depth was reduced quickly to allow light to penetrate through the entire water column. This encouraged photosynthesis and oxygen production. On 23 October, oxygen was still slightly depressed, but not stressful for steelhead, after an 18 October storm. It was in the 5-6 mg/l range near the bottom in the morning and later in the afternoon during a cloudy, misting day (**Appendix A**).

Of the early morning oxygen monitorings, Station 1 at the flume was rated "good" 92% of the time (9 of 10, 2-week monitorings plus Begonia Festival Day) and "fair" the other time (**Table 3; Figure 6b**). Station 2 at Stockton Avenue Bridge was rated "good" 91% of the time (10 of 11 two-week monitorings and not on Festival Day) and "fair" the remainder of the monitoring (**Figure 6c**). Station 3 near the railroad trestle was rated "good" 83% of the time (9 of 10 two-week monitorings and not Begonia Festival Day) and "fair" the remainder of the monitoring (**Figure 6d**). Station 4 at the mouth of Noble Gulch was rated "good" 91% of the time (9 of 10 two-week monitorings plus Begonia Festival Day) and "fair" the remainder of the monitoring (**Figure 6e**).

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 at dawn were generally higher in 2010 than the previous 4 years (**Figures 6a-1; 6f−i**). In 2010, oxygen levels increased at dawn on 2 August and 9 October at all stations compared to other two-week monitorings due to higher algal densities and previous sunny days (**Table 6; Figures 6b-e**). The lower oxygen levels early in the season at some stations were likely a result of less algae and less oxygen production during sunny days. Apparently, greater oxygen production during sunny days at higher lagoon algal densities more than compensated for the algal respiration loss of oxygen overnight. This phenomenon was also observed in past years, such as in 2005−2009 (**Alley 2006–2010**).The lower oxygen level in late October was due to cloudiness and turbidity that inhibited photosynthesis.

On all monitoring days except 23 October at the trestle (Station 3) and Noble Gulch (Station 4) (which was an overcast and misty day), the oxygen concentration near the bottom and throughout the water column was higher in the afternoon than in the morning at all stations, despite warmer afternoon temperatures (**Figures 6b-6e**). This has been the typical pattern during annual lagoon monitoring. 2010 oxygen levels increased the least from morning to afternoon from mid-June to mid-July before aquatic vegetation became established and in late October at the end of the season when sun angle, water clarity and sunlight were reduced (**Figures 6b-e; Appendix A**). Oxygen levels on the afternoon of the Begonia Festival (5 September) were supersaturated at Stockton Bridge despite limited clear skies that day (**Appendix A**).

Salinity Results. In 2010, saline conditions were only detected for a short time after sandbar closure on 4 June 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 2 June. Shrouds were installed on the sandbar inlet to draw the heavier saltwater off the bottom early on, as was recommended in the original lagoon management plan and update (**Alley et. al 2004a**). By our first 2-week monitoring on 19 June, saltwater had dissipated from this location through the flume and sandbar. Then the shrouds were removed. Water temperature had not become elevated in the saline layer on the bottom adjacent to the Venetian Court wall two days after sandbar closure. If it heated up afterwards, steelhead could avoid this area to avoid any thermal stress. Unlike in 2008, there was apparently sufficient lagoon outflow through the flume in 2010 to prevent saltwater from periodically being flushed back into the lagoon through the flume on certain high tides.

Conductivity Results. Conductivity remained low throughout 2010, except in the Venetian Court's wall-hole early on when saltwater was present at the bottom. Otherwise, it ranged between 600 umhos early in the season to 710 umhos after the Begonia Festival (**Appendix A**). Conductivity was usually slightly lower near the bottom 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 or 2010 with higher streamflow than in 2008 (**Table 9**). The year 2001 was most affected by tidal overwash in the last 10 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 2010 lagoon followed a more normal, above average winter rainfall amount, with 3 previous below average winters. Baseflow at the time of sandbar closure was approximately 14 cfs, with a small storm occurring during the sandbar construction period (**Table 9; Figures 21 and 22**). Eight of the last 20 years had higher baseflow on 1 June. By 1 September, prior to any fall rainfall, streamflow had declined to 3.4 cfs at the Soquel Village USGS gage, compared to 1.2 cfs in 2009, 0.7 cfs in 2008, 1.3 cfs in 2007 and 6.6 cfs in 2006. The 1 September 2010 baseflow was the 8th highest in the last 20 years. A relatively small stormflow that peaked at about 80 cfs, but exceeded the capacity of the flume, necessitated an emergency breach of the

sandbar on 24 October. The next significant rainfall causing more than 20 cfs of stormflow did not occur until almost a month later on 20-21 November (**Figure 23**). The sandbar remained open after the original 24 October breach, however.

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, 5 September, was initially overcast until 1300 hr, after which it was sunny, though cool, for the remainder of the day. Water temperatures were very slightly warmer in the morning than the previous week, but oxygen levels were lower, having dropped into the "fair" range at Stations 2 and 3 near the bottom. The lagoon depth was maintained at an adequate gage height of 2.20–2.22 ft. There were 10 floats in the nautical parade and 17 other boats, canoes and rafts 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, pedal kayaks, surfboard paddlers and pole. However, the surfboard paddler float could not be controlled initially, and a wader entered the lagoon and pulled a tow rope a certain distance. Thus, the lagoon bottom was disturbed in the vicinity of the railroad trestle, which increased turbidity slightly in that vicinity. Conductivity near the bottom increased very slightly at the Stockton Avenue Bridge from 701 before to 703 umhos after the parade. Conductivity at the mouth of Noble Gulch was 687 umhos near the bottom after the procession (**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 9.61 to 10.85 mg/l near the bottom before 1430 hr (**Appendix A**). Water temperatures were moderate (17.4−18.8° C) near the bottom at this time at both monitored sites and likely became 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 12 September detected no oxygen depletion resulting from decomposing begonias (**Figure 6a-1; Appendix A**).

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

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.**). 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 indicated only slight differences compared to those taken at the Stockton Bridge, with no impact to steelhead habitat conditions (**Appendix A**). 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 conversations with Bruce Arthur regarding wetland construction and observing the small water output compared to the large input, 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. In 2010, gray water was observed at Noble Gulch on 3 of 10 two-week monitorings, with the first seen in August. High levels of surface algae were observed near the Gulch mouth on 3 of 10 monitorings, and surface algae was commonly higher downstream of Noble Gulch than upstream (**Table 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.

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, gray water plumes were observed on 5 of the 7 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 for the majority of monitorings (**Figure 6g**) and other years, with usually lower oxygen readings at that station (**Alley 2005**). However, in 2006, 2008 and 2009 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 being 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 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. 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.

Soquel Creek Estuary, looking downstream toward Railroad Trestle from present-day Golino Property; circa 1887

(Courtesy of Polhemus Family Photographs, Edith C. Smith Collection, Sourisseau Academy, San Jose State University)

Soquel Lagoon, east margin with tule marsh and path upstream of Railroad Trestle; circa 1927
(Courtesy of the Capitola Historical Museum)

Soquel Lagoon- East margin with Boardwalk, tule marsh and later steel, free-span Railroad Trestle with concrete abutments; circa 1920 (Courtesy of the Capitola Historical Museum)

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 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. Recommend to the Begonia Festival organizers that floats be more 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. 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 penetration 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 2010, as was the case in 2003–2009. 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). In winter 2009-2010, smaller juveniles were planted in the San Lorenzo River and Scott Creek in fear that the Big Creek hatchery would be jeopardized by mudslides resulting from fires the previous summer. 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 3 and 10 October 2010, from just upstream of the Stockton Avenue Bridge, downstream. One week passed between samplings. 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 318 juvenile steelhead were captured and clipped on 3 October after 2 seine hauls. There was 1 mortality. 240 juvenile steelhead were captured on 10 October after 3 seine hauls, with 65 recaptures and no mortalities. The median size of juvenile steelhead captured the first day in 2010 was 115-119 mm SL (**Figure 8**) compared to 155-159 mm SL in 2009 (**Figure 9**), 115-119 mm SL in 2008 (**Figure 10**), 125-129 mm SL in 2007 (**Figure 11**) and 155-159 mm SL in 2006 (**Figure 12**). The median size of captured steelhead on 10 October 2010 was again 115-119 mm SL. A prominent unimodal histogram was evident in 2010 (**Figure 8**), which was typical of most years but not for 2009 (**Figure 9**). It could be that the lagoon population consisted more of larger yearlings and fewer YOY in 2009 than in other years.

Other fish species captured with the large seine were threespine stickleback, 1 juvenile Sacramento sucker and one starry flounder (200 mm SL; 248 mm FL).

On 3October 2010, 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 had been captured the two previous years after dry winters. Fish captured with the small seine included threespine sticklebacks in moderately abundance (50+ per seine haul) and 10 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.

Our steelhead population estimate based on mark and recapture for fall 2010 was 1,174, compared to 449 in 2009, 7,071 in 2008, to 6,064 in 2007, 992 juveniles in 2006 and 1,454 juveniles in 2005 (**Table 10, Figure 7a-b**) (methods in **Ricker 1971**). This was the sixth highest estimate and below

Table 10. Estimates of Juvenile Steelhead Numbers in Soquel Creek Lagoon for the Years 1988 and 1992-2010.

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.

Less juveniles were expected to use the lagoon in 2010 than 2007–2009 because of higher adult passage flows in 2010 and lower adult passage flows late in the spawning season in 2007–2009 (**Figures 21, 24 and 25; Alley 2010**). Higher winter flow in 2010 encouraged more spawning in the upper creek in 2010 with easier access, assumedly seeding the lagoon less with young-of-the-year steelhead than the 3 previously dry years. 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 4 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 larger 2010 lagoon population estimate indicated some improvement in adult returns.

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 2007–2010 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, 1998–2010 corresponding to scatter plots of the data (**Table 11; 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. With our limited time, both factors were not considered in combination. Scatter plots of median juvenile steelhead length as functions of population size (**Figure 7b**) and weeks of lagoon closure prior to sampling (**Figure 7c**) indicated no strong relationship between these factors when considered separately. 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, 1998−2010.

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
1999	18 May	3/10 Oct	20.6	144	928	120-124
2000	7 June	1/8 Oct	17.4	122	875	135-139
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
2003	22 May	5/12 Oct	20.3	142	849	110-114
2004	26 May	3/10 Oct	19.4	136	3,869	115-119
2005	9 June	2/9 Oct	18.1	127	1,454	105-109
2006	14 June	30Sep/8 Oct	16.4	115	992	150-154
2007	23 May	7/14 Oct	20.4	143	6,064	125-129
2008	22 May	27Sep/ 11 Oct (no lengths)	18.1	127	7,071	115-119
2009	21 May	4/11 Oct	20.3	142	449	155-159
2010	2 June	3/10 Oct	18.4	129	1,174	115-119

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 2010 did not promote relatively larger juvenile steelhead despite a moderate population size, although the growth period prior to sampling was 2 weeks less than several years to contribute to smaller size (**Figures 7b-c**). Aquatic plant production was less in 2010 than in the warmer lagoons of 2008 and 2009 (**Tables 6−8**). Oxygen levels at dawn were also higher in 2010 than the two previous years, although they were adequate for steelhead in all years (**Figures 6a-1, 6h and 6i**).

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

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).

In 2010, piscivorous birds commonly observed during two-week monitorings included 0−6 mergansers, 0-1 cormorants and 0−3 pied-billed grebes (one YOY) either roosting on instream wood at the lagoon or in the water nearby (**Appendix A**). Other occasional piscivorous birds included greenback heron, black-crowned night heron, great blue heron and pelican. Piscivorous western pond turtles regularly basked on the instream cottonwood log. As many as 3 pond turtles were observed at one time on the cottonwood 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 24), coots (as many as 23) and gulls (as many as 87). Approximately 6 domestic ducks and one goose were present. On one occasion, a gull was observed chasing a

mother mallard and her young. They took refuge under overhanging willow, emphasizing its importance as cover. A few rocks hurled in the gull's direction also helped.

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 open after first breaching on 25 October 2010, after sandbar breaching on 2 November 2008, the sandbar reformed repeatedly with lagoon filling and then breaching again from early November until mid-December due to low streamflow. 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. Contact the USGS and request that they update the streamflow measurements at their Soquel Village gage (11160000) regularly and preferably every 15 minutes. Updating discontinued at 2100 hr on 24 November 2010 during a storm and did not resume until the next day, making it impossible to remotely monitor stormflow during a critical period of sandbar management. Updating was slow and erratic during the emergency sandbar breaching period of 1-2 November 2008, making it difficult to predict the fluctuation of lagoon level during stormflow.

10. 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.

11. 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.

12. 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

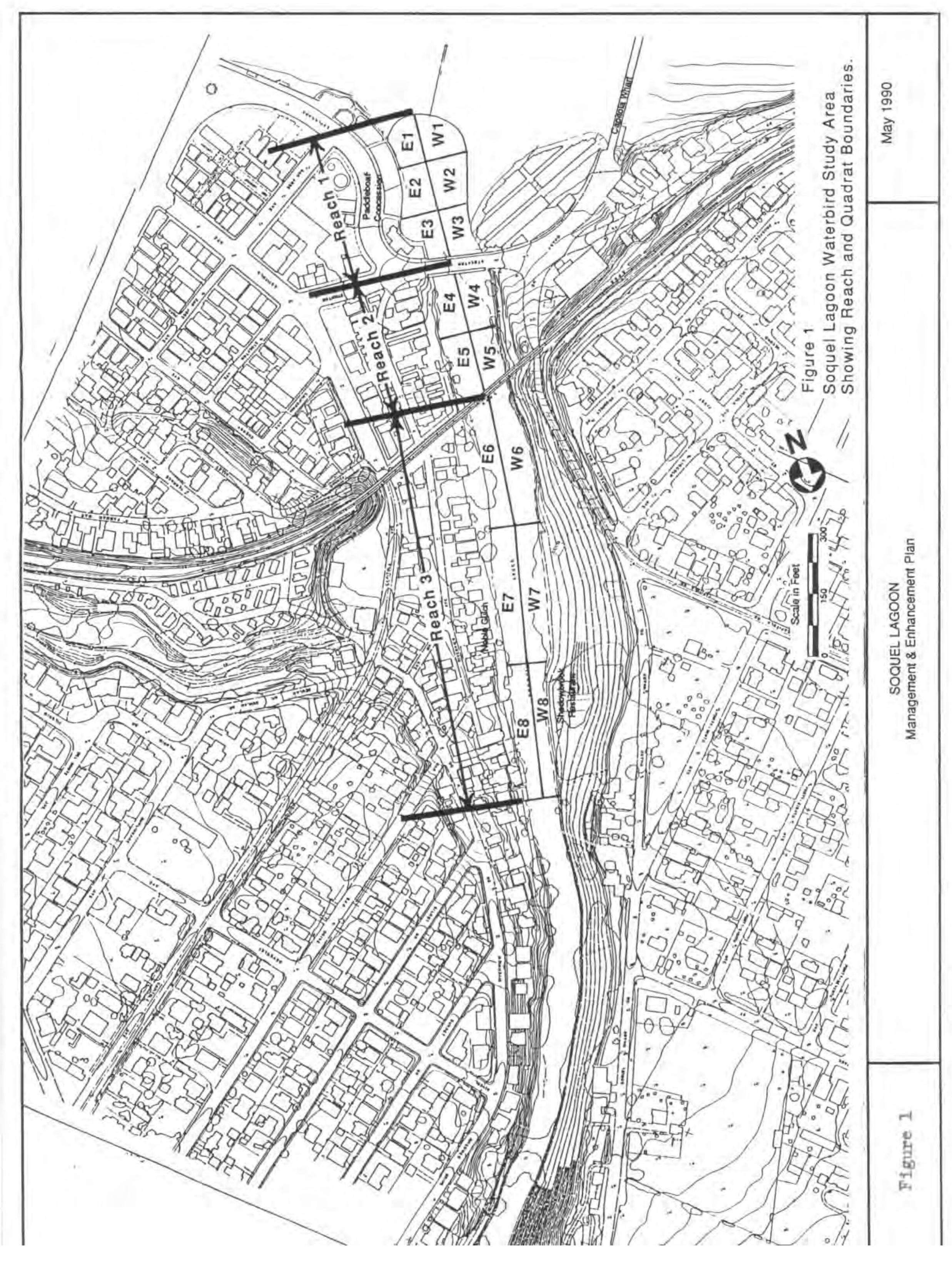


Figure 1
Soquel Lagoon Waterbird Study Area
Showing Reach and Quadrat Boundaries.
May 1990
SOQUEL LAGOON
Management & Enhancement Plan
Figure 1
Reach 1
Reach 2
Reach 3
E1
E2
E3
E4
E5
E6
E7
E8
W1
W2
W3
W4
W5
W6
W7
W8
Paddleboat Concession
Capitola Wharf
Noble Gulch
Scale in Feet
0
150
300
N

Figure 2. Soquel Lagoon Gage Height at Stockton Avenue Bridge, From 25 May to 8 Dcember 2007-2010.

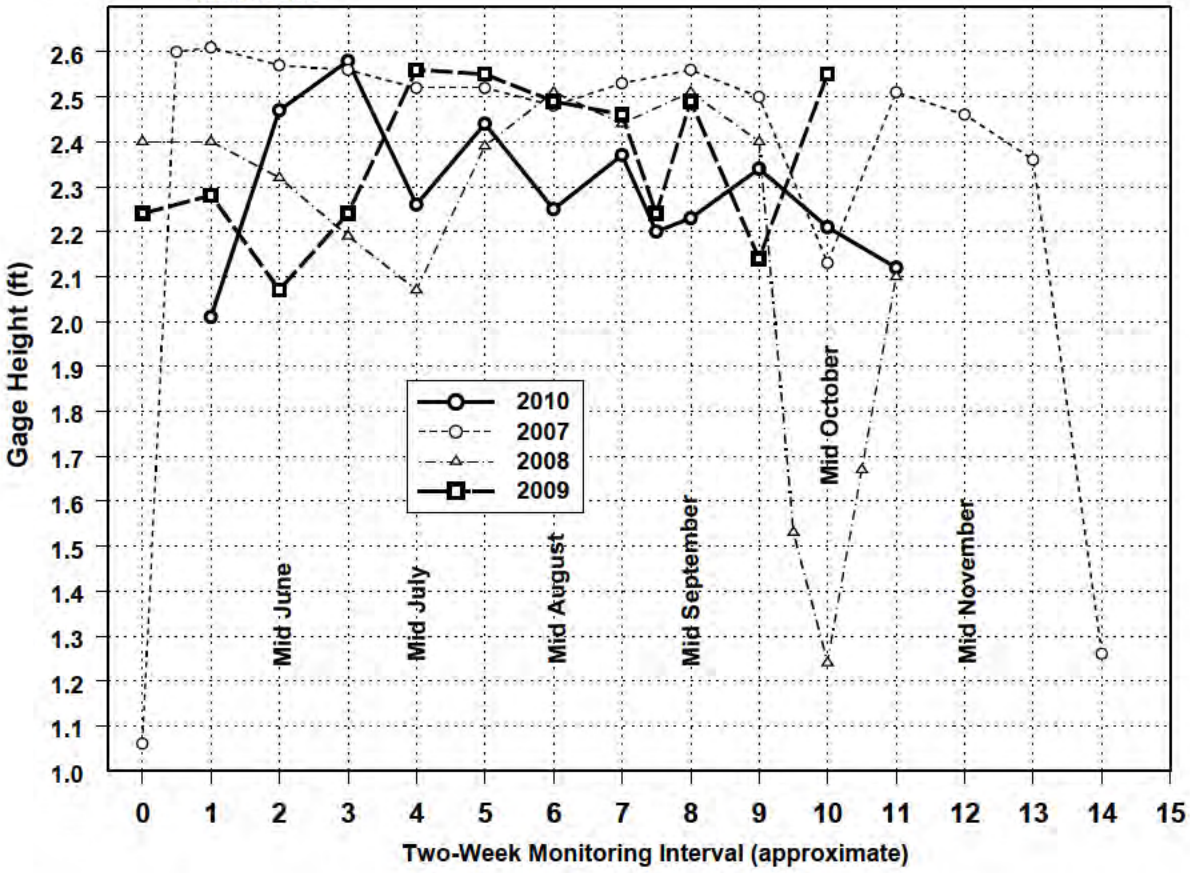


Figure 3a. 2009 and 2010 Soquel Lagoon Water Temperature at the Flume (Station 1) Near the Bottom at Dawn and in the Afternoon after 1500 hr from 7 June to 23 October.

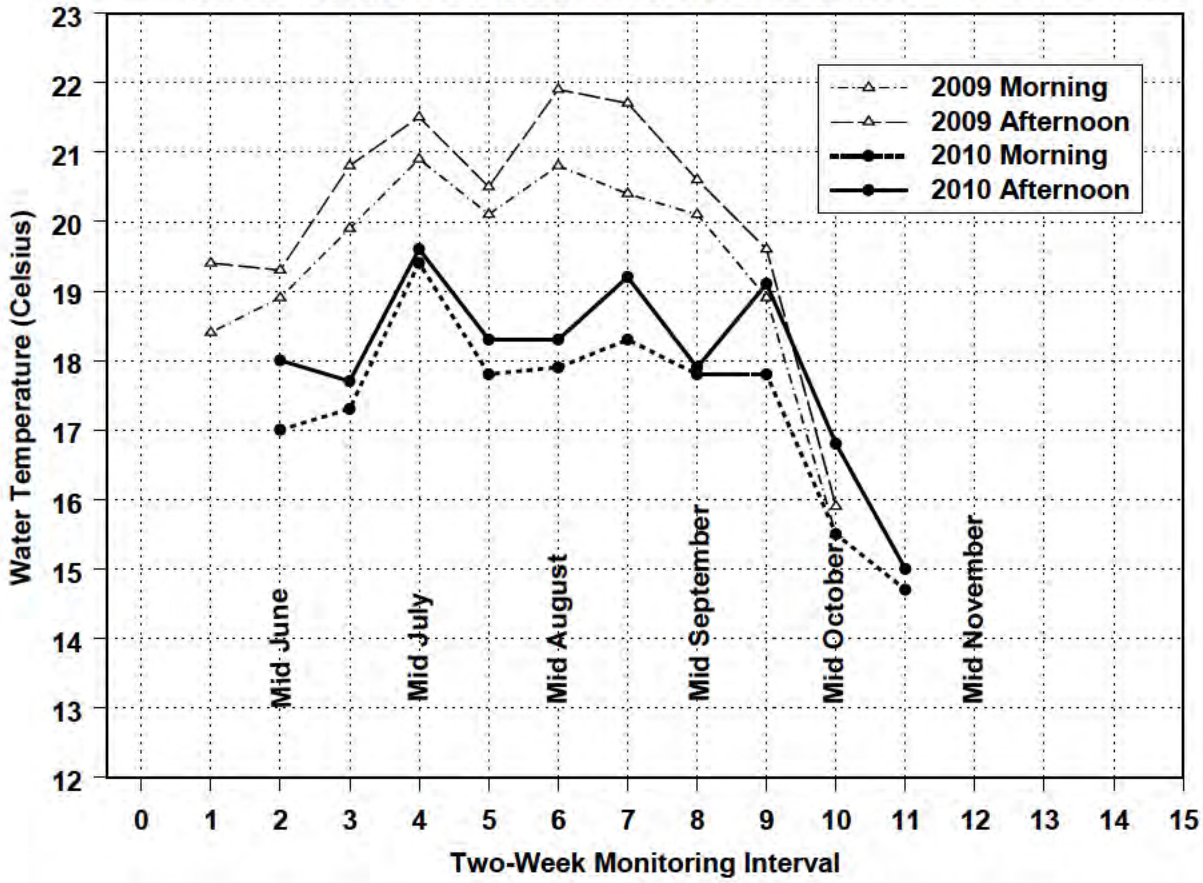


Figure 3b. 2009 and 2010 Soquel Lagoon Water Temperature at Sotckton Avenue Bridge Near the Bottom at Dawn and in the Afternoon after 1500 hr from 7 June to 23 October.

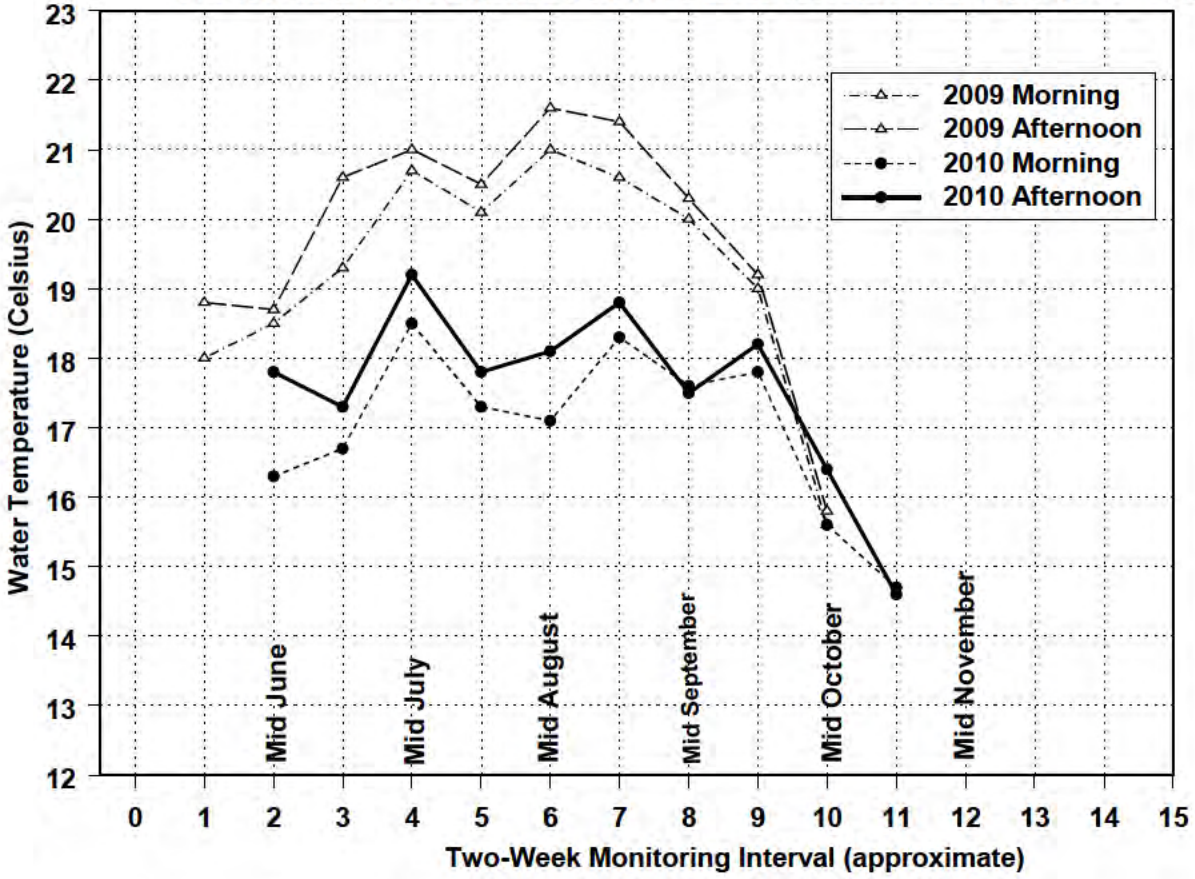


Figure 3c. 2009 and 2010 Soquel Lagoon Water Temperature at the Railroad Trestle (Station 3) Near the Bottom at Dawn and in the Afternoon after 1500 hr from 7 June to 23 October.

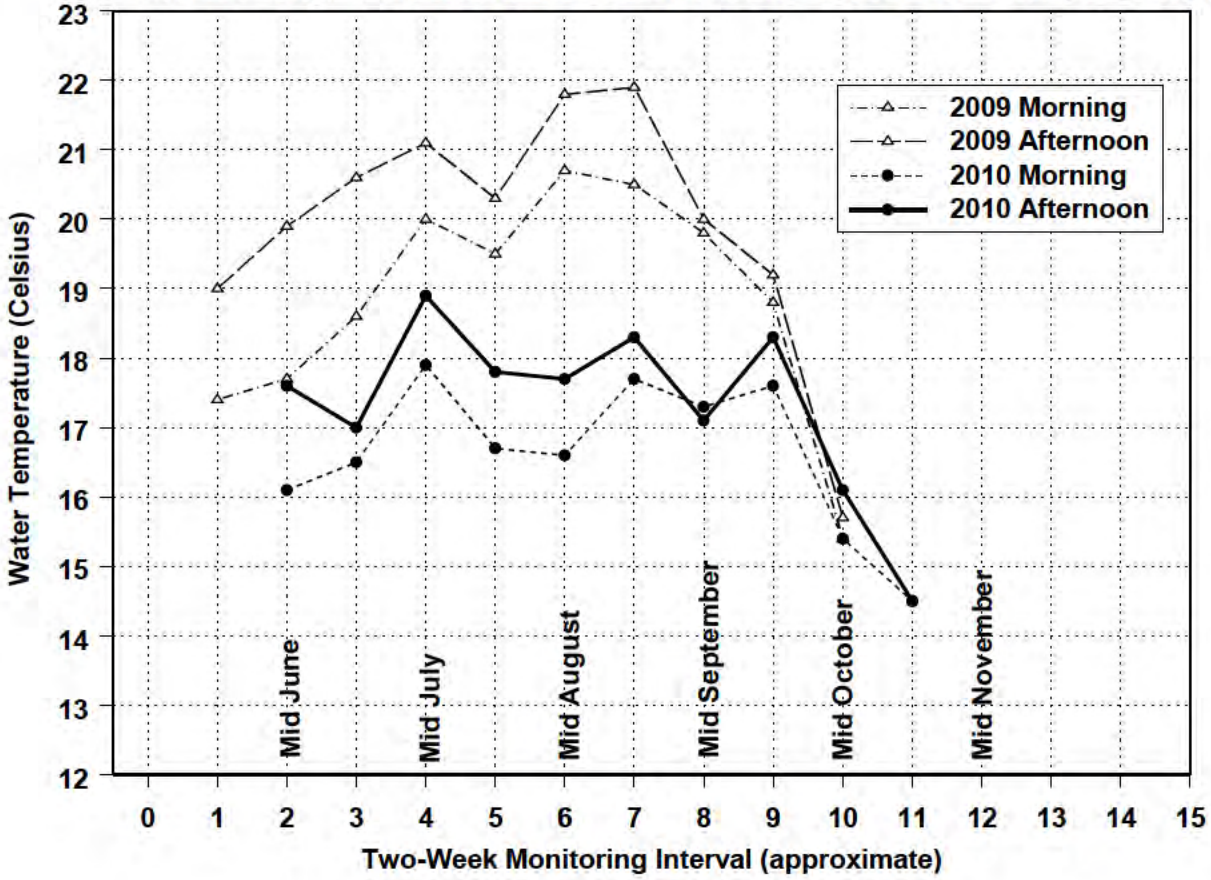


Figure 3d. 2009 and 2010 Soquel Lagoon Water Temperature at Noble Gulch Near the Bottom at Dawn (Station 4) and in the Afternoon after 1500 hr from 7 June to 23 October.

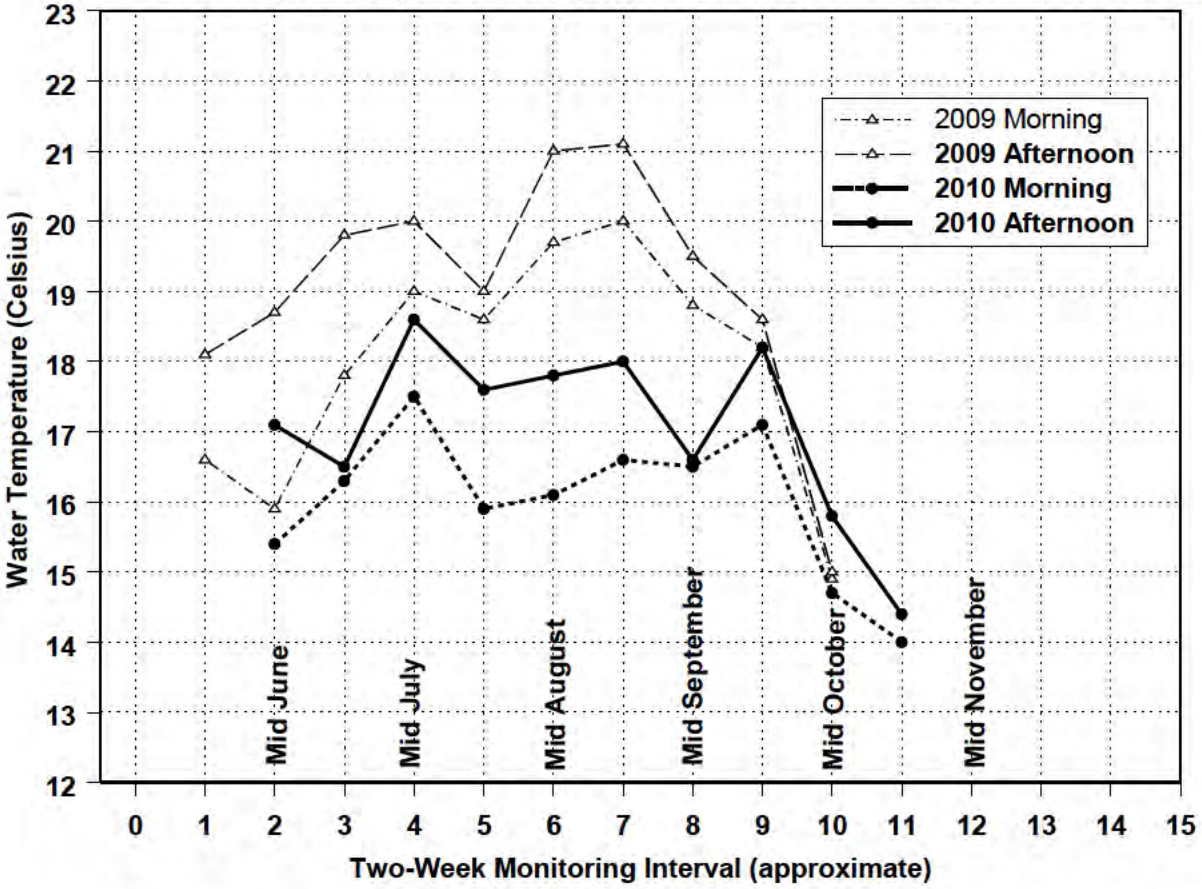


Figure 3e. Soquel Creek Water Temperature at Nob Hill Above the Lagoon in 2007 - 2010. Measured Between 0800 hr and 0930 hr from 7 June to 8 December.

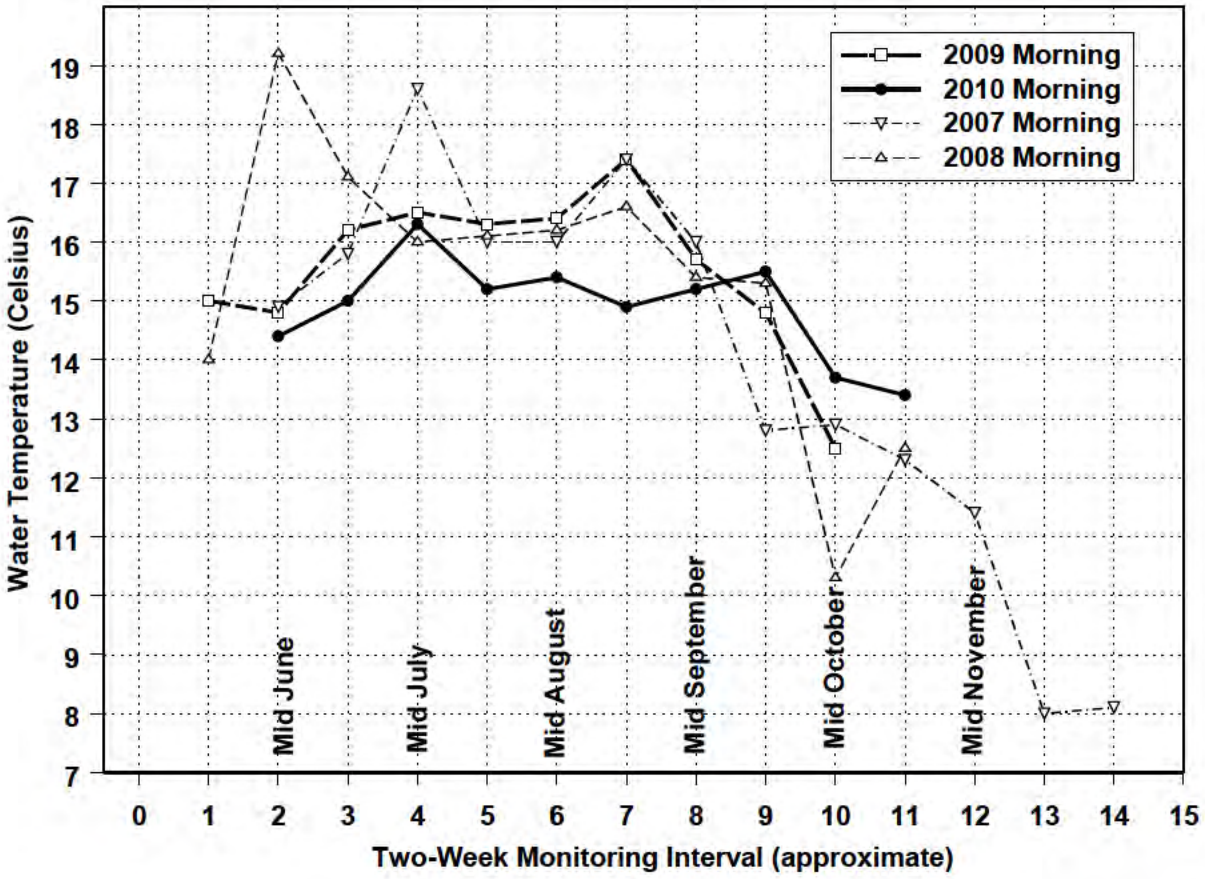


Figure 3f. Water Temperature at Dawn at Four Lagoon Stations Near the Bottom and Upstream in Soquel Creek from 19 June to 23 October 2010.

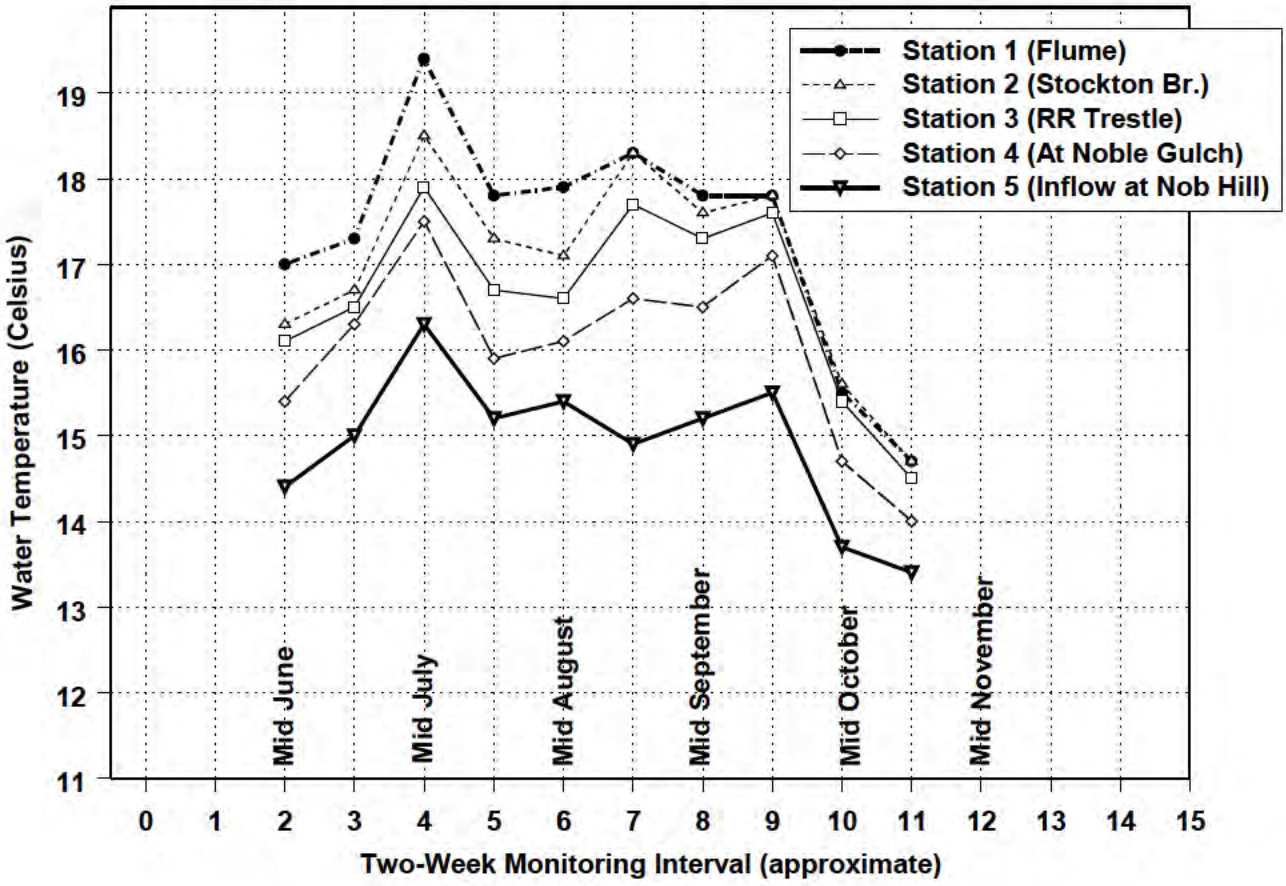


Figure 3g. Water Temperature in the Afternoon at Four Lagoon Stations Near the Bottom and Upstream in Soquel Creek from 19 June to 23 October 2010.

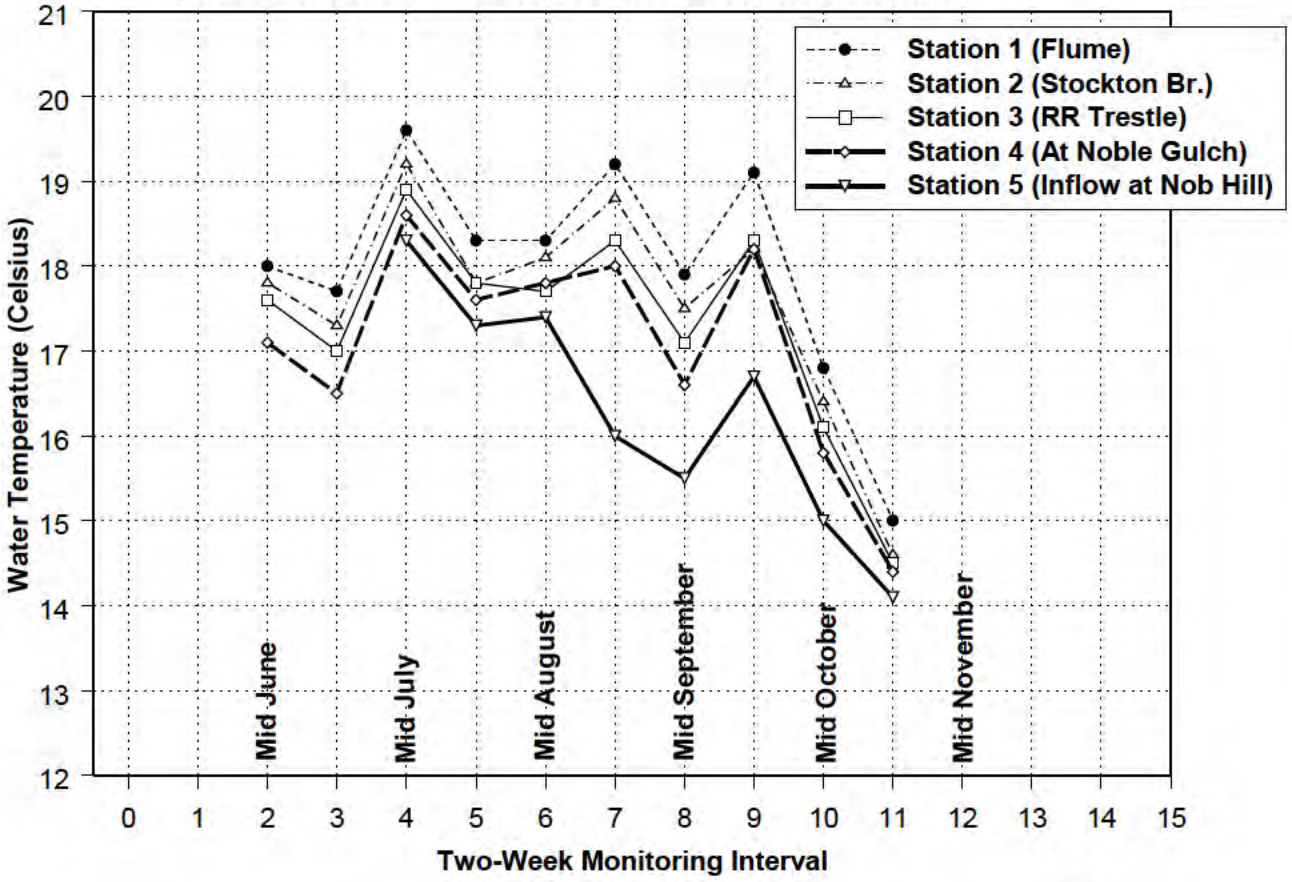


Figure 3h. Water Temperature in the Afternoon at 4 Lagoon Stations Near the Bottom Between 1430 hr and 1630 hr from 7 June to 10 October 2009.

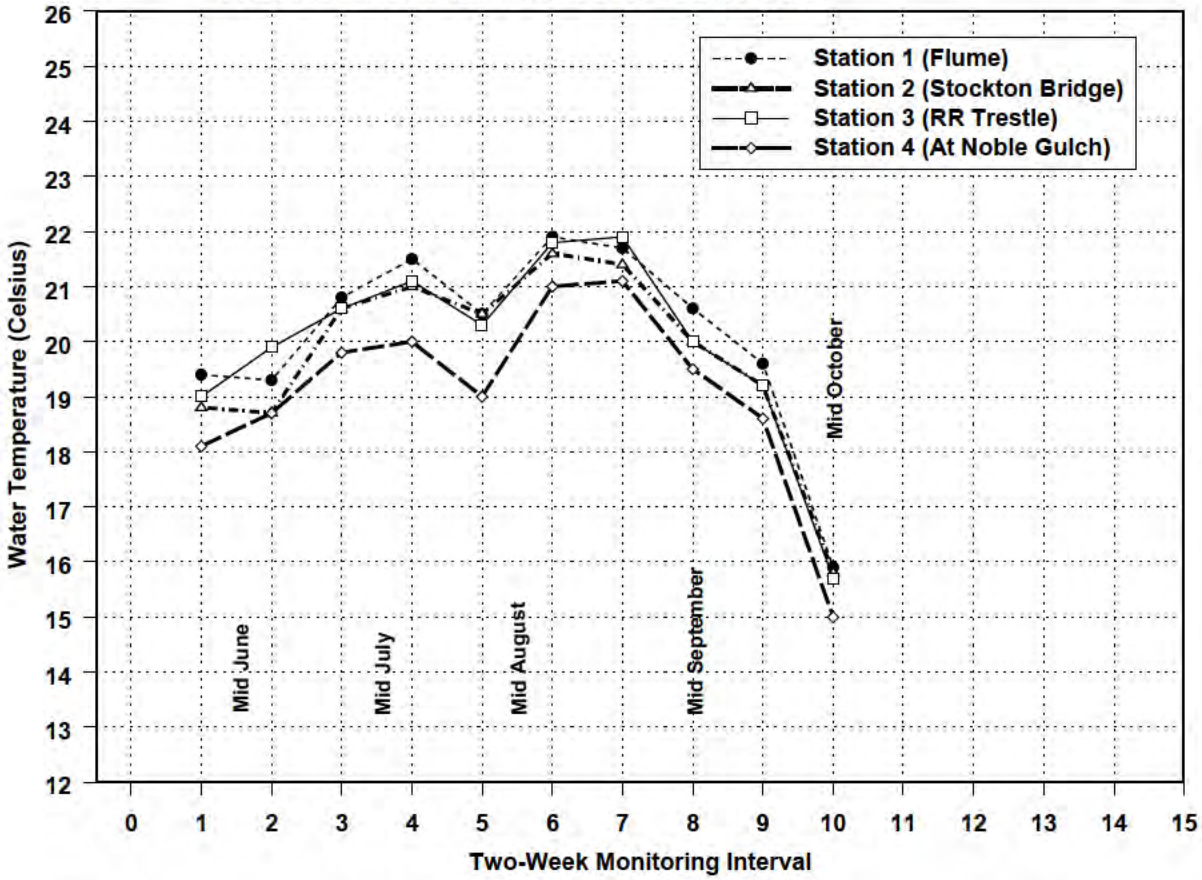


Figure 3i. Water Temperature in the Afternoon at 4 Lagoon Stations Near the Bottom Between 1430 hr and 1630 hr from 7 June to 26 October 2008.

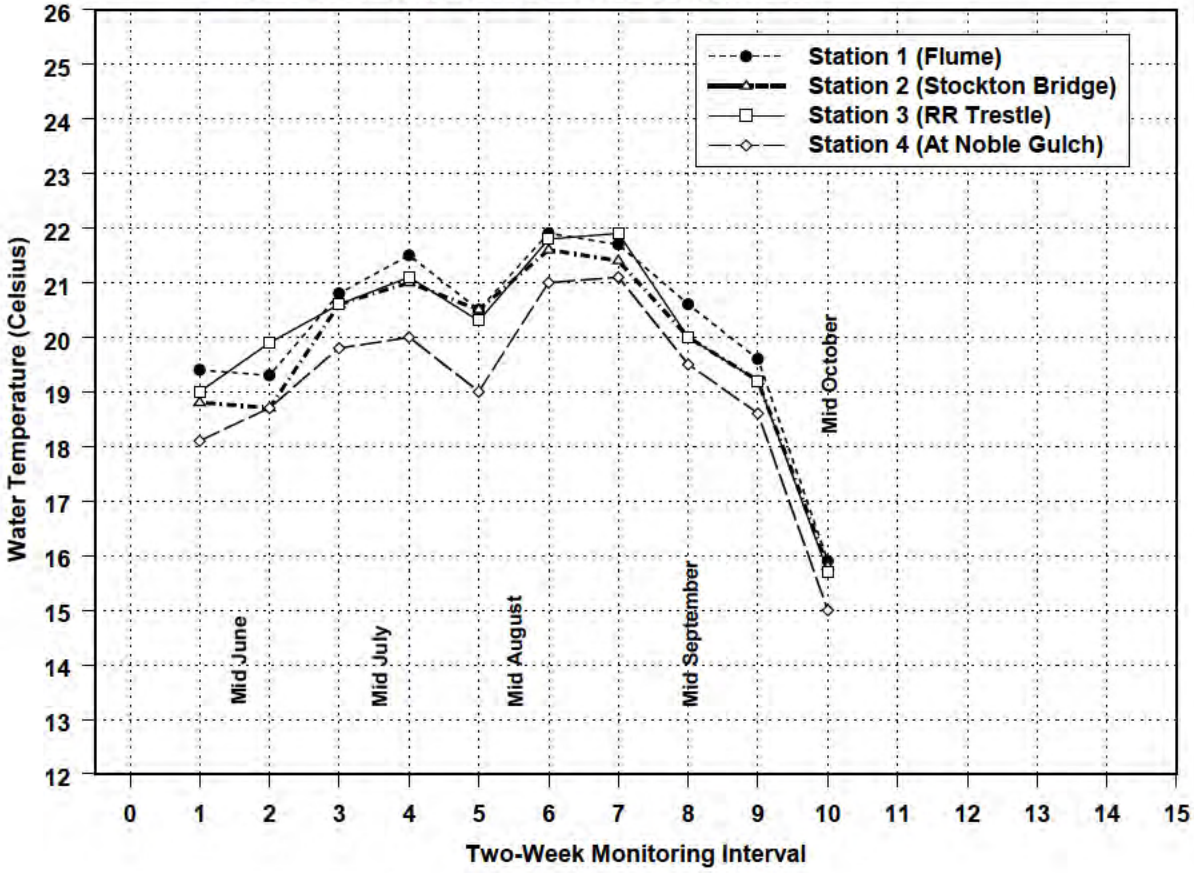


Figure 3j. Water Temperature in the Afternoon at 4 Lagoon Stations Near the Bottom Between 1500 and 1630 hr from 10 June to 8 December 2007.

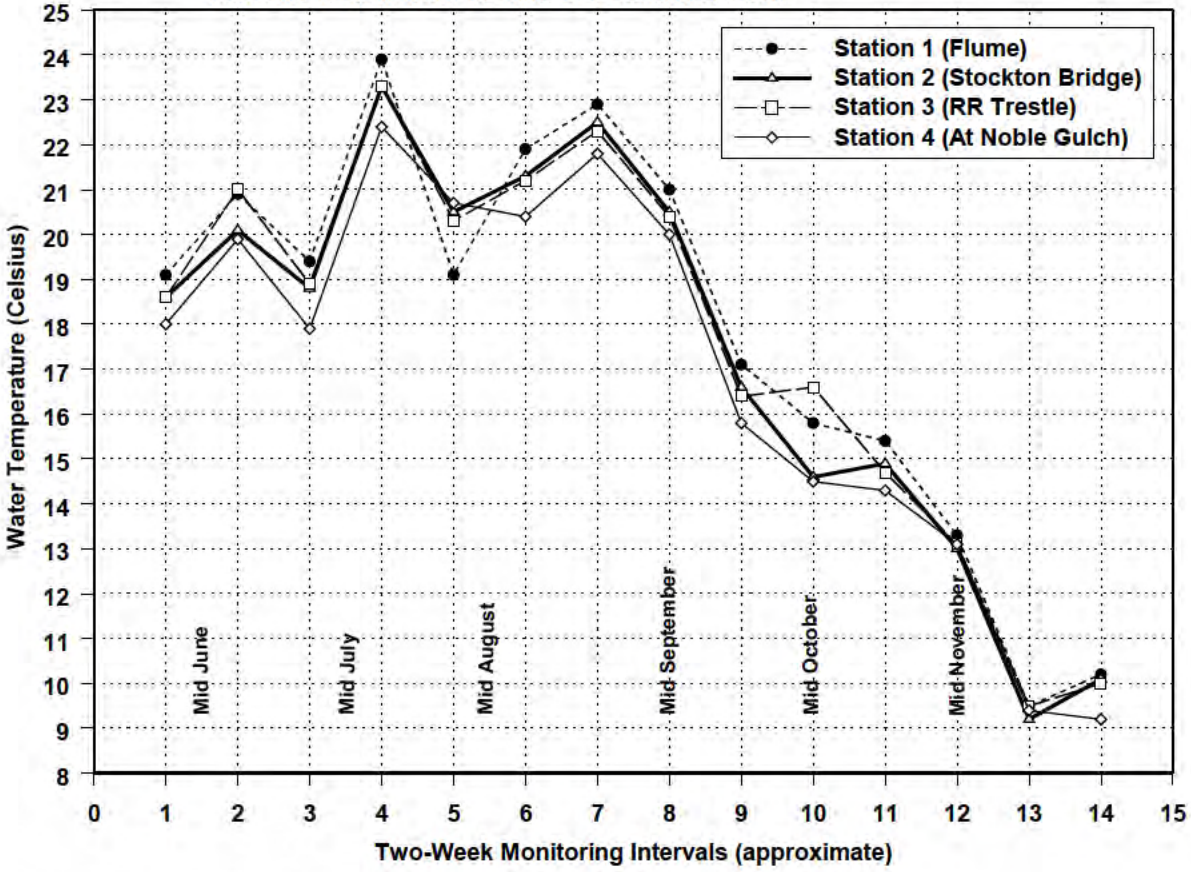


Figure 3k. Water Column Temperature at Stockton Bridge (Station 2) , 19 June 2010 at 0710 hr.

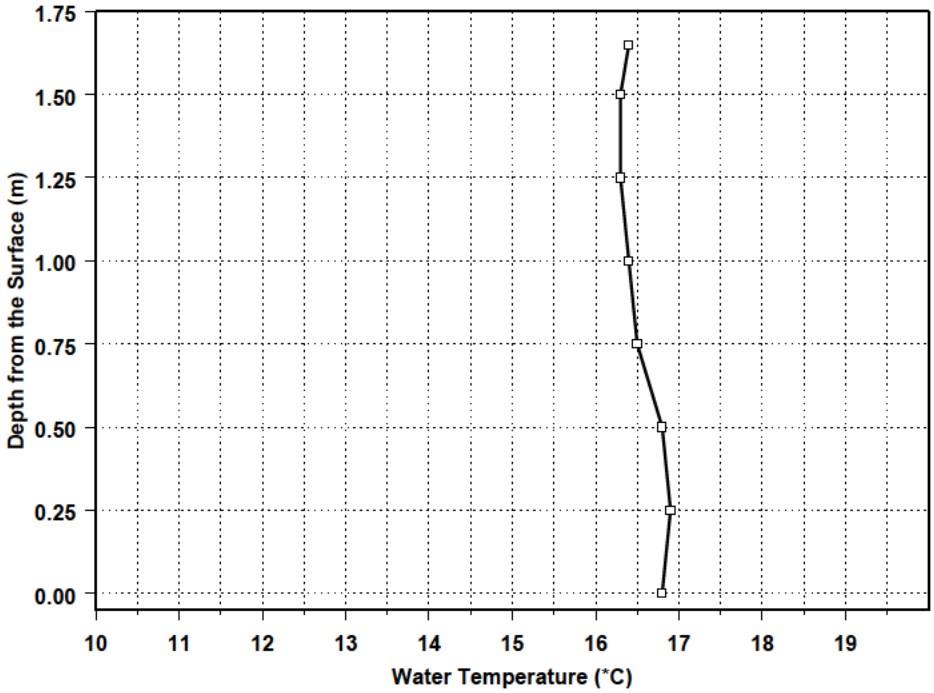


Figure 3l. Water Column Temperature at Stockton Bridge (Station 2), 19 June 2010 at 1530 hr.

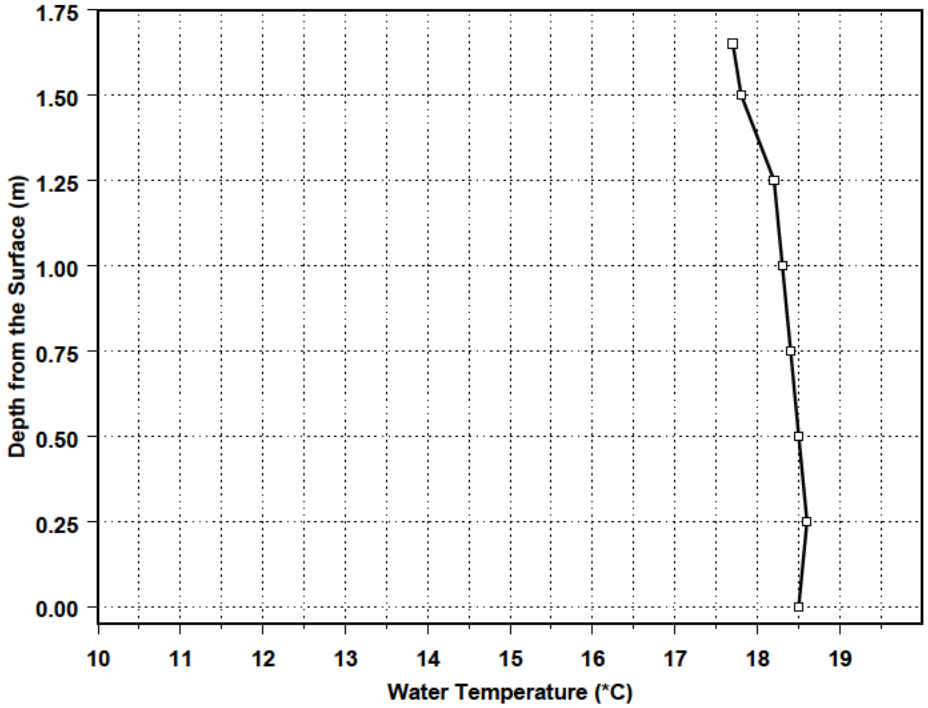


Figure 3m. Water Column Temperature at Stockton Bridge (Station 2), 19 July 2010 at 0724 hr.

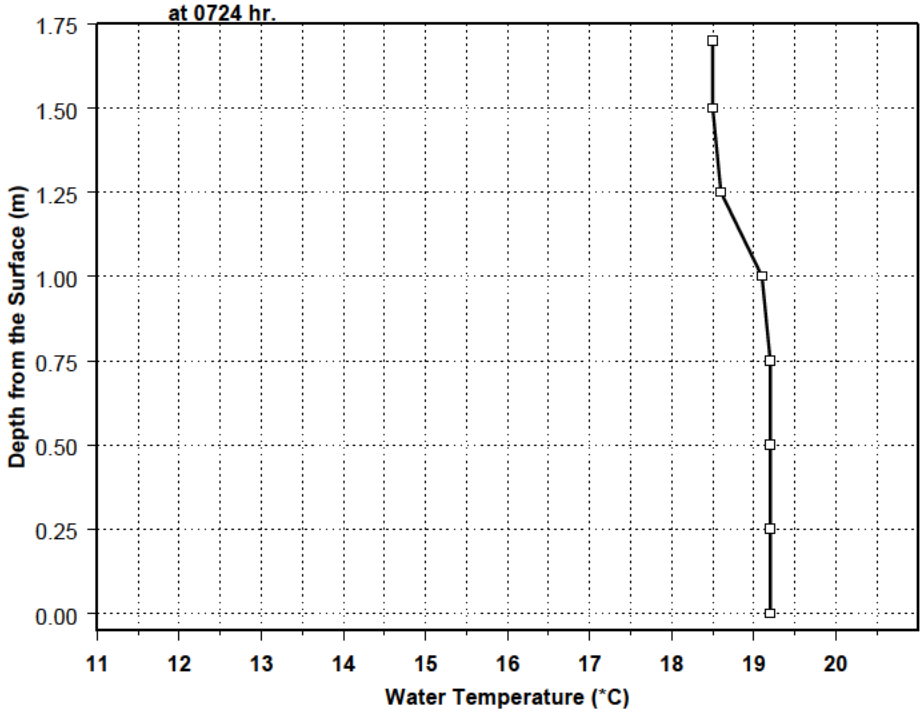
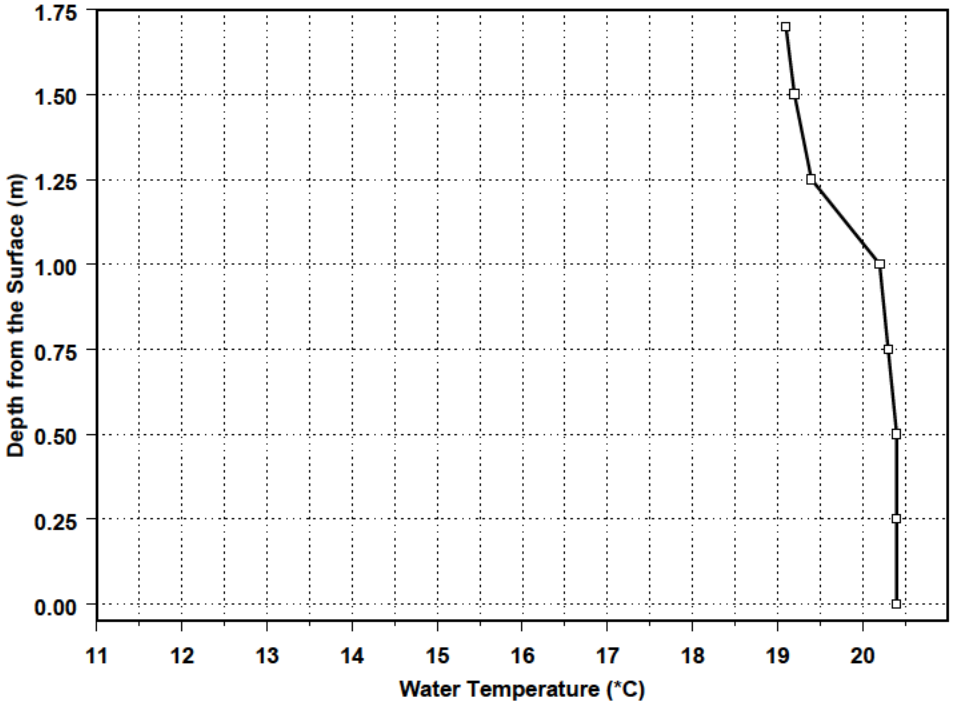


Figure 3n. Water Column Temperature at Stockton Bridge (Station 2), 19 July 2010 at 1602 hr.



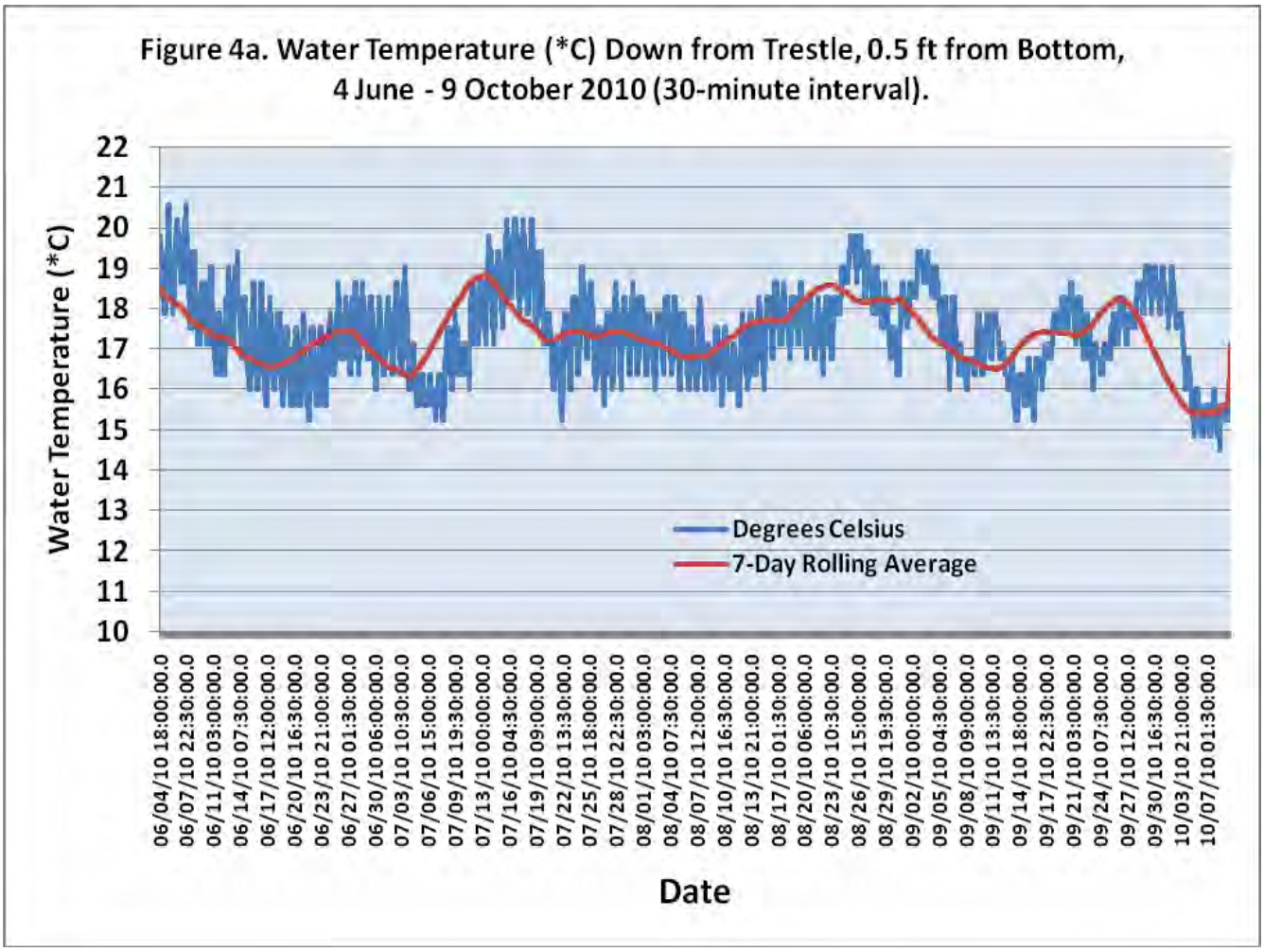


Figure 4a. Water Temperature (*C) Down from Trestle, 0.5 ft from Bottom,
4 June - 9 October 2010 (30-minute interval).
Water Temperature (*C)
22
21
20
19
18
17
16
15
14
13
12
11
10
Degrees Celsius
7-Day Rolling Average
06/04/10 18:00:00.0
06/07/10 22:30:00.0
06/11/10 03:00:00.0
06/14/10 07:30:00.0
06/17/10 12:00:00.0
06/20/10 16:30:00.0
06/23/10 21:00:00.0
06/27/10 01:30:00.0
06/30/10 06:00:00.0
07/03/10 10:30:00.0
07/06/10 15:00:00.0
07/09/10 19:30:00.0
07/13/10 00:00:00.0
07/16/10 04:30:00.0
07/19/10 09:00:00.0
07/22/10 13:30:00.0
07/25/10 18:00:00.0
07/28/10 22:30:00.0
08/01/10 03:00:00.0
08/04/10 07:30:00.0
08/07/10 12:00:00.0
08/10/10 16:30:00.0
08/13/10 21:00:00.0
08/17/10 01:30:00.0
08/20/10 06:00:00.0
08/23/10 10:30:00.0
08/26/10 15:00:00.0
08/29/10 19:30:00.0
09/02/10 00:00:00.0
09/05/10 04:30:00.0
09/08/10 09:00:00.0
09/11/10 13:30:00.0
09/14/10 18:00:00.0
09/17/10 22:30:00.0
09/21/10 03:00:00.0
09/24/10 07:30:00.0
09/27/10 12:00:00.0
09/30/10 16:30:00.0
10/03/10 21:00:00.0
10/07/10 01:30:00.0
Date

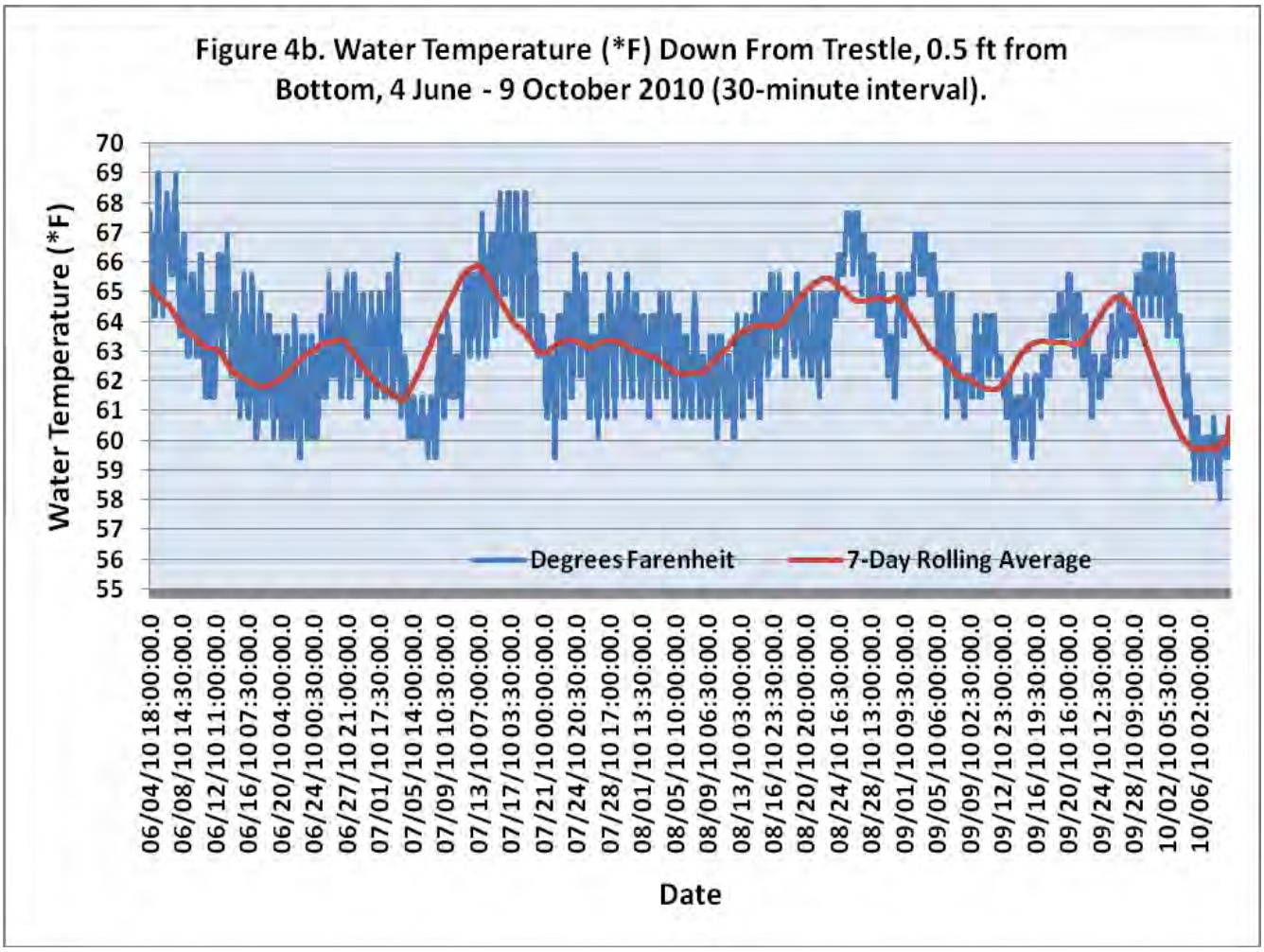


Figure 4b. Water Temperature (*F) Down From Trestle, 0.5 ft from Bottom, 4 June - 9 October 2010 (30-minute interval).
Water Temperature (*F)
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
Degrees Farenheit
7-Day Rolling Average
06/04/10 18:00:00.0
06/08/10 14:30:00.0
06/12/10 11:00:00.0
06/16/10 07:30:00.0
06/20/10 04:00:00.0
06/24/10 00:30:00.0
06/27/10 21:00:00.0
07/01/10 17:30:00.0
07/05/10 14:00:00.0
07/09/10 10:30:00.0
07/13/10 07:00:00.0
07/17/10 03:30:00.0
07/21/10 00:00:00.0
07/24/10 20:30:00.0
07/28/10 17:00:00.0
08/01/10 13:30:00.0
08/05/10 10:00:00.0
08/09/10 06:30:00.0
08/13/10 03:00:00.0
08/16/10 23:30:00.0
08/20/10 20:00:00.0
08/24/10 16:30:00.0
08/28/10 13:00:00.0
09/01/10 09:30:00.0
09/05/10 06:00:00.0
09/09/10 02:30:00.0
09/12/10 23:00:00.0
09/16/10 19:30:00.0
09/20/10 16:00:00.0
09/24/10 12:30:00.0
09/28/10 09:00:00.0
10/02/10 05:30:00.0
10/06/10 02:00:00.0
Date

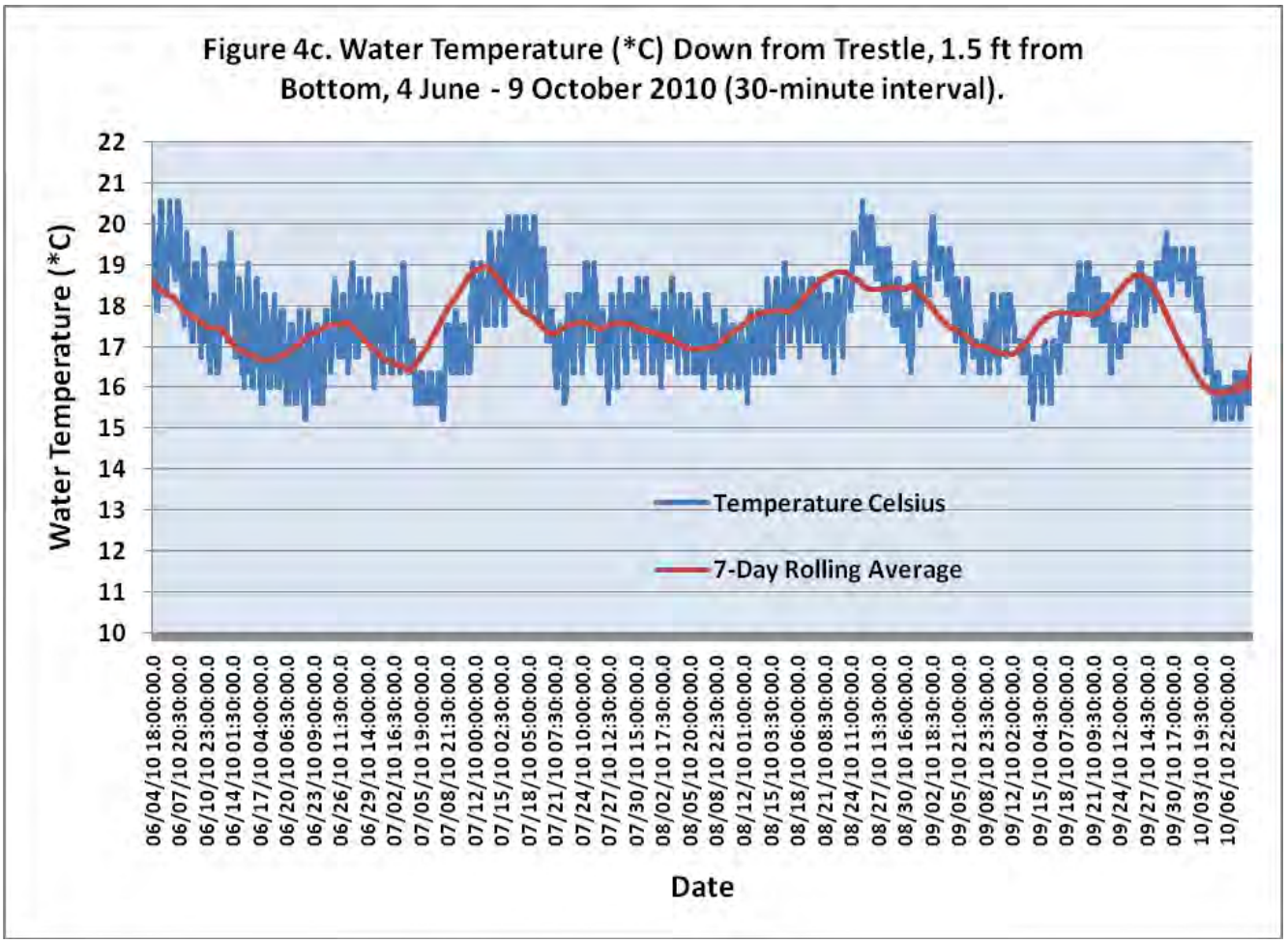


Figure 4c. Water Temperature (*C) Down from Trestle, 1.5 ft from Bottom, 4 June - 9 October 2010 (30-minute interval).
Water Temperature (*C)
22
21
20
19
18
17
16
15
14
13
12
11
10
Temperature Celsius
7-Day Rolling Average
06/04/10 18:00:00.0
06/07/10 20:30:00.0
06/10/10 23:00:00.0
06/14/10 01:30:00.0
06/17/10 04:00:00.0
06/20/10 06:30:00.0
06/23/10 09:00:00.0
06/26/10 11:30:00.0
06/29/10 14:00:00.0
07/02/10 16:30:00.0
07/05/10 19:00:00.0
07/08/10 21:30:00.0
07/12/10 00:00:00.0
07/15/10 02:30:00.0
07/18/10 05:00:00.0
07/21/10 07:30:00.0
07/24/10 10:00:00.0
07/27/10 12:30:00.0
07/30/10 15:00:00.0
08/02/10 17:30:00.0
08/05/10 20:00:00.0
08/08/10 22:30:00.0
08/12/10 01:00:00.0
08/15/10 03:30:00.0
08/18/10 06:00:00.0
08/21/10 08:30:00.0
08/24/10 11:00:00.0
08/27/10 13:30:00.0
08/30/10 16:00:00.0
09/02/10 18:30:00.0
09/05/10 21:00:00.0
09/08/10 23:30:00.0
09/12/10 02:00:00.0
09/15/10 04:30:00.0
09/18/10 07:00:00.0
09/21/10 09:30:00.0
09/24/10 12:00:00.0
09/27/10 14:30:00.0
09/30/10 17:00:00.0
10/03/10 19:30:00.0
10/06/10 22:00:00.0
Date

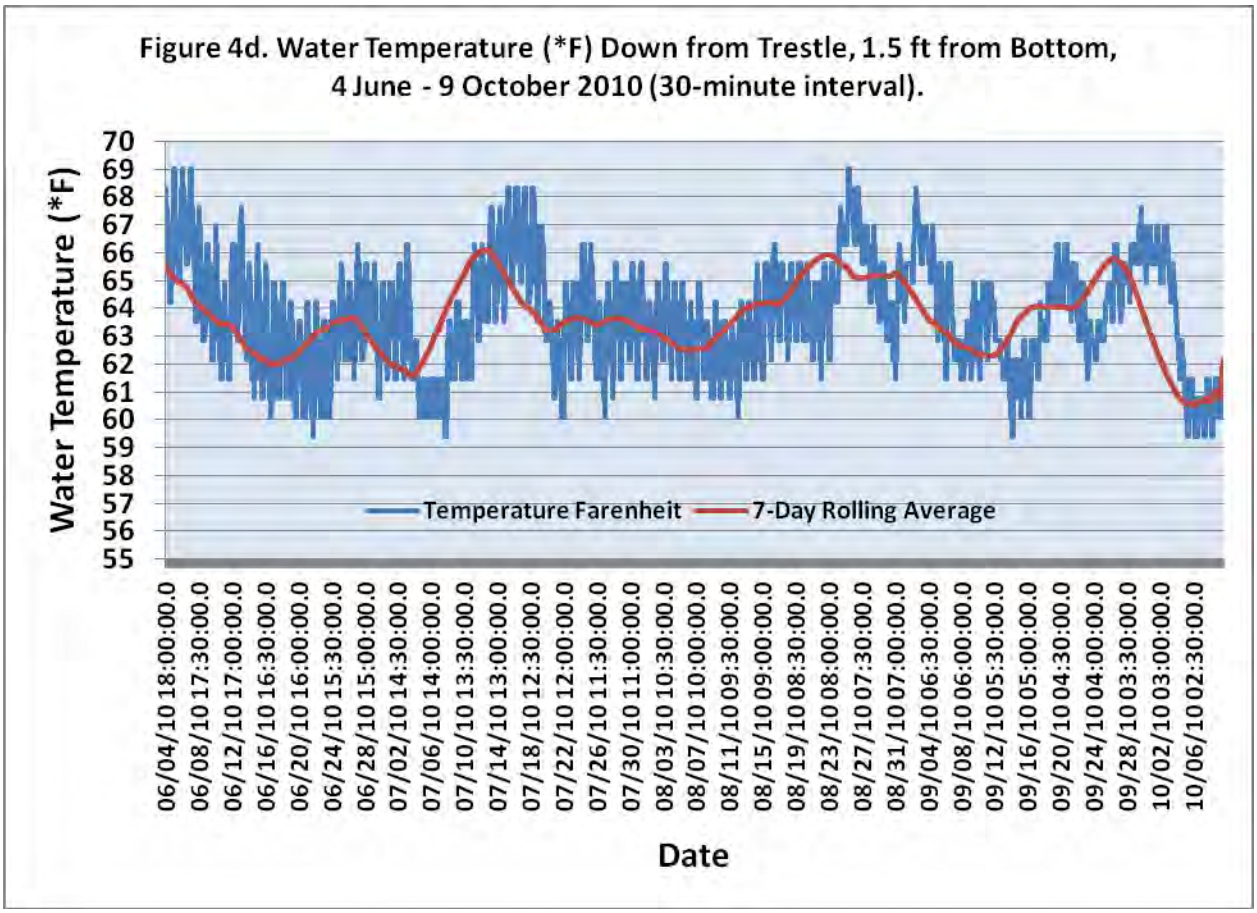


Figure 4d. Water Temperature (*F) Down from Trestle, 1.5 ft from Bottom,
4 June - 9 October 2010 (30-minute interval).
Water Temperature (*F)
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
Temperature Farenheit
7-Day Rolling Average
06/04/10 18:00:00.0
06/08/10 17:30:00.0
06/12/10 17:00:00.0
06/16/10 16:30:00.0
06/20/10 16:00:00.0
06/24/10 15:30:00.0
06/28/10 15:00:00.0
07/02/10 14:30:00.0
07/06/10 14:00:00.0
07/10/10 13:30:00.0
07/14/10 13:00:00.0
07/18/10 12:30:00.0
07/22/10 12:00:00.0
07/26/10 11:30:00.0
07/30/10 11:00:00.0
08/03/10 10:30:00.0
08/07/10 10:00:00.0
08/11/10 09:30:00.0
08/15/10 09:00:00.0
08/19/10 08:30:00.0
08/23/10 08:00:00.0
08/27/10 07:30:00.0
08/31/10 07:00:00.0
09/04/10 06:30:00.0
09/08/10 06:00:00.0
09/12/10 05:30:00.0
09/16/10 05:00:00.0
09/20/10 04:30:00.0
09/24/10 04:00:00.0
09/28/10 03:30:00.0
10/02/10 03:00:00.0
10/06/10 02:30:00.0
Date

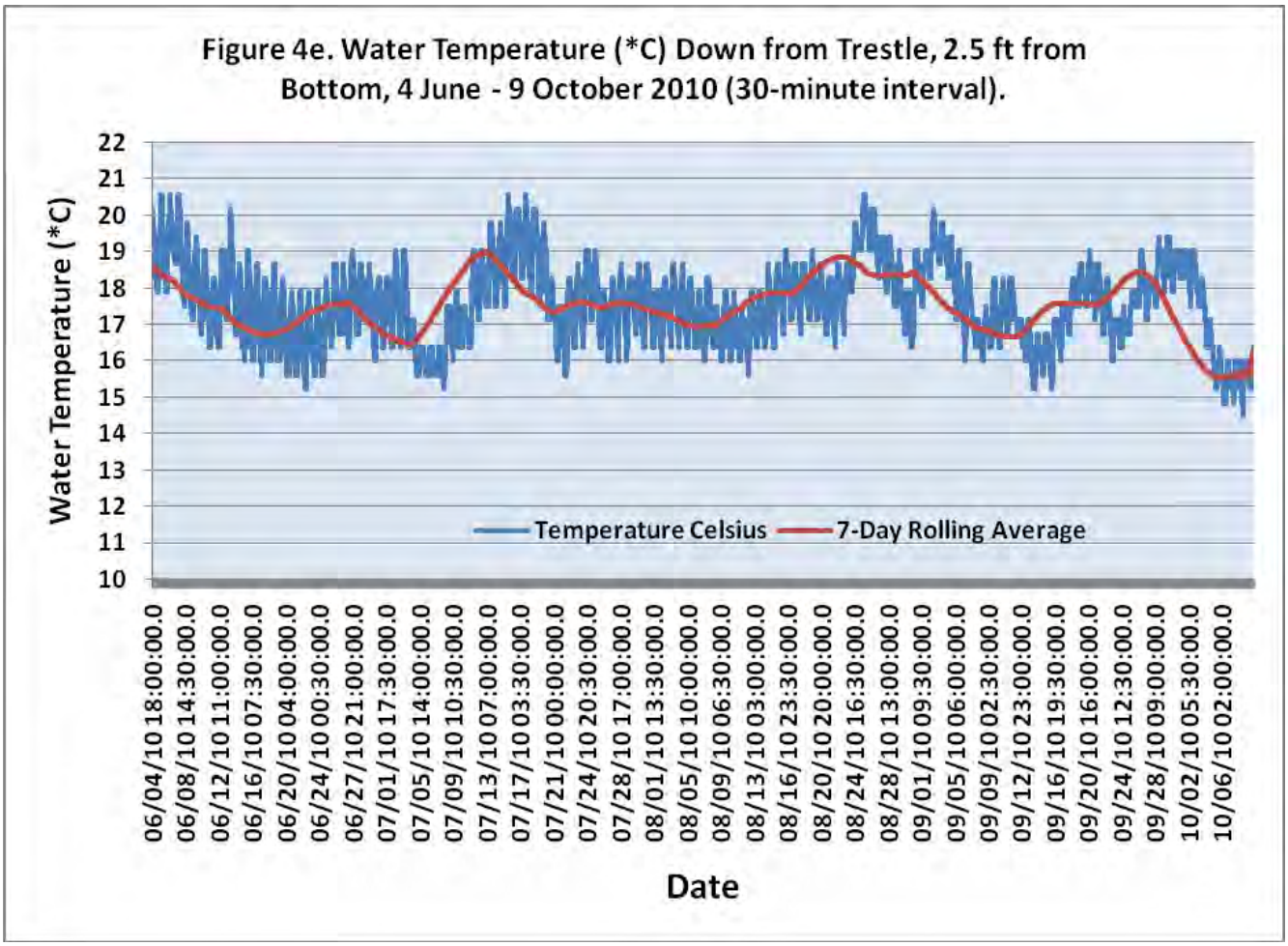


Figure 4e. Water Temperature (*C) Down from Trestle, 2.5 ft from Bottom, 4 June - 9 October 2010 (30-minute interval).
Water Temperature (*C)
22
21
20
19
18
17
16
15
14
13
12
11
10
Temperature Celsius
7-Day Rolling Average
06/04/10 18:00:00.0
06/08/10 14:30:00.0
06/12/10 11:00:00.0
06/16/10 07:30:00.0
06/20/10 04:00:00.0
06/24/10 00:30:00.0
06/27/10 21:00:00.0
07/01/10 17:30:00.0
07/05/10 14:00:00.0
07/09/10 10:30:00.0
07/13/10 07:00:00.0
07/17/10 03:30:00.0
07/21/10 00:00:00.0
07/24/10 20:30:00.0
07/28/10 17:00:00.0
08/01/10 13:30:00.0
08/05/10 10:00:00.0
08/09/10 06:30:00.0
08/13/10 03:00:00.0
08/16/10 23:30:00.0
08/20/10 20:00:00.0
08/24/10 16:30:00.0
08/28/10 13:00:00.0
09/01/10 09:30:00.0
09/05/10 06:00:00.0
09/09/10 02:30:00.0
09/12/10 23:00:00.0
09/16/10 19:30:00.0
09/20/10 16:00:00.0
09/24/10 12:30:00.0
09/28/10 09:00:00.0
10/02/10 05:30:00.0
10/06/10 02:00:00.0
Date

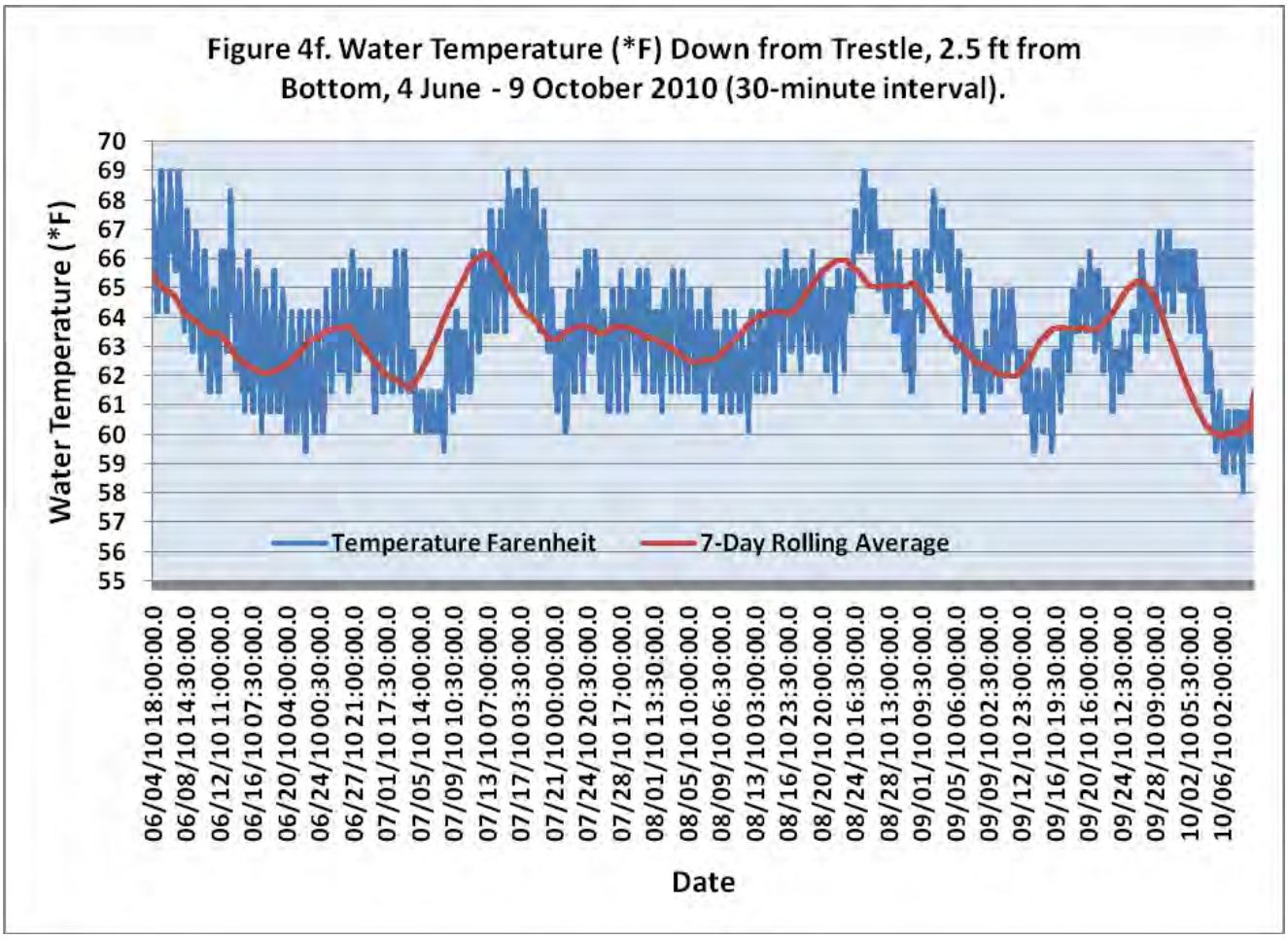


Figure 4f. Water Temperature (*F) Down from Trestle, 2.5 ft from Bottom, 4 June - 9 October 2010 (30-minute interval).
Water Temperature (*F)
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
Temperature Farenheit
7-Day Rolling Average
06/04/10 18:00:00.0
06/08/10 14:30:00.0
06/12/10 11:00:00.0
06/16/10 07:30:00.0
06/20/10 04:00:00.0
06/24/10 00:30:00.0
06/27/10 21:00:00.0
07/01/10 17:30:00.0
07/05/10 14:00:00.0
07/09/10 10:30:00.0
07/13/10 07:00:00.0
07/17/10 03:30:00.0
07/21/10 00:00:00.0
07/24/10 20:30:00.0
07/28/10 17:00:00.0
08/01/10 13:30:00.0
08/05/10 10:00:00.0
08/09/10 06:30:00.0
08/13/10 03:00:00.0
08/16/10 23:30:00.0
08/20/10 20:00:00.0
08/24/10 16:30:00.0
08/28/10 13:00:00.0
09/01/10 09:30:00.0
09/05/10 06:00:00.0
09/09/10 02:30:00.0
09/12/10 23:00:00.0
09/16/10 19:30:00.0
09/20/10 16:00:00.0
09/24/10 12:30:00.0
09/28/10 09:00:00.0
10/02/10 05:30:00.0
10/06/10 02:00:00.0
Date

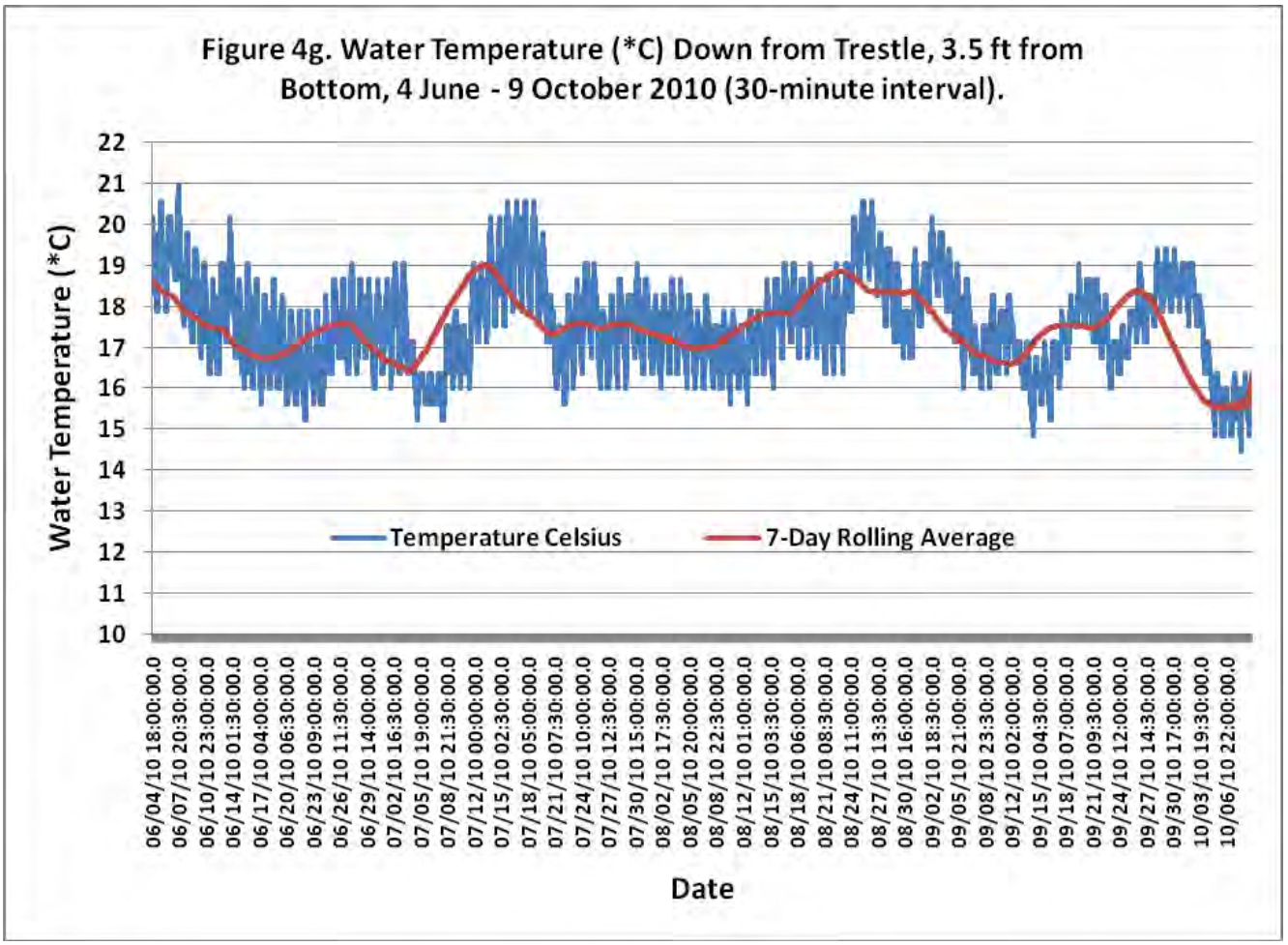


Figure 4g. Water Temperature (*C) Down from Trestle, 3.5 ft from Bottom, 4 June - 9 October 2010 (30-minute interval).
Water Temperature (*C)
22
21
20
19
18
17
16
15
14
13
12
11
10
Temperature Celsius
7-Day Rolling Average
06/04/10 18:00:00.0
06/07/10 20:30:00.0
06/10/10 23:00:00.0
06/14/10 01:30:00.0
06/17/10 04:00:00.0
06/20/10 06:30:00.0
06/23/10 09:00:00.0
06/26/10 11:30:00.0
06/29/10 14:00:00.0
07/02/10 16:30:00.0
07/05/10 19:00:00.0
07/08/10 21:30:00.0
07/12/10 00:00:00.0
07/15/10 02:30:00.0
07/18/10 05:00:00.0
07/21/10 07:30:00.0
07/24/10 10:00:00.0
07/27/10 12:30:00.0
07/30/10 15:00:00.0
08/02/10 17:30:00.0
08/05/10 20:00:00.0
08/08/10 22:30:00.0
08/12/10 01:00:00.0
08/15/10 03:30:00.0
08/18/10 06:00:00.0
08/21/10 08:30:00.0
08/24/10 11:00:00.0
08/27/10 13:30:00.0
08/30/10 16:00:00.0
09/02/10 18:30:00.0
09/05/10 21:00:00.0
09/08/10 23:30:00.0
09/12/10 02:00:00.0
09/15/10 04:30:00.0
09/18/10 07:00:00.0
09/21/10 09:30:00.0
09/24/10 12:00:00.0
09/27/10 14:30:00.0
09/30/10 17:00:00.0
10/03/10 19:30:00.0
10/06/10 22:00:00.0
Date

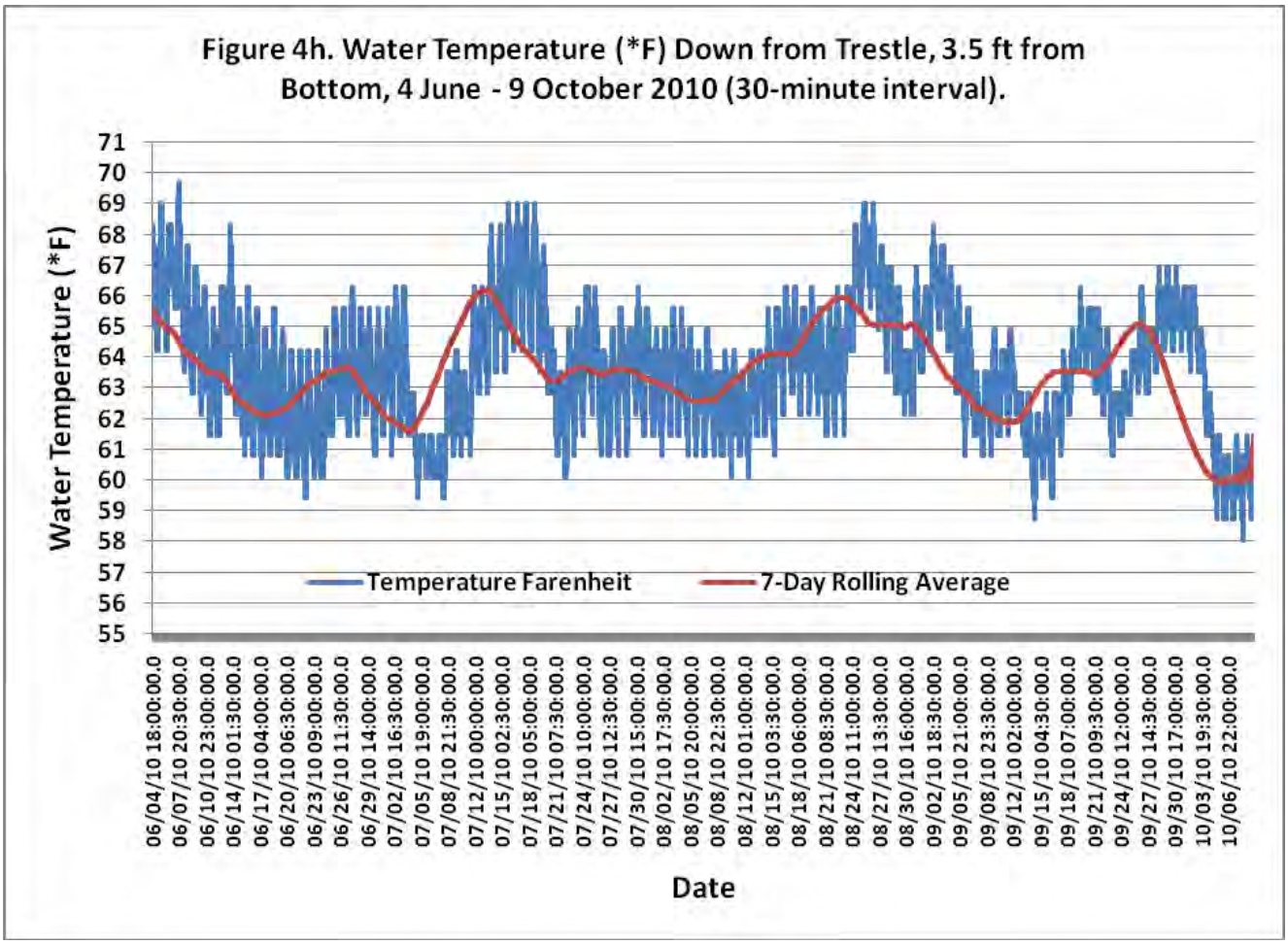


Figure 4h. Water Temperature (*F) Down from Trestle, 3.5 ft from Bottom, 4 June - 9 October 2010 (30-minute interval).
Water Temperature (*F)
71
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
Temperature Farenheit
7-Day Rolling Average
06/04/10 18:00:00.0
06/07/10 20:30:00.0
06/10/10 23:00:00.0
06/14/10 01:30:00.0
06/17/10 04:00:00.0
06/20/10 06:30:00.0
06/23/10 09:00:00.0
06/26/10 11:30:00.0
06/29/10 14:00:00.0
07/02/10 16:30:00.0
07/05/10 19:00:00.0
07/08/10 21:30:00.0
07/12/10 00:00:00.0
07/15/10 02:30:00.0
07/18/10 05:00:00.0
07/21/10 07:30:00.0
07/24/10 10:00:00.0
07/27/10 12:30:00.0
07/30/10 15:00:00.0
08/02/10 17:30:00.0
08/05/10 20:00:00.0
08/08/10 22:30:00.0
08/12/10 01:00:00.0
08/15/10 03:30:00.0
08/18/10 06:00:00.0
08/21/10 08:30:00.0
08/24/10 11:00:00.0
08/27/10 13:30:00.0
08/30/10 16:00:00.0
09/02/10 18:30:00.0
09/05/10 21:00:00.0
09/08/10 23:30:00.0
09/12/10 02:00:00.0
09/15/10 04:30:00.0
09/18/10 07:00:00.0
09/21/10 09:30:00.0
09/24/10 12:00:00.0
09/27/10 14:30:00.0
09/30/10 17:00:00.0
10/03/10 19:30:00.0
10/06/10 22:00:00.0
Date

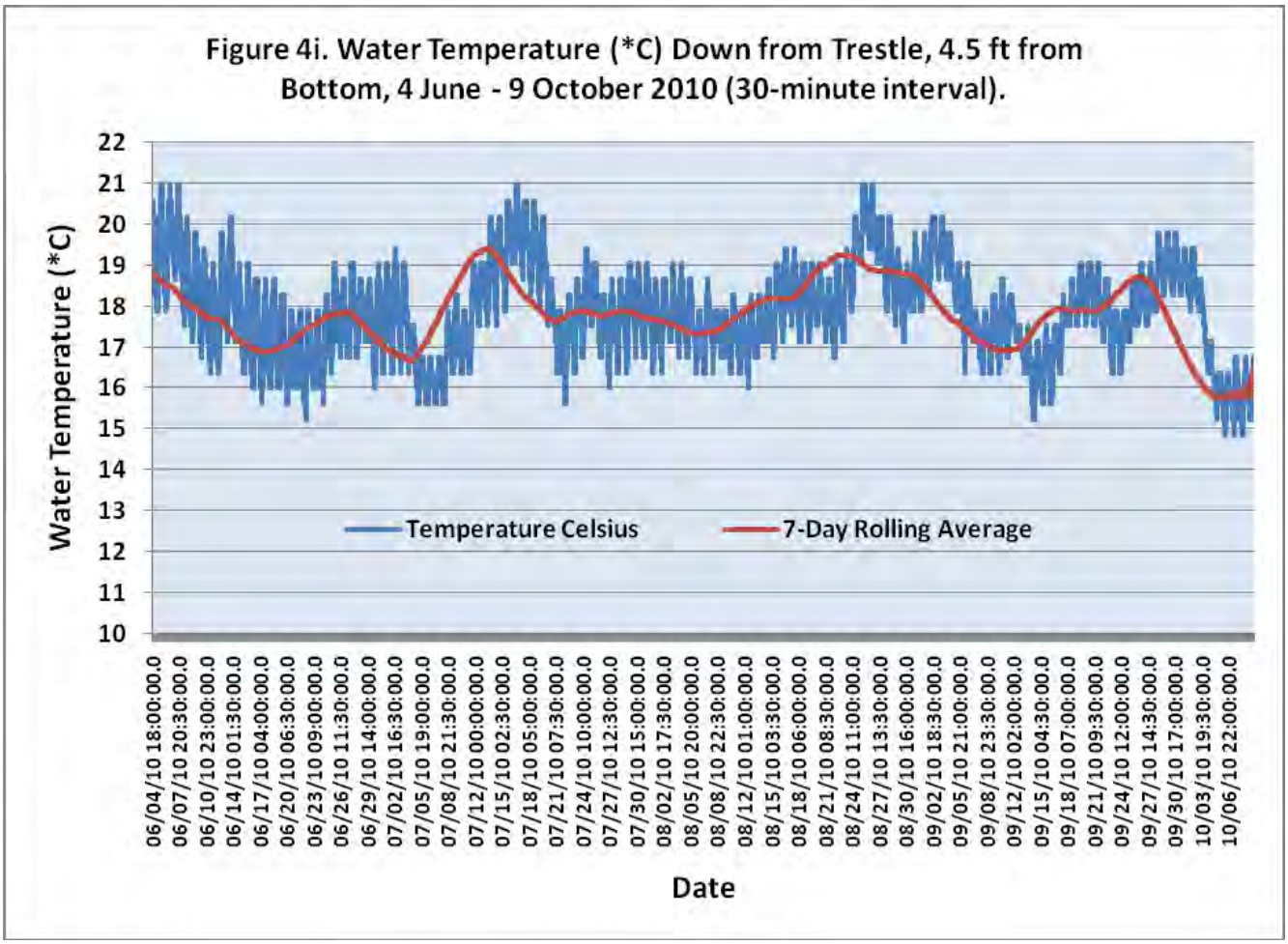


Figure 4i. Water Temperature (*C) Down from Trestle, 4.5 ft from Bottom, 4 June - 9 October 2010 (30-minute interval).
Water Temperature (*C)
22
21
20
19
18
17
16
15
14
13
12
11
10
Temperature Celsius
7-Day Rolling Average
06/04/10 18:00:00.0
06/07/10 20:30:00.0
06/10/10 23:00:00.0
06/14/10 01:30:00.0
06/17/10 04:00:00.0
06/20/10 06:30:00.0
06/23/10 09:00:00.0
06/26/10 11:30:00.0
06/29/10 14:00:00.0
07/02/10 16:30:00.0
07/05/10 19:00:00.0
07/08/10 21:30:00.0
07/12/10 00:00:00.0
07/15/10 02:30:00.0
07/18/10 05:00:00.0
07/21/10 07:30:00.0
07/24/10 10:00:00.0
07/27/10 12:30:00.0
07/30/10 15:00:00.0
08/02/10 17:30:00.0
08/05/10 20:00:00.0
08/08/10 22:30:00.0
08/12/10 01:00:00.0
08/15/10 03:30:00.0
08/18/10 06:00:00.0
08/21/10 08:30:00.0
08/24/10 11:00:00.0
08/27/10 13:30:00.0
08/30/10 16:00:00.0
09/02/10 18:30:00.0
09/05/10 21:00:00.0
09/08/10 23:30:00.0
09/12/10 02:00:00.0
09/15/10 04:30:00.0
09/18/10 07:00:00.0
09/21/10 09:30:00.0
09/24/10 12:00:00.0
09/27/10 14:30:00.0
09/30/10 17:00:00.0
10/03/10 19:30:00.0
10/06/10 22:00:00.0
Date

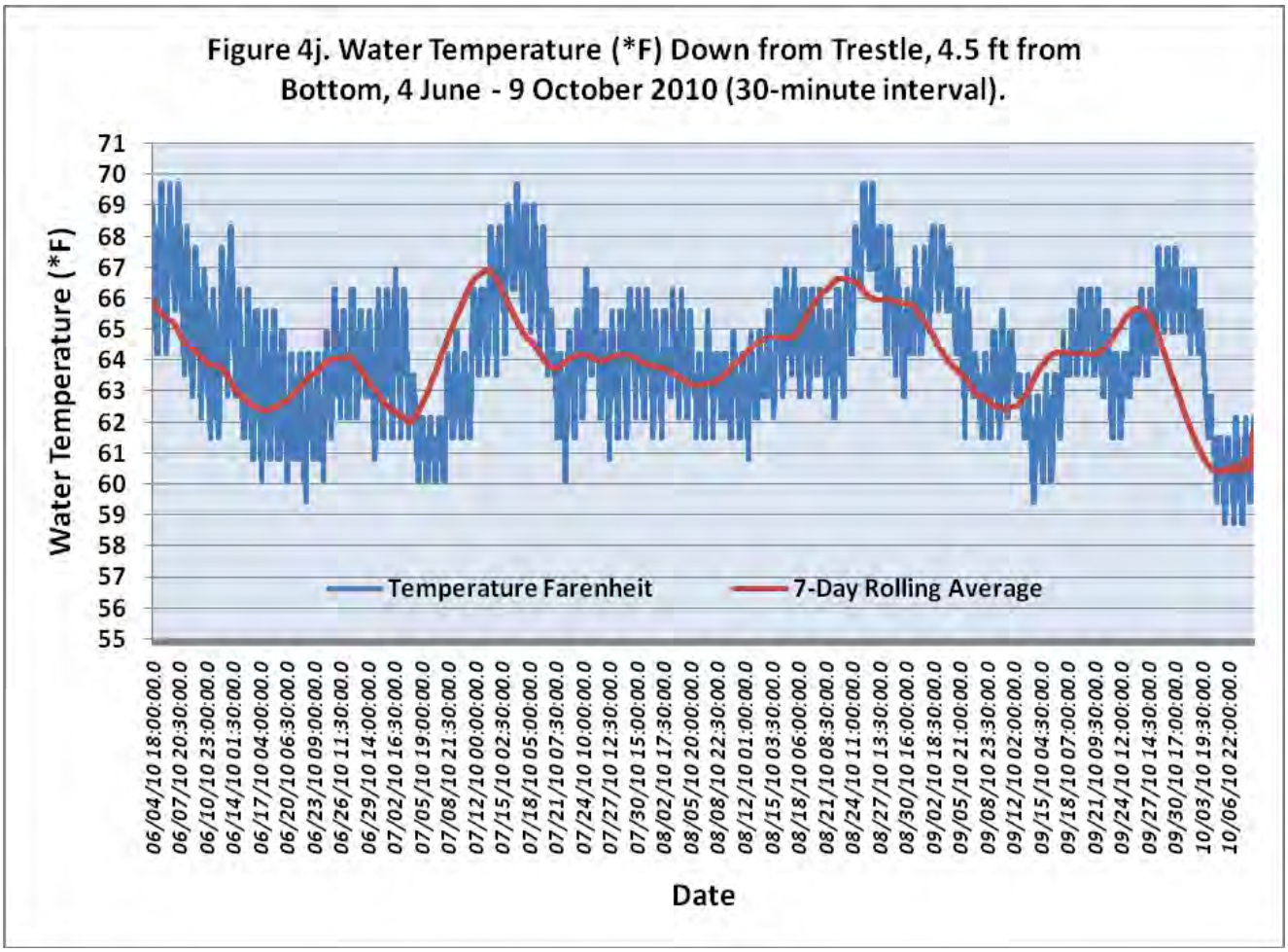


Figure 4j. Water Temperature (*F) Down from Trestle, 4.5 ft from Bottom, 4 June - 9 October 2010 (30-minute interval).
Water Temperature (*F)
71
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
Temperature Farenheit
7-Day Rolling Average
06/04/10 18:00:00.0
06/07/10 20:30:00.0
06/10/10 23:00:00.0
06/14/10 01:30:00.0
06/17/10 04:00:00.0
06/20/10 06:30:00.0
06/23/10 09:00:00.0
06/26/10 11:30:00.0
06/29/10 14:00:00.0
07/02/10 16:30:00.0
07/05/10 19:00:00.0
07/08/10 21:30:00.0
07/12/10 00:00:00.0
07/15/10 02:30:00.0
07/18/10 05:00:00.0
07/21/10 07:30:00.0
07/24/10 10:00:00.0
07/27/10 12:30:00.0
07/30/10 15:00:00.0
08/02/10 17:30:00.0
08/05/10 20:00:00.0
08/08/10 22:30:00.0
08/12/10 01:00:00.0
08/15/10 03:30:00.0
08/18/10 06:00:00.0
08/21/10 08:30:00.0
08/24/10 11:00:00.0
08/27/10 13:30:00.0
08/30/10 16:00:00.0
09/02/10 18:30:00.0
09/05/10 21:00:00.0
09/08/10 23:30:00.0
09/12/10 02:00:00.0
09/15/10 04:30:00.0
09/18/10 07:00:00.0
09/21/10 09:30:00.0
09/24/10 12:00:00.0
09/27/10 14:30:00.0
09/30/10 17:00:00.0
10/03/10 19:30:00.0
10/06/10 22:00:00.0
Date

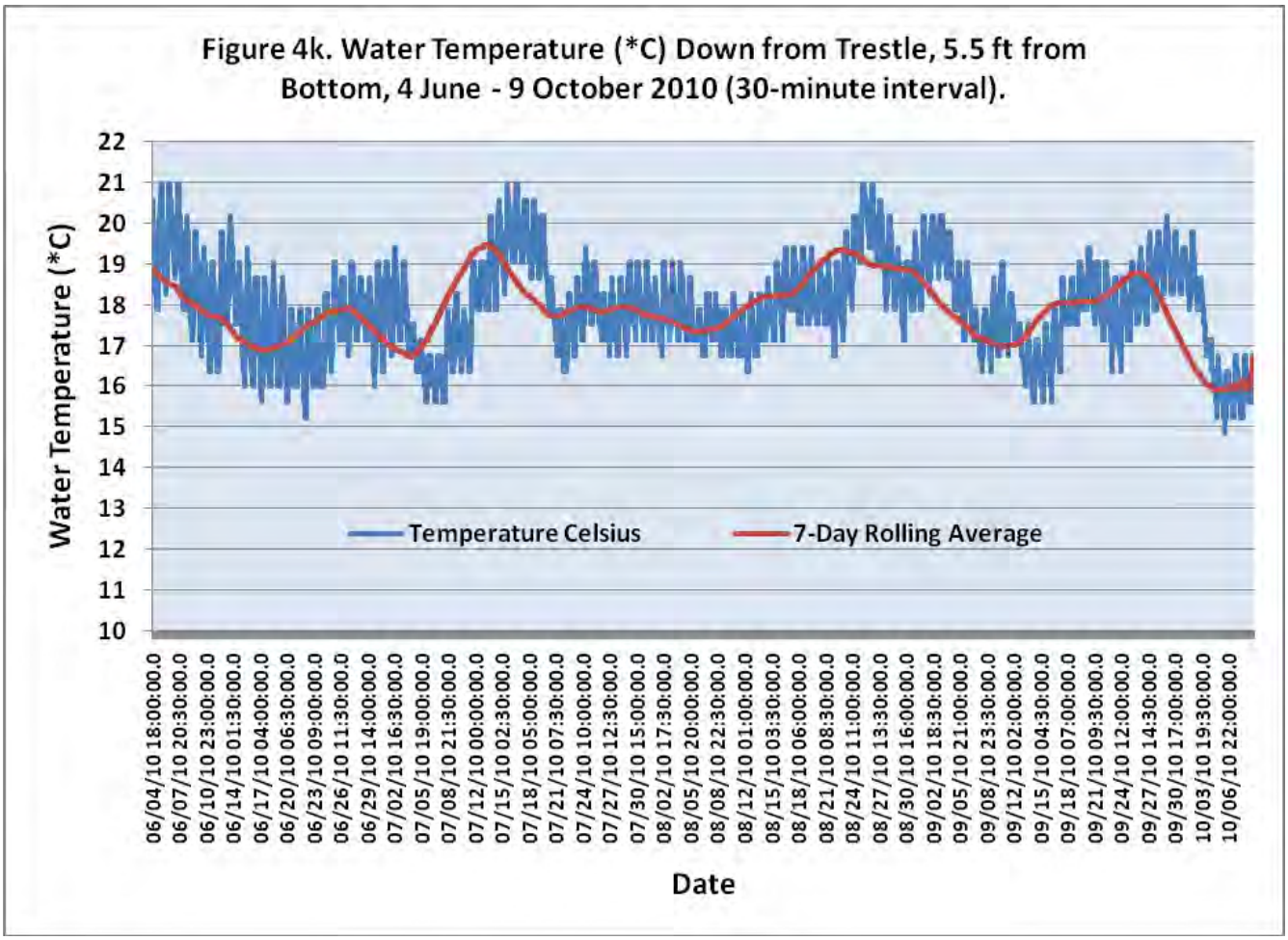


Figure 4k. Water Temperature (*C) Down from Trestle, 5.5 ft from Bottom, 4 June - 9 October 2010 (30-minute interval).
Water Temperature (*C)
22
21
20
19
18
17
16
15
14
13
12
11
10
Temperature Celsius
7-Day Rolling Average
06/04/10 18:00:00.0
06/07/10 20:30:00.0
06/10/10 23:00:00.0
06/14/10 01:30:00.0
06/17/10 04:00:00.0
06/20/10 06:30:00.0
06/23/10 09:00:00.0
06/26/10 11:30:00.0
06/29/10 14:00:00.0
07/02/10 16:30:00.0
07/05/10 19:00:00.0
07/08/10 21:30:00.0
07/12/10 00:00:00.0
07/15/10 02:30:00.0
07/18/10 05:00:00.0
07/21/10 07:30:00.0
07/24/10 10:00:00.0
07/27/10 12:30:00.0
07/30/10 15:00:00.0
08/02/10 17:30:00.0
08/05/10 20:00:00.0
08/08/10 22:30:00.0
08/12/10 01:00:00.0
08/15/10 03:30:00.0
08/18/10 06:00:00.0
08/21/10 08:30:00.0
08/24/10 11:00:00.0
08/27/10 13:30:00.0
08/30/10 16:00:00.0
09/02/10 18:30:00.0
09/05/10 21:00:00.0
09/08/10 23:30:00.0
09/12/10 02:00:00.0
09/15/10 04:30:00.0
09/18/10 07:00:00.0
09/21/10 09:30:00.0
09/24/10 12:00:00.0
09/27/10 14:30:00.0
09/30/10 17:00:00.0
10/03/10 19:30:00.0
10/06/10 22:00:00.0
Date

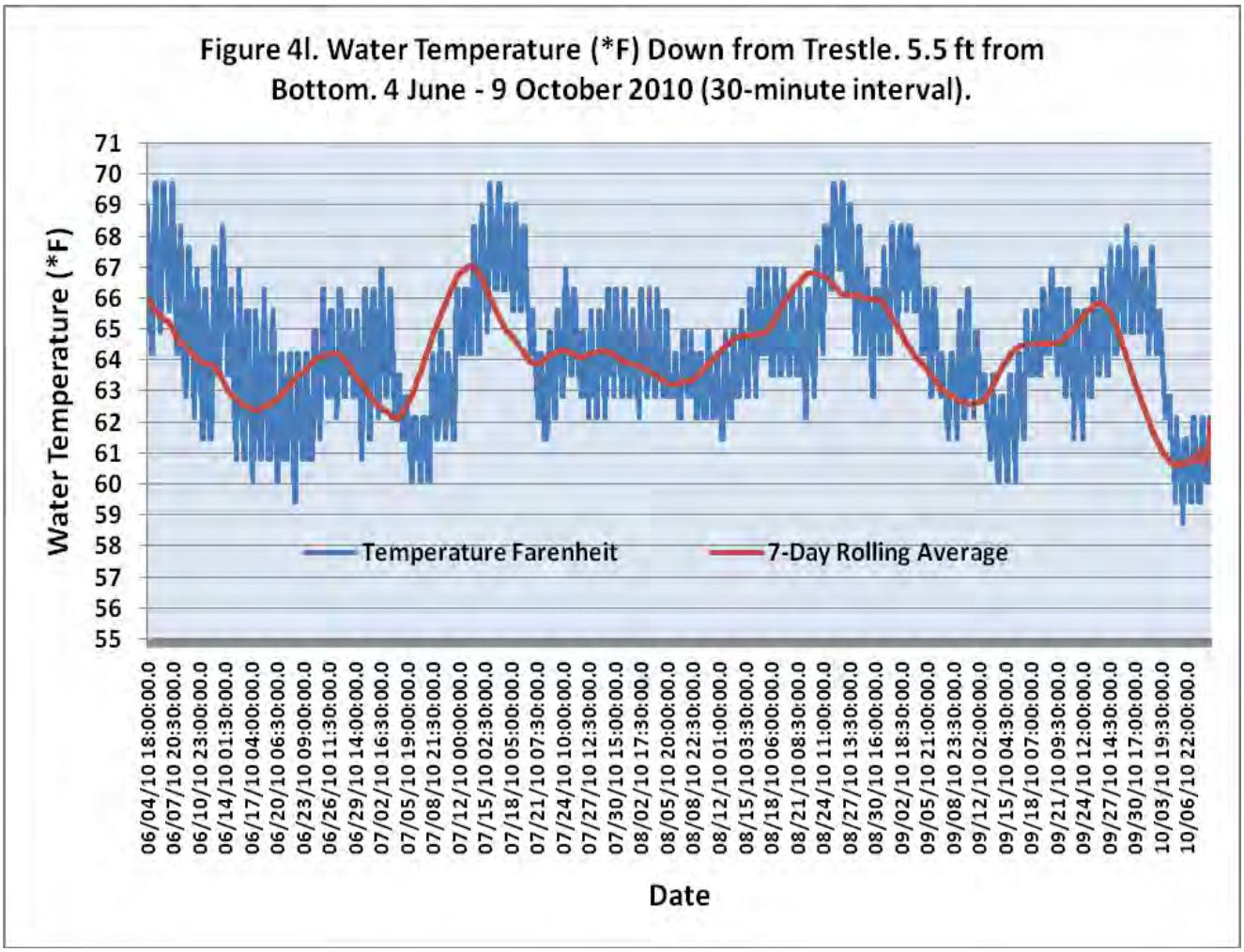


Figure 4l. Water Temperature (*F) Down from Trestle. 5.5 ft from Bottom. 4 June - 9 October 2010 (30-minute interval).
Water Temperature (*F)
71
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
Temperature Farenheit
7-Day Rolling Average
06/04/10 18:00:00.0
06/07/10 20:30:00.0
06/10/10 23:00:00.0
06/14/10 01:30:00.0
06/17/10 04:00:00.0
06/20/10 06:30:00.0
06/23/10 09:00:00.0
06/26/10 11:30:00.0
06/29/10 14:00:00.0
07/02/10 16:30:00.0
07/05/10 19:00:00.0
07/08/10 21:30:00.0
07/12/10 00:00:00.0
07/15/10 02:30:00.0
07/18/10 05:00:00.0
07/21/10 07:30:00.0
07/24/10 10:00:00.0
07/27/10 12:30:00.0
07/30/10 15:00:00.0
08/02/10 17:30:00.0
08/05/10 20:00:00.0
08/08/10 22:30:00.0
08/12/10 01:00:00.0
08/15/10 03:30:00.0
08/18/10 06:00:00.0
08/21/10 08:30:00.0
08/24/10 11:00:00.0
08/27/10 13:30:00.0
08/30/10 16:00:00.0
09/02/10 18:30:00.0
09/05/10 21:00:00.0
09/08/10 23:30:00.0
09/12/10 02:00:00.0
09/15/10 04:30:00.0
09/18/10 07:00:00.0
09/21/10 09:30:00.0
09/24/10 12:00:00.0
09/27/10 14:30:00.0
09/30/10 17:00:00.0
10/03/10 19:30:00.0
10/06/10 22:00:00.0
Date

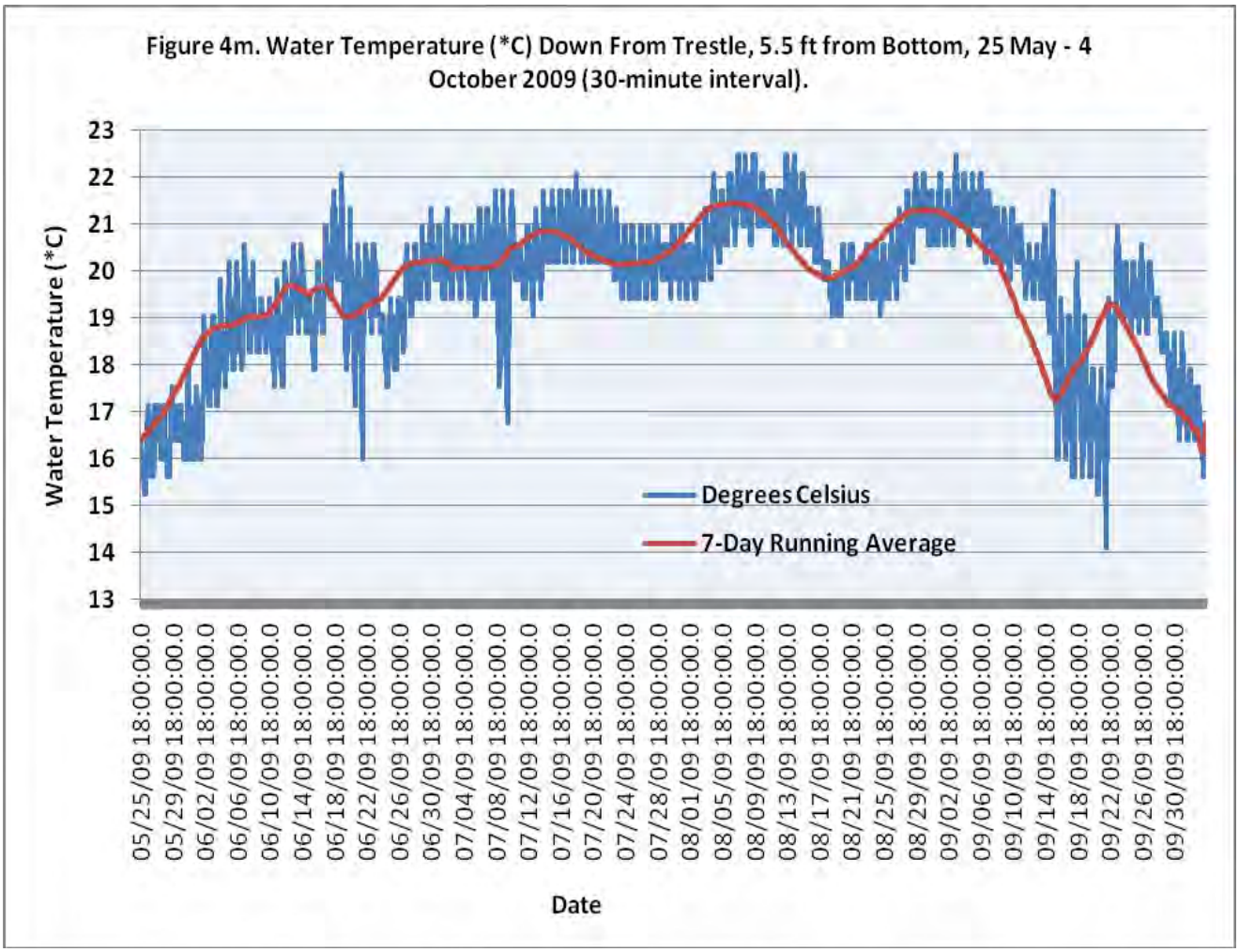


Figure 4m. Water Temperature (*C) Down From Trestle, 5.5 ft from Bottom, 25 May - 4 October 2009 (30-minute interval).
Water Temperature (*C)
23
22
21
20
19
18
17
16
15
14
13
Degrees Celsius
7-Day Running Average
05/25/09 18:00:00.0
05/29/09 18:00:00.0
06/02/09 18:00:00.0
06/06/09 18:00:00.0
06/10/09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

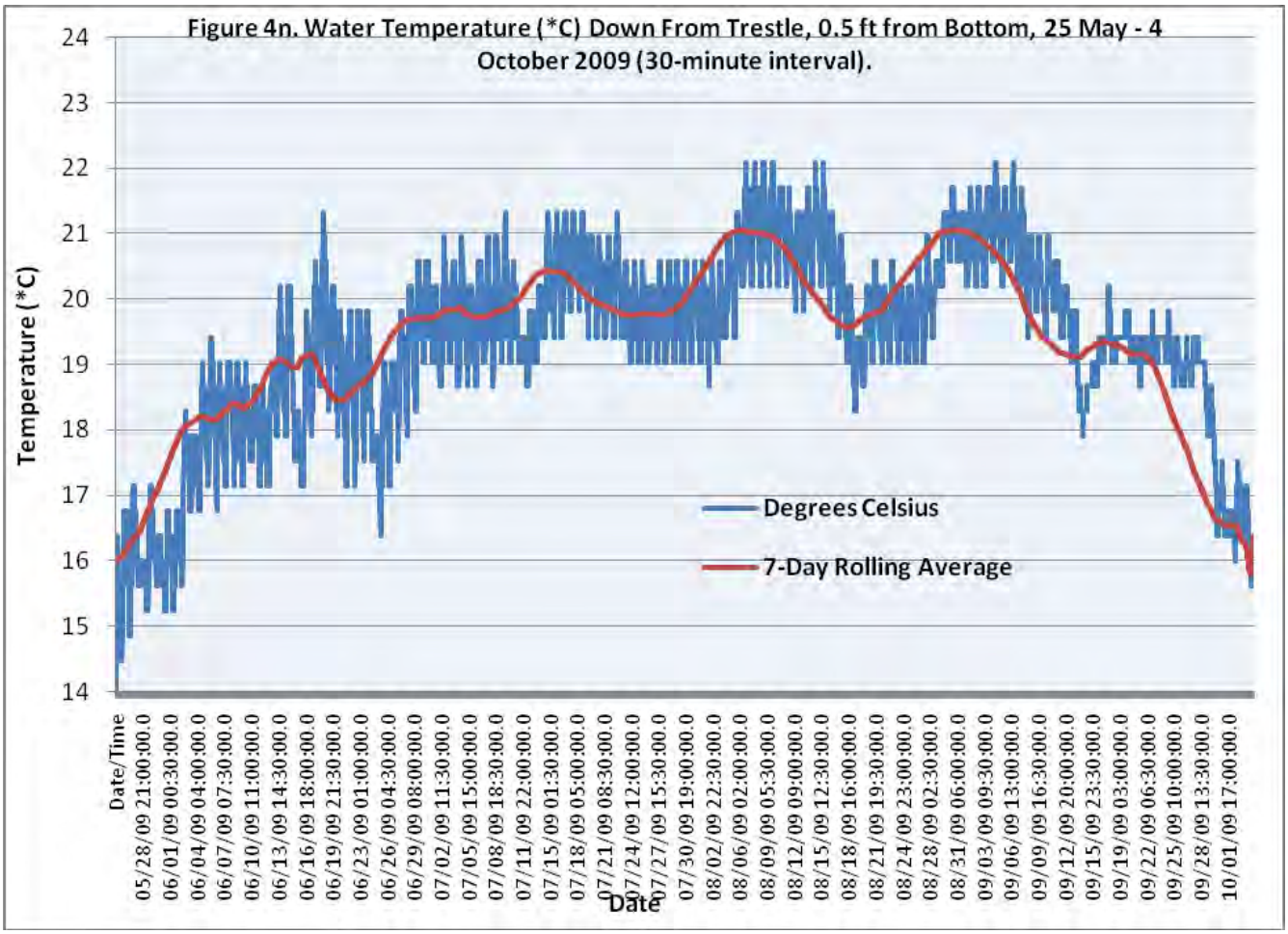


Figure 4n. Water Temperature (*C) Down From Trestle, 0.5 ft from Bottom, 25 May - 4 October 2009 (30-minute interval).
Temperature (*C)
24
23
22
21
20
19
18
17
16
15
14
Degrees Celsius
7-Day Rolling Average
Date/Time
05/28/09 21:00:00.0
06/01/09 00:30:00.0
06/04/09 04:00:00.0
06/07/09 07:30:00.0
06/10/09 11:00:00.0
06/13/09 14:30:00.0
06/16/09 18:00:00.0
06/19/09 21:30:00.0
06/23/09 01:00:00.0
06/26/09 04:30:00.0
06/29/09 08:00:00.0
07/02/09 11:30:00.0
07/05/09 15:00:00.0
07/08/09 18:30:00.0
07/11/09 22:00:00.0
07/15/09 01:30:00.0
07/18/09 05:00:00.0
07/21/09 08:30:00.0
07/24/09 12:00:00.0
07/27/09 15:30:00.0
07/30/09 19:00:00.0
08/02/09 22:30:00.0
08/06/09 02:00:00.0
08/09/09 05:30:00.0
08/12/09 09:00:00.0
08/15/09 12:30:00.0
08/18/09 16:00:00.0
08/21/09 19:30:00.0
08/24/09 23:00:00.0
08/28/09 02:30:00.0
08/31/09 06:00:00.0
09/03/09 09:30:00.0
09/06/09 13:00:00.0
09/09/09 16:30:00.0
09/12/09 20:00:00.0
09/15/09 23:30:00.0
09/19/09 03:00:00.0
09/22/09 06:30:00.0
09/25/09 10:00:00.0
09/28/09 13:30:00.0
10/01/09 17:00:00.0
Date

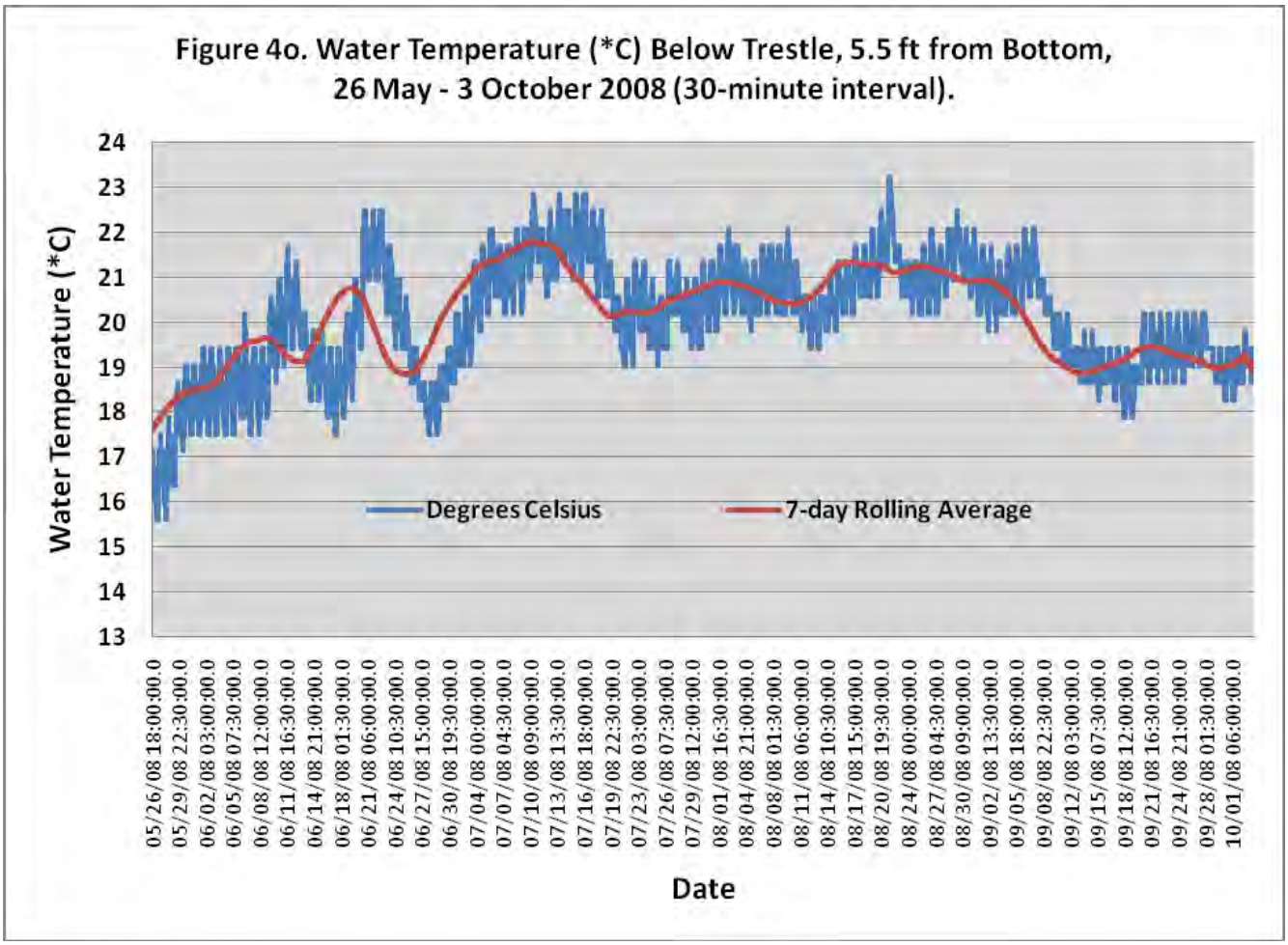


Figure 4o. Water Temperature (*C) Below Trestle, 5.5 ft from Bottom,
26 May - 3 October 2008 (30-minute interval).
Water Temperature (*C)
24
23
22
21
20
19
18
17
16
15
14
13
Degrees Celsius
7-day Rolling Average
05/26/08 18:00:00.0
05/29/08 22:30:00.0
06/02/08 03:00:00.0
06/05/08 07:30:00.0
06/08/08 12:00:00.0
06/11/08 16:30:00.0
06/14/08 21:00:00.0
06/18/08 01:30:00.0
06/21/08 06:00:00.0
06/24/08 10:30:00.0
06/27/08 15:00:00.0
06/30/08 19:30:00.0
07/04/08 00:00:00.0
07/07/08 04:30:00.0
07/10/08 09:00:00.0
07/13/08 13:30:00.0
07/16/08 18:00:00.0
07/19/08 22:30:00.0
07/23/08 03:00:00.0
07/26/08 07:30:00.0
07/29/08 12:00:00.0
08/01/08 16:30:00.0
08/04/08 21:00:00.0
08/08/08 01:30:00.0
08/11/08 06:00:00.0
08/14/08 10:30:00.0
08/17/08 15:00:00.0
08/20/08 19:30:00.0
08/24/08 00:00:00.0
08/27/08 04:30:00.0
08/30/08 09:00:00.0
09/02/08 13:30:00.0
09/05/08 18:00:00.0
09/08/08 22:30:00.0
09/12/08 03:00:00.0
09/15/08 07:30:00.0
09/18/08 12:00:00.0
09/21/08 16:30:00.0
09/24/08 21:00:00.0
09/28/08 01:30:00.0
10/01/08 06:00:00.0
Date

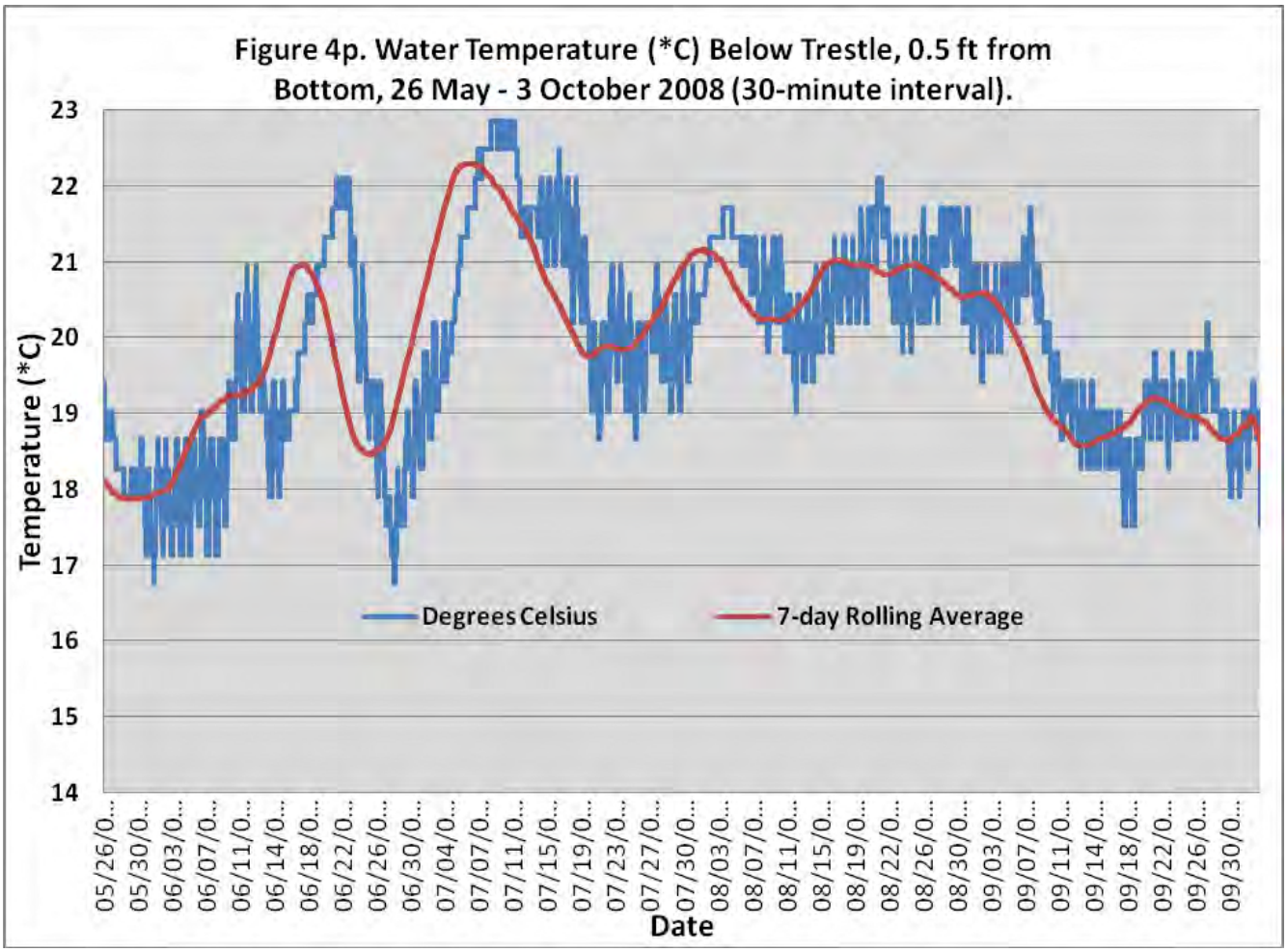


Figure 4p. Water Temperature (*C) Below Trestle, 0.5 ft from Bottom, 26 May - 3 October 2008 (30-minute interval).
Temperature (*C)
23
22
21
20
19
18
17
16
15
14
Degrees Celsius
7-day Rolling Average
05/26/0...
05/30/0...
06/03/0...
06/07/0...
06/11/0...
06/14/0...
06/18/0...
06/22/0...
06/26/0...
06/30/0...
07/04/0...
07/07/0...
07/11/0...
07/15/0...
07/19/0...
07/23/0...
07/27/0...
07/30/0...
08/03/0...
08/07/0...
08/11/0...
08/15/0...
08/19/0...
08/22/0...
08/26/0...
08/30/0...
09/03/0...
09/07/0...
09/11/0...
09/14/0...
09/18/0...
09/22/0...
09/26/0...
09/30/0...
Date

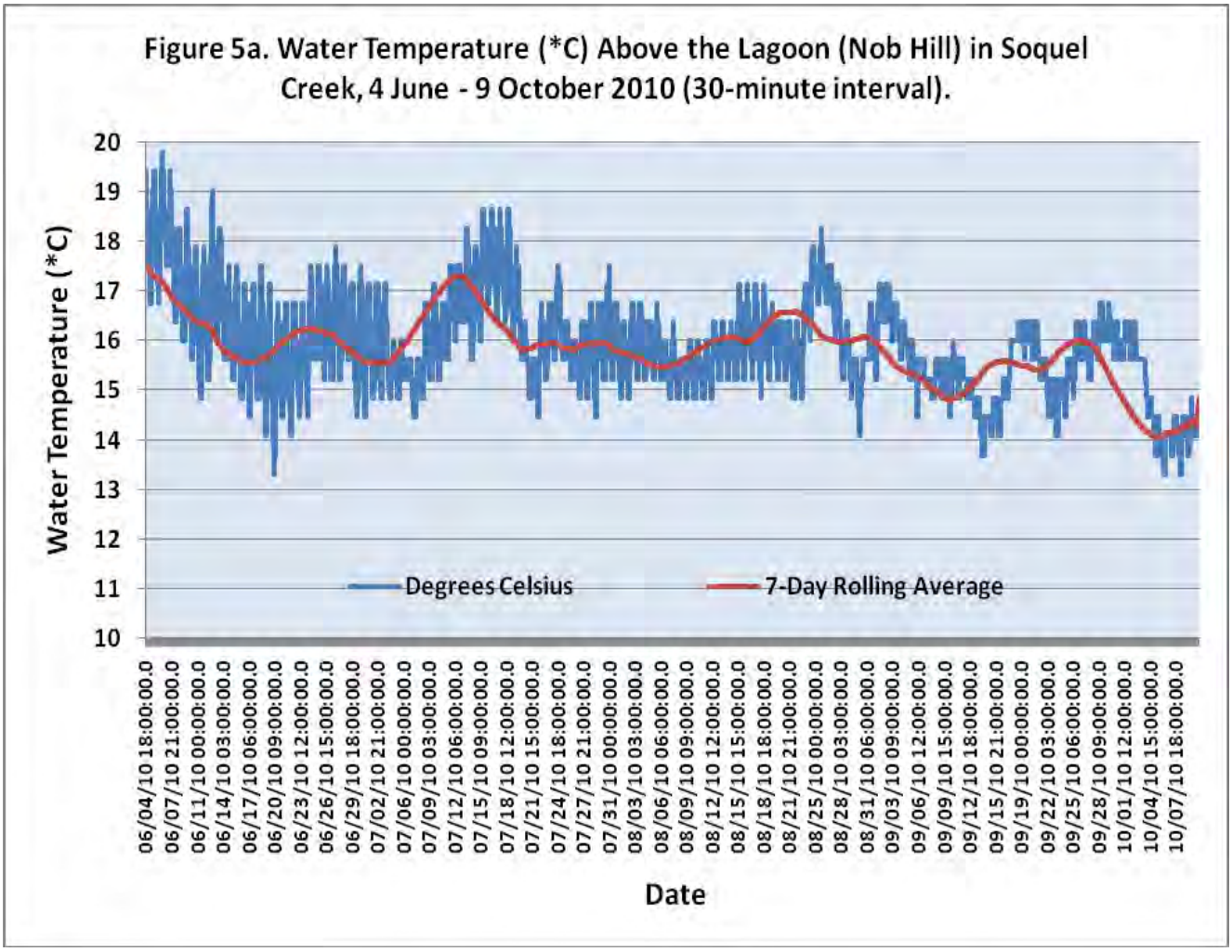


Figure 5a. Water Temperature (*C) Above the Lagoon (Nob Hill) in Soquel Creek, 4 June - 9 October 2010 (30-minute interval).
Water Temperature (*C)
20
19
18
17
16
15
14
13
12
11
10
Degrees Celsius
7-Day Rolling Average
06/04/10 18:00:00.0
06/07/10 21:00:00.0
06/11/10 00:00:00.0
06/14/10 03:00:00.0
06/17/10 06:00:00.0
06/20/10 09:00:00.0
06/23/10 12:00:00.0
06/26/10 15:00:00.0
06/29/10 18:00:00.0
07/02/10 21:00:00.0
07/06/10 00:00:00.0
07/09/10 03:00:00.0
07/12/10 06:00:00.0
07/15/10 09:00:00.0
07/18/10 12:00:00.0
07/21/10 15:00:00.0
07/24/10 18:00:00.0
07/27/10 21:00:00.0
07/31/10 00:00:00.0
08/03/10 03:00:00.0
08/06/10 06:00:00.0
08/09/10 09:00:00.0
08/12/10 12:00:00.0
08/15/10 15:00:00.0
08/18/10 18:00:00.0
08/21/10 21:00:00.0
08/25/10 00:00:00.0
08/28/10 03:00:00.0
08/31/10 06:00:00.0
09/03/10 09:00:00.0
09/06/10 12:00:00.0
09/09/10 15:00:00.0
09/12/10 18:00:00.0
09/15/10 21:00:00.0
09/19/10 00:00:00.0
09/22/10 03:00:00.0
09/25/10 06:00:00.0
09/28/10 09:00:00.0
10/01/10 12:00:00.0
10/04/10 15:00:00.0
10/07/10 18:00:00.0
Date

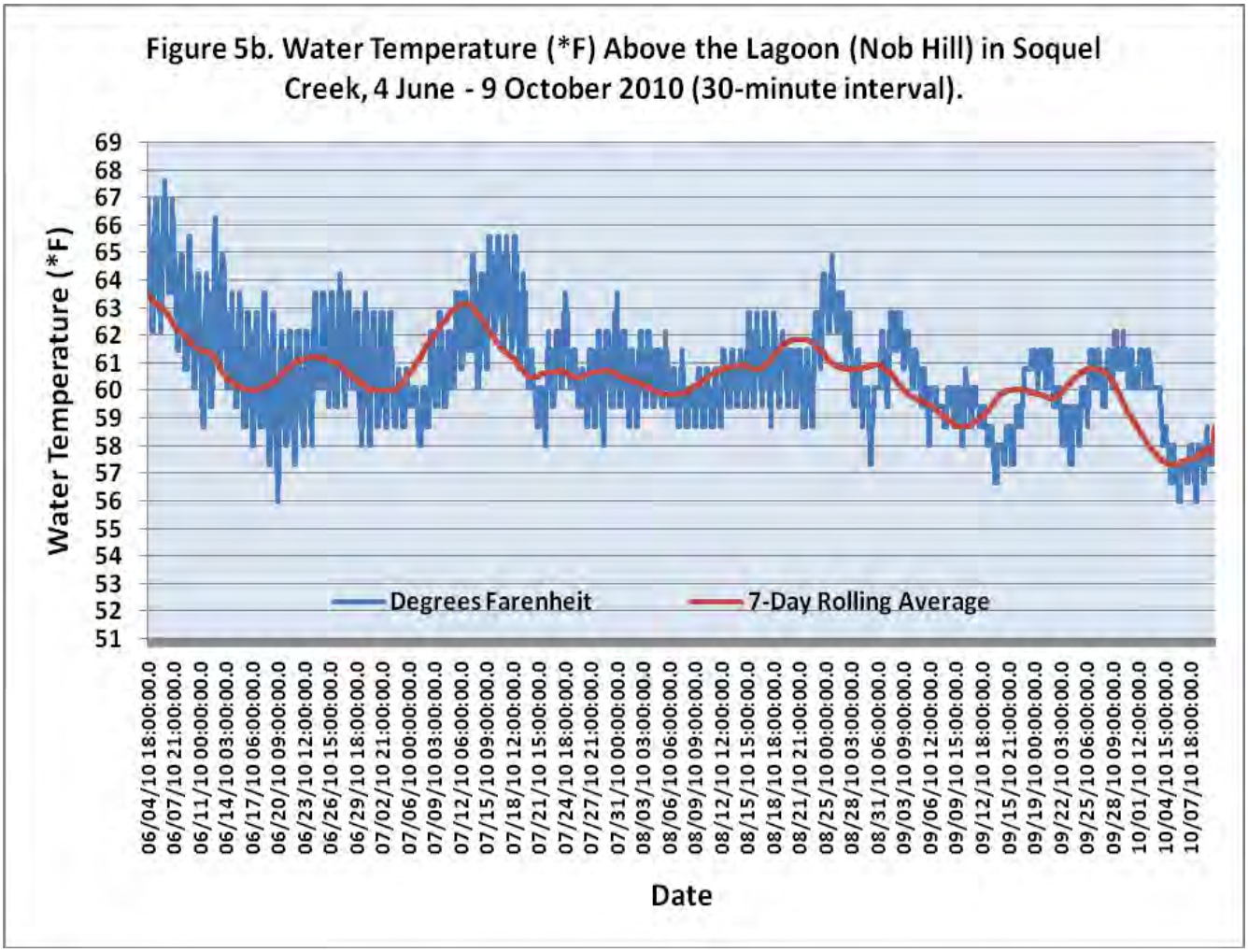


Figure 5b. Water Temperature (*F) Above the Lagoon (Nob Hill) in Soquel Creek, 4 June - 9 October 2010 (30-minute interval).
Water Temperature (*F)
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
Degrees Farenheit
7-Day Rolling Average
06/04/10 18:00:00.0
06/07/10 21:00:00.0
06/11/10 00:00:00.0
06/14/10 03:00:00.0
06/17/10 06:00:00.0
06/20/10 09:00:00.0
06/23/10 12:00:00.0
06/26/10 15:00:00.0
06/29/10 18:00:00.0
07/02/10 21:00:00.0
07/06/10 00:00:00.0
07/09/10 03:00:00.0
07/12/10 06:00:00.0
07/15/10 09:00:00.0
07/18/10 12:00:00.0
07/21/10 15:00:00.0
07/24/10 18:00:00.0
07/27/10 21:00:00.0
07/31/10 00:00:00.0
08/03/10 03:00:00.0
08/06/10 06:00:00.0
08/09/10 09:00:00.0
08/12/10 12:00:00.0
08/15/10 15:00:00.0
08/18/10 18:00:00.0
08/21/10 21:00:00.0
08/25/10 00:00:00.0
08/28/10 03:00:00.0
08/31/10 06:00:00.0
09/03/10 09:00:00.0
09/06/10 12:00:00.0
09/09/10 15:00:00.0
09/12/10 18:00:00.0
09/15/10 21:00:00.0
09/19/10 00:00:00.0
09/22/10 03:00:00.0
09/25/10 06:00:00.0
09/28/10 09:00:00.0
10/01/10 12:00:00.0
10/04/10 15:00:00.0
10/07/10 18:00:00.0
Date

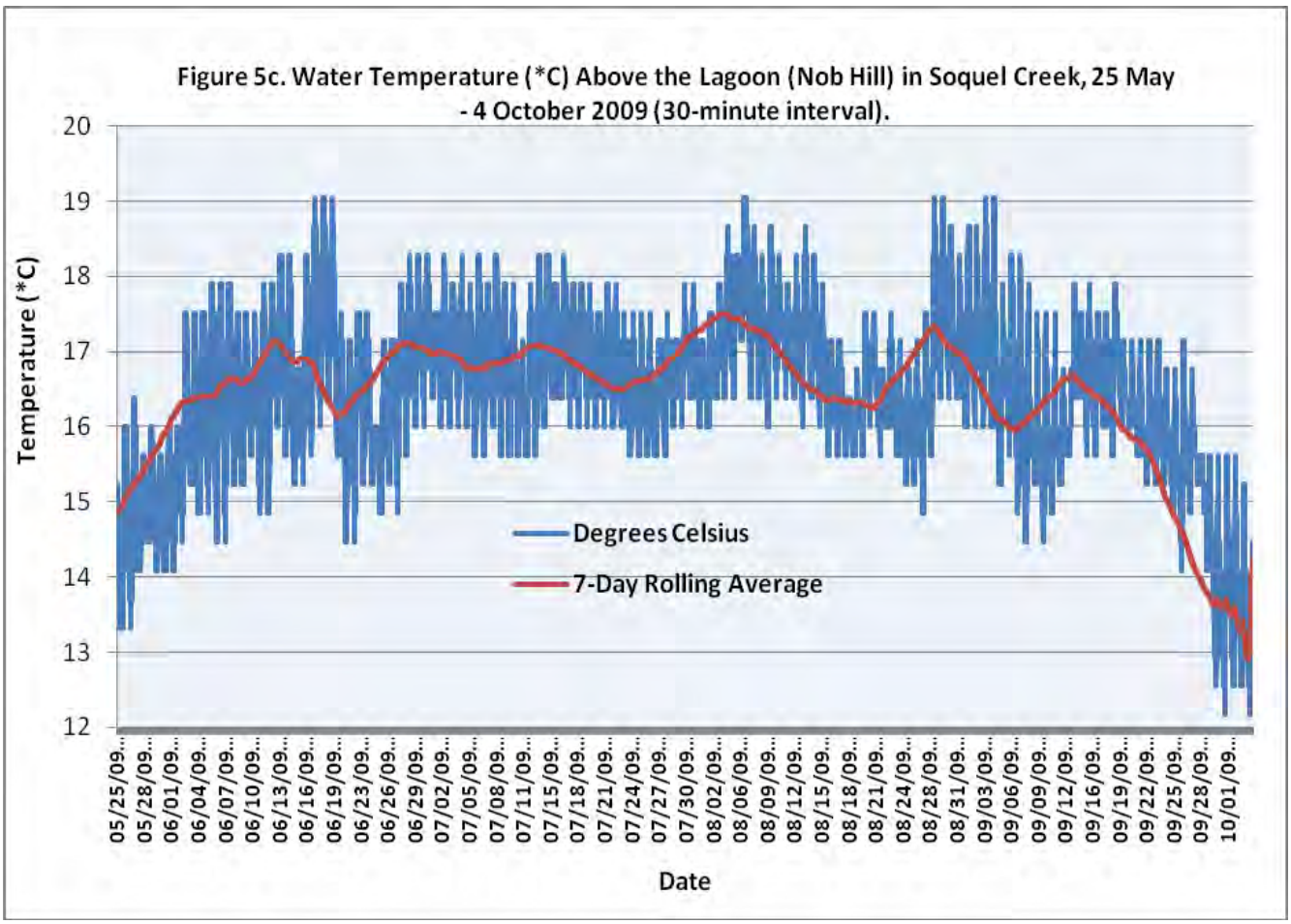


Figure 5c. Water Temperature (*C) Above the Lagoon (Nob Hill) in Soquel Creek, 25 May - 4 October 2009 (30-minute interval).
Temperature (*C)
20
19
18
17
16
15
14
13
12
Degrees Celsius
7-Day Rolling Average
05/25/09...
05/28/09...
06/01/09...
06/04/09...
06/07/09...
06/10/09...
06/13/09...
06/16/09...
06/19/09...
06/23/09...
06/26/09...
06/29/09...
07/02/09...
07/05/09...
07/08/09...
07/11/09...
07/15/09...
07/18/09...
07/21/09...
07/24/09...
07/27/09...
07/30/09...
08/02/09...
08/06/09...
08/09/09...
08/12/09...
08/15/09...
08/18/09...
08/21/09...
08/24/09...
08/28/09...
08/31/09...
09/03/09...
09/06/09...
09/09/09...
09/12/09...
09/16/09...
09/19/09...
09/22/09...
09/25/09...
09/28/09...
10/01/09...
Date

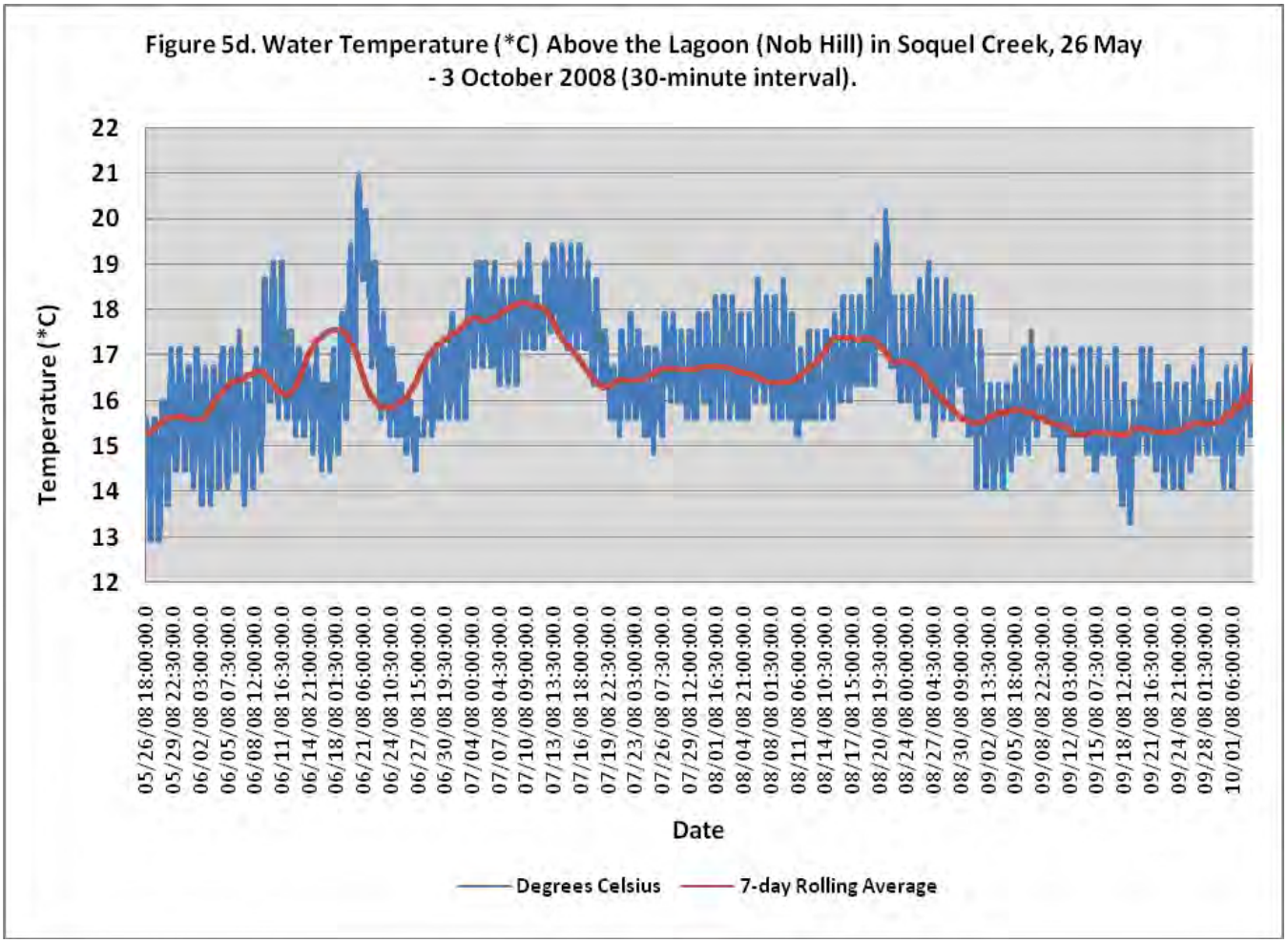


Figure 5d. Water Temperature (*C) Above the Lagoon (Nob Hill) in Soquel Creek, 26 May - 3 October 2008 (30-minute interval).
Temperature (*C)
22
21
20
19
18
17
16
15
14
13
12
05/26/08 18:00:00.0
05/29/08 22:30:00.0
06/02/08 03:00:00.0
06/05/08 07:30:00.0
06/08/08 12:00:00.0
06/11/08 16:30:00.0
06/14/08 21:00:00.0
06/18/08 01:30:00.0
06/21/08 06:00:00.0
06/24/08 10:30:00.0
06/27/08 15:00:00.0
06/30/08 19:30:00.0
07/04/08 00:00:00.0
07/07/08 04:30:00.0
07/10/08 09:00:00.0
07/13/08 13:30:00.0
07/16/08 18:00:00.0
07/19/08 22:30:00.0
07/23/08 03:00:00.0
07/26/08 07:30:00.0
07/29/08 12:00:00.0
08/01/08 16:30:00.0
08/04/08 21:00:00.0
08/08/08 01:30:00.0
08/11/08 06:00:00.0
08/14/08 10:30:00.0
08/17/08 15:00:00.0
08/20/08 19:30:00.0
08/24/08 00:00:00.0
08/27/08 04:30:00.0
08/30/08 09:00:00.0
09/02/08 13:30:00.0
09/05/08 18:00:00.0
09/08/08 22:30:00.0
09/12/08 03:00:00.0
09/15/08 07:30:00.0
09/18/08 12:00:00.0
09/21/08 16:30:00.0
09/24/08 21:00:00.0
09/28/08 01:30:00.0
10/01/08 06:00:00.0
Date
Degrees Celsius
7-day Rolling Average

Figure 5e. Water Temperature (*C) Above the Lagoon (Nob Hill) in Soquel Creek, 29 May- 30 September 2007 (30-minute interval).

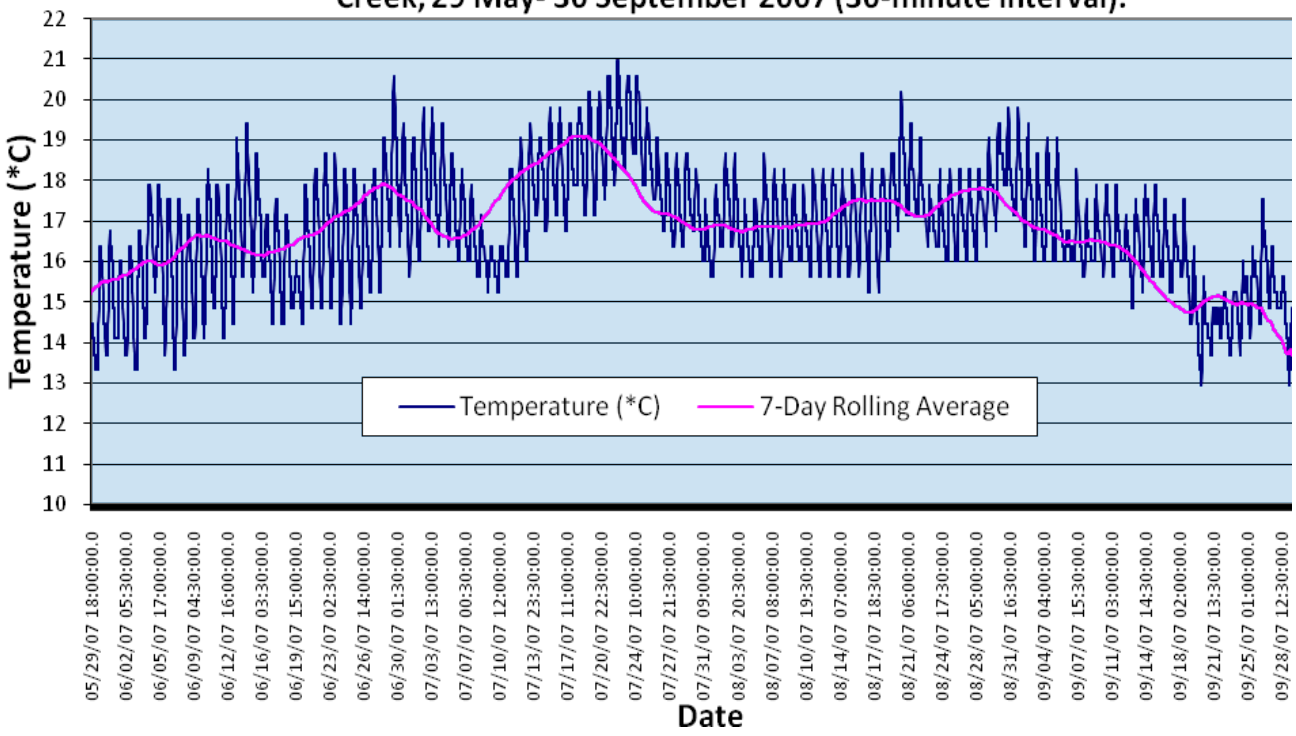


Figure 5f. Water Temperature (*C) Above the Lagoon (Nob Hill) in Soquel Creek, 8 June- 12 September 2006 (30-minute interval).

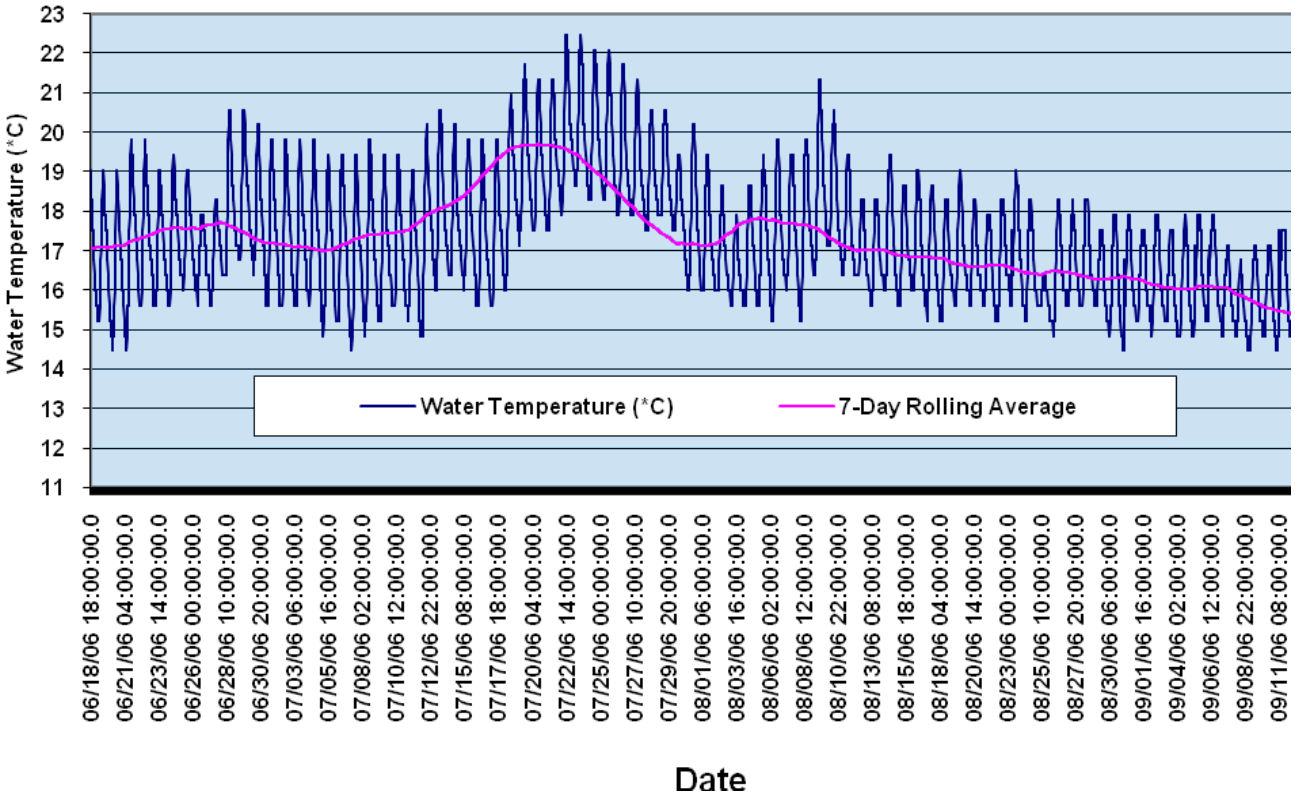


Figure 6a-1. Soquel Lagoon/Stream Oxygen Concentration at Dawn Within 0.25 m of the Bottom at Five Monitoring Stations, 19 June - 23 October 2010.

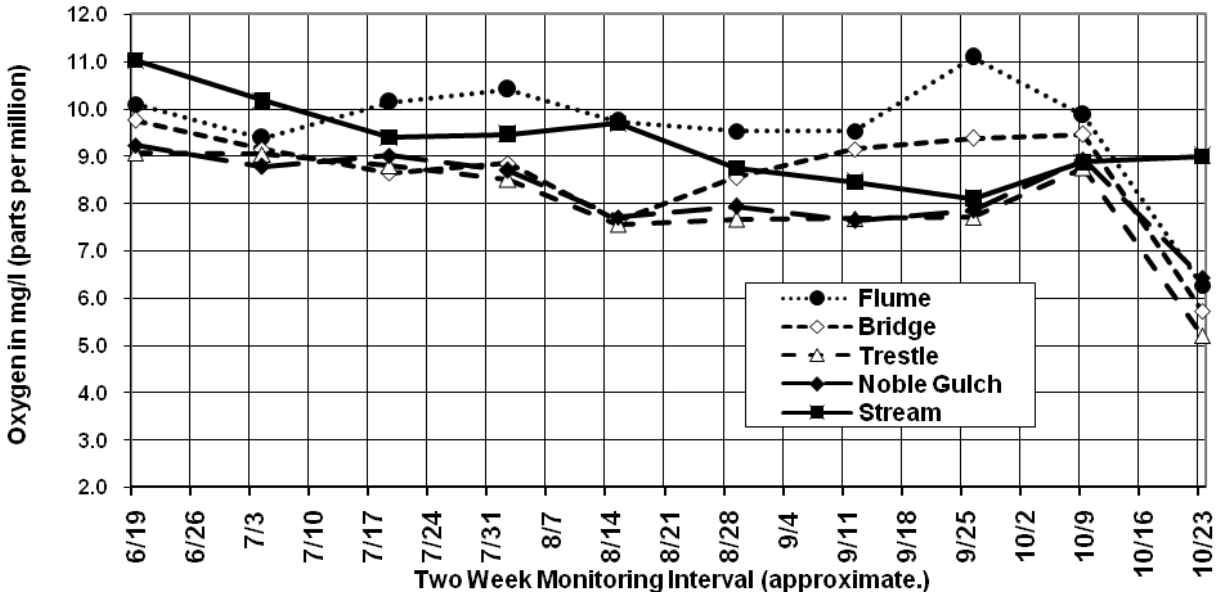


Figure 6a-2. Soquel Lagoon/Stream Oxygen Concentrations in Afternoon Within 0.25 m of the Bottom at Five Stations, 19 June - 23 October 2010.

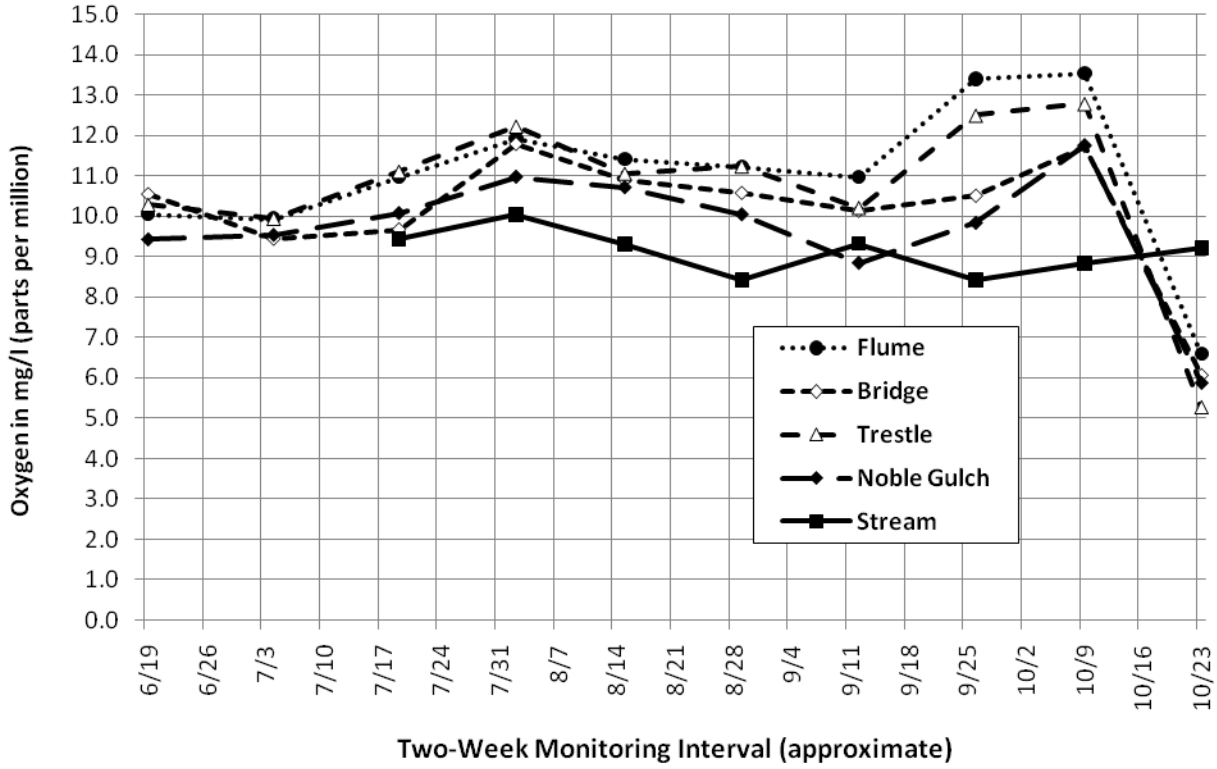


Figure 6b. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 m of the Bottom at Station 1, the Flume, 19 June - 23 October 2010.

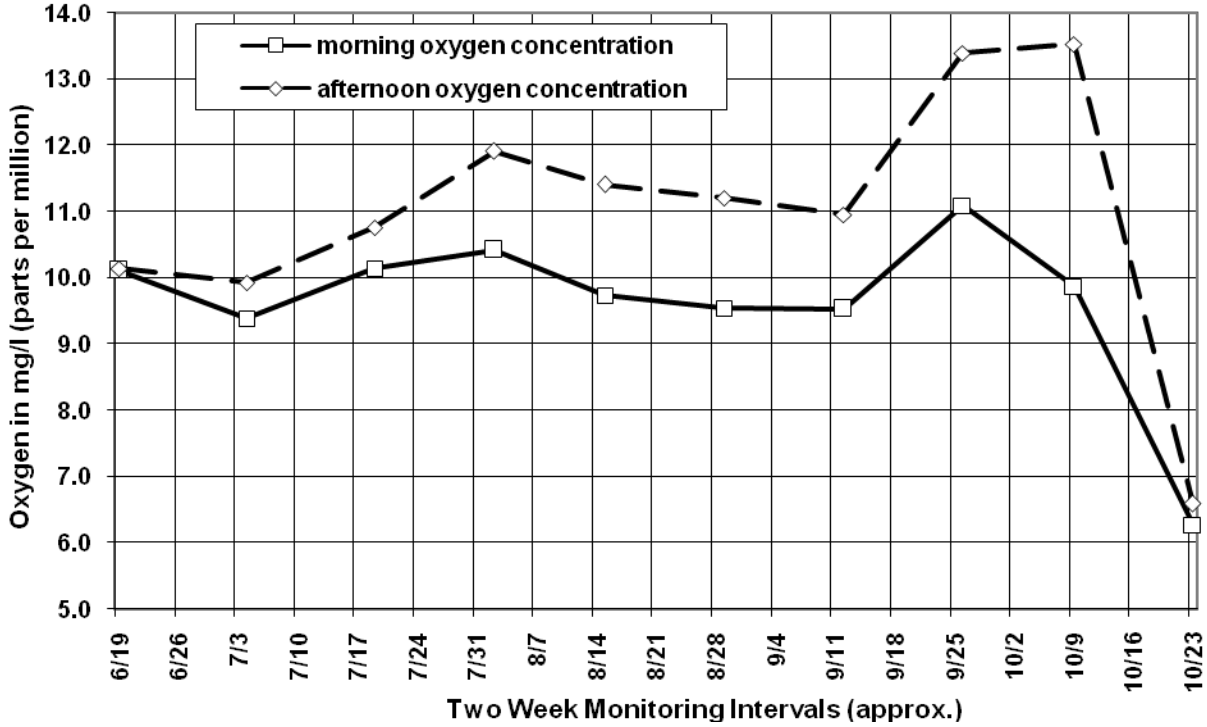


Figure 6c. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 2, the Stockton Avenue Bridge, 19 June - 23 October 2010.

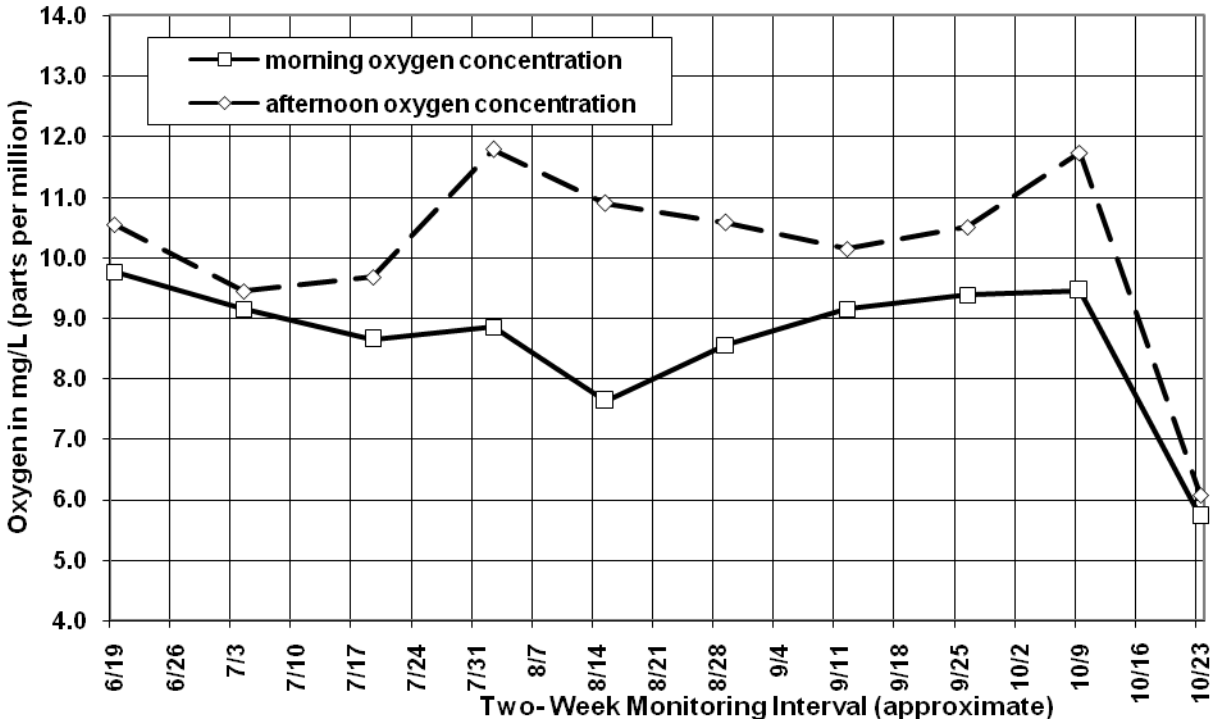


Figure 6d. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon Within 0.25 m of the Bottom at Station 3, the Railroad Trestle, 19 June - 23 October 2010.

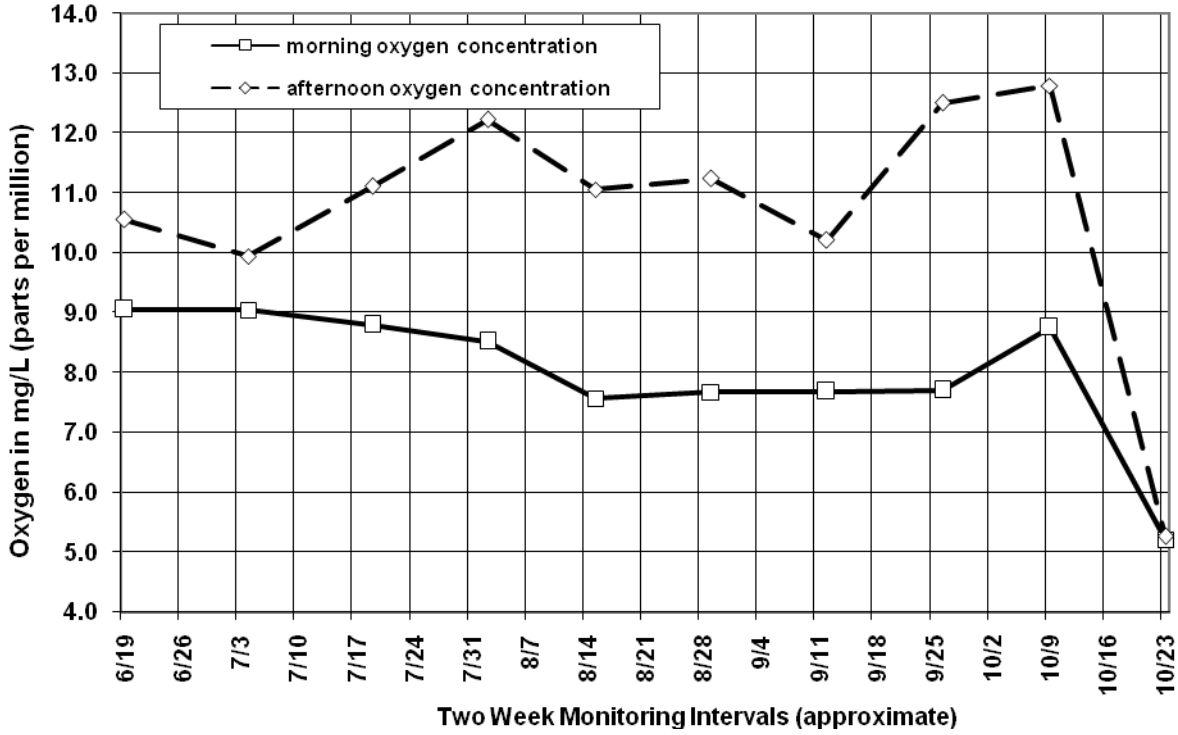


Figure 6e. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 m of the Bottom at Station 4, the Mouth of Noble Gulch, 19 June - 23 October 2010.

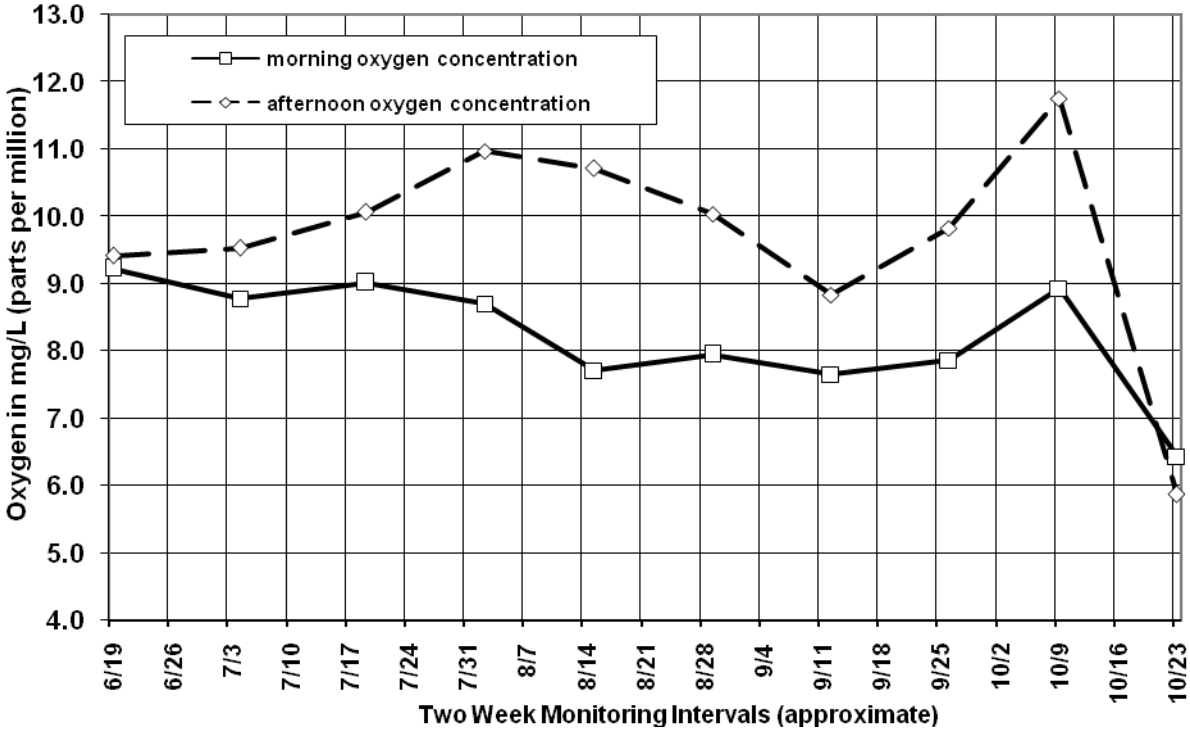


Figure 6f. Soquel Lagoon/Stream Oxygen Concentrations at Dawn Within 0.25 Meters of the Bottom at 5 Stations, 30 June - 6 December 2006

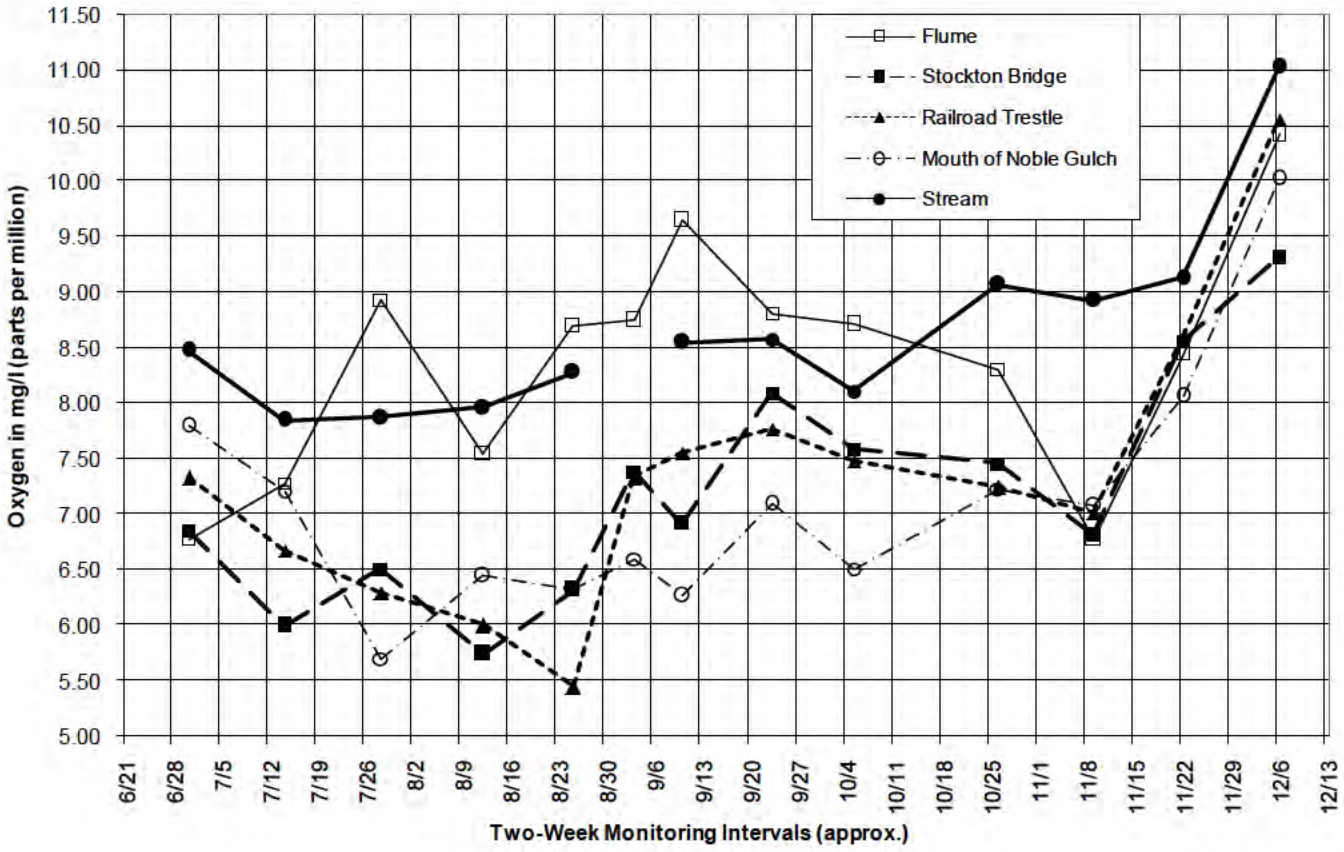


Figure 6g. Soquel Lagoon/Stream Oxygen Concentrations at Dawn within 0.25 Meters of the Bottom at Five Stations, June 10 - December 8, 2007.

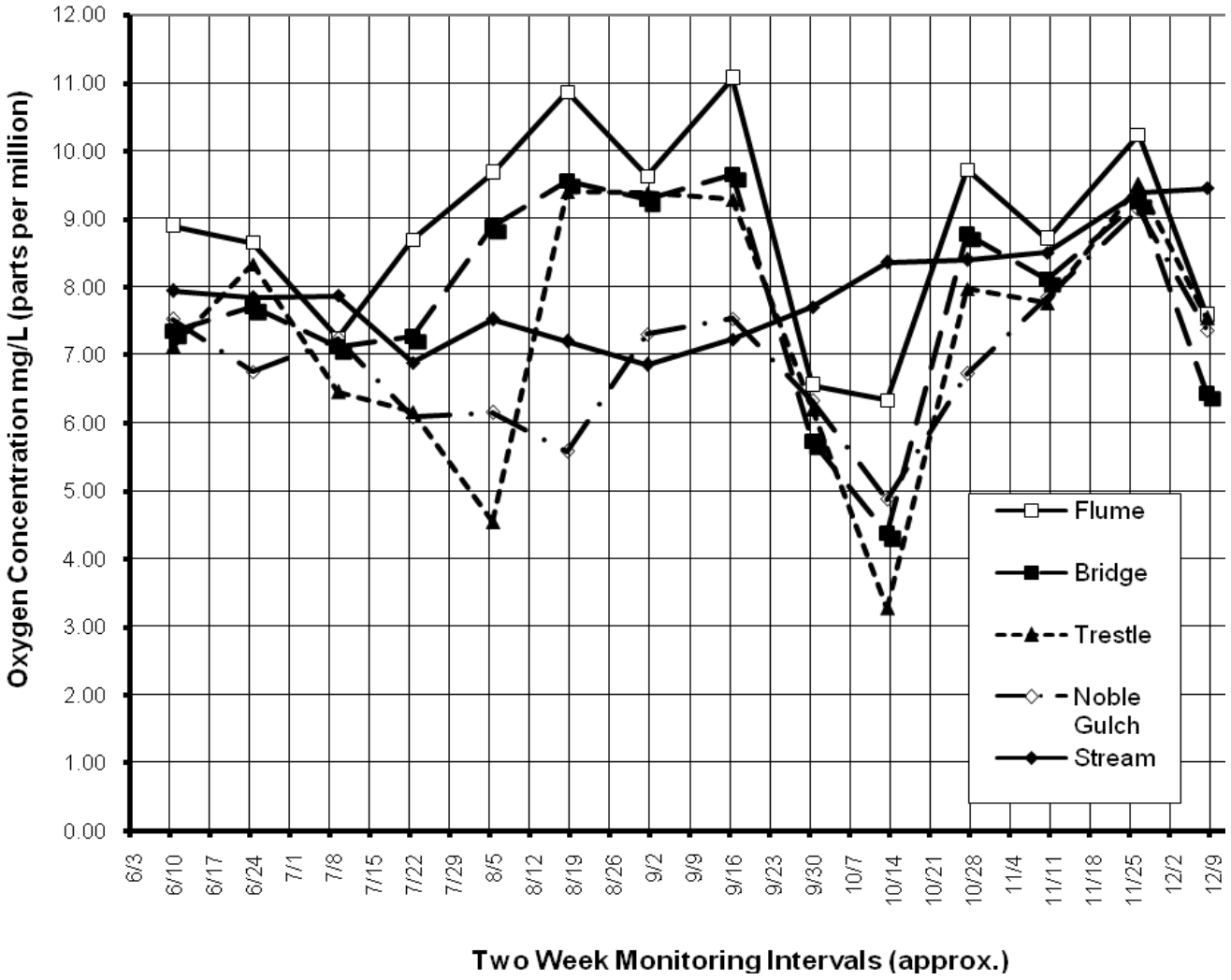


Figure 6h. Soquel Lagoon/Stream Oxygen Concentrations at Dawn Within 0.25 Meters of the Bottom at Five Monitoring Stations, 7 June - 26 October 2008.

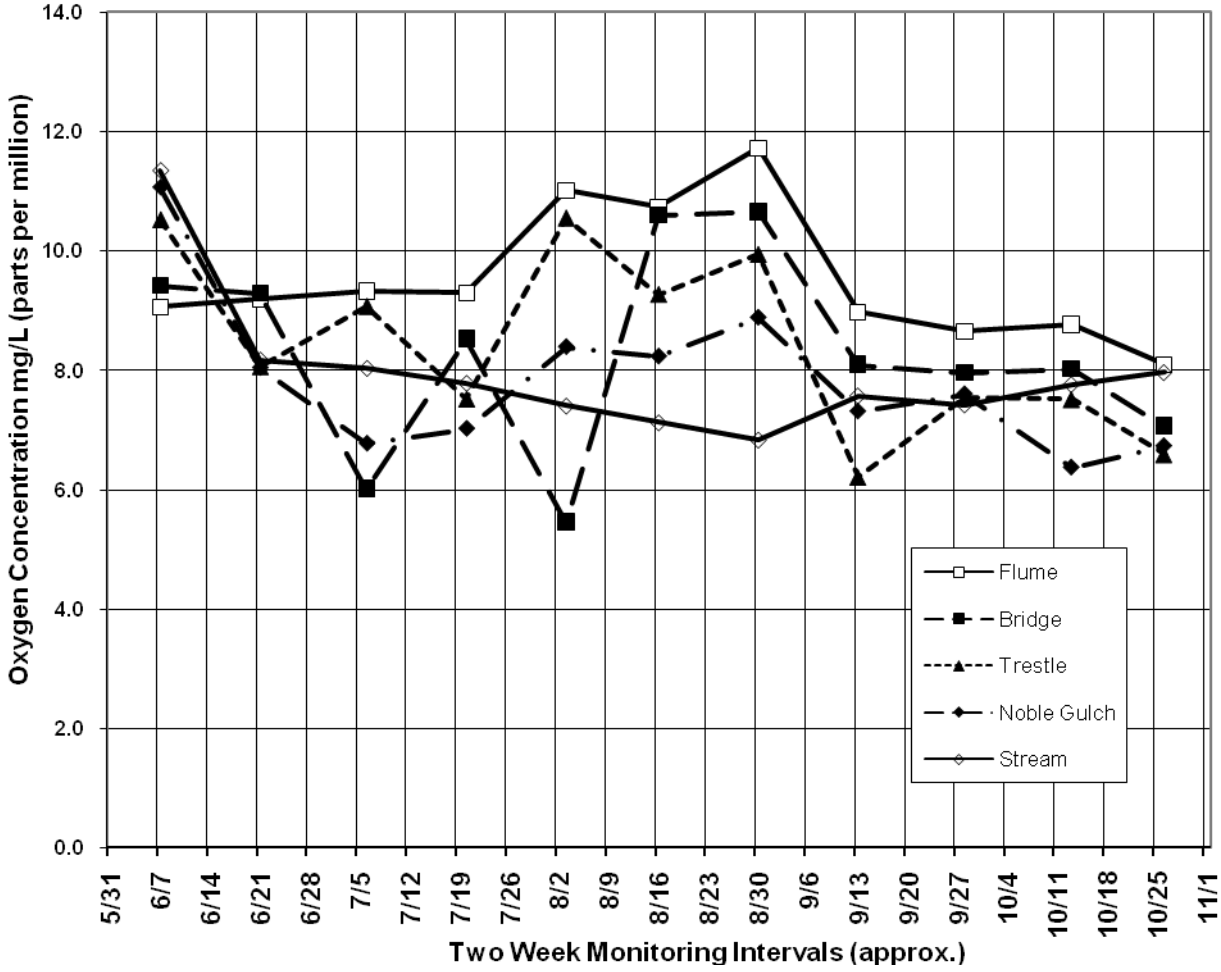
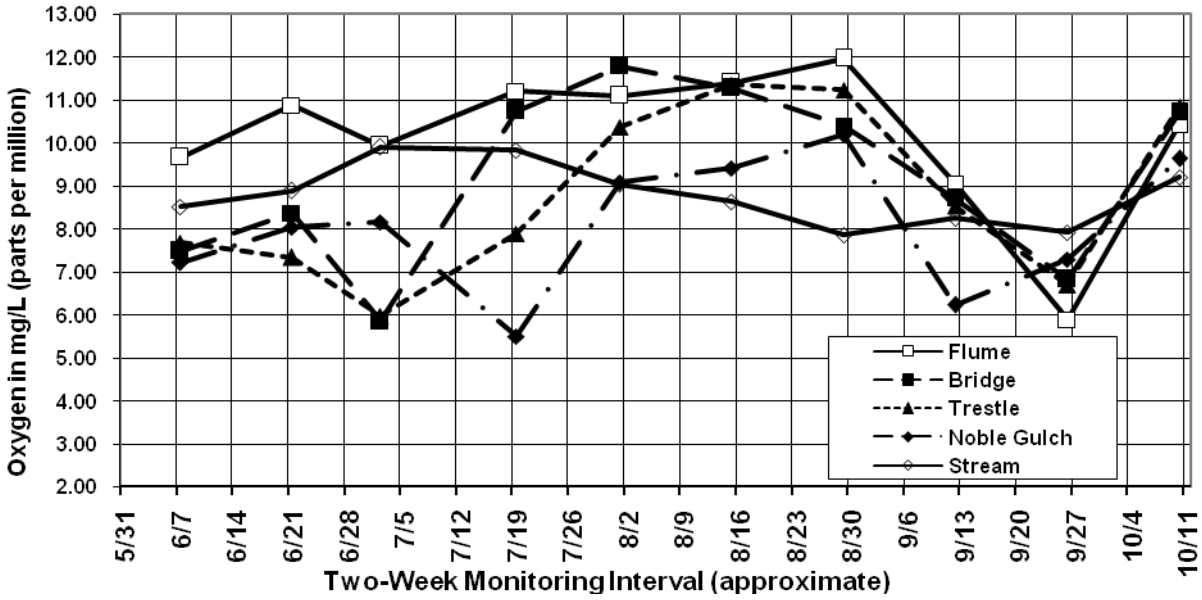


Figure 6i. Soquel Lagoon/Stream Oxygen Concentrations at Dawn Within 0.25 Meters of the Bottom at Five Monitoring Stations, 7 June - 10 October 2009.



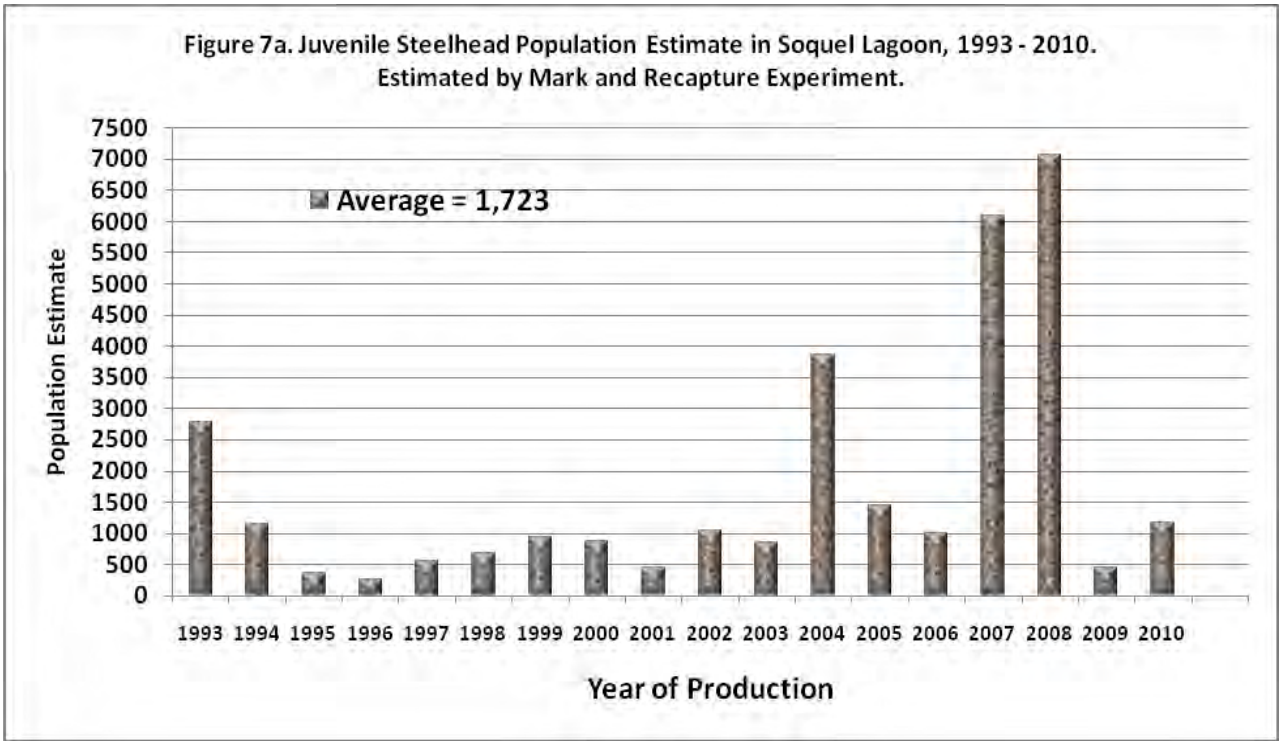


Figure 7a. Juvenile Steelhead Population Estimate in Soquel Lagoon, 1993 - 2010.
Estimated by Mark and Recapture Experiment.
Average = 1,723
Population Estimate
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010
Year of Production

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

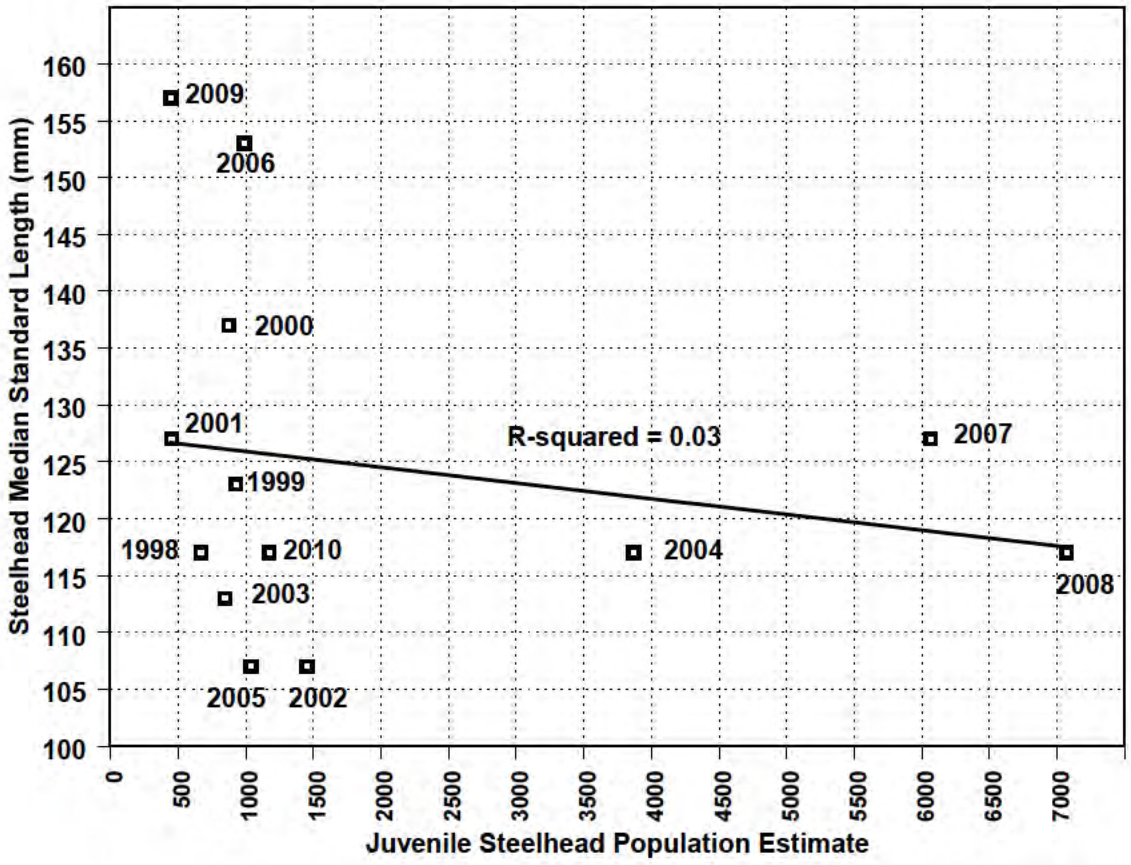
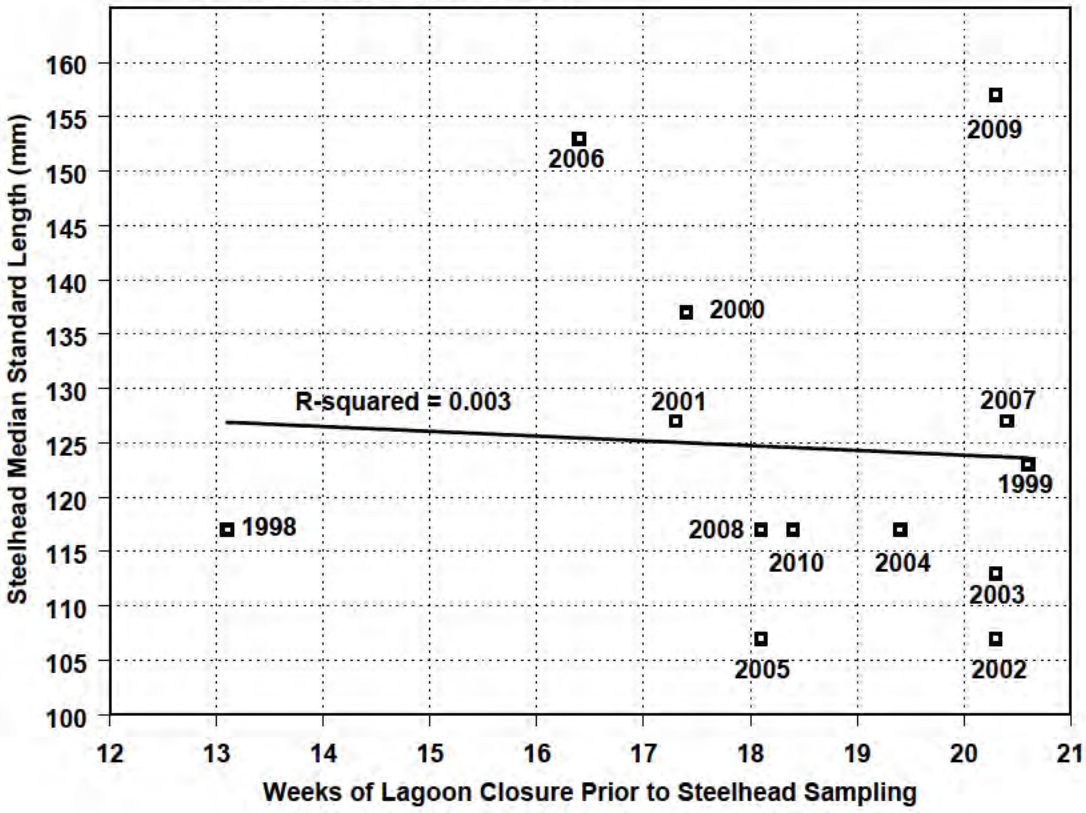


Figure 7c. Steelhead Median Standard Length Versus Weeks of Lagoon Closure Prior to Steelhead Sampling, 1998 - 2010.



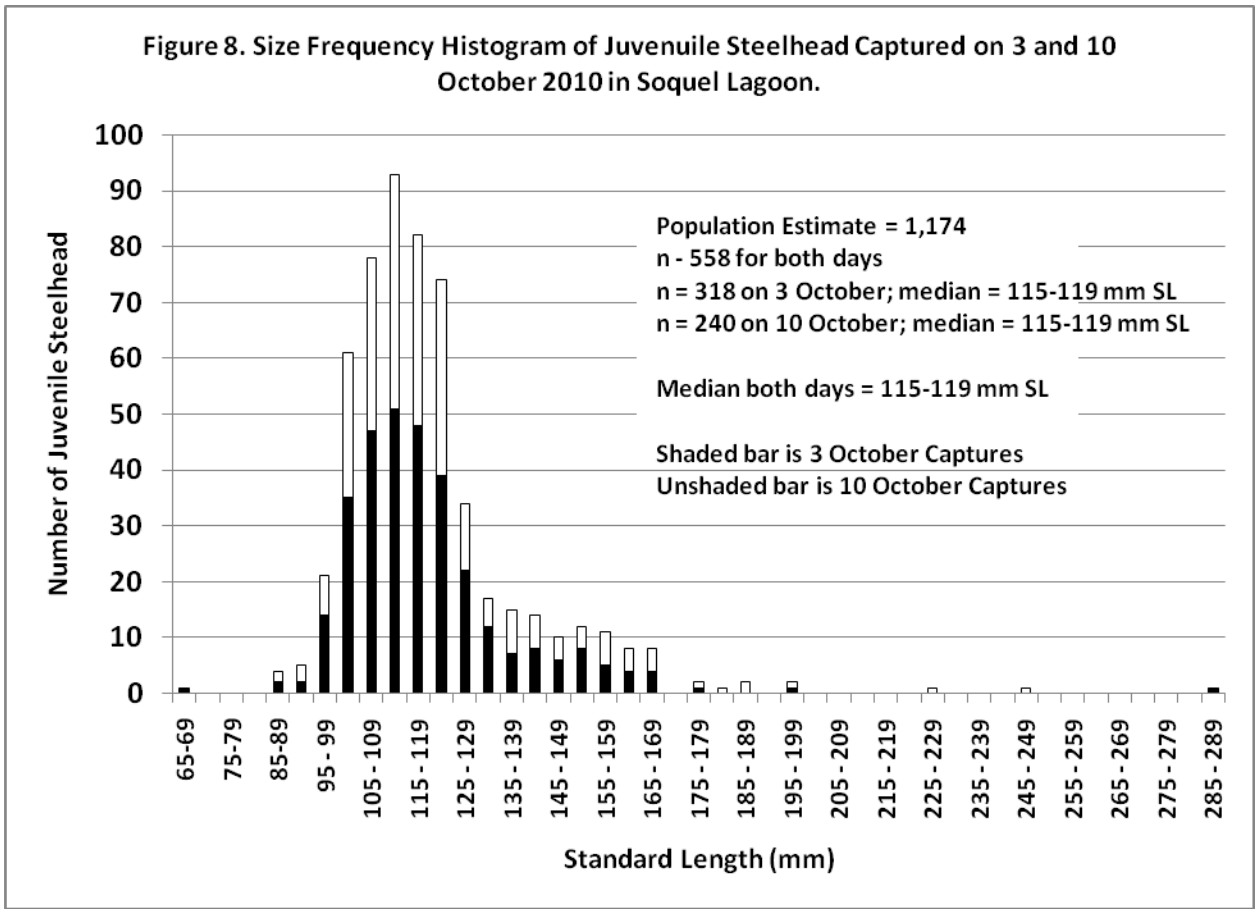


Figure 8. Size Frequency Histogram of Juvenuile Steelhead Captured on 3 and 10 October 2010 in Soquel Lagoon.
Number of Juvenile Steelhead
100
90
80
70
60
50
40
30
20
10
0
Population Estimate = 1,174
n - 558 for both days
n = 318 on 3 October; median = 115-119 mm SL
n = 240 on 10 October; median = 115-119 mm SL
Median both days = 115-119 mm SL
Shaded bar is 3 October Captures
Unshaded bar is 10 October Captures
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
Standard Length (mm)

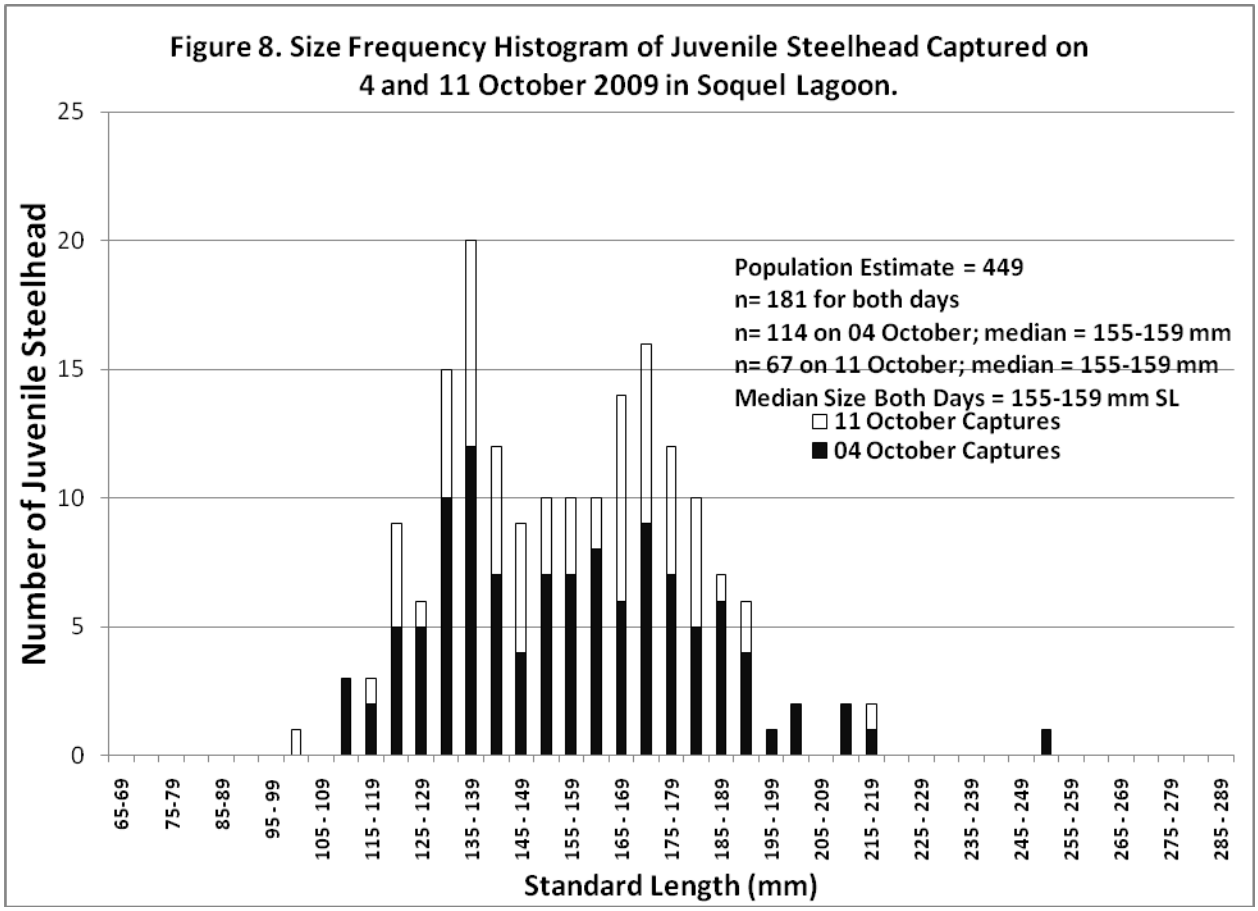


Figure 8. Size Frequency Histogram of Juvenile Steelhead Captured on 4 and 11 October 2009 in Soquel Lagoon.
Number of Juvenile Steelhead
25
20
15
10
5
0
Population Estimate = 449
n= 181 for both days
n= 114 on 04 October; median = 155-159 mm
n= 67 on 11 October; median = 155-159 mm
Median Size Both Days = 155-159 mm SL
11 October Captures
04 October Captures
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
Standard Length (mm)

Figure 8. Size Frequency Histogram of Juvenile Steelhead Captured on 27 September 2008 in the Soquel Lagoon.

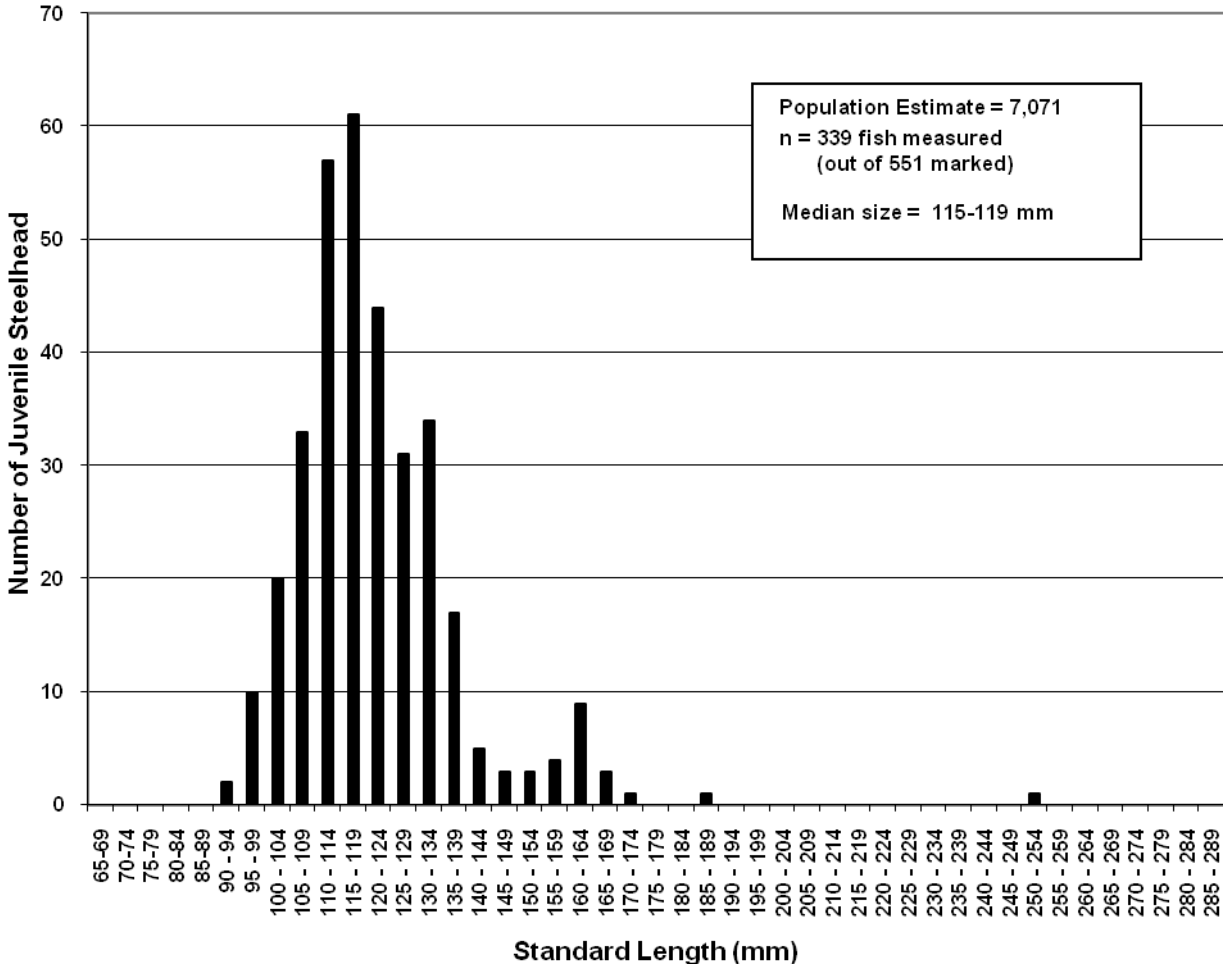


Figure 11. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 7 & 14 October 2007 in the Soquel Lagoon

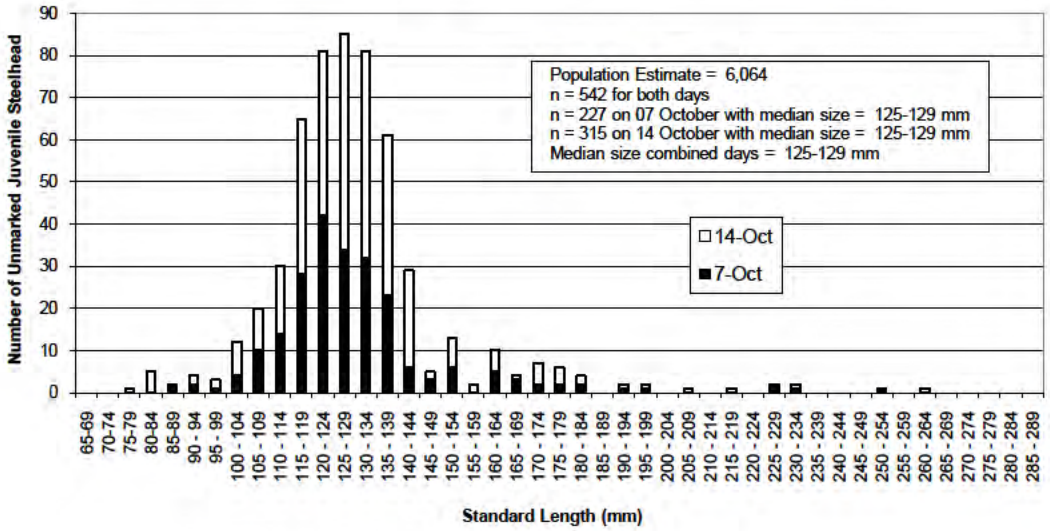


Figure 12. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 30 September and 8 October 2006 in Soquel Lagoon.

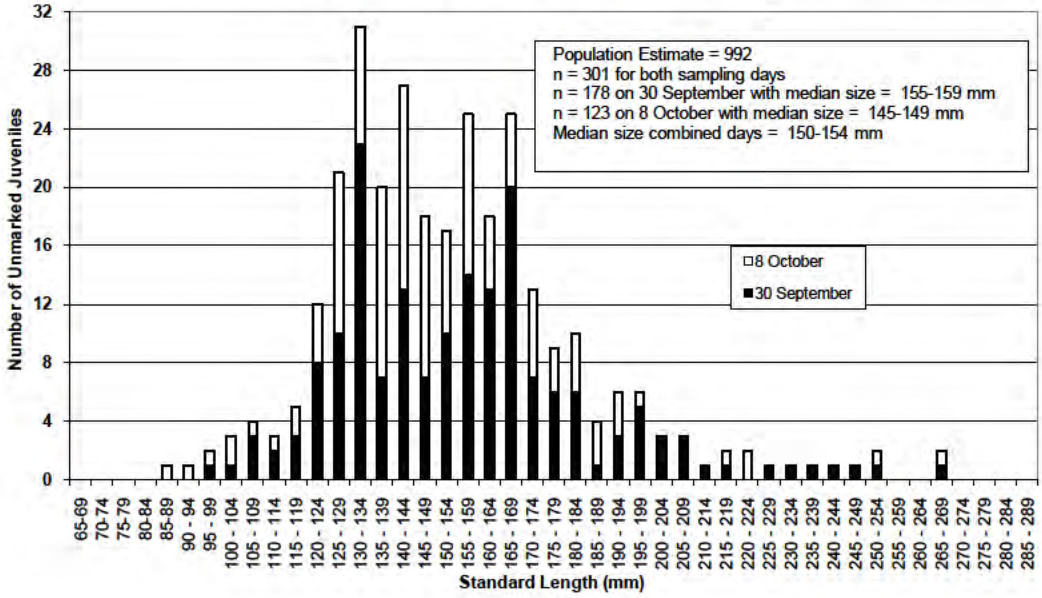


Figure 13. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 2 and 9 October 2005 in Soquel Lagoon.

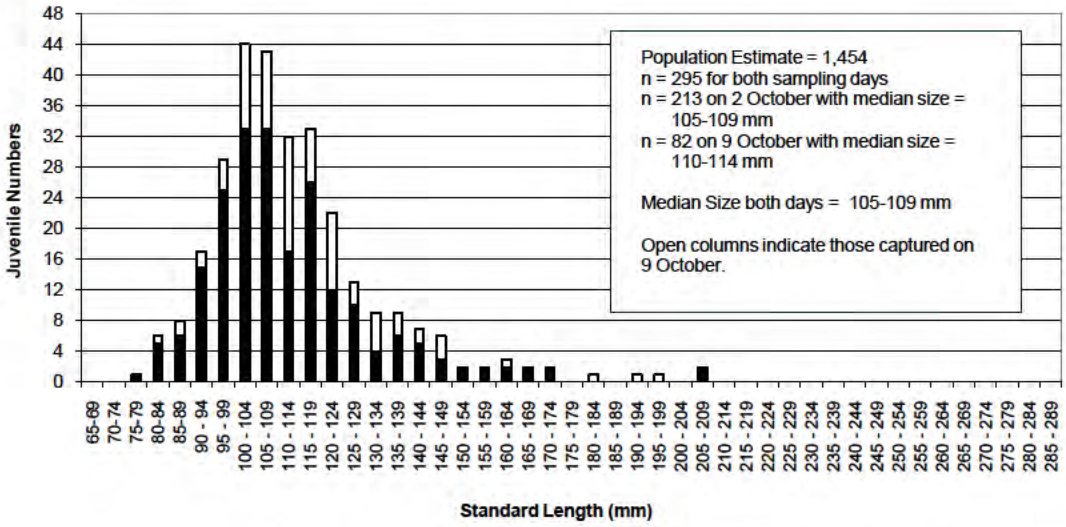


Figure 14. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 and 12 October 2004 in Soquel Lagoon.

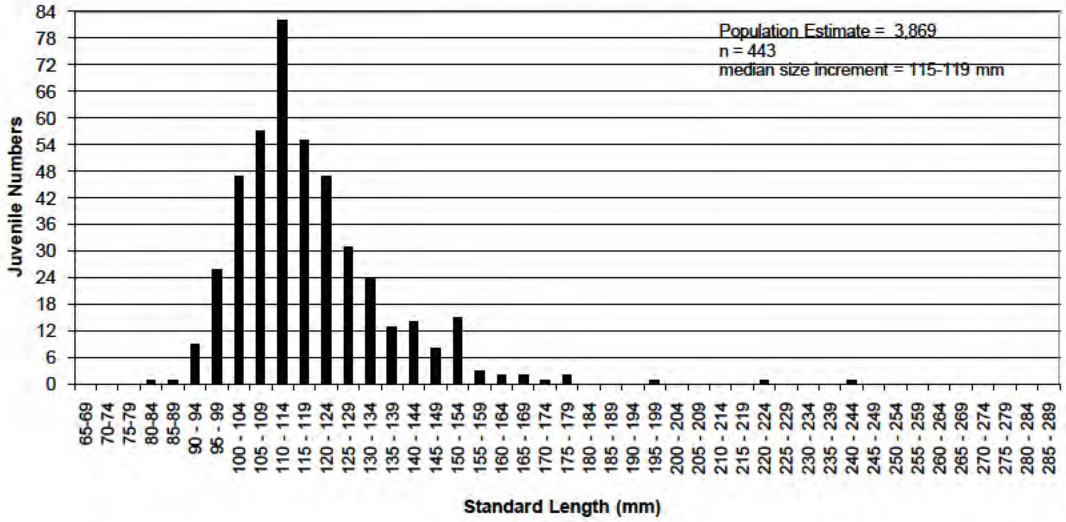


Figure 15. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 5 and 12 October 2003 in Soquel Lagoon.

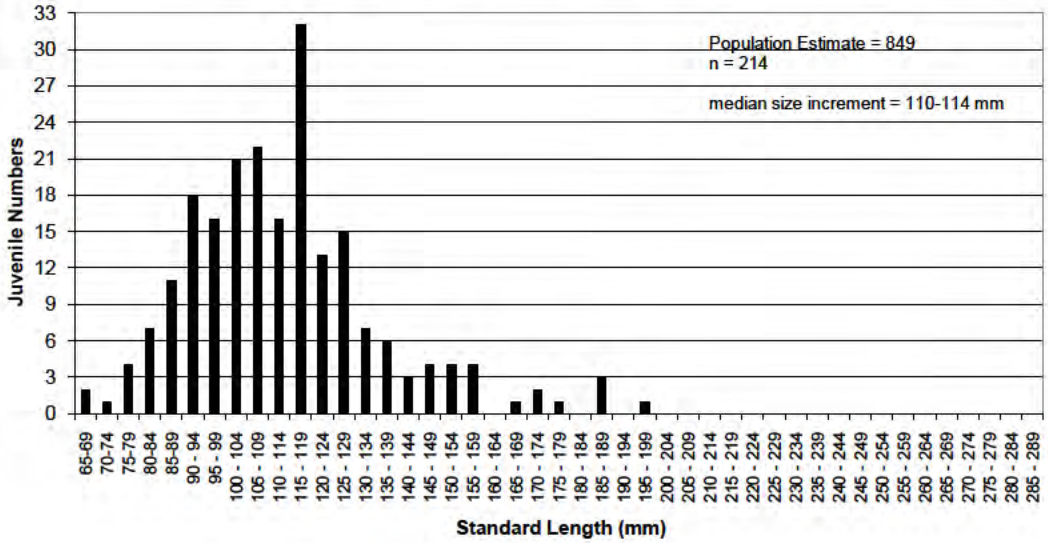


Figure 16. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 6 and 13 October 2002 in Soquel Lagoon.

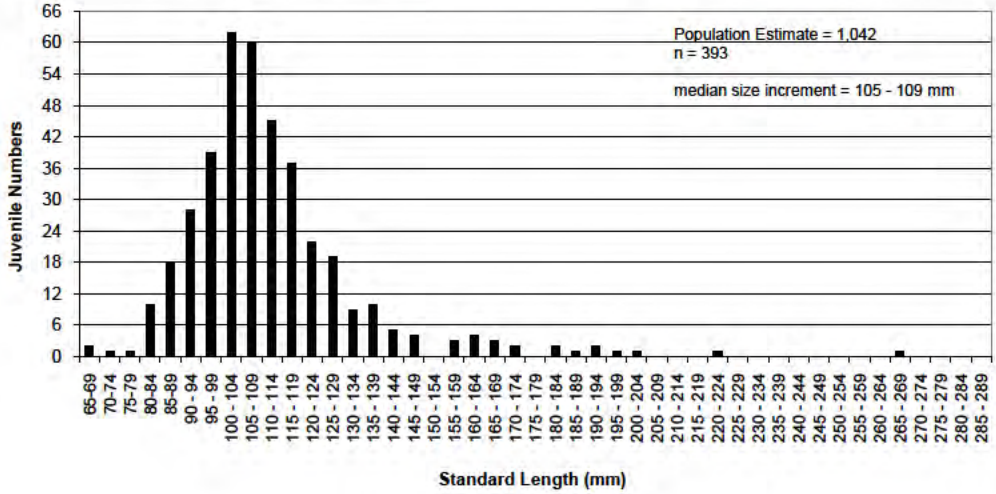


Figure 17. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 7 and 14 October 2001 in Soquel Lagoon.

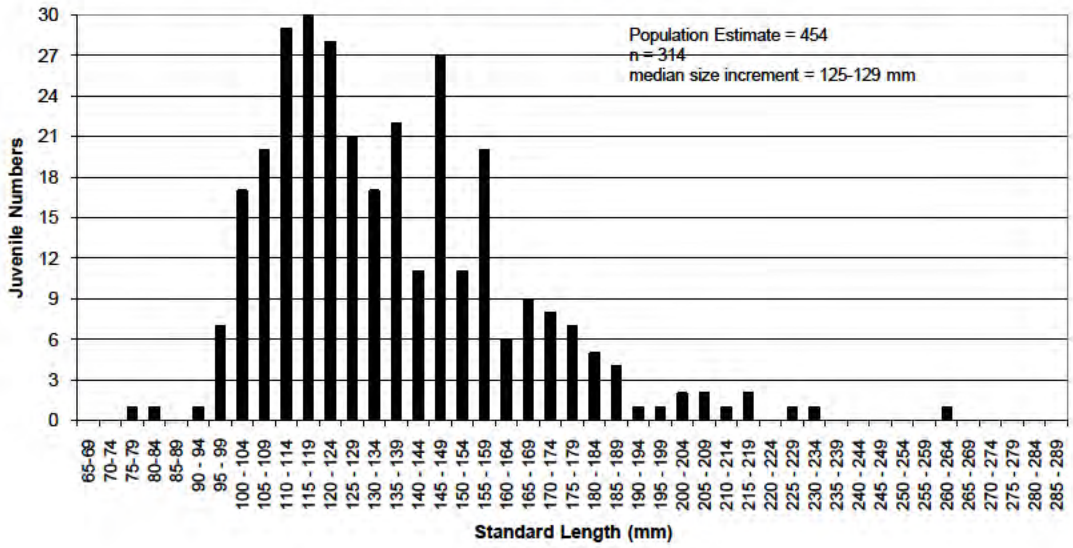


Figure 18. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 1 and 8 October 2000 in Soquel Lagoon.

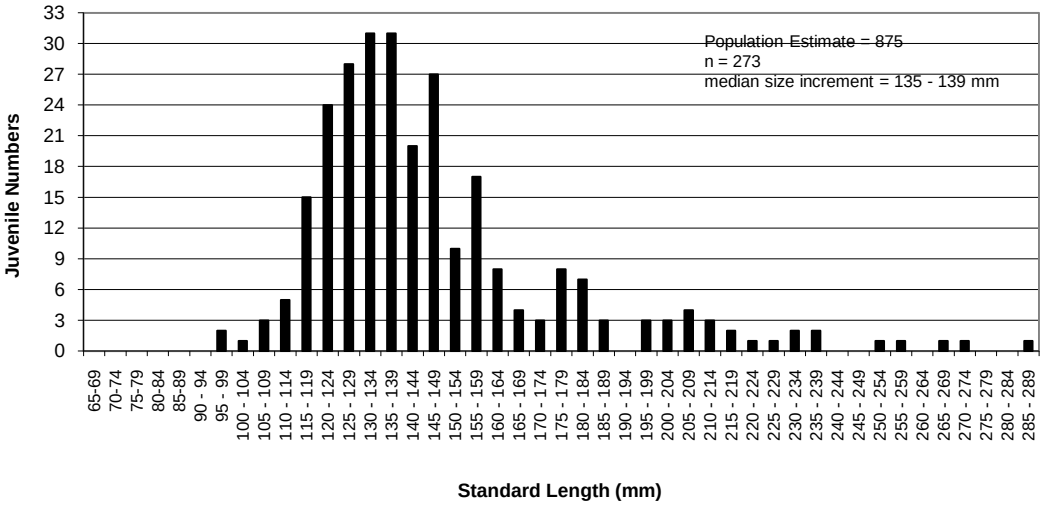


Figure 19. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 October 1999 (only) in Soquel Lagoon.

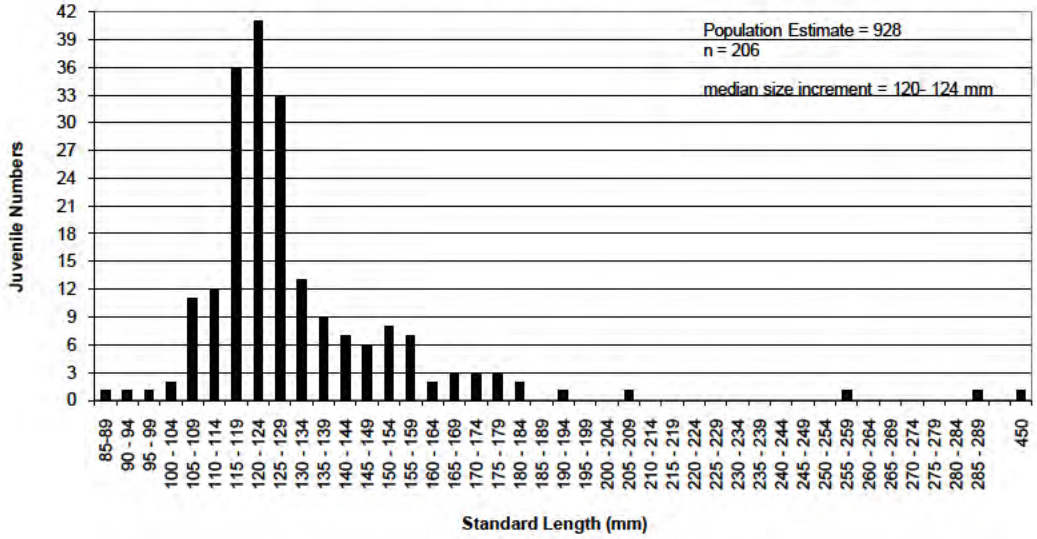


Figure 20. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 4 and 11 October 1998 in Soquel Lagoon.

Population Estimate = 671.

Figure 15. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 4 and 11 October 1998 in Soquel Lagoon.

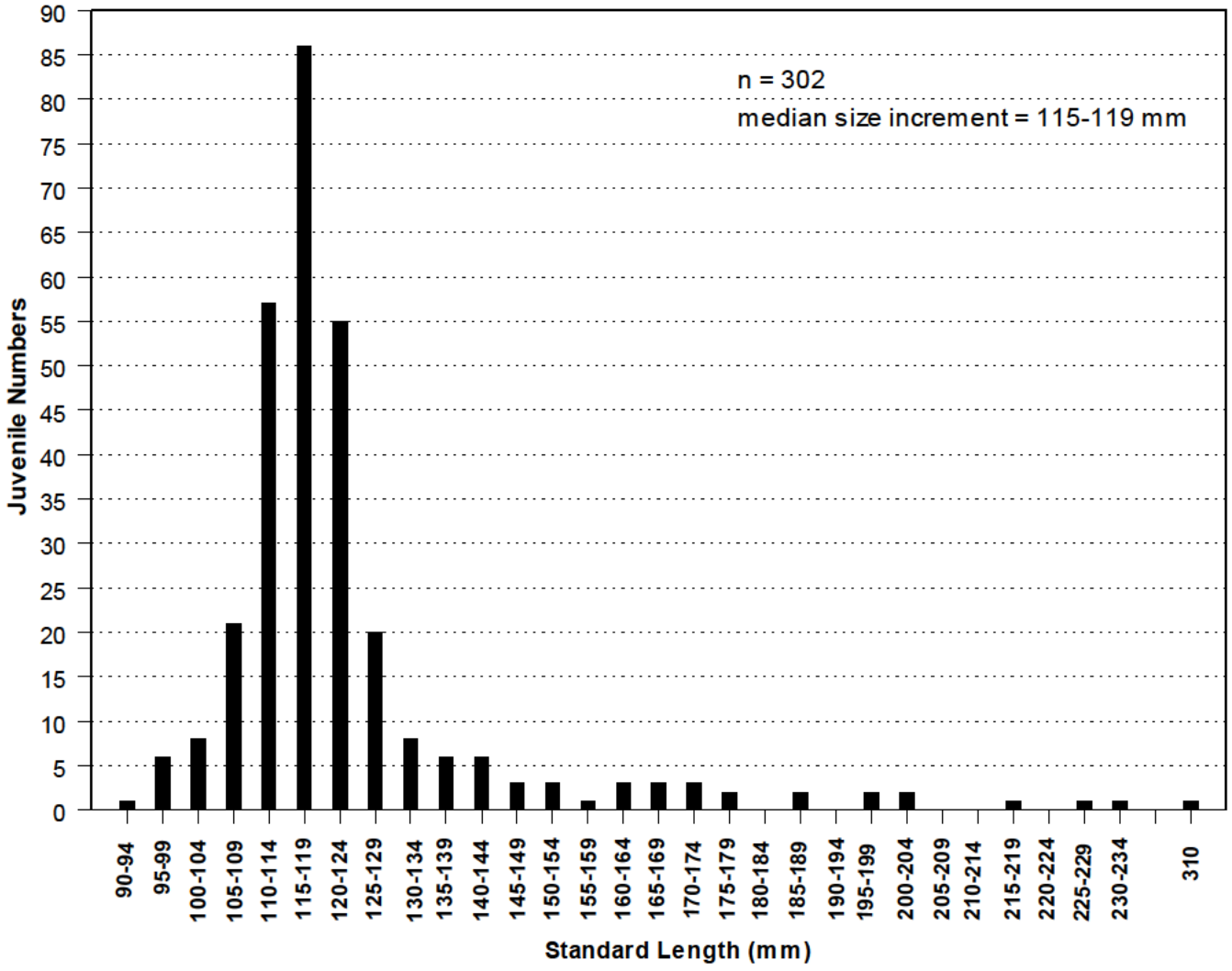


Figure 21. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 1 October 2009 – 30 September 2010.

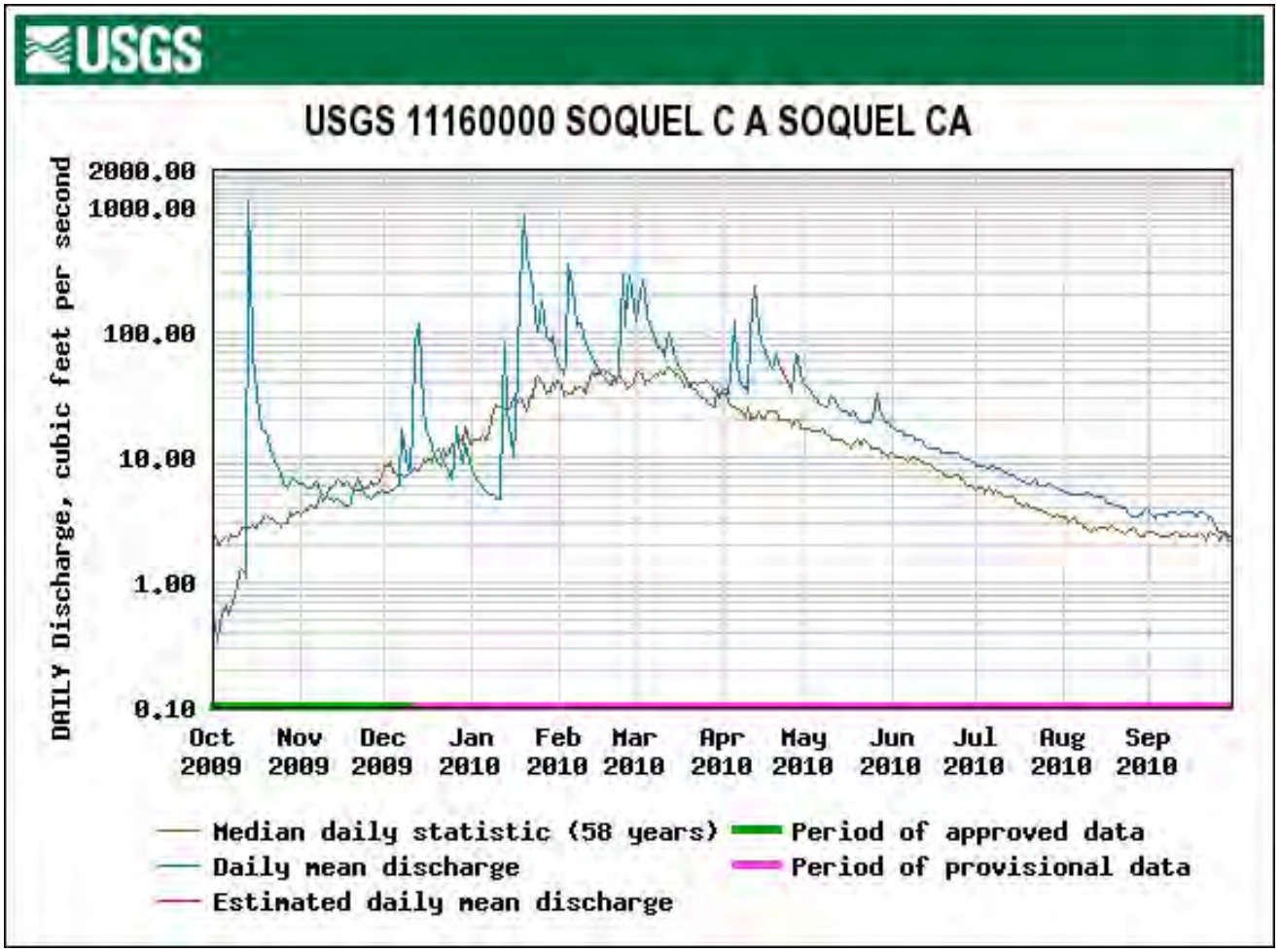


Figure 22. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 1 June 2010 – 30 November 2010.

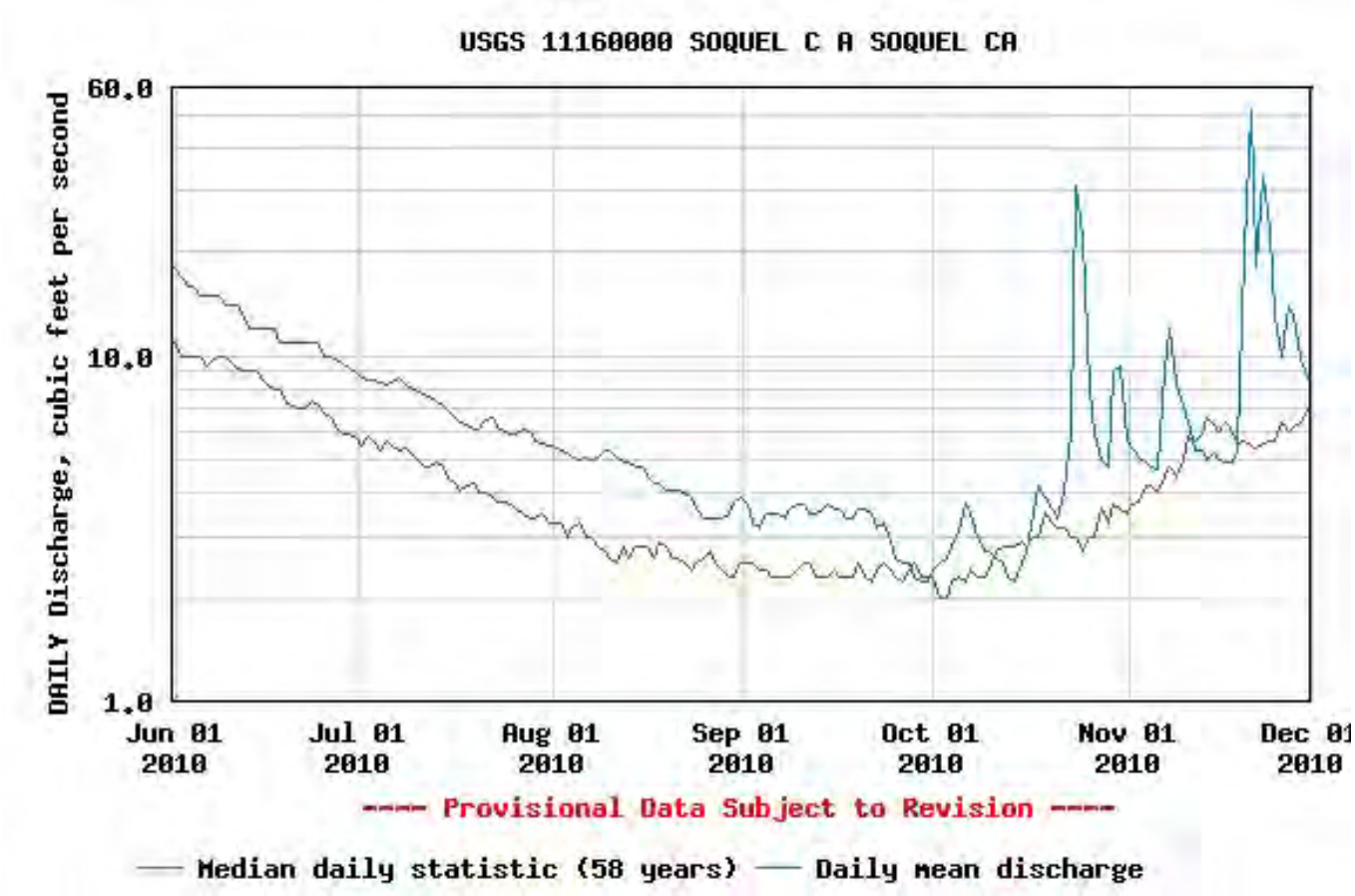


Figure 23. Soquel Creek Real-Time Streamflow at the USGS Gage in Soquel, CA, 2 October 2010 – 30 November 2010.

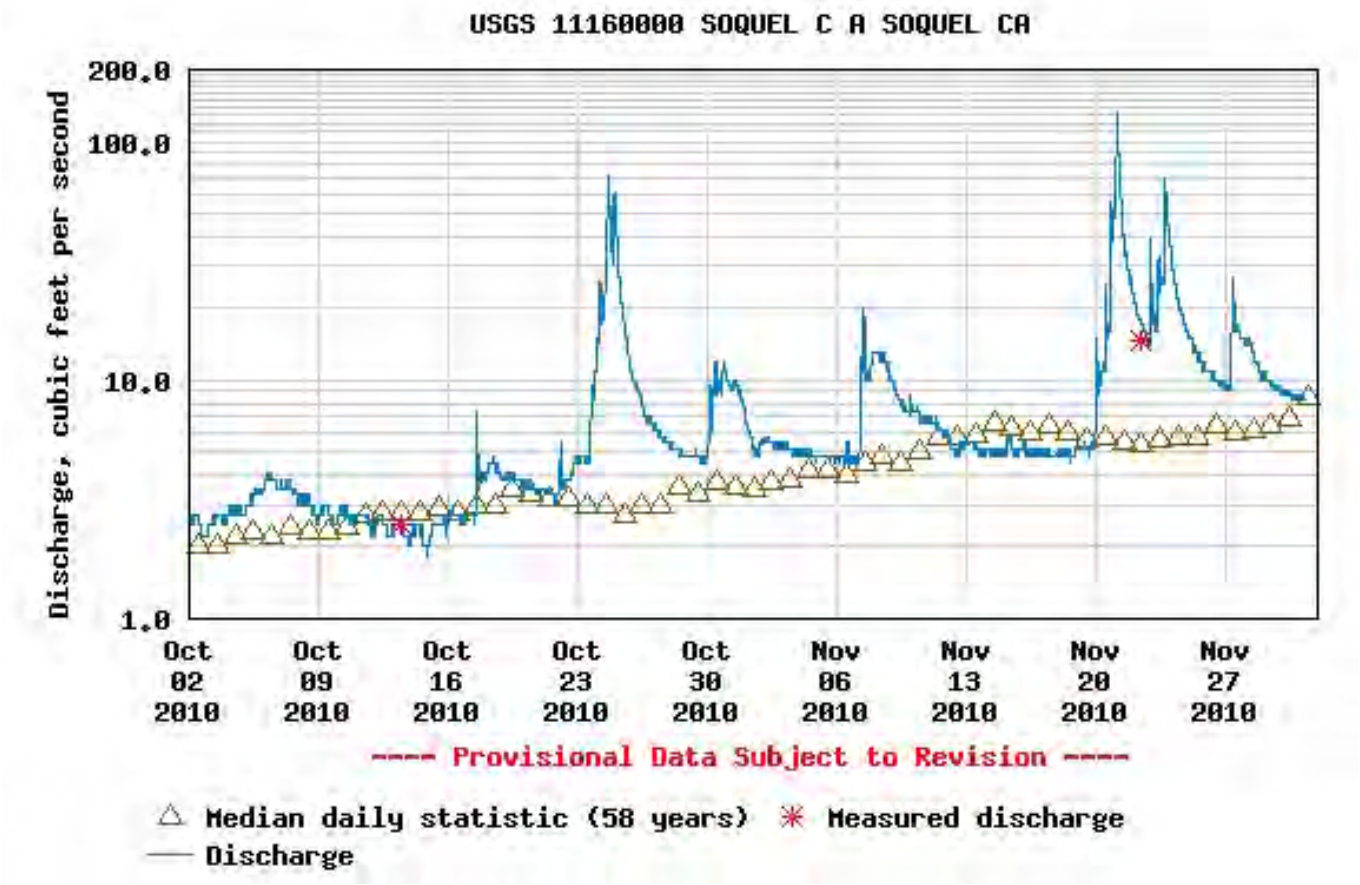


Figure 24. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 1 October 2008 – 30 September 2009.

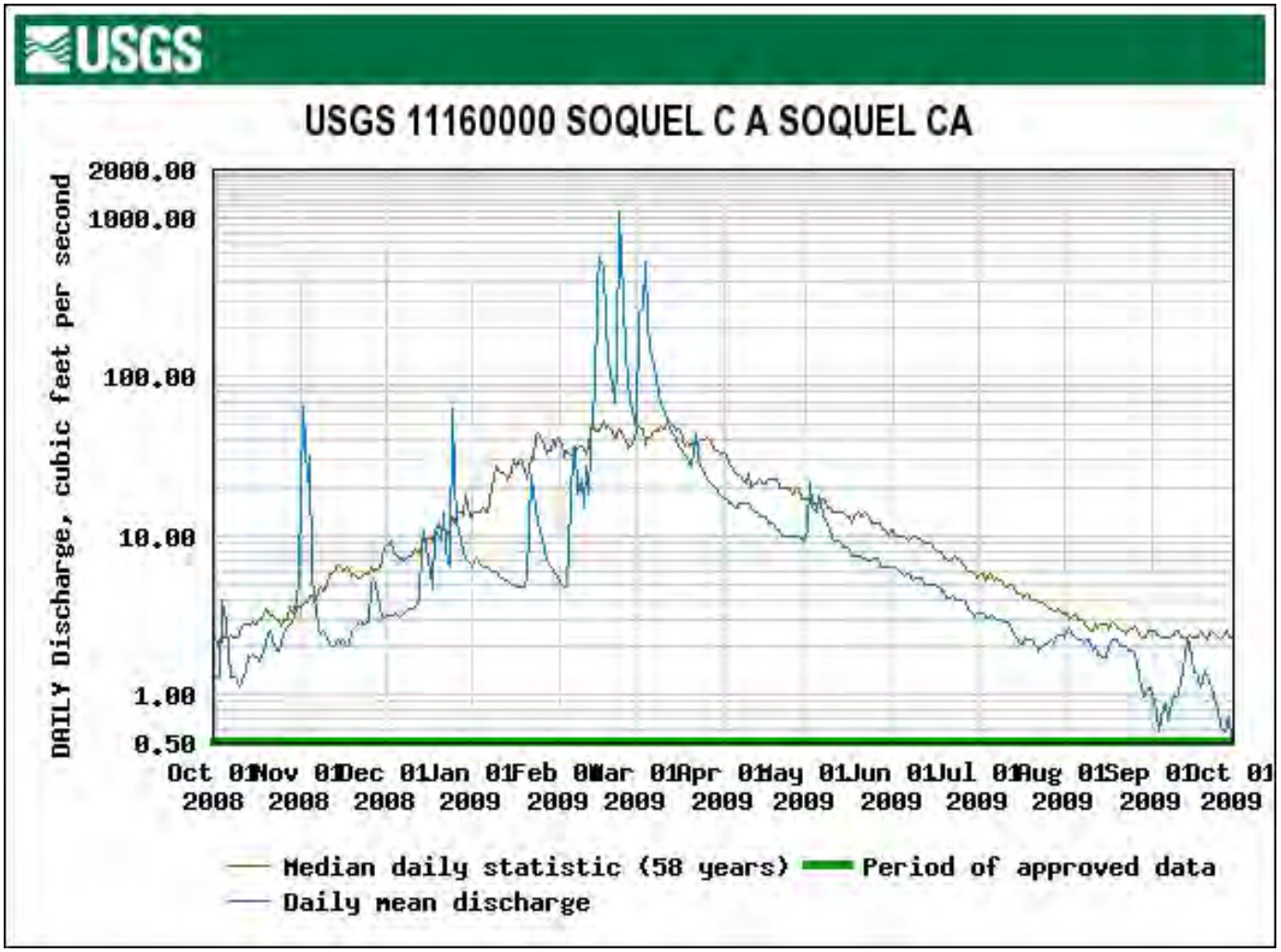
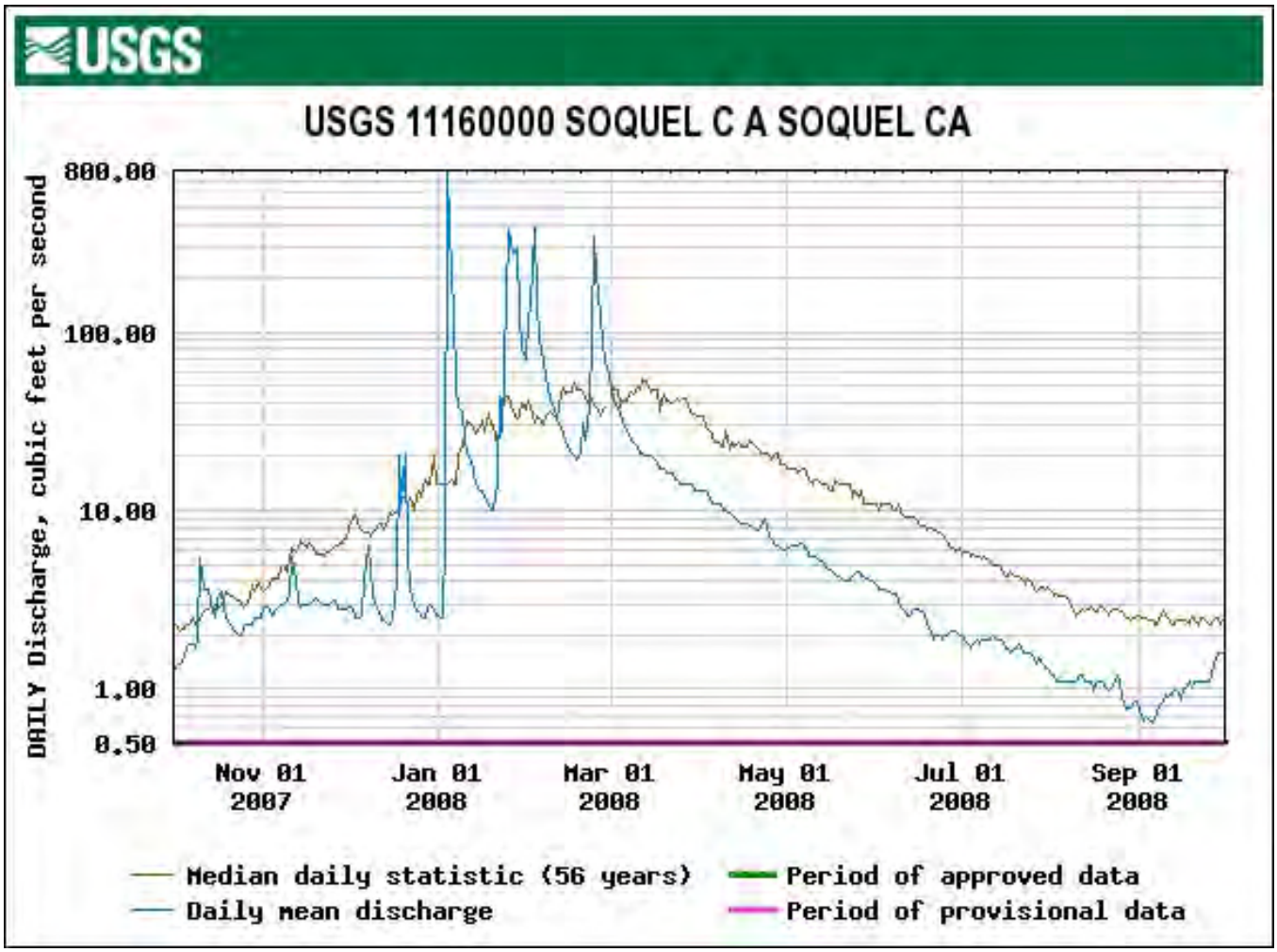


Figure 25. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 1 October 2007 – 30 September 2008.



APPENDIX A.

WATER QUALITY DATA AND GENERAL OBSERVATIONS OF BIRDS AND AQUATIC VEGETATION, 4 June – 23 October 2010.

4 June 2010. Launched temperature probes in the lagoon and upstream. The sandbar had been closed for the summer on 2 June. Gage height 2.01. Sunny. Saltwater was present in the deeper hole adjacent to the Venetian Court wall. Recommended to Morrison that shrouds be placed on flume inlet.

			4-June-10					
	Venetian Wall 1725 hr				**Stockton Ave Bridge Thalweg**			
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	20.2	0.3	8.39	644				
0.25	20.2	0.3	8.46	644				
0.50	20.2	0.3	8.42	644				
0.75	20.1	0.3	8.56	637				
1.00	19.9	0.3	8.58	636				
1.25	19.7	0.3	8.84	636				
1.50	19.6	0.3	8.73	636				
1.75	19.4	0.4	8.30	651				
2.00	18.9	3.2	0.46	4107				
2.15b	18.9	12.2	0.53	17540				
	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								

			19-Jun-10					
	Flume Inlet 0645 hr				**Stockton Ave Bridge** 0710 hr/ **Wetland outlet** 0830 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	16.9	0.3	9.78	621	16.8/16.2	0.4/0.4	10.28/10.23	617/611
0.25	17.0	0.3	10.02	620	16.9/16.2	0.4/0.4	10.26/10.28	617/611
0.50	17.0	0.3	10.12	620	16.8/16.2	0.4/0.4	10.16/10.23	612/611
0.75	17.0	0.3	10.11	621	16.5/16.2	0.4/0.4	10.22/10.08	611/611
1.00	17.0	0.3	10.11	620	16.4/16.2	0.4/0.4	10.16/10.08	611/611
1.15b	17.0	0.3	9.10	620				
1.25b					16.3/16.2	0.4/0.4	9.98/4.52	611/611
1.50					16.3	0.4	9.76	611
1.65b					16.4	0.4	3.62	614
1.75								

	Railroad Trestle 0756hr				**Mouth of Noble Gulch** 0812 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	16.1	0.4	9.19	609	15.4	0.4	9.20	600
0.25	16.1	0.4	9.13	609	15.4	0.4	9.12	600
0.50	16.1	0.4	9.12	609	15.4	0.4	9.09	600
0.75	16.1	0.4	9.10	609	15.4	0.4	9.14	600
1.00	16.1	0.4	9.09	609	15.4	0.4	9.23	600
1.15b					15.5	0.4	5.10	600
1.25	16.1	0.4	9.07	610				
1.42b	16.2	0.4	4.34	610				

		19-Jun-10		
	Venetian Wall 0847 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	16.4	0.4		
0.25	16.3	0.4		
0.50	16.5	0.4		
0.75	16.5	0.4		
1.00	16.6	0.4		
1.25	16.3	0.4		
1.50	16.2	0.4		
1.75	16.2	0.4		
2.00	16.2	0.4		
2.25b	16.2	0.4		

19 June 2010. Gage height 2.47. Partly cloudy. Sunny, cool and breezy. Air temperature 12.7 C at 0645 hr. Reach 1- no surface algae. 4 gulls bathing.
Station 2: Stockton Avenue Bridge at 0710 hr. Secchi depth to bottom. Reach 2- no surface algae.
Station 3: Railroad Trestle at 0756 hr. Reach 3- no surface algae. 21 mallards in water, 9 of which were small ducklings being chased by gull under overhanging willow
Station 4: Mouth of Noble Gulch at 0812 hr. No gray water observed from Noble Gulch. No surface algae. 6 of Reach 3 mallards near Gulch. 1 western pond turtle and greenback heron on downed cottonwood.
Station 5: Nob Hill at 0916 hr. Water temperature 14.4^{o}C. Conductivity 542 umhos. Salinity 0.3 ppt. Oxygen 11.03 mg/l. Estimated streamflow by hydrograph of 9 cfs.

			19-Jun-10					
	Flume		**1545 hr**		**Stockton Avenue Bridge**			1530hr
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	9.46	646	18.5	0.4	9.43	645
0.25	18.6	0.4	9.51	646	18.6	0.4	9.21	644
0.50	18.6	0.4	9.54	645	18.5	0.4	9.34	642
0.75	18.1	0.4	10.08	636	18.4	0.4	9.28	641
1.00	18.0	0.4	10.14	635	18.3	0.4	9.17	636
1.20b	18.1	0.4	8.78	637				
1.25					18.2	0.4	9.96	632
1.50					17.8	0.4	10.55	632
1.65b					17.8	0.4	5.16	632
	Railroad Trestle			1510 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	18.4	0.4	9.64	641	18.7	0.4	9.30	639
0.25	18.4	0.4	9.50	640	18.1	0.4	9.30	634
0.50	18.3	0.4	9.52	636	17.9	0.4	9.26	632
0.75	18.2	0.4	9.53	636	17.6	0.4	9.09	627
1.00	17.8	0.4	10.23	634	17.1	0.4	9.42	628
1.20b					17.4	0.4	6.06	663
1.25	17.6	0.4	10.29	629				
1.45b	17.7	0.4	4.80	630				
1.50								

19 June 2010. Gage height of 2.55 in afternoon. Sunny. Flume inlet 1.5 ft. Flume outlet 0.8 ft with both sides open. No saltwater at Venetian Wall. Underwater adult portal present. Recommended to Morrison that flume shrouds be removed.

Station 1: Flume at 1545 hr. Reach 1- 59 gulls bathing, 1 mallard. Air temp. 16.9 C. No surface algae. 10% of bottom algal clumps 0.3 ft thick, remainder of bottom covered with green film.

Station 2: Stockton Avenue Bridge at 1530 hr. Secchi depth to bottom. Reach 2- 6 mallards (3 domestic), 2 gulls; no surface algae. 15% of bottom algae 0.3 ft thick, remainder of bottom covered with green film.

Station 3: Railroad Trestle at 1510 hr. Reach 3- 7 mallards in water. No surface algae. 25% of bottom algal clumps 0.3 ft, remainder green film. No phytoplankton bloom that is usually present in early summer.

Station 4: Mouth of Noble Gulch at 1500 hr. 2 white ducks and 1 goose on redwood stump. 1 western pond turtle on cottonwood. No gray water.

			4-July-10					
	Flume 0702 hr				**Stockton Avenue Bridge07**15hr/ **Wetland Outlet** 0813hr			
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	9.32	650	17.6/16.9	0.4/0.4	9.77/10.07	649/645
0.25	17.6	0.4	9.27	650	17.6/17.3	0.4/0.4	9.66/10.01	650/645
0.50	17.5	0.4	9.31	648	17.6/17.2	0.4/0.4	9.67/9.98	650/644
0.75	17.4	0.4	9.44	647	17.6/17.2	0.4/0.4	9.54/9.91	649/644
1.00	17.3	0.4	9.39	646	17.6/17.2	0.4/0.4	9.58/9.54	646/641
1.25b	17.3	0.4	7.32	647	16.8/16.6	0.4/0.4	9.13/9.55	637/635
1.45b					/16.6	/0.4	/6.73	/635
1.50					16.7/	0.4/	9.15/	637/
1.75					16.7/	0.4/	4.78/	638/
2.00								
	Railroad Trestle 0732 hr				**Mouth of Noble Gulch**			0750 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	17.2	0.4	9.84	646	16.3	0.4	8.73	634
0.25	17.3	0.4	9.84	645	16.3	0.4	8.58	635
0.50	17.3	0.4	9.81	645	16.3	0.4	8.61	636
0.75	17.0	0.4	8.90	635	16.3	0.4	8.67	635
1.00	16.5	0.4	9.07	635	16.3	0.4	8.78	634
1.20b					16.3	0.4	4.37	630
1.25	16.5	0.4	9.05	635				
1.45b	16.5	0.4	4.55	635				

4 July 2010. Gage height of 2.58 in morning. Overcast/breezy. Air temperature of 14.0^{o}C at 0702 hr. Shrouds removed previously. Underwater adult portal removed as per permit. No sand depression around flume inlet, indicating that no water was leaking under flume.
Station 1: Flume 0702 hr. Reach 1- 6 gulls bathing. No surface algae.
Station 2: Stockton Bridge 0715 hr. Reach 2-no birds; no surface algae.
Station 3: Railroad trestle 0732 hr. Reach 3- 12adult mallards in water; one female with 1 duckling and another female with 2 ducklings. No surface algae.
Station 4: Noble Gulch 0750 hr. 17 mallards and 1 goose roosting on downed cottonwood and redwood stumps (2). No gray water.
Station 5: Nob Hill at 0840 hr. Water temperature 15.0^{o}C. Conductivity 606 umhos. Salinity 0.4 ppt. Oxygen 10.18 mg/l. Streamflow estimated 6.5 cfs.

			4-July-2010					
	Flume			1556 hr	**Stockton Avenue Bridge**			1536 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	9.84	655	17.8	0.4	9.52	654
0.25	17.9	0.4	9.83	655	17.8	0.4	9.53	654
0.50	17.8	0.4	9.73	655	17.8	0.4	9.44	653
0.75	17.8	0.4	9.76	655	17.8	0.4	9.24	652
1.00	17.7	0.4	9.93	653	17.7	0.4	9.39	648
1.15b	17.7	0.4	8.44	653				
1.25					17.5	0.4	9.60	646
1.50					17.3	0.4	9.45	646
1.75b					17.4	0.4	4.33	648
	Railroad Trestle			1521 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	17.5	0.4	9.72		17.3	0.4	9.23	644
0.25	17.5	0.4	9.64		17.2	0.4	9.12	642
0.50	17.5	0.4	9.60		17.0	0.4	8.98	639
0.75	17.4	0.4	9.60		16.6	0.4	9.45	638
1.00	17.0	0.4	9.93		16.5	0.4	9.53	637
1.20b					16.5	0.4	6.43	635
1.25	17.0	0.4	9.94					
1.45b	17.1	0.4	5.16					
1.50								

4 July 2010. Gage height of 2.58 in afternoon. Overcast, breezy. Air temperature of 16.0^{o}C at 1556 hr. Flume inlet approx. 1.3 ft depth. Flume exit depth 0.6 ft with both sides open. 4-inch gap with screening at top of flume outlet, allowing underwater access of smolts to flume. No water leakage observed around flume with no sand depression.

Station 1: Flume at 1556 hr. Reach 1- No surface algae. 30% of bottom with algae 0.2-0.4 ft thick; avg. 0.3 ft. Remainder film. 33 gulls bathing in Reach 1 in afternoon.

Station 2: Stockton Avenue Bridge at 1535 hr. Secchi depth to bottom. Reach 2- no surface algae, 60% of bottom covered with algae, 0.2- 0.4 ft thick, averaging 0.3 ft. Remainder film. 1 merganser that had moved down from near Shadowbrook in Reach 3.

Station 3: Railroad Trestle at 1521 hr. Reach 3- No surface algae, 30% of bottom covered with algae the same thickness as Reaches 1 and 2. 17 mallards and 3 mergansers in water.

Station 4: Mouth of Noble Gulch at 1505 hr. No gray water was entering lagoon from Noble Gulch. 5 mallards roosting on downed cottonwood. 1 merganser seen later in Reach 2, fishing.

			19-July-10					
	Flume 0712 hr				**Stockton Avenue Bridge** 0724 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	19.3	0.4	10.07	688	19.2	0.4	10.01	687
0.25	19.4	0.4	10.10	688	19.2	0.4	10.00	687
0.50	19.4	0.4	10.09	688	19.2	0.4	9.93	686
0.75	19.4	0.4	10.15	688	19.2	0.4	9.82	686
1.00	19.4	0.4	10.14	689	19.1	0.4	9.53	685
1.05b	19.4	0.4	7.50	687				
1.25					18.6	0.4	8.72	680
1.50					18.5	0.4	8.65	680
1.70b					18.5	0.4	4.82	681
1.75								
2.00								
			19-July-10					
	Railroad Trestle 0749 hr				**Mouth of Noble Gulch**			0803 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	18.7	0.4	10.12	681	17.7	0.4	8.27	670
0.25	18.8	0.4	10.09	682	17.7	0.4	8.13	671
0.50	18.8	0.4	9.98	681	17.7	0.4	8.13	671
0.75	18.1	0.4	9.03	680	17.7	0.4	7.97	669
1.00	17.9	0.4	8.91	671	17.7	0.4	9.02	661
1.13b					17.7	0.4	3.04	678
1.25	17.9	0.4	8.80	671				
1.32b	17.9	0.4	4.04	671				

19 July 2010. Gage height of 2.26 morning. Foggy. Air temperature of 15.4°C at 0712 hr. Flume still sealed at lagoon bottom.

Station 1: Flume at 0712 hr. Reach 1- 7 gulls and 8 mallards. 1 great blue heron at flume inlet. <1% surface algae.

Station 2: Stockton Avenue Bridge at 0724 hr. Secchi depth to bottom. Reach 2- 20 mallards attracted by man at Stockton Bridge Park. 2% surface algae.

Station 3: Railroad Trestle at 0749 hr. Reach 3- 1goose and 5 mallards(2 ducklings) near Noble Gulch. 1 merganser on redwood stump. No birds on cottonwood. 20% surface algae downstream of Noble Gulch, <1% upstream of Noble Gulch.

Station 4: Mouth of Noble Gulch at 0803 hr. No gray water.

Station 5: Nob Hill at 0832 hr. Water temperature 16.3° C. Conductivity 641 umhos. Oxygen 9.40 mg/l. Salinity 0.4 ppt. Streamflow estimated by hydrograph at 5 cfs.

			19-July-10					
	Flume 1623 hr				**Stockton Avenue Bridge** 1602 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	20.2	0.4	10.12	704	20.4	0.4	9.71	710
0.25	20.2	0.4	10.00	704	20.4	0.4	9.72	709
0.50	20.2	0.4	10.63	701	20.4	0.4	9.83	707
0.75	19.7	0.4	10.74	692	20.3	0.4	9.74	706
1.00	19.6	0.4	10.76	693	20.2	0.4	10.71	699
1.05b	19.7	0.4	7.24	682				
1.25					19.4	0.4	11.33	693
1.50					19.2	0.4	9.68	692
1.70b					19.1	0.4	3.86	690
1.75								
2.00								
			19-July-10					
	Railroad Trestle 1550 hr				**Mouth of Noble Gulch** 1515 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	20.8	0.4	9.94	710	21.0	0.4	9.15	707
0.25	20.7	0.4	9.80	710	20.5	0.4	8.94	703
0.50	20.6	0.4	9.78	708	19.2	0.4	9.85	693
0.75	20.5	0.4	9.82	703	18.7	0.4	10.24	685
1.00	19.3	0.4	12.09	687	18.6	0.4	10.07	683
1.20b					18.2	0.4	5.23	665
1.25	19.9	0.4	11.11	683				
1.32b	18.9	0.4	5.44	684				

19 July 2010. Gage height of 2.29. Clear. Air temperature of 15.6° C at 1623 hr. Flume inlet 1.0 ft. Flume outlet 0.4 ft with both sides open.

Station 1: Flume at 1623 hr. Reach 1- 39 gulls bathing. No surface algae. 70% of bottom covered with algae 0.3 – 2.0 ft thick, averaging 0.8 ft.

Station 2: Stockton Avenue Bridge at 1602 hr. Secchi depth to bottom. Reach 2- <1% surface algae. 60% of the bottom algae 0.4 – 1.5 ft thick, averaging 0.8 ft. No waterfowl.

Station 3: Railroad Trestle at 1550 hr. Reach 3- No surface algae, 80% bottom algae 0.4 – 1.5 ft, averaging 0.5 ft. <1% pondweed and algae 2 ft thick under railroad trestle. 1 mallard near cottonwood.

Station 4: Mouth of Noble Gulch at 1505 hr. Air temp 21.2° C. 4 mallards, 1 merganser, 1 goose and 3 western pond turtles on cottonwood. Phytoplankton bloom present, could not see bottom. 25% surface algae. Chainsaw being used on Golino property across lagoon.

Station 5: Nob Hill at 1715 hr. Water temperature 18.3° C. Conductivity 637 umhos. Oxygen 9.34 mg/l. Salinity 0.4 ppt.

			02-Aug-10					
	Flume 0655 hr				**Stockton Avenue Bridge** 0706 hr/ **Wetland Outlet** 0802 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	10.24	670	17.6/17.3	0.4/0.4	9.96/10.05	670/
0.25	17.7	0.4	10.39	670	17.6/17.3	0.4/0.4	9.90/10.12	670/
0.50	17.7	0.4	10.36	670	17.7/17.3	0.4/0.4	9.82/10.06	670/
0.75	17.8	0.4	10.41	669	17.6/17.3	0.4/0.4	9.75/10.07	670/
1.00	17.8	0.4	10.42	669	17.6/17.3	0.4/0.4	8.91/9.95	668/
1.15b	17.7	0.4	9.32	669				
1.25					17.3/17.2	0.4/0.4	8.91/9.47	666/
1.45b					/17.0	/0.4	/5.67	
1.50					17.3/	0.4/	8.85/	666/
1.75b					17.3/	0.4/	5.34/	666/
2.00								
			02-Aug-10					
	Railroad Trestle 0726 hr				**Mouth of Noble Gulch** 0740 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	17.2	0.4	10.37	664	15.8	0.4	9.31	636
0.25	17.2	0.4	10.34	664	15.9	0.4	8.99	643
0.50	17.2	0.4	10.64	663	15.9	0.4	8.82	648
0.75	17.0	0.4	8.58	663	15.9	0.4	8.86	647
1.00	16.7	0.4	8.51	660	15.9	0.4	8.70	648
1.25b	16.7	0.4	8.52	660	15.9	0.4	5.63	648
1.38b	16.7	0.4	5.31	661				

02 August 2010. Gage height of 2.44 (morning) and 2.45 (afternoon). Overcast at 0655 hr with air temperature of 13.4 ^{o}C. Air temperature 17.4^{o} C at 1613 hr and clear. Flume inlet 1.0 ft. Flume outlet 0.5 ft in afternoon with incoming tide.

Station 1: Flume at 0655 hr. Reach 1- 17 gulls bathing and 1 mallard. No surface algae.
Station 2: Stockton Avenue Bridge at 0706 hr. Secchi depth to the bottom. Reach 2- no birds; no surface algae.
Station 3: Railroad trestle at 0726 hr. Reach 3- 16 wild mallards and one domestic ducks dabbling. 15% surface algae between trestle and Noble Gulch. 1% surface algae upstream of the Gulch.
Station 4: Mouth of Noble Gulch at 0740 hr. 3% surface algae and gray water at Noble Gulch. 2 wild mallards, 3 domestic ducks, 1 goose and 1 cormorant on cottonwood.
Station 5: Nob Hill at 0830 hr. Water temperature at 15.2°C. Conductivity 623 umhos, Oxygen 9.47 mg/l. Salinity 0.4 ppt. Estimated flow by hydrograph of 4.5 cfs.

1613 hr			02-Aug-10					1549 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	18.9	0.4	11.05	688	19.1	0.4	10.71	692
0.25	18.5	0.4	11.81	687	19.1	0.4	10.50	691
0.50	18.4	0.4	11.73	678	19.0	0.4	10.80	689
0.75	18.3	0.4	11.96	678	18.9	0.4	10.8	687
1.00	18.3	0.4	11.91	677	18.7	0.4	10.23	683
1.13b	18.3	0.4	9.66	678				
1.25					18.3	0.4	12.08	669
1.50					17.8	0.4	11.79	667
1.62b					17.7	0.4	7.27	666
1.75								
2.00								
1534hr			02-Aug-10					1507 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	19.6	0.4	10.89	697	19.5	0.4	10.36	692
0.25	19.4	0.4	10.83	695	19.2	0.4	10.11	686
0.50	19.3	0.4	10.74	691	17.9	0.4	10.71	673
0.75	18.9	0.4	10.60	678	17.7	0.4	11.23	673
1.00	18.0	0.4	12.93	667	17.6	0.4	10.97	664
1.25b	17.8	0.4	12.23	667	17.4	0.4	7.43	656
1.45b	17.6	0.4	6.85	668				

Station 1: Flume at 1613 hr. Reach 1- no surface algae. 80% of bottom covered with algae 2 – 4 ft thick, averaging 3 foot. Remainder with algal film. 26 gulls bathing.
Station 2: Stockton Avenue Bridge at 1535 hr. Secchi depth to the bottom. Reach 2- <1% surface algae. 65% of bottom covered by algae 0.5 – 2 ft thick, averaging 1 ft. No surface algae. 2 mallards, 1 merganser. People feeding ducks.
Station 3: Railroad trestle at 1534 hr. Reach 3- Surface algae < 1%. 40% of bottom covered by algae 1- 3 ft thick, averaging 2 ft, remainder film. 6 mallards dabbling.
Station 4: Mouth of Noble Gulch at 1507 hr. Photoplankton bloom continues. 5% surface algae. 30% of bottom covered by algae 0.2 - 1 ft thick, averaging 0.5 ft. On downed cottonwood- 10 mallards and 1 western pond turtle. On redwood stump- 7 mallards and 1 goose. No gray water.
Station 5: Nob Hill at 1658 hr. Water temperature at 17.3°C. Conductivity 657 umhos, Oxygen 10.04 mg/l. Salinity 0.4 ppt.

0717hr			15-Aug-10					0731hr/0827hr
	Flume				**Stockton Avenue Bridge/ Wetland Outlet**			
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	17.8	0.4	9.72	678	17.6/17.2	0.4/0.4	10.14/9.73	675/673
0.25	17.8	0.4	9.80	678	17.7/17.4	0.4/0.4	10.17/9.82	675/674
0.50	17.8	0.4	9.63	678	17.7/17.4	0.4/0.4	10.06/9.37	675/673
0.75	17.9	0.4	9.80	678	17.7/17.4	0.4/0.4	9.98/9.51	674/673
1.00	17.9	0.4	9.74	680	17.4/17.2	0.4/0.4	7.66/8.13	673/670
1.25b	17.8	0.4	5.44	680	17.2/16.9	0.4/0.4	8.04/7.89	673/669
1.30b					/16.8	/0.4	/5.64	/670
1.50					17.1/	0.4/	7.63/	673/
1.60b					17.1/	0.4/	5.57/	674/
1.75								
2.00								
0802hr			15-Aug-10					0814hr
	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	9.63	675	16.4	0.4	9.62	625
0.25	17.5	0.4	9.61	675	16.1	0.4	8.54	628
0.50	17.5	0.4	9.60	674	16.1	0.4	7.85	657
0.75	17.1	0.4	7.78	667	16.1	0.4	7.82	657
1.00	16.6	0.4	7.57	665	16.1	0.4	7.71	659
1.15b					16.1	0.4	5.33	658
1.25b	16.6	0.4	5.44	666				

15 August 2010. Gage height of 2.25 (morning) and 2.26 (afternoon). Overcast in morning and sunny in afternoon. Air temperature of 14.1°C at 0717 hr and 16.8ºC at 1542 hr. Flume inlet at 1.0 ft. Flume outlet 0.5 feet.

Station 1: Flume at 0717 hr. Reach 1- 20 gulls bathing, 1 pelican, 3 mergansers feeding after moving down from Reach 3. 95 steelhead surface hits/ minute at 0733 hr. Flume at 1542 hr. Reach 1- No surface algae. 85% of bottom with algae 0.6-2.0 ft thick, averaging 1 ft thick; 15% pondweed with algae 2-4 ft thick, avg. = 3.0 ft. 56 gulls bathing.

Station 2: Stockton Avenue Bridge at 0731 hr. Reach 2- no birds. Steelhead hits on surface. Cattail at wetland broken. Reach 2 at 1528 hr. Secchi depth to bottom. No surface algae. 40% of bottom covered with algae 0.3 – 1.5 ft thick, averaging 0.8 ft. 2% pondweed and algae 2 - 3 ft thick, averaging 2.5 ft. 3 mergansers have moved down to trestle area from upstream.

Station 3: Railroad trestle at 0802 hr. Reach 3- 3 merganser fishing, 6 mallards, 1 pied-billed grebe. At 1500 hr, 5 mallards, 1 coot and 1 pied-billed grebe in water. Reach 3- <No surface algae; 50% of bottom covered with algae 0.2 - 2.0 ft thick, averaging 1 ft; 1% pondweed with algae 2-3 ft thick, avg. = 2.5 ft.

Station 4: Mouth of Noble Gulch at 0814 hr. On redwood stump- 3 mallards and 1 gull. Gray water. At 1500 hr, gray-green soup with bottom invisible. On cottonwood - 8 mallards, 1 domestic duck, 3 mergansers and two western pond turtles.

Station 5: Nob Hill at 0850 hr. Water temperature at 15.4°C. Conductivity 629 umhos, Oxygen 9.70

mg/l. Salinity 0.4 ppt. Visually estimated flow of 4 cfs. Nob Hill at 1623 hr. Water temperature 17.4° C. Oxygen 9.31 mg/l. Conductivity 668 umhos. Salinity 0.4 ppt. Estimated streamflow by hydrograph of 3.5 cfs.

1542 hr			15-Aug-10					1528 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	18.9	0.4	10.55	696	19.3	0.4	10.14	701
0.25	18.9	0.4	10.67	694	19.2	0.4	10.17	699
0.50	18.5	0.4	10.92	688	19.0	0.4	9.98	695
0.75	18.4	0.4	11.10	686	18.8	0.4	10.12	690
1.00	18.3	0.4	11.41	684	18.5	0.4	10.96	685
1.13b	18.4	0.4	8.28	684				
1.25					18.2	0.4	10.65	681
1.50					18.1	0.4	10.90	678
1.65b					18.0	0.4	7.23	680
1.75								
2.00								
2.10b								
1514 hr			15-Aug-10					1500 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	19.4	0.4	10.50	697	19.8	0.4	10.00	706
0.25	19.2	0.4	10.45	697	19.5	0.4	9.72	698
0.50	19.0	0.4	10.43	696	18.2	0.4	10.40	677
0.75	18.8	0.4	9.86	689	17.9	0.4	10.72	682
1.00	18.0	0.4	12.34	673	17.8	0.4	10.71	678
1.25b	17.7	0.4	11.06	672	17.7	0.4	11.38	674
1.38b	17.7	0.4	7.50	672				

0728 hr			29-Aug-10					0742 hr/0825 hr
	Flume				**Stockton Avenue Bridge/ Wetland Outlet**			
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	18.2	0.4	9.35	692	18.2/18.1	0.4/0.4	8.81/8.61	691/692
0.25	18.3	0.4	9.49	692	18.2/18.2	0.4/0.4	8.77/8.62	691/692
0.50	18.3	0.4	9.46	692	18.3/18.2	0.4/0.4	8.72/8.68	691/692
0.75	18.3	0.4	9.52	692	18.3/18.2	0.4/0.4	8.66/8.75	691/692
1.00	18.4	0.4	9.53	692	18.3/18.1	0.4/0.4	8.41/8.77	691/690
1.25	18.3	0.4	9.54	691	18.3/18.0	0.4/0.4	8.45/8.57	692/688
1.30b	18.3	0.4	2.14	691	/17.9	/0.4	/5.73	/688
1.50					18.3/	0.4/0.4	8.56/	692/
1.75b					18.3/	0.4/0.4	6.20/	692/
0756 hr			29-Aug-10					0810 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	17.7	0.4	8.02	686	16.6	0.4	8.18	674
0.25	17.8	0.4	7.85	686	16.7	0.4	8.02	674
0.50	17.7	0.4	7.48	686	16.7	0.4	7.89	609
0.75	17.7	0.4	7.66	685	16.6	0.4	8.00	668
1.00	17.7	0.4	7.59	685	16.6	0.4	7.95	660
1.25b	17.7	0.4	7.67	685	16.6	0.4	5.01	660
1.33b	17.8	0.4	5.33	685				
1.50								

29 August 2010. Gage height of 2.37 (morning) and 2.46 (afternoon). Cloudy in morning and sunny in afternoon. Air temperature of 12.0° C at 0728 hr and 14.6°C at 1602 hr.

Station 1: Flume at 0728 hr. Reach 1- 51 gulls bathing and 2 mallards; 35 steelhead surface hits/ minute. No surface algae. Flume at 1602 hr. Reach 1- No surface algae. 60% of bottom with algae 0.5 – 3 ft thick, averaging 2 ft. Failed to count gulls bathing.

Station 2: Stockton Avenue Bridge at 0742 hr. Reach 2- No surface algae; No birds. Reach 2 at 1531 hr. No surface algae. 99% of bottom covered with algae 0.5 - 4 ft thick, averaging 1.0 ft. 3 domestic ducks, 1wild mallard, 1 gull in water.

Station 3: Railroad trestle at 0756 hr. Reach 3- No surface algae; 22 mallards, 1 cormorant, 2 pied-billed grebes in water. At 1517 hr, Reach 3- No surface algae; 99% bottom covered with algae 0.5- 4.0 ft, avg. = 1.0 ft. 6 mallards dabbling. Clouds of black knats along pathway.

Station 4: Mouth of Noble Gulch at 0810 hr. No surface algae and no gray water. On redwood stumps- 1 goose, 3 mallards 1 coot. At 1500 hr. Bottom invisible. No surface algae. On cottonwood- 3 pond turtles. Gray water.

Station 5: Nob Hill at 0857 hr. Water temperature 14.9° C. Oxygen 8.75 mg/l. Conductivity 633 umhos. Salinity 0.4 ppt. Estimated streamflow from hydrograph of 2.8 cfs. Nob Hill at 1653 hr. Water temperature 16.0° C. Oxygen 8.42 mg/l. Conductivity 650 umhos. Salinity 0.4 ppt.

1602 hr			29-Aug-10					1531 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	19.8	0.4	10.27	712	19.8	0.4	9.75	714
0.25	19.8	0.4	10.31	710	19.8	0.4	9.66	714
0.50	19.5	0.4	10.75	708	19.6	0.4	9.41	711
0.75	19.4	0.4	10.73	703	19.5	0.4	9.39	710
1.00	19.2	0.4	11.22	702	19.2	0.4	10.01	701
1.25	19.2	0.4	11.21	702	18.8	0.4	10.79	699
1.33b	19.2	0.4	8.01	703				
1.50b					18.8	0.4	10.58	699
1.75b					18.8	0.4	7.83	699
1517 hr			29-Aug-10					1500 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	19.6	0.4	10.03	709	20.0	0.4	8.47	715
0.25	19.6	0.4	9.83	709	19.5	0.4	8.64	706
0.50	19.5	0.4	9.71	708	19.0	0.4	8.28	700
0.75	19.5	0.4	9.67	706	18.2	0.4	9.62	690
1.00	18.8	0.4	9.95	691	18.0	0.4	10.04	686
1.25b	18.3	0.4	11.24	685	17.9	0.4	12.83	680
1.40b	18.3	0.4	8.03	687				

0848 hr	Begonia	Festival	05-Sep-10		Begonia	Festival		0902 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	18.5	0.4	8.65	703	18.4	0.4	8.15	700
0.25	18.6	0.4	8.67	703	18.4	0.4	8.26	700
0.50	18.6	0.4	8.76	703	18.4	0.4	8.19	700
0.75	18.7	0.4	8.78	703	18.4	0.4	8.10	700
1.00	18.7	0.4	8.76	703	18.4	0.4	8.09	699
1.25	18.7	0.4	8.79	703	18.2	0.4	6.94	700
1.30b	18.7	0.4	6.41	703				
1.50					18.2	0.4	6.86	701
1.55b					18.3	0.4	4.34	701
1.75								
			05-Sep-10					
0927 hr	**Railroad Trestle**				**Mouth of Noble Gulch**			0943 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	18.1	0.4	7.75	697	17.1	0.4	7.22	- (incorrect dial setting)
0.25	18.1	0.4	7.65	697	17.0	0.4	7.17	-
0.50	18.2	0.4	7.38	697	16.6	0.4	7.01	-
0.75	17.9	0.4	5.36	696	16.6	0.4	6.88	-
1.00	17.5	0.4	5.77	694	16.6	0.4	7.01	-
1.13b					16.6	0.4	5.44	-
1.25	17.4	0.4	6.04	693				
1.35b	17.5	0.4	3.72	693				
			5-Sep-10					1419 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					19.0	0.4	10.98	710
0.25					19.0	0.4	10.93	708
0.50					18.9	0.4	10.80	707
0.75					18.7	0.4	10.47	704
1.00					18.7	0.4	10.66	703
1.25					18.8	0.4	13.58	703
1.50					18.8	0.4	10.85	703
1.55b					18.5	0.4	8.95	702
1.75								

			05-Sep-10					1405 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					17.9	0.4	9.39	692
0.25					17.6	0.4	9.43	691
0.50					17.5	0.4	9.28	690
0.75					17.5	0.4	9.29	688
1.00					17.4	0.4	9.61	687
1.20b					17.5	0.4	9.24	691

05 September 2010. Begonia Festival Day. Gage height of 2.20 (morning) and 2.22 (afternoon). Overcast in morning at 1000 hr and stayed that way until early afternoon. Water temperatures were slightly warmer in the morning than the previous week, and oxygen levels were slightly less. There was an oxygen depression at depth at the trestle compared to other sites. Water temperature increased less than 1° C by the afternoon monitoring, but oxygen increased 2 mg/l despite the largely overcast day thus far. Waders were officially prohibited from propelling floats again this year. However, a float propelled by a surf board paddler also temporarily used a wader to pull on a guide rope. He disturbed the lagoon bottom in the vicinity of the trestle. We do not know if officials instructed the wader to exit the lagoon. At least 4 of the10 floats were propelled by electric motor. One float used poles for propulsion. Spectators viewing the procession from the railroad trestle were expelled by the police from the trestle part way through the procession, and observations were interrupted. One of the floats may have been propelled with pedal boats.

The secchi depth (water clarity) was to the lagoon bottom after the float procession. Oxygen levels were supersaturated in a cooler lagoon than most years. Conductivity was slightly higher after the procession than before, indicating slightly more dissolved minerals in the water. No fish mortalities were observed. Only 1 wild mallard was observed in the lagoon this day. Flower petals were collected by Begonia Festival staff and volunteers the following week.

0715 hr			12-Sep-10					0734hr/0822hr
	Flume				**Stockton Avenue Bridge/ Wetland Outlet**			
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	17.7	0.4	9.78	685	17.5/17.4	0.4/0.4	9.37/9.17	686/685
0.25	17.7	0.4	9.81	685	17.6/17.5	0.4/0.4	.34/8.96	686/685
0.50	17.8	0.4	9.84	685	17.6/17.5	0.4/0.4	9.28/8.86	686/685
0.75	17.8	0.4	9.88	685	17.6/17.5	0.4/0.4	9.26/8.87	686/685
1.00	17.8	0.4	9.77	685	17.6/17.5	0.4/0.4	9.27/8.93	686/685
1.25b	17.8	0.4	9.53	686	17.6/17.5	0.4/0.4	9.14/4.92	686/685
1.30b	17.8	0.4	6.24	685				
1.50					17.6/	0.4/	9.15/	686/
1.68b					17.6/	0.4/	6.16/	687/
1.75								
0751 hr			12-Sep-10					0805 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	7.98	685	16.5	0.4	7.95	676
0.25	17.4	0.4	8.01	685	16.6	0.4	8.16	676
0.50	17.4	0.4	7.74	685	16.6	0.4	8.05	677
0.75	17.3	0.4	7.75	685	16.5	0.4	7.73	679
1.00	17.3	0.4	7.79	685	16.5	0.4	7.65	677
1.17b					16.5	0.4	3.74	678
1.25	17.3	0.4	7.68	685				
1.37b	17.3	0.4	4.59	685				

12 September 2010. Weekend of Art and Wine Festival. Gage height of 2.23 (morning) and 2.24 (afternoon). Overcast in the morning and cloudy in afternoon. Air temperature of 13.8 ^{o}C at 0715 hr and 15.1^{o}C at 1541 hr.

Station 1: Flume at 0715 hr. Reach 1- 28 gulls bathing. Steelhead lightly hitting surface. No surface algae.

Station 2: Stockton Avenue Bridge at 0734 hr. Reach 2-no birds. No surface algae.

Station 3: Railroad Trestle at 0751 hr. Reach 3- 3 pied-billed grebes, 11 mallards, 3 domestic ducks, 1 goose and 1 coot in water. Lady was feeding birds. No surface algae above Noble Gulch, 1% up.

Station 4: Mouth of Noble Gulch at 0805 hr. On cottonwood- 1 wild mallard and 1 domestic duck. No gray water.

Station 5: Nob Hill at 0845 hr. Water temperature of 15.2^{o} C. Conductivity of 646 umhos. Oxygen 8.46 mg/l. Salinity 0.4 ppt. Streamflow estimated by hydrograph at 3 cfs. Great blue heron observed.

1541 hr			12-Sep-10					1456 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	18.0	0.4	10.51	689	17.9	0.4	9.78	687
0.25	18.0	0.4	10.86	689	17.9	0.4	9.57	687
0.50	18.0	0.4	10.90	689	17.7	0.4	9.52	687
0.75	17.9	0.4	10.91	688	17.7	0.4	9.63	687
1.00	18.0	0.4	11.03	689	17.6	0.4	10.01	686
1.25	17.9	0.4	10.96	689	17.5	0.4	10.10	688
1.35b	18.0	0.4	7.39	689				
1.50					17.5	0.4	10.14	688
1.68b					17.6	0.4	7.42	686
1.75								
1516 hr			12-Sep-10					1456 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	9.97	684	17.5	0.4	8.63	683
0.25	17.4	0.4	9.86	685	17.2	0.4	8.53	681
0.50	17.3	0.4	10.05	685	16.8	0.4	8.87	675
0.75	17.3	0.4	10.06	685	16.7	0.4	8.86	681
1.00	17.1	0.4	10.14	682	16.6	0.4	8.84	671
1.13b					16.6	0.4	7.42	669
1.25	17.1	0.4	10.21	682				
1.35b	17.1	0.4	6.84	682				

12 September 2010.

Station 1: Flume at 1541 hr. Reach 1- No surface algae, too dark to see bottom vegetation. 44 gulls bathing.

Station 2: Stockton Avenue Bridge at 1526 hr. Reach 2- No surface algae. Too dark to see bottom vegetation. No waterfowl.

Station 3: Railroad Trestle at 1516 hr. Reach 3- No surface algae; too dark to see bottom vegetation. Reach 3- 7 mallards, 3 domestic ducks, 1 pied-billed grebe, 1 goose in water near Noble Gulch.

Station 4: Mouth of Noble Gulch at 1456 hr. No surface algae; too dark to see bottom vegetation. No roosting birds.

Station 5: Nob Hill at 1630 hr. Water temperature of 15.5^{o} C. Conductivity of 648 umhos. Oxygen 9.32 mg/l. Salinity 0.4 ppt.

0737 hr			26-Sep-10					0749 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	17.7	0.4	11.01	690	17.8	0.4	11.06	693
0.25	17.8	0.4	11.08	690	17.8	0.4	10.84	694
0.50	17.8	0.4	11.05	690	17.9	0.4	10.70	696
0.75	17.8	0.4	11.18	690	17.9	0.4	10.56	696
1.00	17.8	0.4	11.15	690	17.8	0.4	10.16	696
1.25	17.8	0.4	11.09	690	17.8	0.4	9.49	696
1.30b	17.8	0.4	8.34	690				
1.50					17.8	0.4	9.38	696
1.67b					17.9	0.4	6.73	696
1.75								
0808 hr			26-Sep-10					0824 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	17.5	0.4	8.71	694	17.1	0.4	8.10	689
0.25	17.6	0.4	8.66	694	17.2	0.4	7.95	689
0.50	17.6	0.4	8.68	694	17.2	0.4	8.05	689
0.75	17.6	0.4	8.34	694	17.2	0.4	7.72	688
1.00	17.6	0.4	7.71	696	17.1	0.4	7.86	684
1.25b	17.6	0.4	4.14	700	17.1	0.4	1.48	690
1.50								

26 September 2010. Gage height of 2.34 (morning) and 2.30 (afternoon). Light fog in morning and clear in afternoon. Air temperature of 16.3° C at 0737 hr, 16.13° C at Flume at 1610 hr.
Station 1: Flume at 0737 hr. Reach 1- 17 gulls bathing. <1% surface algae.
Station 2: Stockton Avenue Bridge at 0749 hr. Reach 2- No birds. 3% surface algae.
Station 3: Railroad Trestle at 0808 hr. Reach 3- 3 mallards, 6 coots, 1 pied-billed grebe in water. 1 black-crowned night heron roosting in willow closer to Shadowbrook.
Station 4: Mouth of Noble Gulch at 0824 hr. 2 mallards, 3 domestic ducks, 1 goose on downed cottonwood. No gray water.
Station 5: Nob Hill at 0852 hr. Water temperature of 15.5° C. Conductivity of 653 umhos. Oxygen 8.11 mg/l. Salinity 0.4 ppt. Streamflow estimated from hydrograph at 2 cfs.

1610 hr			26-Sep-2010					1546 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	19.6	0.4	12.82	725	19.8	0.4	11.93	729
0.25	19.5	0.4	12.74	724	19.6	0.4	11.84	728
0.50	19.4	0.4	13.19	720	19.6	0.4	11.62	727
0.75	19.1	0.4	1.43	716	19.4	0.4	12.05	720
1.00	19.1	0.4	13.39	716	18.9	0.4	12.53	711
1.25b	19.1	0.4	9.04	715	18.3	0.4	10.92	708
1.50					18.2	0.4	10.51	708
1.60b					18.1	0.4	8.15	708
1.75								
1536 hr			26-Sep-2010					1502 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	20.7	0.4	12.05	735	21.0	0.4	10.47	739
0.25	20.3	0.4	11.70	734	20.1	0.4	9.83	727
0.50	20.0	0.4	11.45	724	18.8	0.4	9.86	717
0.75	19.1	0.4	13.43	710	18.6	0.4	11.77	699
1.00	18.7	0.4	12.64	705	18.2	0.4	9.83	650
1.25b	18.3	0.4	12.50	703	17.7	0.4	7.44	659
1.30b	18.3	0.4	7.04	704				

26 September 2010.

Station 1: Flume at 1610 hr. Reach 1- <1% surface algae. 20% bottom algae and pondweed 2 – 5 ft thick, averaging 3.5 ft; 40% bottom algae 0.2-3 ft thick, averaging 0.5 ft; remainder film. 87 gulls, 1 pelican on shore.

Station 2: Stockton Avenue Bridge at 1546 hr. Reach 2- Secchi depth to bottom. 3% surface algae. 15% bottom algae and pondweed (near trestle); 85% bottom algae 0.2 – 3 ft thick, averaging 0.5 feet. 8 mallards, 3 domestic ducks in water.

Station 3: Railroad Trestle at 1536 hr. Reach 3- 2% surface algae. 10% bottom algae and pondweed 2 – 5 ft thick, averaging 3.5 ft; 90% bottom algae 0.2 – 4 ft thick, averaging 0.5 ft. 6 mallards, 2 pied-billed grebes, 2 coots, 2 mergansers and 1 goose in water near Noble Gulch.

Station 4: Mouth of Noble Gulch at 1502 hr. 30% surface algae. 30% bottom algae 2-4 ft thick, averaging 3 ft, remainder film. On cottonwood- 1 pond turtle. On redwood stump- 2 gulls. No gray water.

Station 5: Nob Hill at 1700 hr. Water temperature of 16.7° C. Conductivity of 676 umhos. Oxygen 8.43 mg/l. Salinity 0.4 ppt.

0729 hr			9-Oct-2010					0743 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	15.3	0.4	9.75	654	15.5	0.4	9.62	657
0.25	15.4	0.4	9.89	654	15.6	0.4	9.63	657
0.50	15.5	0.4	9.88	654	15.6	0.4	9.52	657
0.75	15.5	0.4	9.91	654	15.6	0.4	9.31	658
1.00	15.5	0.4	9.87	654	15.6	0.4	9.26	658
1.20b	15.5	0.4	7.17	655				
1.25					15.6	0.4	9.18	658
1.50					15.6	0.4	9.46	658
1.55b					15.6	0.4	6.19	658
1.75								
0801 hr			9-Oct-2010					0817 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	15.4	0.4	8.88	660	14.7	0.4	8.92	668
0.25	15.4	0.4	8.81	660	14.8	0.4	8.89	667
0.50	15.4	0.4	8.85	660	14.7	0.4	9.04	666
0.75	15.4	0.4	8.83	660	14.7	0.4	8.99	666
1.00	15.4	0.4	8.76	660	14.7	0.4	8.93	666
1.13b					14.7	0.4	6.49	666
1.25b	15.5	0.4	3.79	660				

9 October 2010. Gage height of 2.21 (morning) and 2.21 (afternoon). Clear all day and breezy late. Air temperature of 10.7 °C at 0729 hr and 15.7°C at 1558 hr. Flume inlet 1.0 ft, flume outlet 0.5 ft in afternoon. Notch cut in sandbar berm. Secondary berm in place near surf.

Station 1: Flume at 0729 hr. Reach 1- 26 gulls and 1 coot. 1% surface algae.

Station 2: Stockton Avenue Bridge at 0743 hr. Reach 2- 2 coots, 1 gull, 1 pied-billed grebe and 1 goose on trestle abutment. 1% surface algae.

Station 3: Railroad Trestle at 0801 hr. Reach 3- 10 coots, mallards absent, 2 pied-billed grebes, 1 black-crowned night heron perched on willow near Shadowbrook Restaurant. No surface algae.

Station 4: Mouth of Noble Gulch at 0817 hr. Ducks absent and nothing on cottonwood or redwood stumps. No surface algae.

Station 5: Nob Hill at 0850 hr. Water temperature of 13.7 °C. Conductivity of 648 umhos. Oxygen 8.88 mg/l. Salinity 0.4 ppt. Estimated flow from gage reading at 2 cfs.

1558 hr			9-Oct-2010					1543 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	17.2	0.4	13.06	681	17.5	0.4	12.28	685
0.25	17.2	0.4	13.08	681	17.5	0.4	12.04	684
0.50	16.9	0.4	13.08	681	17.3	0.4	11.79	684
0.75	16.8	0.4	13.38	681	17.1	0.4	10.98	681
1.00	16.8	0.4	13.54	681	16.8	0.4	12.23	678
1.25b	16.8	0.4	13.50	680	16.4	0.4	11.87	676
1.50					16.4	0.4	11.74	674
1.55b					16.3	0.4	8.40	674
1.75								
1527 hr			9-Oct-2010					1506 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	17.8	0.4	12.27	692	17.8	0.4	10.60	703
0.25	17.6	0.4	12.26	691	17.8	0.4	10.45	694
0.50	17.4	0.4	12.21	687	16.4	0.4	11.76	674
0.75	17.1	0.4	11.91	677	16.2	0.4	12.17	686
1.00	16.4	0.4	12.87	671	15.8	0.4	11.75	681
1.13b					15.8	0.4	10.97	681
1.25	16.1	0.4	12.79	665				
1.30b	16.1	0.4	12.83	662				

9 October 2010.

Station 1: Flume at 1558 hr in Reach 1, 62 gulls bathing. No surface algae. 20% algae and pondweed 2-5 ft; averaging 4 ft thick. 60% bottom algae 0.3-1.0 ft; average 0.7 feet thick. Remainder film.

Station 2: Stockton Avenue Bridge at 1543 hr in Reach 2, no surface algae. 30% algae and pondweed 2-4 ft thick; average 3 feet. 50% bottom algae 0.5 – 3 feet thick; averaging 2 feet. Remainder film. 1 coot, 1 gull.

Station 3: Railroad Trestle at 1527hr. Reach 3- 1% surface algae. 20% algae and pondweed 2 – 5 feet thick; average 3 ft. 70% bottom algae 0.5 – 4 feet thick; average 1 ft. Remainder film. 5 coots and 1 gull. , 2 white ducks near Shadowbrook with 2 wild mallards.

Station 4: Mouth of Noble Gulch at 1506 hr, 15 ft x 30 ft algal matt on surface just downstream of Gulch. 30% bottom algae 1 – 4 feet thick; averaging 3 ft. Remainder film. On cottonwood- 3 domestic ducks, 1 goose and 2 wild mallards. Redwood stump – 1 gull.

Station 5: Nob Hill at 1708 hr. Water temperature of 15 ^{o}C. Conductivity of 666 umhos. Oxygen 8.84 mg/l. Salinity 0.4 ppt.

17 October 2010. Prior to a small storm on 18 October, Morrison removed the screen with a 4-inch opening from the flume inlet, which had been in place for much of the summer, and replaced it with a flashboard. This left an 8-inch opening in preparation for the stormflow. This 8-inch opening was maintained until 24 October.

0723 hr			23-Oct-10					0736 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	14.6	0.4	6.29	635	14.3	0.4	6.68	628
0.25	14.7	0.4	6.23	635	14.6	0.4	6.00	629
0.50	14.7	0.4	6.23	634	14.7	0.4	5.99	629
0.75	14.7	0.4	6.22	634	14.7	0.4	5.95	629
1.00	14.7	0.4	6.27	634	14.7	0.4	5.75	630
1.20b	14.6	0.4	5.04	634				
1.25					14.7	0.4	5.73	629
1.45b					14.7	0.4	2.80	630
1.50								
1.75								
0757 hr			23-Oct-10					0810 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	14.4	0.4	5.33	620	14.0	0.4	6.43	629
0.25	14.5	0.4	5.28	621	14.0	0.4	6.43	636
0.50	14.5	0.4	5.30	621	14.0	0.4	6.54	636
0.75	14.5	0.4	5.25	620	14.0	0.4	6.57	635
1.00	14.5	0.4	5.21	621	14.0	0.4	6.43	636
1.13b	14.5	0.4	4.12	621	14.0	0.4	2.13	635
1.25								
1.50								

23 October 2010. Gage height of 2.12 (morning) and 2.10 (afternoon). Overcast in morning and light misting rain in afternoon. Air temperature of 11.2° C at 0723 hr, 14.9° C at Flume at 1530 hr.
Station 1: Flume at 0723 hr. Reach 1- 63 gulls bathing; mallards moving down from Reach 2. No surface algae. 1 steelhead surface hit.
Station 2: Stockton Avenue Bridge at 0736 hr. Reach 2- 11 coots and 2 mallards in water. 2 mallards on trestle abutment. 1 steelhead surface hit. No surface algae.
Station 3: Railroad Trestle at 0757 hr. Reach 3- 2 mallards, 12 coots, 2 pied-billed grebes in water. No surface algae.
Station 4: Mouth of Noble Gulch at 0810 hr. No birds using downed wood. No gray water.
Station 5: Nob Hill at 0835 hr. Water temperature of 13.4° C. Conductivity of 625 umhos. Oxygen 9.00 mg/l. Salinity 0.4 ppt. Streamflow estimated from hydrograph at 2 cfs.

1530 hr			23-Oct-10					1515 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	15.3	0.4	7.56	647	15.6	0.4	6.46	642
0.25	15.2	0.4	7.54	645	15.4	0.4	6.43	642
0.50	15.1	0.4	6.26	644	15.4	0.4	6.27	638
0.75	15.0	0.4	6.71	639	15.0	0.4	6.76	634
1.00	15.0	0.4	6.59	639	14.7	0.4	6.34	635
1.20b	15.0	0.4	4.86	640				
1.25					14.6	0.4	6.08	636
1.45b					14.6	0.4	4.39	636
1.50								
1.75								
1505 hr			23-Oct-10					1455 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	15.4	0.4	6.11	639	15.1	0.4	6.82	615
0.25	15.4	0.4	6.08	638	15.0	0.4	6.69	622
0.50	15.4	0.4	6.10	636	14.6	0.4	6.40	639
0.75	14.9	0.4	4.97	628	14.4	0.4	6.12	652
1.00	14.5	0.4	5.26	629	14.4	0.4	5.87	655
1.13b					14.4	0.4	2.63	658
1.20b	14.5	0.4	4.24	629				
1.25								

23 October 2010.
Station 1: Flume at 1530 hr. Reach 1- No surface algae. Too dark to see lagoon bottom vegetation. 62 gulls.
Station 2: Stockton Avenue Bridge at 1515 hr. Reach 2- Secchi depth to bottom. No surface algae. Too dark to see lagoon bottom vegetation. 16 mallards (some down from Reach 3).
Station 3: Railroad Trestle at 1505 hr. Reach 3- No surface algae. Too dark to see lagoon bottom vegetation. 30 coots (11 above N. Gulch), 10 wild mallards (all above N. Gulch), 1 goose above N. Gulch, 2 pied-billed grebes below N. Gulch.
Station 4: Mouth of Noble Gulch at 1455 hr. No surface algae. 30% bottom algae 1-4 ft thick, averaging 3 ft. On redwood stump- 1 gull. No gray water.
Station 5: Nob Hill at 1551 hr. Water temperature of 14.1° C. Conductivity of 662 umhos. Oxygen 9.21 mg/l. Salinity 0.4 ppt.

23 October 2010. 23 October was on a Saturday. Morrison had notified CDFG the previous day that the lagoon may need to be breached over the weekend. Morrison checked flume and lagoon at noon. Lagoon level was 6 inches below top of flume. Streamflow was 5 cfs at the Soquel Village gage. Considerable rain was forecasted overnight. Morrison was closely monitoring streamflow at the gage. Unfortunately, it stopped providing readings at 2100 hr at a streamflow of 12 cfs.

24 October 2010. Morrison checked lagoon conditions at 0900 hr on Sunday. Lagoon level had risen to 1 foot above the flume the previous night. When the gage readings resumed, it showed that flow had reached a maximum of 31 cfs at 0515 hr. At 0800 the level was 8 inches over the flume. At 1000 hr the level was still 6 inches over the flume. Morrison removed 4 more boards to make a 24-inch gap below the top of the flume. More rain was forecasted.

Morrison returned to the lagoon at 1330 hr, noting the lagoon level had dropped 4 inches. But the rain was starting to pick up at that time with gage readings up to 43 cfs at 1345 hr. Steve Jesberg checked the lagoon at 1500 hr and found that it was on the rise again. He called Morrison who headed down to the lagoon. Morrison contacted the biologist, Don Alley, leaving a message on his cell phone. Alley's cell phone did not ring and he missed the call. He called Morrison at approximately 1700 hr to check on conditions and learned that the sandbar had already breached. Streamflow at the gage peaked at 79 cfs by 1615 hr. It was about that time that Kotilla and the tractor arrived on the beach and began the assisted, emergency breach. Lagoon levels had come up to the lower benchmark bolt on our indicator piling, meaning that it was approaching the height where it would overtop the bulkhead near the trestle. The breach occurred at 1646 hr with the lagoon still continuing to rise to a crest of 3 inches over the lower benchmark bolt at approximately 1715 hr. Jesberg provided photos of the breaching to Alley.

25 October 2010. The lagoon continued to drain overnight, with dropping to 28 cfs by 0700 hr. Rain was again in the forecast for later in the week. Alley observed the breached sandbar and took photographs. As Ed Morrison stated, "Another year in the books."

20-21 November 2010. The next significant stormflow occurred, with the sandbar remaining open from the emergency breach until this storm.

Appendix B.

2010 Drain Line Test for Restaurants Contiguous with Soquel Creek Lagoon.

2010 DRAIN LINE TEST FOR RESTAURANTS CONTIGUOUS WITH SOQUEL CREEK				
RESTAURANT	**INITIAL CONTACT**	**TEST DATE**	**COMMENTS**	**SIGN OFF**
MY THAI BEACH 207 ESPLANADE	5-May-10 P. Ky 464-3800	5/18/2010	NONE	Henry Juarez
BAY BAR 209 ESPLANADE	5-May-10 Matt and Raylene 477-0749	5/20/2010	NONE	Mark Wheeler
PIZZA MY HEART 209-A ESPLANDE	5-May-10 Garritt LaTorre 332-7996	5/20/2010	NONE	Mark Wheeler
FOG BANK 211 ESPLANDE	5-May-10 Linda 462-1881	5/18/2010	NONE	Henry Juarez
PARADISE BAR & GRILL 215 ESPLANADE	5-May-10 Stephan Hanecak 476-4900	5/18/2010	NONE	Henry Juarez
ZELDA'S 201 ESPLANADE	5-May-10 Ed 475-4900	5/07/2010	NONE	DJK