D.W. ALLEY & Associates aquatic biology

Soquel Lagoon Monitoring Report- 2012

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

CITY OF CAPITOLA
420 Capitola Avenue
Capitola, California 95010

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340 Old River Lane, P.O. BOX 200, Brookdale, California 95007-0200 (831) 338-7971

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Sunrise at Capitola Lagoon. 24 October 2012.

SOQUEL CREEK LAGOON MONITORING REPORT, 2012

ACKNOWLEDGMENTS

Ed Morrison and the Capitola Public Works Department did well in creating and maintaining the lagoon in 2012. The flume leaked around the inlet, but staff kept on top of it, filling the void with sandbags to maintain lagoon levels. We appreciated that Matt Kotila, as heavy equipment operator, and Ed Morrison, as Contracting Supervisor, teamed to daily observe the lagoon and adjust to its needs. Every year is different, and we are grateful for their attentiveness. The series of small rains in the fall were successfully passed through the flume by skilled personnel until a larger storm came in mid-November, requiring facilitated breaching.

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

We were grateful to the volunteers who assisted in the annual fish censusing at the lagoon. There were local residents and a good turnout of UCSC and Cabrillo College student volunteers. The students received valuable field experience. Biologists, Inger-Marie Laurson and Josie Moss, again provided their positive energies. The regulars, Chad Steiner and Walter Heady, rounded out the fish-crew. Kristen Heady brought young Quincy again this year with his new brother, Wiley, to see their father work with the fish and to ride in the boat. Quincy paid close attention as we measured each fish. Chad brought his daughters, Autumn and Lucinda, who helped their Dad in seining and learning to identify the fish.

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

Girdie, the last of the original domestic geese at Soquel lagoon since monitoring began 22 years ago, died during late summer. She avoided capture during our domestic goose and duck roundup/ relocation efforts early on. Though she was a survivor, she moved slowly towards the end with obvious discomfort as she swam and limped along. There had been 3 domestic geese at the lagoon for many years, with her outlasting the others by 5 years or so. Girdie got along with the other birds. She was always surrounded by smaller ducks in the water and on her favorite cottonwood log across from Noble Gulch. We will remember the egg she laid on the redwood stump in the lower lagoon in 2011. In a futile effort, she sat on it continuously for 3+ days despite nearby sand-moving and raking. While people came and went through the years, Girdie lived in Capitola Lagoon for a good long while. Summer lagoon monitoring will be different without her.

Girdie, Capitola's matriarchal goose, nesting during sandbar construction in May 2011.

REPORT SUMMARY

Sandbar Construction. No negative impacts to steelhead were detected during sandbar construction in 2012. Constructing the sandbar and creating a freshwater lagoon of maximal depth represented habitat enhancement. Sandbar construction was done prior to Memorial Day weekend in May 2012. 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. Winter storms had been few during a largely dry winter, and streamflow had declined steadily to 13 cfs on 21 May, the day that sandbar construction activities began. Three rainstorms had occurred in March and April, and below normal sand had deposited on the beach. The flume had been mostly cleared of sand the previous week. The lateral channel was seined immediately after it was blocked off to allow fish rescue. The overflow from the lagoon ran through a narrow channel cut adjacent to but not immediately alongside the flume. Cary Oyama and Ed Morrison of the Capitola Public Works Department assisted Don Alley in the fish relocation. Nearly all fish were localized in the upper lateral channel. No tidewater gobies (*Eucyclogobius newberryi*) or steelhead (*Oncorhynchus mykiss*) were found in the lateral channel during relocation efforts. Water quality was poor in the lateral channel, with oxygen stress evident in the captured fish. Due to poor water quality, there was approximately 20% mortality of fish (staghorn sculpins (*Leptocottus armatus*) and threespine sticklebacks (*Gasterosteus aculeatus*)) during relocation from the lateral channel. Rescued fish were relocated to the main lagoon/ estuary. The estuary's western margin adjacent to Venetian Court was steep and did not require seining. No fish mortalities were observed during sandbar construction after the lateral channel was covered over with sand on 21 May. The biologist observed an adult Pacific lamprey (*Lampetra tridentata*) in the lower estuary on 21 May. It had fungus on its back and was likely out-migrating after spawning. No fish were stranded in side pools during estuary fluctuations. On 24 May, a school of approximately 12 steelhead smolts were observed exiting the auxiliary channel at 0940 hr. A remnant of a redwood trunk with rootwad was present from the previous year, upstream of the railroad trestle. Cut sections from this redwood lay in the cove next to Margaritaville Restaurant.

The entire estuary reach was surveyed for steelhead spawning redds, including the glide above estuary influence. No steelhead redds were found. The channel bifurcated downstream of Noble Gulch, with a center cobble and sandbar extending downstream to the trestle. The remnant of the redwood trunk (40+ feet in length) from the previous year still lay on this bar, downstream of the Mader residence. It had been cut into approximately 15-foot sections with the cuts going 90% through the trunk, but it was still holding together with the rootwad attached. It likely continued to divert winter streamflow to the western bank under the trestle along the bedrock outcrop.

As required in the permit, a fisheries biologist was present during all sandbar construction activities that could affect fish habitat in the lagoon/estuary. This was year 22 of our monitoring and assisting in activities associated with sandbar construction. Annual monitoring reports for the first 21 years are available at the City (**Alley 1991-2011**). As stated in the Soquel Lagoon Management and Enhancement Plan (**1990**) and 2004 Soquel Creek Lagoon Management and Enhancement Plan Update (**2004**), all instream removal of kelp, sea grass and other organic debris was to be accomplished without the use of heavy equipment in the stream channel except within 25 feet of the flume. The bulldozer/tractor could traverse the area adjacent to the flume.

The sandbar was closed for the season on 24 May. Seven Public Works staff, Ed Morrison and the biologist hand-raked approximately 90% of the decomposing kelp and seagrass from the estuary, downstream of Stockton Bridge prior to final sandbar closure. A jumping-jack hammer was utilized this year to better compact the sand around the flume inlet to reduce seepage.

Sandbar Breaching. Ed Morrison and Public Works staff did an excellent job of maintaining the productive lagoon as long as possible in fall 2012, manipulating inlet boards before 3 small fall storms to keep the sandbar and lagoon intact. The breaching was done in a gentle way to minimize cutting through the sandbar and maximizing residual estuary depth. When a storm was predicted to bring rain and stormflow in excess of the flume's flow capacity, they facilitated a gentle sandbar breaching. A facilitated breaching occurred sometime during the early morning hours of 18 November, after the inner berm nearest the lagoon margin had been mechanically breached and the outer berm reinforced on 17 November by Kotilla, the equipment operator, under direction of Morrison and Jesberg with the biologist present. This was done in preparation for higher flows from a forecasted, significant storm. A near-flume capacity flow of 27 cfs existed on 17 November, with the lagoon level 4 inches above the flume inlet, prior to the storm. The flume capacity is estimated at approximately 30 cfs, and stormflow peaked at 58 cfs at the Soquel Village gage shortly after midnight on 18 November, resulting in "natural" breaching of the outer berm near the surf. The biologist observed the open estuary at 1315 hr on 18 November. The outlet channel was approximately 50 feet wide alongside the flume. It appeared to have been a gentle breach, with the estuary spanning the full width of the previous lagoon as the tide was beginning to come in. Areas with estimated minimum depth of 2−3 feet existed in Reach 1 along the Venetian Court wall and in Reach 2 along the western thalweg between Stockton Bridge and the railroad trestle at low tide, offering slackwater with some depth for residual steelhead remaining in the estuary.

Facilitated sandbar breaching procedure (inner berm breached and outer berm reinforced). 17 November 2012.

Facilitated breach completed with estuary formation. 18 November 2012

Stream Inflow to the Lagoon. Stream inflow, though below the median in August and September, was sufficient to prevent water temperatures to rise to stressful levels for steelhead in 2012. Stream inflow to the 2012 lagoon followed a below average winter rainfall amount. There were three late, small stormflows in March and April that contributed to higher summer baseflows than would be expected through much of the dry season. Baseflow at the time of the first sandbar closure was approximately 10 cfs (compared to 25 cfs in 2011) (**Table 10; Figures 23 and 24**). 2012 had the 12th highest baseflow on 1 June for the past 22 years. By 1 September, prior to any fall rainfall, 2012 streamflow had declined to 1.8 cfs at the Soquel Village USGS gage, compared to 5.8 cfs in 2011, 3.4 cfs in 2010, 1.2 cfs in 2009, 0.7 cfs in 2008, 1.3 cfs in 2007 and 6.6 cfs in 2006. The 1 September 2012 baseflow was the 14^{th} highest in the last 22 years, tied with 1993 and 2004. The 4th relatively small stormflow in the fall that peaked at approximately 60 cfs, but exceeded the capacity of the flume, necessitated a facilitated breach of the sandbar on 18 November.

Water Temperature. Lagoon water temperature was well within the tolerance range of steelhead in 2012. 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 2012 by the data loggers at the deep area near the trestle or at any of the 4, two-week monitoring stations (**Figures 4a-l; 6a-1 and 6a-2**). Lagoon water temperature was slightly warmer near the surface than near the bottom, as seasonal maxima and minima of temperatures and 7-day rolling averages indicated (**Table 4**). As in past years, lagoon water temperatures in 2012 closely reflected those of the stream inflow and were somewhat elevated above stream inflow temperature (**Figures 4a-l; 5a-b**).

The 2012 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 2012 when water temperature rose to 21°C on only one day in July (**Figures 4a and 4k**). The coho management goal of keeping maximum water temperatures below 20ºC (68ºF) near the bottom in the presence of steelhead was not met for 5% of the days measured. It had been met in 2011 for the only time in 22 years.

At the creek site near Nob Hill in 2012, the stream management goal was met for steelhead of *no more than 4 hours a day at greater than 20ºC (68ºF)* (**Figures 5a**). The Soquel Creek water temperature goal for coho salmon in stream habitat is *average weekly temperature (7-day rolling average) of16.7º C (62º F) or cooler*. In 2012, the coho management goal not met on 9 days (7%) from late June to mid-August of a 134-day lagoon period (**Figure 5a**), with it reaching a maximum of 17.7°C. With the recent series of cool summers, coho salmon may have survived in stream habitat near the lagoon in 2010−2012, 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.

In 2012, water temperatures near the lagoon bottom in the morning were rated "good" at all stations throughout the lagoon season except for "fair" on 3 July at the flume (**Table 3**). The warmest afternoon water temperature recorded in 2012 near the bottom during two-week monitoring was 21.2°C at the flume inlet in mid-August (**Figure 3h**).

As in most years when no saline layer develops later in the summer from tidal overwash, water temperature at dawn within 0.25 m of the bottom of the lagoon became warmer as the monitoring stations progressed down the lagoon from Noble Gulch to the flume (**Figure 3g**). With cooler water emptying in from Noble Gulch, Station 4 near the bottom was always cooler than the other 3 stations. Water temperature of the stream inflow was cooler in the morning than the lagoon, with fluctuations in lagoon inflow temperature mirrored in early-morning lagoon temperatures (**Figure 3g**). The correspondence between inflow fluctuations and lagoon temperature fluctuations indicated that the inflow temperature influenced the lagoon temperature in 2012 as in previous years. Stream inflow temperatures were typically 1-3° C cooler in the morning than lagoon water temperature at the 3 lower lagoon stations.

In analyzing temperature data from the 6 continuous data loggers throughout the water column just downstream of the railroad trestle, results were consistent with temperature data collected at 2-week intervals through the water column at monitoring stations over the past 22 years. Consistently, the difference in 7-day rolling averages for water temperature, day by day, was approximately 2°C warmer in the lagoon near the bottom compared to the stream inflow. The average 7-day rolling average of 16.2°C in the stream was 1.9°C less than the average 7-day rolling average of 18.1°C at 0.5 feet from the lagoon bottom. In 2012, the maximum and minimum 7-day rolling average temperatures were 1.5°C and 0.7°C cooler, respectively, in the stream than near the lagoon bottom near the trestle, as was substantiated by seasonal maximal temperature (20.2°C vs. 21.0°C) and minimal temperature (12.6° C vs. 14.5°C) (**Table 4**).

Aquatic Vegetation. 2012 was an especially good year for pondweed growth, offering good fish cover and fish food by providing a good food source and substrate for aquatic insects. Bottom algae thickness and coverage was similar in 2010−2012 (except reduced at the mouth of Noble Gulch in 2012) and less than in 2009 (**Tables 5-9**). In 2012 it was thinner than in 2011. The pondweed that had nearly disappeared in 2011, returned to flourish in the highest concentration of the past 4 years. The higher pondweed growth in 2012 likely competed with algae for nutrients and inhibited algae production. Evidence of nutrient inputs from Noble Gulch in 2012 was expressed by recurrent thick planktonic algae and sporadically high levels of surface algae nearby, though bottom algae was not thicker than at other sites as had been the case in past years. In 2012, bottom algae thickness at in Reaches 1−3 and at the mouth of Noble Gulch averaged 0.5 ft, 0.4 ft, 0.4 ft and 0.5 ft, respectively (**Table 5**).

Filamentous algae was first noted in mid-June 2012 as it had been in 2009 and 2010. With the sandbar being constructed a month later in 2011, filamentous algae was first detected in mid-July. Pondweed was first detected in mid-July, it being initially most prominent in Reach 1 in August and September and then later dominating Reach 3 by October (70% coverage).

Oxygen Concentration. Oxygen concentrations were maintained in the lagoon at levels conducive to steelhead survival in 2012. Oxygen levels for steelhead were rated “good” (greater than 7 mg/l at dawn) *near the bottom* at most stations during the 12 two-week monitorings (**Tables 2 and 3, Figure 6a-1 and Appendix A**). Exceptions were “fair” ratings (5−7 mg/l at dawn) at the mouth of Noble Gulch from mid-July to mid-August, “poor” (2−5 mg/l at dawn) at one station to “fair” ratings elsewhere on 24 October after stormflow had clouded the water to reduce photosynthesis. “Fair” ratings were registered at the railroad trestle and mouth of Noble Gulch in 7 November with “good” ratings elsewhere. Lagoon oxygen levels were higher in the afternoon than morning in 2012, as in most years (**Figures 6b-6e**). This was also true at the stream inflow Site 5 except in fall during cloudy or rainy days, when morning oxygen concentration was higher than in the afternoon (**Figure 6f**).

Salinity Monitoring. No negative impacts from saltwater entering the lagoon were detected in 2012. In 2012, saline conditions were detected on 30 May, a short time after sandbar closure (24 May) in the deeper lagoon area along the wall at Venetian Court (**Appendix A**). This resulted from a small amount of saltwater being trapped in the lagoon at the time of sandbar closure. Shrouds were not installed on the sandbar inlet at that time to pull bottom water out of the lagoon because it was assumed that sufficiently high stream inflow would soon force the saltwater out through the sandbar. No salinity was detected on 5 June or afterwards throughout the lagoon period.

Begonia Festival Observations and Water Quality Findings. No negative impacts to fish were detected during the Begonia Festival or afterwards in 2012. The City’s fishery biologist (Donald Alley) was present before, during and after the Begonia Festival parade. The day of the parade, 2 September, fog cleared off by 0930 hr and the sky was clear the remainder of the day. Water temperatures were cooler in the morning than 4 days previous, and oxygen levels were slightly less and in the “good” range. The lagoon depth was maintained at an excellent gage height of 2.55- 2.57 ft during the nautical parade. There were 8 floats in the nautical parade and 23 other boats and 6 standing surfboarders in the water. In conformance with the permit requirements from the California Department of Fish and Game, no floats were set up to be propelled by waders. Means of propulsion was by electric motor. Thus, the lagoon bottom was undisturbed. Conductivity near the bottom increased very slightly at the Stockton Avenue Bridge from 650 before to 659 umhos after the parade. Conductivity at the mouth of Noble Gulch was 654 umhos near the bottom before the procession and 674 afterwards. The measured levels of conductivity were not stressful to steelhead. There was no odor of hydrogen sulfide, and no fish mortality was observed. Oxygen concentrations in the afternoon following the nautical parade were high, ranging between 10.52 and 12.78 mg/l near the bottom prior to 1502 hr. Water temperature at this time was 19.5° C near the bottom in the afternoon at the 2 monitored sites. The secchi depth (water clarity) was to the lagoon bottom after the float procession. Flower petals were collected by Begonia Festival staff and volunteers the following week, and there were minimal petals left by the parade of floats.

Fish Sampling. An alarmingly small juvenile steelhead population inhabited the lagoon in 2012, even though high quality nursery habitat was available. Our steelhead population estimate based on mark and recapture for fall 2012 was 220 compared to 678 in 2011 and 1,174 in 2010 (**Table 11**) (methods in **Ricker 1971**). This was the lowest estimate thus far and well below our 20-year average of 1,595 juveniles. Four especially productive years inflated the average. Other species captured in fall 2012 were threespine sticklebacks, staghorn sculpins, 1 prickly sculpin and 1 starry flounder. No tidewater gobies were captured. The 2012 lagoon population size was small likely because young-of-the-year (YOY) steelhead numbers were low throughout the watershed (**Alley 2012**) and ample stormflows were available late in the season for spawning adults to migrate higher in the watershed to spawn, away from the lagoon. We suspect that there had been a small adult population returning to spawn due to poor production of soon-to-smolt juveniles in 2009 during drought, when there was also a small lagoon population size (449).

Though we do not have a 2012 steelhead population estimate for the entire Soquel Creek watershed, the lagoon population of larger soon-to-smolt-sized fish was likely a significant percent of the total watershed population of larger juveniles, based on data from years when watershed estimates were possible. Thus, the lagoon provides valuable steelhead nursery habitat through proper management.

Pollution Sources and Solutions. No negative impacts to fish were detected from pollution sources in 2012. 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. City building permit 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.

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. There was a large surface algal raft just downstream of Noble Gulch on 3 July 2012. Therefore, Noble Gulch continues to be a pollution source to the summer lagoon. In past years when gray water was observed at the Noble Gulch culvert outlet to the lagoon, streamflow was clear in Noble Gulch at the park when checked, before the creek went underground into the culvert. By minimizing the summer stream inflow from Noble Gulch, nutrients and bacteria entering the lagoon would be reduced.

Another drain into the lagoon is situated under the railroad trestle, where slight oxygen depletion has been detected in recent years and in October 2011 and in October and early November 2012. This drain could be capped if summer runoff was re-directed into the sewer. 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 pollution from urban runoff once the rains start in fall, 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. There has been a pollution problem and high flashiness in streamflow in the past during the first small storms of the fall. Early storms turn the lagoon water dark, requiring lagoon water level reduction to allow light to penetrate to the bottom and allow photosynthesis and oxygen production to continue. 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.

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.

New and Continuing Recommendations and Those Not Yet Fully Implemented

1. Continue to repair the cracked flume. Its integrity is jeopardized, and the beach sinkholes created by flume underflow are a safety hazard. Repair the flume at a time that does not obstruct fish passage or require lowering of the lagoon water level.

2. 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.

3. Prior to sandbar breaching in the fall, notch the sandbar across the beach, minimizing the gradient of the notch to slow the evacuation of water through the beach and to minimize beach erosion. The purpose is to maximize the residual estuary depth after the emergency breach.

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

5. Continue to facilitate sandbar breaching in the manner followed in 2012. Breach the inner berm prior to the forecasted stormflow that will clearly exceed the flume capacity and allow the streamflow to “naturally” breach the outer berm.

6. Seek volunteers to re-establish tules in the alcoves under the railroad trestle, near the Golino property and in Margaritaville Cove. This will provide additional cover for steelhead and tidewater gobies and may reduce dissolved nutrients and bacteria in the lagoon.

7. Seek funding to secure large woody material to the lagoon bottom with anchor boulders in appropriate locations to provide additional cover for juvenile steelhead and to scour deeper habitat. Continue to retain large woody material that naturally enters the lagoon.

8. Allow a clear path from under the bridge to the beach at Venetian Courts to enable seining for juvenile steelhead during fall censusing.

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

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

11. Closing the sandbar in late May is better than mid-June or later because streamflow is sufficient to rapidly fill the lagoon in most years, and the juvenile steelhead most likely to be present in the lagoon in May are out-migrating smolts. Late May is prior to down-migration of most YOY steelhead from spawning sites above the lagoon. Small steelhead fry remain in the vicinity of spawning sites before moving down into the lagoon.

12. 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.

13. 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.

14. 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**).

15. 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.

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

17. 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-migrating smolts until 1 July. However, in dry years such as 2007−2009, when stream inflow is insufficient to both fill an underwater portal and allow lagoon filling, opt for a larger notch in the top plank to accommodate adult kelts and smolts in place of the underwater portal for kelts.

18. 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.

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

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

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

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

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

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

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

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

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

28. 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.

29. 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.

30. 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.

31. 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.

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

33. 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.

34. 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.

35. 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.

36. 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.

37. 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.

38. 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.

39. 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.

40. 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.

41. 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.

42. 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.

43. 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.

44. 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.

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

LAGOON AND ESTUARY FORMATION

Results of Fish Seining Prior to Construction Activities

21 May 2012. The Creek flowed laterally across the beach at approximately 13 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 0745 hr. The channel was blocked off to allow fish rescue. The overflow from the lagoon ran through the flume. An auxiliary channel was not constructed this day. Seventeen seine hauls were made in the lateral channel from 0745 to 0945 hr with a beach seine that was 30 ft x 4 feet with 1/8-inch mesh. Dipnetting of fish continued until 1130 hr. No steelhead or tidewater goby were captured in the lateral channel. The lateral channel was filled with kelp and seagrass in its upper extent, preventing effective seine hauling except at the periphery of the plant mass. The lateral channel was wide (approximately 25 feet wide) and flat downstream to a large redwood stump that had washed out of the estuary (just as the previous year). It had been in the summer lagoon for several years before washing out. The stump created a hydraulic control, and the gradient of the lateral channel increased downstream of it. Two prickly sculpins (*Cottus asper*) were rescued from under the stump. Cary Oyama and Andrew Barry of the Capitola Public Works Department and Ed Morrison (now a contractor) assisted fishery biologist, Donald Alley, in the fish relocation. Most fish were localized in the upper lateral channel, above the redwood stump. Water quality was apparently poor, with oxygen stress evident in the captured fish. Fish captured included 300+ staghorn sculpins (approximately half were small YOY), 500+ adult threespine sticklebacks and 5 adult prickly sculpin. No other fish species were detected. Rescued fish were relocated to the main lagoon/ estuary. There were approximately 20% mortalities due to poor water quality. After seining of the upper lateral channel was completed, remaining fish moved into the lower lateral channel where they were dipnetted as water quality worsened. The estuary's western margin adjacent to Venetian Court was steep and did not require seining because isolated pools would not form.

As required in the permit, a fishery biologist was present during all activities that could affect the fish habitat in the lagoon/estuary during sandbar construction. This was our twenty-second year of monitoring and assisting in activities associated with sandbar construction at Soquel Creek Lagoon. Annual monitoring reports for the first 21 years are available at the City (**Alley 1991-2011**). 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

21 May 2012. The fishery biologist, Alley, arrived at 0615 hr. Sand grading on the beach began this day. As in most years, Soquel Creek was flowing out to the Monterey Bay in a channel that laterally crossed the beach to the eastern jetty. The flume had been mostly cleared of sand the previous week by Public Works staff, with adequate screening of the intake hose for water pumped into the flume. On 21 May, no auxiliary channel was cut through the beach adjacent to the flume. Overflow water was bypassed through the flume. The fish removal from the lateral channel began at approximately 0745 hr (when the lateral channel was blocked off) and ended at approximately 1130 hr. The lateral channel became pool-like upstream of the redwood stump in the lateral channel and continued to flow past the redwood stump until after the fish rescue was completed. Fish were relocated to the main estuary/lagoon. Half of the flume boards on the eastern restaurant side of the flume inlet were removed. The estuary began filling after the lateral channel was blocked off. The lateral channel was covered over after the fish relocation was completed. All tractor work was performed above the tidal action. The estuary thalweg was not well-defined, and the estuary width was wide like the previous year, although the western margin was mostly steep. The lower estuary remained wide during the construction activities. There was no need for the biologist to walk upstream because the estuary was deepening. Morrison had observed 4 mergansers fishing in the lower estuary in early morning. The biologist observed an adult Pacific lamprey (*Lampetra tridentata*) in the lower estuary during morning hours. It had fungus on its back and was likely out-migrating after spawning. Water was flowing through the flume outlet before the biologist left at 1300 hr.

22 May 2012. The biologist arrived at 0610 hr. The equipment operator (Kotila) was grading sand over the former lateral channel near the jetty. The lagoon had filled completely to the top of the flume during the night and was exiting the flume outlet, providing smolt passage overnight. The sandbar was opened with an auxiliary channel at 0640 hr. The outlet channel was positioned adjacent to the flume. The biologist surveyed upstream in the estuary at 0840 hr. No side pools were observed until the upper estuary was reached (past the Westmans' residence), where an artificial side pool, ringed with rocks, was observed. However, its bottom was below the grade of the estuary, and it remained watered. One prickly sculpin was observed in it and could not be captured. An outlet channel was then dug from this side pool. A dead and decomposing adult Sacramento sucker (*Catostomus occidentalis*) was observed upstream of the Westman residence. The entire estuary reach was surveyed for steelhead spawning redds, including the glide above estuary influence. Two glides existed within the estuary reach. No steelhead redds were found. The channel bifurcated downstream of Noble Gulch, with a center cobble and sandbar extending downstream to the trestle. The remnant of the redwood trunk (40+ feet in length) lay on this bar, downstream of the Mader residence. It had been cut into approximately 15-foot sections with the cuts going 90% through the trunk, but it was still holding together with the rootwad attached.

No juvenile steelhead were observed during the upstream survey. At its lowest water surface elevation, the estuary ranged from 15 to 50 feet wide. Its thalweg depth varied between 0.3 feet (riffles) and 2.2 feet, averaging 1 foot. The channel under the overhanging willows (just downstream of the railroad trestle) was a uniform 1.5 feet deep. Threespine sticklebacks were observed as the biologist approached the Stockton Bridge. Seven Public Works staff and Ed Morrison raked kelp and seagrass until the sandbar was closed by Kotila at 0950 hr to prevent tidal inflow. Much of the decomposing plant material was removed from the lower lagoon. The sand around the flume inlet was compacted by Kotila's bulldozer. The biologist left at 1300 hr.

23 May 2012. The fishery biologist arrived at 0620 hr. Flow was passing out the flume exit. The lagoon had partially filled overnight. There had been problems with water leaking under the flume the previous evening, and there was concern about allowing the lagoon to fully fill overnight. Therefore, all but the lowermost boards had been removed from the inlet, and the water level was approximately 20 inches below the top of the flume. The water depth at the flume inlet was approximately 2 feet. The weir inside the flume was intact. The constructed bar had held overnight without leakage after it had been reinforced the evening before. The sandbar was opened at 0800 hr. The biologist surveyed upstream in the estuary for stranded fish at 0855 hr. None were found. The same prickly sculpin was seen in the artificial side pool with the now partial ring of rocks, as was observed the previous day. The dead Sacramento sucker had not floated away. No steelhead were observed during the survey. However, the tail splash from presumably an adult steelhead was heard in a glide downstream of Noble Gulch. The fish could not be located. The run under the overhanging willows was again 1.5 feet deep. Two adult suckers were observed under the willows. The channel adjacent to the Venetian Court wall varied in depth between 1.8 and 2.8 feet, averaging 2.2 feet at the minimum estuary elevation, offering good depth for any steelhead present in the estuary. Six Public Works rakers plus Morrison and the biologist worked on removing the plant material in the lower estuary until Kotila closed the sandbar with a berm at 1020 hr. Most of the plant material was gone by the end of this activity, and no further raking was deemed necessary. All flume boards had been removed from the flume inlet. The biologist left at 1300 hr.

24 May 2012. The fishery biologist arrived at 0615 hr. The sand berm had held overnight, and the water level was within approximately 20 inches of the top of the flume. The water depth at the flume inlet was approximately 2 feet. The berm across the auxiliary channel was opened at 0810 hr. The biologist surveyed upstream for stranded fish at 0900 hr. No stranded fish were found. While Alley was upstream looking for stranded fish, Morrison observed a school of approximately 12 steelhead smolts exiting the auxiliary channel at 0940 hr. Kotila began compacting sand around the flume inlet at 1000 hr, in preparation for final lagoon closure for the season. Sand was further compacted around the flume inlet with a hand-held compacting hammer (common name was a "jumping jack hammer"). Clear visquine was secured around the flume inlet with sandbags. One of two visquine sheets was keyed into the lagoon bottom with a trench. The berm was constructed across the auxiliary channel at 1125 hr. Kotila had closed the sandbar for the season. The visquine was covered with a layer of sand by 1130 hr. The jumping jack hammer was then used to compact the sand along both sides of the flume to resist lagoon underflow and seepage. The biologist left at 1400 hr.

25 May 2012. Morrison informed the fishery biologist that the sandbar had held overnight and that the lagoon had filled to within 10 inches of the top of the flume overnight. He said a screen was in place with an open portal for adult steelhead passage through the flume.

26 May 2012. The fishery biologist arrived at the lagoon in early afternoon to inspect the sandbar and flume inlet/outlet. The west side of the inlet was completely boarded. The east side was partially with 2"x 3" mesh that allowed smolt passage through. The flagged portal for adult steelhead was present. Water was flowing out the flume outlet, maintaining continuous fish access to the Monterey Bay. The lagoon water level was within 10 inches of the top of the flume. The water depth in the flume inlet was approximately 2.5 feet. The border of the portal was flagged with yellow flagging for easy visibility, as requested by the biologist.

30 May 2012. Temperature probes were launched in the lagoon and upstream. Water quality was measured at 1810 hr to detect any saline water still present in the lagoon. None was detected under the Stockton Bridge. A small 1 x 1 meter area with partly saline water (12 ppt) along the bottom was located adjacent to the Venetian Court wall at 3 meters depth was detected. This was a deep pocket. Two other pockets of similar size registered 3 ppt salinity. With the continued streamflow at approximately 10 cfs and low salinity of the deep pockets, it was not recommended that shrouds be put on the flume inlet. Oxygen levels were above 9 mg/L through most of the water column, with it just 1.3 mg/L in the deepest saline pocket. Water temperature was between 16.8 (bottom) and 17.9°C (surface) through the water column.

Effect of Sandbar Construction on Tidewater Gobies in 2012

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 lighter than median rainfall season. However, artificial water level fluctuations were created during sandbar construction activities. Three sandbar breaches were required during sandbar preparation in 2012, with 3 breaches allowed by the permit without regulatory consultation. The 3 breaches closely mimicked normal tidal fluctuations of the estuary.

With each lowering of the water in the estuary during sandbar construction, tidewater gobies would have to retreat to deeper water in the upper estuary as water surface receded in the upper estuary. A well defined, bathtub-like margin existed in the upper estuary in 2012, allowing easy retreat to deeper water.

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

Effect of Sandbar Construction on Steelhead in 2012

No juvenile steelhead were detected in the lateral channel before it was covered over in May. The flume outlet was open during the entire period of sandbar construction in May, and smolts had access to the ocean nightly. It was beneficial to promote lagoon filling each night. One school of juvenile steelhead was observed during sandbar construction, indicating that the smolt migration was still occurring.

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. During the relocation of fishes from the lateral channel, provide limited water in-flow to the lateral channel until fish relocation is completed. In this way, water quality in the lateral channel will be maintained for fish in the event that considerable vegetative material is present and decomposition is occurring in the lateral channel.

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

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

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

5. The management solution for minimizing the time required for sandbar construction is for the City to remain flexible on timing of the work. If rain is in the forecast within two

days after the intended starting date for sandbar construction, Public Works should postpone construction until clear weather is forecasted. If 4-5 working days are set aside to construct the sandbar, the sandbar construction may be delayed as late as 4-5 days before the Memorial Day weekend and may still satisfy the tradition of lagoon formation before then.

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

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

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

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

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

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

12. 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.

13. 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.

14. Maintain the 1-foot high weir/ 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.

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

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

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

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

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

Sandbar Breaching During the 2012-2013 Rainy Season.

A facilitated breaching occurred sometime during the early morning hours of 18 November, after the inner berm nearest the lagoon margin had been mechanically breached and the outer berm reinforced on 17 November by Kotilla, the equipment operator, under direction of Morrison and Jesberg. Alley was present. This was done in preparation for higher flows from a forecasted, significant storm. Because the notch was not constructed diagonally across the beach, the facilitated breach would not occur diagonally across the sandbar. A near-flume capacity flow of 28 cfs existed on 17 November, with the lagoon level 4 inches above the flume inlet at 1500 hr, prior to the storm. The outer berm was 8 inches above the lagoon level through the beach. Low tide was to occur at 1930 hr. The biologist left the beach at 1545 hr. The flume capacity is estimated at approximately 30 cfs, and stormflow peaked at 58 cfs at the Soquel Village gage shortly after midnight on 18 November, resulting in stormflow breaching of the outer berm in a facilitated breach. The biologist observed the open estuary at 1315 hr on 18 November. The outlet channel was approximately 50 feet wide alongside the flume. It appeared to have been a gentle breach, with the estuary spanning the full width of the previous lagoon as the tide was beginning to come in. Areas with estimated minimum depth of 2−3 feet existed in Reach 1 along the Venetian Court wall and in Reach 2 along the western thalweg between Stockton Bridge and the railroad trestle at low tide, offering slackwater with some depth for residual steelhead remaining in the estuary.

Recommendations Regarding Sandbar Breaching

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

2. Prior to sandbar breaching in the fall, notch the sandbar across the beach just below the elevation of the piling bolt indicating flooding, minimizing the gradient of the notch to slow the evacuation of water through the beach and to minimize beach erosion. The purpose is to maximize the residual estuary depth after the emergency breach.

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

4. Just as the first storm of the fall season begins, remove boards from each side of the flume if a small storm is anticipated. The number of boards removed will be dictated by the anticipated size of the storm. Remove two boards or more 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.

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 breached during later, larger storms usually occurring after Thanksgiving.

6. After the first small storms of the season with the sandbar still intact, lower the water level to a point where light penetrates to the lagoon bottom. Thus, plants in the lagoon may continue to photosynthesize and remain 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 2012

Rating Criteria

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

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

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

Locations and Timing of Water Quality Monitoring

As required under the CDFG permit for 2012, water quality was monitored in late afternoon, as well as in the early morning near first light. Prior to 2003, water quality had been measured only in the early morning after dawn because the most limiting factor, oxygen concentration, is usually a minimum at that time. Water quality was monitored at four lagoon stations and one stream station. Station 1 was at the flume inlet (**Figure 1**). Station 2 was on the downstream side of the Stockton Avenue Bridge in the deepest thalweg area. Station 3 was just downstream of the railroad trestle on the east side. Station 4 was at the mouth of Noble Gulch. Station 5 was monitored in the morning and afternoon in Soquel Creek near the Nob Hill shopping center, just upstream of the lagoon. The stream data were compared to lagoon conditions of water temperature and oxygen levels in early morning.

In 2012, as required by the CDFG permit, 6 HOBO temperature loggers were launched on 30 May 2012, just downstream of the railroad trestle in Reach 2 (as in 2008−2011) 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 2012. Another logger was placed in Soquel Creek near the Nob Hill Shopping Center. All 7 loggers were removed on 14 October 2012, prior to any forecasted rain.

Water quality in terms of oxygen concentration, temperature, conductivity and salinity was measured at each lagoon station at two-week intervals after the sandbar was constructed until the sandbar breached in the fall. Prior to the first full monitoring, salinity was measured in deeper portions of the lagoon to determine if saltwater had been trapped during sandbar construction. Saltwater was not detected in 2012 after the second sandbar closure, and no inlet shroud was needed.

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

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

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

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

Water Temperature Goals for Soquel Creek and Lagoon

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

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

The management goal for water temperature in stream habitat upstream of the lagoon should be maintenance below 20ºC (68ºF) in April and May when baseflow still remains above summer low-flow and juvenile salmonids are feeding and growing rapidly. From June1 to September 1, the water temperature should not rise above 20ºC (68ºF) more than 4 hours a day (15% of the month) and preferably the maximum daily temperature, averaged weekly, should not rise above

21ºC (70ºF). These goals are based on literature review of physiological relationships between fish metabolic rate and water temperature (**Kubicek and Price (1976); Brett (1959, cited in Kubicek and Price 1976); and Snyder and Blahm (1971, cited in Kubicek and Price 1976)**).

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

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

Results of Lagoon Water Quality Monitoring After Sandbar Closure

Lagoon Level. **Appendix A** provides detailed water quality data. **Table 3** rates habitat conditions. The lagoon level was maintained mostly in the good range for the summer and during the Begonia Festival, except in the fair range in mid-June, mid-July and mid-October. It lowered to a critical level later in October after a small fall stormflow that colored the water, forcing the management technique of reducing depth until water penetrated the bottom to allow continued photosynthesis. The lagoon level was monitored 12 times in 2-week intervals from 5 June to 7 November 2012. For 2012, lagoon levels as measured on the staff gage were rated "good" (**Table 2**) on 8 occasions, “fair” on 3 occasions and “critical” once (**Table 3; Figure 2a**).

Maintenance of lagoon gage height was initially “good” in early June and fluctuated between “good” and “fair” the rest of June and July until baseflow became more stable in August. In August and September the level remained “good” until small stormflows insued in October and November when it fluctuated between “critical” and “good.” Typically, it is more difficult for the City to maintain the highest water surface elevation during wetter years. But this was not the case when comparing the wetter 2011 and the drier 2012 years in which lagoon levels were similar between years for June through September. A small amount of saltwater was trapped on the lagoon bottom near the Venetian Court wall at the time of sandbar closure as measured on 30 May, not justifying shroud installation. On 5 June, no salinity was detected.

No vandalism of the flume inlet was detected in 2012. Plywood protects against both back-pressure and vandalism for most of the lagoon season. However, with early, small storms, the plywood is not used between storms. While the wedges discourage all but the most determined vandals and prevent dislodging of boards, they do not allow easy removal of boards when surface algae and debris near the flume needs to be drained out or when sandbar breaching is to be prevented by increasing the volume through the flume. The grated hole in the top of the flume alleviates the need for rapid board removal and replacement during small stormflows.

Flume Passability. According to the Management Plans (**1990; 2004**), steelhead smolt passage is to be maintained until July 1. A flume depth of 12 inches or deeper was desired at the entrance until July 1. The flume was cleared of sand prior to sandbar construction in 2012. With moderate baseflows (10 cfs), the lagoon filled sufficiently each night during the sandbar construction period on 21 and 23 May to provide smolt passage through the flume each night. On 22 May, the flume was undermined and the exit channel remained open overnight to allow smolt passage. The sandbar was closed for the summer on 24 May. Once sandbar construction was complete, both sides of the flume inlet were screened with 2”x 3” mesh that allowed smolt passage through. The screening on the east (restaurant) side had an 8”x 8” underwater portal for adult fish access to the flume. The screen was painted white, and the border of the portal was flagged with yellow flagging for easy visibility, as requested by the biologist. The flume remained passable to steelhead smolts during the entire summer.

The inner berm across the beach notch, closest to the lagoon was breached on 17 November and the outer berm was reinforced, in preparation for a forecasted significant stormflow. The early morning stormflow on 18 November reached 58 cfs at the Soquel Village gage and was probably somewhat higher at the creekmouth, causing the outer berm near the surf to breach unattended and partially drain the lagoon.

Water Temperature Results from Two-Week Monitoring. In 2012, water temperature of stream inflow for much of the dry season was slightly warmer than in the higher flow years of 2010 and 2011 and slightly cooler than the lower flow years of 2008 and 2009 (**Figure 3e**). In 2012, the lagoon was generally warmer near the bottom in the morning and afternoon compared to 2011 except in mid-July (**Table 3, Figures 3a-d; Appendix A**). 2011 had the coolest lagoon in the past 22 years of monitoring. The warmer water temperatures in 2012 corresponded with the consistently warmer air temperatures measured at the lagoon compared to 2011 (**Figure 3f**). The warmest water temperature measured in 2012 near the bottom in the morning was 20.3°C (68.5°F) on 3 July at the flume inlet (**Figure 3g**). In 2012, water temperatures near the lagoon bottom in the morning were rated "good" at all stations throughout the lagoon season except for "fair" on 3 July at the flume (**Table 3**). The warmest afternoon water temperature recorded in 2012 near the bottom during two-week monitoring was 21.2°C on 14 August at the flume inlet (**Figure 3h**) compared to 19.4°C on 26 July 2011, 19.6°C in mid-July 2010, 21.9° C in late August 2009 and 24.6° C under the Stockton Bridge in early July 2008.

At the mouth of Noble Gulch in 2012, the water layer near the bottom was noticeably cooler than above at dawn from mid-July through August. It was 1°C cooler or more than the surface in the afternoon from mid-June to mid-September (**Appendix** A). This resulted from slightly cooler water entering from Noble Gulch during the lagoon period. For example, on the warmest water temperature monitoring day in 2012 (14 August), at the mouth of Noble Gulch, the surface and bottom temperature readings at dawn were 18.8 and 17.7° C, respectively (**Appendix A**). In the afternoon at 1550 hr they were 21.5 and 19.3° C, respectively.

Table 3. 2012 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 @ 0.5 cfs less than Soquel Village Gage Readings (cfs)
5June12	open	2.53 good	good	good	good	9.5 cfs
19June12	open	2.00 fair	good	good	good	7.2 cfs
03Jul12	open	2.27 good	fair good good good	good good good good	good good good good	5.0 cfs
16Jul12	open	2.10 Fair	good good good good	good good good fair	good good good good	3.8 cfs
1Aug12	open	2.45 good	good good good good	good good good fair	good good good good	2.4 cfs
14Aug12	open	2.21 good	good good good good	good good good fair	good good good good	1.7 cfs
02Sep12 Begonia Festival	open (morning)	2.55 good	good	good	good	1.4 cfs
02Sep12	open (afternoon)	2.57 good	- good - good	- good - good	- good - good	1.4 cfs
12Sep12	open	2.55 good	good	good	good	1.5 cfs
26Sep12	open	2.55 good	good	good	good	1.2 cfs
10Oct12	open	2.18 fair	good	good	good	1.9 cfs
24Oct12	open	1.13 critical	good good good good	poor fair fair fair	good good good good	1.2 cfs
07Nov12	open	2.44 good	good good good good	good good fair fair	good good good good	2.0 cfs

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

As in most years when no saline layer develops later in the summer from overwash, water temperature at dawn within 0.25 m of the bottom of the lagoon became warmer as the monitoring stations progressed down the lagoon from Noble Gulch to the flume (**Figure 3g**). With cooler water emptying in from Noble Gulch, Station 4 was always cooler than the other 3 stations. Water temperature of the stream inflow was cooler in the morning than the lagoon, with fluctuations in lagoon inflow temperature mirrored in early-morning lagoon temperatures (**Figure 3g**). The correspondence between inflow fluctuations and lagoon temperature fluctuations indicated that the inflow temperature influenced the lagoon temperature in 2012 as in previous years. Stream inflow temperatures were typically 1.5−3.5° C cooler in the morning and 1.5−3°C cooler in the afternoon (**Figure 3h**) than lagoon water temperature at the 3 lower lagoon stations. The cool inflow from Noble Gulch maintained substantially cooler lagoon water temperature in the morning and afternoon at Station 4 near the bottom than the other three lagoon stations (**Figures 3g and 3h**). Usually in 2012, morning water temperature was 1−2° C cooler at Station 4 than Station 1. In the afternoon, the difference was similar. Water temperature differences between stations in 2012 lagoon near the bottom in the afternoon were similar to previous summers, such as 2008 and 2009, but not similar to 2007, 2010 and 2011 when Station 4 had similar afternoon water temperatures to other stations (**Figures 3i-m**). Water temperature stratification was not maintained in the water column of the summer lagoon, with thorough nightly mixing and cooling of the water throughout (**Appendix A**).

Water Temperature Results from Continuous Data Loggers. In analyzing water 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 22 years. However, the following analysis pertains to the vicinity of these continuous data loggers only. Keep in mind that our 2-week monitoring at the 4 sites indicated that Station 4 near the mouth of Noble Gulch had cooler water temperatures near the bottom than Site 3 near the trestle, where these continuous data loggers were deployed (**Figures 3g and 3h**).

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

As in past years, lagoon water temperatures in 2012 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 1999-2012 (**Table 4**). In 2012, the maximum and minimum 7-day rolling average temperatures were 1.5°C and 0.7°C cooler, respectively, in the stream than near the lagoon bottom near the trestle, as was substantiated by seasonal maxima (20.2°C vs. 21.0°C) and minima (12.6° C vs. 14.5°C) (**Table 4**). The average 7-day rolling average of 16.2°C in the stream was 1.9°C less than the average 7-day rolling average of 18.1°C at 0.5 feet from the lagoon bottom. Consistently, the difference in 7-day rolling averages, day by day, was also approximately 2°C warmer in the lagoon near the bottom compared to the stream inflow. Stream inflow temperature in 2012 was generally about 2°C cooler in the morning and 1−1.5°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 (**Figures 4a and 5a**). We see from comparisons of 7-day rolling averages for 2012 and 2011 near the bottom that it fluctuated more in 2012 and generally at least 1°C warmer than in 2011 and about 0.5°C warmer than in 2010 for July through mid-September. However, in 2009, the rolling average was about 1°C warmer than 2012 (**Table 4; Figures 4a, 4k, 4m-s; 5a-e**).

Table 4. Water Temperature Statistics for Continuous Water Temperature Probes at 30-minute Intervals in Soquel Lagoon and Immediately Upstream, Early June – 15 September in 2009, 2010 and 2012 and 30 June – 15 September in 2011.

Year	Statistic	Stream Inflow Temperature °C	Near-Surface Lagoon Temperature @5.5 ft from Bottom °C	Near-Bottom Lagoon Temperature @ 0.5 ft from Bottom °C
2012	Maximum Water Temperature °C	20.2	23.2	21.0
2012	Minimum Water Temperature °C	12.6	11.0	14.5
2012	Maximum 7-Day Rolling Average	17.7	19.9	19.3
2012	Minimum 7-Day Rolling Average	15.5	15.6	16.2
2012	**Average 7-Day Rolling Average**	**16.2**	**17.9**	**18.1**
2011	Maximum Water Temperature °C	20.3	21.0	19.8
2011	Minimum Water Temperature °C	14.1	16.0	15.6
2011	Maximum 7-Day Rolling Average	17.3	19.0	18.2
2011	Minimum 7-Day Rolling Average	15.4	16.8	16.2
2011	**Average 7-Day Rolling Average**	**16.4**	**18.0**	**17.2**
2010	Maximum Water Temperature °C	19.8	21.0	20.6
2010	Minimum Water Temperature °C	13.7	15.2	15.2
2010	Maximum 7-Day Rolling Average	17.5	19.5	18.8
2010	Minimum 7-Day Rolling Average	14.8	16.7	16.3
2010	**Average 7-Day Rolling Average**	**16.0**	**17.9**	**17.4**
2009	Maximum Water Temperature °C	19.1	22.5	22.1
2009	Minimum Water Temperature °C	14.1	15.9	15.3
2009	Maximum 7-Day Rolling Average	17.5	21.5	21.0
2009	Minimum 7-Day Rolling Average	15.7	18.0	17.6
2009	**Average 7-Day Rolling Average**	**16.7**	**20.1**	**19.8**

As in past years, no stratification or lagoon thermocline (*a thermocline has a warm, well-mixed, oxygen-rich epilimnion above it and a cool, non-circulated, oxygen-poor hypolimnion below*) was detected in 2012 by the data loggers at the deep area near the trestle or at any of the 4, two-week monitoring stations (**Figures 4a-1; 6a-1 and 6a-2**). The lagoon was likely 7−8 feet deep, at most, and subject to daily inland breezes that circulated the water, surface to bottom. There was complete, diurnal (daily) mixing of the water column except in deeper pockets when a temporary, heavy and stagnant saline layer developed from a small amount of saltwater being trapped during sandbar closure. In this case, the saltwater had dissipated 10 days afterwards. During the short period of less than two weeks, a stagnant saline layer developed in the deep hole adjacent to the Venetian Court wall.

Lagoon water temperature was warmer near the surface than near the bottom in the heart of the dry summer season, as indicated by the maximum water temperatures and maximum 7-day rolling averages at each location (**Table 4**). However, at the cooler beginning and end of the season, the surface has cooler water, as indicated by minimum water temperatures and minimum 7-day rolling averages at each location (**Table 4**).

The greatest increase in water temperature recorded from morning to afternoon near the bottom in 2012 was **2.7°C** (4.9°F) on 19 June compared to **3°C** (5.4° F) in 2011, **2.7°C** in 2010, **2.7° C** in 2009; **1.9° C** in 2008 and **3.0°C** in 2007 (**Figures 4a-b; 4n and 4p; Alley 2010b**). The greatest morning to afternoon increase near the lagoon surface in 2012 was **8.4°C** (15.1°F) on 10 June compared to only **2.7°C** (4.8°F) in 2011, **3.1°C** in 2010, **4.6° C** in 2009, **2.3° C** in 2008 and **5.4°C** in 2007 (**Figures 4k-l; 4m and 4o; Alley 2011b**).

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 2010−2012, water temperature did not rise above 21°C near the bottom, with a maximum in 2012 of 21°C on 1 July (**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**).

In 2010−2012, the lagoon met the steelhead management goal of maintaining early morning minimum temperature below 20°C near the bottom throughout the season (**Figures 4a and 4m**) compared to not meeting the goal on 16 of 131 days (12%) in 2009 (**Figure 4n**), 54 of 130 days (42%) in 2008 and 35 of 124 days (28%) in 2007 (**Alley 2010b)**. In 2005 and 2006 (after wetter winters), the management goal was reached during the lagoon season. In the 2004 lagoon, 27% of the days (34 of 125 days) failed to meet the management goal partially due to tidal overwash. This was compared to 19% in 2003 and 10% in 2002.

The coho management goal of keeping maximum water temperatures below 20ºC (68ºF) near the bottom in the presence of steelhead was not met for 5% of the days measured (7 of 134 days) of the lagoon period in 2012 compared to being met all the time in 2011, not being met 6% of the days measured (7 of 127 days) in 2010 and not being met 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 down to 16°C or below on 24 days (18%) in 2012 compared to 26 days (28%) in 2011 and 56 days (44%) in 2010. But the daily maximum was above 16°C except for the last 3 days in October 2012, always above 16°C in 2011 and above 16°C except for 5 days in early October 2010. In 2009, lagoon temperature went down to 16° C or below on 9 days but the daily maximum was always more. The 2008 lagoon failed to cool to 16°C.

At the creek site near Nob Hill in 2009−2012, the stream management goal was met for steelhead of *no more than 4 hours a day at greater than 20ºC (68ºF)* (**Figures 5a, 5c and 5d**) and failed on only 1 day (**0.8%**) in 2008 (**Figure 5e**). In 2011 and 2012, water temperature reached 20°C on one day while in 2009 and 2010, water temperature did not reach 20°C. In 2007, water temperature failed to meet this management goal on **4%** of the days (**Figure 5e**) compared to **12%** in 2006 (**Figure 5f**). At the creek site in 2005, water temperature failed to meet the management goal **5%** of the days (**Alley 2005**). In 2004, **7%** of the days did not meet the goal. September was unusually cool in 2004 and 2005 (**Alley 2005**). At the Creek site in 2003, **17%** of the days failed to meet the management goal (**Alley 2005**).

The Soquel Creek water temperature goal for coho salmon in stream habitat is to have an average weekly temperature (7-day rolling average) of 16.7º C (62º F) or cooler. In 2012, the management goal was not met on 9 days (7%) from late June to mid-August of a 134-day lagoon period (**Figure 5a**). In 2011, the management goal was not met 23 days (25%) in July of the 93-day lagoon period (**Figure 5a**), with it reaching a maximum of 17.3°C. In 2010 the goal was met except for 7 days (6% of the days) consisting of 3 days in early June and 4 days in mid-July (**Figure 5c**). Coho salmon may have survived in the 2010 and 2011 stream habitat near the lagoon if present. However, in all other past monitoring years, considerably more stream shading and streamflow would be required to make lower Soquel Creek habitable for this species. From late May to the end of September 2009, the 7-day rolling average 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 7-day rolling average went as high as 18.2ºC (64.7ºF) on 9 July and was higher than 16.7° C for a 20-day period (**Figure 5d**).

The daily stream water temperature fluctuated more than the daily lagoon water temperature near the bottom in 2012, which was typical for previous years except 2010. The maximum daily lagoon water temperature typically occurred between 1700 and 2100 hr each day.

The 7-day rolling average for creek water temperatures were similar for 2011 and 2012, except for higher values in 2012 in late June caused by a short warm spell in early July and lower values in September and early October 2012.

Creek water temperatures in 1999-2012 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 warm stream temperatures and higher stream inflow in 1998, lagoon water temperatures were relatively cool compared to other years (**Alley 2003**).

Aquatic Vegetation Monitoring. In 2012 at the time of sandbar construction on 24 May, approximately 90% of the kelp and seagrass had been raked out of the lower lagoon, and the lagoon bottom was relatively firm. This was compared to 60% removal in 2011, 90% in 2010 and 70% in 2009. Bottom algae thickness and coverage was similar in 2010−2012 (except reduced at the mouth of Noble Gulch in 2012) and less than in 2009 (**Tables 5-9**).The pondweed that had nearly disappeared in 2011, returned to flourish in the highest concentration of the past 4 years. Evidence of nutrient inputs from Noble Gulch in 2012 was expressed by recurrent thick planktonic algae and sporadically high levels of surface algae nearby, though bottom algae was not thicker than at other sites as had been the case in past years. Filamentous algae was first noted in mid-June 2012. Pondweed was first detected in mid-July, it being initially most prominent in Reach 1 in August and September and then later dominating Reach 3 by October (70% coverage).

Surface algae in 2012 varied between 0 and 5% in Reach 1 (0 and <1% in 2011), 0 and 5% in Reach 2 (0 and 25% in 2011), 0 and 25% in Reach 3 (0 and 5% in 2011) and 0 and 15% at the mouth of Noble Gulch (0 and 20% in 2011) (**Tables 5 and 6**). Surface algae was less prevalent in 2010−2012 than 2009, except once it was as high in Reach 3 just downstream of Noble Gulch, forming a raft 50 ft x 120 ft on 3 July. 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 8 and 9**). The average surface algae coverage for Reaches 1−3 and the mouth of Noble Gulch in 2012 were 0.6%, 0.6%, 3% (below Noble Gulch) and 3%, respectively (0.1%, 3.6%, 1.3% and 1%, respectively in 2011 and 2%, 4%, 0.6% and 8.2% respectively in 2009). The years, 2007−2009, were dry years with minimal stream inflow to the lagoon, although 2012 baseflow was similar in fall to those years. 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 in mid-August and early September 2007 (**Alley 2008**). Surface algae in 2006 (a relatively wet year with high stream inflow) varied between 0 and 5% coverage, with the most being present in Reach 3 and near Noble Gulch (**Alley 2007**). In contrast, surface algae in 2005 (also a wet year) varied between 0 and 20% coverage of Reach 3, with very little in the lower 2 reaches (maximum was 2%) (**Alley 2006**). In conclusion, surface algae in the vicinity of Noble Gulch seemed to be sporadically high and was not well correlated to stream inflow to the lagoon when comparing different years. It was not well correlated with bottom algal thickness in any one year either.

Bottom algae thickness in the 2012 lagoon was less than in 2009−2011. In 2012, bottom algae thickness at in Reaches 1−3 and at the mouth of Noble Gulch averaged 0.5 ft, 0.4 ft, 0.4 ft and

0.5 ft, respectively (**Table 5**). This was compared to 2011 averages of 0.6 ft, 0.6 ft, 0.3 ft and 1.1 ft, respectively, 2010 averages of 0.8 ft, 0.8 ft, 0.8 ft and 2.2 ft, respectively, and 2009 averages of 1.7 ft, 1.2 ft, 0.9 ft and 1.4 ft, respectively (**Tables 6–9**). The higher pondweed growth in 2012 likely competed with algae for nutrients and inhibited algae production.

Table 5. Visually Estimated Algae Coverage and Thickness in the 2012 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
6-5	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
6-19	0.2	10	0	0.2	30	0	0.4	60	0	0.4	60	0
7-3	0.50	90	5	0.7	100	5	0.5	100	25/3 below/above Noble G.	0.4	60	15
7-16	1.0	70	0	0.5	40 (<1% pond-weed)	0	1.0	90	0	Thick plankton bloom- no vis.	Turbid	0
8-1	0.4	90	0	0.4 (1.0 pond-Weed)	99(1% pond-weed)	0	0.2 (1.0 Pond-Weed	99(1% pond-weed)	0	0.2	100	0
8-14	0.2 (1.5 pond-Weed)	80 (10 pond-Weed)	0	0.3 (0.8 pond-Weed)	85 (15 pond-Weed)	0	0.3 (0.8 pond-Weed)	85 (15 pond-Weed)	0	0.5	80	0
8-29	0.4 (2.5 Pond-weed)	70 (25 Pond-weed)	0	0.3 (2.5 Pond-weed)	85 (15 pond-weed)	0	0.4 (2.5 pond-weed)	80 (20 pond-weed)	0	0.5	70	10
9-12	0.2 (3.0 pond-weed)	65 (35 pond-Weed)	<1	0.5 (2.5 pond-weed)	70 (30 pond-weed)	0	0.5 (2.0 pond-weed)	70 (30 pond-weed)	0	0.4	70	0
9-26	2.0 (3.0 pond-weed)	55 (35 pond-weed)	0	0.7 (1.5 pond-weed)	70 (30 pond-weed)	0	0.3 (1.0 pond-weed)	50 (50 pond-weed)	0	1.5 (2.5 pond-weed)	70 (10 pond-weed)	0
10-10	Dark	Dark	0	Film (1.5 pond-weed)	60 (40 pond-weed)	0	Film (1.0 pond-weed)	30 (70% pond-weed)	0	Thick plankton bloom- no vis.	Turbid	0
10-24	Turbid	Turbid	0	Turbid	Turbid	0	Turbid	Turbid	0	Turbid	Turbid	0
11-7	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0
Avg- 6-05 – 9-26	**0.5 algae**	**59 algae**	**0.6**	**0.4 algae**	**64 algae**	**0.6**	**0.4 algae**	**70 algae**	**3 below Noble G.; 0.3 above**	**0.5 algae**	**64 algae**	**3**

Table 6. Visually Estimated Algae Coverage and Thickness in the 2011 Lagoon (pondweed with attached algae included).

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

Table 7. 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 8. 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 9. 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 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 the time when oxygen concentrations are most importantly measured and rated. In 2012, oxygen levels for steelhead were "good" (greater than 7 mg/l at dawn) *near the bottom* at most stations during the 12 two-week monitorings (**Tables 2 and 3, Figure 6a-1 and Appendix A**). Exceptions were "fair" ratings (5−7 mg/l) at the mouth of Noble Gulch from mid-July to mid-August, "poor" (2−5 mg/l) to "fair" ratings on 24 October at all stations after stormflow clouded the water to reduce photosynthesis and "fair" ratings at the railroad trestle and mouth of Noble Gulch on 7 November.

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.

Although average lagoon oxygen levels in 2012 at dawn were in the "good" range above 7 mg/l until October when small stormflows ensued, they were generally lower than in 2010 and 2011 June and July, after which they were similar (**Figure 6h**). For average afternoon lagoon oxygen concentrations, 2012 had somewhat higher concentrations than 2010 and 2011 in July, August and early September (**Figure 6i**). Average afternoon oxygen levels were similarly high between years in late September and declined in October with incidence of small stormflows. The relatively lower oxygen concentrations in late October in 2010 and 2012 and early November in 2012 resulted from early fall storms creating turbidity to inhibit light penetration and photosynthesis and generally less plant growth and photosynthesis associated with lower sun angle and shading by the western slope as the fall season progressed.

In comparing morning and afternoon oxygen levels, usually oxygen concentration was higher in the afternoon than morning, despite warmer water temperature in the afternoon which has a lower oxygen saturation point. This was the case for lagoon sites in 2012 (**Figures 6b-e**). However, at the stream station at Nob Hill, oxygen was only slightly higher in the afternoon of the lightly rainy 10 October and lower in the afternoon than in the morning on the cloudy 24 October (**Figure 6f**). This was in contrast to 2011 when oxygen levels were consistently less in the afternoon than in the morning at Site 5 above the lagoon (**Figure 6g**). In stream settings, oxygen is typically at or close to full saturation due to water turbulence in riffles. In 2011, the morning air and water temperatures were generally cooler (**Figures 3e and 3f**) with a higher oxygen saturation point than in 2012, yielding higher oxygen concentration in the morning. Afternoon oxygen concentrations were similar between 2011 and 2012.

Salinity Results. In 2012, saline conditions were only detected a short time after sandbar closure (30 May) in the deeper lagoon area along the wall at Venetian Court (**Appendix A**). This resulted from a small amount of saltwater being trapped in the lagoon at the time of sandbar closure on 24 May. Shrouds were not installed on the sandbar inlet at that time because it was assumed that the sufficient stream inflow would soon force the saltwater out through the sandbar. None was detected on 5 June. Unlike in 2008, there was apparently sufficient lagoon outflow through the flume in 2012 to prevent saltwater from periodically being flushed back into the lagoon through the flume on certain high tides. A freshwater lagoon was maintained until the facilitated breach in mid-November, with salinities of 0.3-0.4 ppt throughout the water column until late October. On 24 October and 7 November, salinity at the bottom at Station 3 below the railroad trestle was 0.6 and 1.2 ppt, respectively, while elsewhere it was 0.4-0.5 ppt.

Conductivity Results. Conductivity remained low throughout 2012, except in the Venetian Court's wall-hole early on when saltwater was present at the bottom. Otherwise, it ranged between 486 umhos on 5 June to 704 umhos on 26 September (**Appendix A**). Then in October and November, conductivity increased just at the bottom at Station 3 (railroad trestle) and Station 4 (mouth of Noble Gulch). On 10 October, it increased to 839 umhos on the bottom at Station 4. On 24 October it increased to 966 umhos on the bottom at Station 3. On 7 November it increased to 1872 umhos at the bottom at Station 3 and 793 umhos at the bottom at Station 4. We have no explanation for these slight increases in conductivity, except that they might indicate an unknown pollution source. Conductivity was slightly lower at Station 5 above the lagoon than in the lagoon through the summer.

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 2009−2012 with higher streamflow than in 2008 (**Table 10**). The year 2001 was most affected by tidal overwash in the last 12 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 2012 lagoon followed a below median stormflow amount. Fortunately, there were 3 small, spring storms in March and April that created higher than expected baseflow early in the dry season that was typical of an average year (**Figures 22 and 23**). Also the previously above average, the two previous wet seasons (**Figures 25 and 26**) may have maintained the aquifer at a higher level prior to the below average 2011-2012 wet season to aid in baseflow levels. Hydrographs for the three previous dry water years, 2007-2009, may be found in **Figures 27−29**. before that are Baseflow at the time of the first sandbar closure was approximately 10 cfs (compared to 25 cfs in 2011) (**Table 10; Figures 22 and 23**). By August the baseflow began to drop further below the median daily statistic. 2012 had the 12th highest baseflow on 1 June for the past 22 years. By 1 September, prior to any fall rainfall, 2012 streamflow had declined to 1.8 cfs at the Soquel Village USGS gage, compared to 5.8 cfs in

2011, 3.4 cfs in 2010, 1.2 cfs in 2009, 0.7 cfs in 2008, 1.3 cfs in 2007 and 6.6 cfs in 2006. The 1 September 2012 baseflow was the 14th highest in 22 years, tied with 1993 and 2004. The 4th relatively small stormflow in the fall that peaked at about 60 cfs, but exceeded the flume capacity, necessitated a facilitated breach of the sandbar on 18 November (**Figure 24**).

Table 10. Daily Mean Discharge Recorded at the USGS Stream Gage (11160000) in Soquel Village, At One Month Intervals from 1 June to 1 October, 1991-2012.

Year	1 June Streamflow (cfs)	1 July Streamflow (cfs)	1 August Streamflow (cfs)	1 September Streamflow (cfs)	1 October Streamflow (cfs)
1991	4.1	2.6	1.5	0.65	0.37
1992	4.0	4.0	0.6	0.1	0.2
1993	12	5.8	3	1.8	1.6
1994	4.2	1.3	0.7	0.2	0.05
1995	24	17	7.8	4.5	3.7
1996	23	17	8	4.6	3.6
1997	9	7.7	4.2	2.6	2.3
1998	58	22	13	9.7	7.2
1999	16	10	7.4	5.7	4.3
2000	14	9.5	6.2	4.6	7.4
2001	7.2	4.0	3.4	2.6	1.6
2002	9.1	4.9	3.3	2.8	2.2
2003	15	7.2	4	2.2	1.8
2004	5.2	3.3	2.7	1.8	1.4
2005	20	13	7.5	5.1	3.1
2006	28	17	8.7	6.6	7.1
2007	4.7	2.3	2.0	1.4	1.3
2008	3.8	2.0	1.3	0.7	1.4
2009	6.2	3.3	2.5	1.2	0.5
2010	14	7.3	5.3	3.4	2.2
2011	25	15	8.6	5.8	4.5
2012	9.8	5.6	2.9	1.8	1.4

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, 2 September, fog cleared off by 0930 hr and the sky was clear the remainder of the day. Air temperature in the morning was 16.8°C at 1025 hr at the flume. Water temperatures were cooler in the morning than 4 days previous, and oxygen levels were slightly less and in the "good" range. The lagoon depth was maintained at an excellent gage height of 2.55- 2.57 ft during the nautical parade. There were 8 floats in the nautical parade and 23 other boats and 6 standing surfboarders in the water. In conformance with the permit requirements from the California Department of Fish and Game, no floats were set up to be propelled by waders. Means of propulsion was by electric motor. Thus, the lagoon bottom was undisturbed. Conductivity near the bottom increased very slightly at the Stockton Avenue Bridge from 650 before to 659 umhos after the parade. Conductivity at the mouth of Noble Gulch was 654 umhos near the bottom before the procession and 674 afterwards. The measured levels of conductivity were not stressful to steelhead. There was no odor of hydrogen sulfide, and no fish mortality was observed. Oxygen concentrations in the afternoon following the nautical parade were high, ranging between 10.52 and 12.78 mg/l near the bottom before 1502 hr. Water temperature at this time was 19.5° C near the bottom in the afternoon at the 2 monitored sites. The secchi depth (water clarity) was to the lagoon bottom after the float procession. Flower petals were collected by Begonia Festival staff and volunteers the following week, and there were minimal petals left by the parade of floats.

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**).

Pollution Sources and Solutions. 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. City building permit 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.

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. There was a large surface algal raft just downstream of Noble Gulch on 3 July 2012. Therefore, Noble Gulch continues to be a pollution source to the summer lagoon. In past years when gray water was observed at the Noble Gulch culvert outlet to the lagoon, streamflow was clear in Noble Gulch at the park when checked, before the creek went underground into the culvert. By minimizing the summer stream inflow from Noble Gulch, nutrients and bacteria entering the lagoon would be reduced.

Another drain into the lagoon is situated under the railroad trestle, where slight oxygen depletion has been detected in recent years and in October 2011 and in October and early November 2012. This drain could be capped if summer runoff was re-directed into the sewer. 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 pollution from urban runoff once the rains start in fall, 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. There has been a pollution problem and high flashiness in streamflow in the past during the first small storms of the fall. Early storms turn the lagoon water dark, requiring lagoon water level reduction to allow light to penetrate to the bottom and allow photosynthesis and oxygen production to continue. 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.

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 following 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.

Capitola's Soquel Lagoon with tule marsh.
(circa 1927; Provided by the Capitola Historical Museum.)

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

1. Prior to sandbar breaching in the fall, notch the sandbar across the beach at an elevation just below the piling bolt for flooding, minimizing the gradient of the notch to slow the evacuation of water through the beach and to minimize beach erosion. The purpose is to maximize the residual estuary depth after the emergency breach.

2. The notch in the sandbar should be cut slightly lower than the piling bolt. *Continue to* m*ake*

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

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

4. To provide cover for juvenile fishes and to scour deeper habitat, secure large woody material to the lagoon bottom with anchor boulders in appropriate locations. Continue to retain large woody material that naturally reaches the lagoon.

5. Allow a clear path from under the bridge to the beach at Venetian Courts to enable seining for juvenile steelhead during fall censusing.

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

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

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

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

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

11. 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.

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

13. 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.

14. 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.

15. 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.

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

17. 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.

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

19. Do not reduce the lagoon level for the Begonia Festival's nautical parade.

20. 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.

21. 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.

22. "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**).

23. 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.

24. 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.

25. 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 2012, as was the case in 2003–2011. CDFG allowed juvenile planting of smolts in spring only in streams where planted juveniles were descendents of captured adult steelhead brood stock from those streams (San Lorenzo River and Scott Creek). No adult steelhead were captured from Soquel Creek for hatchery propagation. Therefore, no juveniles were planted there.

Fish Sampling Results. Fall sampling for steelhead occurred on 7 and 14 October 2012, from just upstream of the Stockton Avenue Bridge to the beach. The population estimate was considered valid because it was assumed that the probability was the same for marked and unmarked steelhead to either enter the bay or move upstream of the estuary after the sandbar breached. A bag-seine with dimensions 106 feet long by 6 feet high by 3/8-inch mesh was used. The seine was set perpendicular to shore, parallel to the Stockton Avenue Bridge and just upstream of it. Juvenile steelhead congregate in the shade under the bridge. The seine was pulled to the beach in front of Venetian Court. With this larger, coarser-meshed seine, no tidewater gobies were captured. A total of only 44 juvenile steelhead were captured and clipped on 7 October after 6 seine hauls. There were no mortalities. Only 20 juvenile steelhead were captured on 14 October after 6 seine hauls, with 4 recaptures and no mortalities. Other species captured with the large seine were one starry flounder (205 mm SL), 12 staghorn sculpins and 1 prickly sculpin. The median size of juvenile steelhead captured on both days in 2012 was 140-144 mm SL (**Figure 7**) compared to 155-159 mm SL on the first day and 160-164 mm SL on the second day in 2011 (**Figure 8**). A somewhat bimodal histogram was evident in 2012 (largest grouping in the smaller size classes), as was evident in 2011 and 2009 (**Figure 10**) (but groupings in the larger size classes larger than usual). The same bimodal pattern was observed in steelhead captured in Aptos Lagoon/Estuary in 2011 and 2012 (**Alley 2012**). It could be that the lagoon population consisted more of larger yearlings and fewer YOY in 2009 and 2011 than in other years. Size histograms for other years of sampling back to 1998 may be found in **Figures 11−20**.

Our steelhead population estimate based on mark and recapture for fall 2012 was 220 compared to 678 in 2011 and 1,174 in 2010 (**Table 11; Figure 21**) (methods in **Ricker 1971**). This was the lowest estimate in 20 years.

On 7 October 2012, 5 seine hauls were made for tidewater gobies with a 30-foot x 4-foot x 1/8-inch mesh beach seine in lower Soquel Lagoon near the beach. No tidewater gobies were captured. They were last captured in 2008 and 2009 after dry winters. Fish captured with the small seine included threespine sticklebacks in high abundance. 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 2-year drought (2007-2008). Tidewater gobies have been reported in recent years in adjacent Moran Lake Lagoon by Jerry Smith (**pers. communication**). Tidewater gobies from up-coastal-current Moran Lake likely re-colonized Soquel Lagoon in 2008, when Soquel Creek had experienced two mild winters in a row. Tidewater gobies were found in Aptos Lagoon in 2011 and 2012

(**Alley 2012;2013**).

Table 11. Estimates of Juvenile Steelhead Numbers in Soquel Creek Lagoon for the Years 1988 and 1992-2012.

Year	Steelhead Population Estimate for Soquel Creek Lagoon
1988-	Rough estimate of a few hundred. No mark/recapture activity done. 157 juveniles captured in 5 seine hauls.
1992-	Rough estimate of a few hundred. No mark/recapture activity was done. 60 juveniles captured in 4 seine hauls.
1993-	2,787 +/- 306 (standard error). 1,046 fish marked from two seine hauls.
1994-	1,140 +/- 368 (standard error). 76 fish were marked from two seine hauls.
1995-	360 +/- 60 (standard error). 59 fish were marked from 4 seine hauls.
1996-	255 +/- 20 (standard error). 105 fish were marked from 3 seine hauls.
1997-	560 +/- 182 (standard error). 53 fish were marked from 3 effective seine hauls.
1998-	671 +/- 74 (standard error). 164 fish were marked from 3 effective and one snagged seine haul.
1999-	928 +/- 55 (standard error). 397 fish were marked in 4 effective seine hauls.
2000-	875 +/-156 (standard error).185 fish were marked in 4 effective seine hauls.
2001-	454 +/- 27 (standard error). 186 fish were marked in 4 effective seine hauls.
2002-	1,042 +/-84 (standard error). 363 fish were marked in 4 effective seine hauls.
2003-	849 +/-198 (standard error). 109 fish were marked in 5 effective seine hauls.
2004-	3,869 +/-1,009 (standard error). 281 fish were marked in 4 effective seine hauls.
2005-	1,454 +/-347 (standard error). 212 fish were marked in 5 effective seine hauls and one with rope tangled around one pole.
2006-	992 +/- 125 (standard error). 178 fish were marked in 5 effective seine hauls.
2007-	6,064 +/- 1,671 (standard error). 226 fish were marked in 5 effective seine hauls
2008 -	7,071 +/- 1,574 (standard error). 551 fish were marked in 2 effective seine hauls
2009 -	449 +/- 87 (standard error). 114 fish were marked in 6 effective seine hauls.
2010-	1,174+/- 111 (standard error). 318 fish marked in 2 effective seine hauls.
2011-	678 +/- 107 (standard error). 197 fish marked in 5 effective seine hauls.
2012-	220 +/- 94 (standard error). 44 fish marked in 6 seine hauls hindered by submerged log.

More juvenile steelhead were expected to use the lagoon in 2012 than 2011 because adult passage opportunities to the upper watershed were less during the drier 2012 winter, with assumedly more spawning near the lagoon (**Figures 21 and 25**). However, the opposite occurred with a higher juvenile population in 2011 than 2012. Higher winter flow in 2011 encouraged more spawning in the upper creek with easier access, assumedly seeding the lagoon less with young-of-the-year steelhead than the previously dry years of 2007−2009 and 2012 (**Figures 27-29**). However, the 3 small storms late in the wet season of 2012 must have been sufficient to provide adult passage and spawning further upstream.

Another likely reason for the small lagoon population size in 2012 was that the adult return was probably small the previous winter, those returning adults having been spawned primarily during 2009, the third year of a drought with a small lagoon juvenile population. 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**.).

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 2007–2012 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.

Two factors that may influence growth of juvenile steelhead at the time of fall sampling are population size and the time of lagoon closure prior to sampling. A summary table was prepared for the years, 1998−2012 (**Table 12**), corresponding to scatter plots of the data found in previous reports (**Alley 2011**). Scatter plots of median juvenile size versus weeks of sandbar closure and versus population size done for data in 1998−2010, indicated no strong relationship between these factors when considered separately.

One would predict that if the population was large, then competition for food would be high and juvenile size would be less. One would expect that since the lagoon is a very food-productive habitat, then juvenile size would be larger with longer the lagoon growth periods. The population estimates may not be entirely precise but likely are accurate in reflecting relative annual differences in actual population size. The proportion of larger yearlings may also vary between years, but usually the lagoon population is overwhelmingly dominated by young-of-the-year steelhead, based on past scale analysis. The population in 2011 may have been an exception, though, with it dominated by yearlings after poor YOY survival.

Table 12. Summary of Annual Fish Sampling Dates, Population Estimates, Steelhead Size and Lagoon Growth Period Prior to Sampling, 1998−2011.

Year	Sandbar Closure Date	Fish Sampling Dates	Weeks of Sandbar Closure Prior to Final Fish Measurements	Days of Sandbar Closure Prior to Final Sampling	Steelhead Population Estimate	Median Size Grouping of Captured Fish (mm SL)
1998	9 July	4/11 Oct	13.1	92	671	115-119 First Day
1999	18 May	3/10 Oct	20.6	144	928	120-124 First Day
2000	7 June	1/8 Oct	17.4	122	875	135-139 First Day
2001	14 June	7/14 Oct	17.3	121	454	125-129
2002	23 May	6/13 Oct	20.3	142	1,042	105-109 First Day
2003	22 May	5/12 Oct	20.3	142	849	110-114 First Day
2004	26 May	3/10 Oct	19.4	136	3,869	115-119 First day
2005	9 June	2/9 Oct	18.1	127	1,454	105-109& 110-114
2006	14 June	30Sep/8 Oct	16.4	115	992	150-154 & 145-149
2007	23 May	7/14 Oct	20.4	143	6,064	125-129 Both days
2008	22 May	27Sep/ 11 Oct (no lengths)	18.1	127	7,071	115-119 First day
2009	21 May	4/11 Oct	20.3	142	449	155-159 Both days
2010	2 June	3/10 Oct	18.4	129	1,174	115-119 Both days
2011	20 June	2/16 Oct	15.3+1.6 estuary	106+11 days estuary	678	155-159 & 160-164
2012	24 May	7/14 Oct	20.3	142	220	140-144 Both days

We suspect from the size distributions of juveniles captured, that steelhead grew faster in 2006, 2009 and 2012 than either 2007 or 2008 because of less competition for food with much smaller juvenile populations (**Table 12**). 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. We see that with similarly low population sizes in 1998, 2001 and 2009, as the growth period increased, the median size also increased, respectively. 2012 also had relatively large juveniles with a long growth period. 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. 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. 2012 had a high density of pondweed. 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 for maintenance and may allow a higher portion of the food intake to be used for growth. However, cooler lagoons may have less production of aquatic vegetation, and fish digestion rate is slower in cooler lagoons, which slows the processing of food for growth. The cooler lagoon in 2011 may have promoted relatively larger juvenile steelhead with a relatively small population size, although the lagoon growth period prior to sampling time was relatively short (**Table 12**). Aquatic plant production was less in 2011 than in the warmer lagoons of 2008, 2009 and 2012 (more pondweed) (**Tables 5-9**), indicating less food in 2011. There may have been a higher proportion of yearlings in the lagoon population in 2011 compared to other years due to overall low YOY survival in the watershed. A higher proportion of yearlings would have increased the median size of juveniles.

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 2012, the seepage problem returned after little seepage the previous year. This may have been partially responsible for the considerable fluctuation in lagoon height in June−August. Usually, in drier years it is easier to maintain a high gage height.

If the lagoon water surface drops, steelhead habitat in the upper lagoon is lost. Therefore, the lagoon level should be kept as high as possible during summer. The flume's flashboards must be secured against vandals removing them and against tidal backpressure that may dislodge them.

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

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

In 2012, mergansers were again less common than other years, as was the case in 2011. In 2012, one merganser was observed on only 3 days of monitorings (25% of the time) (3 July, 29 August and 12 September) (**Appendix A**). Only 1 egret was sighted. However, cormorants were more common in 2012 than most years, being observed on 4 days of monitoring (33% of the days of monitoring) late in the season (26 Sep, 10 October, 24 October and 7 November) and sometimes were in pairs. They appeared to be much faster predators than mergansers, and were observed swallowing sticklebacks. They used the redwood log in the middle of the lagoon to sun themselves. Two or 3 pied-billed grebes were usually observed each monitoring in past years. In 2012, 1 pied billed grebe was observed on 4 monitoring days early in the season and a pair of pied-billed grebes were observed on 4 monitoring days late in the season (67% of the monitoring days with grebe sightings). Piscivorous western pond turtles regularly basked on the instream cottonwood log and additional logs further downstream adjacent to the Golino Property. As many as 3 pond turtles were observed at one time on the cottonwood log and the nearby log. Brown pelicans frequented the 2012 lagoon, which is highly unusual. They would perch on the cut logs that had accumulated near Margaritaville cove or bath in the lower lagoon. They were seen on 4 occasions, and on 29 August there were three in the lower lagoon. No pelicans were seen feeding in the lagoon.

Maintenance of lagoon depth is important to make feeding more difficult for piscivorous animals. Other bird species that utilized the lagoon included mallard (as many as 22), coots (as many as 82) and gulls (as many as 100+). Approximately 5 domestic ducks (two were white) and one goose (Girdie) were present until the goose disappeared between the 12th and 26th of September. The additional redwood log with rootmass located in Reach 3 remained from 2011, offering additional roosting area for birds. It was heavily utilized by all bird species. The redwood log had been cut through at about 15-foot intervals but was still intact except for 2 sections in Margaritaville cover.

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. Seek funding to ecure large wood to the lagoon bottom with anchor boulders as added fish cover and as scour objects to deepen the lagoon and enhance rearing habitat.

3. 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.

4. 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.

5. 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.

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

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

8. 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.

9. 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.

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

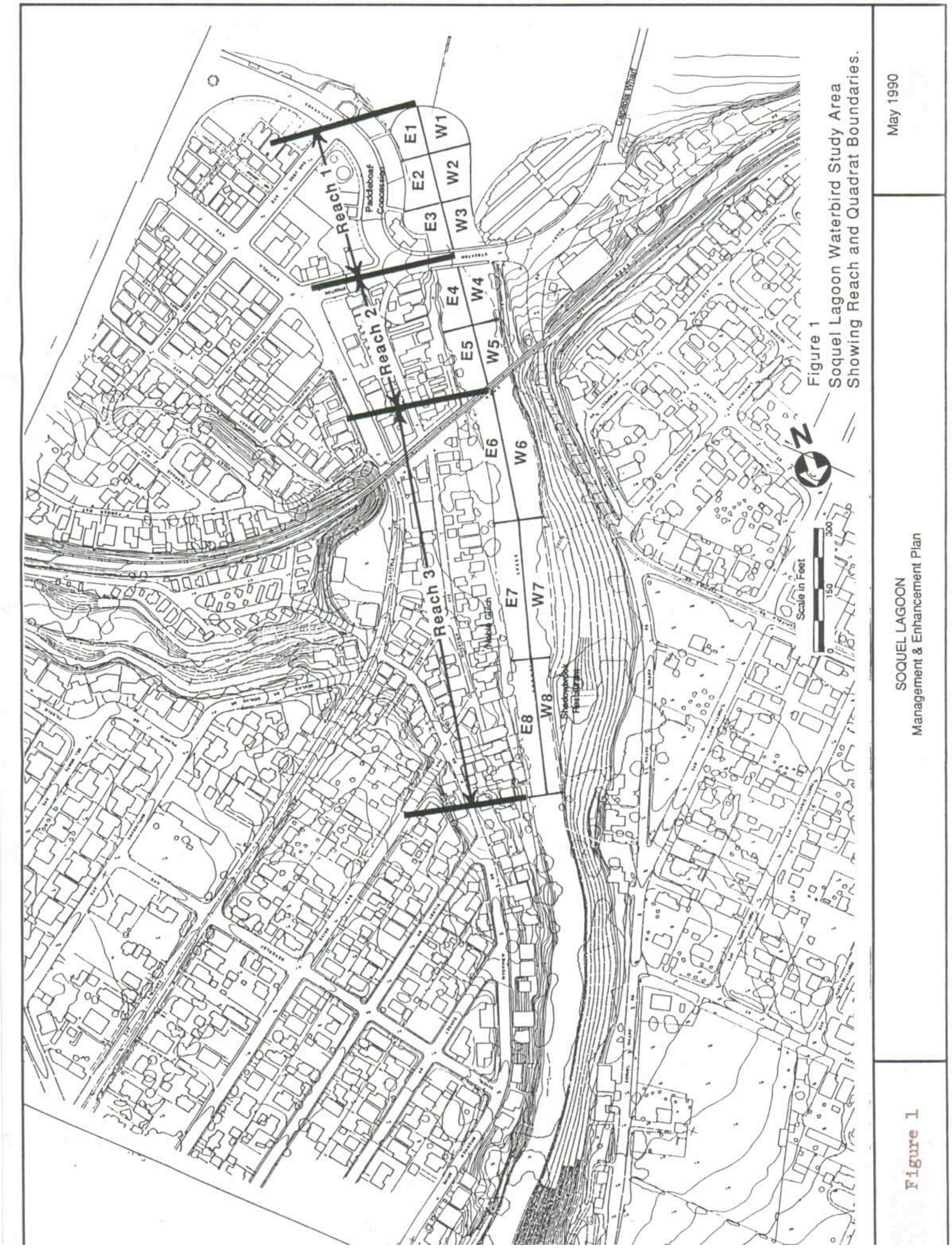


Figure 1
Soquel Lagoon Waterbird Study Area
Showing Reach and Quadrat Boundaries.
May 1990
SOQUEL LAGOON
Management & Enhancement Plan
Reach 1
Reach 2
Reach 3
Paddleboat Concession
E1
E2
E3
E4
E5
E6
E7
E8
W1
W2
W3
W4
W5
W6
W7
W8
Noble Gulch
Shadowbrook Restaurant
Capitola Wharf
N
Scale in Feet
0
150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

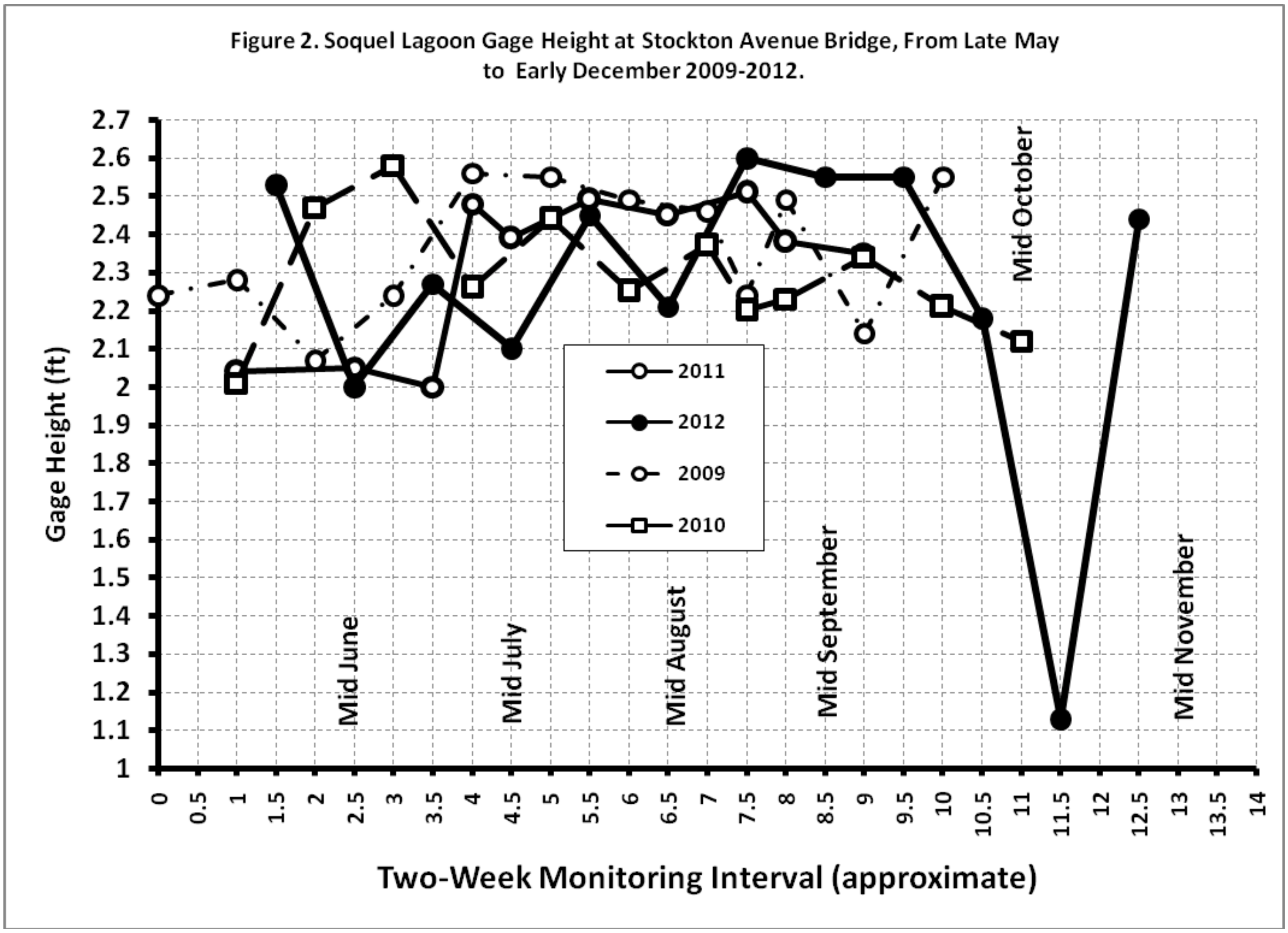


Figure 2. Soquel Lagoon Gage Height at Stockton Avenue Bridge, From Late May to Early December 2009-2012.
Gage Height (ft)
Two-Week Monitoring Interval (approximate)
Mid June
Mid July
Mid August
Mid September
Mid October
Mid November
2011
2012
2009
2010

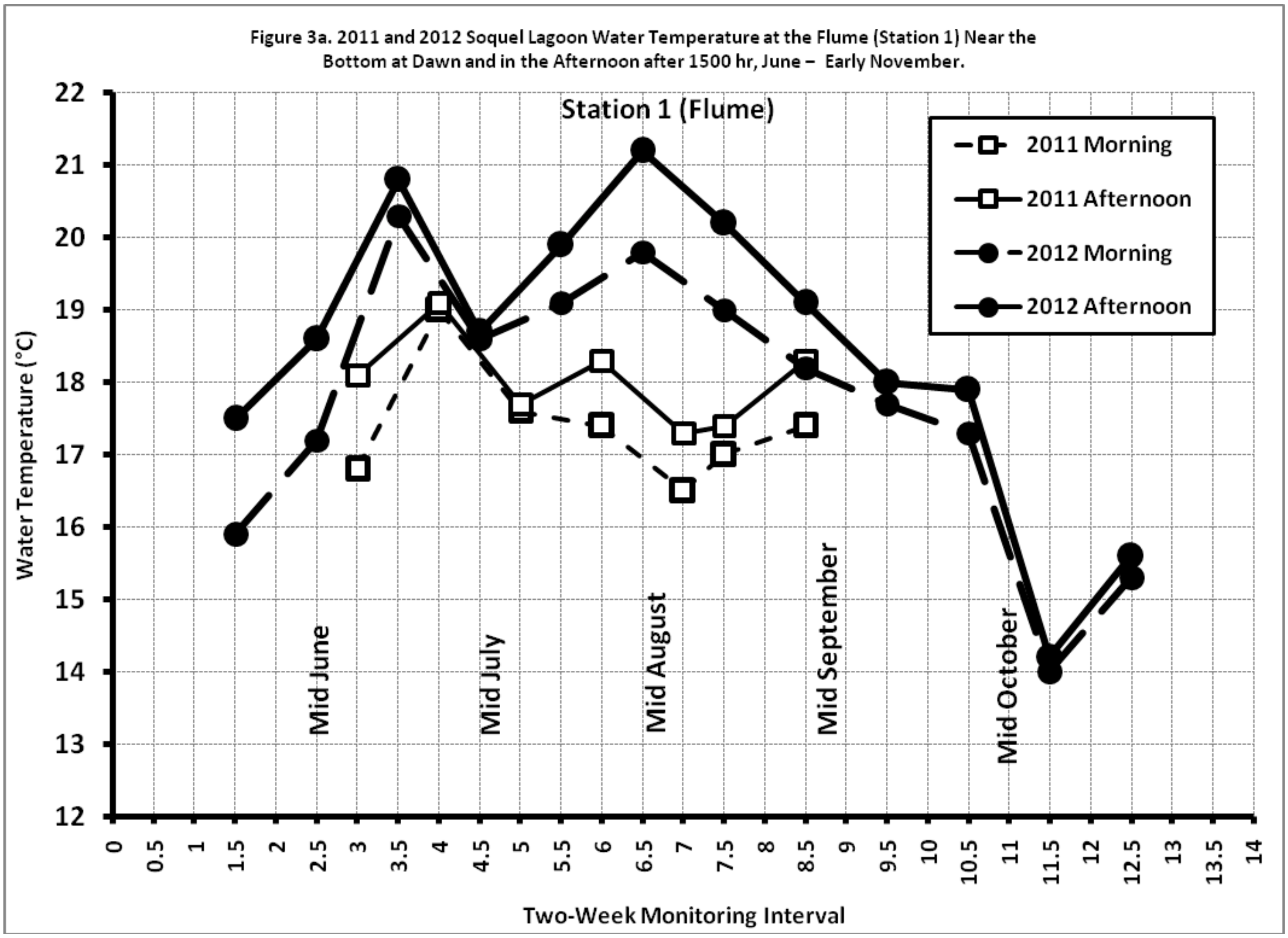


Figure 3a. 2011 and 2012 Soquel Lagoon Water Temperature at the Flume (Station 1) Near the Bottom at Dawn and in the Afternoon after 1500 hr, June – Early November.
Station 1 (Flume)
2011 Morning
2011 Afternoon
2012 Morning
2012 Afternoon
Water Temperature (°C)
Two-Week Monitoring Interval
Mid June
Mid July
Mid August
Mid September
Mid October
22
21
20
19
18
17
16
15
14
13
12
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14

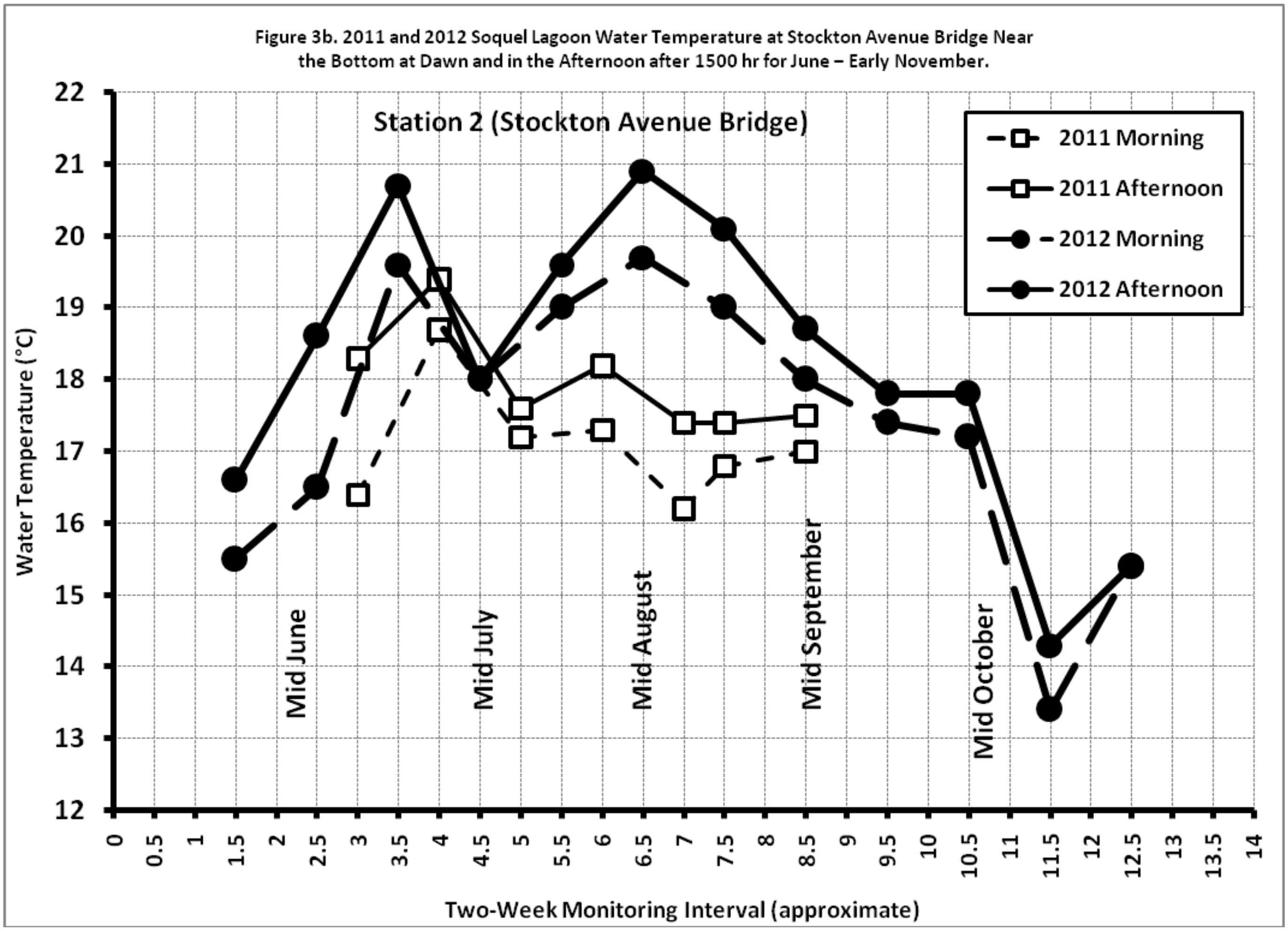


Figure 3b. 2011 and 2012 Soquel Lagoon Water Temperature at Stockton Avenue Bridge Near the Bottom at Dawn and in the Afternoon after 1500 hr for June – Early November.
Station 2 (Stockton Avenue Bridge)
2011 Morning
2011 Afternoon
2012 Morning
2012 Afternoon
Water Temperature (°C)
Two-Week Monitoring Interval (approximate)
Mid June
Mid July
Mid August
Mid September
Mid October
22
21
20
19
18
17
16
15
14
13
12
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14

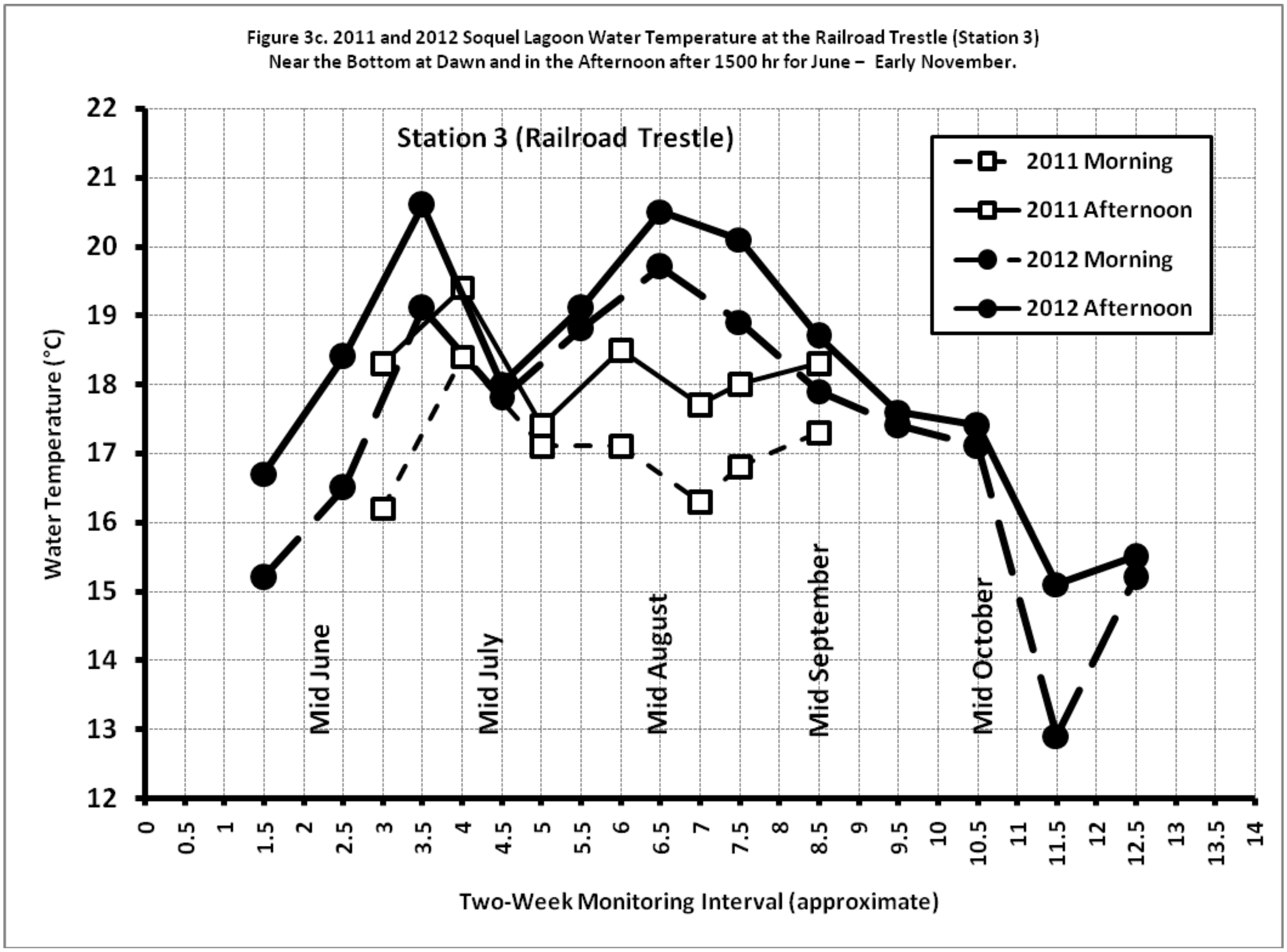
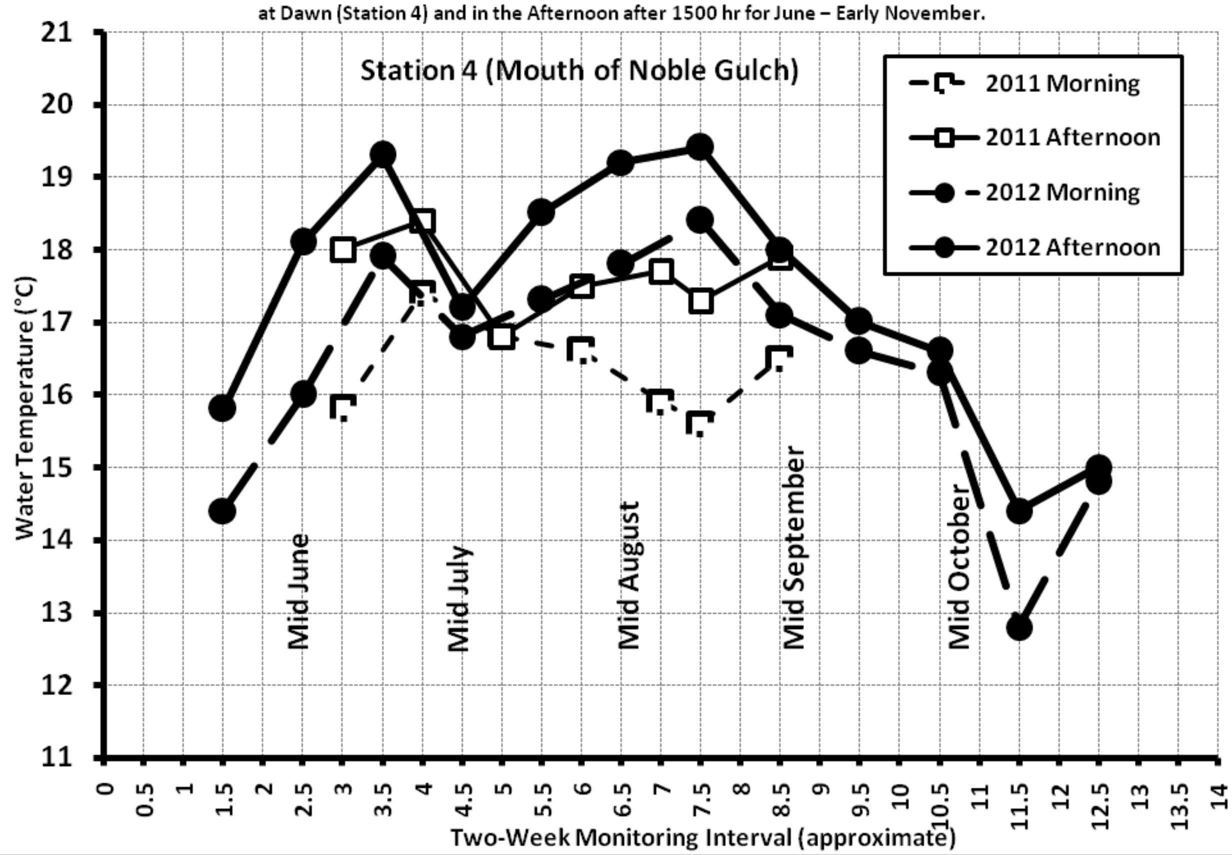


Figure 3c. 2011 and 2012 Soquel Lagoon Water Temperature at the Railroad Trestle (Station 3)
Near the Bottom at Dawn and in the Afternoon after 1500 hr for June – Early November.
Station 3 (Railroad Trestle)
2011 Morning
2011 Afternoon
2012 Morning
2012 Afternoon
Water Temperature (°C)
Mid June
Mid July
Mid August
Mid September
Mid October
Two-Week Monitoring Interval (approximate)
22
21
20
19
18
17
16
15
14
13
12
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14

Figure 3d. 2011 and 2012 Soquel Lagoon Water Temperature at Noble Gulch Near the Bottom at Dawn (Station 4) and in the Afternoon after 1500 hr for June – Early November.



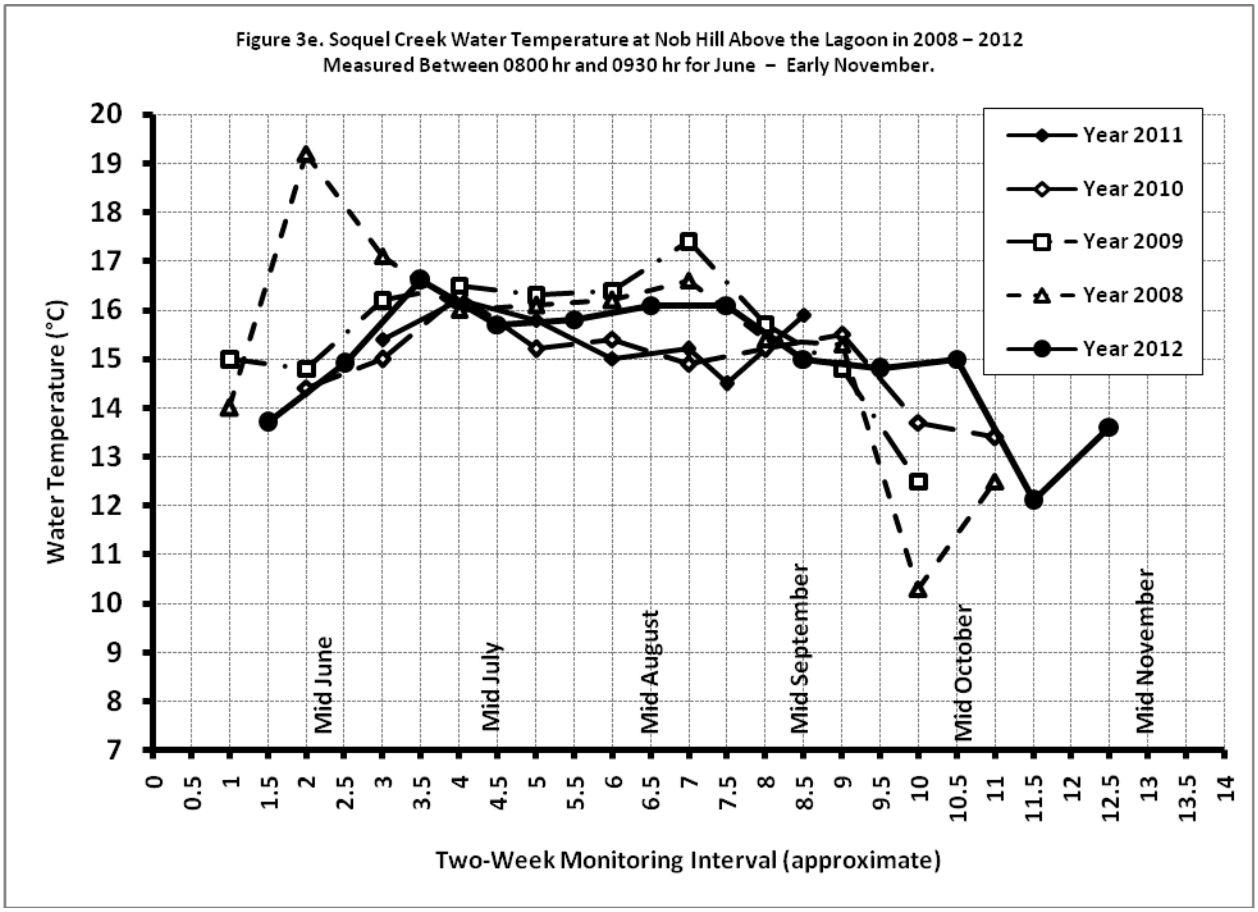


Figure 3e. Soquel Creek Water Temperature at Nob Hill Above the Lagoon in 2008 – 2012
Measured Between 0800 hr and 0930 hr for June – Early November.
Water Temperature (°C)
Two-Week Monitoring Interval (approximate)
Year 2011
Year 2010
Year 2009
Year 2008
Year 2012
Mid June
Mid July
Mid August
Mid September
Mid October
Mid November

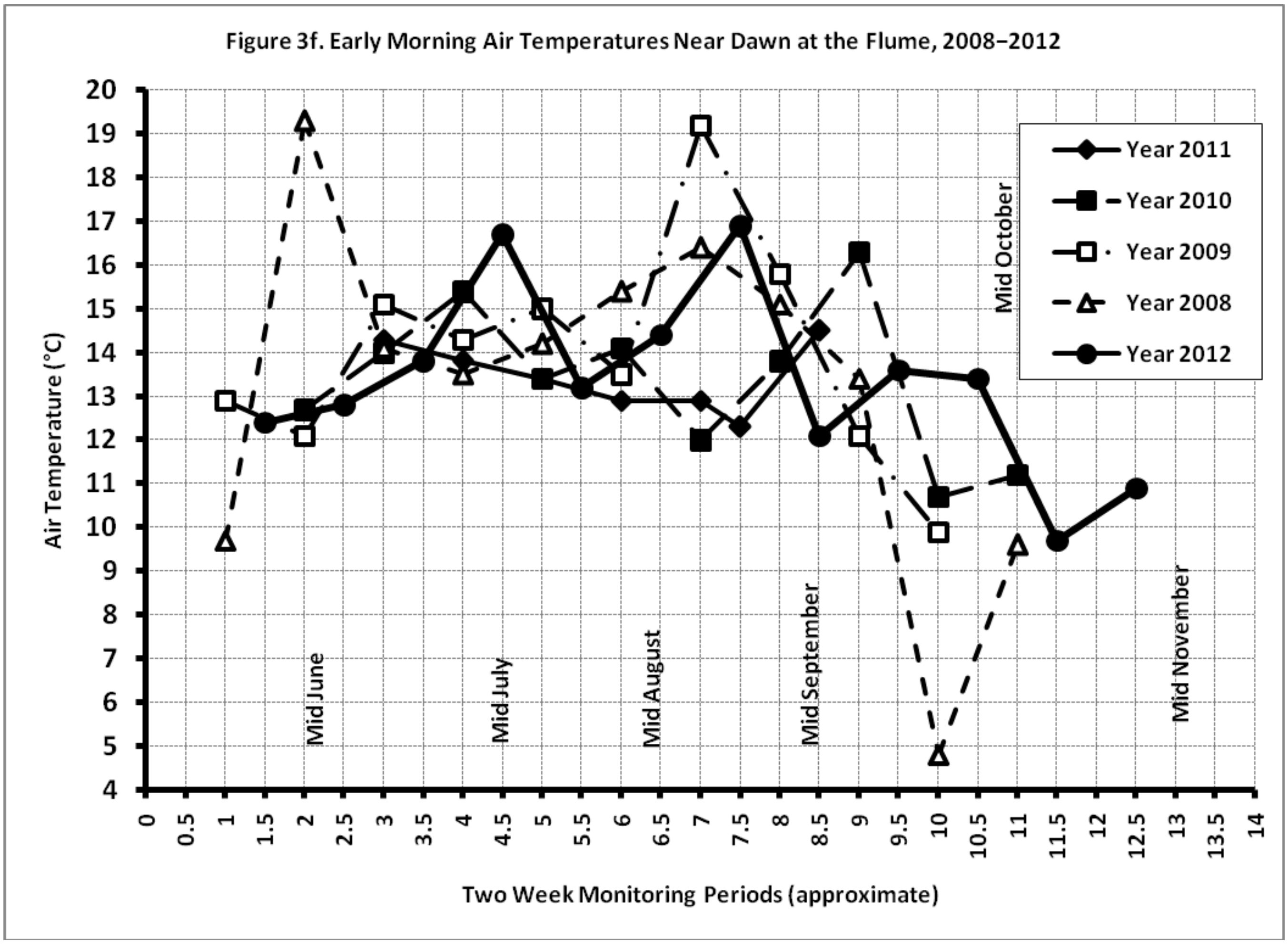


Figure 3f. Early Morning Air Temperatures Near Dawn at the Flume, 2008–2012
Air Temperature (°C)
Two Week Monitoring Periods (approximate)
Year 2011
Year 2010
Year 2009
Year 2008
Year 2012
Mid June
Mid July
Mid August
Mid September
Mid October
Mid November
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
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10
10.5
11
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12
12.5
13
13.5
14

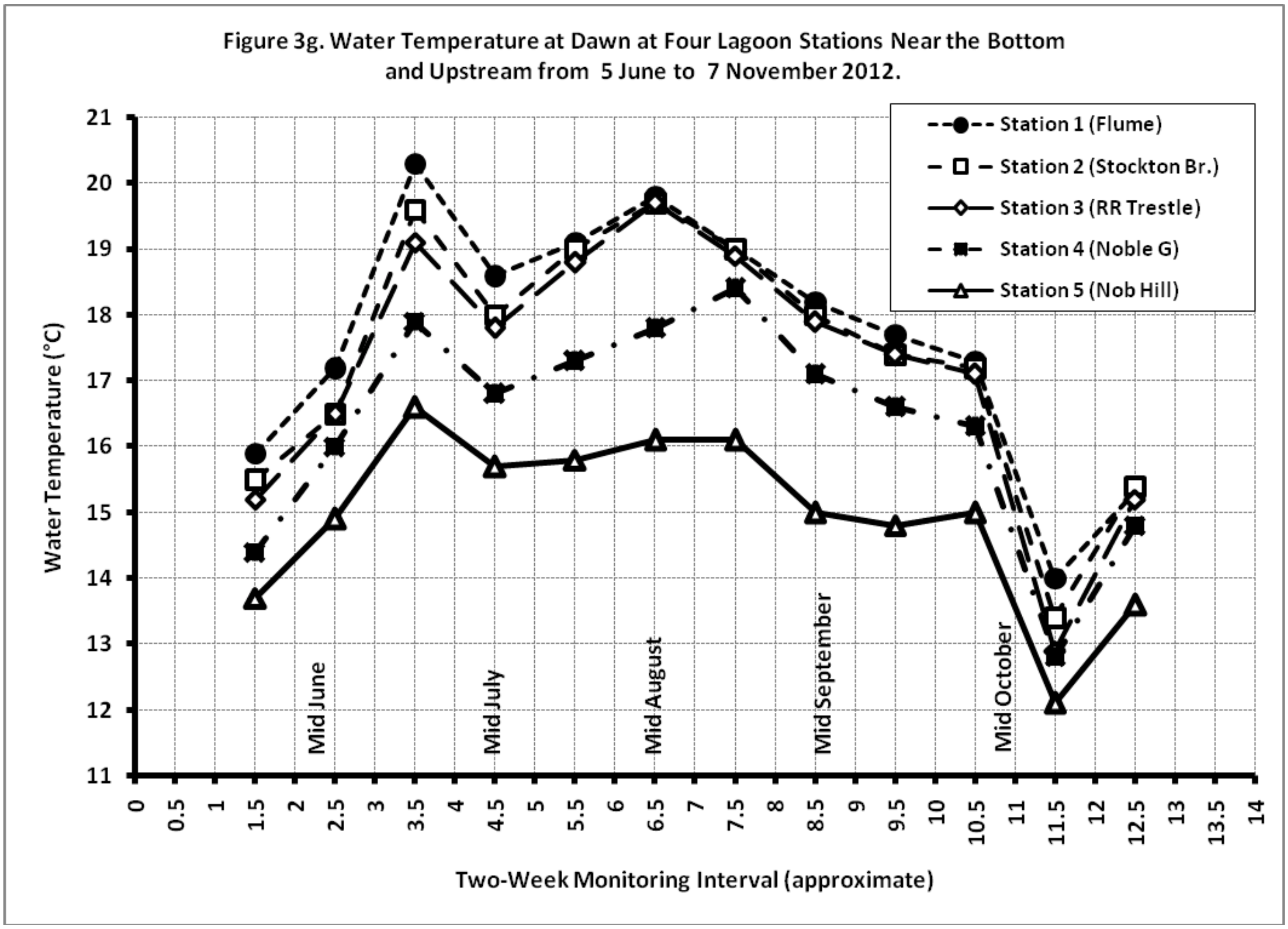


Figure 3g. Water Temperature at Dawn at Four Lagoon Stations Near the Bottom and Upstream from 5 June to 7 November 2012.
Station 1 (Flume)
Station 2 (Stockton Br.)
Station 3 (RR Trestle)
Station 4 (Noble G)
Station 5 (Nob Hill)
Water Temperature (°C)
Mid June
Mid July
Mid August
Mid September
Mid October
Two-Week Monitoring Interval (approximate)

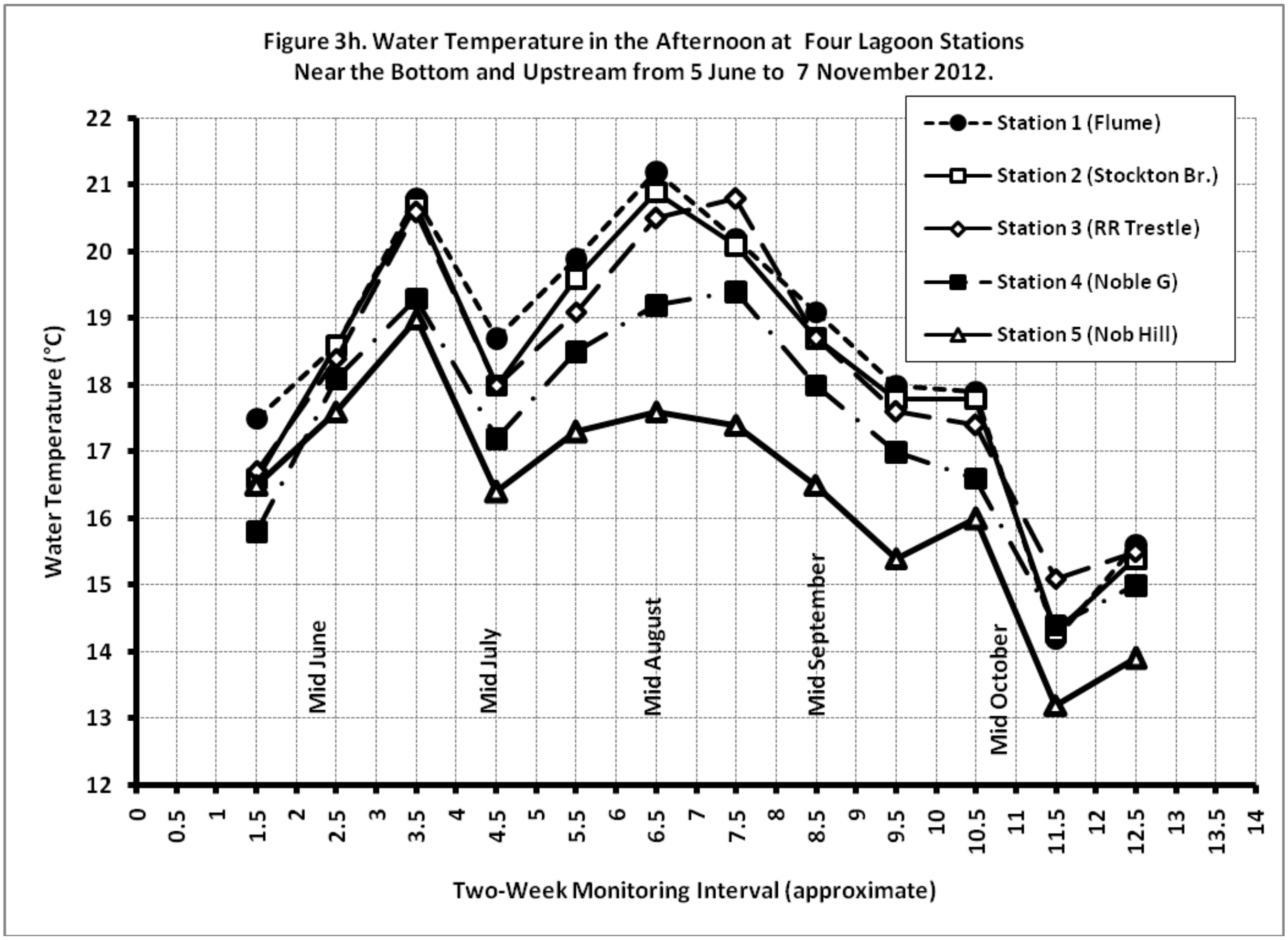


Figure 3h. Water Temperature in the Afternoon at Four Lagoon Stations
Near the Bottom and Upstream from 5 June to 7 November 2012.
Station 1 (Flume)
Station 2 (Stockton Br.)
Station 3 (RR Trestle)
Station 4 (Noble G)
Station 5 (Nob Hill)
Water Temperature (°C)
22
21
20
19
18
17
16
15
14
13
12
Mid June
Mid July
Mid August
Mid September
Mid October
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
14
Two-Week Monitoring Interval (approximate)

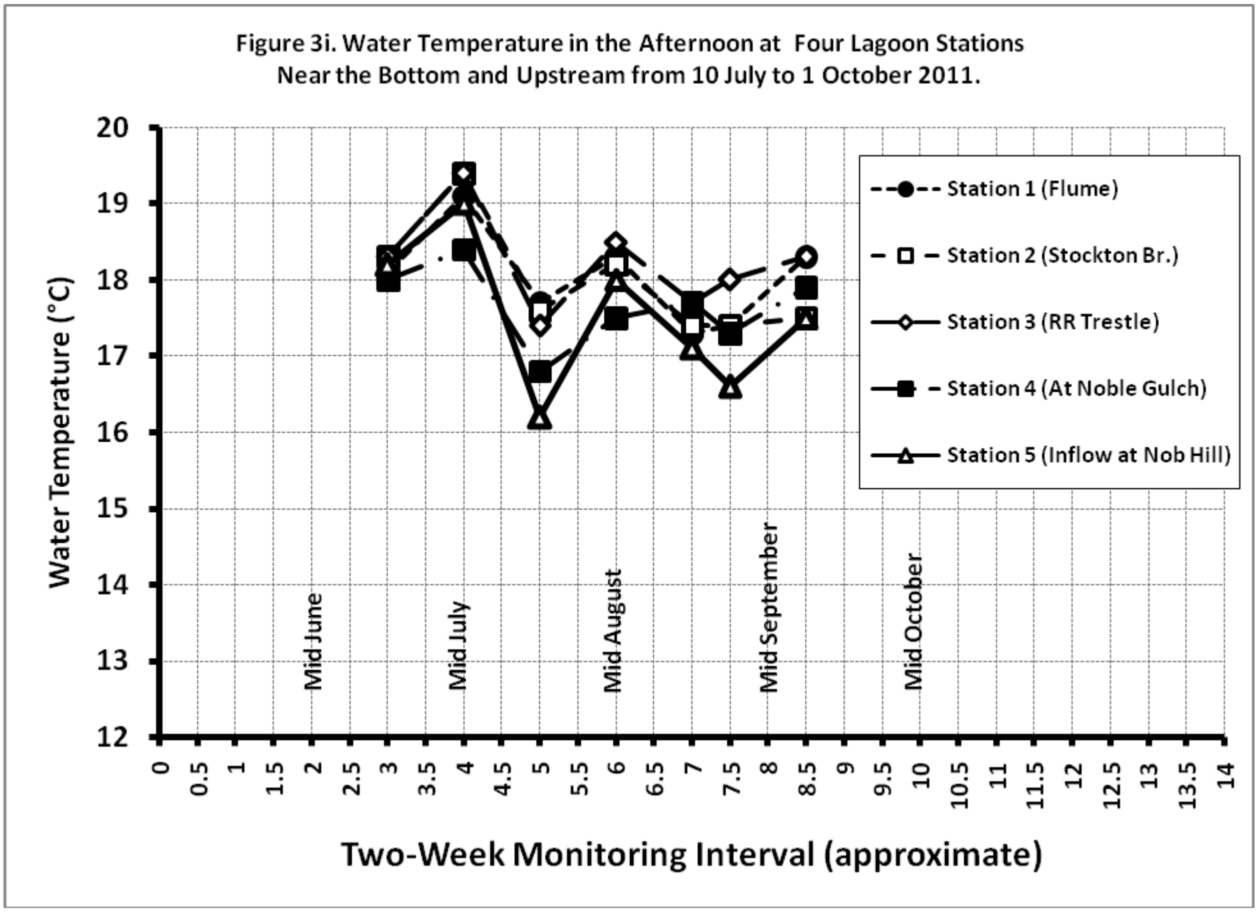


Figure 3i. Water Temperature in the Afternoon at Four Lagoon Stations
Near the Bottom and Upstream from 10 July to 1 October 2011.
Water Temperature (°C)
20
19
18
17
16
15
14
13
12
Mid June
Mid July
Mid August
Mid September
Mid October
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
6.5
7
7.5
8
8.5
9
9.5
10
10.5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

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

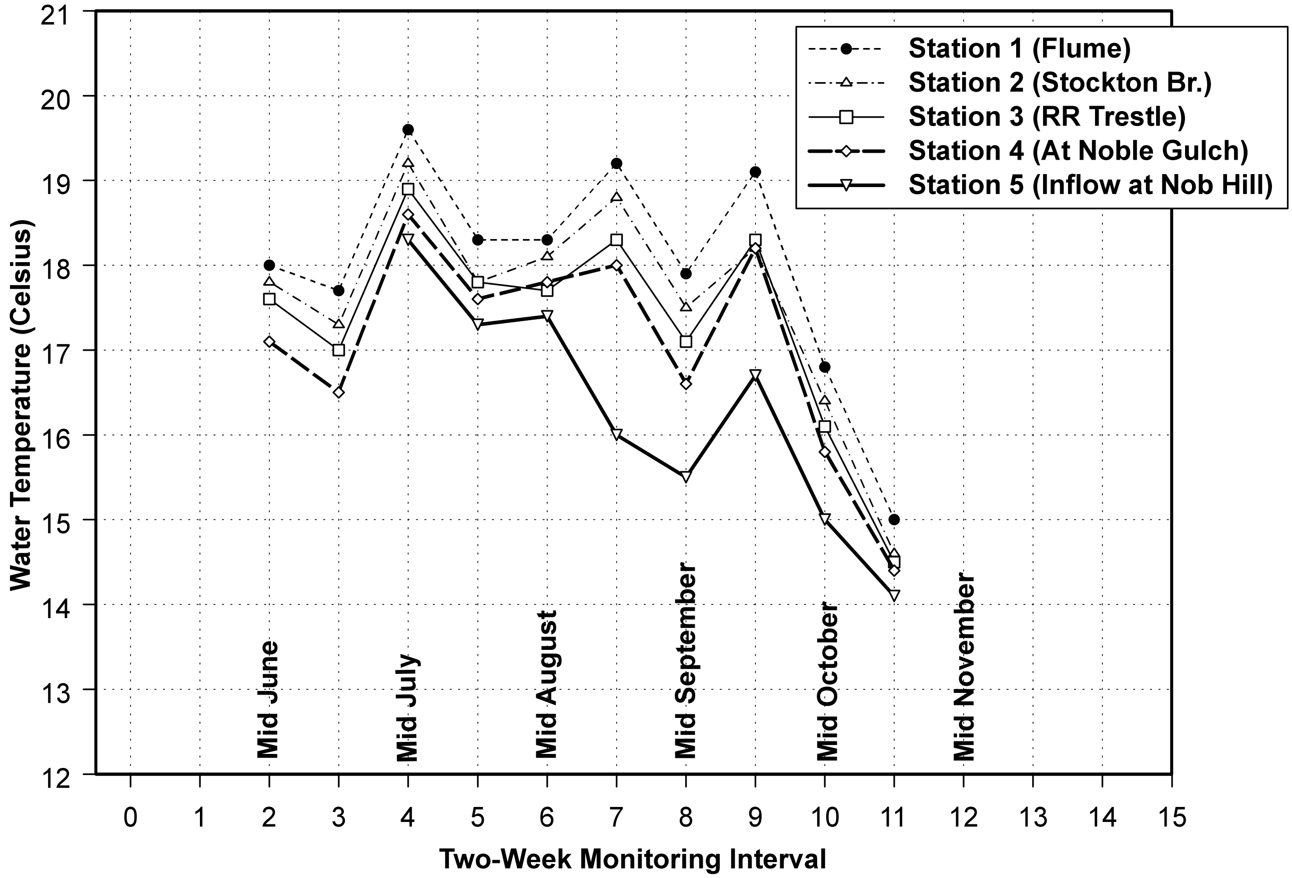


Figure 3k. Water Temperature in the Afternoon at 4 Lagoon Stations Near the Bottom Between 1430 hr and 1630 hr from 7 June to 10 October 2009.

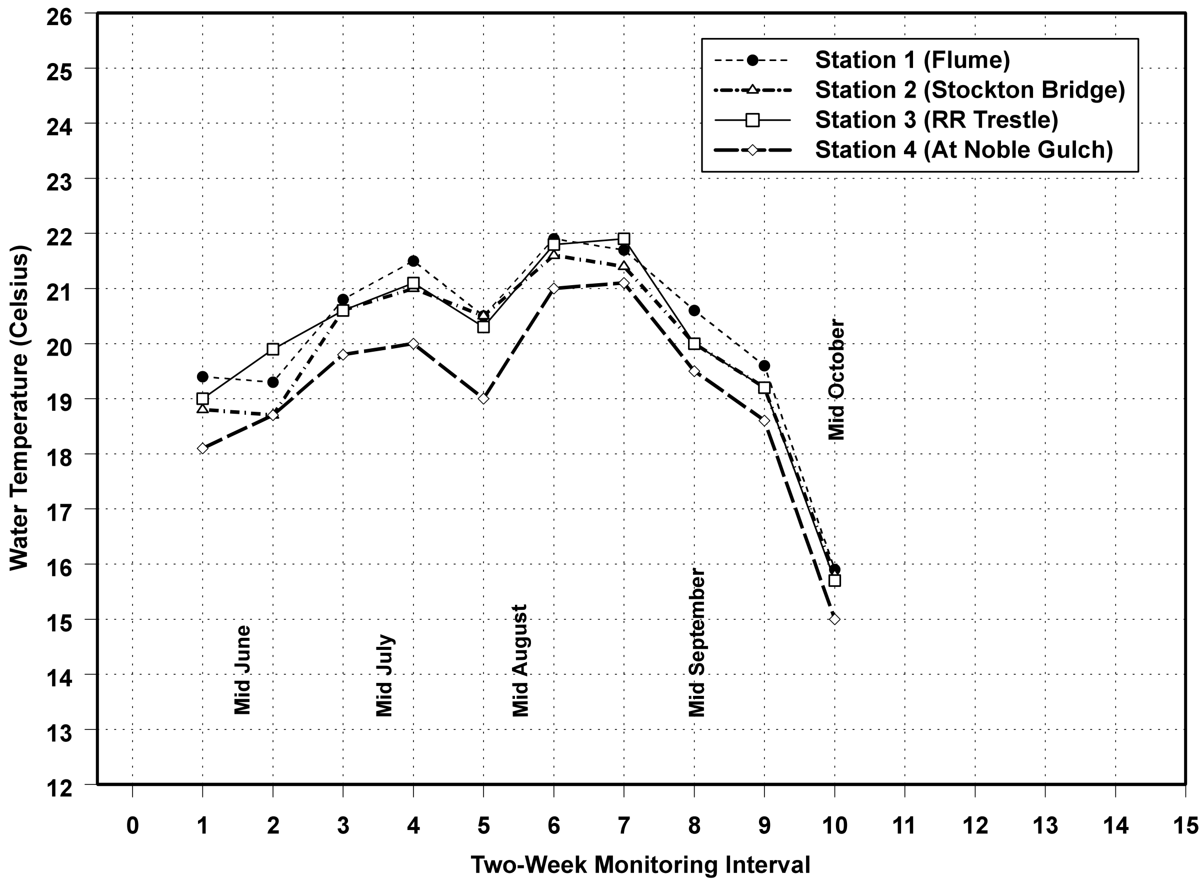


Figure 3l. Water Temperature in the Afternoon at 4 Lagoon Stations Near the Bottom Between 1430 hr and 1630 hr from 7 June to 26 October 2008.

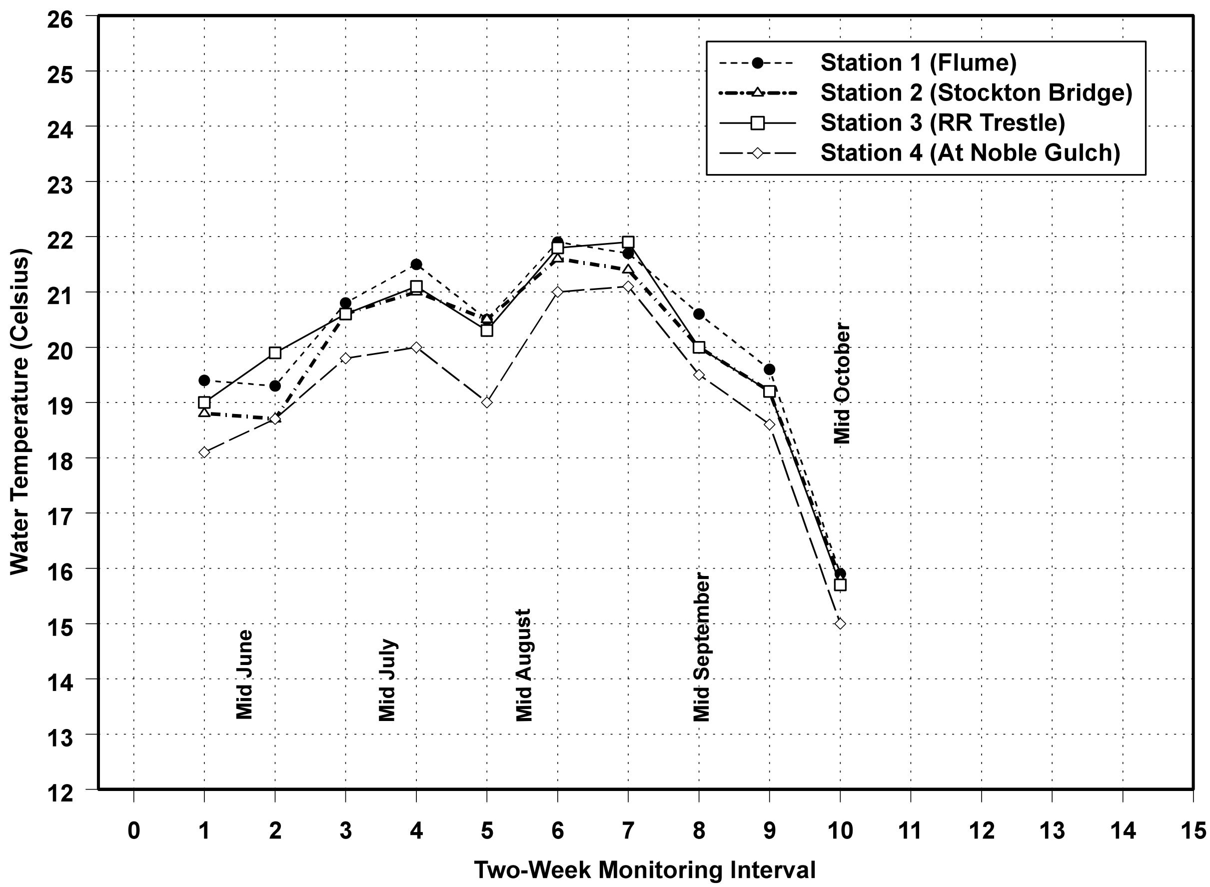


Figure 3m. Water Temperature in the Afternoon at 4 Lagoon Stations Near the Bottom Between 1500 and 1630 hr from 10 June to 8 December 2007.

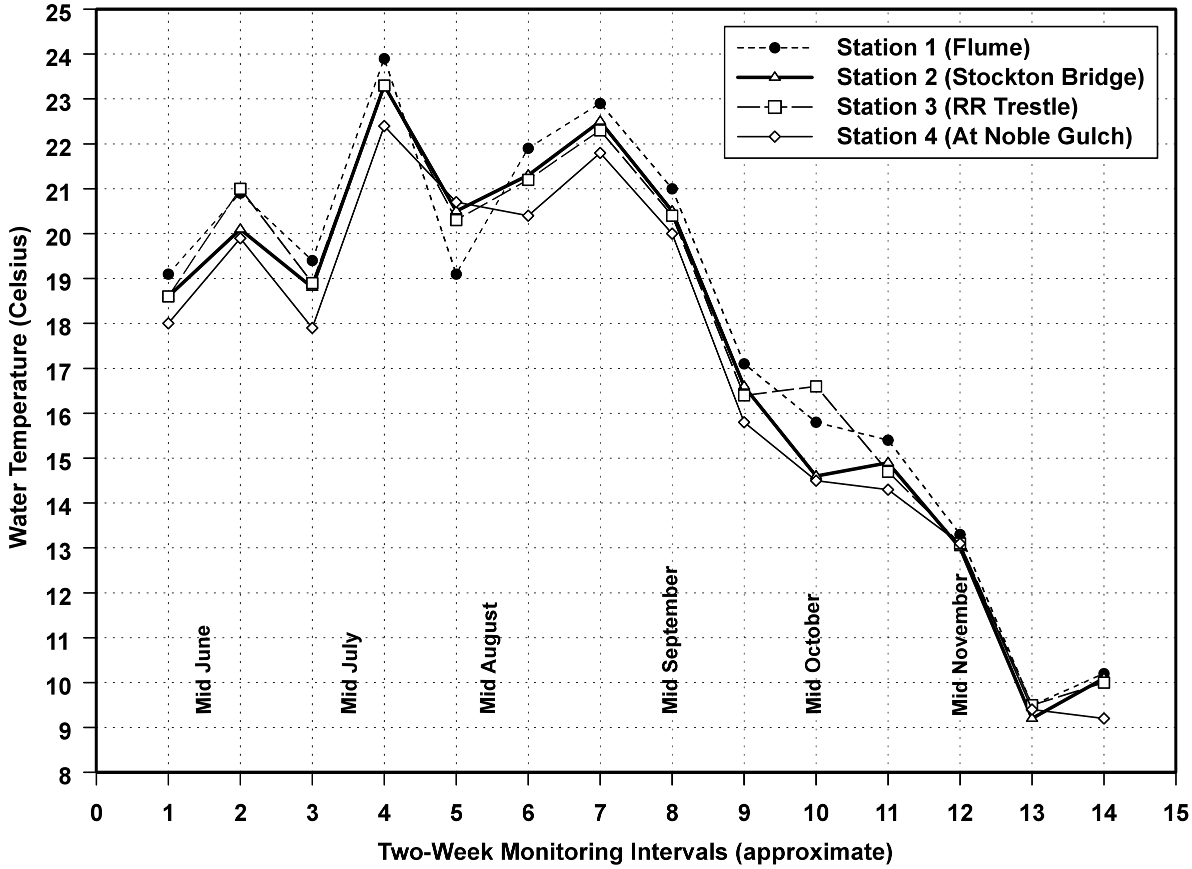


Figure 4a. Water Temperature (°C) Down from Trestile, 0.5 ft from Bottom, 30 May – 14 October 2012 (30-minute Interval).

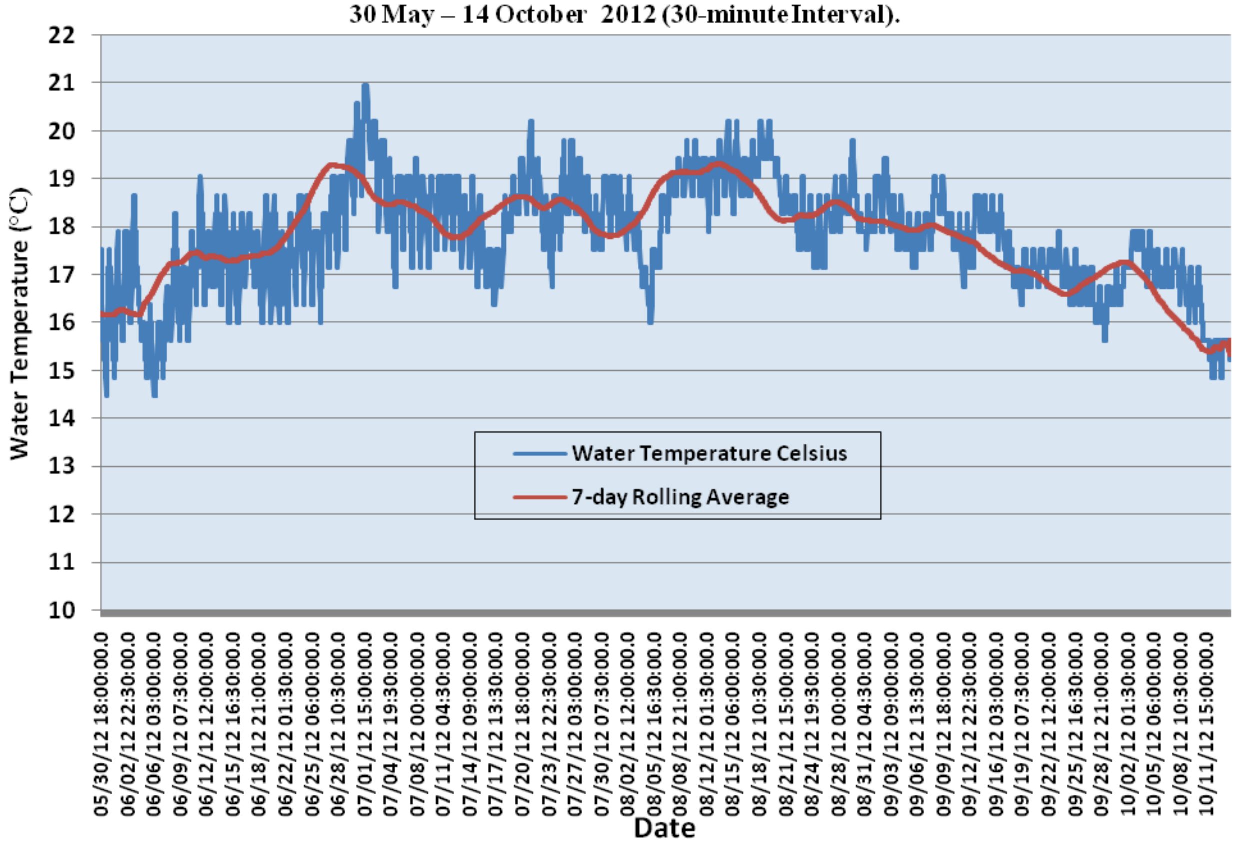


Figure 4b. Water Temperature (°F) Down from Trestile, 0.5 ft from Bottom,
30 May – 14 October 2012 (30-minute Interval).

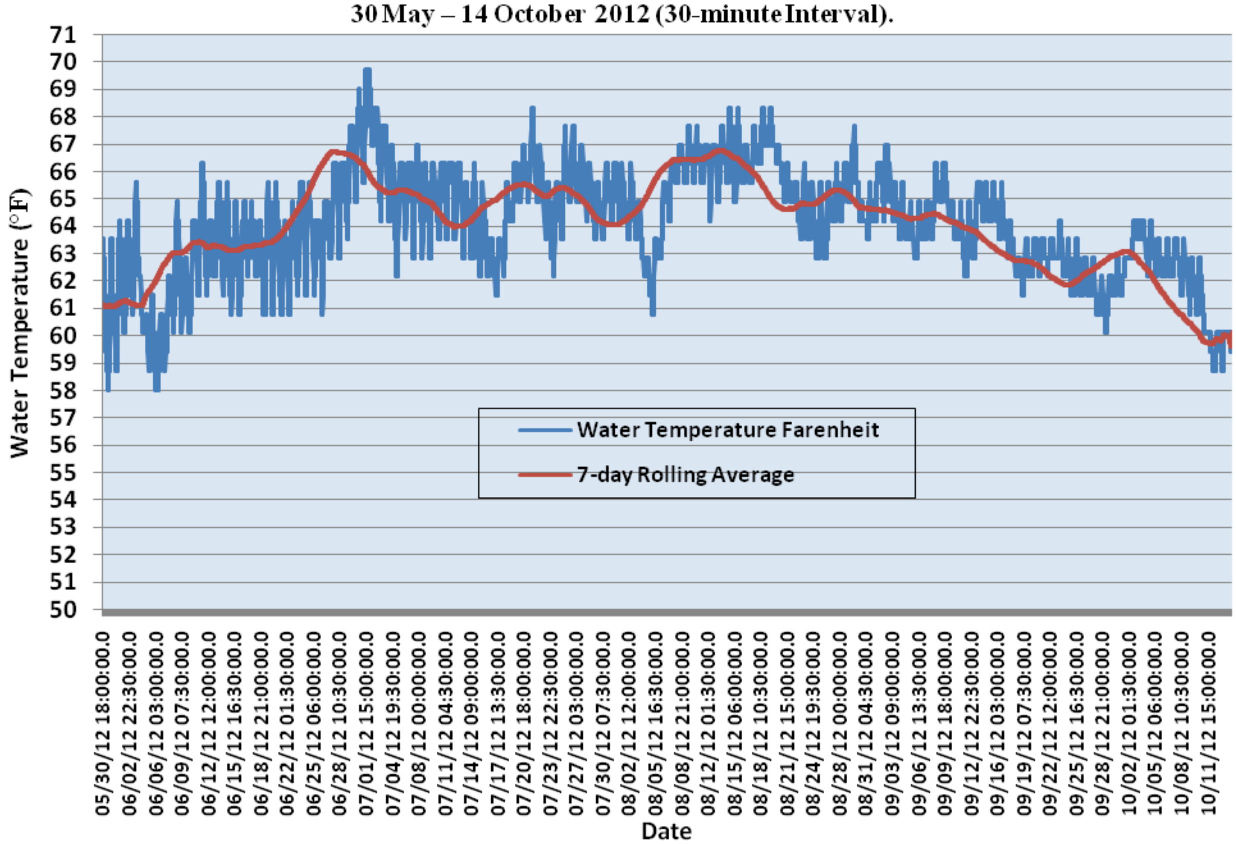


Figure 4c. Water Temperature (°C) Down from Trestle, 1.5 ft from Bottom, 30 May – 14 October 2012 (30-minute Interval).

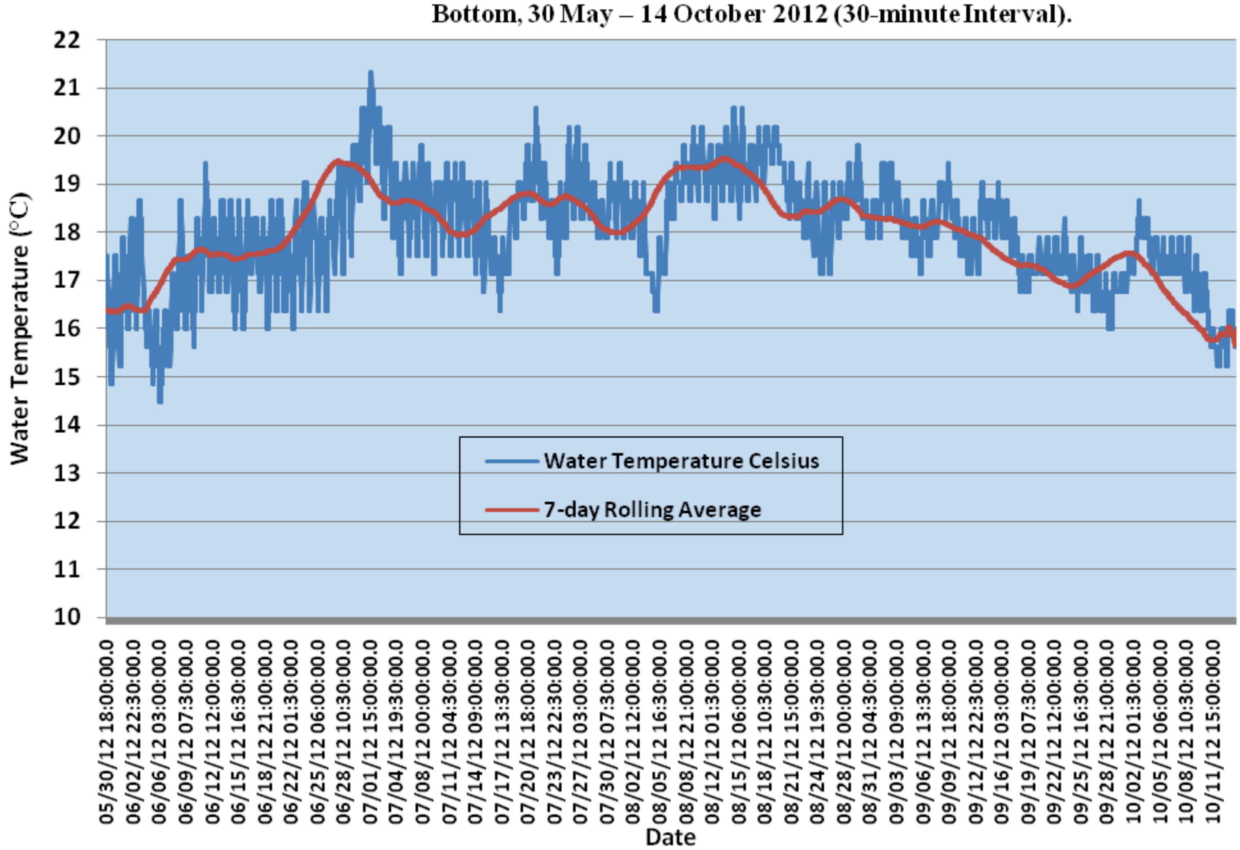


Figure 4d. Water Temperature (°F) Down from Trestle, 1.5 ft from Bottom, 30 May – 14 Octiober 2012 (30-minute Interval).

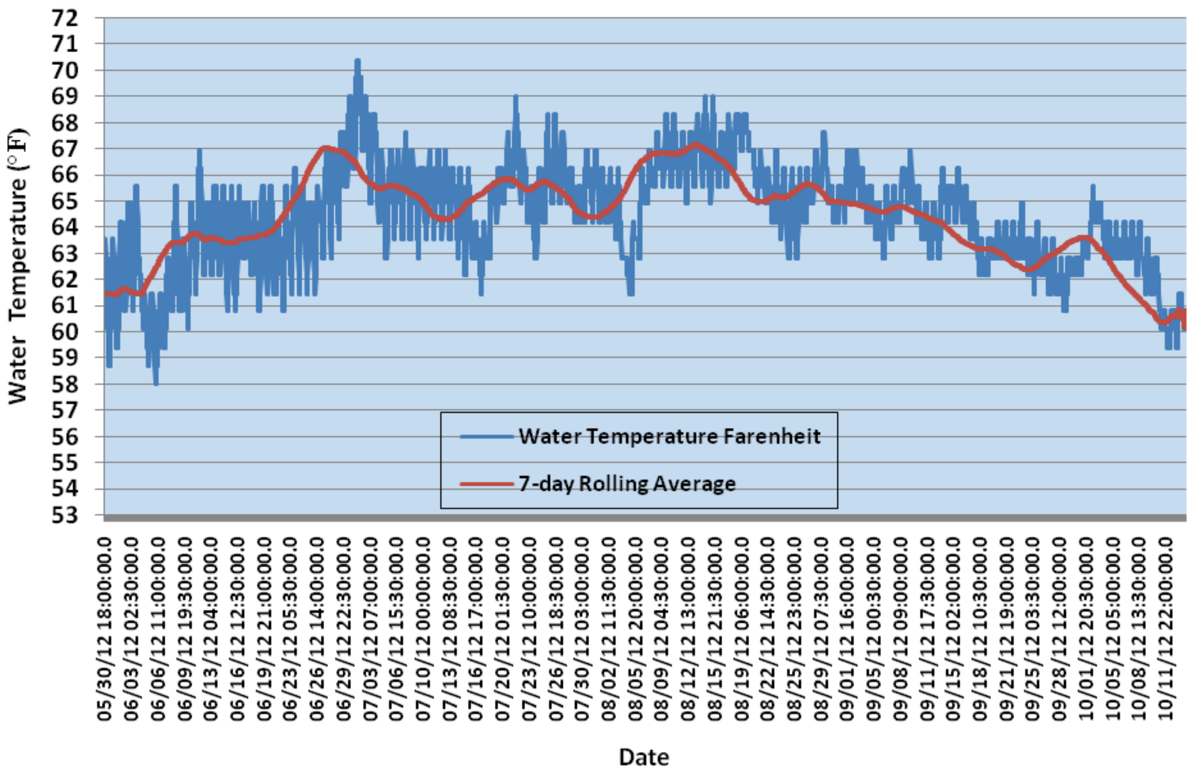


Figure 4e. Water Temperature (°C) Down from Trestle, 2.5 ft from Bottom, 30 May – 14 October 2012 (30-minute Interval).

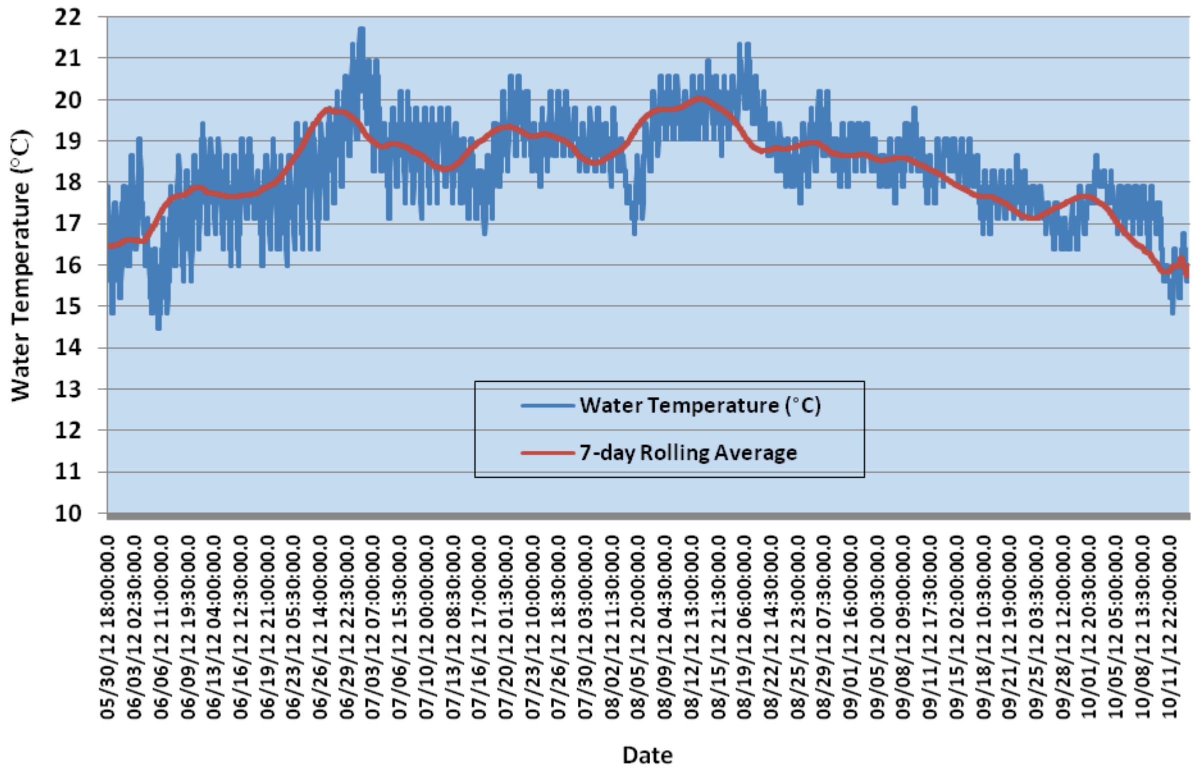


Figure 4f. Water Temperature (°F) Down from Trestle, 2.5 ft from Bottom, 30 May – 14 October 2012 (30-minute Interval).

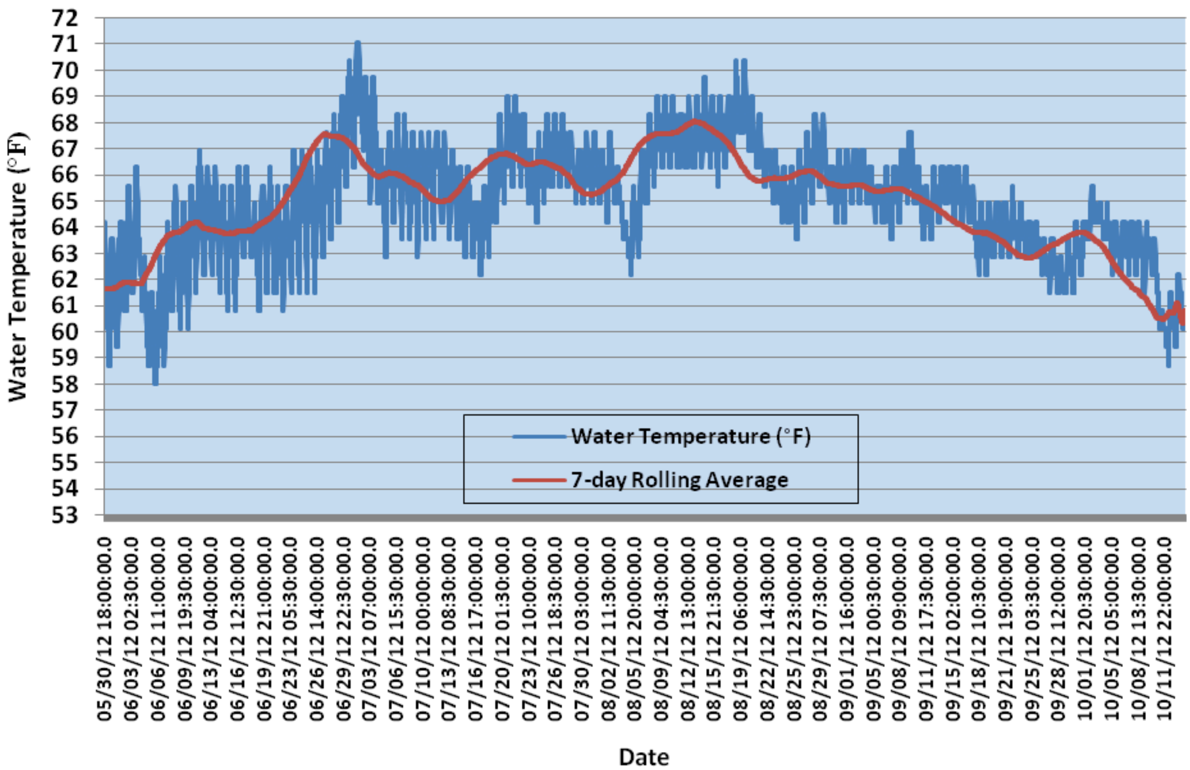


Figure 4g. Water Temperature (°C) Down from Trestle, 3.5 ft from Bottom, 30 May –14 October 2012 (30-minute Interval).

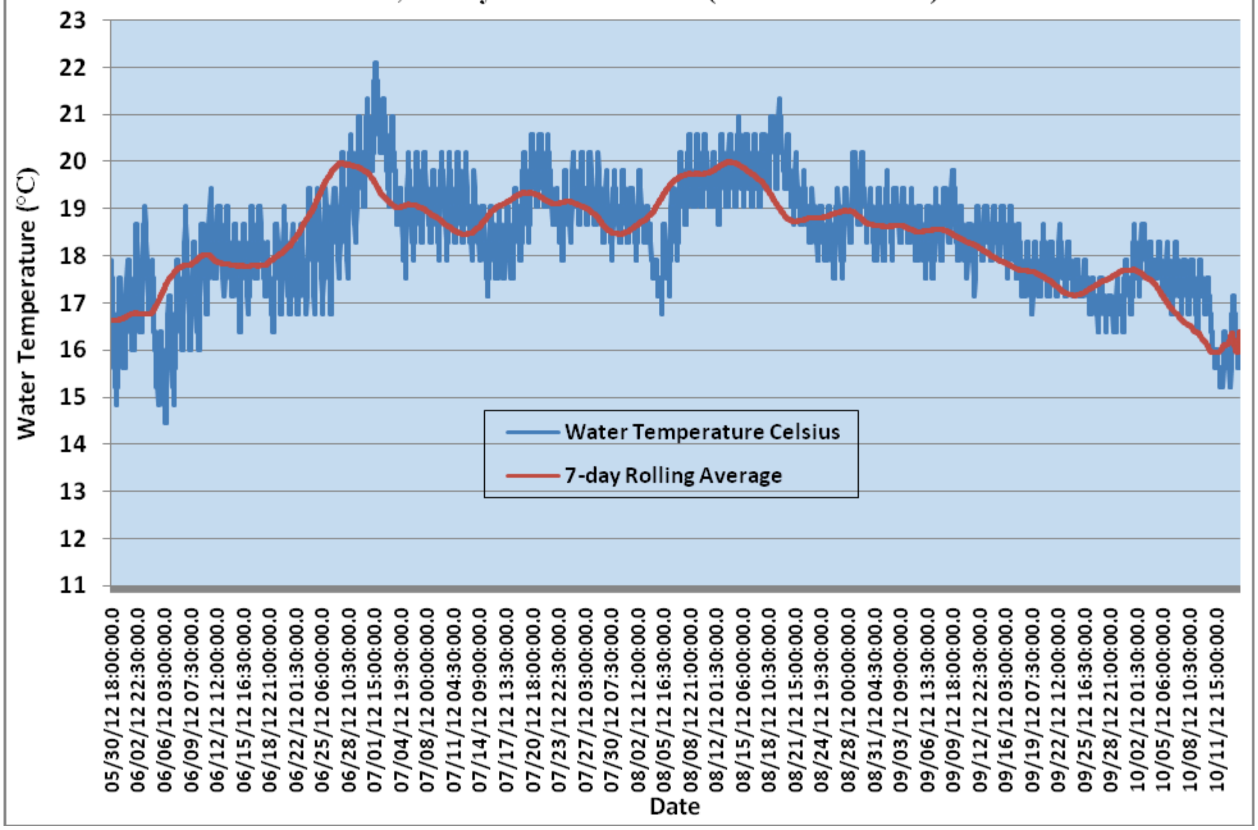
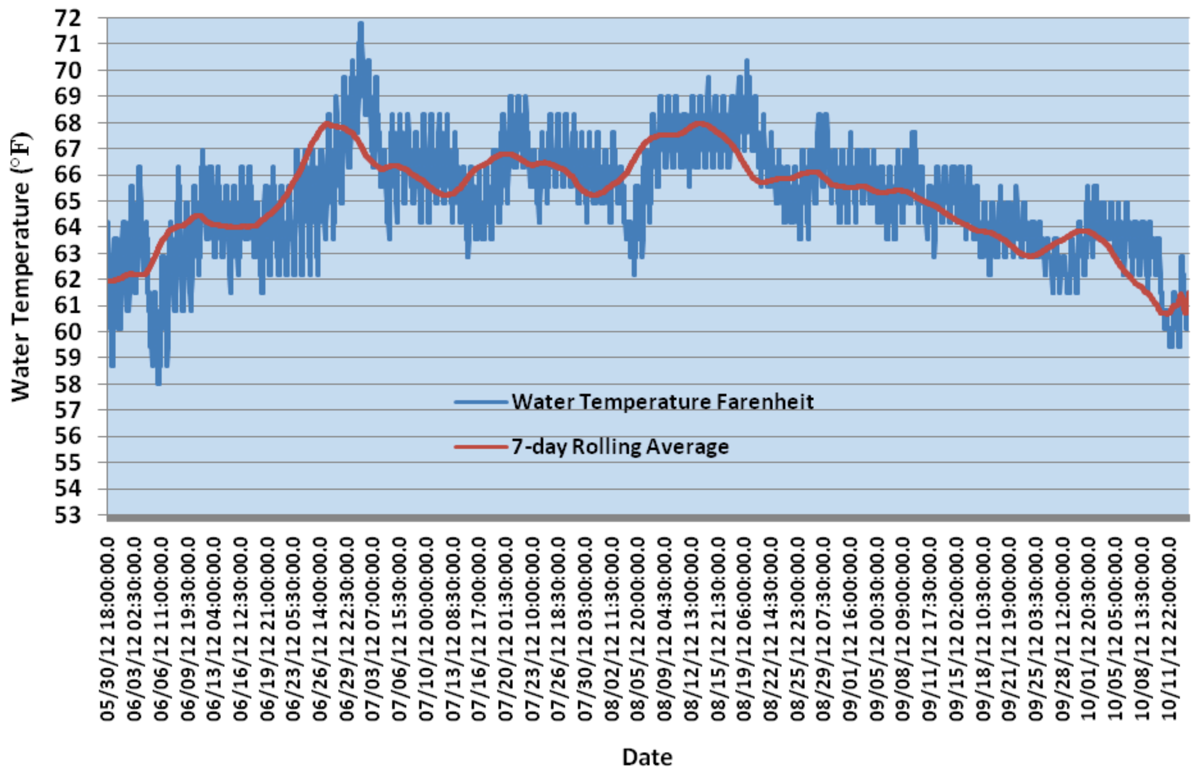


Figure 4h. Water Temperature (°F) Down from Trestle, 3.5 ft from Bottom, 30 May – 14 October 2012 (30-minute Interval).



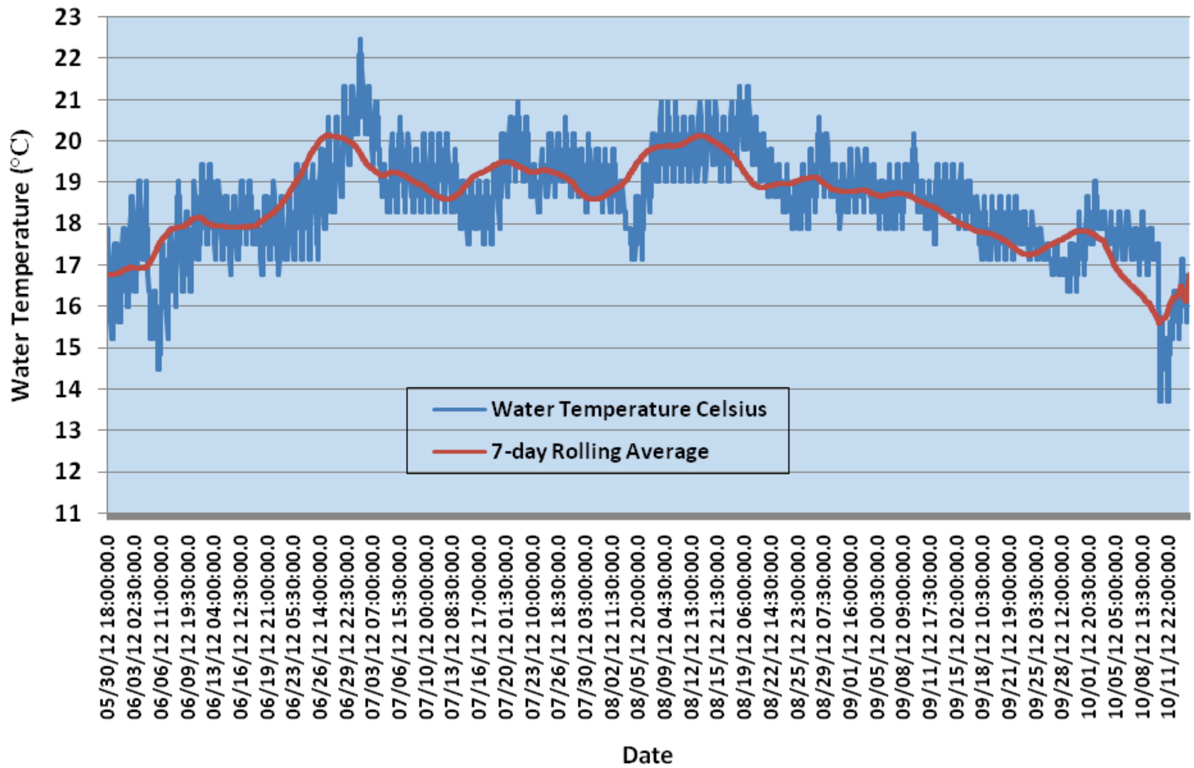
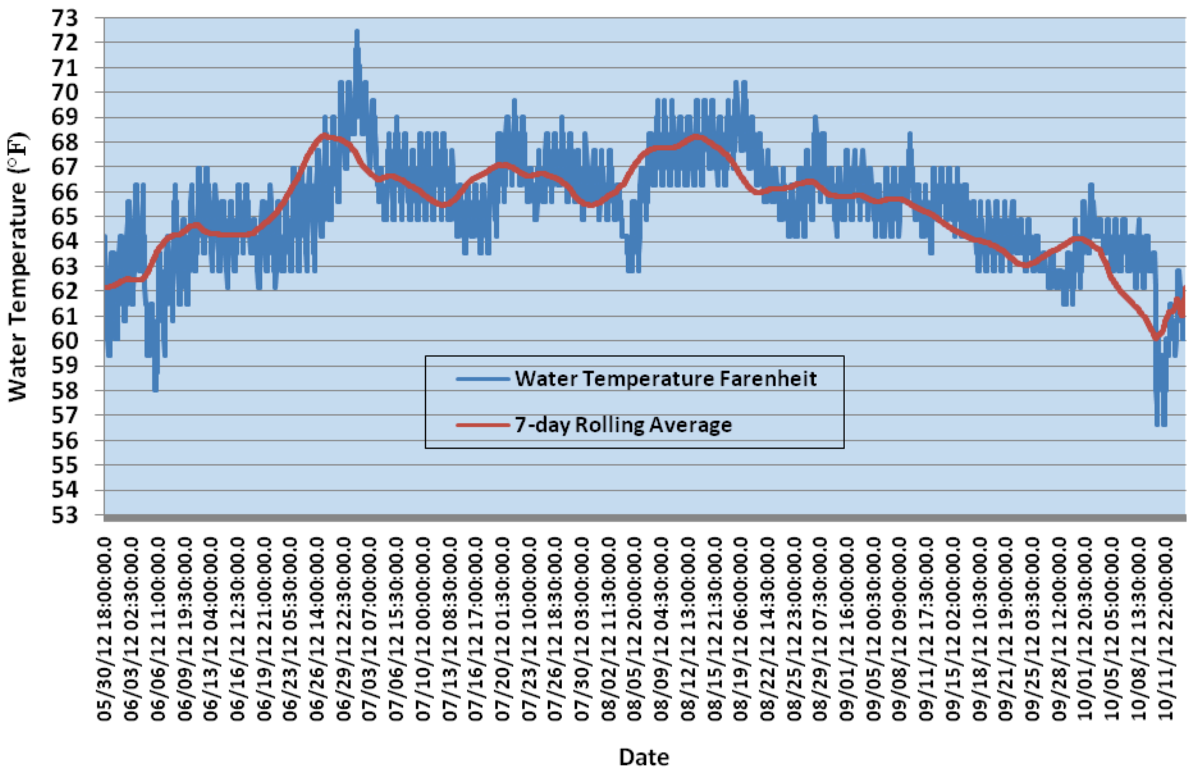


Figure 4i. Water Temperature (°C) Down from Trestle, 4.5 ft from Bottom, 30 May – 14 October 2012 (30-minute Interval).

Figure 4j. Water Temperature (°F) Down from Trestle, 4.5 ft from Bottom, 30 May – 14 October 2012 (30-minute Interval).



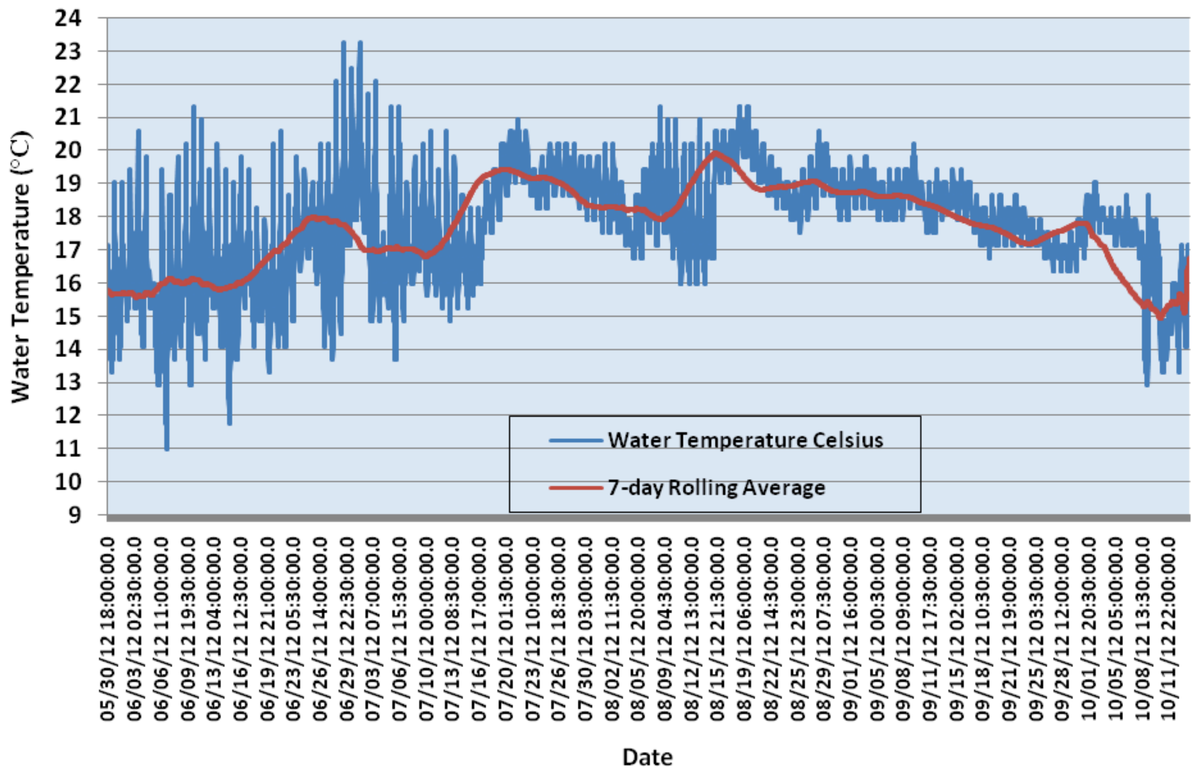


Figure 4k. Water Temperature (°C) Down from Trestle, 5.5 ft from Bottom, 30 May – 14 October 2012 (30-minute Interval).

Figure 4l. Water Temperature (°F) Down from Trestle, 5.5 ft from Bottom, 30 May – 14 October 2012 (30-minute Interval).

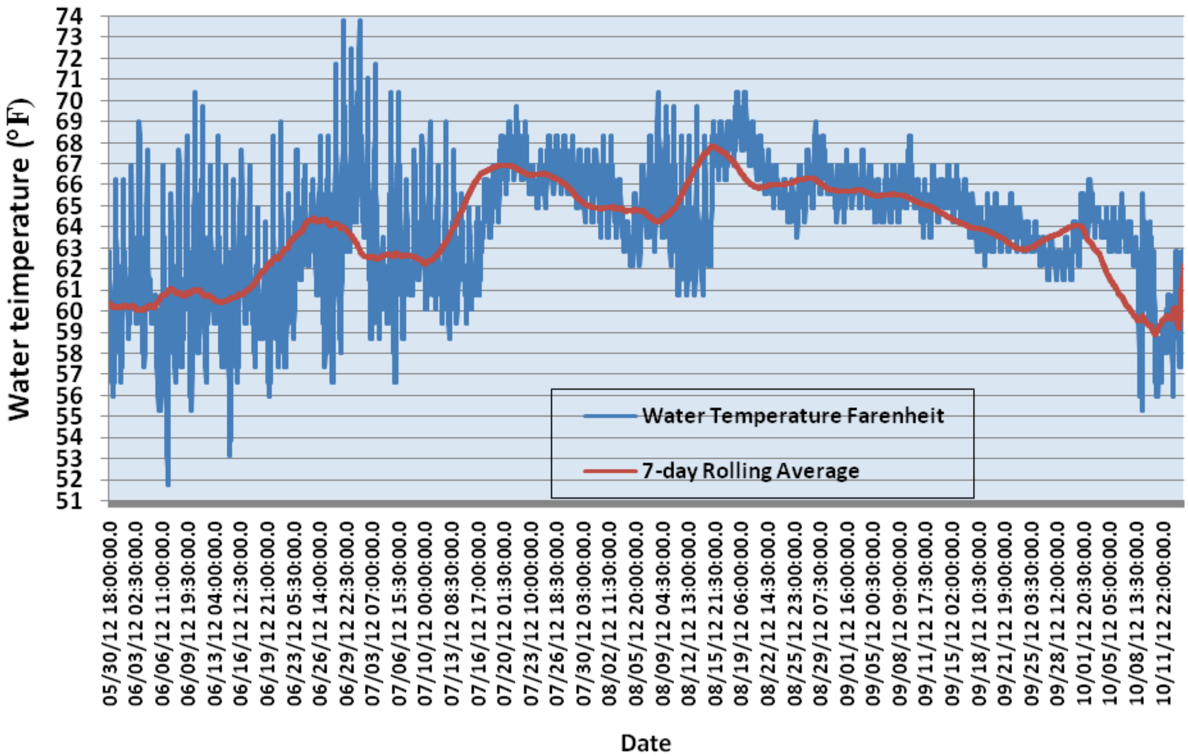


Figure 4m. Water Temperature (°C) Down from Trestle, 5.5 ft from Bottom, 30 June – 2 October 2011 (30-minute interval).

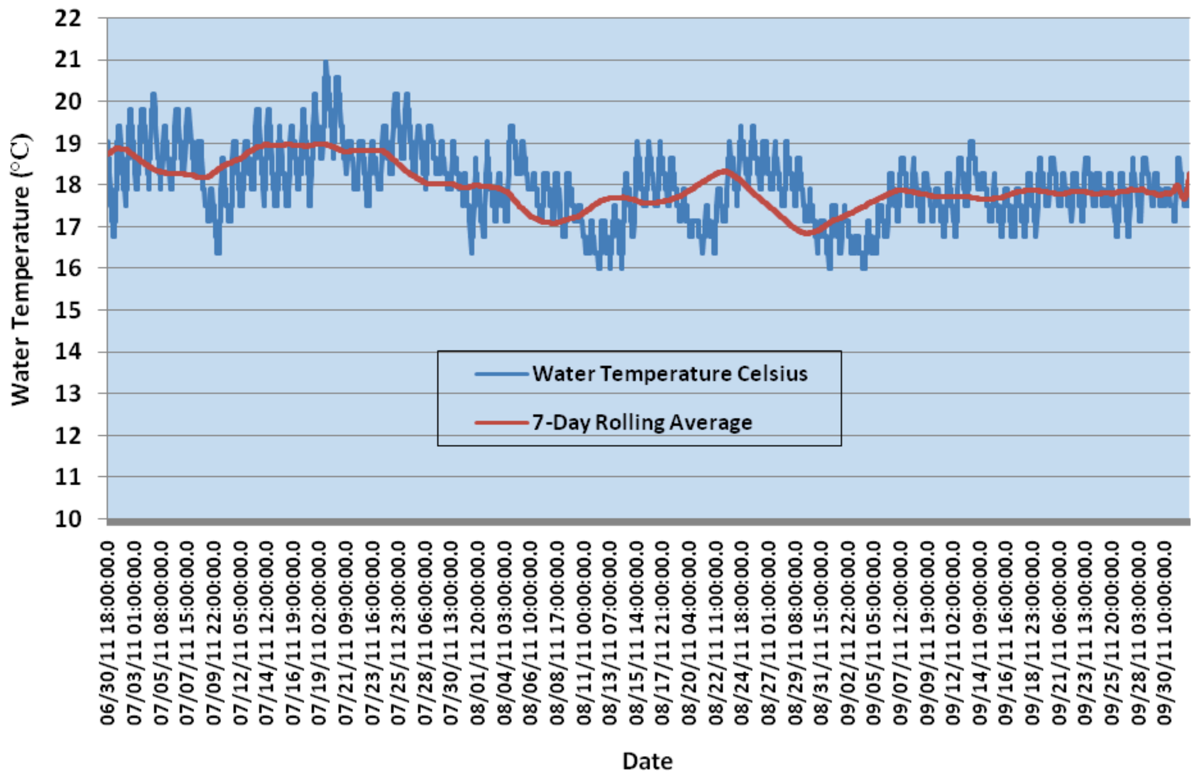
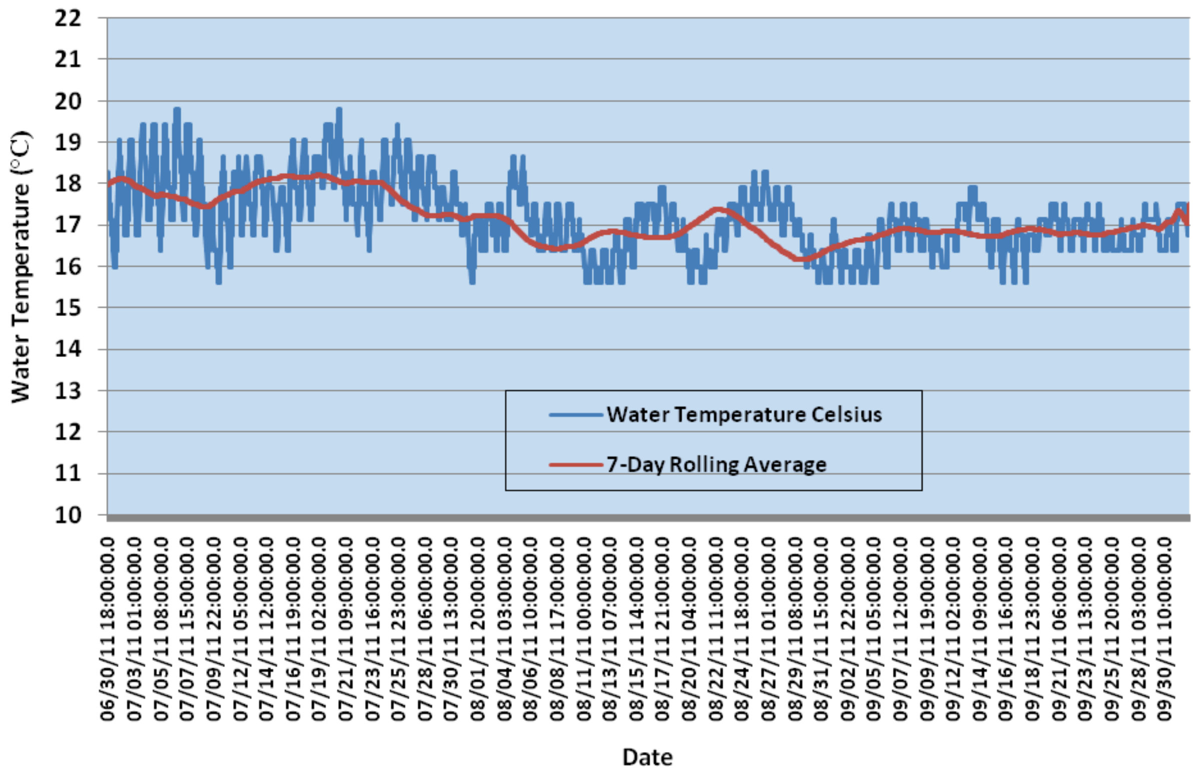


Figure 4n. Water Temperature (°C) Down from Trestle, 0.5 ft from Bottom, 30 June – 2 October 2011 (30-minute interval).



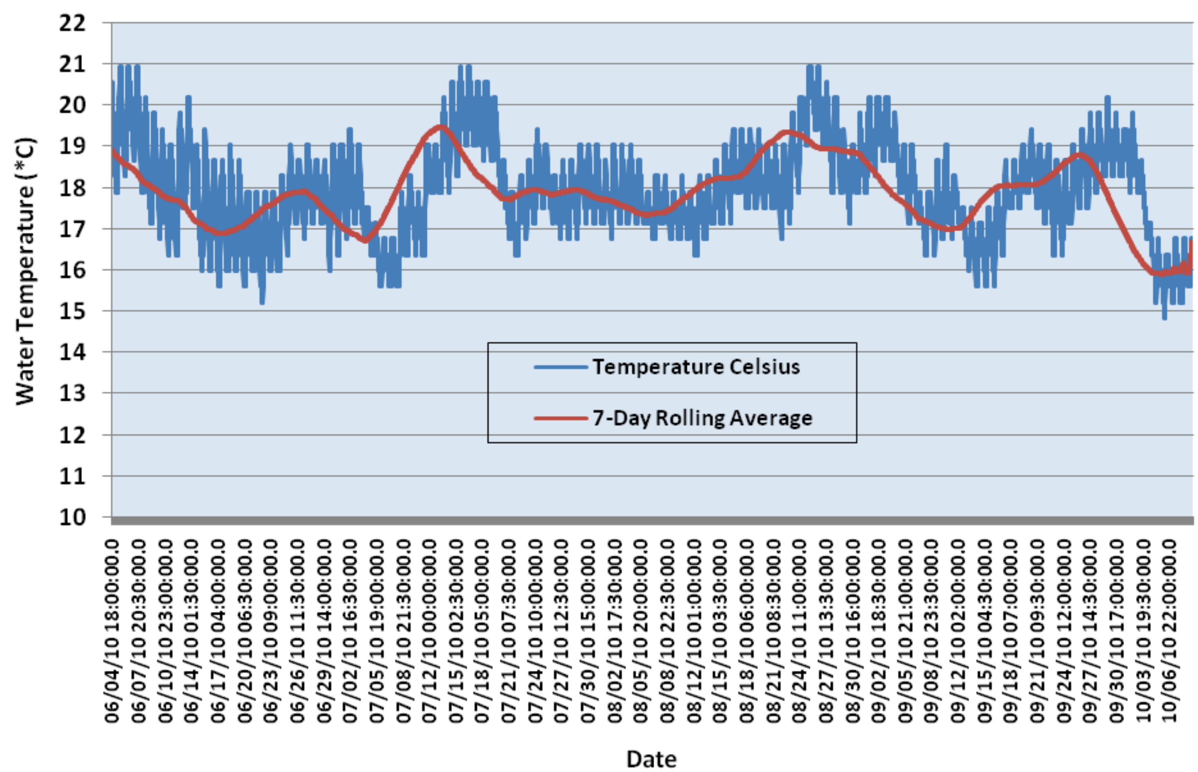
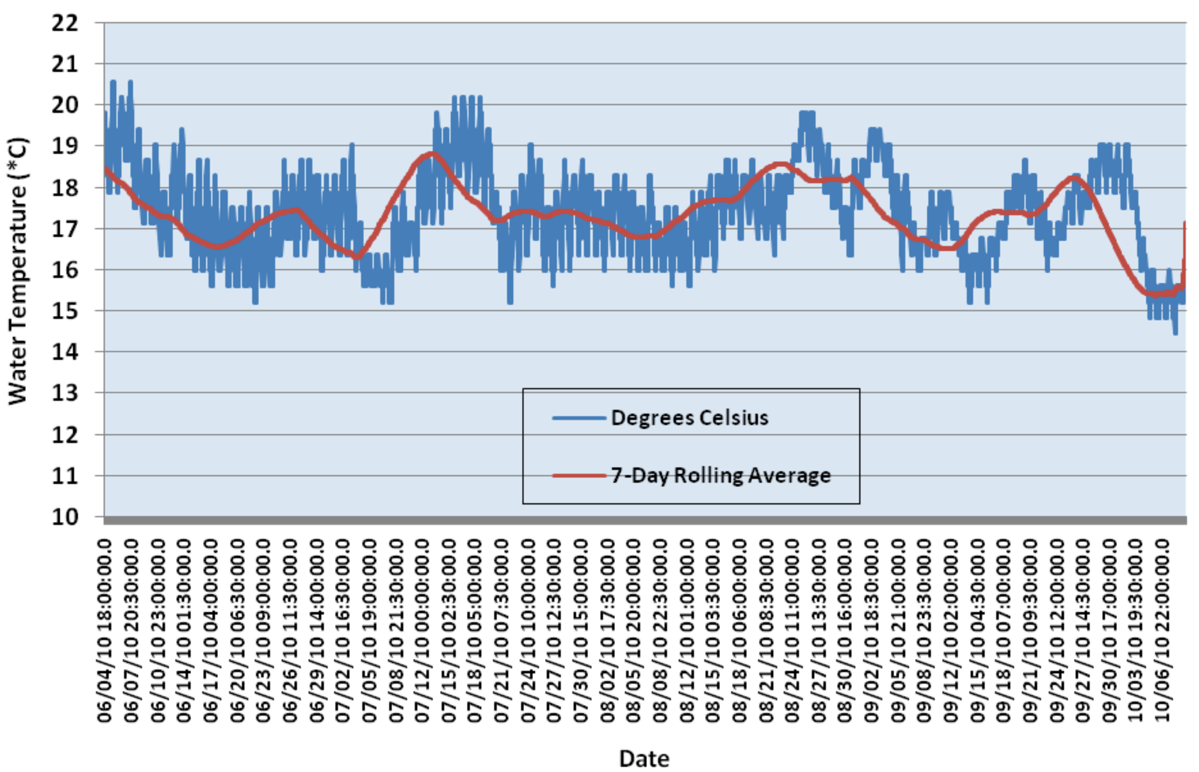


Figure 4o. Water Temperature (*C) Down from Trestle, 5.5 ft from Bottom, 4 June - 9 October 2010 (30-minute interval).

Figure 4p. Water Temperature (*C) Down from Trestle, 0.5 ft from Bottom, 4 June - 9 October 2010 (30-minute interval).



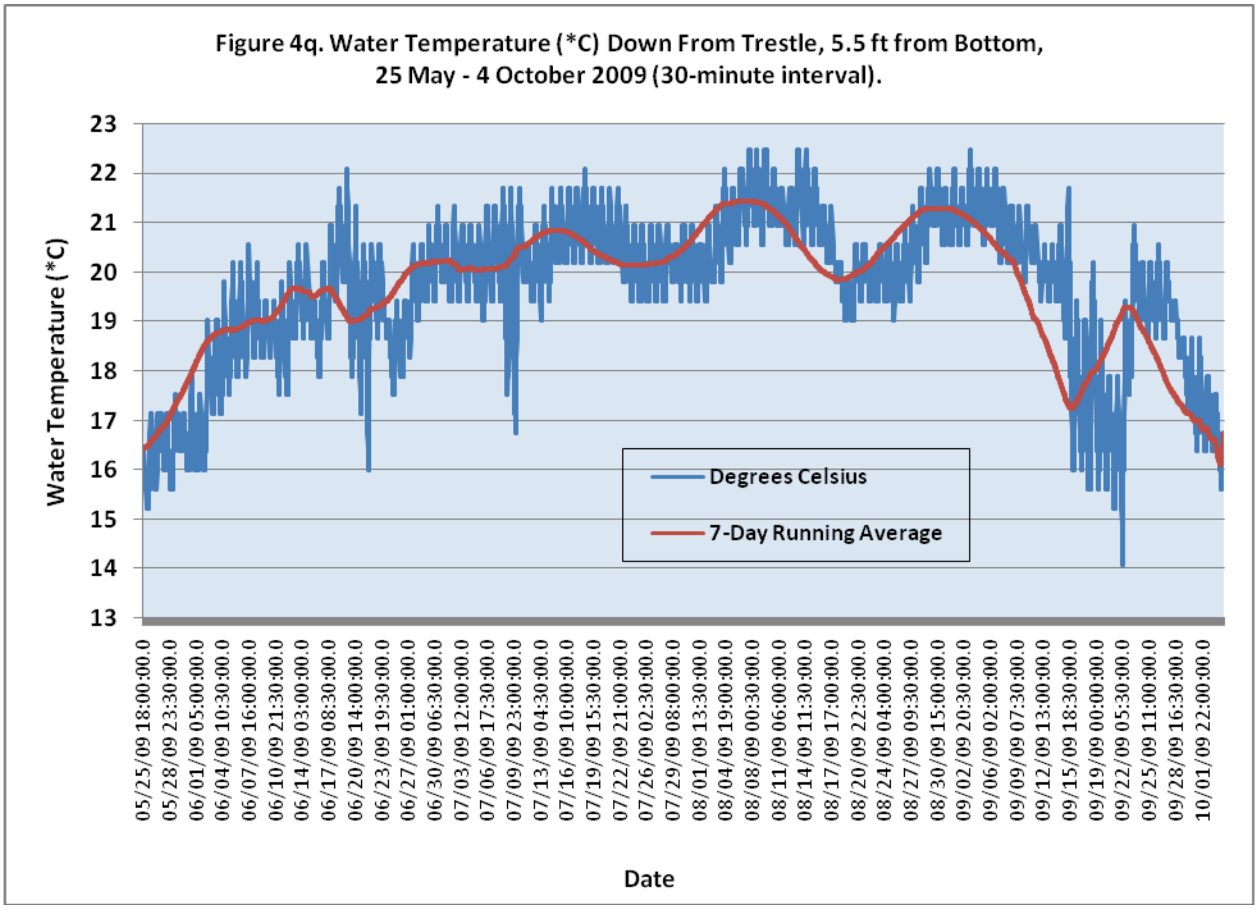


Figure 4q. Water Temperature (*C) Down From Trestle, 5.5 ft from Bottom,
25 May - 4 October 2009 (30-minute interval).
Water Temperature (*C)
Date
Degrees Celsius
7-Day Running Average

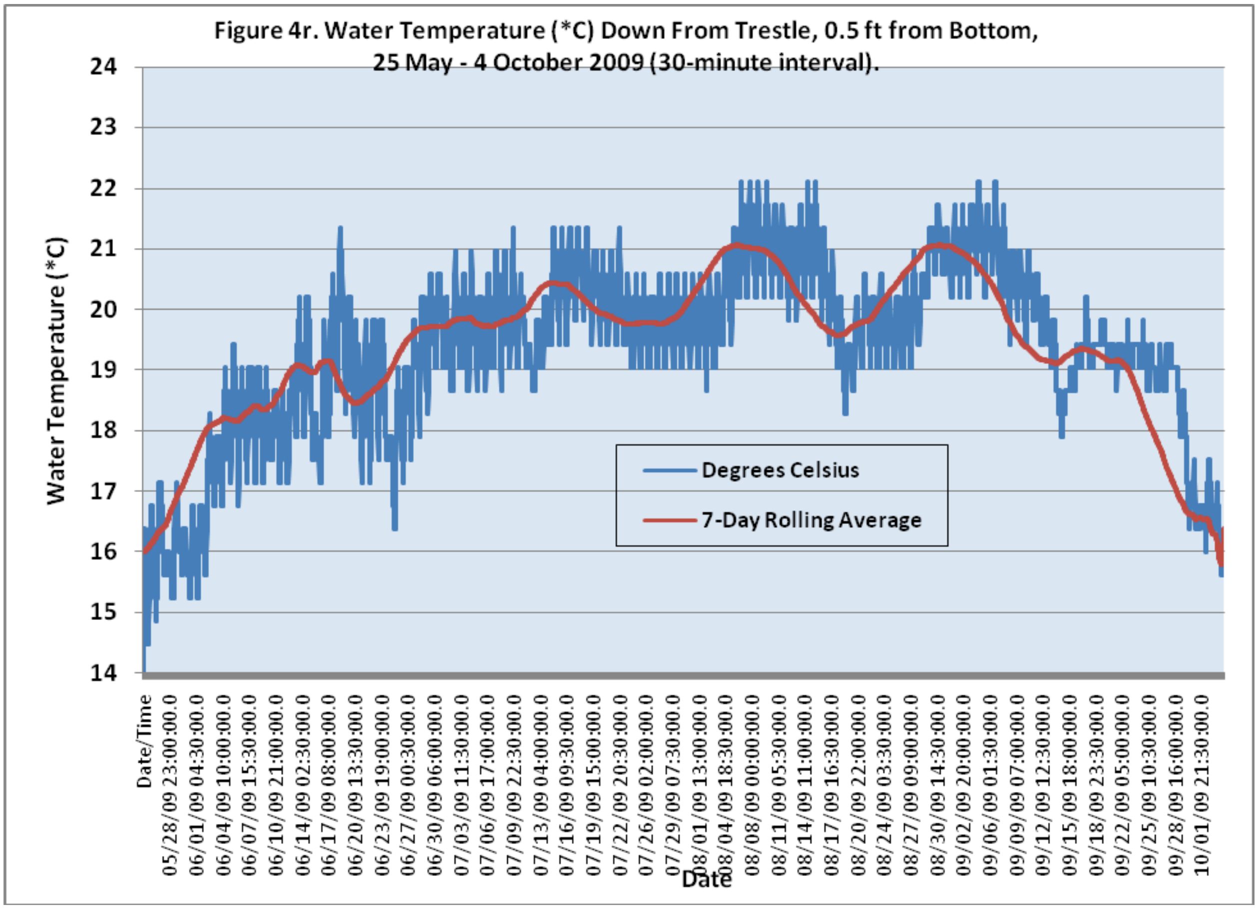


Figure 4r. Water Temperature (*C) Down From Trestle, 0.5 ft from Bottom, 25 May - 4 October 2009 (30-minute interval).

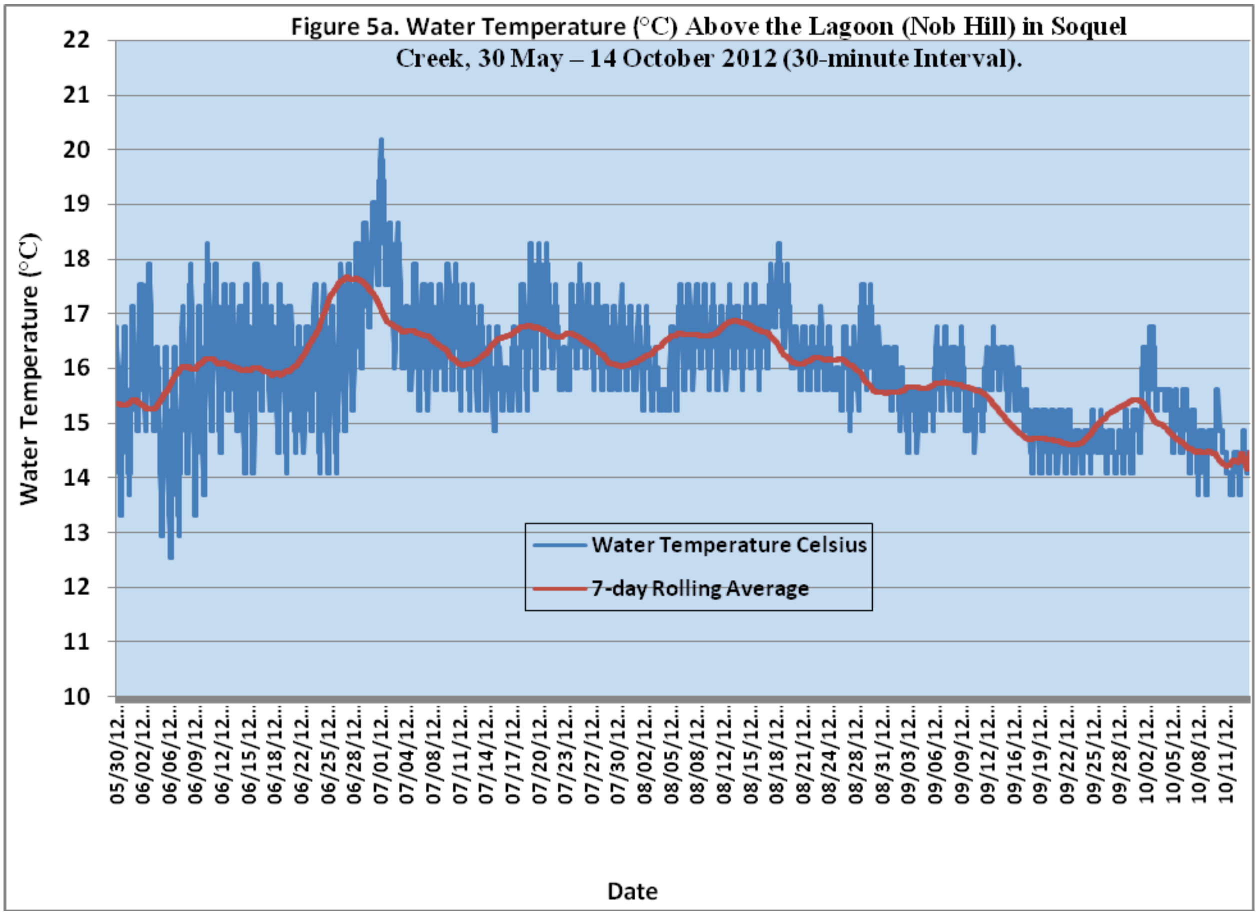


Figure 5a. Water Temperature (°C) Above the Lagoon (Nob Hill) in Soquel Creek, 30 May – 14 October 2012 (30-minute Interval).
Water Temperature (°C)
Date
Water Temperature Celsius
7-day Rolling Average
22
21
20
19
18
17
16
15
14
13
12
11
10

Figure 5b. Water Temperature (°F) Above the Lagoon (Nob Hill) in Soquel Creek, 30 May – 14 October 2012 (30-minute Interval).

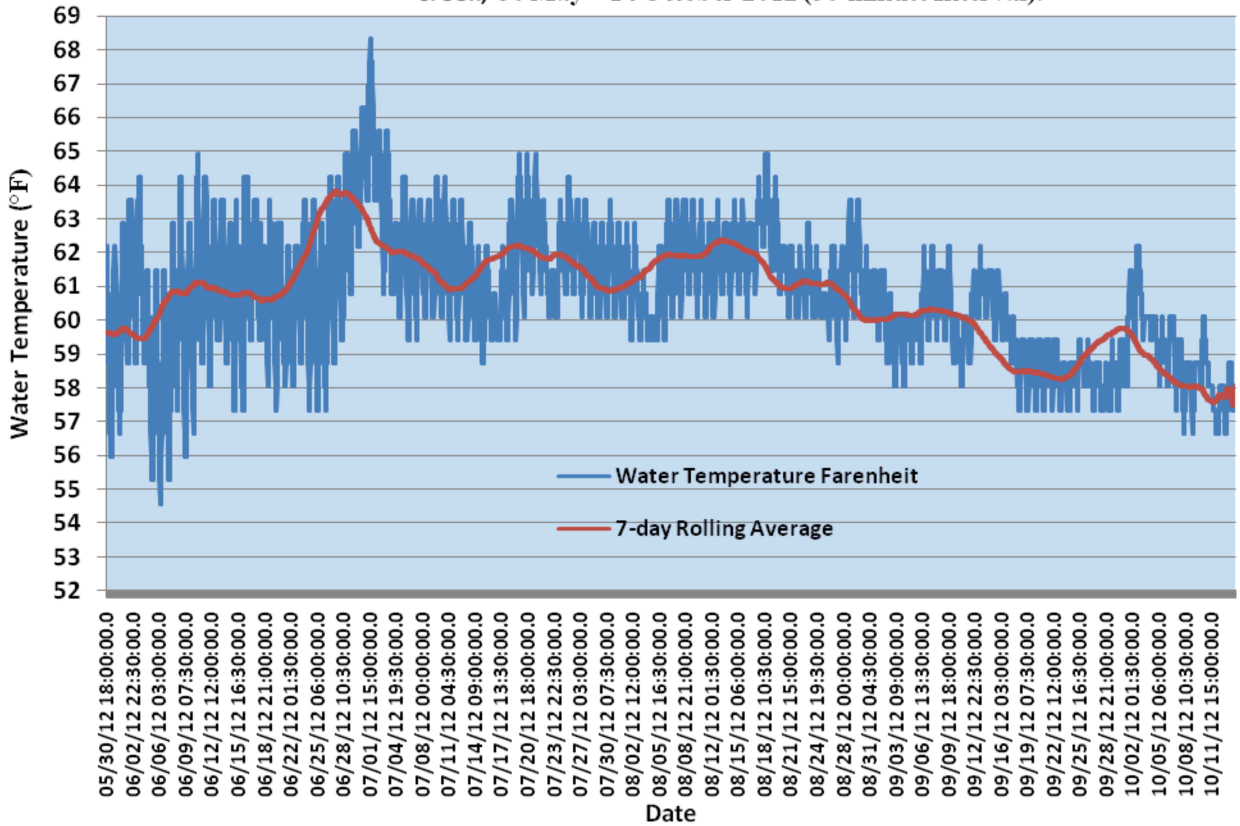
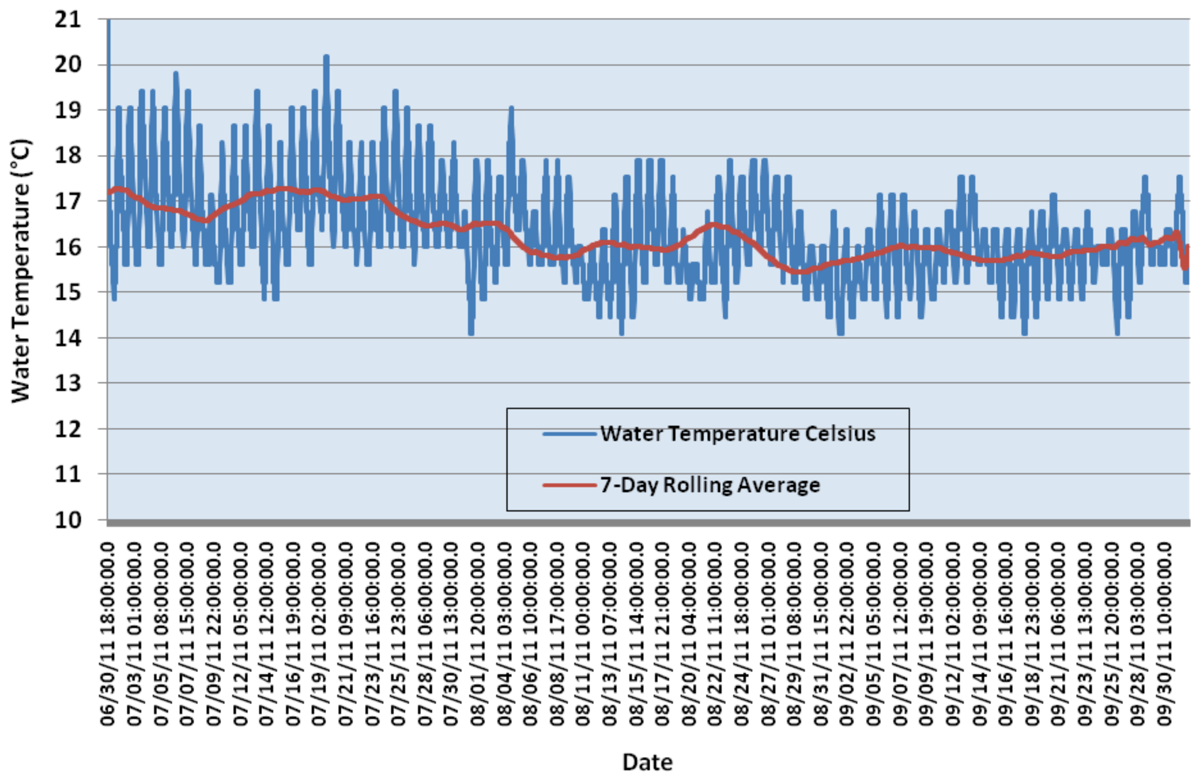


Figure 5c. Water Temperature (°C) Above the Lagoon (Nob Hill) in Soquel Creek, 30 June – 2 October 2011 (30-minute interval).



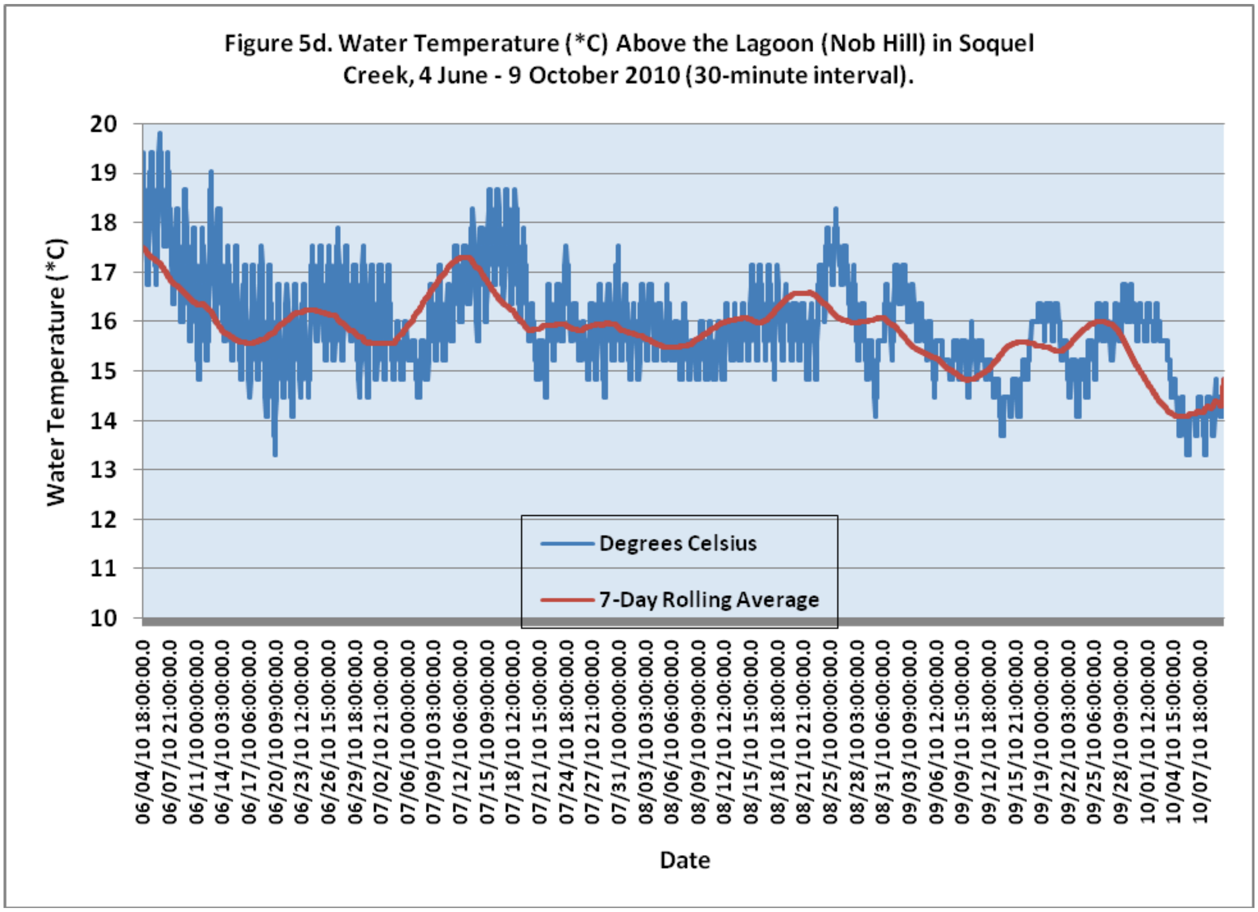


Figure 5d. Water Temperature (*C) Above the Lagoon (Nob Hill) in Soquel Creek, 4 June - 9 October 2010 (30-minute interval).

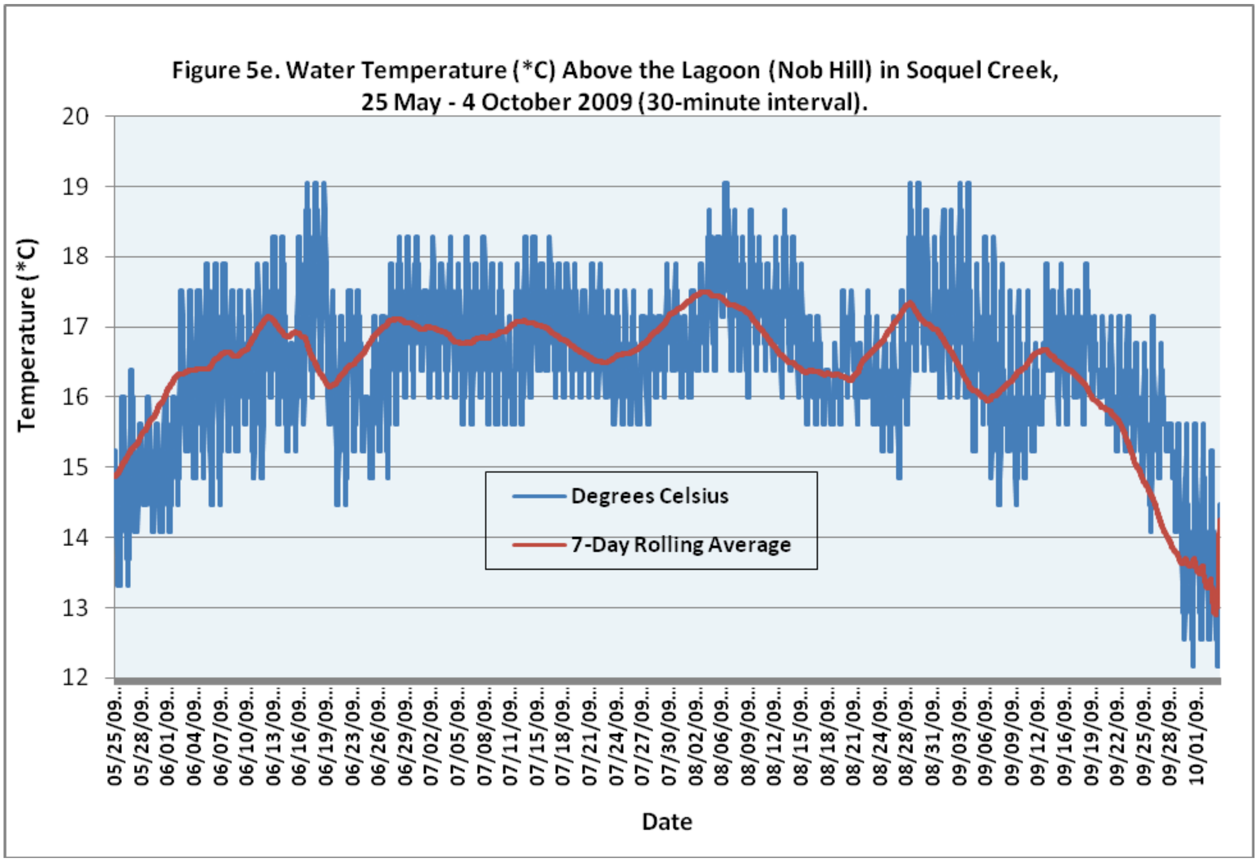


Figure 5e. Water Temperature (*C) Above the Lagoon (Nob Hill) in Soquel Creek, 25 May - 4 October 2009 (30-minute interval).

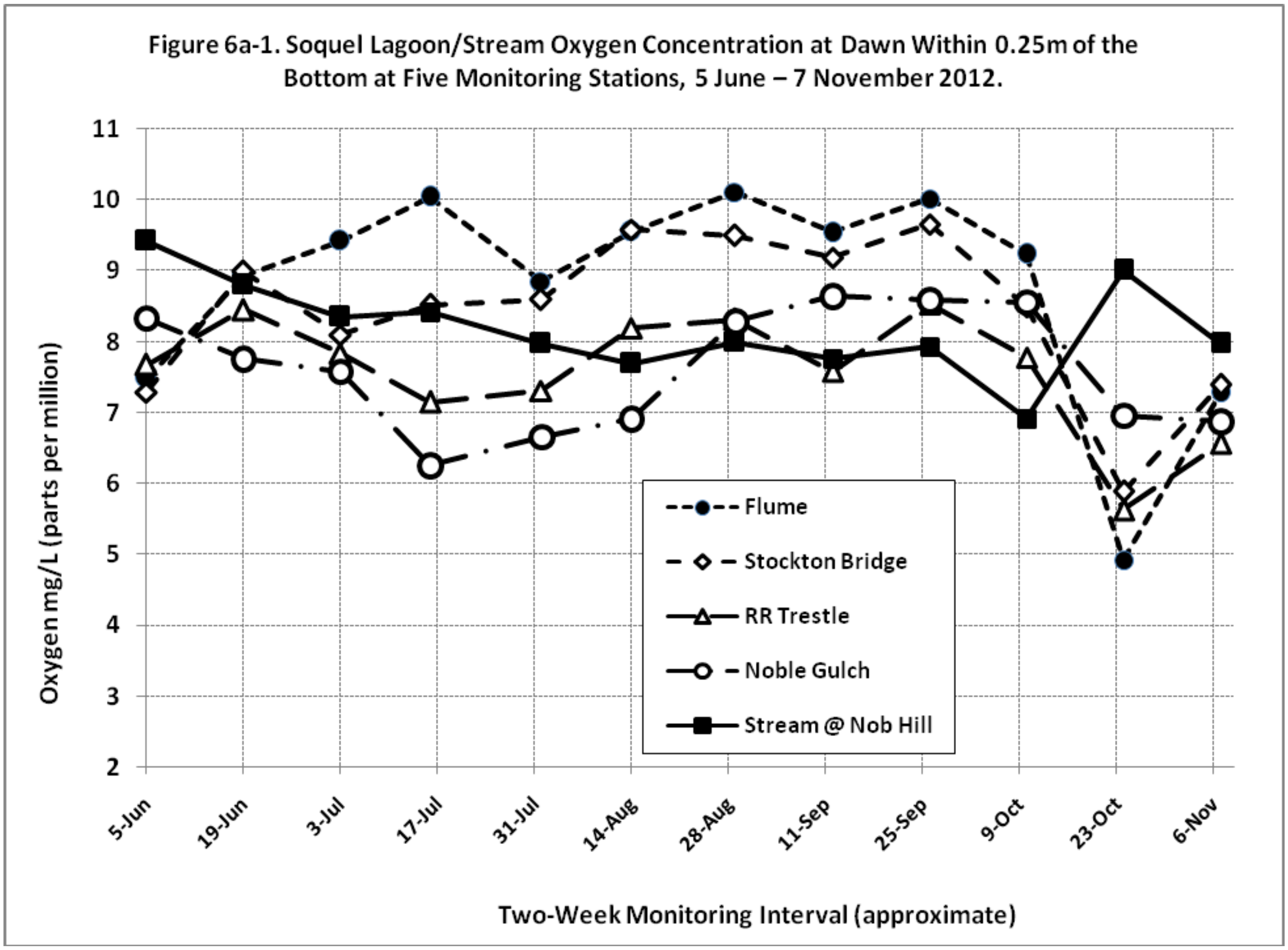
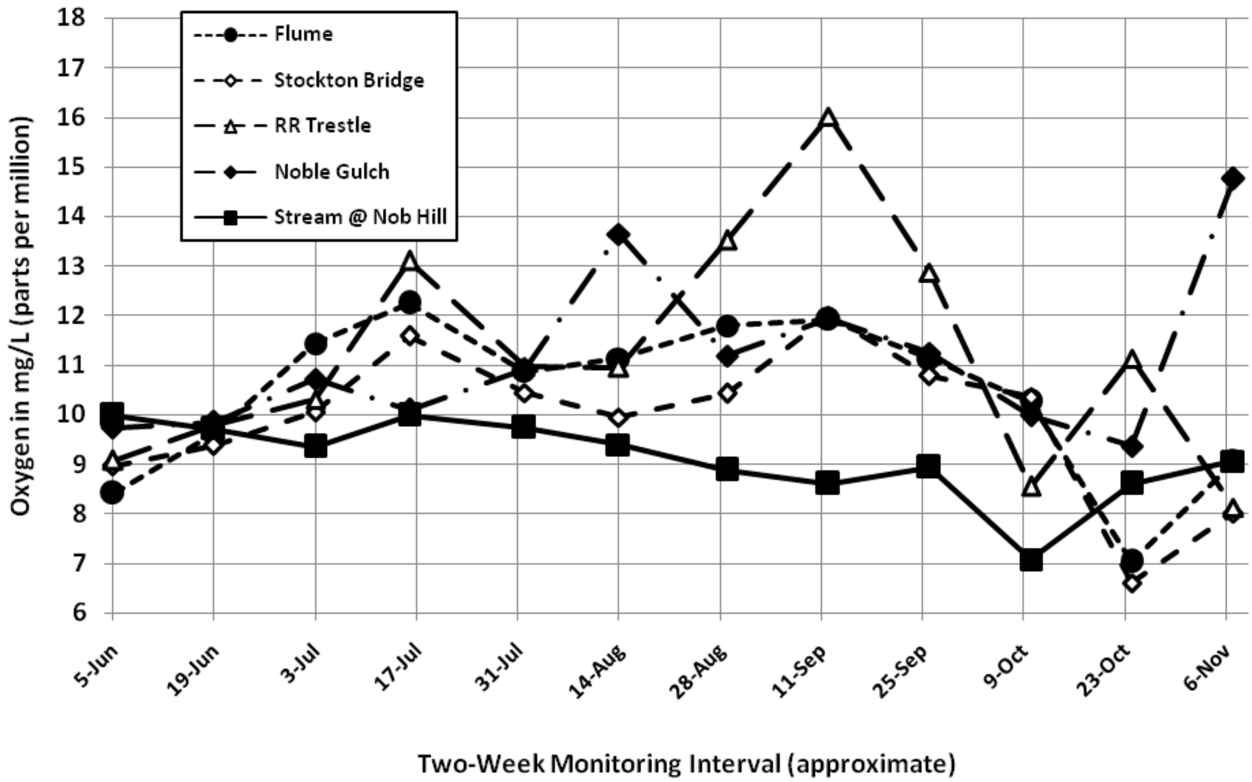


Figure 6a-1. Soquel Lagoon/Stream Oxygen Concentration at Dawn Within 0.25m of the Bottom at Five Monitoring Stations, 5 June – 7 November 2012.
Oxygen mg/L (parts per million)
11
10
9
8
7
6
5
4
3
2
5-Jun
19-Jun
3-Jul
17-Jul
31-Jul
14-Aug
28-Aug
11-Sep
25-Sep
9-Oct
23-Oct
6-Nov
Two-Week Monitoring Interval (approximate)
Flume
Stockton Bridge
RR Trestle
Noble Gulch
Stream @ Nob Hill

Figure 6a-2. Soquel Lagoon/Stream Oxygen Concentrations in Afternoon Within 0.25m of the Bottom at five Stations, 5 June – 7 November 2012.



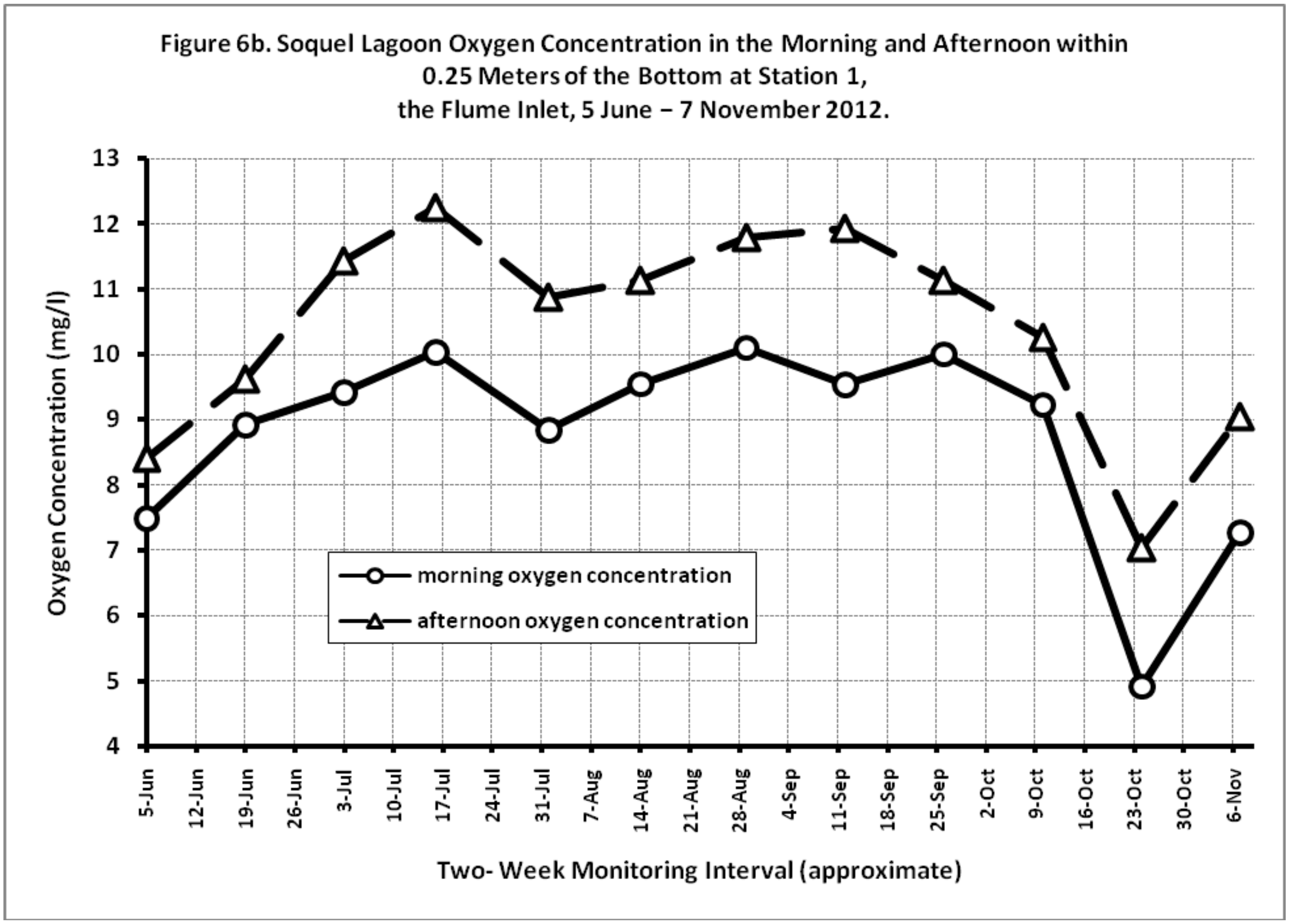


Figure 6b. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within
0.25 Meters of the Bottom at Station 1,
the Flume Inlet, 5 June – 7 November 2012.
Oxygen Concentration (mg/l)
13
12
11
10
9
8
7
6
5
4
morning oxygen concentration
afternoon oxygen concentration
5-Jun
12-Jun
19-Jun
26-Jun
3-Jul
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep
2-Oct
9-Oct
16-Oct
23-Oct
30-Oct
6-Nov
Two- Week Monitoring Interval (approximate)

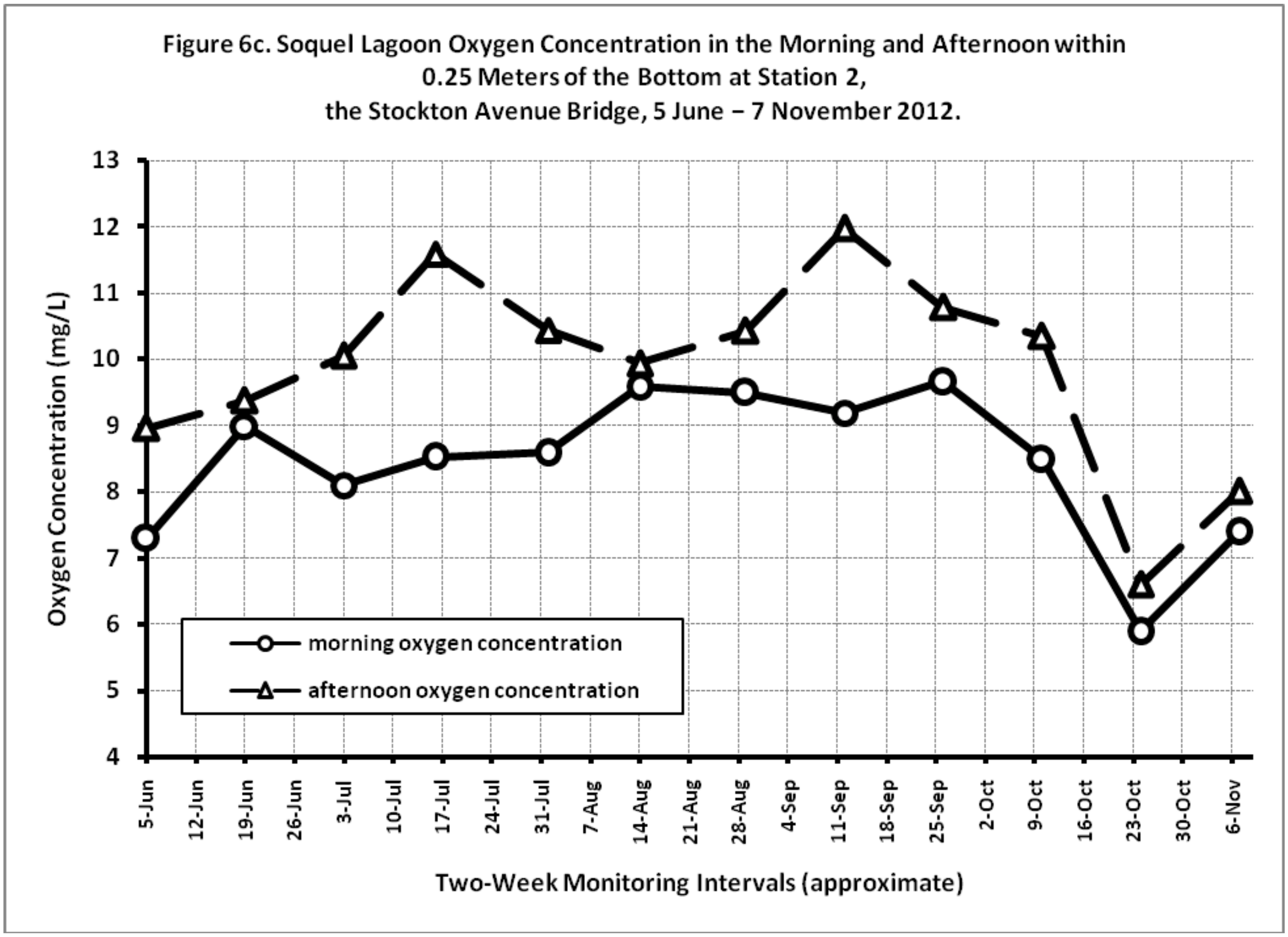


Figure 6c. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within
0.25 Meters of the Bottom at Station 2,
the Stockton Avenue Bridge, 5 June – 7 November 2012.
Oxygen Concentration (mg/L)
13
12
11
10
9
8
7
6
5
4
morning oxygen concentration
afternoon oxygen concentration
5-Jun
12-Jun
19-Jun
26-Jun
3-Jul
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep
2-Oct
9-Oct
16-Oct
23-Oct
30-Oct
6-Nov
Two-Week Monitoring Intervals (approximate)

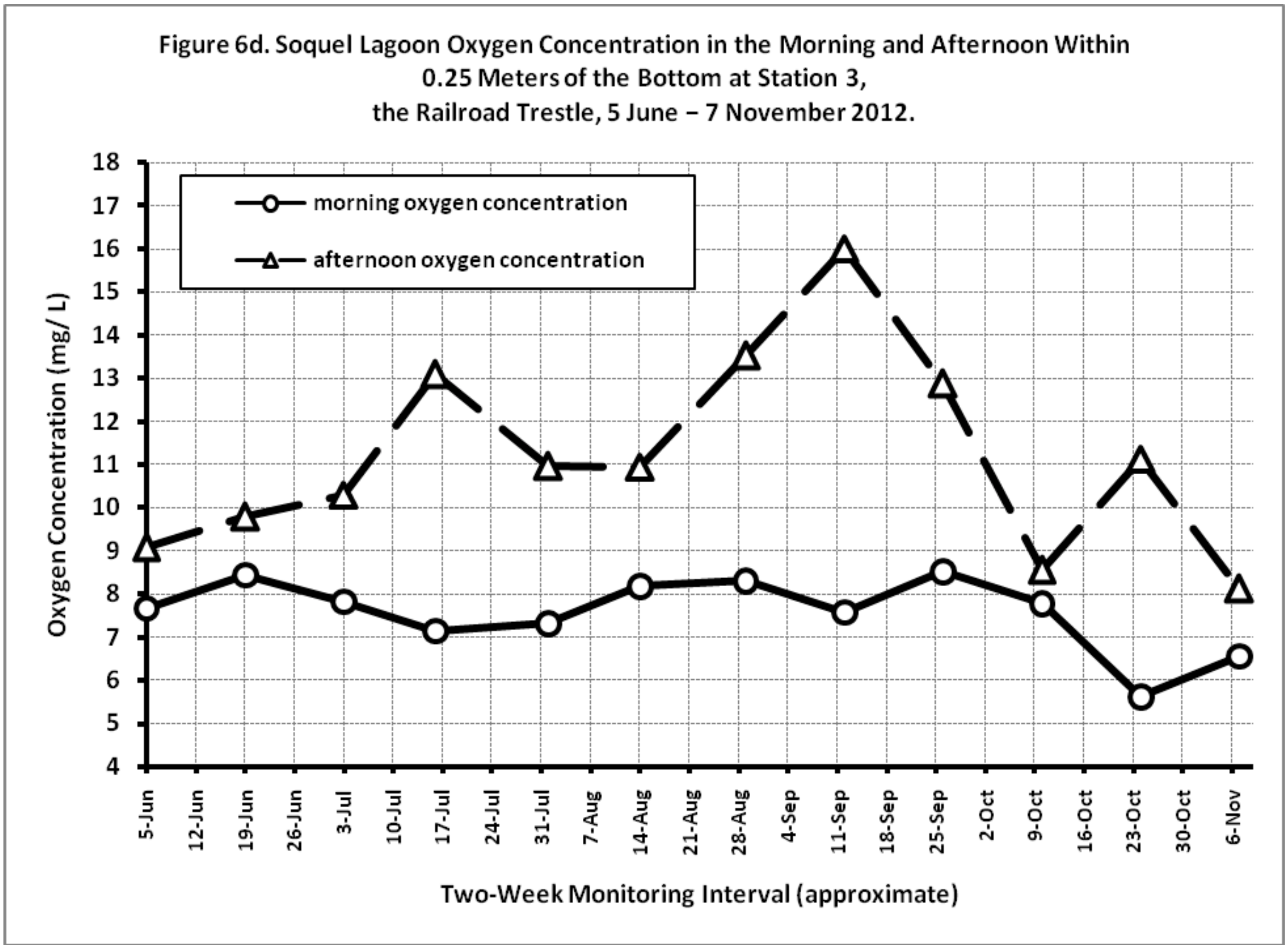


Figure 6d. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon Within
0.25 Meters of the Bottom at Station 3,
the Railroad Trestle, 5 June – 7 November 2012.
morning oxygen concentration
afternoon oxygen concentration
Oxygen Concentration (mg/ L)
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
5-Jun
12-Jun
19-Jun
26-Jun
3-Jul
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep
2-Oct
9-Oct
16-Oct
23-Oct
30-Oct
6-Nov
Two-Week Monitoring Interval (approximate)

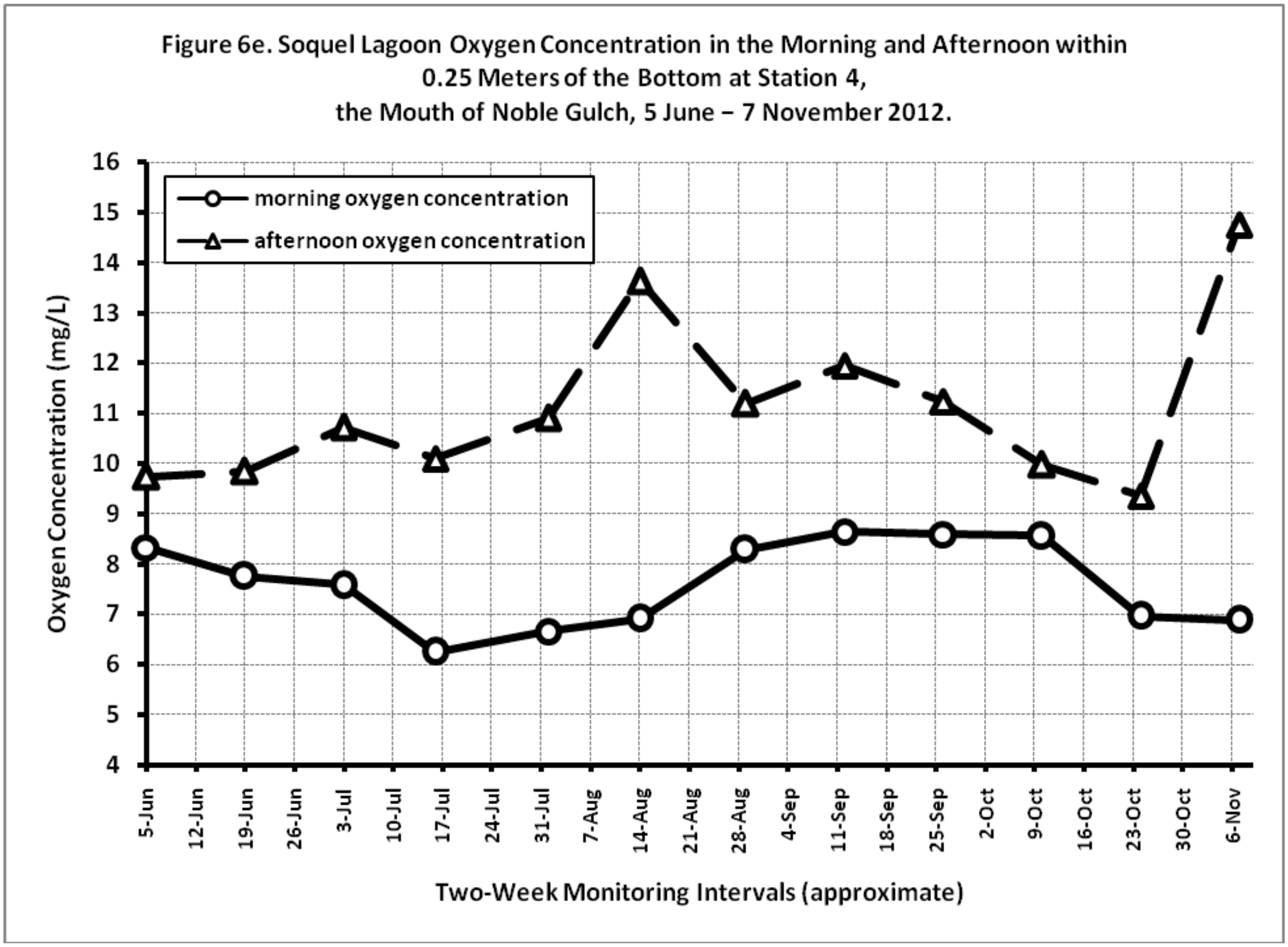


Figure 6e. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within
0.25 Meters of the Bottom at Station 4,
the Mouth of Noble Gulch, 5 June – 7 November 2012.
morning oxygen concentration
afternoon oxygen concentration
Oxygen Concentration (mg/L)
16
15
14
13
12
11
10
9
8
7
6
5
4
5-Jun
12-Jun
19-Jun
26-Jun
3-Jul
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep
2-Oct
9-Oct
16-Oct
23-Oct
30-Oct
6-Nov
Two-Week Monitoring Intervals (approximate)

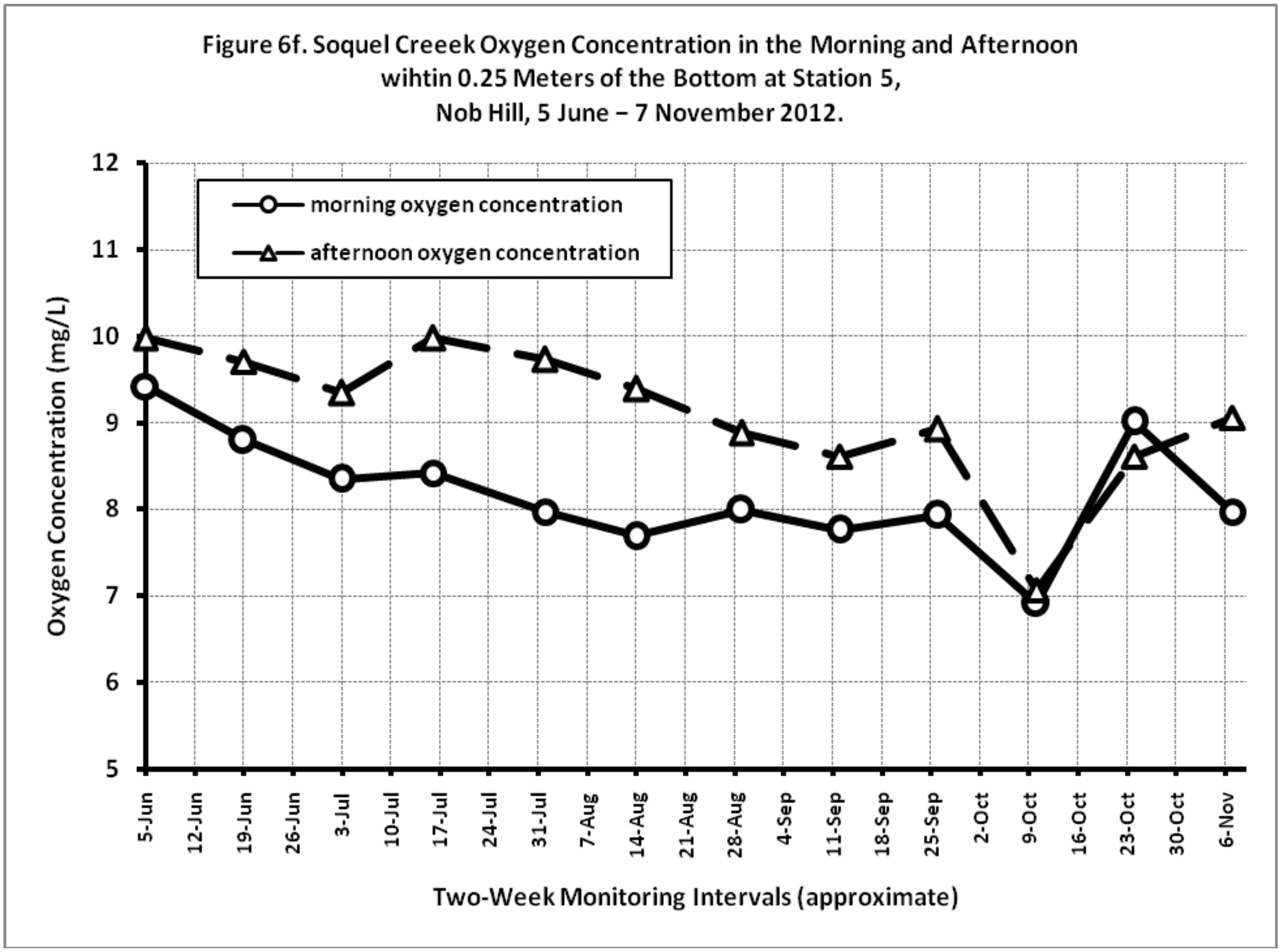


Figure 6f. Soquel Creeek Oxygen Concentration in the Morning and Afternoon
wihtin 0.25 Meters of the Bottom at Station 5,
Nob Hill, 5 June – 7 November 2012.
morning oxygen concentration
afternoon oxygen concentration
Oxygen Concentration (mg/L)
12
11
10
9
8
7
6
5
5-Jun
12-Jun
19-Jun
26-Jun
3-Jul
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep
2-Oct
9-Oct
16-Oct
23-Oct
30-Oct
6-Nov
Two-Week Monitoring Intervals (approximate)

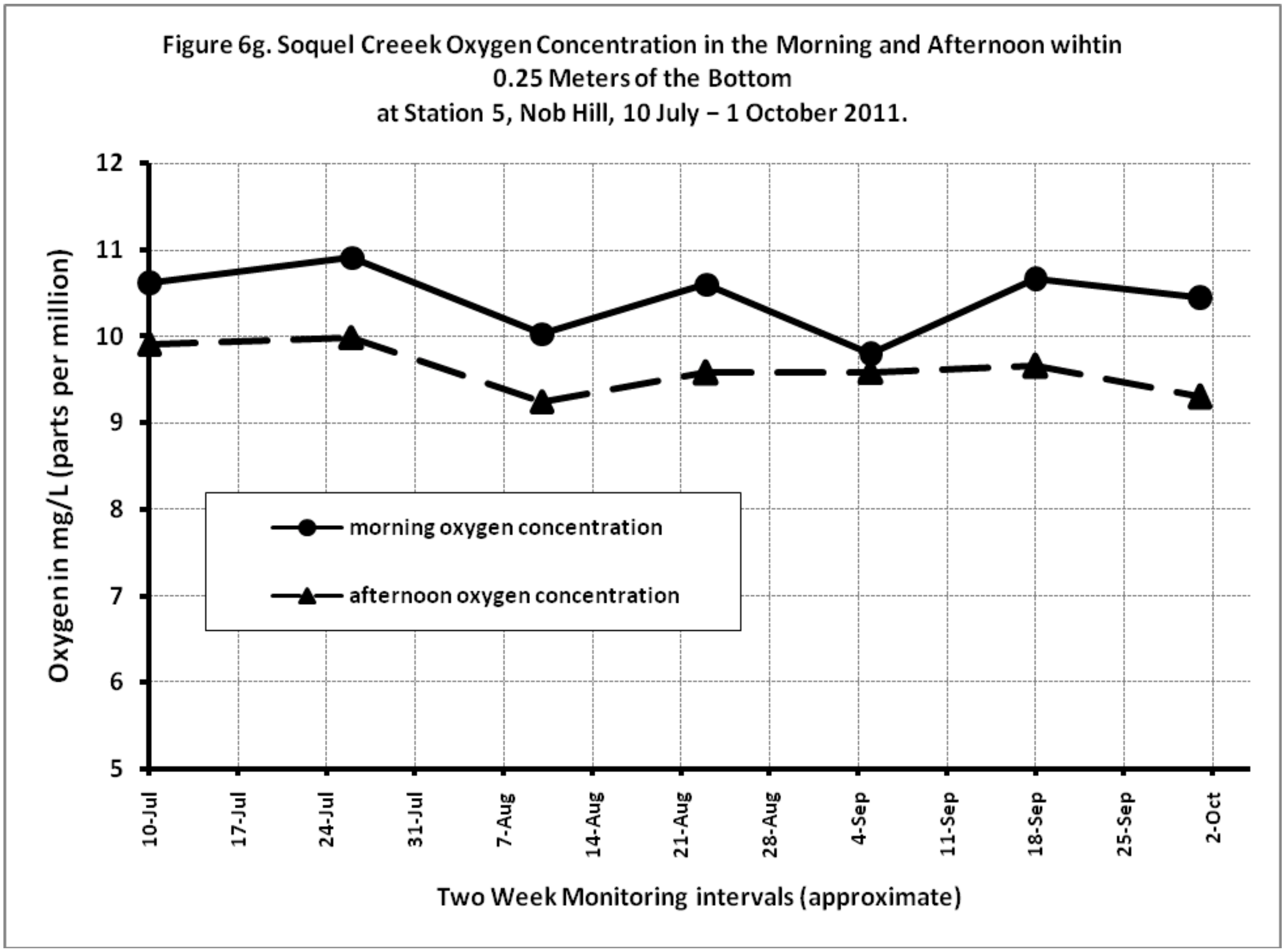
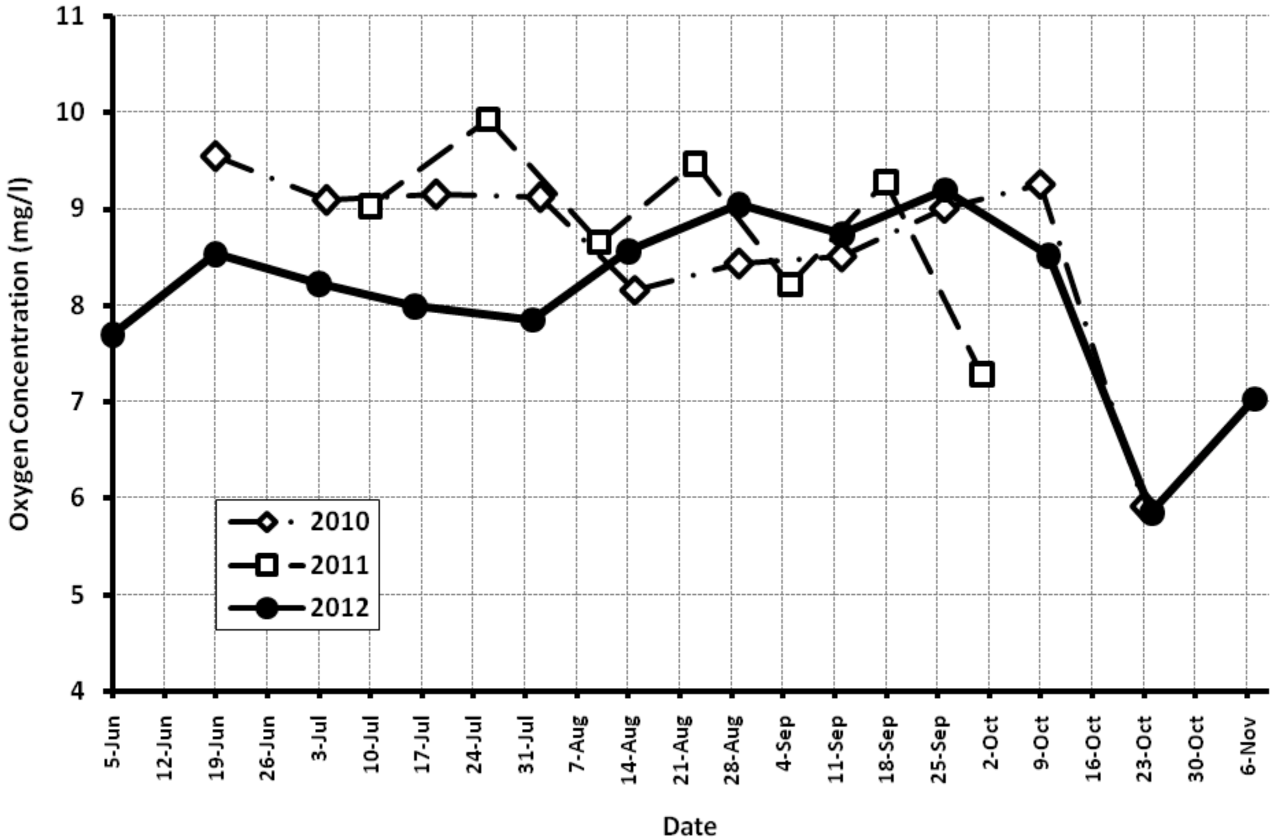


Figure 6g. Soquel Creeek Oxygen Concentration in the Morning and Afternoon wihtin
0.25 Meters of the Bottom
at Station 5, Nob Hill, 10 July – 1 October 2011.
Oxygen in mg/L (parts per million)
12
11
10
9
8
7
6
5
morning oxygen concentration
afternoon oxygen concentration
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep
2-Oct
Two Week Monitoring intervals (approximate)

Figure 6h. Average MORNING Oxygen Concentration at Four Lagoon Monitoring Stations, 2010–2012.



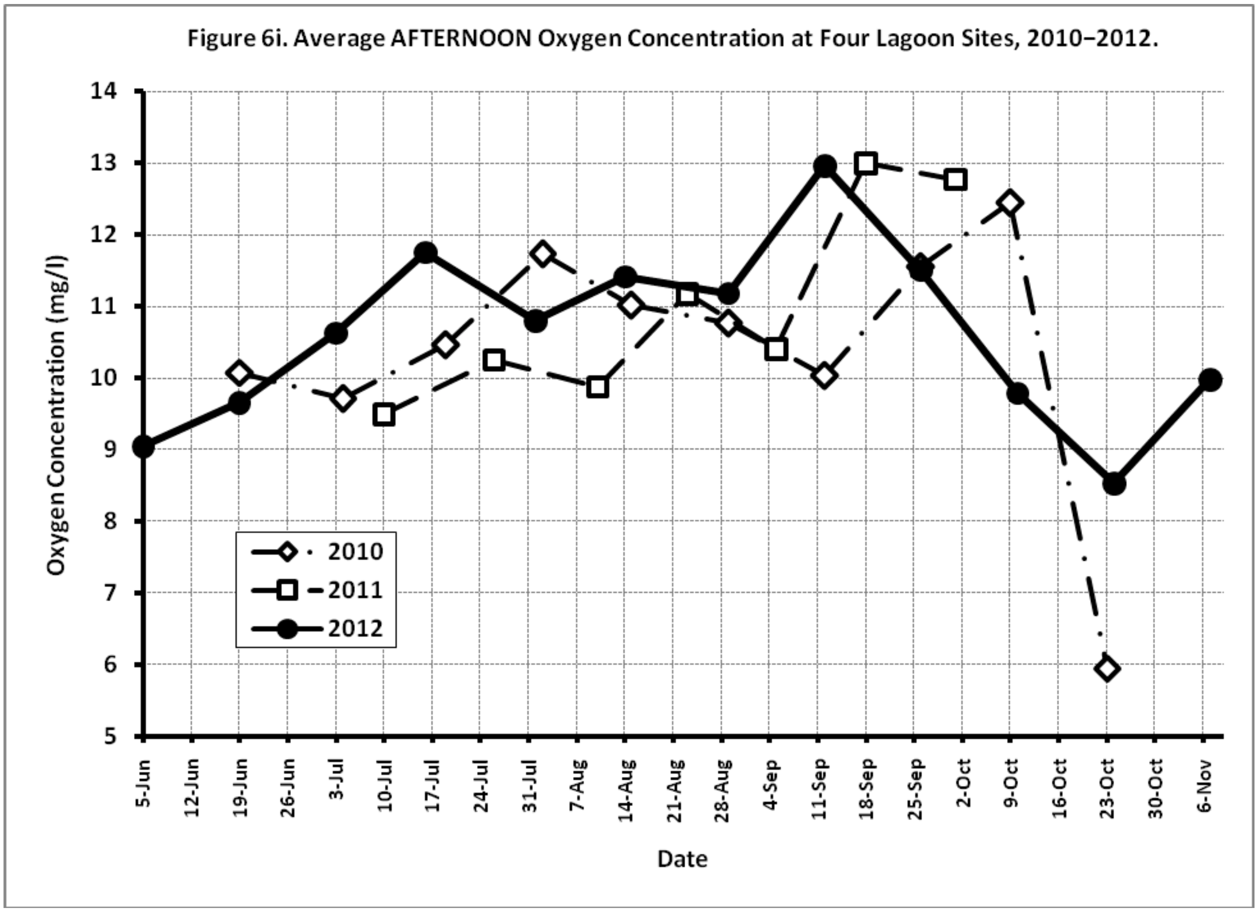


Figure 6i. Average AFTERNOON Oxygen Concentration at Four Lagoon Sites, 2010–2012.
Oxygen Concentration (mg/l)
14
13
12
11
10
9
8
7
6
5
2010
2011
2012
5-Jun
12-Jun
19-Jun
26-Jun
3-Jul
10-Jul
17-Jul
24-Jul
31-Jul
7-Aug
14-Aug
21-Aug
28-Aug
4-Sep
11-Sep
18-Sep
25-Sep
2-Oct
9-Oct
16-Oct
23-Oct
30-Oct
6-Nov
Date

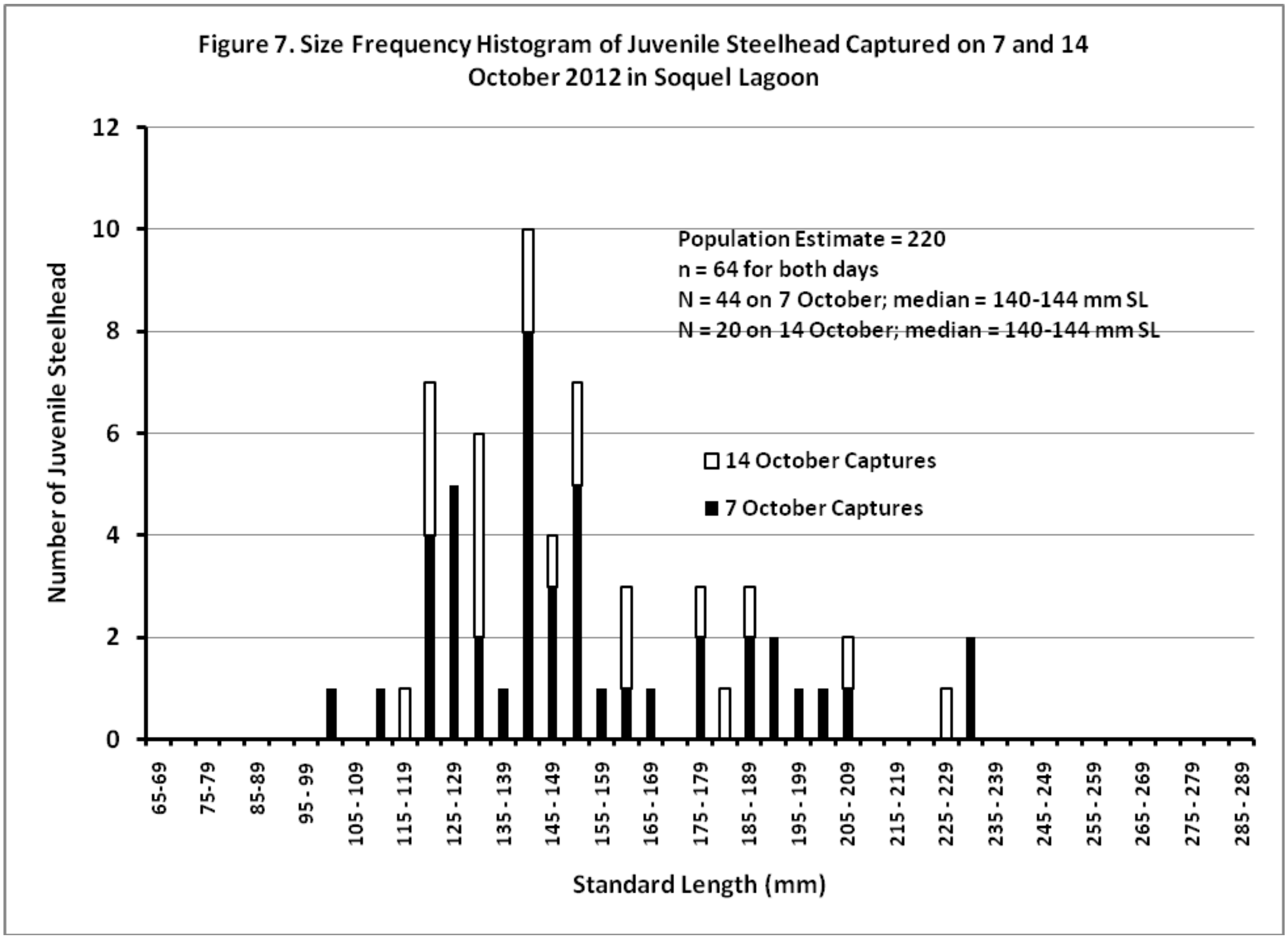
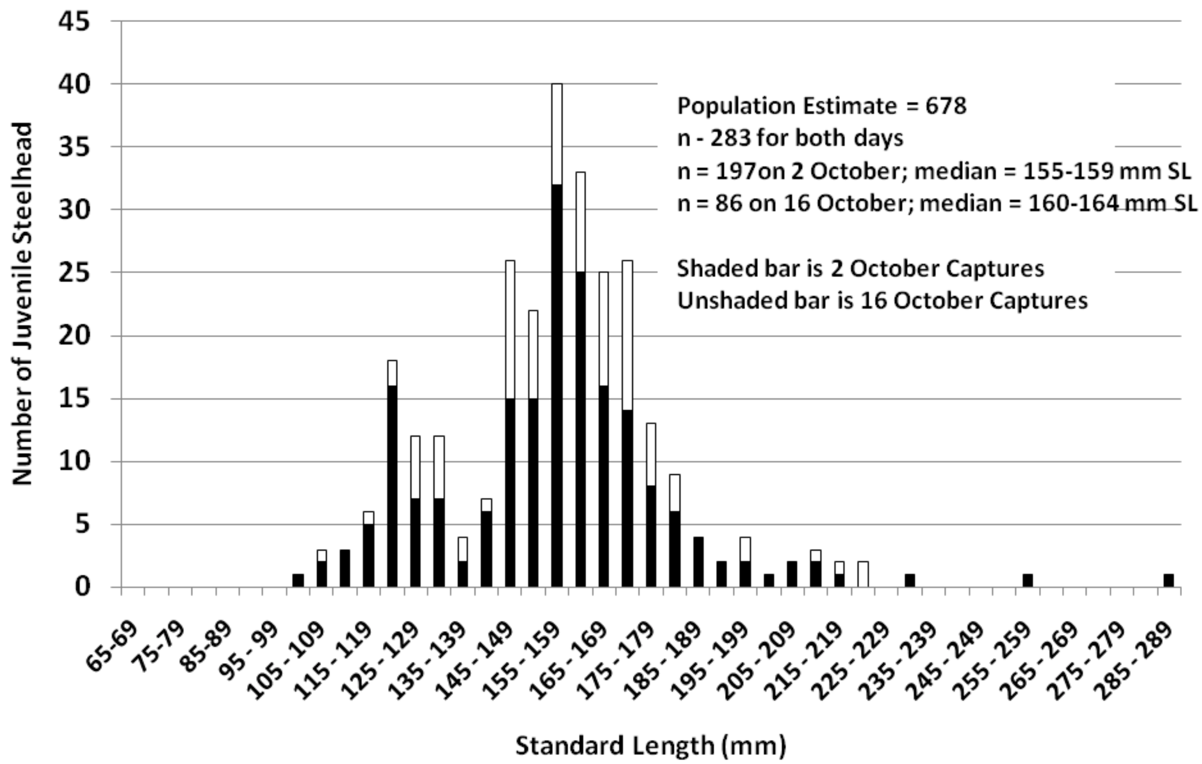


Figure 7. Size Frequency Histogram of Juvenile Steelhead Captured on 7 and 14 October 2012 in Soquel Lagoon
Population Estimate = 220
n = 64 for both days
N = 44 on 7 October; median = 140-144 mm SL
N = 20 on 14 October; median = 140-144 mm SL
14 October Captures
7 October Captures
Number of Juvenile Steelhead
Standard Length (mm)
0
2
4
6
8
10
12
65-69
75-79
85-89
95 - 99
105 - 109
115 - 119
125 - 129
135 - 139
145 - 149
155 - 159
165 - 169
175 - 179
185 - 189
195 - 199
205 - 209
215 - 219
225 - 229
235 - 239
245 - 249
255 - 259
265 - 269
275 - 279
285 - 289

Figure 8. Size Frequency Histogram of Juvenile Steelhead Captured on 2 and 16 October 2011 in Soquel Lagoon/Estuary.



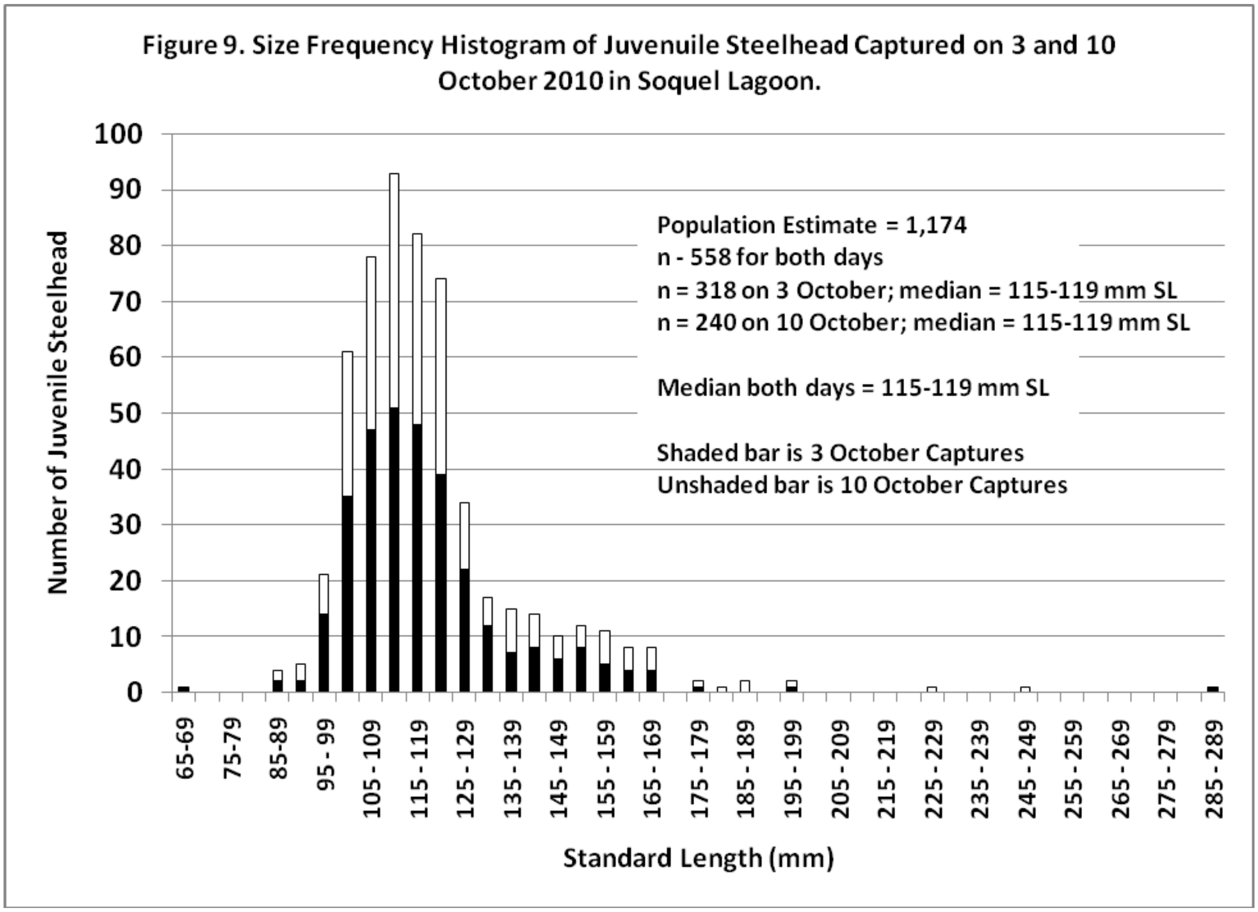


Figure 9. Size Frequency Histogram of Juvenuile Steelhead Captured on 3 and 10 October 2010 in Soquel Lagoon.
Number of Juvenile Steelhead
100
90
80
70
60
50
40
30
20
10
0
Population Estimate = 1,174
n - 558 for both days
n = 318 on 3 October; median = 115-119 mm SL
n = 240 on 10 October; median = 115-119 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)

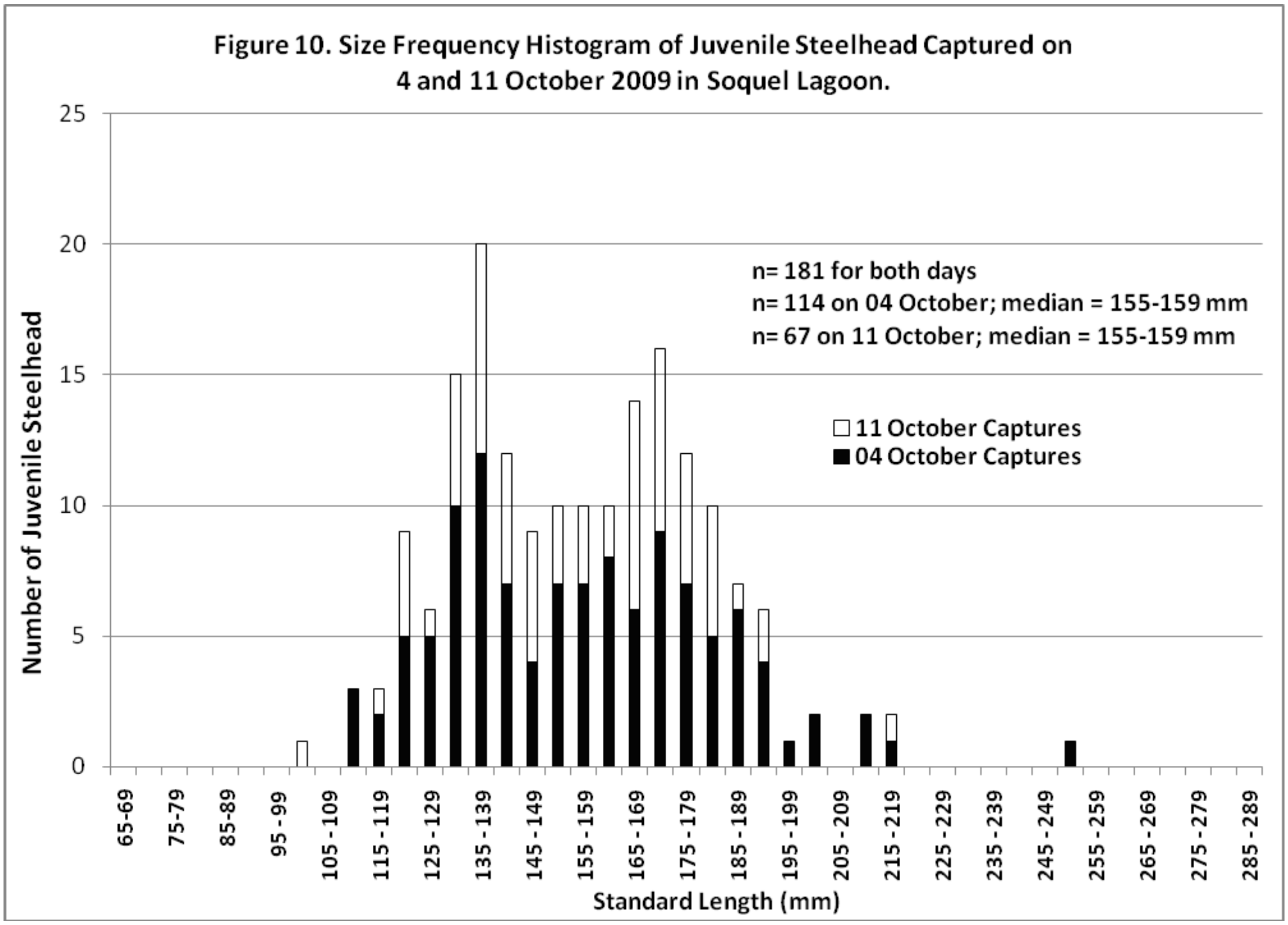


Figure 10. Size Frequency Histogram of Juvenile Steelhead Captured on
4 and 11 October 2009 in Soquel Lagoon.
n= 181 for both days
n= 114 on 04 October; median = 155-159 mm
n= 67 on 11 October; median = 155-159 mm
11 October Captures
04 October Captures
Number of Juvenile Steelhead
Standard Length (mm)
0
5
10
15
20
25
65-69
75-79
85-89
95 - 99
105 - 109
115 - 119
125 - 129
135 - 139
145 - 149
155 - 159
165 - 169
175 - 179
185 - 189
195 - 199
205 - 209
215 - 219
225 - 229
235 - 239
245 - 249
255 - 259
265 - 269
275 - 279
285 - 289

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

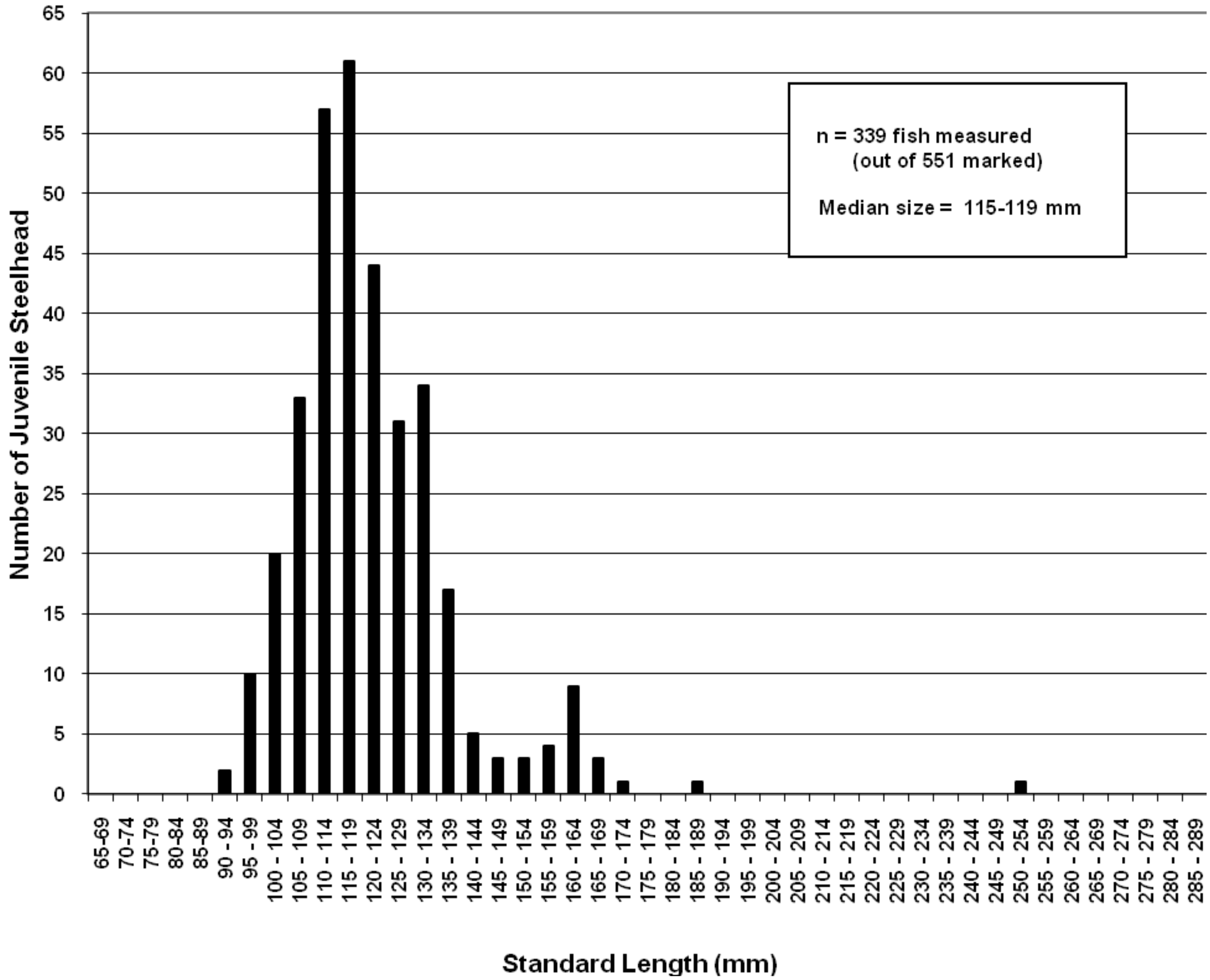


Figure 12. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 7 & 14 October 2007 in the Soquel Lagoon

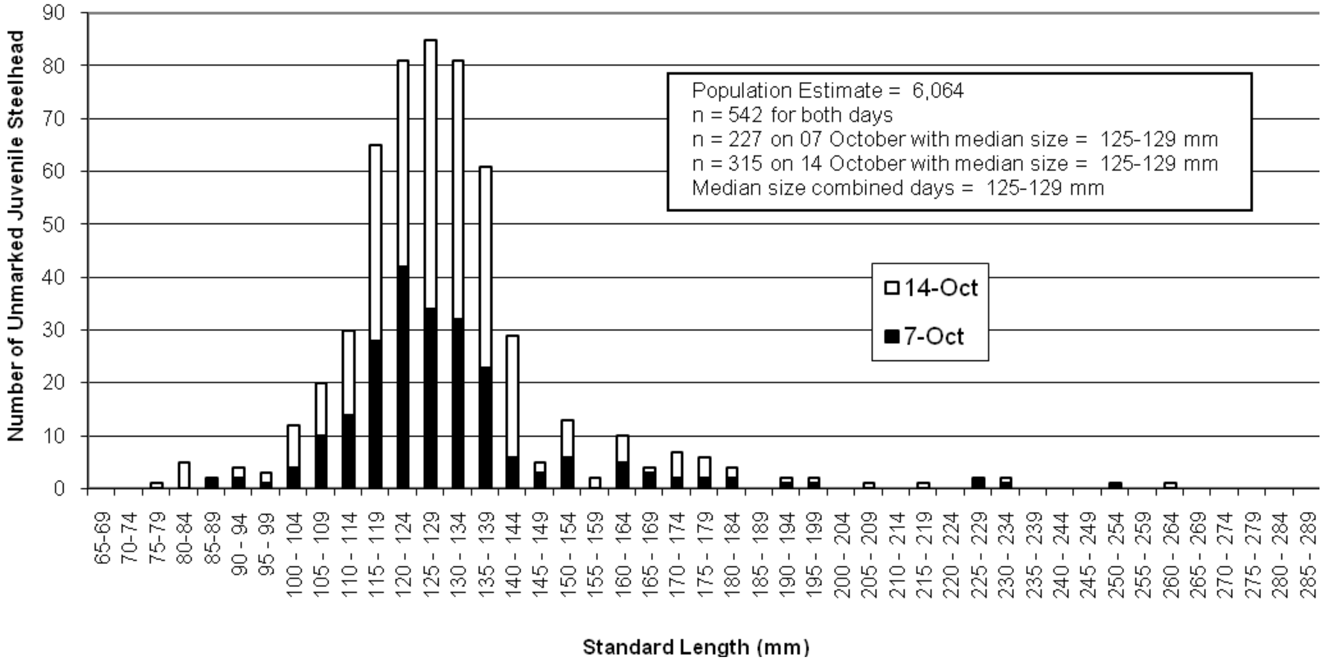


Figure 13. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 30 September and 8 October 2006 in Soquel Lagoon.

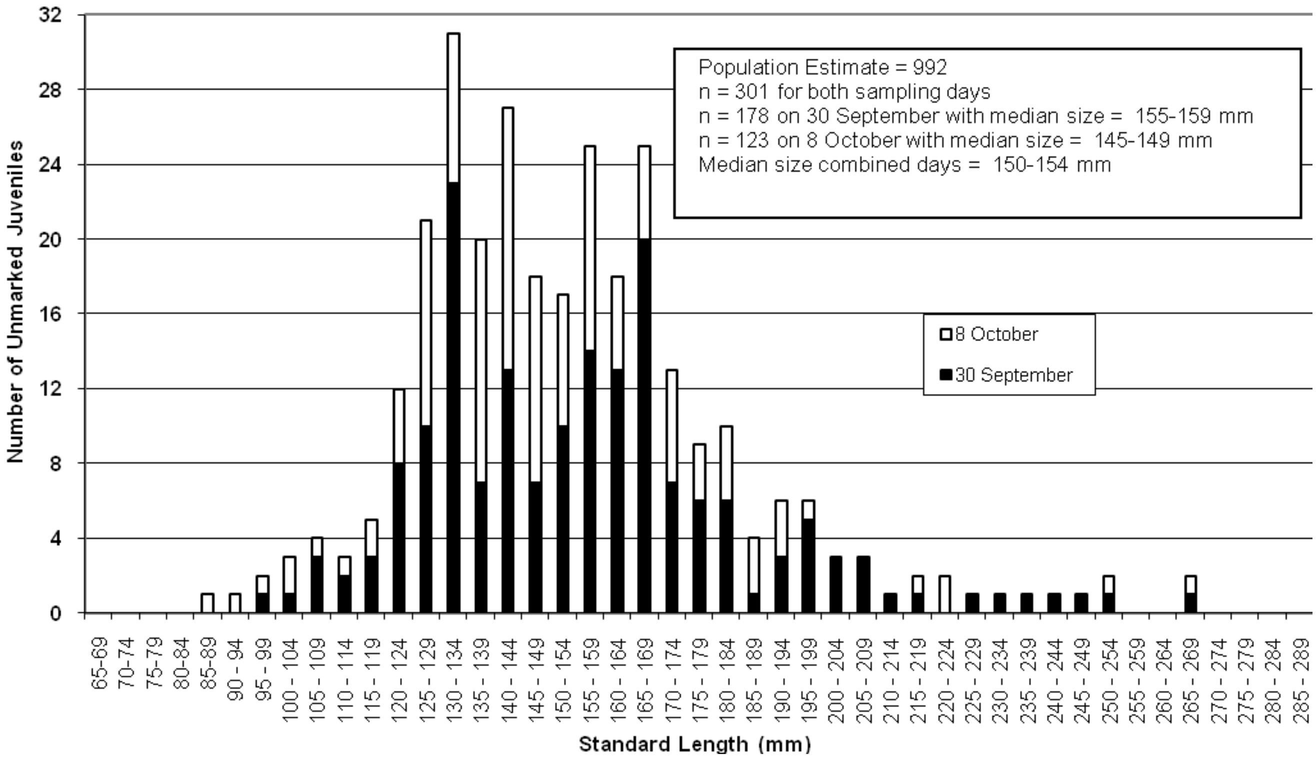


Figure 14. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 2 and 9 October 2005 in Soquel Lagoon.

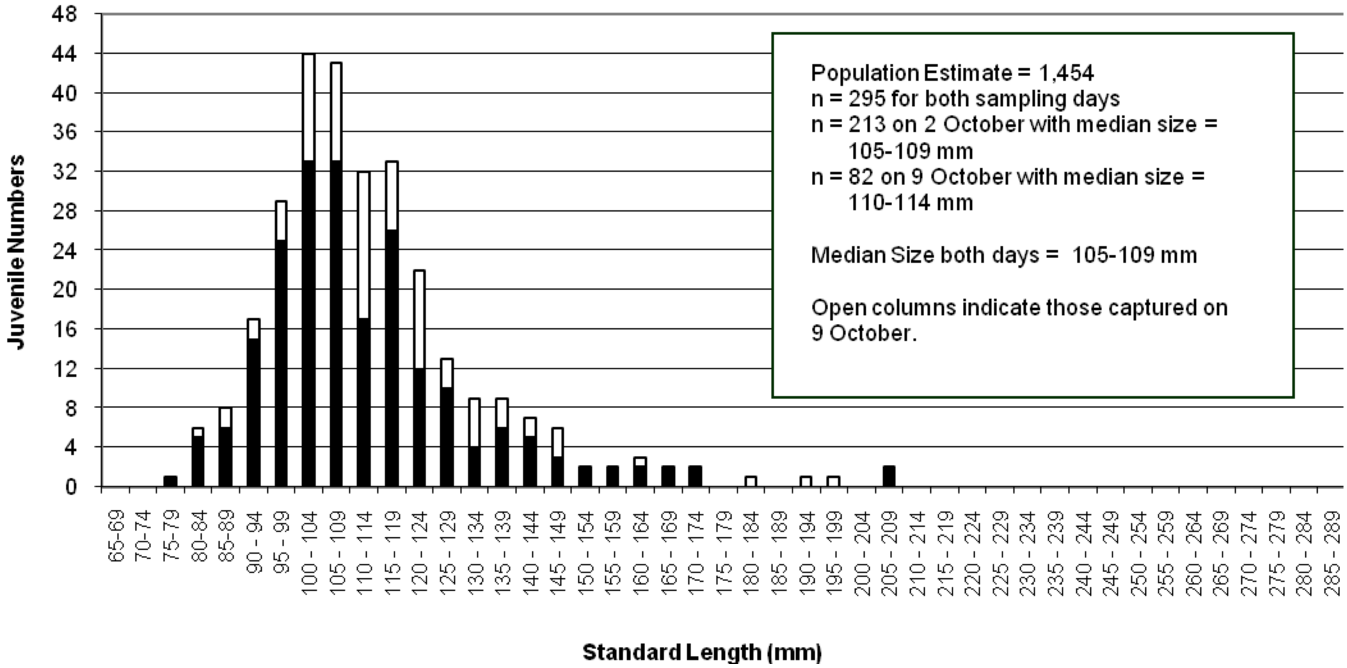


Figure 15. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 and 12 October 2004 in Soquel Lagoon.

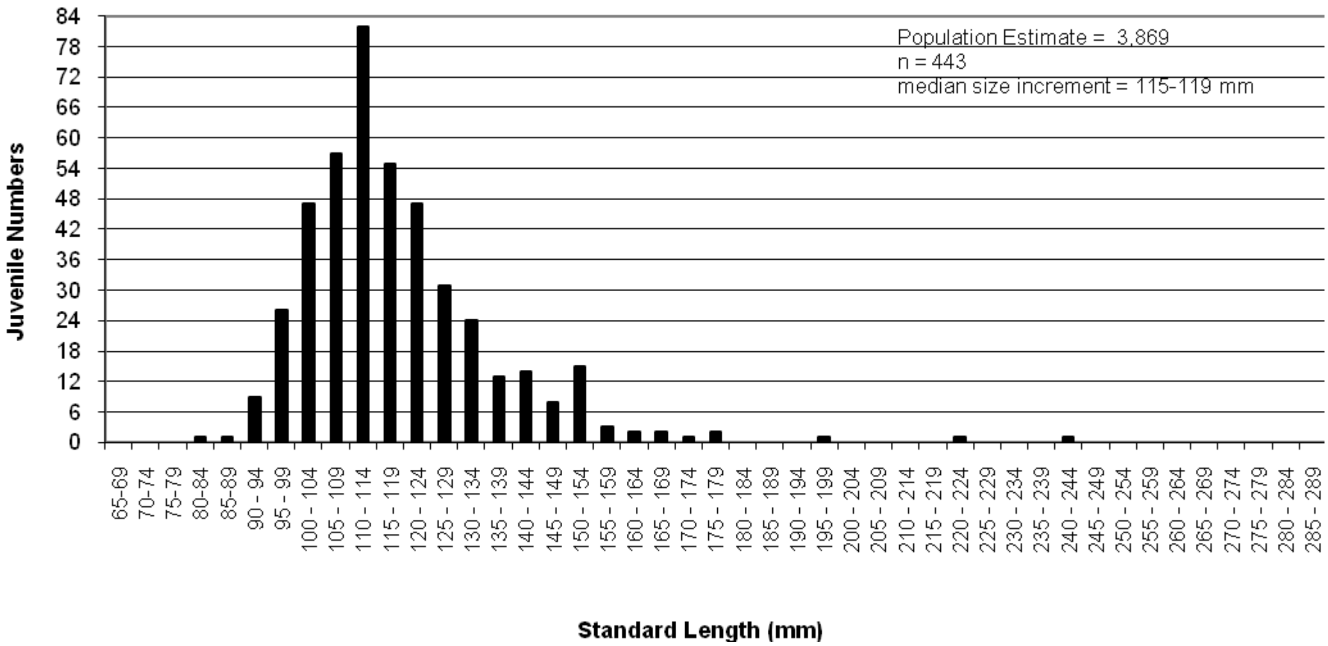


Figure 16. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 5 and 12 October 2003 in Soquel Lagoon.

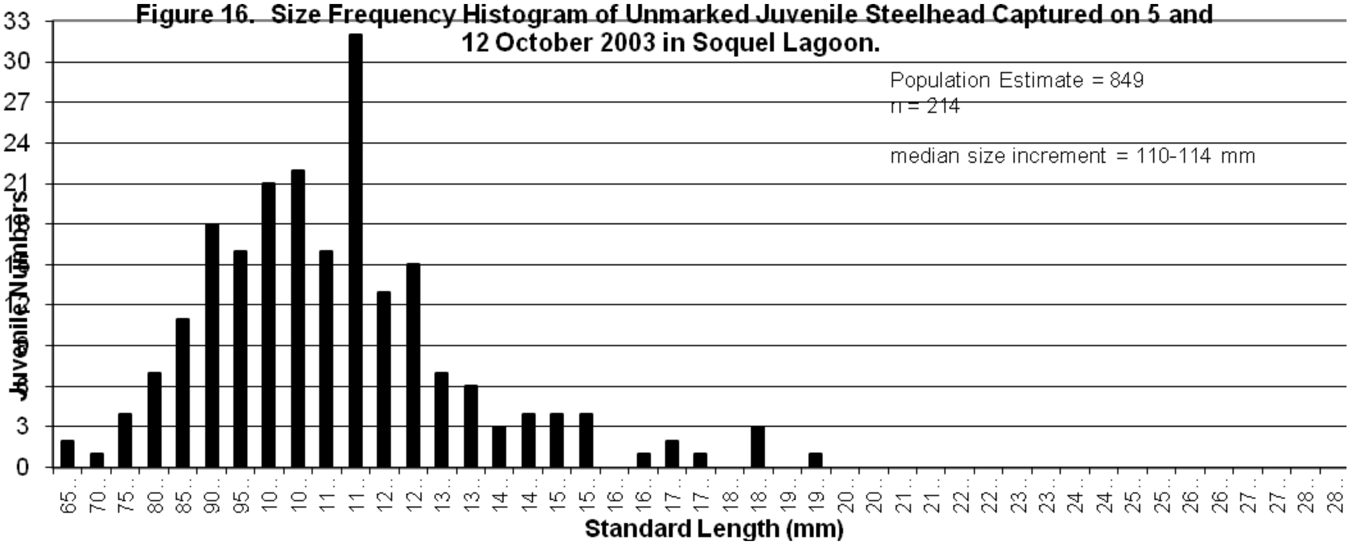


Figure 17. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 6 and 13 October 2002 in Soquel Lagoon.

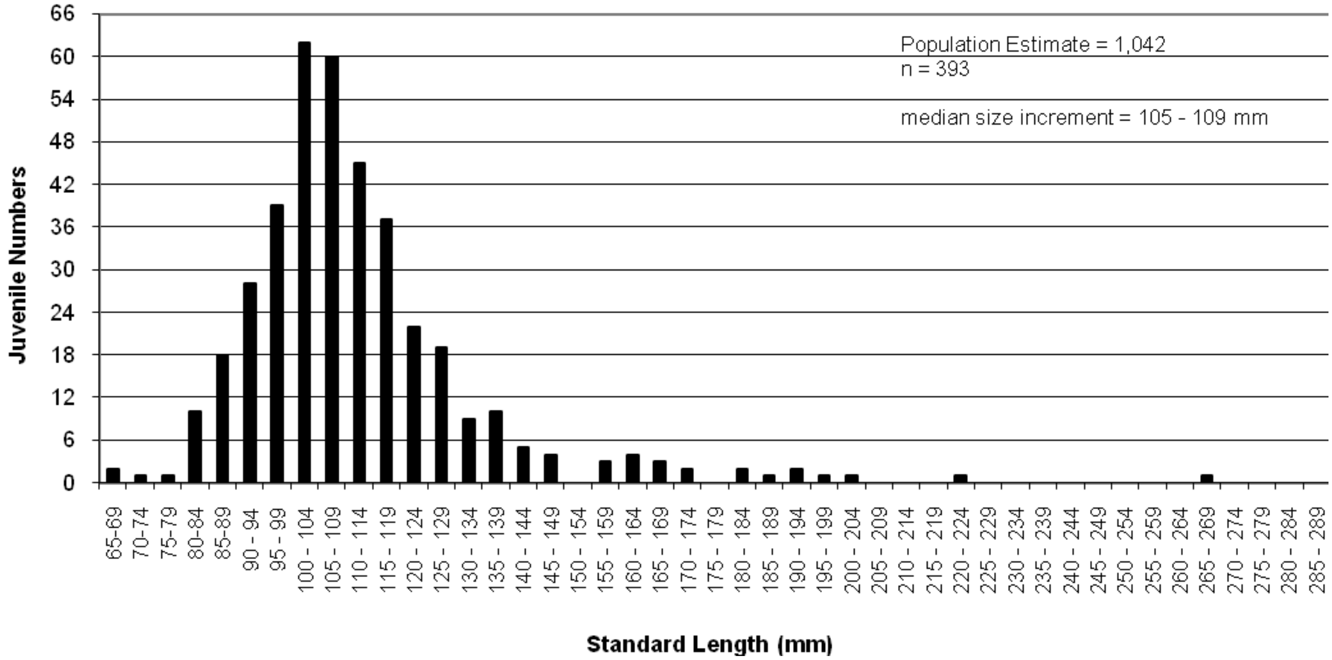


Figure 18. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 7 and 14 October 2001 in Soquel Lagoon.

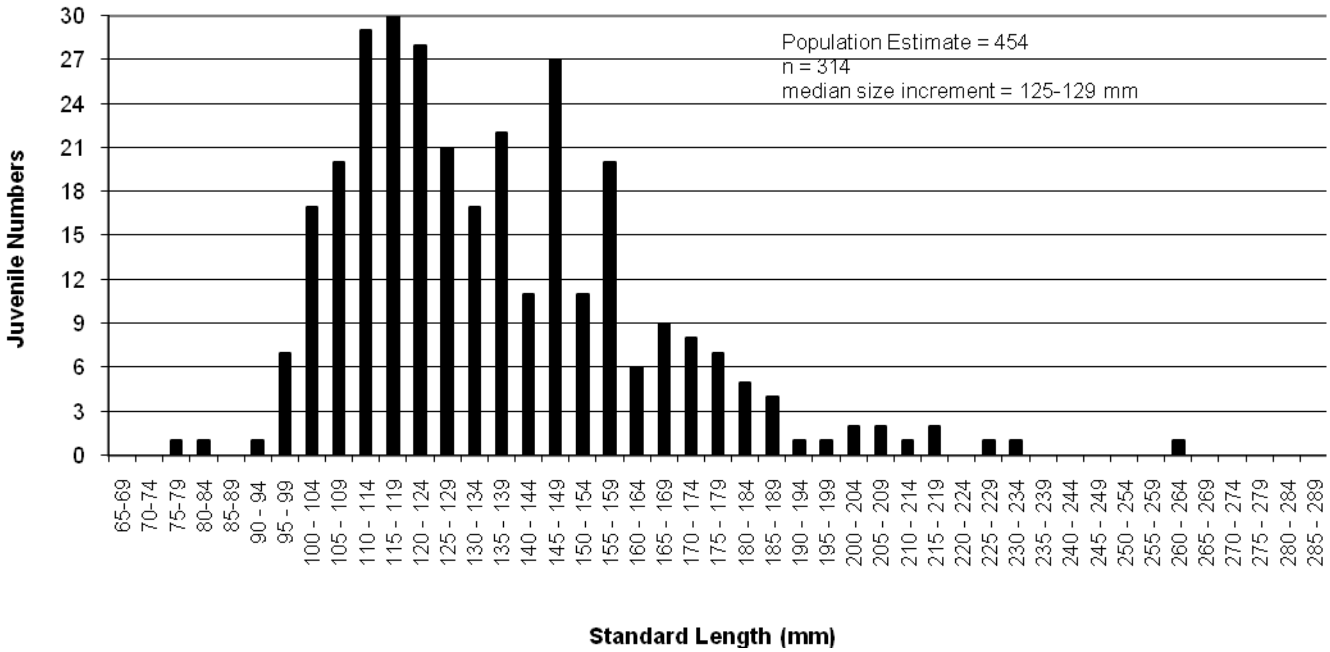


Figure 19. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 1 and 8 October 2000 in Soquel Lagoon.

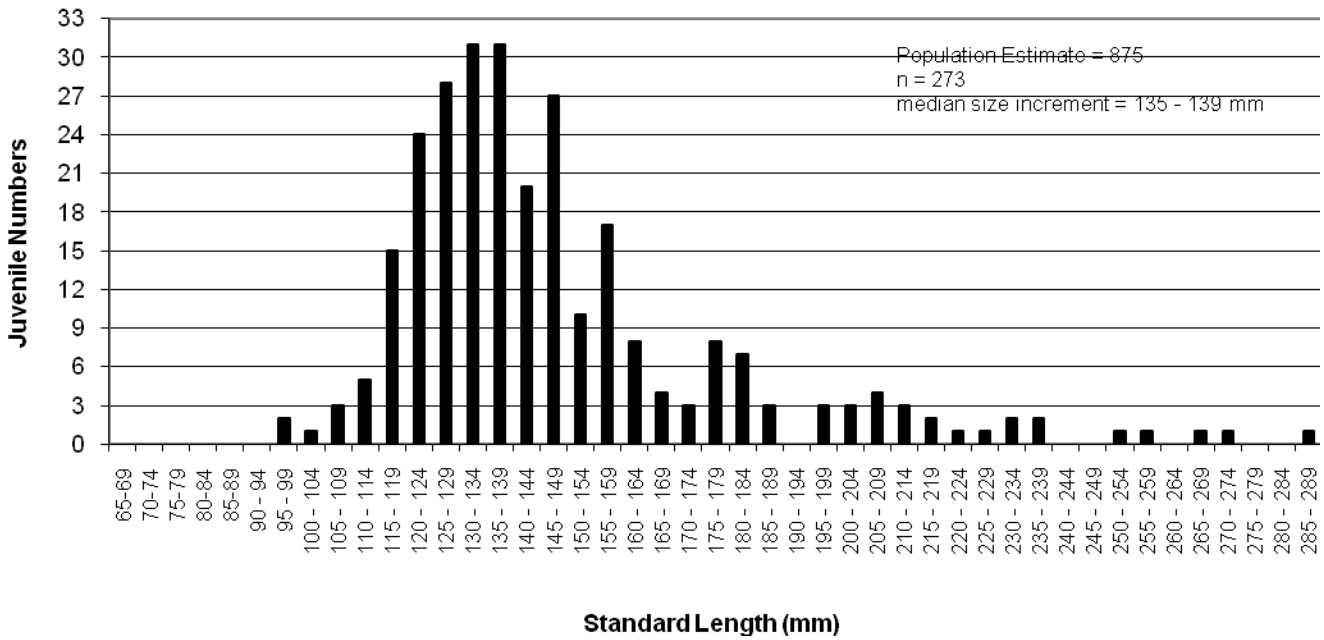


Figure 20. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 October 1999 (only) in Soquel Lagoon.

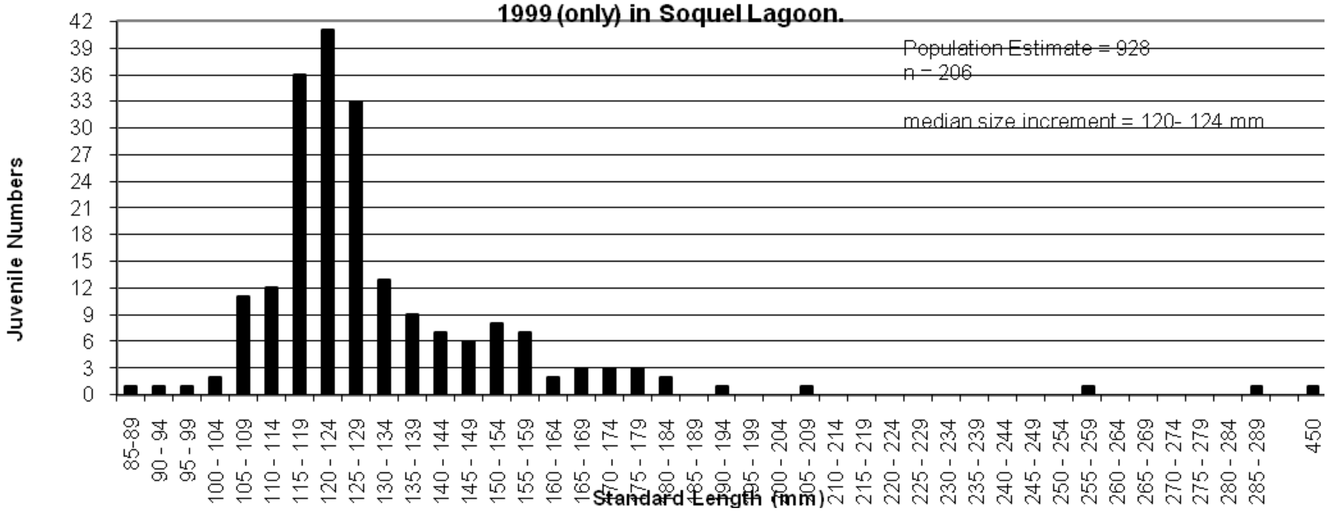


Figure 21. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 4 and 11 October 1998 in Soquel Lagoon.

Population Estimate = 671.

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

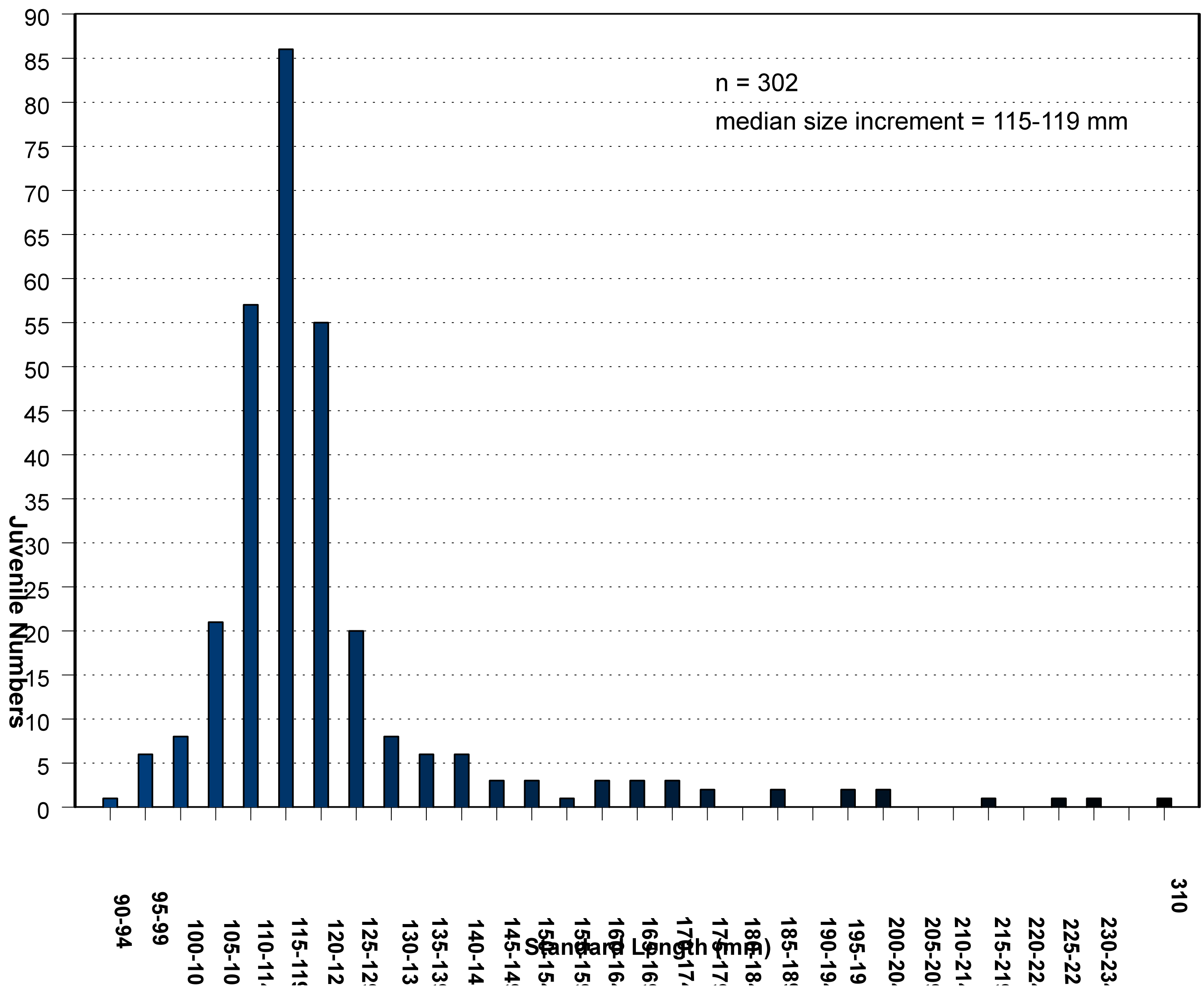


Figure 22. Juvenile Steelhead Population Estimate in Soquel Lagoon, 1993–2012. Estimated by Mark and Recapture Experiment.

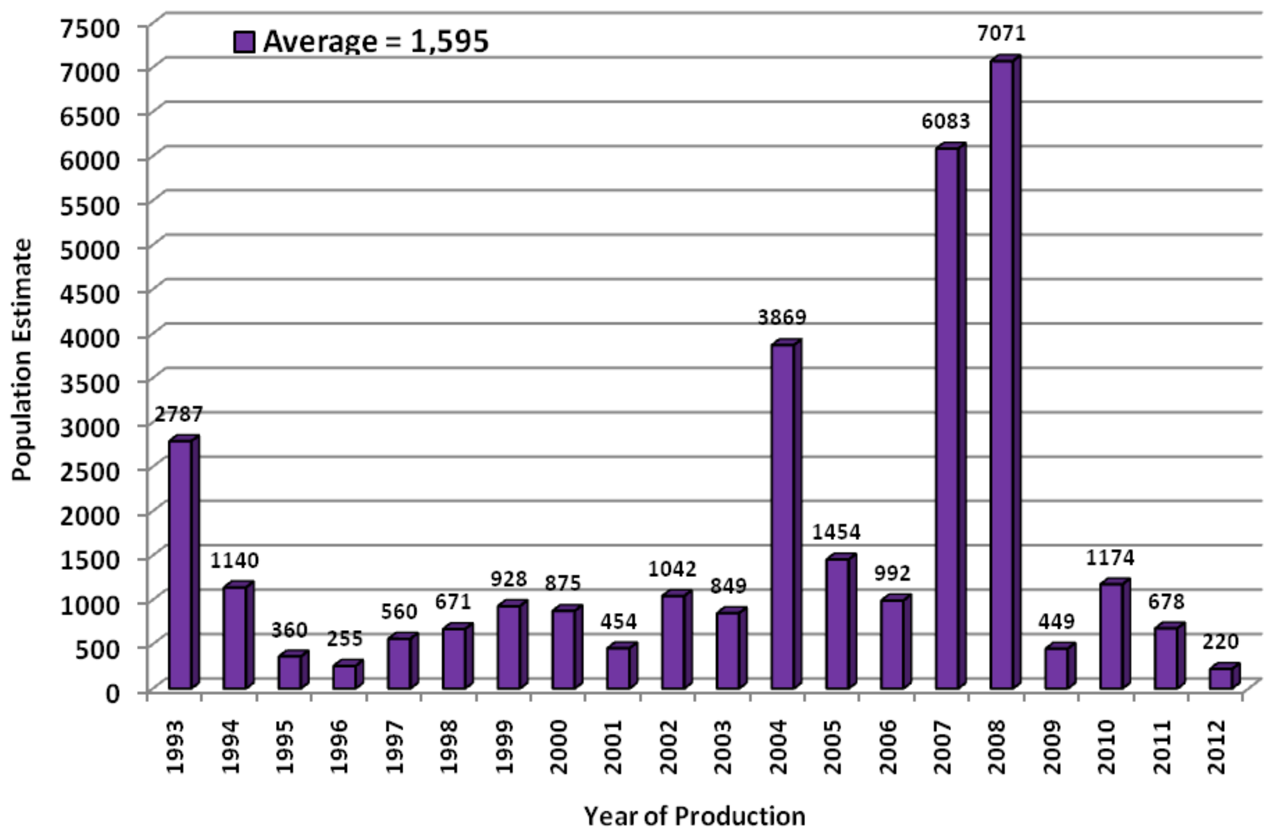


Figure 23. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2012.

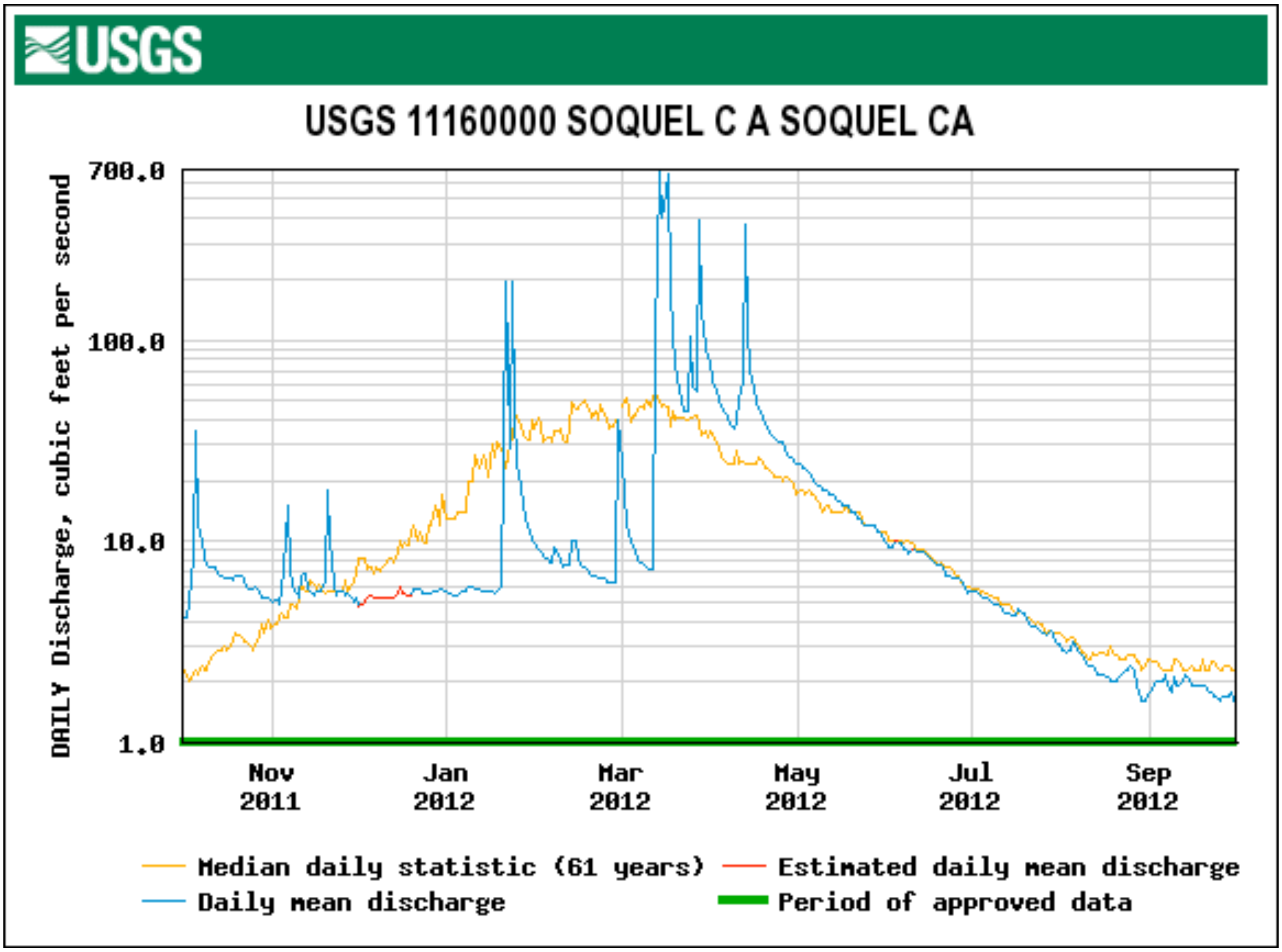


Figure 24. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 15 May 2012 – 20 November 2012.

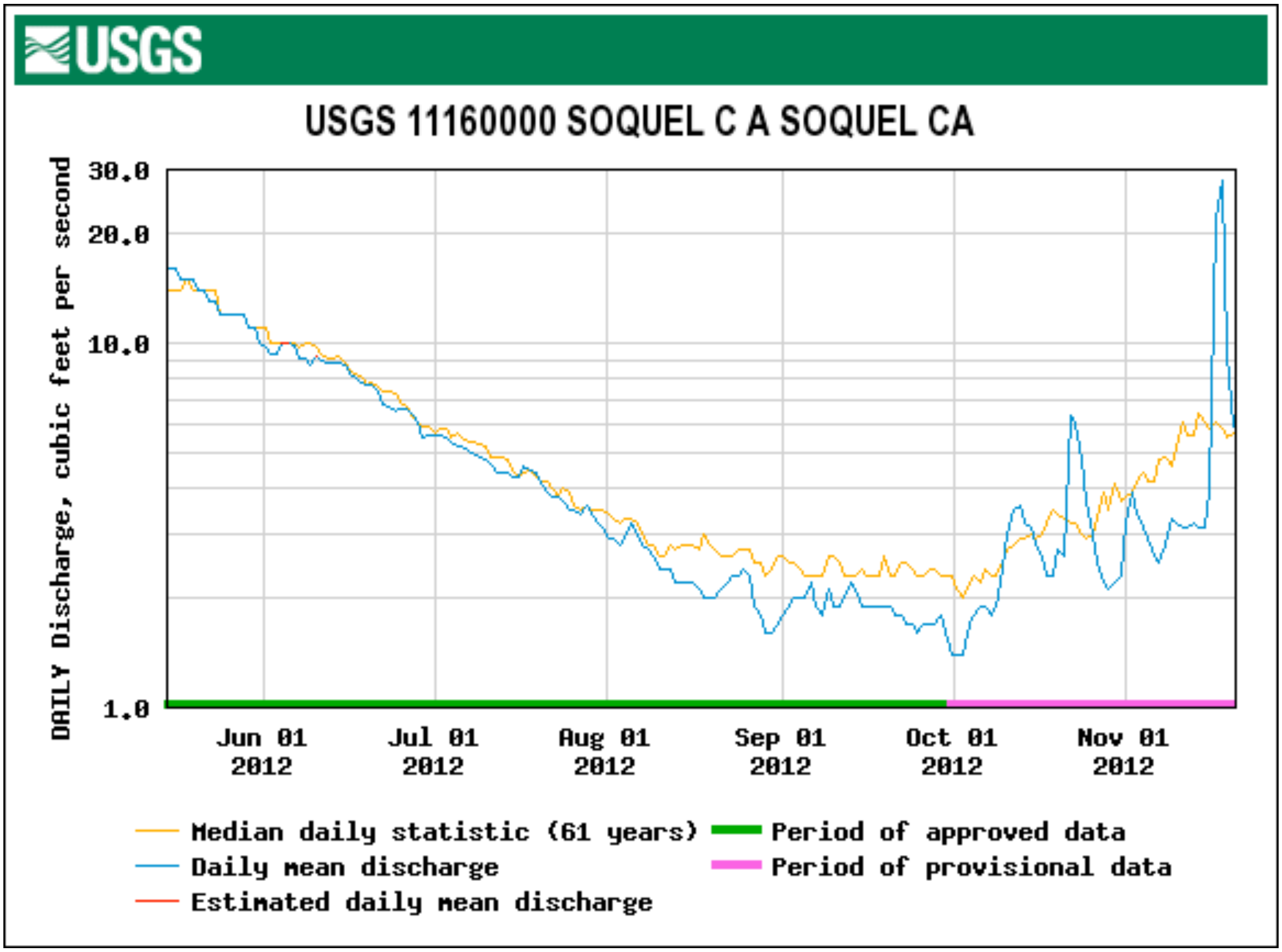


Figure 25. Soquel Creek Real-Time Streamflow at the USGS Gage in Soquel, CA, 1 October 2012 – 26 November 2012.

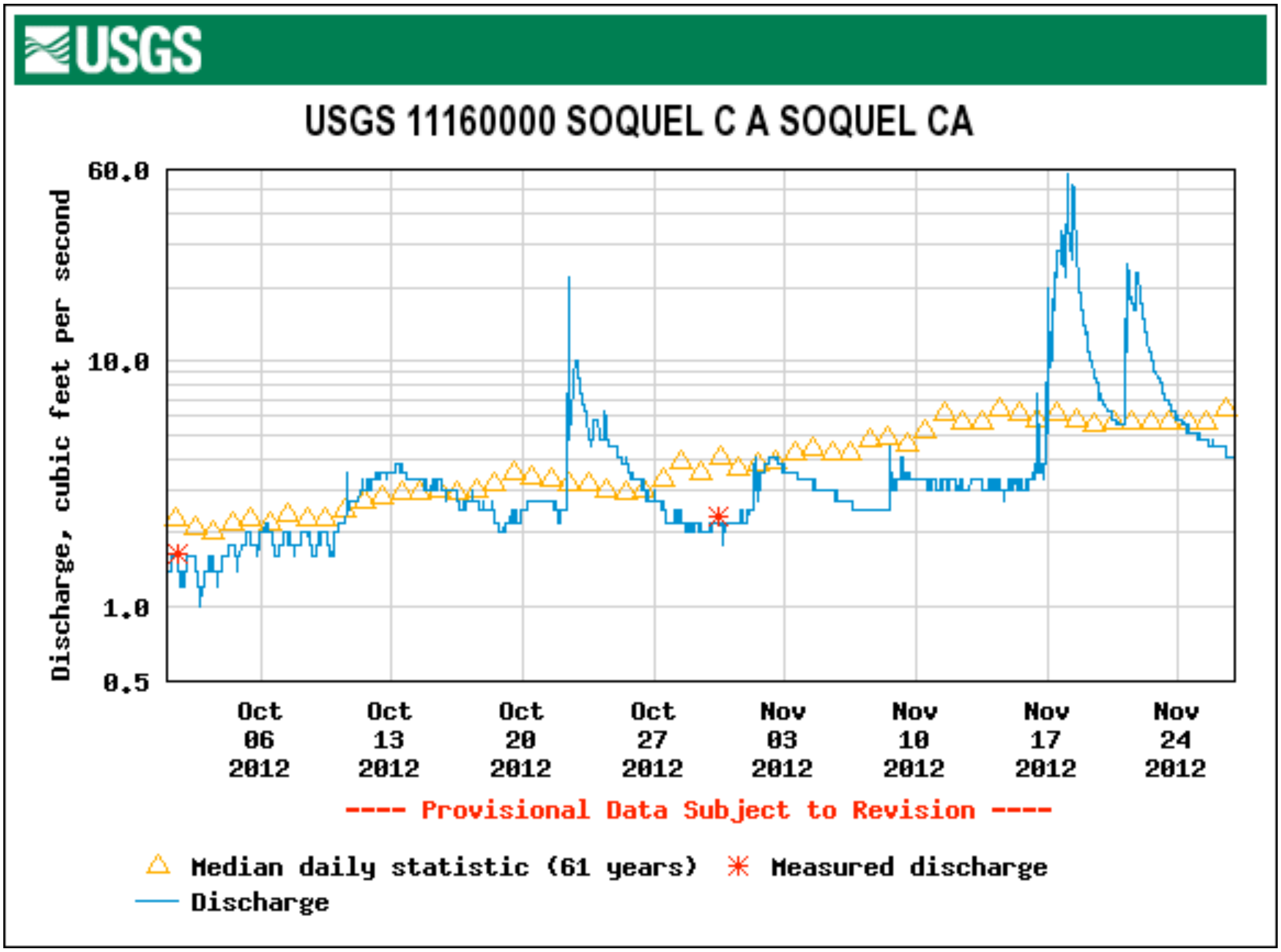


Figure 26. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2011.

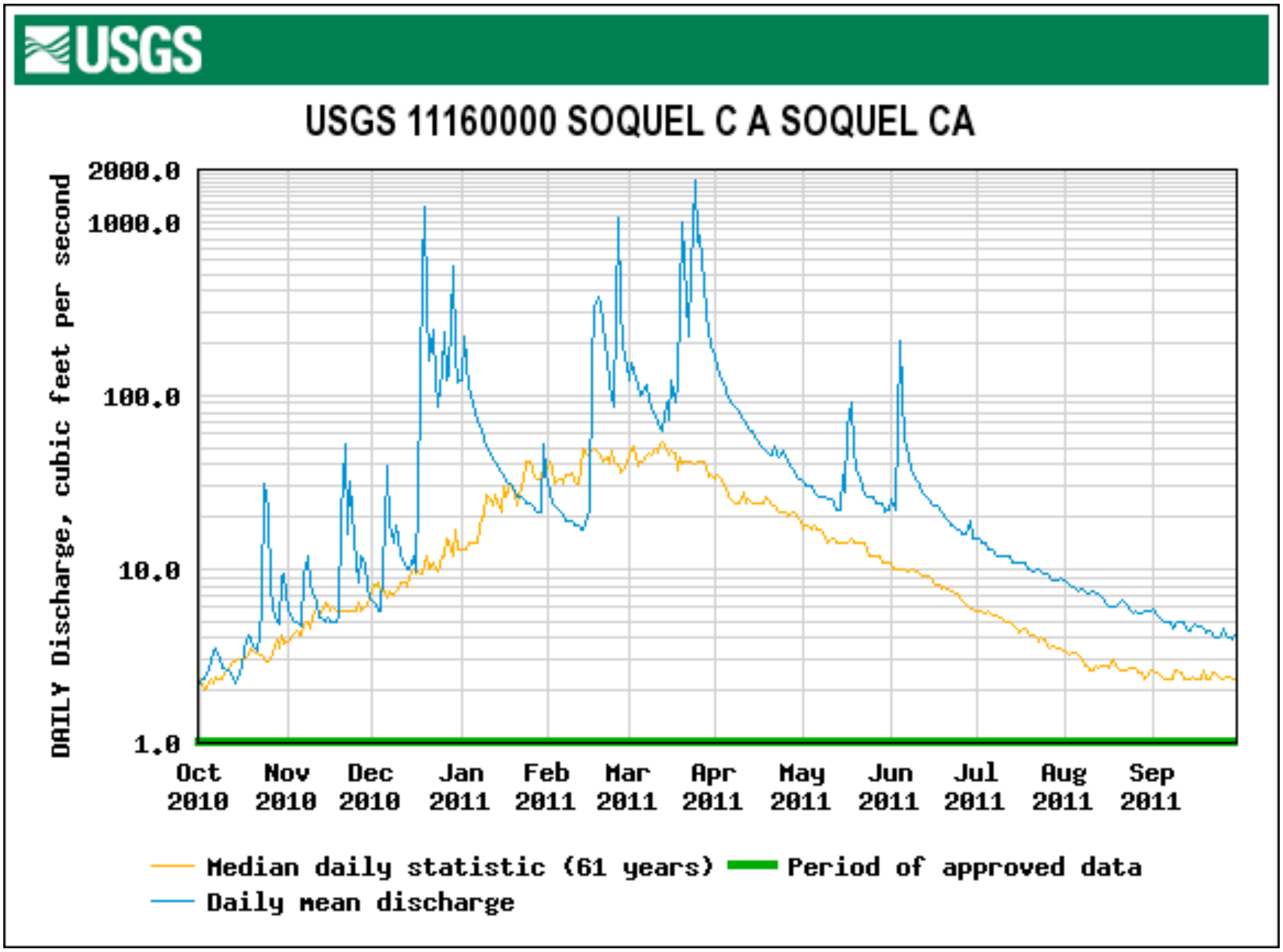


Figure 27. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2010.

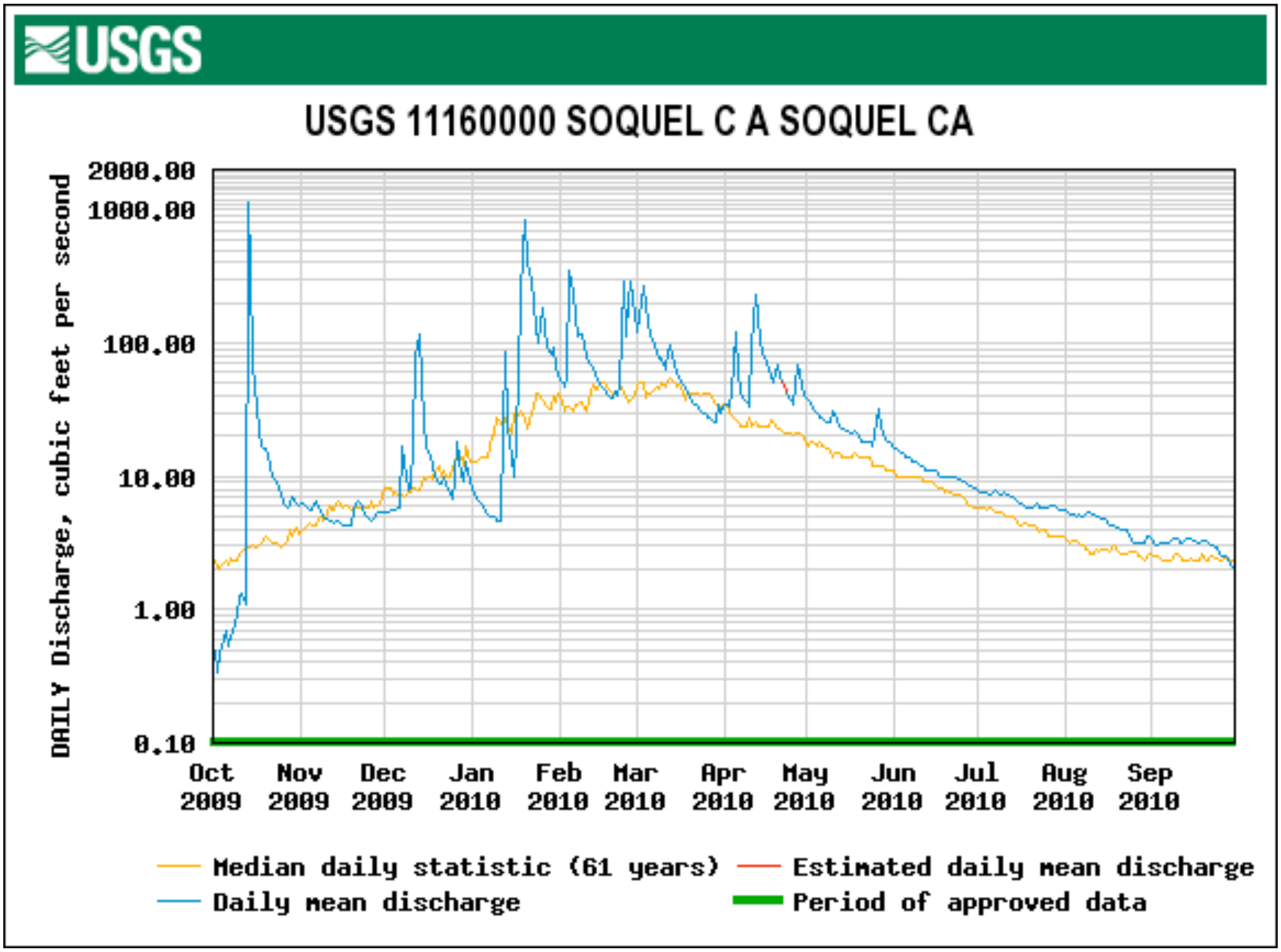


Figure 28. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2009.

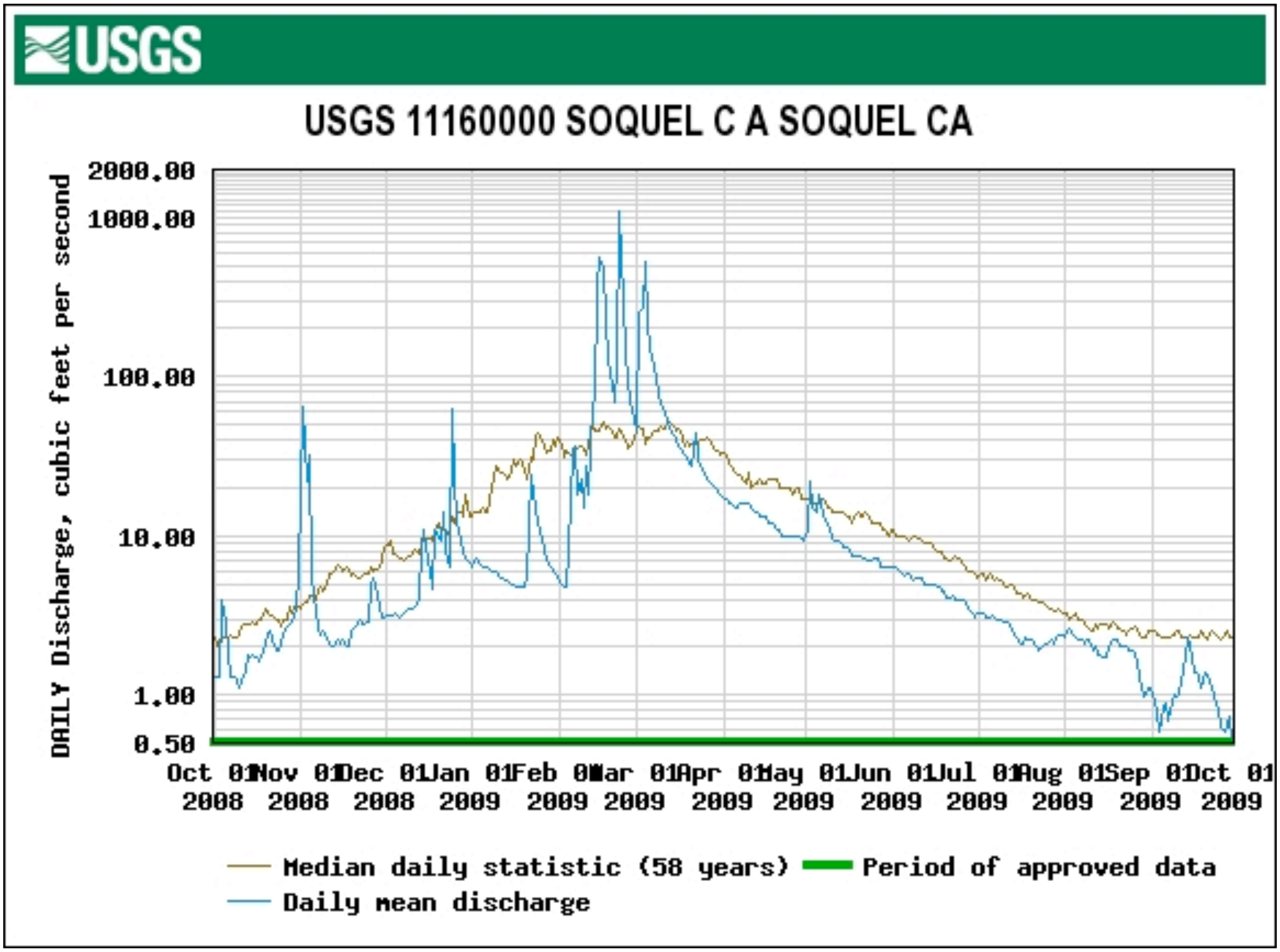


Figure 29. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2008.

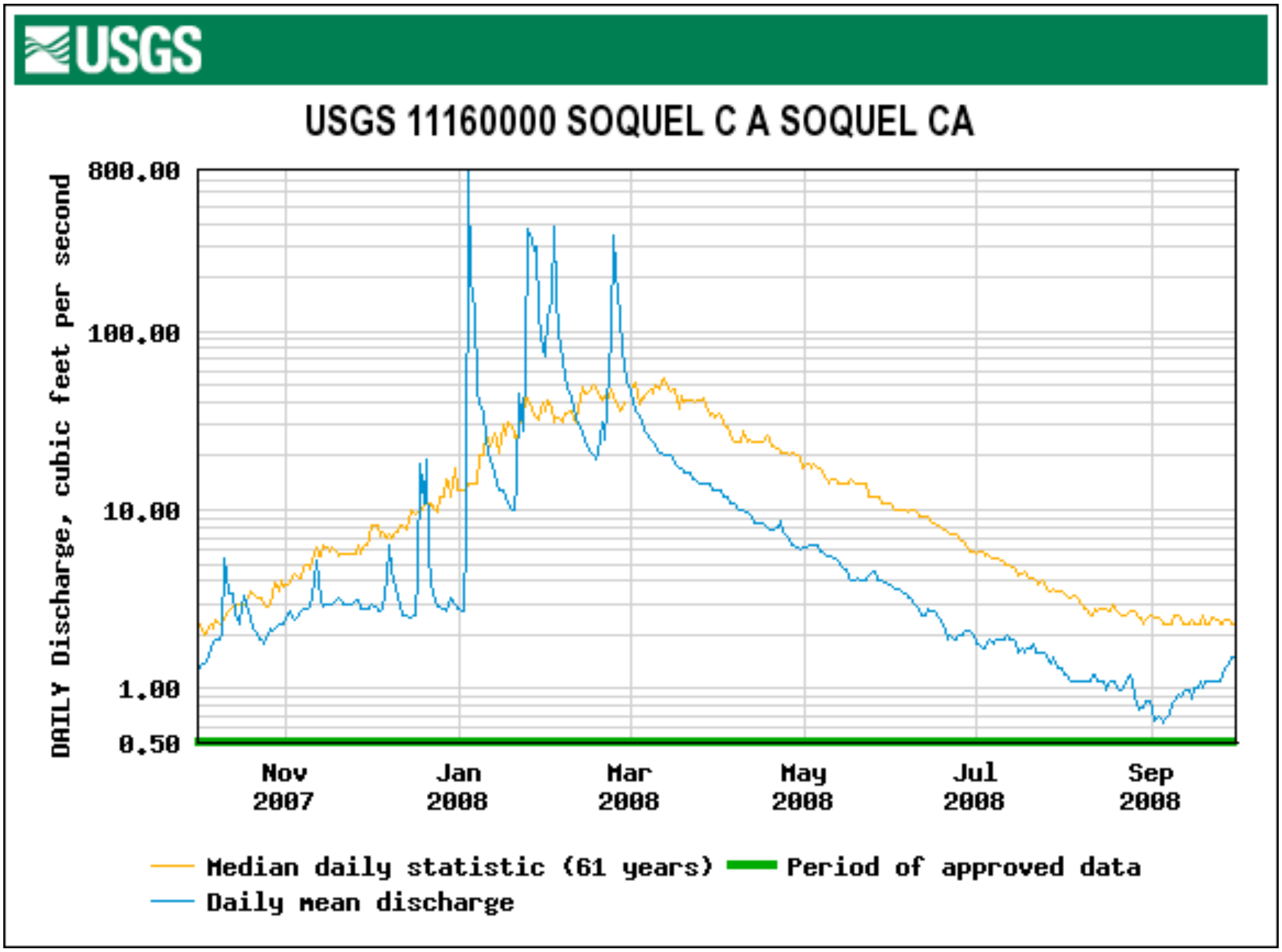
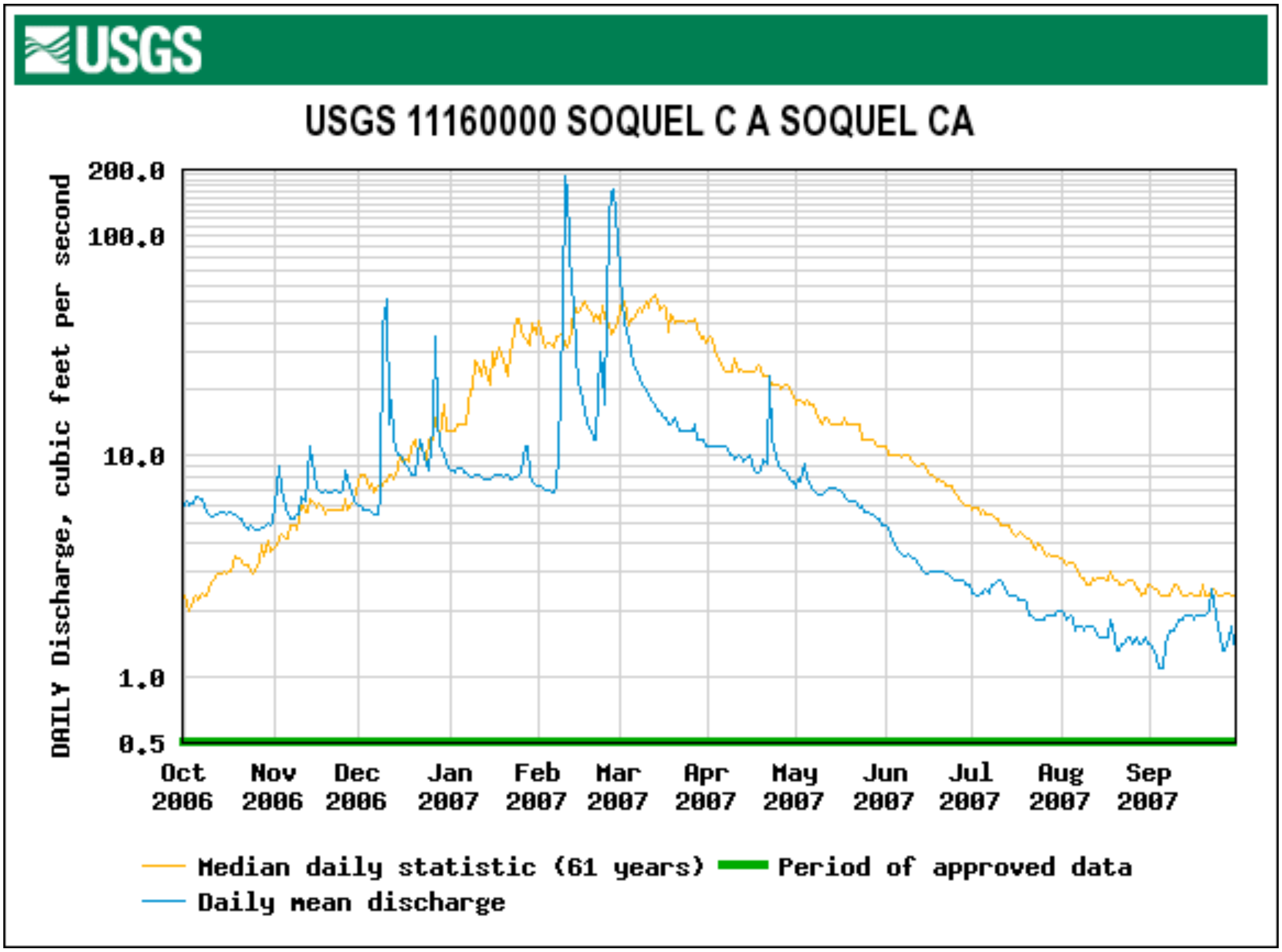


Figure 30. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2007.



APPENDIX A.

WATER QUALITY DATA AND GENERAL OBSERVATIONS OF BIRDS AND AQUATIC VEGETATION
30 MAY – 7 November 2012.

30 May 2012. The sandbar had been closed since 24 May. Temperature probes were launched this day in the lagoon and upstream. Lagoon gage height = 1.57. Water quality was measured at 1810 hr to detect any saline water still present in the lagoon. None was detected under the Stockton Bridge. A small 1 x 1 meter area with partly saline water (11.7 ppt) along the bottom was located adjacent to the Venetian Court wall at 3 meters depth was detected. This was a deep pocket. Two other pockets of similar size registered 3 ppt salinity. Oxygen levels were above 9 mg/L through most of the water column, with it just 1.3 mg/L in the deepest saline pocket. Water temperature was between 16.8 (bottom) and 17.9°C (surface) through the water column. With the continued streamflow at approximately 10 cfs and low salinity in the deep pockets, the fishery biologist recommended that shrouds not be put on the flume inlet and they were not.

			30-May 2012					
	Flume				**Venetian Court Wall** 1810 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	9.32	590
0.25								
0.50								
0.75								
1.00								
1.25								
1.50								
1.75								
2.00								
2.25								
2.50								
2.75								
3.0b					17.6/ 16.9/ 16.8	0.4/ 11.7/ 3.1	9.09/ 4.22/ 3.26	

			5-June 12					
	Flume		0700 hr		**Stockton Avenue Bridge**			0716 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	15.8	0.3	7.49	488	15.5	0.3	7.45	486
0.25	15.9	0.3	7.47	489	15.5	0.3	7.44	486
0.50	15.9	0.3	7.48	491	15.5	0.3	7.44	486
0.75	15.9	0.3	7.48	492	15.5	0.3	7.45	487
1.00	15.9	0.3	7.49	492	15.5	0.3	7.40	487
1.13b	15.8	0.3	7.31	493				
1.25					15.5	0.3	7.34	486
1.50					15.5	0.3	7.29	486
1.63b					15.5	0.3	6.89	489
	Railroad Trestle			0730 hr	**Mouth of Noble Gulch**			0747 hr
Depth	**Temp 3**	**Salin 3**	**O2 3(sat.)**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	15.2	0.3	7.77	552	14.4	0.3	8.38	545
0.25	15.2	0.3	7.76	552	14.4	0.3	8.34	549
0.50	15.2	0.3	7.73	552	14.4	0.3	8.33	549
0.75	15.2	0.3	7.73	553	14.4	0.3	8.35	549
1.00	15.2	0.3	7.67(76%)	553	14.4	0.3	8.30	549
1.25	15.2	0.3	7.24	553	14.4	0.3	8.33	549
1.45b					14.4	0.3	7.58	549
1.50								
1.75								
2.00								

5 June 2012. Gage height of 2.53 in morning. Clear. Air temperature 12.4 C at 0700 hr.
Station 1: Flume at 0700 hr. Reach 1- 1 gull bathing, 3 mallards on Venetian Court beach near lagoon margin. No surface algae.
Station 2: Stockton Avenue Bridge at 0716 hr. Secchi depth to bottom. Reach 2-no birds in water, 3 wild mallards on western trestle abutment. No surface algae.
Station 3: Railroad Trestle at 0730 hr. Reach 3- 2 white domestic ducks in water near adjacent Shadowbrook Restaurants, 3 wild mallards and 1 coot in water below Noble Gulch. No surface algae.
Station 4: Mouth of Noble Gulch at 0747 hr. 1 goose, 2 domestic ducks and 2 pond turtles on downed cottonwood.
Station 5: Nob Hill at 0815 hr. Water temp. = 13.2 C. Oxygen= 9.42 mg/L. (90% sat.), cond.= 471 umhos, salinity= 0.3 ppt. Streamflow 10.5 cfs (gage estimate + 0.5 cfs).

			5-June 2012					
	Flume		1544 hr		**Stockton Avenue Bridge**			1530 hr
Depth	**Temp 1**	**Salin 1**	**O2 1(sat.)**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2(sat.)**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.6	0.3	8.04	576	16.8	0.3	9.13	572
0.25	17.6	0.3	7.95	575	16.8	0.3	9.04	574
0.50	17.6	0.3	8.14	576	16.7	0.3	9.06	574
0.75	17.5	0.3	8.36	578	16.7	0.3	9.00	573
1.00	17.5	0.3	8.41 (87%)	577	16.6	0.3	9.03	572
1.25b	17.5	0.3	8.42	577	16.6	0.3	8.96 (92%)	572
1.50b					16.6	0.3	8.23	572
1.75								
	Railroad Trestle			1515 hr	**Mouth of Noble Gulch**			1500 hr
Depth	**Temp 3**	**Salin 3**	**O2 3(sat.)**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4(sat.)**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	16.7	0.3	9.29	574	16.4	0.3	9.85	574
0.25	16.7	0.3	9.25	573	16.3	0.3	9.79	572
0.50	16.7	0.3	9.32	574	16.1	0.3	10.05	570
0.75	16.7	0.3	9.28	575	15.9	0.3	10.13	568
1.00	16.7	0.3	9.07 (93%)	572	15.8	0.3	9.74 (98%)	568
1.25b	16.7	0.3	9.09	574	15.9	0.3	9.23	567
1.50								

5 June 2012. Gage height of 2.39 in afternoon. 8 inches of screened inlet height. Underwater portal present for adults. Flume inlet depth = 2 ft. Outlet depth = 2 ft. Sunny.
Station 1: Flume at 1544 hr. Air temp. 16.1 C. No surface algae. Reach 1- 74 gulls bathing.
Station 2: Stockton Avenue Bridge at 1530 hr. Secchi depth to bottom. No surface algae. Reach 2- no birds.
Station 3: Railroad Trestle at 1515 hr. Reach 3- 4 mallards and 3 gulls downstream of Noble Gulch. No surface algae.
Station 4: Mouth of Noble Gulch at 1500 hr. Water tea-colored (light rain yesterday). 1 goose, 2 domestic ducks and 1 western pond turtles on cottonwood. One western pond turtle on Golino wood. No gray water.
Station 5: Nob Hill at 1615 hr. Water temp. =16.5. Oxygen= 9.98 mg/L (102% saturation), cond. = 575 umhos. Salinity =0.3 ppt.

			19-June-2012					
	Flume			0706 hr	**Stockton Avenue Bridge**			0725 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	17.3	0.4	9.14	621	17.1	0.4	9.17	614
0.25	17.4	0.4	9.04	620	17.3	0.4	9.10	617
0.50	17.4	0.4	9.06	619	17.3	0.4	9.08	615
0.75	17.2	0.4	9.06	617	17.2	0.4	9.14	615
1.00	17.2	0.4	8.93(93%)	616	17.0	0.4	9.04	612
1.15b	17.2	0.4	8.54	612				
1.25					16.5	0.4	8.99 (92%)	604
1.35b					16.5	0.4	8.25	603
1.50								
1.75b Venetian Wall bottom					16.5	0.4	8.54	602
	Railroad Trestle			0740 hr	**Mouth of Noble Gulch**			0755 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	16.7	0.4	9.20	604	16.1	0.4	7.79	592
0.25	16.7	0.4	9.18	608	16.1	0.4	7.70	595
0.50	16.7	0.4	9.13	606	16.1	0.4	7.67	596
0.75	16.6	0.4	8.65	605	16.0	0.4	7.76 (78%)	596
1.00b	16.5	0.4	8.45 (87%)	602	16.0	0.4	7.01	589
1.10b	16.5	0.4	8.21	602				
1.25								
1.45b								

19 June 2012. Gage height of 2.00 in morning. Cloudy. Air temperature of 12.8°C at 0706 hr. **Station 1:** Flume 0706 hr. Reach 1- 6 gulls bathing, 2 domestic ducks in water, shivering pelican on log. No surface algae.
Station 2: Stockton Bridge 0725 hr. Reach 2 mallards on trestle abutment; no surface algae.
Station 3: Railroad trestle 0740 hr. Reach 3- 5 adult mallards and 4 ducklings. No surface algae.
Station 4: Noble Gulch 0755 hr. 7 mallards and 1 goose roosting on cottonwood. No gray water.
Station 5: **N**ob Hill at 0825 hr. Water temperature 14.9°C. Conductivity 563 umhos. Salinity 0.3 ppt. Oxygen 8.80 mg/l (87% saturation). 9.4 cfs (gage estimate + 0.5 cfs). 2 mallards present.

			19 June 2012					
	Flume			1545 hr	**Stockton Avenue Bridge**			1530 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.7	0.4	9.65	632	18.7	0.4	9.37	631
0.25	18.7	0.4	9.71	630	18.7	0.4	9.34	632
0.50	18.6	0.4	9.62	630	18.7	0.4	9.23	632
0.75	18.6	0.4	9.61	629	18.7	0.4	9.30	632
1.00	18.6	0.4	9.62 (103%)	630	18.6	0.4	9.27	631
1.25b	18.6	0.4	9.28	629	18.6	0.4	9.38 (99%)	631
1.37b					18.5	0.4	8.88	630
1.50								
1.75								
	Railroad Trestle			1517 hr	**Mouth of Noble Gulch**			1506 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	9.83	628	18.9	0.4	9.48	641
0.25	18.4	0.4	9.78	629	18.7	0.4	9.42	636
0.50	18.4	0.4	9.78	629	18.6	0.4	9.39	630
0.75	18.4	0.4	9.80	629	18.1	0.4	9.84(105%)	628
1.00	18.4	0.4	9.78 (104%)	628	17.8	0.4	9.95	620
1.10b	18.4	0.4	9.20	628				
1.25								
1.50								

19 June 2012. Gage height of 2.15 in afternoon. Clear and breezy. Air temperature of 16.6^{o}C at 1545 hr. Flume inlet = 1.2 ft. Flume outlet = 1.0 ft

Station 1: Flume 1545 hr. Reach 1- 12 gulls bathing. Bottom algae 10% coverage, avg thickness = 0.2 ft; range 0.1-0.5 ft thick. Phytoplankton bloom present. No surface algae.

Station 2: Stockton Bridge 1530 hr. Reach 2- 3 adult mallards and 3 ducklings, 5 gulls. Bottom algae 30% coverage; avg. thickness = 02 ft; range of 0.1-1.0 ft; no surface algae.

Station 3: Railroad trestle 1517 hr. Reach 3- 41 adult mallards and 1 duckling, 3 domestic ducks, 1 coot and 2 gulls. Bottom algae 60% coverage; avg thickness = 0.4 ft; range of 0.1 to 1.0 ft. No surface algae.

Station 4: Noble Gulch 1506 hr. 1 mallard, 1 western pond turtle and 1 goose roosting on cottonwood. 1 WPT on Golino wood. Bottom algae 60% coverage; avg. thickness = 0.4 ft; range = 0.2 to 0.8 ft. No gray water.

Station 5: **N**ob Hill at 1628 hr. Water temperature 17.6^{o}C. Conductivity 604 umhos. Salinity 0.3 ppt. Oxygen 9.71 mg/l (102% saturation).

			3 July 2012					
	Flume 0700 hr				**Stockton Avenue Bridge** 0715hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	20.1	0.4	9.32	671	19.9	0.4	9.49	667
0.25	20.2	0.4	9.43	672	20.0	0.4	9.36	668
0.50	20.2	0.4	9.43	673	20.0	0.4	9.34	668
0.75	20.2	0.4	9.45	672	20.0	0.4	9.35	668
1.00	20.3	0.4	9.42(104%)	671	19.9	0.4	8.79	668
1.13b	20.1	0.4	8.97	670				
1.25					19.6	0.4	8.10 (89%)	668
1.37b					19.5	0.4	7.59	661
1.50								
	Railroad Trestle 0736hr				**Mouth of Noble Gulch**			0753hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.4	0.4	8.64	659	17.9	0.4	7.68	632
0.25	19.4	0.4	8.60	660	18.0	0.4	7.65	633
0.50	19.4	0.4	8.72	659	18.0	0.4	7.64	634
0.75	19.2	0.4	7.86	659	18.0	0.4	7.61	634
1.00	19.1	0.4	7.83 (85%)	658	17.9	0.4	7.58 (80%)	634
1.20b	19.1	0.4	7.21	658				
1.25					17.7	0.4	6.85	636
1.50								

3 July 2012. Gage height of 2.27 in morning. Partly cloudy. Air temp. = 13.8°C at 0700 hr.
Station 1: Flume 0700 hr. Reach 1- No gulls bathing. 1 mallard with 1 duckling. No surface algae.
Station 2: Stockton Bridge 0715 hr. Reach 2-8 mallards, 2 domestic ducks; 5% surface algae.
Station 3: Railroad trestle 0736 hr. Reach 3- 5 adult mallards and 1 duckling. 1 mallard and 1 gull on redwood log. 1 coot on Golino wood. 25% surface algae downstream of Noble Gulch and 3% above. Raft of algae 120 ft x 50 ft downstream of Noble Gulch. Largest ever observed.
Station 4: Noble Gulch 0753 hr. 6 mallards, 1 merganser and 1 goose roosting on cottonwood. No gray water. 1 black-crowned night heron in standing cottonwood.
Station 5: Nob Hill at 0820 hr. Water temperature 16.6°C. Conductivity 604 umhos. Salinity 0.4 ppt. Oxygen 8.35 mg/l (85% saturation). 6.0 cfs estimate (gage estimate + 0.5 cfs).

			3 July 2012					
	Flume			1613 hr	**Stockton Avenue Bridge**			1548 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	21.0	0.4	10.27	679	21.6	0.4	10.32	689
0.25	21.1	0.4	11.12	679	21.6	0.4	10.14	689
0.50	21.1	0.4	10.98	679	21.4	0.4	9.83	686
0.75	20.8	0.4	11.41	674	21.1	0.4	10.12	682
1.00	20.8	0.4	11.43 (128%)	673	20.9	0.4	10.54	680
1.25b	20.8	0.4	10.95	673	20.7	0.4	10.05(111%)	677
1.50b					20.6	0.4	8.26	664
1.75								
	Railroad Trestle			1522 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	22.0	0.4	9.56	694	21.7	0.4	9.28	696
0.25	21.8	0.4	9.61	694	21.5	0.4	9.08	691
0.50	21.5	0.4	9.55	689	21.0	0.4	8.85	687
0.75	21.4	0.4	10.33	682	19.4	0.4	10.82	662
1.00	20.6	0.4	10.30 (115%)	673	19.3	0.4	10.72 (117%)	657
1.10b					19.5	0.4	10.35	657
1.15b	20.5	0.4	9.56	673				
1.25								
1.50								

3July 2012. Gage height of 2.26 in afternoon. Sunny. Air temperature of 18.2°C at 1613 hr. Flume inlet approx. 1.0 ft depth. Flume exit depth 1.0 ft.
Station 1: Flume at 1613 hr. Reach 1- Bottom algae 90% coverage, 0.2-3.0 ft thick; avg. 1.0 ft. Remainder film. 2% surface algae. 28 gulls bathing.
Station 2: Stockton Avenue Bridge at 1548 hr. Secchi depth to bottom. Reach 2% surface algae, 100% of bottom covered with algae, 0.2- 3.0 ft thick, averaging 0.7 ft. Remainder film. No birds.
Station 3: Railroad Trestle at 1522 hr. Reach 3- 5% surface algae, 100% of bottom covered with algae. 0.2-2.5 ft thick, averaging 0.4 ft. 5 mallards and 2 white domestic ducks in water upstream of Noble Gulch.
Station 4: Mouth of Noble Gulch at 1500 hr. No gray water was entering lagoon from Noble Gulch. 1 mallard, 1 WPT, 1 goose, 1 merganser and 1 domestic duck roosting on downed cottonwood. 15% surface algae. Bottom algae 0.2-2.5 ft thick; avg. = 0.4 ft.
Station 5: Nob Hill at 1652 hr. Water temperature 19.0°C. Conductivity 634 umhos. Salinity 0.4 ppt. Oxygen 9.35 mg/l (101% saturation).

			16-July-12					
	Flume 0700 hr				**Stockton Avenue Bridge** 0718 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	18.6	0.4	9.81	657	18.3	0.4	10.34	648
0.25	18.6	0.4	10.02	657	18.3	0.4	10.32	650
0.50	18.6	0.4	10.5	657	18.3	0.4	10.15	650
0.75	18.6	0.4	10.09	657	18.2	0.4	10.09	650
1.00	18.6	0.4	10.04 (108%)	657	18.2	0.4	9.69	649
1.20b	18.6	0.4	9.39	656				
1.25					18.0	0.4	8.52 (90%)	649
1.40b					18.0	0.4	8.21	648
1.50								
1.75								
2.00								
			16-July-12					
	Railroad Trestle 0745 hr				**Mouth of Noble Gulch**			0758 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	8.76	647	17.3	0.4	9.62	625
0.25	18.1	0.4	8.96	648	17.3	0.4	9.39	631
0.50	18.1	0.4	8.78	648	17.1	0.4	8.97	626
0.75	17.9	0.4	7.56	650	16.7	0.4	7.33	608
1.00	17.8	0.4	7.15 (75%)	654	16.8	0.4	6.25 (65%)	647
1.10b					16.8	0.4	5.64	649
1.15b	17.8	0.4	6.82	654				
1.25								
1.50								

16 July 2012. Gage height of 2.10 in morning. Overcast/misty. Air temperature of 16.7°C at 0700 hr.
Station 1: Flume at 0700 hr. Reach 1- 7gulls. No surface algae.
Station 2: Stockton Avenue Bridge at 0718 hr. Secchi depth to bottom. Reach 2- No birds or surface algae.
Station 3: Railroad Trestle at 0745 hr. Reach 3- 7 adult mallards and 1 duckling in water. No surface algae. 33 surface steelhead hits/ minute while feeding.
Station 4: Mouth of Noble Gulch at 0758 hr. No gray water. 1 goose and 7 mallards and on downed cottonwood. 1 mallard on upstream redwood stump. 2 gulls, 1 coot and 1 mallard on redwood log near Mader's. Thick phytoplankton bloom. No surface algae.
Station 5: Nob Hill at 0826 hr. Water temperature 15.7° C. Conductivity 597 umhos. Oxygen 8.47 mg/l (85% saturation). Salinity 0.4 ppt. Estimated streamflow = 4.8 cfs.

			16-July-12					
	Flume 1400 hr				**Stockton Avenue Bridge** 1535 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	19.0	0.4	11.02	656	19.0	0.4	10.53	659
0.25	19.1	0.4	11.50	656	18.8	0.4	10.43	658
0.50	19.0	0.4	11.49	656	18.8	0.4	10.32	657
0.75	18.7	0.4	12.25 (131%)	652	18.7	0.4	10.73	656
1.00b	18.7	0.4	11.50	651	18.4	0.4	10.92	650
1.25					18.0	0.4	11.59 (123%)	643
1.40b					18.0	0.4	10.82	642
1.50								
1.55b								
1.75								
2.00								
			16-July-12					
	Railroad Trestle 1520 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	19.0	0.4	10.73	659	18.5	0.4	11.89	659
0.25	18.9	0.4	10.78	658	18.5	0.4	12.19	649
0.50	18.8	0.4	12.13	656	17.7	0.4	11.19	627
0.75	18.3	0.4	13.3	650	17.3	0.4	9.86	622
1.00	18.0	0.4	13.10 (139%)	643	17.2	0.4	10.10 (105%)	630
1.15b					17.3	0.4	9.46	632
1.25b	18.0	0.4	11.57	643				
1.50								

16 July 2012. Gage height of 2.10 in afternoon. Partly cloudy and cool. Air temp. = 16.1^{o} C at 1400 hr.
Station 1: Flume at 1400 hr. Reach 1- 39 gulls and 2 pelicans bathing. No surface algae. 70% of bottom covered with algae 0.2 – 4.0 ft thick, averaging 1.0 ft. 30% film on remainder.
Station 2: Stockton Avenue Bridge at 1535 hr. Secchi depth to bottom. Reach 2- No surface algae. 40% of the bottom algae 0.2 – 2.0 ft thick, averaging 0.5 ft. 60% film remainder. 2 gulls.
Station 3: Railroad Trestle at 1520 hr. Reach 3- No surface algae. 90% of bottom covered with algaie 0.5 – 3 ft thick, avg = 1.0 ft. <1% pondweed + algae 2 ft thick. 22 mallards (18 swam out of Noble Gulch culvert) and 1 duckling, 1 coot, 2 domestic ducks below Noble Gulch, 2 domestic white ducks adjacent Shadowbrook Restaurant and 1 pied billed grebe in water.
Station 4: Mouth of Noble Gulch at 1500 hr. Thick phytoplankton bloom (bottom invisible). No surface algae. 2 mallards roosting on downed cottonwood.
Station 5: Nob Hill at 1650 hr. Water temperature 16.4 ^{o}C. Conductivity 601 umhos. Oxygen 9.98 mg/l (102% saturation). Salinity 0.4 ppt.

			1-Aug-12					
	Flume 0702 hr				**Stockton Avenue Bridge** 0716 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	19.0	0.4	8.84	679	18.9	0.4	8.82	676
0.25	19.1	0.4	8.95	681	18.9	0.4	8.78	676
0.50	19.1	0.4	8.97	681	18.9	0.4	8.77	677
0.75	19.1	0.4	8.89	681	19.0	0.4	8.66	677
1.00	19.1	0.4	8.85 (96%)	680	19.0	0.4	8.66	677
1.05b	19.1	0.4	8.36	680				
1.25					19.0	0.4	8.59 (93%)	677
1.50b					19.0	0.4	8.25	677
1.75								
2.00								

			1-Aug-12					
	Railroad Trestle 0733 hr				**Mouth of Noble Gulch** 0748 hr			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	18.7	0.4	7.26	674	18.1	0.4	7.70	651
0.25	18.8	0.4	7.29	676	18.0	0.4	7.81	658
0.50	18.8	0.4	7.23	677	18.0	0.4	7.83	658
0.75	18.8	0.4	7.28	677	18.0	0.4	7.58	658
1.00	18.8	0.4	7.31 (79%)	677	17.3	0.4	6.66 (69%)	617
1.20b					17.2	0.4	5.86	641
1.25	18.8	0.4	6.83	677				
1.50								

1 August 2012. Gage height of 2.45 (morning) and 2.48 (afternoon). Clear at 0702 hr with air temperature of 13.2 ^{o}C. Air temperature 17.4º C at 1555 hr and clear. Flume inlet 1.0 ft. Flume outlet 0.8 ft in afternoon.

Station 1: Flume at 0702 hr. Reach 1- 17 gulls bathing, 1 mallard, 1 pied billed grebe. No surface algae.
Station 2: Stockton Avenue Bridge at 0716 hr. Secchi depth to the bottom. Reach 2-1 mallard, No surface algae.
Station 3: Railroad trestle at 0733 hr. Reach 3- 7 mallards, 2 domestic ducks near Noble Gulch. No surface algae. 60 steelhead surface hits/min @ 0800 hr.
Station 4: Mouth of Noble Gulch at 0748 hr. No surface algae. 7 mallards, 1 goose on downed cottonwood.
Station 5: Nob Hill at 0815 hr. Water temperature at 15.8°C. Conductivity 609 umhos, Oxygen 7.97 mg/l (80% saturation). Salinity 0.4 ppt. Estimated streamflow = 3.4 cfs.

1555 hr			1-Aug-12					1539 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	19.9	0.4	11.46	689	20.1	0.4	10.28	690
0.25	19.9	0.4	11.15	688	20.2	0.4	10.43	693
0.50	19.9	0.4	11.26	687	20.1	0.4	10.49	692
0.75	19.8	0.4	10.56	687	19.8	0.4	10.23	689
1.00	19.9	0.4	10.87 (120%)	687	19.8	0.4	9.98	688
1.05b	19.8	0.4	10.57	687				
1.25					19.6	0.4	10.44 (114%)	685
1.50b					19.6	0.4	9.97	684
1.75								
2.00								
1525hr			1-Aug-12					1505 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	20.1	0.4	10.34	693	19.6	0.4	9.56	689
0.25	19.9	0.4	10.26	693	19.5	0.4	9.60	684
0.50	19.8	0.4	10.38	689	19.4	0.4	9.61	682
0.75	19.5	0.4	10.78	686	19.1	0.4	9.22	679
1.00	19.1	0.4	10.97 (118%)	680	18.5	0.4	10.91 (116%)	666
1.20b					18.6	0.4	12.83	657
1.25b	18.9	0.4	10.45	674				

Station 1: Flume at 1555 hr. Reach 1- 2 mallards, 40 gulls. 1 gull on log. No surface algae. 90% bottom algal coverage 0.2- 1.5 ft thick, avg. = 0.4 ft.
Station 2: Stockton Avenue Bridge at 1539 hr. Secchi depth to the bottom. Reach 2- No surface algae. 99% of bottom covered by algae 0.2 – 2 ft thick, averaging 0.4 ft. 1% pondweed + algae 1 ft thick near trestle. No waterfowl.
Station 3: Railroad trestle at 1525 hr. Reach 3- No surface algae. 99% of bottom covered by algae 0.1- 2 ft thick, averaging 0.2 ft. 1% pondweed + algae 2 ft thick near trestle. 13 mallards and 2 domestic ducks dabbling near Noble Gulch; 2 gulls near Mader log.
Station 4: Mouth of Noble Gulch at 1505 hr. No surface algae. 100% of bottom covered by algae 0.1 - 1 ft thick, averaging 0.2 ft. 1 goose on downed cottonwood. No gray water.
Station 5: Nob Hill at 1643 hr. Water temperature at 17.3°C. Conductivity 625 umhos, Oxygen 9.73 mg/l. Salinity 0.4 ppt.

			14-Aug-12					
	Flume 0707 hr				**Stockton Avenue Bridge** 0723 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	19.8	0.4	9.44	696	19.6	0.4	9.67	686
0.25	19.8	0.4	9.52	697	19.7	0.4	9.48	692
0.50	19.8	0.4	9.58	697	19.7	0.4	9.32	692
0.75	19.8	0.4	9.55 (105%)	696	19.7	0.4	9.42	691
1.00b	19.8	0.4	9.19	696	19.7	0.4	9.41	691
1.25					19.7	0.4	9.58 (103%)	692
1.35b					19.7	0.4	9.11	691
1.50								
1.75								
2.00								

			14-Aug-12					
	Railroad Trestle 0740 hr				**Mouth of Noble Gulch** 0752 hr			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	19.6	0.4	8.38	686	18.8	0.4	8.40	675
0.25	19.7	0.4	7.76	693	18.8	0.4	8.28	675
0.50	19.7	0.4	8.07	693	18.8	0.4	8.29	675
0.75	19.7	0.4	8.24	693	18.3	0.4	8.07	674
1.00	19.7	0.4	8.19 (90%)	693	17.8	0.4	8.19 (90%)	657
1.10b					17.7	0.4	7.72	683
1.25b	19.7	0.4	7.72	694				
1.50								

<u>14 August 2012.</u> Gage height of 2.21 (morning) and 2.21 (afternoon). Overcast/breezy at 0707 hr with air temperature of 14.4 ^{o}C. Air temperature 18.0º C at 1640 hr and clear. Flume inlet 1.0 ft. Flume outlet 1.0 ft in afternoon.

Station 1: Flume at 0707 hr. Reach 1- 21 gulls bathing, 1 pelican, 1 pied billed grebe. No surface algae. 7 steelhead hits/min at 0720 hr.
Station 2: Stockton Avenue Bridge at 0723 hr. Secchi depth to the bottom. Reach 2-4 mallards, 1 goose moved down from downed cottonwood. No surface algae.
Station 3: Railroad trestle at 0740 hr. Reach 3- 1 mallard, 1 pied billed grebe in water. No surface algae. Light steelhead surface hits.
Station 4: Mouth of Noble Gulch at 0752 hr. No surface algae. 7 mallards, 1 goose on downed cottonwood; goose limping badly. 3 mallards and 1 coot on Golino wood. 1 mallard on Mader log.
Station 5: Nob Hill at 0815 hr. Water temperature at 16.1°C. Conductivity 612 umhos, Oxygen 7.69 mg/l (78% saturation). Salinity 0.4 ppt. Estimated streamflow = 2.7 cfs.

1640 hr			14-Aug-12					1625 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	21.2	0.4	10.65	709	21.1	0.4	10.35	711
0.25	21.2	0.4	10.92	710	21.2	0.4	`0.23	712
0.50	21.2	0.4	10.94	711	21.1	0.4	10.22	711
0.75	21.2	0.4	11.13 (125%)	709	21.1	0.4	10.25	711
1.00 b	21.2	0.4	10.92	708	21.0	0.4	10.10	710
1.25					20.9	0.4	9.94 (111%)	709
1.35b					20.8	0.4	9.66	708
1.50								
1.75								
2.00								
1607hr			14-Aug-12					1550 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	21.1	0.4	12.31	706	21.5	0.4	9.67	718
0.25	21.2	0.4	12.18	707	21.1	0.4	9.64	716
0.50	21.1	0.4	12.50	707	20.9	0.4	9.86	712
0.75	20.9	0.4	11.84	705	19.9	0.4	13.10	693
1.00	20.5	0.4	10.95 (119%)	702	19.2	0.4	13.64 (148%)	647
1.10b					19.3	0.4	13.28	640
1.15b	20.0	0.4	9.13	696				

Station 1: Flume at 1640 hr. Reach 1- 52 gulls. 1 gull on log. No surface algae. 80% bottom algal coverage 0.1- 0.3 ft thick, avg. = 0.2 ft. 10% pondweed + algaie 0.5 – 2 ft thic; averaging 1.5 ft.
Station 2: Stockton Avenue Bridge at 1525 hr. Secchi depth to the bottom. Reach 2- No surface algae. 85% of bottom covered by algae 0.1 – 2 ft thick, averaging 0.3 ft. 15% pondweed + algae 0.3 – 1.5 ft thick, averaging 0.8 ft. No waterfowl.
Station 3: Railroad trestle at 1607 hr. Reach 3- No surface algae. 85% of bottom covered by algae 0.1- 2 ft thick, averaging 0.3 ft. 15% pondweed + algae 0.3 – 2.0 ft thick, averaging 0.8 ft. 9 mallards, 1 domestic duck, 1 gull in water. 1 gull on wood beneath trestle.
Station 4: Mouth of Noble Gulch at 1550 hr. No surface algae. 80% of bottom covered by algae 0.1 - 2 ft thick, averaging 0.5 ft. 3 mallards and 1 western pond turtle on downed cottonwood; 2 WPT on Golino wood. 1 gull on Mader log. No gray water.
Station 5: Nob Hill at 1715 hr. Water temperature at 17.6°C. Conductivity 630 umhos, Oxygen 9.39 mg/l (98% saturation). Salinity 0.4 ppt.

			29-Aug-12					
	Flume 0755 hr				**Stockton Avenue Bridge** 0808 hr			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 umhos**
0.00	19.0	0.4	10.01	671	19.0	0.4	9.55	667
0.25	19.0	0.4	10.35	671	19.0	0.4	9.48	671
0.50	19.0	0.4	10.36	671	19.0	0.4	9.52	671
0.75	19.0	0.4	10.26	671	19.0	0.4	9.54	671
1.00	19.0	0.4	10.11 (109%)	671	19.0	0.4	9.47	670
1.07b	19.0	0.4	9.78	671				
1.25					19.0	0.4	9.47	670
1.50					19.0	0.4	9.50 (103%)	670
1.55b					19.0	0.4	9.46	670
1.75								

			29-Aug-12					
	Railroad Trestle 0823 hr				**Mouth of Noble Gulch** 0840 hr			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	18.9	0.4	8.43	671	18.4	0.4	8.49	658
0.25	18.9	0.4	8.28	672	18.4	0.4	8.30	659
0.50	18.9	0.4	8.33	672	18.4	0.4	8.38	658
0.75	18.9	0.4	8.28	672	18.4	0.4	8.36	659
1.00	18.9	0.4	8.31 (89%)	672	18.4	0.4	8.28 (88%)	659
1.15b					18.4	0.4	6.06	659
1.25b	18.9	0.4	8.08	672				
1.50								

29 August 2012. Gage height of 2.55 (morning) and 2.60 (afternoon). Clear then overcast in morning. At 0755 hr- air temperature of 12.7 ^{o}C. Air temperature 16.9º C at 1555 hr and clear/breezy. Flume inlet 1.0 ft. Flume outlet 0.8 ft in afternoon.

Station 1: Flume at 0755 hr. Reach 1- 8 gulls bathing. No surface algae.
Station 2: Stockton Avenue Bridge at 0808 hr. Secchi depth to the bottom. Reach 2-2 domestic ducks, 4 mallards roosting on trestle abutment. No surface algae.
Station 3: Railroad trestle at 0823 hr. Reach 3- 2 mallards, 2 pied billed grebes and 1 coot in water. Surface algae < 1%.
Station 4: Mouth of Noble Gulch at 0840 hr. 2% surface algae. 8 mallards + 1 goose on downed cottonwood; 1 merganser on Golino wood. 1 mallard on redwood stump nearer Shadowbrook Restaurant.
Station 5: Nob Hill at 0913 hr. Water temperature at 16.1°C. Conductivity 604 umhos, Oxygen 7.99 mg/l. Salinity 0.4 ppt. Estimated streamflow = 2.1 cfs.

1555 hr			29-Aug-12					1532 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	20.2	0.4	11.07	683	20.7	0.4	10.71	692
0.25	20.2	0.4	11.47	683	20.6	0.4	10.89	690
0.50	20.2	0.4	11.68	683	20.5	0.4	10.91	689
0.75	20.2	0.4	11.79 (131%)	683	20.5	0.4	10.91	688
1.00 b	20.2	0.4	11.74	683	20.4	0.4	10.50	688
1.25					20.2	0.4	10.41 (115%)	685
1.50					20.1	0.4	10.43	685
1.55b					20.1	0.4	8.63	684
1.75								
1519 hr			29-Aug-12					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	21.0	0.4	11.17	694	21.3	0.4	9.71	707
0.25	21.1	0.4	11.26	694	21.1	0.4	10.03	704
0.50	20.9	0.4	11.37	692	20.9	0.4	9.90	700
0.75	20.8	0.4	11.38	691	20.3	0.4	10.41	696
1.00	20.1	0.4	13.52 (150%)	684	19.4	0.4	11.19 (121%)	674
1.15b					19.4	0.4	13.98	676
1.25b	19.4	0.4	9.82	682				

Station 1: Flume at 1555 hr. Reach 1- 94 gulls, 3 pelicans, 1 mallard. 3 gull on log. No surface algae. 70% bottom algal coverage 0.2- 2.0 ft thick, avg. = 0.4 ft. 25% pondweed + algae 1.0 – 3.5 ft thick; averaging 2.5 ft.
Station 2: Stockton Avenue Bridge at 1532 hr. Secchi depth to the bottom. Reach 2- No surface algae. 85% of bottom covered by algae 0.2 – 2 ft thick, averaging 0.3 ft. 15% pondweed + algae 1.0 – 3.5 ft thick, averaging 2.5 ft. 1 pied billed grebe, 1 gull.
Station 3: Railroad trestle at 1519 hr. Reach 3- No surface algae. 80% of bottom covered by algae 0.2- 1 ft thick, averaging 0.4 ft. 20% pondweed + algae 1.0 – 3.5 ft thick, averaging 2.5 ft (thick under trestle) 16 mallards, 1 pied billed grebe. Mallards appeared later- may have been inside Noble Gulch culvert.
Station 4: Mouth of Noble Gulch at 1509 hr. 10% surface algae. 70% of bottom covered by algae 0.3 - 2 ft thick, averaging 0.5 ft. 5 mallards, 2 domestic ducks, 1 merganser and 1 western pond turtle on downed cottonwood; 1 WPT on Golino wood. No gray water.
Station 5: Nob Hill at 1635 hr. Water temperature at 17.4°C. Conductivity 617 umhos, Oxygen 8.88 mg/l. Salinity 0.4 ppt.

0934 hr	Begonia	Festival	02-Sep-12		Begonia	Festival		1000 hr
	Mouth of Noble Gulch				**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	17.8	0.4	7.59	656	18.8	0.4	9.17	649
0.25	17.8	0.4	7.62	656	18.9	0.4	9.13	649
0.50	17.8	0.4	7.50	656	18.8	0.4	9.08	649
0.75	17.8	0.4	7.53	655	18.7	0.4	9.11	648
1.00	17.7	0.4	7.73 (84%)	654	18.7	0.4	9.04	648
1.17b	17.7	0.4	6.69	674				
1.25					18.7	0.4	9.03 (96%)	649
1.50					18.7	0.4	8.57	650
1.55b					18.8	0.4	8.41	650
			02-Sep-12					
0946 hr	**Railroad Trestle**				**Flume**			1019 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	18.5	0.4	8.89	648	19.0	0.4	9.41	651
0.25	18.5	0.4	8.76	648	19.0	0.4	9.41	650
0.50	18.5	0.4	8.73	648	18.9	0.4	9.48	649
0.75	18.5	0.4	8.58	648	18.9	0.4	9.45	649
1.00	18.5	0.4	8.60 (92%)	648	18.9	0.4	9.53 (103%)	649
1.10b					18.9	0.4	9.60	649
1.20b	18.5	0.4	7.67	649				
			2-Sep-12					1445 hr
1502 hr	**Mouth of Noble Gulch**				**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	19.7	0.4	10.18		19.7	0.4	10.59	
0.25	19.8	0.4	10.31		19.7	0.4	10.57	
0.50	19.7	0.4	10.35		19.7	0.4	10.63	
0.75	19.6	0.4	10.75		19.6	0.4	10.47	
1.00	19.5	0.4	12.78 (137%)		19.6	0.4	10.42	
1.15b	19.6	0.4	15.48					
1.25					19.6	0.4	10.35	
1.50					19.5	0.4	10.52 (116%)	
1.75b					19.6	0.4	11.58	

02 September 2012. Begonia Festival Day. Gage height of 2.55 (morning) and 2.57 (afternoon). Fog cleared off by 0930 hr and clear the remainder of the day. Air temp. morning 16.8°C at 1025 hr at the flume. Water temperatures were cooler in the morning than 4 days previous, and oxygen levels were slightly less and in the "good" range. The lagoon depth was maintained at an excellent gage height of 2.55- 2.57 ft during the nautical parade. There were 8 floats in the nautical parade and 23 other boats and 6 standing surfboarders in the water. In conformance with the permit requirements from the California Department of Fish and Game, no floats were set up to be propelled by waders. Means of propulsion was by electric motor. Thus, the lagoon bottom was undisturbed. Conductivity near the bottom increased very slightly at the Stockton Avenue Bridge from 650 before to 659 umhos after the parade. Conductivity at the mouth of Noble Gulch was 654 umhos near the bottom before the procession and 674 afterwards. The measured levels of conductivity were not stressful to steelhead. There was no odor of hydrogen sulfide, and no fish mortality was observed. Oxygen concentrations in the afternoon following the nautical parade were high, ranging between 10.52 and 12.78 mg/l near the bottom before 1502 hr. Water temperature at this time was 19.5° C near the bottom in the afternoon at the 2 monitored sites. The secchi depth (water clarity) was to the lagoon bottom after the float procession. Flower petals were collected by Begonia Festival staff and volunteers the following week, and there were minimal petals left by the parade of floats.

			12-Sep-12					
	Flume			0723 hr	**Stockton Avenue Bridge**			0733 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.2	0.4	9.50	653	17.9	0.4	9.18	643
0.25	18.2	0.4	9.52	653	18.0	0.4	9.21	649
0.50	18.2	0.4	9.59	653	18.0	0.4	9.27	650
0.75	18.2	0.4	9.54	652	18.0	0.4	9.19	650
1.00b	18.2	0.4	9.42	568	18.0	0.4	9.13	650
1.25					18.0	0.4	9.19	649
1.50b					18.0	0.4	8.76	650
1.75								
2.00								
	Railroad Trestle			0755 hr	**Mouth of Noble Gulch**			0810 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	17.9	0.4	8.16	652	16.8	0.4	9.21	632
0.25	17.9	0.4	7.88	654	17.1	0.4	9.23	636
0.50	17.9	0.4	7.74	654	17.1	0.4	9.23	636
0.75	17.9	0.4	7.68	654	17.1	0.4	9.20	636
1.00	17.9	0.4	7.58	655	17.1	0.4	8.64	633
1.15b					16.9	0.4	2.92	670
1.25b	17.9	0.4	7.34	655				

12 September 2012. Gage height of 2.55 (morning) and 2.56 (afternoon). Overcast/breezy in morning and sunny in afternoon. Air temperature of 12.1°C at 0723 hr and 18.5ºC at 1552 hr.
Station 1: Flume at 0723 hr- Reach 1- 28 gulls bathing. <1% surface algae. Flume at 1552 hr- Reach 1- 65 gulls bathing. <1% surface algae. Woman feeding birds at Venetian Courts. Secchi depth to bottom. 65% of bottom with algae 0.1-0.5 ft thick, averaging 0.2 ft thick; 35% pondweed + algae 1.0- 4.0 ft thick; averaging 3.0 ft.
Station 2: Stockton Avenue Bridge at 0733 hr- Reach 2- 8 mallards. No surface algae. Reach 2 at 1529 hr- . Secchi depth to bottom. No surface algae. 70% of bottom covered with algae 0.2 – 3.0 ft thick, averaging 0.5 ft. 30% pondweed + algae 1.0- 4.0 ft thick, averaging 2.5 ft.
Station 3: Railroad trestle at 0755 hr- Reach 3- 6 mallards dabbling, 1 pied billed grebe, 1 coot all near Noble Gulch. Steelhead feeding on surface. No surface algae. At 1523 hr- 16 mallards and 2 domestic ducks, 1 coot dabbling in water near Noble Gulch. 2 mallards on Mader redwood log. No surface algae. 70% of bottom covered with algae 0.1- 3 ft thick, averaging 0.5 ft. 30% pondweed + algae 1.0- 4.- ft thick, averaging 2 ft.
Station 4: Mouth of Noble Gulch at 0810 hr- 2 mallards and 1 merganser on cottonwood. No birds on cottonwood or redwood log, downstream. At 1459 hr- 3 mallards, 1 goose, 1 WP turtle and 1 merganser on downed cottonwood. 2 WPT on Golino wood. 70% algae coverage 0.2- 2.0 ft, averaging 0.4 ft. no surface algae. Gray water present.
Station 5: Nob Hill at 0840 hr. Water temperature at 15.0°C. Conductivity 601 umhos, Oxygen 7.76 mg/l. Salinity 0.4 ppt. Nob Hill at 1648 hr. Water temperature 16.5° C. Oxygen 8.61 mg/l. Conductivity 619 umhos. Salinity 0.4 ppt. Streamflow 1.5 cfs.

			12-Sep-12					
	Flume			1552 hr	**Stockton Avenue Bridge**			1529 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	19.4	0.4	11.33	667	19.5	0.4	10.85	670
0.25	19.2	0.4	11.71	666	19.4	0.4	10.91	670
0.50	19.1	0.4	11.84	661	19.4	0.4	10.68	669
0.75	19.1	0.4	11.92 (129%)	661	19.2	0.4	10.67	667
1.0b	19.1	0.4	11.87	610	18.8	0.4	11.15	664
1.25					18.7	0.4	11.98 (128%)	660
1.50b					18.5	0.4	11.95	657
1.75								
2.00								
			12-Sep-12					
	Railroad Trestle			1523hr	**Mouth of Noble Gulch**			1503hr
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	11.62	671	20.2	0.4	10.41	688
0.25	19.6	0.4	11.97	670	19.8	0.4	10.74	678
0.50	19.5	0.4	11.90	670	19.3	0.4	10.36	674
0.75	19.2	0.4	16.55	666	18.1	0.4	11.87	660
1.00	18.7	0.4	16.01 (174%)	653	18.0	0.4	11.95 (126%)	659
1.15b					18.1	0.4	12.49	659
1.25	18.5	0.4	8.17	649				
1.50								

			26-Sep-12					
	Flume			0705 hr	**Stockton Avenue Bridge**			0725 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	17.7	0.4	10.02	666	17.2	0.4	10.43	667
0.25	17.7	0.4	10.02	668	17.3	0.4	9.71	662
0.50	17.7	0.4	10.07	668	17.4	0.4	9.68	664
0.75	17.7	0.4	10.01	667	17.4	0.4	9.71	664
1.00b	17.7	0.4	9.50	553	17.4	0.4	9.69	664
1.25					17.4	0.4	9.66 (103%)	664
1.50b					17.4	0.4	9.40	664
1.75								
2.00								
			26-Sep-12					
	Railroad Trestle			0740hr	**Mouth of Noble Gulch**			0755 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	17.4	0.4	8.85	669	16.6	0.4	9.77	645
0.25	17.4	0.4	8.74	669	16.6	0.4	9.80	645
0.50	17.4	0.4	8.69	669	16.6	0.4	9.87	645
0.75	17.4	0.4	8.70	669	16.6	0.4	9.84	644
1.00	17.4	0.4	8.53 (89%)	669	16.6	0.4	8.59 (89%)	644
1.25	17.4	0.4	7.95	670	16.5	0.4	4.03	671

26 September 2012. Gage height of 2.55 (morning) and 2.55 (afternoon). Overcast/ misty in morning and overcast then clearing (1630 hr) in afternoon. Air temperature of 13.6°C at 0705 hr and 15.1ºC at 1621 hr.

Station 1: Flume at 0705 hr- Reach 1- 31 gulls bathing, 12 mallards dabbling. No surface algae. Flume at 1621 hr- Reach 1- 26 gulls bathing, 2 gulls on log. No surface algae. 55% bottom algae 1.0- 3.0 ft thick, averaging 2 ft thick; 35% pondweed + algae 1-3 ft thick, averaging 2 ft.

Station 2: Stockton Avenue Bridge at 0725 hr- Reach 2- no birds or surface algae. Reach 2 at 1603 hr- Secchi depth to bottom. No surface algae. 70% bottom algae 0.5 – 1.0 ft thick, averaging 0.7 ft. 30% bottom pondweed + algae 1 – 3.5 ft thick, averaging 1 ft.

Station 3: Railroad trestle at 0740 hr- Reach 3- 11 mallards dabbling (some from Reach 1). 3 mallards on Mader log. 2 mallards on Golino wood. At 1549 hr, 13 mallards near Noble Gulch, 1 cormorant, 8 coots, 2 pied billed grebes and 1 gull in water. 1 cormorant perched on Mader log. Reach 3- No surface algae; 50% bottom algae 0.1 - 1.0 ft thick, averaging 0.3 ft; 50% pondweed with algae 0.5- 4 ft thick, averaging 1 ft.

Station 4: Mouth of Noble Gulch at 0755 hr- no birds on cottonwood. NO GOOSE. No surface algae. At 1521 hr- 2 mallards and 2 domestic ducks on cottonwood. NO GOOSE. 70% bottom algae 1.0- 4.0 ft thick; averaging 1.5 ft. 10% bottom pondweed + algae 2-3 ft thick. No surface algae.

Station 5: Nob Hill at 0826 hr- Water temperature at 14.8°C. Conductivity 596 umhos, Oxygen 7.93 mg/l (78% saturation). Salinity 0.4 ppt. Nob Hill at 1521 hr- Water temperature 15.4°C. Oxygen 8.93 mg/l (89% saturation). Conductivity 602 umhos. Salinity 0.4 ppt. Streamflow 1.3 cfs.

			26-Sep-12					
	Flume			1621 hr	**Stockton Avenue Bridge**			1603 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.1	0.4	10.13	672	17.8	0.4	10.40	667
0.25	18.0	0.4	10.71	670	17.8	0.4	10.60	668
0.50	18.0	0.4	10.97	669	17.8	0.4	10.54	669
0.75	18.0	0.4	11.13 (117%)	696	17.8	0.4	10.48	668
1.00b	18.0	0.4	10.98	312	17.8	0.4	10.73	668
1.25					17.8	0.4	10.79 (114%)	668
1.50b					17.8	0.4	10.61	666
1.75								
2.00								
			26-Sep-12					
	Railroad Trestle			1549hr	**Mouth of Noble Gulch**			1521hr
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	12.28	669	17.5	0.4	10.07	669
0.25	17.8	0.4	12.41	670	17.5	0.4	10.13	669
0.50	17.7	0.4	12.78	669	17.5	0.4	10.30	668
0.75	17.6	0.4	12.95	668	17.4	0.4	10.56	667
1.00	17.6	0.4	12.83 (135%)	667	17.0	0.4	11.24 (115%)	665
1.25	17.4	0.4	4.06	671	17.0	0.4	12.42	704
1.50								

			7-Oct-12				0925 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					17.4	0.4	9.27	678
0.25					17.4	0.4	9.29	667
0.50					17.2	0.4	9.32	664
0.75					17.2	0.4	9.17	664
1.00					17.2	0.4	9.03	663
1.25					17.2	0.4	9.05 (93%)	663
1.50b					17.2	0.4	9.07	663
0750 hr			7-Oct-12					0804 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00								
0.25								
0.50								
0.75								
1.00								
1.05b								
1.18b								
1.25								

7 October 2012. Fish sampling day.

0753 hr			10-Oct-12					0807 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	17.3	0.4	9.94	668	17.1	0.4	8.64	665
0.25	17.3	0.4	9.46	668	17.2	0.4	8.66	668
0.50	17.3	0.4	9.38	668	17.2	0.4	8.59	667
0.75	17.3	0.4	9.23	669	17.2	0.4	8.59	668
0.85b	17.3	0.4	8.63	556				
1.00					17.2	0.4	8.59	668
1.25					17.2	0.4	8.49 (88%)	668
1.35b					17.2	0.4	8.13	668
1.50b								
1.70b								
0825 hr			10-Oct-12					0840 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	17.1	0.4	7.60	670	16.4	0.4	8.63	639
0.25	17.1	0.4	7.61	672	16.4	0.4	8.59	642
0.50	17.1	0.4	7.51	672	16.4	0.4	8.57	643
0.75	17.1	0.4	7.81	670	16.3	0.4	8.56 (88%)	642
1.00b	17.1	0.4	7.78 (81%)	670	16.4	0.4	1.76	800
1.15b	17.1	0.4	5.49	670				
1.18b								
1.25								

<u>10 October 2012.</u> Gage height of 2.18 (morning) and 1.91 (afternoon). Light sprinkling and scattered light showers in morning. Cloudy in afternoon. One flume board removed in morning- anticipated showers. 3 boards removed on both sides of flume with screens in afternoon. Air temperature of 13.4^{o} C at 0753 hr and 16.7ºC at 1553 hr.

Station 1: Flume at 0753 hr. Reach 1- 10 gulls bathing. 2 mallards on wood adj. Margaritaville. 8 mallards standing along margin adj. Venetian Court. No surface algae. Flume at 1545 hr. Reach 1- No surface algae. Bottom to dark for vegetation observations. 46 gulls bathing.

Station 2: Stockton Avenue Bridge at 0807 hr. Secchi depth to bottom. Reach 2- No surface algae; 1 gull and 7 coots. Reach 2 at 1538 hr. No surface algae. 40% of bottom covered with pondweed with attached algae 0.5- 3.5 ft thick, averaging 1.5 ft thick. Remainder algal film. 7 coots, 1 gull.

Station 3: Railroad trestle at 0825 hr. Reach 3- No surface algae; 19 coots in water, 4 coots on Mader log, 2 mallards in water, 4 mallards on Golino wood. At 1520 hr, Reach 3- No surface algae; 70% bottom covered with pondweed with attached algae 0.5- 3.5 ft, avg. = 1.0 ft. Remainder algal film. 20 coots, 2 pied billed grebes, 6 mallards near Noble Gulch, 2 domestic ducks in water. 1 great egret and 5 coots on Mader log. At 1615, egret replaced by cormorant. Mallards creating turbid water from feeding in Reach 3 with shallower water.

Station 4: Mouth of Noble Gulch at 0840 hr. No surface algae. 2 domestic ducks and 1 mallard on cottonwood. NO GOOSE. Oil sheen on water surface. At 1505 hr. No surface algae. Too dark to see submerged vegetation. NO GOOSE.

Station 5: Nob Hill at 0914 hr. Water temperature 15.0^{o} C. Oxygen 6.91 mg/l (68% saturation). Conductivity 603 umhos. Salinity 0.4 ppt. Nob Hill at 1628 hr. Water temperature 16.0^{o} C. Oxygen 7.09 mg/l (72% saturation). Conductivity 605 umhos. Salinity 0.4 ppt. Flow 1.7 cfs.

1553 hr			10-Oct-12					1538 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	17.9	0.4	10.53	674	17.0	0.4	10.55	677
0.25	17.8	0.4	10.72	674	17.9	0.4	10.50	678
0.50	17.8	0.4	10.78	674	17.9	0.4	10.57	678
0.75	17.9	0.4	10.26 (108%)	675	17.9	0.4	10.36	677
0.80b	17.9	0.4	10.60	674				
1.00					17.8	0.4	10.35(109%)	677
1.25b					17.6	0.4	10.32	675
1.50								
1.75								
1520 hr			10-Oct-12					1505 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	13.19	676	18.0	0.4	10.35	681
0.25	17.8	0.4	13.02	676	17.9	0.4	10.26	676
0.50	17.8	0.4	12.26	676	17.7	0.4	10.06	674
0.75	27.8	0.4	8.55 (89%)	675	16.6	0.4	9.98(102%)	640
1.00b	17.6	0.4	0.57	691	16.8	0.4	4.08	839
1.25								
1.50								

			14-Oct-12					0828 hr
	Flume				**Stockton Avenue Bridge**			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00					16.0	0.4	7.28	674
0.25					16.0	0.4	7.24	675
0.50					16.0	0.4	7.16	675
0.75					16.0	0.4	7.11	674
1.00					16.0	0.4	7.13 (72%)	674
1.25b					16.0	0.4	6.78	675
1.50								
1.75								

			14-Oct-12					
	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								

14 October 2012. Fish sampling day.

0720hr			24-Oct-12					0737 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	13.9	0.3	4.88	492	13.7	0.4	5.68	498
0.25	14.0	0.3	4.92 (48%)	494	13.7	0.4	5.69	530
0.50	13.9	0.3	4.86	465	13.5	0.4	5.93	534
0.75					13.4	0.4	5.89 (56%)	542
1.00					13.4	0.4	4.82	543
1.25								
1.50								
1.75								
0757 hr			24-Oct-12					0808 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	12.9	0.4	5.86	578	12.9	0.4	6.95	529
0.25	13.0	0.4	5.82	581	12.8	0.4	6.98	588
0.50	12.9	0.4	5.63 (54%)	579	12.8	0.4	6.96 (66%)	590
0.55b	13.3	0.4	1.97	714				
0.75b					13.2	0.4	1.68	606
1.00								
1.25								

<u>24 October 2012.</u> Gage height of 1.13 (morning; 20 inches from top of flume) and 1.20 (afternoon). Cloudy and sprinkling (wet pavement) in morning and partly cloudy in afternoon. Air temperature of 9.7^{o} C at 0720 hr and 15.3ºC at 1546 hr. Lagoon kept shallow to allow light penetration to bottom.

Station 1: Flume at 0720 hr. Reach 1- 2 gulls bathing, 10 coots, 2 mallards. No surface algae. Flume at 1546 hr. Reach 1- No surface algae. Too turbid to see underwater vegetation. 40 gulls bathing, 17 coots (all but one around periphery of gulls).

Station 2: Stockton Avenue Bridge at 0737 hr. Secchi depth to bottom (1.05 m). Reach 2- No surface algae; 7 coots. Reach 2 at 1531 hr. No surface algae. To turbid for observing underwater vegetation. 15 coots, 6 mallards under trestle, 1 cormorant moved down from upstream to feed on sticklebacks closeup.

Station 3: Railroad trestle at 0757 hr. Reach 3- No surface algae; 30 mallards, 12 coots, 1 cormorant in water (moved into Reach 2 later). 5 coots on Mader log. At 1515 hr, Reach 3- No surface algae; too turbid for observing underwater vegetation. 15 coots, 5 mallards, 1 pied-billed grebes in water.

Station 4: Mouth of Noble Gulch at 0808 hr. No surface algae. No birds on downed wood. At 1500 hr. No surface algae. Water too turbid to view underwater vegetation. 5 mallards on cottonwood.

Station 5: Nob Hill at 0831 hr. Water temperature 12.1^{o}C. Oxygen 9.01 mg/l (84%). Conductivity 564 umhos. Salinity 0.4 ppt. Nob Hill at 1615 hr. Water temperature 13.2^{o}C. Oxygen 8.61 mg/l (82%). Conductivity 577 umhos. Salinity 0.4 ppt.

1546 hr			24-Oct-12					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	14.2	0.4	7.17	596	15.1	0.4	6.45	424
0.25	14.2	0.4	7.05 (69%)	578	15.1	0.4	6.34	583
0.50	13.7	0.4	6.89	430	14.7	0.4	6.31	581
0.75					14.3	0.4	6.50(64%)	578
1.00					13.6	0.4	7.08	588
1.25								
1.50								
1.75								
1515 hr			24-Oct-12					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	15.7	0.4	7.96	475	15.0	0.4	8.84	359
0.25	15.6	0.4	8.53	586	15.0	0.4	8.85	400
0.50	15.1	0.4	11.13(111%)	587	14.4	0.4	9.36(91%)	572
0.75	14.2	0.4	0.00	966	14.0	0.4	2.87	653
1.00								
1.25								

31 October 2012. Water surface 3 boards below top of flume (3.5 inches per board) = 10.5 inches.
1 November 2012. 4.1 cfs after previous night's storm.
4 November 2012. Gage height = 2.46. secchi depth to bottom.

			7-Nov-12					
	Flume			0700 hr	**Stockton Avenue Bridge**			0710 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	15.2	0.4	7.95	653	15.3	0.4	7.65	654
0.25	15.2	0.4	7.86	653	15.4	0.4	7.53	658
0.50	15.3	0.4	7.69	654	15.4	0.4	7.50	659
0.75	15.3	0.4	7.28(73%)	654	15.4	0.4	7.46	659
0.90b	15.3	0.4	6.59	639				
1.00					15.4	0.4	7.43	659
1.25					15.4	0.4	7.39 (74%)	659
1.50b					15.4	0.4	6.77	659
1.75								
2.00								
			7-Nov-12					
	Railroad Trestle			0725hr	**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	15.2	0.4	7.52	662	14.7	0.4	7.47	581
0.25	15.2	0.4	7.46	662	14.7	0.4	7.17	648
0.50	15.2	0.4	7.51	661	14.7	0.4	7.17	651
0.75	15.2	0.4	7.50	660	14.8	0.4	7.17	654
1.00	15.2	0.4	6.56 (66%)	674	14.8	0.4	6.88 (68%)	655
1.25	16.0	1.0	0	1554	15.0	0.4	5.35	695

7 November 2012. Gage height of 2.44 (morning) and 2.44 (afternoon). Overcast in morning and partly cloudy in afternoon. Air temperature of 10.9°C at 0700 hr and 13.9°C at 1527 hr.
Station 1: Flume at 0700 hr- Reach 1- 44 gulls bathing, 45 coots dabbling, 1 coot on log. No surface algae. Flume at 1527 hr- Reach 1- 100+ gulls bathing, 1 gull on log, 25 coots. No surface algae. Too dark to observe vegetation.
Station 2: Stockton Avenue Bridge at 0710 hr- Secchi depth to bottom. Reach 2- No surface algae. 13 coots, 1 gull, 1 black crowned night heron on willow- Westside. Reach 2 at 1512 hr- Secchi depth to bottom. No surface algae. Too dark to see vegetation. 7 coots, 1 pied-billed grebe in water, 2 mallards on trestle abutment.
Station 3: Railroad trestle at 0725 hr- Reach 3- 6 mallards dabbling, 36 coots. 1 cormorant, 2 coots and 2 gulls on Mader log. 2 mallards on Golino wood. At 1458 hr, Reach 3- No surface algae; 18 mallards, 26 coots, 1 pied billed grebe and 2 domestic ducks in water. 3 coots and 1 gull on Mader log.
Station 4: Mouth of Noble Gulch at 0740 hr- no birds on cottonwood. No surface algae. No gray water. At 1445 hr- surface algae. No gray water. No birds on cottonwood. Too dark to observe vegetation. No surface algae.
Station 5: Nob Hill at 0810 hr- Water temperature at 13.6°C. Conductivity 618 umhos, Oxygen 7.97 mg/l (76% saturation). Salinity 0.4 ppt. Nob Hill at 1550 hr- Water temperature 13.9° C. Oxygen 9.06 mg/l (88% saturation). Conductivity 618 umhos. Salinity 0.4 ppt.

			7-Nov-12					
	Flume			1527 hr	**Stockton Avenue Bridge**			1512 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	15.6	0.4	8.58	655	15.5	0.4	8.67	660
0.25	15.6	0.4	8.41	657	15.5	0.4	8.50	661
0.50	15.6	0.4	8.87	655	15.5	0.4	8.45	661
0.75	15.6	0.4	9.04 (91%)	655	15.5	0.4	8.37	661
1.00b	15.6	0.4	8.02	654	15.5	0.4	8.30	661
1.25					15.4	0.4	8.01 (80%)	660
1.50b					15.4	0.4	8.70 (86%)	660
1.75								
2.00								
			7-Nov-12					
	Railroad Trestle			1458hr	**Mouth of Noble Gulch**			1445hr
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	15.7	0.4	8.84	672	15.3	0.4	8.65	642
0.25	15.6	0.4	8.70	671	15.2	0.4	8.49	638
0.50	15.5	0.4	8.71	670	15.1	0.4	8.45	646
0.75	15.5	0.4	8.72	669	15.0	0.4	9.20	649
1.00	15.5	0.4	8.12 (82%)	672	15.0	0.4	14.76 (149%)	662
1.25	16.2	1.2	0.21	1872	15.3	0.5	2.48	793
1.50								

Appendix B.

2012 Drain Line Test for Restaurants Contiguous with Soquel Creek Lagoon.

2012 DRAIN LINE TEST FOR RESTAURANTS CONTIGUOUS WITH SOQUEL CREEK				
RESTAURANT	**INITIAL CONTACT**	**TEST DATE**	**COMMENTS**	**SIGN OFF**
MY THAI BEACH	FRIDAY, 5/4/11	23-May-12	PASSED-NO LEAKS	5/23/2012 VAN SON
BAY BAR	FRIDAY, 5/4/12	5/18/2012 5/23/2012	CAULK FLOOR SINKS/REMOVE ALL OLD PIPING PASSED-NO LEAKS	5/23/2012 VAN SON
PIZZA MY HEART	FRIDAY, 5/4/12	5/18/2012 5/23/2012	LEAKING PIPES/CAULK FLOOR SINKS PASSED-NO LEAKS	5/23/2012 VAN SON
FOG BANK	FRIDAY, 5/4/12	5/16/2012	PASSED-NO LEAKS	5/16/2012 VAN SON
PARADISE BAR & GRILL	FRIDAY, 5/4/12	5/18/2012 5/23/2012	LEAKING PIPES/CAULK FLOOR SINKS/ REMOVE OLD PIPING PASSED-NO LEAKS	5/23/2012 VAN SON
ZELDA'S	FRIDAY, 5/4/12	18-May-12	PASSED-NO LEAKS	5/18/2012 WHEELER