D.W. ALLEY & Associates aquatic biology

Soquel Lagoon Monitoring Report- 2015

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

CITY OF CAPITOLA
420 Capitola Avenue
Capitola, California 95010

January 2016 **Project # 106-25**

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

TABLE OF CONTENTS

List of Tables

Table of Figures

SOQUEL CREEK LAGOON MONITORING REPORT, 2015

ACKNOWLEDGMENTS

Ed Morrison and the Capitola Public Works Department did well in creating and maintaining the lagoon in 2015, despite very low stream inflow through the summer and fall. 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, along with that of other Public Works staff. The lagoon inhabitants (wildlife and humans alike) benefitted greatly from the daily attention given to manage the flume inlet as streamflow lessened greatly through the summer.

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.

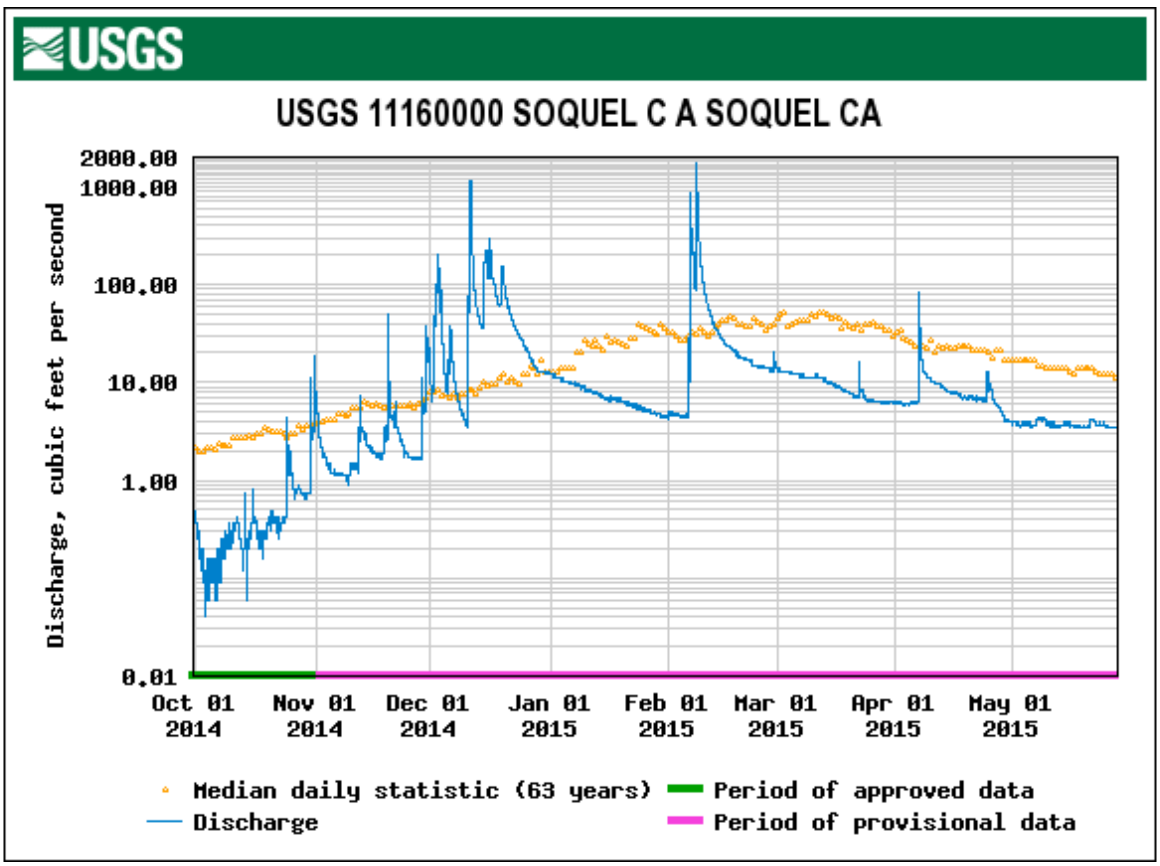
We were grateful to the volunteers who assisted in the annual fish censusing at the lagoon. There were local residents and Coastal Watershed Council staff (Debie Chirco-MacDonald) and volunteers. Bruce Ashley of the Santa Cruz Fly Fishers and Gary Quayle assisted. Biologists, Josie Moss and Inger Marie Laursen, again provided their positive energy. Chad Steiner was key in setting the seine and processing the fish. Chad brought family members, including his mother, who helped us in seining and examining 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.

REPORT SUMMARY

Sandbar Construction. As required in the permit Army Corps and California Fish and Wildlife permits, a fisheries biologist was present during all sandbar construction activities that could affect fish habitat in the lagoon/estuary. This was year 25 of our lagoon monitoring and activities associated with sandbar construction. Annual monitoring reports for the first 25 years are available at the City of Capitola (**Alley 1991-2016**). No negative impacts to steelhead were detected during sandbar construction in 2015. Sandbar construction and creation of a freshwater lagoon of maximal depth represented habitat enhancement. Sandbar construction was done prior to Memorial Day weekend in May 2015. Sandbar construction has been permitted by the California Department of Fish and Wildlife (1600-2003-0357-3), the Army Corps of Engineers (25714-0S) and under the National Marine Sanctuary Permit MBNMS-2004-033-A1.

Previous winter storms had been few after January 1, with only 2 moderate stormflows occurring during the rainy season (in December and February). Streamflow had declined steadily to only approximately 3.0 cfs on 18 May at the lagoon, the day that sandbar construction activities began.



Kelp and seagrass were present in the center of the lower estuary, downstream of the Stockton Bridge. Seagrass was deposited as far upstream as Noble Gulch, and much of the estuary bottom between Stockton Bridge and the trestle had decomposing seagrass and kelp. The streambed was firm below Stockton Bridge and soft above. The estuary had filled in with sand on the east and west side from wave action without sufficient winter flow to maintain depth except in a rather narrow thalweg down the center. Two bankfull stormflows occurred in the 1,000 – 2,000 cfs range over the winter. There were only 3 other stormflows in the 100 to 300 cfs range, all occurring before New Years. A small storm of less than 100 cfs occurred in early April to provide the last opportunity for adult steelhead to access the upper watershed. The typical lateral channel across the beach to the jetty did not develop in 2015. The Creek deflected somewhat to the east and had cut through the sandbar adjacent to Zelda's Restaurant, approximately 50 feet east of the flume earlier in the winter. But the creekmouth was closed to the ocean when construction activity began. Morrison reported that the sandbar had been intermittently opened and closed since late March. The sandbar would close at high tide, and the lagoon would fill. Then a channel would cut through the sandbar to the Bay as the tide receded.

Fortunately, kelp and seagrass were limited in the lower estuary in 2015. Approximately 60% of the plant material was removed from Reach 1 below Stockton Avenue Bridge during 2 days of raking and 4 artificial openings of the sandbar during sandbar construction. In normal years, 70−90% of the plant material is raked out below Stockton Bridge. When the outlet channel was cut alongside the flume on 18 May, the small pool that had been filled with kelp, adjacent to Zelda's Restaurant, quickly evacuated. Seining to rescue fish was unnecessary. No tidewater gobies (*Eucyclogobius newberryi*) or steelhead (*Oncorhynchus mykiss*) were observed as this pool drained. Decomposing kelp provided a ripe aroma. No other fish were observed in the lower estuary below Stockton Bridge on 18 May. However, a school of 20-25 yearling steelhead (likely pre-smolts with parr marks visible) was observed swimming upstream of Noble Gulch through a shallow run, 2-3 inches deep, during a survey for potentially stranded fish. Young-of-the-year (YOY) threespine sticklebacks (*Gasterosteus aculeatus*) were common, and 3 prickly sculpin (*Cottus asper*) were observed during the 4 days of upstream surveying. One YOY steelhead died adjacent to the flume on 19 May. Raking on succeeding days was cancelled due to the poor draining of foul water during the raking process.

No fish were stranded during estuary fluctuations because estuary sidepools were absent. A remnant of a redwood trunk with rootwad remained across from the Noble Gulch confluence and adjacent to the old downed cottonwood, as they had in 2014.

The entire estuary reach was surveyed for steelhead spawning redds, including the glide above estuary influence. No steelhead redds were found. As stated in the Soquel Lagoon Management and Enhancement Plan (**1990**) and the 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 flume outlet was closed on the last night of the 3 nights that encompassed sandbar construction, thus preventing smolt access to the Bay only one night (May 20-21). The lagoon was completely full by 28 May, with plywood covering the lower boards of the flume inlet and the adult portal in place. The 1-night break in steelhead smolt access to the Bay during sandbar construction and lagoon filling likely had little impact on smolt out-migration. The sandbar was closed for the season on 21 May. Plywood remained under the flume pilings and perpendicular to underflow to successfully reduce seepage under the flume during the summer lagoon phase.

The shroud was placed over the flume inlet on 28 May to draw residual saltwater out of the lagoon.

Sandbar Breaching. The lagoon was rising quickly in late morning of 7 November at 1050 hr when the biologist was notified and had to be emergency breached at 1100 hr. The storm had passed by the time the biologist reached the lagoon, with blue sky overhead. The Soquel Village gage, 2 miles upstream, jumped from 6 to 40 cfs between readings. Inflow from Noble Gulch was estimated at 10-15 cfs after biologist's arrival at 1145 hr, making the estimated flow at the beach in the range of 50-60 cfs at the time of the facilitated breach. The flume capacity is approximately 25−30 cfs. The stream had overtopped the bulkhead along the lagoon margin below and downstream of the railroad trestle by approximately 6 inches after the breach. The pathway alongside the lagoon had flooded, with a water line 3-4 inches high on fence beside pathway. The lagoon water surface had reached the second bolt on the piling, 1 foot above first bolt at its highest. Exit channel width at the flume inlet was 40 feet; it was 60 feet wide at the flume outlet, with a 60-foot deflection south from the flume. Once the channel through the sandbar had stabilized, the slackwater between the Stockton Bridge and the railroad trestle remained 1.5 feet deep with the water surface of the estuary 2 feet below base of flume. The flume inlet had three 4x4 inch boards removed on one side. All boards were removed from one side of flume outlet and all but 1 board appeared removed on the other side. The estuary remained open for the season despite rapid decrease in baseflow after the storm to summertime levels of less than 3 cfs between the next few small stormflows leading into mid-December.

Stream Inflow to the Lagoon. Stream inflow was considerably below the median and the lowest since the drought years of 1987-92 and 1994 after 1 August. Baseflow in late May was more than the previous year, but it dropped to less than 2014 levels at times in August and September, with Soquel Creek being observed as intermittent on 11 September. Baseflow was insufficient to prevent water temperatures to potentially rise to stressful levels for steelhead. The lagoon cooled down less at night in 2014 and 2015 than previous years, as indicated by the minimum water temperatures and minimum 7-day rolling averages compared to other years (**Table 4**). Baseflow at the time of sandbar closure was less than 3 cfs (**Table 11**). 2014 had the lowest baseflow on 1 June of the past 24 years of monitoring. By 1 September, prior to any fall rainfall, 2014 streamflow had declined to only 0.35 cfs at the Soquel Village USGS gage. This was the third lowest flow on 1 September in the last 24 years, just above those in 1992 and 1994. Since streamflow is lost between the gage and the lagoon, lagoon inflow was merely a trickle (approximately 0.1 cfs) later in September.

Water Temperature. Lagoon water temperature was within the tolerance range of steelhead in 2015 but was likely stressful much of the summer and early fall. In 2015, the lagoon steelhead management goal of maintaining early morning MINIMUM temperature below 20°C near the bottom was NOT met at the data logger location on 96 of the 129 days (74%). The lagoon management goal to maintain the daily water temperature MAXIMUM below 22ºC at 0.5 feet above the bottom was NOT met for 64 straight days (50% of the monitoring period; 4 July to 4 September). For 32 complete days the water temperature was above 22˚C the entire time. Lagoon water temperatures through the summer/fall lagoon phase were the warmest in the last 7 years from August onward (commonly in the 21−24˚C range near the bottom) and even warmer than in

2014 (**Figures 3a−3e**). Warm conditions were likely caused by low stream inflow and consistent warm air conditions (**Figure 3f**). It occurred despite good flume management to maximize depth (**Figure 2**). During the last 25 years of monitoring, the 1992, 1994, 2013−2015 lagoons were the warmest and most similar in early morning water temperatures, though the lagoons of 2007−2009 (other dry years) were nearly as warm. All had relatively dry, previous winters with low summer inflow. Of these, 2015 usually had the warmest early morning water temperatures near the bottom, though 1994 often had warmer afternoon temperatures due to the shallow lagoon (only 1.35 m deep under Stockton Bridge compared to 1.75 m in 2015), which would heat up faster during the day.

The warmest water temperature measured during 2-week monitorings in 2015 near the bottom (where steelhead typically reside) in the morning was at the Stockton Bridge (22.8˚ C (73˚ F) on 15 August) (**Figure 3b**) and at the railroad trestle (22.8˚ C on 29 August) (**Figure 3c**). The warmest early morning temperatures in the past 25 years was 24˚C in 1992 at Stockton Bridge. The warmest afternoon water temperature recorded in 2015 near the bottom during two-week monitorings was 24.6 C on 15 and 29 August at the flume (**Figure 3h**). In 2015, the warmest SURFACE water temperature was 25.1˚ C (77.2˚ F) at the flume on 15 August. This was compared to a surface water temperature of 27.7˚C measured at the flume on 20 July 2014, which was the warmest in 25 years.

In 2015, *water temperatures near the lagoon bottom in the early morning* were rated "good" (<20°C) at all stations only on 7 June and from 10 October onward (**Tables 2 and 3**). Ratings of "poor" (21.5−23°C) were most common with some "fair" (20−21.5°C) ratings. From 5 July to 29 August (5 consecutive monitorings) the ratings were "poor" (21.5–23˚C) at all stations in the morning. The warmer afternoon water temperatures in 2015 corresponded with the consistently warmer air temperatures measured at the lagoon in July to mid-September (**Figure 3e**) and the often warmer inflow (**Figure 3f**).

As in past years, no stratification or lagoon thermocline was detected in 2015 by the data loggers. As in past years, lagoon water temperatures near the bottom in 2015 somewhat reflected those of the temperature of stream inflow (**Figures 4a-l; 5a-b**). Daily temperature *minima* in the lagoon were consistently warmer near the bottom than in the stream inflow (**Table 4**). Consistently, the difference in 7-day rolling averages, day by day, were approximately 3.5−5°C warmer in the lagoon near the bottom in the morning compared to that in the stream inflow (**Figures 4a and 5a**). Stream inflow temperature in 2015 was generally about 4−5°C cooler in the morning and 3−4°C cooler in the afternoon than near the lagoon bottom, with much greater daily fluctuation in the stream than in the lagoon.

Aquatic Vegetation. In 2015 at the time of sandbar construction, only approximately 60% of the decomposing kelp and seagrass had been raked out of the lower lagoon, and the lagoon bottom was hard downstream of Stockton Bridge and soft with detritus above. There were more nutrients available for plant growth in 2013 and 2014 than in 2015 and previous years. There was much less surface algae through the summer in 2015 than in 2014, despite a warmer lagoon for a more extended period in 2015 (**Tables 5 and 6**). In 2015, surface algae and pondweed fragments varied between 0 and 10% coverage in Reach 1, 0 and 5% in Reach 2, 0 and 5% in Reach 3, and 0 and 10% at the mouth of Noble Gulch.

Algae and pondweed compete for nutrients in the lagoon. Invertebrate densities are greater in the pondweed than in algae alone. In 2015, thickness of bottom algae alone was slightly less with less coverage than in 2014, on average. In 2015, bottom algae thickness in Reaches 1−3 and at the mouth of Noble Gulch averaged 1.4 ft, 1.3 ft, 1.1 ft and 1.2 ft, respectively (**Table 5**). In 2015, thickness of pondweed with attached algae was slightly thicker with greater coverage than in 2014, on average. Pondweed had the thickest growth in 2015 of the past 7 years. In 2015, it ranged between 30 and 70% coverage and averaged 3.75 to 4.6 ft thickness in the three reaches for August through early October. Pondweed dominated the aquatic vegetation in 2015.

Oxygen Concentration. Oxygen concentration was lowest at dawn, or soon after, because oxygen was most depleted by cell respiration overnight before plant photosynthesis could begin producing oxygen with the light. Near dawn is the time when oxygen concentrations are most importantly measured and rated.

In 2015, the average oxygen level remained “good” (greater than 7 mg/l at dawn) for steelhead *near the bottom* at all 4 stations during 9 of the first 11 two-week monitorings, the exceptions being “fair” ratings during the first and third monitorings (**Table 2; Figure 6a-e**). Then it rained on 2 November, after which there was insufficient lowering the lagoon water level so that light could reach photosynthesizing aquatic plants. This caused a depression in oxygen to “poor” levels near the bottom by the morning of 7 November when water quality was monitored. No steelhead mortality was observed. Then it rained on 9 November and the sandbar breached with City facilitation. Low lagoon inflow in 2015 delayed and prevented lagoon water clarity from completely returning after the initial stormflow on 2 November. In most years, the water turbidity clears up after the first storm with higher stream inflow.

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. In 2015, morning oxygen concentrations were typically higher, on average, than the 4 previous years from mid-August to mid-October, despite lower stream inflow, higher water temperature and abundant plant life (**Figure 6h**). Afternoon oxygen readings followed a similar pattern (**Figure 6i**). The afternoon lagoon was typically supersaturated with oxygen throughout the water column, except at times along the bottom near the mouth of Noble Gulch, where a stagnant saline layer existed after early August.

Salinity Monitoring. In 2015, saline conditions were only detected a short time after sandbar closure (28 May and 7 June) in the deeper lagoon area along the wall at Venetian Court and at Stockton Bridge (**Appendix A**). Saline conditions resulted from a small amount of saltwater being trapped in the lagoon at the time of sandbar closure on 21 May, which created a stagnant layer along the lagoon bottom that heated up. A shroud was installed on the sandbar inlet on 28 May to pull saltwater off the bottom and out through the flume. No salinity was detected on 21 June at the monitoring stations. Despite limited lagoon outflow in 2013−2015, saltwater was not periodically flushed back into the flume on certain high tides. The flume outlet was partially boarded up to maintain depth within the flume, which likely inhibited saltwater back flush. Low levels of salinity were detected at the bottom at the mouth of Noble Gulch between 1 August and

24 October, ranging between 1.3 and 5.1 ppt during 2-week monitorings (**Appendix A**). A freshwater lagoon was maintained from late June until sandbar breaching on 9 November. No tidal overwash was allowed to occur through the dry season in 2015 with the elevated berm around the lagoon.

Begonia Festival Observations and Water Quality Findings. No negative impacts to fish were detected during the Begonia Festival. The City's fishery biologist (Donald Alley) was present before, during and after the Begonia Festival procession of floats on 6 September. The day of the parade was clear in the morning and afternoon. Water temperatures near the bottom were much cooler than the previous week and rated "fair" (20.4˚C at Stockton Bridge and 20.3˚C at the mouth of Noble Gulch) in the morning. Early afternoon (1420 hr) temperatures went to 21.4˚C at Stockton Bridge and 21.8˚C near the mouth of Noble Gulch, which were within the management goal of a maximum of 22˚C in the afternoon. The continuous data logger in the deep area near the railroad trestle registered a maximum of 21.1˚C near the bottom that day (**Figure 4a**). However, maximum afternoon water temperature near the bottom may have reached 22˚C in some locations. Oxygen concentrations were excellent and supersaturated in the morning and afternoon at measured stations. Lagoon water surface elevation was excellent and maintained relatively high at 2.59. In conformance with the permit requirements from the California Department of Fish and Wildlife, no floats were to be propelled by waders. Means of propulsion could be by towing or use of electric motors. Aside from 5 electric motor-powered floats, there were 40 other personal boats, kayaks, paddle boards and barges. 1 cormorant continued to fish below Stockton Bridge until late morning. One mother mallard and 6 ducklings remained in the water prior to procession. One drone was present to film the Festival. The only mishap occurred with a staff kayaker flipping his kayak and then waded to shore. Thus, the lagoon bottom was undisturbed for the most part. Conductivity increased slightly from disturbance during the procession but was not a problem. Conductivity in the afternoon at Stockton Bridge was slightly less than the previous week. The secchi depth (water clarity) was to the lagoon bottom after the float procession. Begonias were cleaned out of the lagoon in the succeeding days.

Floats were dismantled the week following the parade, and flowers were gathered from the lagoon, using a boat. More than 90% of the petals were retrieved. Water quality measurements on 13 September detected no oxygen depletion resulting from decomposing begonias (**Figure 6a-1; Appendix A**).

Fish Sampling. A total of only 10 juvenile steelhead were captured and marked on 4 October after 6 seine hauls (the same total as in 2014). There were no mortalities. Only 5 juvenile steelhead was captured on 11 October in 6 seine hauls. There were no recaptures and no mortalities. Therefore, it was impossible to obtain a steelhead population estimate based on mark and recapture for fall 2015, as was the case in 2014. Staghorn sculpins, small adult Sacramento suckers, starry flounders and threespine stickleback were also captured with the large bag seine. There were likely few YOY steelhead in the 2015 lagoon due to limited adult passage flows and spawning conditions and poor egg survival due to low winter/spring streamflows (**Figures 25 and 26**). Most storms came in December, which is early in the steelhead spawning season. The storm in February was large enough to allow adult steelhead to migrate into the upper watershed to spawn considerable distance from the lagoon. Juveniles were scarce in the lower mainstem's stream sampling sites in 2015 (**Alley 2016**). Size histograms of captured steelhead from the lagoon for 2015 and other years of sampling back to 1998 may be found in **Figures 7a−23**. The 2013 lagoon population estimate was 1,681 compared to 220 in 2012 and 678 in 2011 (**Table 12; Figure 24**) (methods in **Ricker 1971**). The average steelhead population size in the lagoon for 1993-2013 was 1,599.

A total of 309 tidewater gobies were captured on 4 and 11 October with the smaller beach seine without mortality. Two staghorn sculpins and numerous threespine stickleback were also captured. 481 tidewater gobies were captured in 2014 in 6 seine hauls. Ten tidewater gobies were captured in 2013. Prior to that they were captured in 2008 and 2009 after dry winters. 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 years of the late 1980's and early 1990's and reappeared during the recent two, less severe droughts (2007-2009 and 2013-2015). 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 two mild winters in a row. They likely re-colonized Soquel Lagoon again in 2013 after the two large stormflows in December 2012. We found them in Aptos Lagoon in 2011−2014 (**Alley 2012; 2013; 2014; 2015**) but did not sample the lagoon in 2015.

<u>Pollution Sources and Solutions.</u> No negative impacts to fish were detected from pollution sources in 2014. 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.

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, though none was detected in 2014 or 2015. A thick planktonic algal bloom was present much of the summer at the mouth of Noble Gulch with oxygen depletion on 7 June (5.86 mg/L; 61% saturation at 0821 hr), and slightly elevated conductivity at the bottom from August onward (**Appendix A**) indicated that 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.

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. **Remove three 4x4-inch boards from the flume inlet on one side as soon as possible after the first stormflow of the season which does not require sandbar breaching. This will insure light penetration to the lagoon bottom. If turbidity still prevents light penetration to the bottom after removal of 3 boards, remove enough boards to achieve complete light penetration. As water clarity improves, add boards back into the flume inlet.** . 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, low oxygen concentration or anoxic conditions will be prevented.

2. Seek volunteers to re-establish tules in the alcoves under the railroad trestle and near the Golino property. When this becomes successful, approach the restaurants to allow tule plantings in Margaritaville Cove. This will provide additional cover for steelhead and tidewater gobies against predators and may reduce dissolved nutrients and bacteria in the lagoon.

3. After a small stormflow in the fall that has made the lagoon turbid, if the flume exit closes after boards have been removed from the flume inlet to reduce the lagoon water level, excavate the flume exit daily, if necessary, to maintain lagoon outflow and a shallower lagoon for effective light penetration.

4. Continue to maintain and repair the flume as necessary. Repair the flume at a time that does not obstruct fish passage or require lowering of the lagoon water level.

5. 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. Continue to add plywood cutoff sheets between the pilings and perpendicular to underflow to maintain sand under the flume and to reduce water seepage and sink holes from forming.

6. 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.

7. Continue to maintain an outer berm near the surf and an inner berm near the lagoon margin with a wide notch in between. 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. 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.

8. When breaching must be facilitated to prevent flooding, notch the inner berm first, allowing the notch across the beach to fill with water. Then notch the outer berm to finish the sandbar breach, if necessary. If possible, allow the streamflow and tidal action to "naturally" breach the outer berm..

9. Seek funding to secure large woody material to the lagoon bottom with anchor boulders and cabling to bedrock in appropriate locations on the east bank under the railroad trestle or upstream adjacent to the Golino property. This large woody material will provide additional cover and scour deeper habitat to protect juvenile steelhead from predators. Continue to retain large woody material that naturally enters the lagoon.

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

11. 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.

12. 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). If the biologist is unavailable during emergency cases, have experienced Public Works staff and Morrison 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.

13. 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.

14. 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.

15. 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.

16. 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 Wildlife 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**).

17. 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.

18. 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.

19. 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 and 2013−2014, 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.

20. 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.

21. Place a 4-inch by 4-inch plank in the base of the flume outlet to maintain adequate flume depth, if necessary.

22. 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.

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

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

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

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

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

28. 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.

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

30. 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.

31. If the sandbar is in place after November 15, maintain an opening in the flume inlet during early, small stormflows to allow early spawning adults to pass through the flume from the Bay.

32. 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.

33. 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.

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

35. 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 Wildlife Department so that direct water pumping from the stream may be reduced or discontinued until flow returns. Loss of surface flow should be prevented.

36. 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.

37. 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.

38. 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.

39. 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.

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

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

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

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

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

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

the lagoon.

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

47.

LAGOON AND ESTUARY FORMATION

Fishery Rescue Actions Required Prior to Construction Activities

18 May 2015. The pooled channel adjacent to Zelda's Restaurant was very small, shallow and choked with kelp. This made seining impossible. The shallowness and small size also made seining unnecessary. The biologist searched through the kelp with a dip net while the pool evacuated after the outlet channel was cut alongside the flume. No fish were observed in what was presumably oxygen-deficient water. On the Venetian Court side, the estuary margin had a continuous, gradual slope without pooling, making seining unnecessary there.

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-fifth year of monitoring and assisting in activities associated with sandbar construction at Soquel Creek Lagoon. Annual monitoring reports for the first 24 years are available at the City (**Alley 1991-2015**). 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 done without heavy equipment in the stream channel except within 25 feet of the flume. The bulldozer/tractor could work adjacent to the flume.

Monitoring of Flume Maintenance and Sandbar Construction

18 May 2015. The fishery biologist, Alley, arrived at 0625 hr. The equipment operator, Matt Kotila, began moving sand on the beach beyond water contact. There was not the typical lateral channel across the beach to the jetty. There was no outlet channel, with the sandbar closed and of uniform height across the beach. Previous tidal overwash was evident. The lagoon was very full, with a gage height of 3.9, and the water surface was above the top of the flume by several inches. The flume inlet was completely boarded up, and the outlet was closed with a metal plate. The lagoon pooled adjacent to Zelda's restaurant, within 50 feet of the flume inlet, but did not reach the ocean on the outgoing tide. There was no lateral channel across the beach. The flume had been cleared of sand the previous week by Public Works staff, with adequate screening of the intake hose for water pumped into the flume. The stream inflow to the lagoon was approximately 4 cfs (3.5 cfs gage reading at Soquel Village). The outlet channel was cut by Matt Kotila at 0645 hr. Prior to this, the biologist inspected the lagoon margin upstream as far as Noble Gulch and observed no coho or other salmonids. The biologist surveyed upstream for potentially stranded fish from 0730 hr to 0840 hr. The lower estuary was mostly drained by 0830 hr at a rate of about 2 feet per hour, with pooled slackwater present on the west side between Stockton Bridge and the railroad trestle (approximately 150 feet in length) averaging 1.4 feet with maximum depth of 2.1 feet. Approximately 100 YOY stickleback were rescued from an isolated pool beneath Stockton Bridge. No other isolated pools or stranded fish were observed during the upstream survey. Crows combed the exposed streambed for food. A school of 20-25 yearling steelhead (likely pre-smolts with parr marks visible) was observed swimming upstream of Noble Gulch through a shallow run, 2-3 inches deep, during the survey for potentially stranded fish. Slackwater was common upstream of the Shadowbrook Restaurant. Young-of-the-year (YOY) threespine sticklebacks (*Gasterosteus aculeatus*) were common. A YOY steelhead was observed in a pool approximately 300 yards/ meters downstream of the pedestrian bridge, which was approximately 0.4 miles from the creekmouth. The lagoon had extended up past Nob Hill when full. The only observed potential spawning glide for salmonids, located downstream of the pedestrian bridge, had been inundated by the lagoon. No spawning redds were observed there. The next spawning glide would have been upstream of Nob Hill. Eight Public Works staff and Ed Morrison raked the estuary from 0730 hr to 0815 hr. The sandbar was closed at 0815 hr due to incoming tide. The biologist left at 1030 hr as the beach alongside Zelda's and the concrete wall were being filled in with sand.

19 May 2015. The biologist arrived at 0640 hr. The biologist walked the periphery of the lagoon up to Noble Gulch prior to sandbar opening, looking for any coho salmon juveniles. No salmonids were observed. The sandbar had remained closed overnight. The lagoon had partially filled through the night. Water was flowing through the flume overnight, with a 0.2 foot opening at the base of the flume inlet and a 0.3 foot opening at the flume exit. This allowed smolt passage. Kotila breached the sandbar at 0710 hr. The lagoon drained slowly at a rate of approximately 1 foot per 120 minutes. The lateral boards remained under the flume to discourage seepage under the flume after final sandbar closure. Eleven personnel, including Morrison and Alley, raked kelp and seagrass from the lower lagoon within approximately 100 feet of the flume inlet. The low head of water that had developed overnight did not help in transporting the vegetative matter out of the lagoon. The biologist walked upstream to the upper extent of the estuary near the Rispin Mansion, looking for potentially stranded fish along the margin (0840−0908 hr). The slackwater pool between Stockton Bridge and the railroad trestle averaged 2.3 feet, with a maximum depth of 3.1 feet. No stranded fish or isolated sidepools were observed. Threespine sticklebacks and 3 prickly sculpins were observed during the survey. Raking was ended at 0915 hr after a YOY steelhead had died near the flume inlet. Kotila closed the sandbar at 1001 hr and continued to work along the lagoon periphery. The biologist left at 1215 hr.

20 May 2015. The fishery biologist arrived at 0630 hr. The biologist walked the periphery of the lagoon up to Noble Gulch prior to sandbar opening, looking for any coho salmon juveniles. No salmonids were observed. One cormorant was observed. The sandbar was still closed, and the lagoon water surface had risen sufficiently for water to flow through the flume and allow smolt passage overnight. The sandbar was opened at 0810 hr. It drained slowly at about 1 foot per hour. No raking occurred this day. The biologist surveyed upstream in the estuary for stranded fish, beginning at 0930 hr. None were found because there were no isolated side pools. The Slackwater pool between Stockton Bridge and the trestle averaged 2.2 feet deep with maximum depth of 3.1 feet. The pad around the flume inlet was built up by Kotila. The flume inlet was unboarded. The weir inside the flume was present from last year. The sandbar was closed at 1050 hr. The lagoon margin was deepened adjacent to the restaurants above high water. The biologist left afterwards at 1239 hr.

21 May 2015. The fishery biologist arrived at 0652 hr. The sandbar was intact. Water was flowing through the flume for smolt passage. The lagoon periphery was walked by the biologist up to Noble Gulch in search of coho juveniles. No salmonids were observed. The lagoon water surface elevation was still below the flume inlet. The sandbar was opened at 0805 hr. No raking occurred this day. The lagoon drained at about 1 foot per hour. The water velocity at the entrance to the outlet channel was approximately 1 foot per second. The biologist surveyed upstream for potentially stranded fish at 0915 hr. The Slackwater pool between the Stockton Bridge and the railroad trestle averaged 2.8 feet with a maximum depth of 3.6 feet. During the survey, a mother mallard and 3 large ducklings was observed, along with a black-crowned night heron. No stranded fish were found. A wide, shallow riffle existed just upstream of the house with the steep slope and past erosion problems. The riffle was 0.2 feet deep at its thalweg and passable to steelhead smolts. The pad around the flume inlet was added to and packed down with the bulldozer. Some cracks inside the flume were patched. Clear visquine was laid down around the flume inlet and held in place with sandbags. The visquine was covered by shovel with sand. The sand was packed again with the bulldozer. The lower portion of the flume was boarded, with a screen placed over the remainder of the flume inlet. An 8-inch high by 6-inch wide hole was cut in the screen and the screen was painted white. The sandbar was closed at 1115 hr. Kotila packed the sand berm adjacent to the flume and outlet channel. The sandbar was closed for the season at 1115 hr. The flume inlet boards were closed at the base, and the plate at the flume exit was closed to allow the lagoon to fill. No smolt passage would be possible this night. Approximately 70% of the kelp and seagrass was raked out below Stockton Bridge. The biologist left at 1245 hr.

22 May 2015. Morrison reported on 22 May that the lagoon had filled overnight to the point where the flume inlet widened. A 0.3 foot gap was created in the flume outlet plate to allow smolt passage overnight. The plate on top of the flume was removed and the grate was exposed.

23 May 2015. Morrison reported that the lagoon increased 8 inches in depth since 1200 hr on 22 May. Smolt passage was possible overnight.

25 May 2015. Morrison reported that the lagoon water surface level was within 8 inches of the top of the flume. Smolt passage had been possible the two previous nights.

26 May 2015. A frame was placed in the flume outlet, increasing the flume exit to 8 inches in height. Adult portal was in place at the top of screen. The lagoon surface was 6 inches from the top of the flume. They had lost water while working on the flume inlet. Smolt access through the flume occurred overnight.

27 May 2015. Plywood was added to the lower portion of the flume inlet. The lagoon water surface was within 4 inches of the top of the flume. Five of the 8 inches of the adult portal was underwater and adult passage through the flume was possible.

28 May 2015. The biologist visited the lagoon to detect any remaining salinity in the lagoon. It was found in the lower 0.25 m below the Stockton Bridge and along the Venetian Court wall. There was no stratification of water temperature or oxygen in the upper 1.75 m of the lagoon water column under the bridge. The lagoon water surface was within 2 inches of the top of the flume, with a gage height of 2.32. Water temperature was already above 18˚ C in the unstratified portion by 1200 hr, and oxygen concentration was above 10 mg/l (slightly supersaturated) through the water column. Adult and smolt passage were provided through the flume. The berm around the lagoon periphery had been reinforced and raised to prevent tidal overwash. The sheetmetal covers had been installed along the sidewalk drains of the Esplanade. Kotila would install the shroud on the flume inlet the next day to pull saltwater out of the lagoon.

29 May 2015. Temperature probes were installed in the lagoon and upstream. The shroud was in place on the flume inlet.

Effect of Sandbar Construction on Tidewater Gobies and Steelhead in 2015

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. Tidewater gobies were detected in good numbers in the fall between the flume inlet and the Esplanade restaurants after a relatively dry rainfall season. After the first day of sandbar breaching, slow, artificial water level fluctuations were created during sandbar construction activities on succeeding days. Four sandbar breaches were required during sandbar preparation. The last 3 daily breaches during sandbar construction closely mimicked normal tidal fluctuations of the estuary. The estuary was partially filled with sand pushed in from the beach due to little winter scour.

With each lowering of the water in the estuary during sandbar construction, tidewater gobies would have to retreat to deeper slackwater in the upper estuary as water surface receded. A well defined, bathtub-like margin existed in the upper estuary in 2015, allowing easy retreat to deeper water. No isolated side pools were found.

The channel in lower Soquel Creek lacks sheltered backwaters for tidewater gobies to escape high water velocity during high stormflows, except possibly under the restaurants, and the populations that have re-occurred during the dry years of 2008, 2009, 2013 and 2014 may be transitory.

No salmonids were observed along the margin of the lower lagoon prior to each daily sandbar opening. A school of apparent pre-smolt steelhead was observed in the creek above Noble Gulch, and sufficient slackwater existed in the residual estuary after daily sandbar breaching to provide refuge for such fish. As a rare occurrence, one YOY steelhead succumbed near the flume during the second day of raking. This indicated especially poor water quality conditions below Stockton Bridge with the slow draining of the estuary during another drought year. This was a rather early appearance of YOY steelhead in the lower estuary. Cessation of raking during succeeding days prevented further steelhead mortality. The flume outlet was open to juvenile steelhead smolt passage during the period of sandbar construction, until the lagoon filled and afterwards. The lagoon had filled by the sixth day after final sandbar closure.

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 (when it is present), 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 an experienced Public Works staff member 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 (not 2013 or 2014), 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 CDFW) 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 state Fish and Wildlife permit for sandbar construction. County Environmental Health approved of this method so long as kelp is spread over a wide area (**J. Ricker, personal communication cited in the original 1990 Soquel Creek Lagoon Management and Enhancement Plan**).

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

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

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

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

12. 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 and 2014, when stream inflow is insufficient to fill an underwater portal and allow lagoon filling, opt for a notch in the upper boards to accommodate smolts instead of a deeper underwater portal for kelts. If kelts are observed in the lagoon in these dry years without the underwater portal, provide a larger opening in the top of the flume inlet temporarily to allow kelts the opportunity to exit the lagoon.

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.

17. In very dry years, such as 2013−2015, when stream inflow is low and stream outflow through the flume may be delayed for one or more days after final sandbar closure, close the flume outlet to prevent tidal influx of saltwater through the flume into the lagoon at high tide. This will reduce the saltwater volume collected in the lagoon prior to the lagoon filling and providing freshwater outflow to prevent tidal influx.

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 at 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, but slightly deflected to the east. 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, maintaining light penetration to the bottom of the lagoon.

Sandbar Breaching During the 2015-2016 Rainy Season.

The biologist (Alley) arrived at the open creekmouth at 1145 hr, November 9, after communication with Morrison that morning at 1050 hr. The lagoon was rising quickly at that time and had to be emergency breached at 1100 hr. The storm had passed by the time the biologist reached the lagoon, with blue sky overhead. The Soquel Village gage, 2 miles upstream, jumped from 6 to 40 cfs between readings. Inflow from Noble Gulch was estimated at 10-15 cfs after biologist's arrival, making the estimated flow at the beach in the range of 50-60 cfs at the time of the breach. The flume capacity is approximately 25−30 cfs. The stream had overtopped the bulkhead below the trestle by approximately 6 inches after the breach. The pathway had flooded with a water line 3-4 inches high on fence beside pathway. Water surface had reached the second bolt on the piling, 1 foot above first bolt at its highest. Exit channel width at the flume inlet was 40 feet; it was 60 feet wide at the flume outlet, with a 60-foot deflection south from the flume. The backwater between the Stockton Bridge and the railroad trestle remained 1.5 feet deep with the water surface of the estuary 2 feet below base of flume. The flume inlet had three 4x4 inch boards removed on one side. All boards were removed from one side of flume outlet and all but 1 board appeared removed on the other side. This was only the second storm of the season, and baseflow dropped rapidly to less than 2 cfs soon afterwards.

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. Continue to maintain an outer berm near the surf and an inner berm near the lagoon margin with a wide notch in between. 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. The City may have to periodically re-establish the notch if it does not rain or if high tides obliterate it. If a storm is predicted, the sandbar may require a fresh notch.

4. When breaching must be facilitated to prevent flooding, notch the inner berm first, allowing the notch across the beach to fill with water. Then notch the outer berm to finish the sandbar breaching, if necessary. If possible, allow the streamflow and tidal action to "naturally" breach the outer berm.

5. 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.

6. 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.

7. 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.

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

9. 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.

10. 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 2015

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 (**J. Cech, personal communication**). Water temperatures above 22º C (72º F) (**Table 1**) and oxygen levels below 5 parts per million (mg/L) are thought to stress steelhead. Regarding temperature optima, Moyle (**2002**) stated, "*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.*" Rainbow trout are the same species as steelhead but with a freshwater life history pattern. Optimal temperature for rainbow trout in higher elevation mountain streams of the Sierra Nevada or Cascades may be lower than what is optimal for juvenile steelhead along the Central Coast. Coastal lagoons are very food-rich environments where steelhead growth rates are very high, despite warmer water temperatures. A study completed by **Farrel et al. (2015)** indicated that the thermal range over which a Tuolumne River *O. mykiss* population could maintain 95% of peak aerobic capacity was 17.8°C to 24.6°C. Furthermore, up to a temperature of 23°C, all individual fish could maintain a factorial aerobic scope (FAS) value >2.0 (FAS = Maximum metabolic rate (MMR)/ Routine metabolic rate (RMR), one that is predicted to provide sufficient aerobic capacity for the fish to properly digest a meal. An added benefit of higher water temperature is that it increases digestive rate, allowing faster food processing and faster growth potential when food is more abundant. Under controlled laboratory conditions, food consumption, growth, and temperature tolerance were compared for Nimbus-strain steelhead (an introgressed breeding stock in the American River) acclimated to and held at 11, 15, and 19˚C in replicated laboratory experiments. Although food consumption rate showed no statistical difference between temperatures, the growth rate was higher at 19˚C than at 11˚C or 15˚C, providing evidence that food conversion efficiency in juvenile steelhead is higher at the warmer temperature (**Myrick and Cech 2005**).

The Santa Ynez River Technical Advisory Committee (SYRTAC) proposed guidelines with upper limits of 20 ˚C average daily temperature and 25 ˚C daily maximum as providing acceptable habitat conditions for steelhead in the Santa Ynez River, south of the Santa Maria River (**SYRTAC 2000**). The SYRTAC (**2000**) decided that a mean daily temperature of 22 ˚C in the River may be the threshold between acceptable and unsuitable from a long-term perspective. This was based on studies by Hokanson et al. (**1977**) who concluded that the highest constant temperature at which the effects of growth and mortality balance out was 23 ˚C. 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 were 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 survived 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 3-4º 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." If salinity was less than 10 ppt, the rating was "good." If the salinity was more than 10 ppt due to tidal overwash, it was rated "poor." 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, 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 2015, water quality was monitored in late afternoon, as well as in the early morning near first light. Water quality was monitored at four lagoon stations 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. Stream data were compared to lagoon conditions of water temperature and oxygen levels in early morning.

As required by the CDFG permit for 2015, 6 HOBO temperature loggers were launched on 29 May 2015, just downstream of the railroad trestle in Reach 2 (as in 2008−2014) at 1-foot intervals through the water column, beginning at 0.5 feet above the bottom and ending 5.5 feet from the bottom. Another logger was placed in Soquel Creek near the Nob Hill Shopping Center. The 6 lagoon loggers were removed on 4 October 2015, and the stream logger was removed on 6 October, prior to any forecasted rain.

Water quality in terms of oxygen concentration, temperature, conductivity and salinity was measured at each lagoon station at two-week intervals after the sandbar was constructed until the sandbar breached in the fall. Prior to the first full monitoring, salinity was measured in deeper portions of the lagoon to determine if saltwater had been trapped during sandbar construction. Saltwater was detected in 2015 after the sandbar closure, and the inlet shroud was needed to pull saltwater off of the bottom. The shroud was removed after 21 June, after salinity was no longer detected in Reach 1.

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 after Sunrise and for Rating Gage Height Readings.

MORNING RATING	MORNING TEMPERATURE (Celsius)	MORNING 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). 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. However, measurement of juvenile steelhead from Soquel Lagoon indicates that growth rate in the lagoon has been greater than in upstream stream reaches (**Alley 2008a; 2008b**), with nearly all young-of-the-year juveniles rearing in the lagoon reaching soon-to-smolt size the first summer each year. This indicates that despite higher water temperature in the lagoon, growth rate of juveniles is rapid because food is abundant. The Farrel et al. (2015) work indicated that near peak activity (at least 95%) can be maintained up to 24.6˚C in warm-water acclimated steelhead in the Toulemne River, and the Myrick and Cech (**2005**) work with steelhead indicated that growth rate increased with temperature provided that food was 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 its relatively high baseflow and deeper lagoon. In 2010, water temperature near the bottom exceeding 20° C for only 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 exceeds summer baseflow, and juvenile salmonids are feeding and growing rapidly. From June 1 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. As stated earlier, 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. As stated earlier, according to Moyle (**2002**), regarding temperature optima, "*many factors affect choice of temperatures by trout (if they have a choice), including the availability of food*." As stated earlier, 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, south of the Santa Maria 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 in Fall 2008 by NOAA Fisheries biologists and D.W. ALLEY & Associates in Reach 9 of the East Branch, 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 and lagoon height data. The lagoon level was monitored 12 times in 2-week intervals from 7 June 2014 to 7 November 2015, plus during the Begonia Festival. **Table 3** rates habitat conditions according to a rating scale (**Table 2**). The lagoon level was maintained in the "good" range for the summer and during the Begonia Festival. It remained good into the fall until after the first rain in early November when it was rated "poor" (**Figure 2**). After the 2 November stormflow that colored the water, forcing the management technique of reducing lagoon depth until water penetrated the bottom to allow continued photosynthesis for the remainder of the lagoon period. On 7 November, the gage height was maintained at 1.71 ft ("poor") to allow more light penetration to allow photosynthesis and higher oxygen levels. The sandbar breach was facilitated on 9 November due to stormflow that exceeded the capacity of the flume.

Gage height in 2015 was consistently near the highest recorded through the dry period of the last 4 years (**Figure 2**). This good management maintained lagoon depth as great as possible in 2015. Typically, it is more difficult for the City to maintain the highest water surface elevation after wetter winters that bring higher stream inflow during the following summer.

Saltwater was trapped on the lagoon bottom near the Venetian Court wall at the time of sandbar closure, as measured on 28 May and 7 June, justifying shroud installation on the flume inlet. On 21 June, no salinity was detected under the Stockton Bridge, and temperature monitoring near the trestle indicated no saltwater near the bottom in 2015 (**Figure 4a**).

No vandalism of the flume inlet was detected in 2015. Plywood over the flashboards protected against both back- pressure and vandalism after the adult portal was removed. 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 (**Alley et al. 1990; 2004**), steelhead adult passage is to be maintained with an underwater portal through 15 June and smolt passage is to be maintained with a notch in the uppermost flashboard until July 1 with an open flume to the Bay. A flume depth of 12 inches or deeper is desired at the entrance until July 1.

The flume was cleared of sand prior to sandbar construction in 2015. Unfortunately because of the very low streamflow during sandbar construction, the flume outlet was closed to steelhead passage during one night of sandbar construction, and smolts had no access to the ocean that night (May 20-21). The sandbar was closed for the summer on 21 May. The flume became passable before daybreak the following morning, and passage requirements were met for smolts and adult steelhead. The lagoon was completely full by 28May.

Once sandbar construction was complete, the Venetian side of the flume inlet was left completely boarded up. The Esplanade side had all flashboards repositioned to minimize leakage, and plywood was attached to the outside. The underwater portal was provided for adults through 15 June. The top flashboard was notched to provide smolt passage afterwards. The flume outlet was partially closed after 15 June but allowed a gap of 0.3 feet at the base of the outlet where water seeped out during the dry season. The inner berm across the beach was notched to initiate a facilitated sandbar breach on 9 November 2015 after one previous small stormflow on 2 November. The streamflow at the Soquel Village USGS gage was 40 cfs at the time of the breach, with stormflow reaching an estimated 60 cfs that day.

Water Temperature Results from Two-Week Monitoring

In 2015, water temperature of stream inflow was the warmest in the last 6 years and 2−3.5°C warmer in the morning in July to mid-September than in the higher flow years of 2010 and 2011 (**Figure 3e**). During the last 25 years of monitoring, the 1992, 1994 and 2013−2015 lagoons were the warmest and most similar in early morning water temperatures, though the lagoons of 2007−2009 (other dry years) were nearly as warm. In 2015, the lagoon water temperature was similar to that in 2014 in the morning until September and October when it was warmer in 2015. Water temperature was consistently slightly warmer in the afternoon near the bottom, especially as baseflow nearly disappeared in September and October in 2015 (**Figures 3a-d; Appendix A**). The 4 warmest years have been 1992, 1994, 2014 and 2015, all after relatively dry winters with low summer inflow. Of these, 2014 and 2015 had similar and the warmest early morning water temperatures near the bottom, though 1994 and 2015 often had warmer afternoon temperatures due to the shallow lagoon in 1994 (only 1.35 m deep under Stockton Bridge compared to 2.0 m in 2014 and 1.75 m in 2015) and the warm or nearly non-existent stream inflow in 2015. The lagoon was also shallower in 2015 than 2014, which would heat up faster during the day. In contrast, 2011 had the coolest lagoon temperatures in the past 25 years of monitoring. The warmer afternoon water temperatures in 2015 corresponded to consistently warmer air temperatures at the lagoon in July to mid-September (**Figure 3e**) and warmer inflow (**Figure 3f**).

The warmest water temperature measured during 2-week monitorings in 2015 near the bottom in the morning was at the Stockton Bridge (22.8˚ C (73˚ F) on 15 August) (**Figure 3b**) and at the railroad trestle (22.8˚ C on 29 August) (**Figure 3c**) compared to 2014 when it was warmer at the Stockton Bridge after the saline layer was dissipated (23˚C (73.4˚F) on 20 July) compared to 22.2°C (72°F) on 1 September 2013. The warmest early morning temperature near the bottom in 25 years was 24˚C (75.2˚F) in 1992 at Stockton Bridge. In 2015, *water temperatures near the lagoon bottom in the early morning* were rated "good" (<20°C) at all stations only on 7 June and from 10 October onward (**Tables 2 and 3**). Ratings of "poor" (21.5−23°C) were most common with some "fair" (20−21.5°C) ratings. From 5 July to 29 August (5 consecutive monitorings) the ratings were "poor" (21.5–23˚C) at all stations in the morning.

The warmest afternoon water temperature recorded in 2015 near the bottom during two-week monitorings was 24.6 C on 15 and 29 August at the flume (**Figure 3h**) compared to 24.4˚C on 20 July at the flume in 2014 (**Figure 3j**), 23.5°C on 1 September 2013 and 21.2°C on 14 August 2012, all at the flume inlet, 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 after tidal overwash that had created a stagnant saline layer under the Stockton Bridge in early July 2008.

The warmest SURFACE water temperature recorded in 25 years was in 2014 at the flume on 20 July (27.7˚C; 81.9˚F). The temperature there in the morning had been 22.8˚C. In 2015, the warmest surface temperature was 25.1˚ C (77.2˚ F) at at the flume on 15 August. In 1992 and 1994, the warmest surface temperatures were at the flume; 26˚C (78.8˚F) and 24.8°C (76.6°F), respectively. There were cooler spots for steelhead near the bottom under the Stockton Bridge and upstream in these instances.

At the mouth of Noble Gulch in 2015, as in most years, the water temperature near the bottom in the afternoon was typically the coolest of the lagoon monitoring sites from June through mid-September and about 1.5 C cooler than the surface (**Figure 3h; Appendix A**). However, from 1 August onward in 2015, noticeably higher salinity/conductivity at the very bottom resulted in elevated water temperature there as high as 25.4˚ C on 1 August. The same pattern occurred in 2014 with less pronouncement.

As in past years, lagoon water temperatures in 2015 closely reflected those of the stream inflow and were 4–5˚C warmer than stream inflow temperature in the morning from late July to late September (**Figure 3g**). Daily temperature minima in the lagoon were consistently warmer near the bottom than the stream inflow (**Table 4**). In most years, morning water temperatures near the bottom are the coolest at the upper Station 4 and warm up downstream. This was the case in 2015 (**Figure 3g**). Often the warmest early morning water temperature was at the railroad trestle. By afternoon in 2015, we saw the typical pattern of warming at downstream monitoring stations, the difference usually being 0.5 to 2° C cooler at Station 4 than Station 1 (**Figure 3h**). in 2015, water temperature stratification at the bottom was noted only on the first monitoring at the deepest Station 2 (7 June), with thorough nightly mixing and cooling of the water column at monitoring stations afterwards (**Appendix A**).

Table 3. 2015 Morning Water Quality Ratings at Monitoring Stations in Soquel Creek Lagoon, Within 0.25 m of Bottom.

Date	Flume Passage	Gage Height	Water Temperature	Oxygen	Salin-ity	Lagoon In-flow Estimated @ 0.5 cfs less than Soquel Village Gage Readings through July; visual estimates after (cfs)
7June15	open	2.58	good*	good	good	2.3 cfs
		good	good	fair	good	
			good	fair	good	
			good	fair	good	
21June15	open	2.33	fair	good	good	1.2 cfs
		good	fair	good	good	
			fair	good	good	
			good	good	good	
05Jul15	open	2.58	poor	good	good	0.8 cfs
		good	poor	fair	good	
			poor	fair	good	
			poor	fair	good	
18Jul15	open	2.58 good	poor	good	good	0.5 cfs
01Aug15	open	2.57 good	poor	good	good	0.1 cfs
15Aug15	open	2.57 good	poor	good	good	< 0.1 cfs
29Aug15	open	2.56 good	poor	good	good	< 0.1 cfs
06Sep15 Begonia Festival	open (morning)	2.59 good	fair	good	good	< 0.1 cfs
13Sep15	open	2.54 good	fair	good	good	< 0.1 cfs
26Sep15	open	2.56 good	fair	good	good	< 0.1 cfs
10Oct15	open	2.58 good	good	good	good	< 0.1 cfs
24Oct15	open	2.61 Good	good	good	good	< 0.1 cfs
07Nov15**	open	1.71	good	poor	good	0.6 cfs
	(after	poor	good	poor	good	
	rain)		good	poor	good	
			good	poor	good	

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

**Water level was intentionally lowered after a small stormflow to allow light to penetrate to plant life to maintain healthy oxygen concentrations.

Water Temperature Results from Continuous Data Loggers

In analyzing water temperature data from the 6 data loggers down the water column in the deepest portion of the lagoon, 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 25 years. In 2015, between the time of logger launching (28 May) and our first 2-week monitoring (7 June) there was a blip increase in water temperature from the surface to near the bottom of the lagoon (**Figures 4a−4j**). This corresponded to the same blip in temperature in the stream inflow at Nob Hill (**Figures 5a and 5b**). The following analysis pertains to the vicinity of these continuous data loggers only. Keep in mind that our 2-week monitoring at Station 3 near the trestle was closest to these data loggers (**Figures 3g and 3h**).

Juvenile steelhead likely spend most of their time near the bottom if oxygen and temperature levels are tolerable, 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 near the bottom in 2015 somewhat reflected those of the stream inflow (**Figures 4a-j; 5a-b**). Daily temperature *minima* in the lagoon were consistently warmer near the bottom than the stream inflow in 1999-2015 (**Table 4**). In 2015 from 29 May to 15 September, the maximum and minimum 7-day rolling average temperatures were 5.4°C and 3.5°C cooler, respectively, in the stream than near the lagoon bottom near the trestle, as was substantiated by seasonal maxima (20.6°C in the stream vs. 24.0°C in the lagoon) and minima (14.5°C in the stream vs. 19.0°C in the lagoon) (**Table 4**). Consistently, the difference in 7-day rolling averages, day by day, was also approximately 3.5−5°C warmer in the lagoon near the bottom in the morning compared to that in the stream inflow (**Figures 4a and 5a**). Stream inflow temperature in 2015 was generally about 4−5°C cooler in the morning and 3−4°C cooler in the afternoon than near the lagoon bottom, with much greater daily fluctuation in the stream than in the lagoon. We see from comparisons of the 7-day rolling average for 2015 versus 2014 near the bottom that it was 1−2˚C warmer in 2015 than 2014 in late June, early July and August through September, with similar values at other times after the saltwater dissipated in 2014. In comparing 2014 versus 2013 near the bottom, it was 1-3˚C warmer in mid-summer 2014. Previous comparisons of 7-day rolling averages in 2013 versus 2012 and 2011, in 2013 it was at least 2°C warmer than in 2012 and about 3°C warmer than in 2011 (higher stream inflow) for July through August. The 2015 season consistently had the warmest 7-day rolling averages heretofore recorded, with 2014 being the next warmest (**Table 4; Figures 4a-n; 5a-c; Alley 2014; 2015**).

As in past years, no lagoon thermocline (*a thermocline has a warm, well-mixed, oxygen-rich epilimnion above it and a cool, non-circulated, oxygen-poor hypolimnion below*) or temperature stratification was detected in 2015 by the data loggers in the deep area near the railroad trestle. The completely freshwater 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 saltwater being trapped during sandbar closure. In this case, the saltwater had dissipated within 10 days of sandbar closure under Stockton Bridge and was not indicated just downstream of the railroad trestle (deeper area) 7 days after sandbar closure. Saltwater in the deep pocket along the Venetian Court wall dissipated within 10 days after sandbar closure.

Lagoon water temperature was warmer near the surface than near the bottom throughout the dry summer season, as indicated by the maximum water temperatures and 7-day rolling averages (**Table 4; Figures 4a−b and 4k−l**). This was consistent with measurments at 2-week monitoring stations (**Appendix A**).

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 2015, water temperature rose above 22º C at 0.5 feet above the bottom at the data logger location for 64 straight days (50% of the monitoring period; 4 July to 4 September). For 32 complete days the water temperature was above 22˚C the entire time. In 2014, water temperature rose above 22º C at 0.5 feet above the bottom for 81 days (57% of the monitoring period and more than in 2015 because of the warm saline layer early in the summer) compared to 25 days in 2013 (18.5% of the monitored period) (**Figures 4a and 4n; Alley 2015**). 2015 had the warmest water temperatures near the bottom since continuous data logger measurements began in 1999 and even warmer than in 2014 after 15 June, with them especially warm during the last half of the dry season from late July through September (**Figures 4a and 4n**). This was when baseflow into the lagoon was especially low (**Table 3**). 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. The years 2007−2009, stream inflow was lower and water temperatures were higher. 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 the higher stream inflow year of 2006 (**Alley 2006**). In 2005, water temperature near the bottom never reached this threshold with high stream inflow. 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**).

Table 4. Water Temperature Statistics from Continuous Water Temperature Probes at 30-minute Intervals in Soquel Lagoon and Immediately Upstream, Late May to 15 September in 2010−2015.

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
2015	Maximum Water Temperature °C	**20.6 (15 August)**	**24.8 (15-16 August)**	**24.0 (16-17 and 19 August)**
2015	Minimum Water Temperature °C	**14.5 (1, 5-6 June)**	**17.9 (30 May, 1 and 5-6 June)**	**19.0 (6-7 June)**
2015	Maximum 7-Day Rolling Average	**18.3 (16 July)**	**23.7 (13-14 August)**	**23.3 (13-15 August)**
2015	Minimum 7-Day Rolling Average	**15.7 (31 May)**	**19.2 (4 June)**	**19.6 (4-6 June)**
2015	**Average 7-Day Rolling Average**	**17.4**	**21.9**	**21.7**
2014	Maximum Water Temperature °C	**20.2 (18-20 July)**	**24.8 (23,24,30 July)**	**24.0 (2 June; 30 July)**
2014	Minimum Water Temperature °C	**14.5 (1-4, 17-18, 22-25 June; 9 Sep)**	**18.3 (6 June)**	**19.4 (9-10 Sep)**
2014	Maximum 7-Day Rolling Average	**18.2 (15 July)**	**23.7 (19-20, 23-26 July)**	**23.4 (25-27 July)**
2014	Minimum 7-Day Rolling Average	**15.5 (1 June)**	**19.3 (1 June)**	**20.3 (5-7 Sep)**
2014	**Average 7-Day Rolling Average**	**16.8**	**21.9**	**22.0**
2013	Maximum Water Temperature °C	21.0 (26 Jun)	23.2 (5 July; 31 Aug−5 Sep)	25.2 (1 June due to saline layer)
2013	Minimum Water Temperature °C	14.1 (31 May; 4-5 June)	17.1 (5 June)	17.1 (26 June)
2013	Maximum 7-Day Rolling Average	18.7 (26 June−2 July)	22.5 (30 Aug−5 Sep)	23.4 (30 May−5 June)
2013	Minimum 7-Day Rolling Average	15.7 (3-9 June)	18.4 (4-10 Jun)	18.9 (20 June−26 June
2013	**Average 7-Day Rolling Average**	**17.0**	**20.8**	**20.7**
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	20.3	21.0	19.8

	Temperature °C			
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**

In 2015, the lagoon steelhead management goal of maintaining early morning MINIMUM temperature below 20°C near the bottom was NOT met on 96 of the 129 days (74%). In 2014, the lagoon steelhead management goal was not met on 113 of the 141 days (80%) compared to 63 of 135 days (47%) in 2013 (**Figures 4a and 4n; Alley 2015a**). 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 (**Alley 2014**) compared to not meeting the goal on 16 of 131 days (12%) in 2009, 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 of the days not meeting the goal.

The coho management goal of keeping MAXIMUM water temperatures below 20ºC (68ºF) near the bottom in the presence of steelhead was NOT met in 2015 except for 15 days in late May-early June and 3 days in early October (86% of 129 days) compared to 85% of the 140 days in 2014 and 73% of the days in 2013. However, it was met for all but 5% of the days in 2012, it being met all the time in 2011, it 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.

At the creek site near Nob Hill, the stream management goal was met for steelhead of *no more than 4 hours a day at greater than 20ºC (68ºF)* was met in 2015 (except for 2 days), in 2014 and in 2013 (except for 1 day) (**Figures 5a and 5c; Alley 2015a**). In 2009−2012, the stream management goal was met for steelhead (**Alley 2014**) and failed on only 1 day (**0.8%**) in 2008 (**Alley 2013**). In 2014, water temperature reached 20°C on 3 days compared to 7 days in 2013. 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 compared to **12%** in 2006 (**Alley 2014**). 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 2015, the management goal was NOT met on 114 of 122 days (93%; reaching a maximum of 18.3˚C) compared to 71 of 134 days (53%) in 2014; 83 of 128 days (65%) in 2013 (**Figures 5a and 5c; Alley 2015a**). In 2012, the coho management goal was not met on 9 days (7%) (**Alley 2014**). In 2011, the management goal was not met 23 days (25%) in July of the 93-day lagoon period, with it reaching a maximum of 17.3°C (**Alley 2014**). 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 (**Alley 2014**). Coho salmon may have survived in the 2010−2012 stream habitat near the lagoon if present. However, in all other past monitoring years, especially a low flow years such as 2013 and 2014, considerably more stream shading and streamflow would likely be required to make lower Soquel Creek habitable for coho salmon. The shading would need to come from larger trees of tall stature, such as redwood and Douglas fir.

The daily stream water temperature fluctuated more than the daily lagoon water temperature near the bottom in 2015, which was typical for previous years except 2010. The maximum daily lagoon water temperature typically occurred between 1600 and 2100 hr each day.

Creek water temperatures in 1999-2015 were much cooler than in 1998 (measured by Brooke Kraeger 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 2015 at the time of sandbar construction on 21 May, approximately 60% of the decomposing kelp and seagrass had been raked out of the lower lagoon, downstream of Stockton Bridge. The lagoon bottom was not soft with a thick layer of detritus downstream of Stockton Bridge, as it had been in 2014, when only 30% of the kelp and seagrass had been raked out. This was compared to 20–25% removal in 2013, 90% removal in 2012, 60% removal in 2011, 90% in 2010 and 70% in 2009. There were more nutrients available for plant growth in 2013 and 2014 than in 2015 and previous years. There was much less surface algae through the summer in 2015 than in 2014, despite a warmer lagoon for a more extended period in 2015 (**Tables 5 and 6**). In 2015, thickness of bottom algae alone was slightly less with less coverage than in 2014, on average. In 2015, thickness of pondweed with attached algae was slightly thicker with greater coverage than in 2014, on average. Thicknesses of bottom algae alone and pondweed (with attached algae) were greater in all reaches in 2014 compared to 2010−2013, with similar coverage (**Tables 6–10**). Thickness and coverage was similar in 2010−2012 (except reduced at the mouth of Noble Gulch in 2012) and less than in 2009 (**Tables 8-10; Alley 2015**). Evidence of nutrient inputs from Noble Gulch in 2013−2015 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 2015, pondweed with attached algae contributed a higher proportion of the aquatic vegetation in Reaches 1 and 2, on average, than previous years, and it was slightly less common in Reach 3 in 2015 than in 2014. It contributed 50–70% lagoon coverage in Reach 3 between 29 August and 26 September (70−80% in Reach 3 in 2014).

Filamentous algae was first noted on 21 June compared to 7 June in 2014 and to mid-June 2013. Regarding relative algal thickness over the past 7 years, from most to least the years were ranked 2014, 2013, 2009, 2015, 2010, 2011 and 2012. In 2015, bottom algae thickness in Reaches 1−3 and at the mouth of Noble Gulch averaged 1.4 ft, 1.3 ft, 1.1 ft and 1.2 ft, respectively (**Table 5**) compared to 2.0 ft, 1.8 ft, 1.4 ft and 1.5 ft, respectively in 2014 (**Table 6**) and 2.0 ft, 1.1 ft, 1.2 ft and 1.2 ft, respectively in 2013, (**Table 7**) and 0.5 ft, 0.4 ft, 0.4 ft and 0.5 ft, respectively in 2012 (**Table 8**). This was compared to 2011 averages of 0.6 ft, 0.6 ft, 0.3 ft and 1.1 ft, respectively (**Table 8**), 2010 averages of 0.8 ft, 0.8 ft, 0.8 ft and 2.2 ft, respectively (**Table 9**), and 2009 averages of 1.7 ft, 1.2 ft, 0.9 ft and 1.4 ft, respectively (**Alley 2014**).

Pondweed had nearly disappeared in 2011, but flourished in 2012–2015 with the thickest growth in 2015 of the past 7 years, with 2014 a close second. Pondweed was first detected in early August 2015, it being slightly more prominent in Reaches 2 and 3 but slightly thicker in Reach 1 through September. In 2015, it ranged between 30 and 70% coverage and averaged 3.75 to 4.6 ft thickness in the three reaches for August through early October.

Surface algae with floating pondweed fragments were less common than in 2014. In 2014 they had met a 23-year high (since 1990). Surface algae and pondweed fragments varied between 0 and 10% coverage in Reach 1 in 2015 (between 0 and 15% in 2014; 0 and 7% in 2012 and 2013), 0 and 5% in Reach 2 in 2015 (0 and 30% in 2014; 0 and 5% in 2012 and 2013), 0 and 5% in Reach 3 in 2015 (0 and 40% in 2014; 0 and 10% in 2013 and 0 and 25% in 2012) and 0 and 10% at the mouth of Noble Gulch in 2015 (0 and 50% in 2014; 0 and 30% in 2013 and 0 and 15% in 2012) (**Tables 5–8**). Regarding season averages for surface algae (and pondweed fragments), in Reaches 1–3 for 2015 it was 1.1, 0.6 and 1%, respectively. In 2014 it was 11.1, 5.9 and 10.9%, respectively. This was compared to averages of only 1.8, 0.6 and 2.5% in 2013. On 20 July 2014, surface algae was at a 23-year high (since 1990) between 30 and 50% coverage at all stations.

Table 5. Visually Estimated Algae Coverage and Thickness in the 2015 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**	**0**	**<1%**	**Film**	**20**	**0**	**Film**	**25**	**0**	**Film**	**50**	**0**
6-21	0.2	100	0	0.3	100	0	0.15	100	0	0.7	100	0
7-5	Soupy	Soupy	0	Soupy	Soupy	0	Soupy	Soupy	0	Soupy	Soupy	0
7-18	Soupy	Soupy	0	2.0	30	0	Soupy	Soupy	0	Soupy	Soupy	0
8-1	Soupy	Soupy	0	2.0 (4.0 pond-weed)	70 (30 pond-weed)	0	2.0 (4.0 pond-weed)	80 (20 pond-weed)	0	1.5	100	0
8-15	Soupy	Soupy	0	2.5 (3.5 pond-weed)	60 (40 pond-weed)	0	2.5 (4.0 pond-Weed)	70 (30 pond-Weed)	0	2.0 (3.0 Pond-Weed)	70 (30 Pond weed)	0
8-29	3.0 (4.5 Pond-weed)	70 (30 Pond-weed)	0	2.0 (4.0 Pond-weed)	60 (40 pond-weed)	0	2.0 (4.0 pond-weed)	50 (50 pond-weed)	0	2.0 (3.5 Pond-Weed)	70 (30 Pond weed)	0
9-13	2.0 (4.5 pond-weed)	70 (30 pond-Weed)	0	1.0 (4.0 pond-weed)	60 (40 pond-weed)	0	1.0 (3.0 pond-weed)	70 (30 pond-weed)	0	0.5 (3.5 Pond-weed)	70 (30 pond-weed)	0
9-26	1.0 (5.0 pond-weed)	70 (30 pond-Weed)	10	0.8 (4.0 pond-weed)	50 (50 pond-Weed)	5	0.5 (3.5 pond-weed)	30 (70 pond-Weed)	5	2.0 (4.0 pond-weed)	50 (50 pond-weed)	5
10-10	2.0 (4.5 pond-weed)	60 (40 pond-Weed)	5	1.0 (4.0 pond-weed)	70 (30 pond-Weed)	1	1.0 (4.0 pond-weed)	60 (40 pond-Weed)	5	Soupy (3.5 pond-weed)	70 (30 pond-Weed)	10
10-24	Dark	Dark	0	Dark	Dark	<1	Dark	Dark	<1	Dark	Dark	0
11-8	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0
Avg- 6-07 – 10-10	**1.4 algae (4.6 pond-Weed)**	**62 Algae (22 Pond-Weed)**	**1.5**	**1.3 algae (3.9 Pond-Weed)**	**58 algae (26 Pond-Weed)**	**0.6**	**1.1 algae (3.75 Pond-Weed)**	**61 algae (23 Pond-weed)**	**1**	**1.2 Algae (3.5 Pond weed)**	**73 Algae (34 Pond weed)**	**1.5**

Table 6. Visually Estimated Algae Coverage and Thickness in the 2014 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	**0.2**	**25**	**0**	**0.2**	**70**	**0**	**0.2**	**15**	**0**	**Soupy**	**Soupy**	**0**
6-21	Soupy	Soupy	0	Soupy	Soupy	0	Soupy	Soupy	0	Soupy	Soupy	0
7-6	1.0	60	0	1.0	100	0	1.0	100	0	0.8	40	0
7-20	3.5	100	50	3.0	99 (1 pond-weed)	30	3.0	100	40	3.0	60	50
8-3	2.5 (5 pond-weed)	95 (3 pond-weed)	15	2.5 (2.5 pond-weed)	70 (30 pond-weed)	2	1.0 (3.0 pond-weed)	70 (30 pond-weed)	7	0.7	70	10
8-16	3.0 (5.0 pond-2eed)	95 (5 pond-weed)	10	3.0 (3.0 pond-weed)	60 (40 pond-weed)	2	1.5 (3.0 pond-Weed)	25 (75 pond-Weed)	3	Soupy	Soupy	0
8-31 Begonia Festival	2.0 (4.0 Pond-weed)	85 (15 Pond-weed)	7	2.0 (3.0 Pond-weed)	70 (30 pond-weed)	10	2.0 (3.5 pond-weed)	30 (70 pond-weed)	15	Soupy	Soupy	5
9-13	soupy (4.0 pond-weed)	80 (20 pond-Weed)	8	1.0 (3.5 pond-weed)	60 (40 pond-weed)	10	1.0 (3.5 pond-weed)	20 (80 pond-weed)	15	soupy (3.0 Pond-weed)	soupy (20 pond-weed)	2
9-28	Turbid	Turbid	10	Turbid	Turbid	10	Turbid	Turbid	20	Turbid	Turbid	10
10-11	Turbid	Turbid	7	Turbid	Turbid	10	Turbid	Turbid	20	Turbid	Turbid	10
10-26	Turbid	Turbid	0	Turbid	Turbid	<1	Turbid	Turbid	<1	Turbid	Turbid	0
11-8	Turbid	Turbid	0	Turbid	Turbid	0	Turbid	Turbid	0	Turbid	Turbid	0
11-23	Turbid	Turbid	0	Turbid	Turbid	0	Turbid	Turbid	0	Turbid	Turbid	0
Avg-6-07 – 9-28	**2.0 algae (4.5 pond-Weed)**	**77 Algae (6.1 Pond-Weed)**	**11.1**	**1.8 algae (3.0 Pond-Weed)**	**76 algae (20 Pond-Weed)**	**5.9**	**1.4 algae (3.25 Pond-Weed)**	**51 algae (27 Pond-weed)**	**10.9**	**1.5 algae**	**57 algae**	**7.9**

Table 7. Visually Estimated Algae Coverage and Thickness in the 2013 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**
6-8	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
6-22	Soupy	Soupy	0	0.8	20	0	0.8	15	0	0.2	30	0
7-6	Soupy	Soupy	0	0.8	100	0	1.0	100	0	0.5	100	0
7-20	Dark	Dark	0	1.0	100	0	Dark	Dark	0	1.2	100	0
8-3	2.0	100	0	1.5	100	0	0.5 (1.0 Pond-Weed	99 (<1% pond-weed)	0	2.0	60	0
8-17	2.0	100	0	1.0	100	0	0.5 (2.0 pond-Weed)	99 (1 pond-Weed)	0	1.5	100	0
9-1 Begonia Festival	3.0 (4.0 Pond-weed)	85 (15 Pond-weed)	0	1.0 (2.0 Pond-weed)	78 (20 pond-weed)	0	2.0 (2.0 pond-weed)	85 (15 pond-weed)	1	2.0	100	30
9-14	3.0 (4.0 pond-weed)	85 (15 pond-Weed)	5	2.0 (4.0 pond-weed)	85 (15 pond-weed)	2	3.0 (4.0 pond-weed)	85 (15 pond-weed)	10	2.0	100	1
9-28	2.0 (5.0 pond-weed)	80 (20 pond-weed)	3	2.0 (4.0 pond-weed)	80 (20 pond-weed)	0	2.0 (3.0 pond-weed)	75 (25 pond-weed)	10	1.0 (3.5 pond-weed)	75 (25 Pond-Weed)	0
10-12	Dark	Dark	5	1.0 (3.0 pond-weed)	80 (20 pond-weed)	<1	1.0 (3.0 pond-weed)	80 (20% pond-weed)	2	1.0 (2.5 pond-weed)	80 (20 Pond-Weed)	2
10-26	Dark	Dark	7	Dark	Dark	5	Dark	Dark	5	2.0 (3.0 pond-weed)	70 (30 Pond-Weed)	10
11-9	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0
11-23	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0
12-8	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0
Avg-6-08 – 10-26	**2.0 algae**	**50 algae**	**1.8**	**1.1 algae**	**74 algae**	**0.6**	**1.2 algae**	**62 algae**	**2.5**	**1.2 algae**	**74 algae**	**3.9**

Table 8. 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 9. 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 10. 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**

Dissolved Oxygen Results During the 2-Week Monitorings

Oxygen concentration was lowest at dawn, or soon after, because oxygen was depleted by cell respiration overnight before plant photosynthesis could begin producing oxygen with the light. Near dawn is the time when oxygen concentrations are most importantly measured and rated. In 2015, the average oxygen level remained "good" (greater than 7 mg/l at dawn) for steelhead *near the bottom* at all 4 stations during 9 of the first 11 two-week monitorings, the exceptions being "fair" ratings during the first and third monitorings (**Table 2; Figure 6a-e**). Then it rained on 2 November, after which there was insufficient lowering the lagoon water level so that light could reach photosynthesizing aquatic plants. This caused a depression in oxygen to "poor" levels near the bottom by the morning of 7 November when water quality was monitored. By afternoon on 7 November, oxygen had increased somewhat but remained in the "poor" range. No steelhead mortality was observed. Then the sandbar had to be emergency breached on 9 November.

With clear water conditions, 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. In 2015, morning oxygen concentrations were typically similar to or higher than in 2014, on average, and higher than the 3 previous years until the first small stormflow in early November, despite lower stream inflow, higher water temperature and abundant plant life (**Figure 6h**). Afternoon oxygen readings followed a similar pattern (**Figure 6i**). At dawn after a previously sunny day with good water clarity, oxygen levels are higher because the water becomes supersaturated with oxygen from high photosynthetic rates of the lagoon algae and pondweed the previous day. When water clarity is reduced after small stormflows, if light does not penetrate to photosynthesizing plant life, oxygen concentrations decline rapidly, as occurred after 2 November 2015.

In comparing morning and afternoon oxygen levels in the lagoon, 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 2015 (**Figures 6b-e**). Supersaturated oxygen levels existed near the bottom in afternoon throughout the lagoon from 5 July to 24 October. Oxygen concentrations were significantly lower at the stream Station 5 at Nob Hill than at lagoon stations in the morning and afternoon from early August to early October (**Figures 6a-1 and 6a-2**). In stream settings, oxygen is typically at or close to full saturation due to water turbulence in riffles. However, oxygen was only between 35 and 55% full saturation in the morning in September and October 2015 (**Appendix A**). Oxygen failed to reach full saturation from 1 August onward (meter malfunction in mid-July prevented measurements then).

Salinity Results

In 2015, saline conditions were only detected a short time after sandbar closure (28 May and 7 June) in the deeper lagoon area along the wall at Venetian Court and at Stockton Bridge (**Appendix A**). Saline conditions resulted from a small amount of saltwater being trapped in the lagoon at the time of sandbar closure on 21 May, which created a stagnant layer along the lagoon bottom that heated up. A shroud was installed on the sandbar inlet on 28 May to pull saltwater off the bottom and out through the flume. No salinity was detected on 21 June at the monitoring stations. Despite limited lagoon outflow in 2013−2015, saltwater was not periodically flushed back into the flume on certain high tides. The flume outlet was partially boarded up to maintain depth within the flume, which likely inhibited saltwater back flush. Low levels of salinity were detected at the bottom at the mouth of Noble Gulch between 1 August and 24 October, ranging between 1.3 and 5.1 ppt during 2-week monitorings (**Appendix A**). A freshwater lagoon was maintained from late June until sandbar breaching on 9 November. No tidal overwash was allowed to occur through the dry season in 2015 with the elevated berm around the lagoon.

Conductivity Results

Measured conductivity remained low throughout 2015, except in the Venetian Court's wall-hole early on when saltwater was present at the bottom and from 1 August to 24 October on the bottom at the mouth of Noble Gulch. Otherwise, it ranged between 850 and 1120 umhos at the various monitoring stations (**Appendix A**). Conductivity was the highest since the drought years of 1991−92 (**Alley 1992 and 1993**) but not stressful to steelhead. Conductivity was 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 summer baseflow can discourage saltwater back-flushes into the lagoon during high tides. The lagoon mixes and cools more overnight when inflow is higher. Inflow in 2015 started out higher than in 2014. But by early August, 2015 baseflow was similar or less than in 2014, making 2015 baseflow the lowest over an extended part of the summer since 1994 (**Tables 2 and 10)**. The lagoon cooled down less at night in 2014 and 2015 than previous years, as indicated by the minimum water temperatures and minimum 7-day rolling averages compared to other years (**Table 4**). In 2008, there were repeated problems with apparent saltwater back-flushes through the flume at high tides. This was not a problem in 2009−2015, perhaps resulting in partial boarding of the flume exit in 2014 and 2015and the use of plywood over the flashboards. The year 2001 was most affected by tidal overwash in the previous 14 years (**Alley 2002a**). In recent years since 2008, the sandbar around the periphery of the lagoon has been maintained at a higher elevation to reduce/prevent tidal overwash.

With proper flume management and the 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 in 2015 was considerably below the median and the lowest since the drought of 1987-92 and 1994 from August onward. Soquel Creek was detected as intermittent at the Walnut Street Bridge on 11 September 2015. Stream baseflow was insufficient to prevent water temperatures from rising to stressful levels. The management goal of maintaining early morning minimum water temperature below 20°C near the bottom was not met for a continuous period from 29 June to 16 September (80 days) and then from 20 September to 29 September (10 days), as well as 9 days in June (Figure 4a). That was 77% of the days from 29 May to 4 October. Stream inflow to the 2015 lagoon followed a much below average winter rainfall amount that came primarily from three stormflows in December and one in February, resulting in very low baseflows through the entire dry season (**Figures 25–28**). Baseflow in Capitola at the time of sandbar closure was less than 3 cfs compared to 1.5 cfs in 2014, 2–3 cfs in 2013, 10 cfs in 2012 and 25 cfs in 2011) (**Table 11**). By 1 September, prior to any fall rainfall, 2015 streamflow had declined to 0.4 cfs at the Soquel Village USGS gage, compared to 0.35 cfs in 2014, 0.4 cfs in 2013, 1.8 cfs in 2012 and 5.8 cfs in 2011. The 1 September 2015 baseflow at the gage was fourth lowest in the last 25 years, just above those in 1992, 1994 and 2014. In September, 2015 flows went below those in 2014 because Soquel Creek was observed to be intermittent at Walnut Street walk bridge in September 2015 and not in 2014. Since streamflow is lost between the gage and the lagoon, streamflow was merely a trickle as it entered the lagoon in September. A record of annual hydrographs since 2007 are provided in **Figures 25−42**.

The second relatively small stormflow in the fall of 2015 peaked at 42 cfs at the USGS gage in Soquel Village, but exceeded the flume capacity. This required a facilitated breach of the sandbar on 7 November 2015 to prevent flooding (**Figure 28**). Without significant rain and unsaturated soils after drought, baseflow after the first several storms of the season went back down to less than 2 cfs, allowing the sandbar to open and close repeatedly until the time of this writing on 17 December.

<u>Drain Line Test for Restaurants Contiguous with Soquel Creek Lagoon</u>

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**.

Table 11. Daily Mean Discharge Recorded at the USGS Stream Gage (11160000) in Soquel Village, At One Month Intervals from 1 June to 1 October, 1991-2015.

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
2013	3.3	1.7	1.3	0.4	0.5
2014	1.5	0.7	0.5	0.35	0.5
2015	2.6	1.2	0.6	0.4	0.25

Begonia Festival Observations and Water Quality Findings

No negative impacts to fish were detected during the Begonia Festival. The City's fishery biologist (Donald Alley) was present before, during and after the Begonia Festival procession of floats on 6 September. The day of the parade was clear in the morning and afternoon. Water temperatures near the bottom were much cooler than the previous week and rated "fair" (20.4˚C at Stockton Bridge and 20.3˚C at the mouth of Noble Gulch) in the morning. Early afternoon (1420 hr) temperatures went to 21.4˚C at Stockton Bridge and 21.8˚C near the mouth of Noble Gulch, which were within the management goal of a maximum of 22˚C in the afternoon. The continuous data logger in the deep area near the railroad trestle registered a maximum of 21.1˚C near the bottom that day (**Figure 4a**). However, maximum afternoon water temperature near the bottom may have reached 22˚C in some locations. Oxygen concentrations were excellent and supersaturated in the morning and afternoon at measured stations. Lagoon water surface elevation was excellent and maintained relatively high at 2.59. In conformance with the permit requirements from the California Department of Fish and Wildlife, no floats were to be propelled by waders. Means of propulsion could be by towing or use of electric motors. Aside from 5 electric motor-powered floats, there were 40 other personal boats, kayaks, paddle boards and barges. 1 cormorant continued to fish below Stockton Bridge until late morning. One mother mallard and 6 ducklings remained in the water prior to procession. One drone was present to film the Festival. The only mishap occurred with a staff kayaker flipping his kayak and then waded to shore. Thus, the lagoon bottom was undisturbed for the most part. Conductivity increased slightly from disturbance during the procession but was not a problem. Conductivity in the afternoon at Stockton Bridge was slightly less than the previous week. The secchi depth (water clarity) was to the lagoon bottom after the float procession. Begonias were cleaned out of the lagoon in the succeeding days.

Floats were dismantled the week following the parade, and flowers were gathered from the lagoon, using a boat. More than 90% of the petals were retrieved. Water quality measurements on 13 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, though none was detected in 2014 or 2015. A thick planktonic algal bloom was present much of the summer at the mouth of Noble Gulch with oxygen depletion on 7 June (5.86 mg/L; 61% saturation at 0821 hr), and slightly elevated conductivity at the bottom from August onward (**Appendix A**) indicated that 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 on 7 June 2015 (5.66 mg/L; 58% saturation at 0807 hr). This drain could be capped if summer runoff was re-directed into the sewer.

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 turbid (cloudy), requiring lagoon water level reduction to allow light penetration to the bottom and photosynthesis and oxygen production to continue. In most years like 2015, the lagoon required breaching prematurely because the flume could not accept all of the stormflow with flooding 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. *Orient the notch laterally (diagonally) across the beach to the southeast of the flume. 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. *When breaching must be facilitated, notch the inner berm first, allowing the notch across the beach to fill with water. Then notch the outer berm to the east to finish the sandbar breach.*

3. ***Remove three 4x4-inch boards from the flume inlet on one side as soon as possible after the first stormflow of the season (which does not require sandbar breaching). This will insure light penetration to the lagoon bottom. If turbidity still prevents light penetration to the bottom, remove enough boards to achieve complete light penetration.*** This will allow algal growth despite the high turbidity. Plant photosynthesis will produce oxygen and prevent anoxic conditions. As water clarity improves, add boards back to the flume inlet. 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.

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

5. 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.

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

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

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

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

10. 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.

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

12. 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.

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

14. 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.

15. 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 notched upper flashboard for steelhead smolts because of the adult portal after June 1, close the portal. If inflow is sufficient to maintain lagoon depth with the adult portal open, leave it open through the dry season. If adult steelhead are seen in the lagoon after June 1 with the portal closed, then open it for a week to allow out-migration.

16. 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.

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

18. 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.

19. After a small stormflow in the fall that has made the lagoon turbid, if the flume exit closes after boards have been removed from the flume inlet to reduce the lagoon water level, excavate the flume exit daily, if necessary, to maintain lagoon outflow and a shallower lagoon for effective light penetration.

20. 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.

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

22. 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.

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

24. "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**).

25. 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.

26. 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.

27. 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 2015, as was the case in 2003–2014. CDFW 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 4 and 11 October 2015, from just upstream of the Stockton Avenue Bridge to the beach. 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 10 juvenile steelhead were captured and marked on 4 October after 6 seine hauls (the same total as in 2014). There were no mortalities. Only 5 juvenile steelhead was captured on 11 October in 6 seine hauls. There were no recaptures and no mortalities. Therefore, it was impossible to obtain a steelhead population estimate based on mark and recapture for fall 2015, as was the case in 2014. There were likely few YOY steelhead in the 2015 lagoon due to limited adult passage flows and spawning conditions and poor egg survival due to low winter/spring streamflows (**Figures 25 and 26**). Most storms came in December, which is early in the steelhead spawning season. The storm in February was large enough to allow adult steelhead to migrate into the upper watershed to spawn considerable distance from the lagoon. Juveniles were scarce in the lower mainstem's stream sampling sites in 2015 (**Alley 2016**). Size histograms of captured steelhead from the lagoon for 2015 and other years of sampling back to 1998 may be found in **Figures 7a−23**. The 2013 lagoon population estimate was 1,681 compared to 220 in 2012 and 678 in 2011 (**Table 12; Figure 24**) (methods in **Ricker 1971**). The average steelhead population size in the lagoon for 1993-2013 was 1,599.

Other species captured with the large seine on both days combined were 14 staghorn sculpins and 5 small adult Sacramento suckers and 2 starry flounders. The median size of juvenile steelhead captured on 4 Oct 2015 was 95-99 mm SL (**Figure 7a; Table 13**) compared to 155-159 mm SL on the first day of 2014 125-129 mm SL on the first day and 130-134 mm SL on the second day in 2013 (**Figure 8**), 140-144 mm SL on both sampling days in 2012 (**Figure 9)**, 155-159 mm SL on the first day and 160-164 mm SL on the second day in 2011 (**Figure 10**). The 2015 median size was the smallest thus far, although the sample size was small.

On 4 October 2015, 3 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. On 11 October 2015, two additional seine hauls were made in a different location along the lagoon periphery from the 4 October sampling. A total of 309 tidewater gobies were captured without mortality. Two staghorn sculpins and numerous threespine stickleback were also captured. 481 tidewater gobies were captured in 2014 in 6 seine hauls. Ten tidewater gobies were captured in 2013. Prior to that they were captured in 2008 and 2009 after dry winters. 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 years of the late 1980's and early 1990's and reappeared during the recent two, less severe droughts (2007-2009 and 2013-2015). 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 two mild winters in a row. They likely re-colonized Soquel Lagoon again in 2013 after the two large stormflows in December 2012. We found them in Aptos Lagoon in 2011−2014 (**Alley 2012; 2013; 2014; 2015**) but did not sample the lagoon in 2015.

Past calculations indicated that lagoon steelhead 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 2007–2015 population estimates for the entire Soquel Creek watershed, the lagoon population of larger smolt-sized fish has likely been a significant percentage of the total watershed population in most dry years. The lagoon provides valuable habitat in most years 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, 1998−2015 (**Table 13**), 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 at the time of fall capture would be less. One would expect that since the lagoon is a very food-productive habitat, then juvenile size would be larger with longer 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. Median size was slightly smaller in 2013 compared to 2012, which had a much smaller juvenile population, a likely higher proportion of yearlings and presumably less competition. In addition, the 2013 lagoon was warmer than previously, which increased metabolic rates and food demands of juvenile steelhead and may have slowed growth rate in 2013. The median size in 2011 was larger than the following years with the population likely dominated by larger yearlings after poor overwinter YOY survival with multiple large stormflows in late March and a moderate storm in early June (**Figures 37 and 38**).

Table 12. Estimates of Juvenile Steelhead Numbers in Soquel Creek Lagoon for the Years 1988 and 1992-2015.

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. 1 hindered by submerged log.
2013-	1,681+/- 265 (standard error). 195 fish marked in 4 effective seine hauls.
2014-	No Estimate Possible. 10 fish marked in 6 seine hauls. 2 unmarked fish caught on day 2.
2015-	No Estimate Possible. 10 fish marked in 6 seine hauls. 5 unmarked fish caught on day 2.

Table 13. Summary of Annual Fish Sampling Dates, Population Estimates, Steelhead Size and Lagoon Growth Period Prior to Sampling, 1998−2015.

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
2013	23 May	6/13 Oct	20.3	142	1,681	125-129 & 130-134
2014	22 May	12/19 Oct (2 fish)	21.3	149	None possible	155-159 First Day
2015	21 May	4/11 Oct	20.4	143	None possible	95-99 First day

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 availability. 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. 2013 had good densities of pondweed with attached algae (15-25% of bottom coverage in various reaches) from 1 September onward **(Table 7).** However 2012 had much higher densities (15-70% bottom coverage in various reaches) that began in mid-August **(Table 8)**, which would be consistent with large individuals**.** 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. Pondweed with attached algae was also relatively abundant in 2014 and 2015, affording abundant food. The median size of captured steelhead in 2014 was large and consistent with presumed low competition and high food abundance. However, in 2015 the median size was the smallest measured since 1998, which is inconsistent with the presumed low competition and high food abundance. But the sample size was small and perhaps unrepresentative. Water temperature was especially warm in the latter portion of the dry season, which would have increased metabolic costs.

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 2013−2015 lagoon was relatively warm with very limited stream inflow. The 2012 lagoon was cooler with the 2011 lagoon cooler still. Aquatic plant production was less in 2011 than in the warmer lagoons of 2008, 2009, 2012 and 2013−2015 (more pondweed) (**Tables 5-10; Alley 2014**), 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. The 2015 lagoon was shallower than in 2013 and 2014, though this was due to sand being pushed in during swells without sufficient outflow to scour it out. There was likely limited sedimentation over the very mild winter of 2014-2015, though the February storm likely exceeded bankfull. 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. Although a seepage problem existed in 2012, it was largely solved in 2013−2015. Prior to sandbar construction in 2013, plywood sheets were inserted between the flume pilings to slow or divert any water and sand underflow beneath the flume and discourage undermining. These sheets remained in 2015. The lagoon water surface was kept at the top of the flume inlet throughout the summer/ fall until lagoon depth had to be reduced to allow light penetration to the bottom after early, small stormflows that created turbidity. 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. The lagoon opened and closed repeatedly after the early breaching on 9 November 2015. But succeeding storms prevented closure for extended times that would lead to anoxic conditions. 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 population size and 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. Maintenance of lagoon depth is important to make feeding more difficult for piscivorous animals.

Mergansers were common in 2015 as they were in 2013 and 2014. However, the most we observed at a time was three, whereas there were as many as 6 in earlier years. In 2015, mergansers were observed on 6 of 12 monitoring occasions (50%) (**Appendix A**). They were observed on 6 of 13 monitorings (46%) in 2014 compared to 9 of the 18 two-week monitorings (50%) in 2013. In 2012, one merganser was observed on only 3 days of monitorings (25% of the time). Snowy egrets were uncommon in 2015, being observed on only 1 occasion compared to 4 times in 2014. No egrets were sighted in 2013 (1 observation in 2012). In 2015, a cormorant made the lagoon its home. It was observed on 7 of 12 two-week monitorings plus on the day of the Begonia Festival. On two occasions there were 2 cormorants. One cormorant was observed on one occasion in 2014 compared 3 times in 2013 and 4 times in 2012. Pied billed grebes were less common in 2015, having been observed on only 4 of 12 occasions and not until 13 September. They were seen on 7 of 13 monitorings in 2014. A pied-billed grebe was observed on 6 July 2014 but not again until 13 September. Similarly, 1-4 pied-billed grebes were seen in the lagoon not until 14 September but for the 10 monitorings thereafter (56% of the monitorings). 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). One brown pelican was observed on the lagoon periphery near Venetian Courts on one occasion on 13 September 2015. No brown pelicans were observed in the lagoon in 2014. A black crowned night heron was observed on one occasion on 24 October, at which time a greenback heron was observed, along with one greenback heron sighting during sandbar construction. A lagoon-side resident said there was a night heron nest in a redwood near the railroad trestle.

In 2015, a red-eared slider turtle was observed once on 15 August in the water near Noble Gulch, but none were observed on the logs across from there. No western pond turtles were observed in 2013−2015, although a paddle-boarder observed a turtle in the upper lagoon. Previously, they regularly basked on the instream cottonwood log and additional logs further downstream adjacent to the Golino Property. The cottonwood that had been previously used had sagged and was mostly underwater in 2013−2015, offering limited basking area. In 2012, as many as 3 pond turtles were observed at one time on the cottonwood log and another nearby log.

Other bird species that utilized the 2015 lagoon included mallards (as many as 46 (23 were ducklings) with especially high survival of ducklings), coots (as many as 113 on 24 October but reduced to 71 by 7 November) and gulls (as many as 150+ on 26 September).

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 secure 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 Wildlife 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 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 before the first small storm that does not require sandbar breaching 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. When the first small storm of the season creates turbidity, remove three 4x4-inch as soon as possible after the storm to insure that light penetrates to the bottom of the intact lagoon. 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, low oxygen concentrations or 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.

LITERATURE CITED

Alley, D.W. 1992. Soquel Creek Lagoon Monitoring Report, 1990- 91. Prepared by D.W. ALLEY & Associates for the City of Capitola and the Coastal Conservancy.

Alley, D.W. 1993. Soquel Creek Lagoon Monitoring Report, 1991- 92. Prepared by D.W. ALLEY & Associates for the City of Capitola and the Coastal Conservancy.

Alley, D.W. 1994. Soquel Creek Lagoon Monitoring Report, 1992- 93. Prepared by D.W. ALLEY & Associates for the City of Capitola and the Coastal Conservancy.

Alley, D.W. 1995a. Soquel Creek Lagoon Monitoring Report, 1993- 94. Prepared by D.W. ALLEY & Associates for the City of Capitola and the Coastal Conservancy.

Alley, D.W. 1995b. Monitoring Report, 1993-1994. Lagoon Water Quality for Fish, Streamflow Measurements, Fish Sampling and Passage Conditions in San Simeon and Santa Rosa Creeks, San Luis Obispo County, California. Prepared by D.W. ALLEY & Associates for the Cambria Community Services District.

Alley, D.W. 1996a. Summary Report Regarding Development, Implementation and Monitoring of the Soquel Creek Lagoon Management and Enhancement Plan, 1996. Prepared by D.W. ALLEY & Associates for the City of Capitola and the Coastal Conservancy.

Alley, D.W. 1996b. Soquel Creek Lagoon Monitoring Report, 1994- 95. Prepared by D.W. ALLEY & Associates for the City of Capitola and the Coastal Conservancy.

Alley, D.W. 1997. Soquel Creek Lagoon Monitoring Report, 1995- 96. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 1998. Soquel Creek Lagoon Monitoring Report, 1996- 97. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 1999. Soquel Creek Lagoon Monitoring Report, 1997- 98. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2000. Soquel Creek Lagoon Monitoring Report, 1998-1999. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2000. Soquel Creek Lagoon Monitoring Report, 1999-2000. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2001. Determination of Juvenile Steelhead Densities in Soquel Creek, Santa Cruz County, California; With a 2000 Estimate of Juvenile Production and Index of Expected Adult Returns. Prepared by D.W. ALLEY & Associates for the Soquel Creek Water District.

LITERATURE CITED (continued)

Alley, D.W. 2002a. Soquel Creek Lagoon Monitoring Report, 2000-2001. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2002b. Determination of Juvenile Steelhead Densities in Soquel Creek, Santa Cruz County, California; With a 2001 Estimate of Juvenile Production and Index of Expected Adult Returns. Prepared by D.W. ALLEY & Associates for the Soquel Creek Water District.

Alley, D.W. 2003a. Soquel Creek Lagoon Monitoring Report, 2002. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2003b. Determination of Juvenile Steelhead Densities in Soquel Creek, Santa Cruz County, California; With a 2002 Estimate of Juvenile Production and Index of Expected Adult Returns. Prepared by D.W. ALLEY & Associates for the Soquel Creek Water District and Santa Cruz County Environmental Planning.

Alley, D.W. 2003c. Soquel Creek Lagoon Monitoring Report, 2003. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley D.W., K Lyons and S Chartrand. 2004a. Soquel Creek Lagoon Management and Enhancement Plan Update. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2004b. Soquel Creek Lagoon Monitoring Report, 2004. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2005. Soquel Creek Lagoon Monitoring Report, 2005. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2006a. Soquel Creek Lagoon Monitoring Report, 2006. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2006b. Monitoring Results for Lower San Simeon and Santa Rosa Creeks, 2004-2005: Lagoon Water Quality, Fishery Resources and Inflow Near Cambria, San Luis Obispo County, California. Prepared by D.W.ALLEY & Associates for the Cambria Community Services District

Alley, D.W. 2008a. Soquel Creek Lagoon Monitoring Report, 2007. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2008b. 2007 Juvenile Steelhead Densities in the San Lorenzo, Soquel, Aptos and Corralitos Watersheds, Santa Cruz County, California, With Trend Analysis in the San Lorenzo and Soquel Watersheds, 1997-2007.

LITERATURE CITED (continued)

Alley, D.W. 2009. Soquel Creek Lagoon Monitoring Report, 2008. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2010a. Soquel Creek Lagoon Monitoring Report, 2009. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2010b. Soquel Creek Lagoon Monitoring Report, 2010. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2011. Soquel Creek Lagoon Monitoring Report, 2010. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2012. Soquel Creek Lagoon Monitoring Report, 2011. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2013. Soquel Creek Lagoon Monitoring Report, 2012. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2014. Soquel Creek Lagoon Monitoring Report, 2013. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2015a. Soquel Creek Lagoon Monitoring Report, 2014. Prepared by D.W. ALLEY & Associates for the City of Capitola.

Alley, D.W. 2015. 2014 Juvenile Steelhead Densities in the San Lorenzo, Soquel, Aptos and Corralitos Watersheds, Santa Cruz County, CA.

Alley, D.W. 2016. 2015 Juvenile Steelhead Densities in the San Lorenzo, Soquel, Aptos and Corralitos Watersheds, Santa Cruz County, CA.

Baltz, D.M., B. Vondracek, L. R. Brown, and P.B. Moyle. 1987. Influence of temperature on microhabitat choice by fishes in a California stream. Trans. Am. Fish. Soc. 116:12-20. (Cited in Moyle 2002).

Bjornn, T. and D. Reiser. 1991. Habitat requirements of salmonids in streams. In Meehan, W. ed., Influences of Forest and Rangeland Management on Salmonids Fishes and Their Habitat. American Fisheries Society Special Publication 19. pp. 83-138.

Brett, J.R. 1959. Thermal requirements of fish – three decades of study, 1940-1970. In: Biological problems in Water Pollution. USPHS Tech. Rept. W60-3, 110 Cincinnati, Ohio. pp. 110-117. (Cited by Kubicek and Price 1976).

Cech, Joseph. 1993. Personal Communication. Fish Physiologist and Professor. University of California, Davis, CA. Phone # (916) 752-3103.

LITERATURE CITED (continued)

Coche, A.G. 1967. Production of juvenile steelhead trout in a freshwater impoundment. Ecol. Monographs 37: 201-228. (Cited by Kubicek and Price 1976).

Dettman, David. 1991. Personal Communication. Senior Fishery Biologist. Monterey Peninsula Water Management District.

Farrel, A.P., N.A. Fangue, C.E. Verhille, D.E. Cocherell, K.K. English. 2015. Thermal Performance of Wild Juvenile *Oncorhynchus mykiss* in the Lower Tuolumne River: A Case for Local Adjustment to High River Temperature. Prepared for Turlock Irrigation District and Modesto Irrigation District.

Hokanson, K.E.F., C.F. Kleiner and T.W. Thorslund. 1977. Effects of constant temperatures and diel temperature fluctuations on specific growth and mortality rates and yield of juvenile rainbow trout, Salmon Gairdneri. J. Fish. Res. Board Can. 34:639-648. (Cited in Santa Ynez River Technical Advisory Committee 2000).

Kubicek, P.F. and D.G. Price. 1976. An evaluation of water temperature and its effect on juvenile steelhead trout in geothermally active areas of Big Sulphur Creek. Pacific Gas and Electric Company Department of Engineering Research.

Moyle, P.B. 2002. Inland Fishes of California. Revised and Expanded. Univ. of Calif. Press. Berkeley, Los Angeles and London. ISBN: 0-520- 22754-9.

Myrick, C.A. and J.J. Cech. 2005. Effects of Temperature on the Growth, Food Consumption, and Thermal Tolerance of Age-0 Nimbus-Strain Steelhead. N. Am. Journal of Aquaculture 67: 324−330.

Ricker, W.E. (ed.) 1971. <u>Methods for Assessment of Fish Production in Fresh Waters</u>. Blackwell Scientific Publications. Oxford and Edinburgh. ISBN: 0-632-08490-1. 2nd edition. 543pp.

Santa Ynez River Technical Advisory Committee (SYRTAC). 2000. Lower Santa Ynez River Fish Management Plan. Volume II Appendices. *Prepared for* Santa Ynez River Consensus Committee. *Prepared by* Santa Ynez River Technical Advisory Committee. October 2, 2000.

Sherman, Y. 2002. Personal Communication. Editorial Services. San Diego, California.

Smith, J.J. 1999 and 2009. Personal Communication. Professor. San Jose State University.

Snyder, G.R. and T.H. Blahm. 1971. Effects of increased temperature on cold water organisms. J. Water Poll. Control Fed. 43: 890-899. (Cited by Kubicek and Price 1976).

Soquel Creek Lagoon Management and Enhancement Plan. 1990. Donald Alley, Project Manager. Prepared by Habitat Restoration Group for City of Capitola and Coastal Conservancy.

LITERATURE CITED (continued)

Welsh, H.H., G.R. Hodgson, B.C. Harvey and M.F. Roche. 2001. Distribution of juvenile coho in relation to water temperatures in tributaries of the Matthole River, California. N. Am. J. Fisheries Mgmt. 21: 464-470.

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 since 1931 photo; circa 1955-56 after the flood.
(Courtesy of the Capitola Historical Museum)

FIGURES

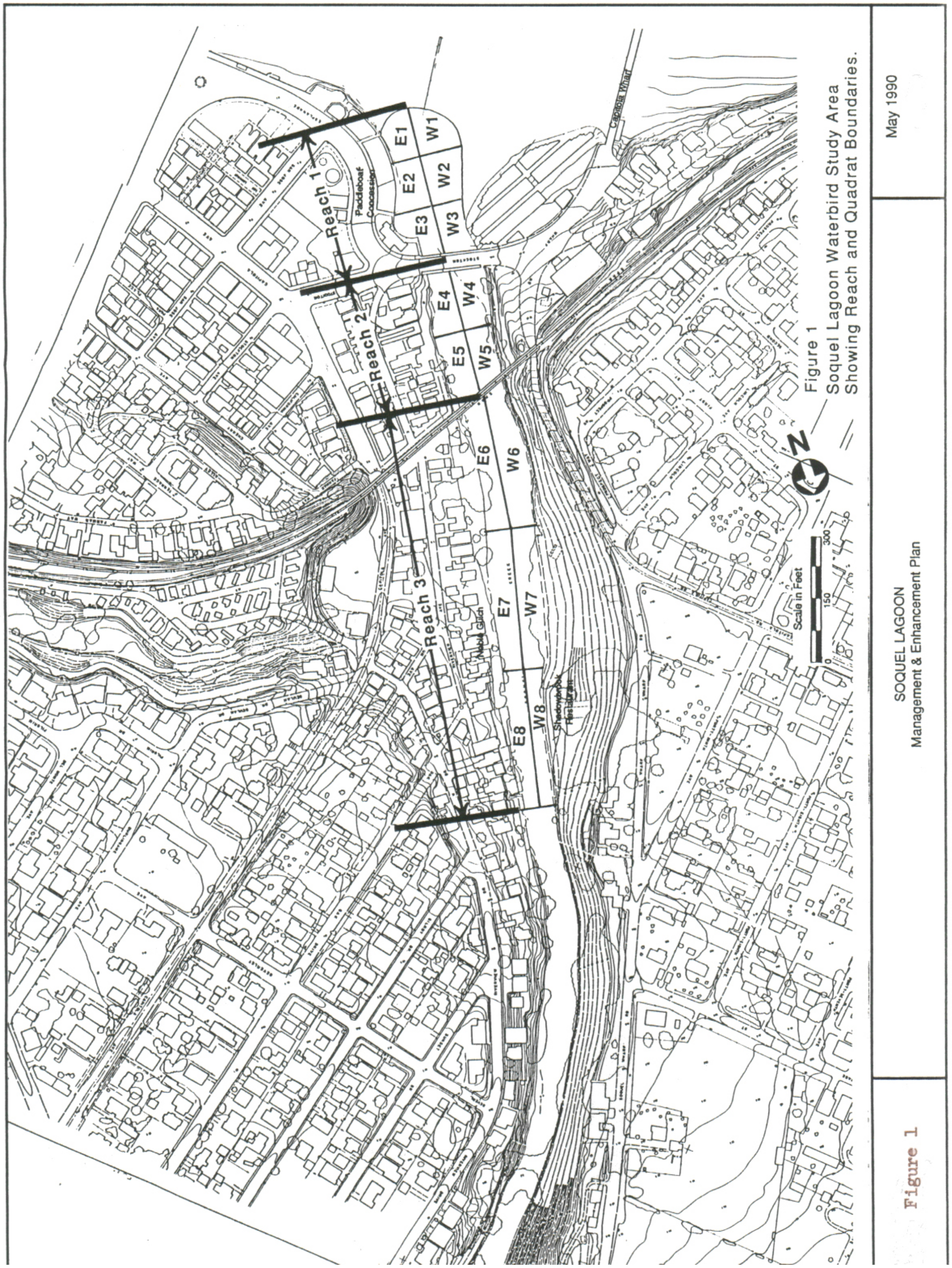


Figure 1. Map of Reaches in Soquel Creek Lagoon

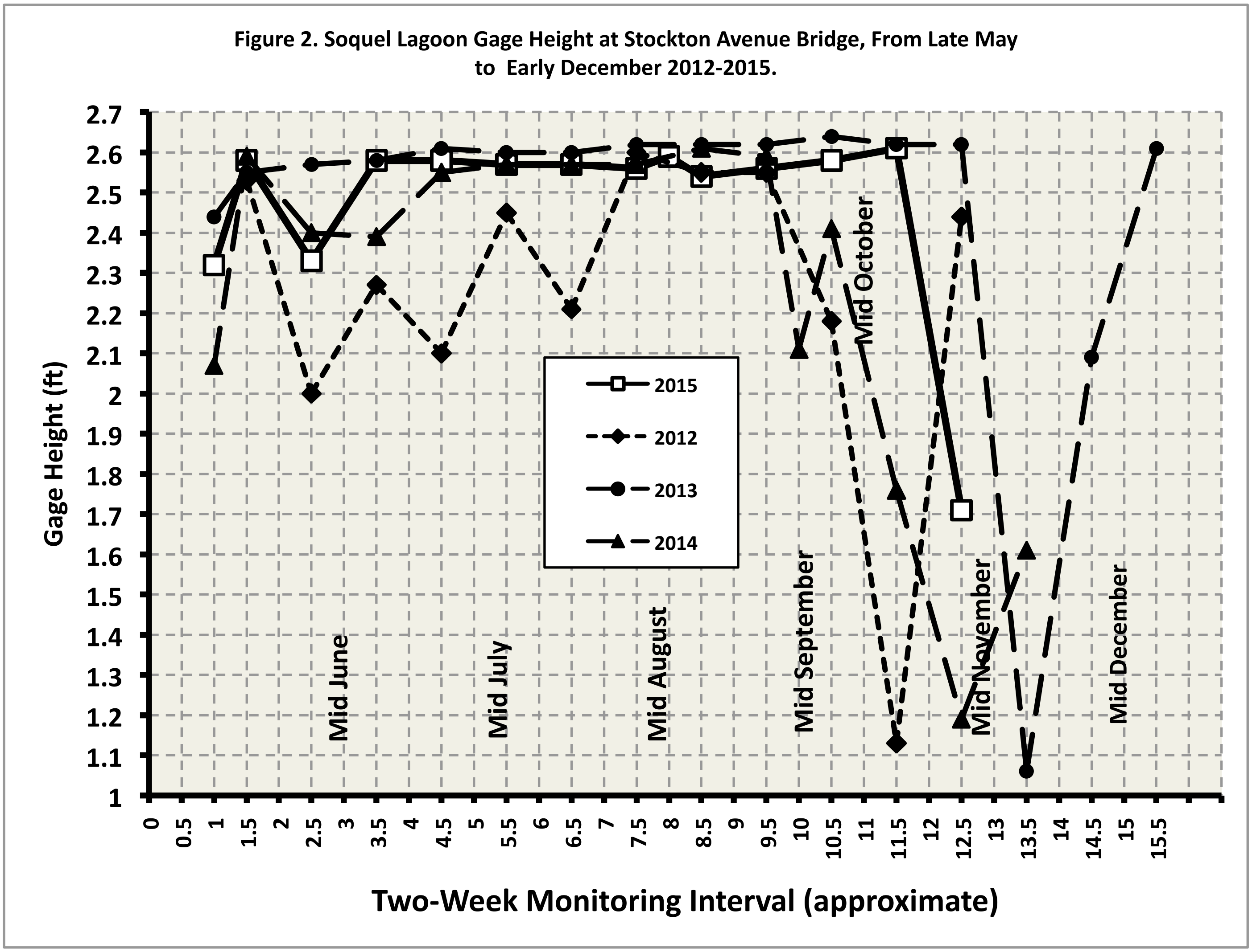


Figure 2. Soquel Lagoon Gage Height at Stockton Avenue Bridge, From Late May to Early December 2012-2015

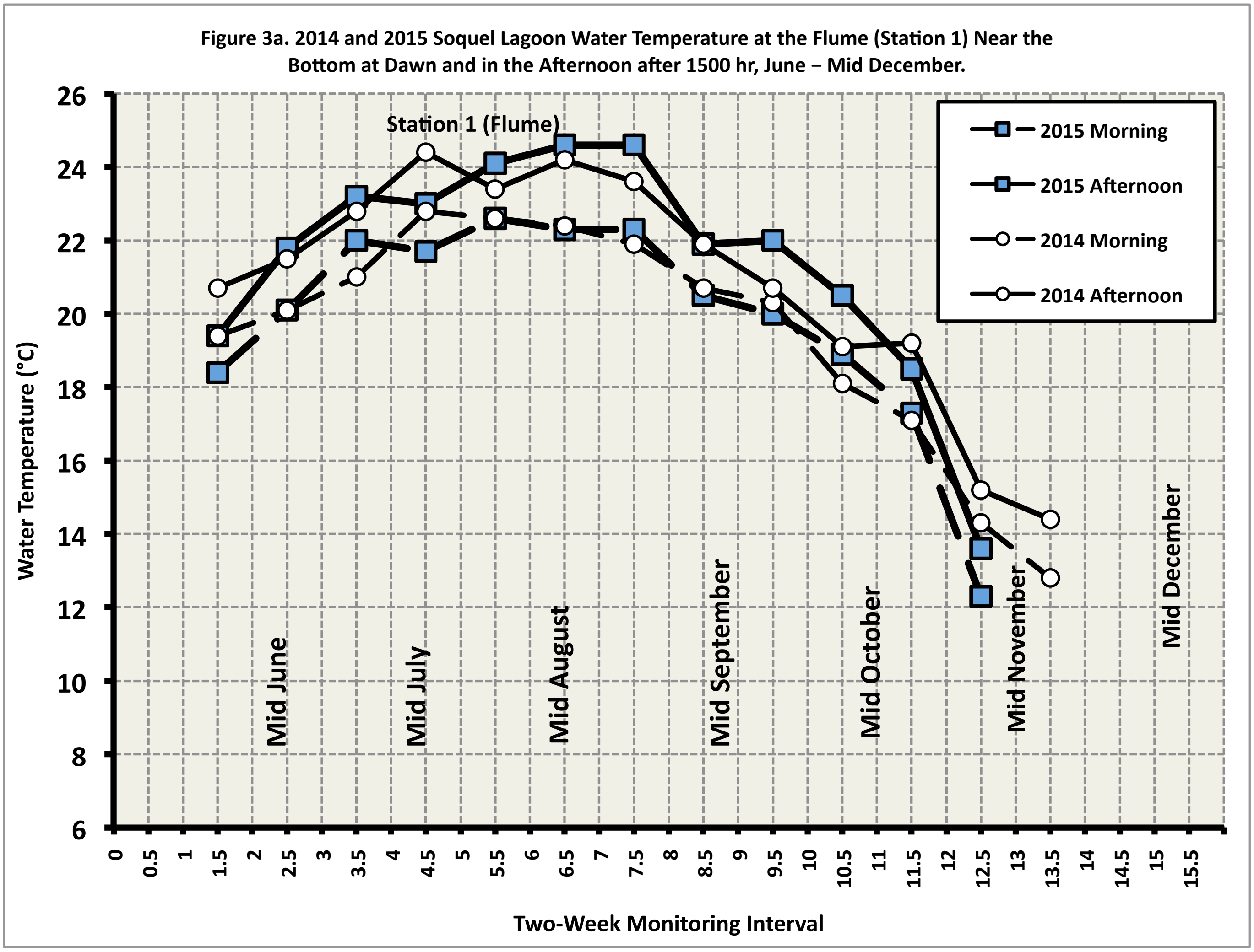


Figure 3a. 2014 and 2015 Soquel Lagoon Water Temperature at the Flume (Station 1) Near the Bottom at Dawn and in the Afternoon after 1500 hr, June – Mid November.

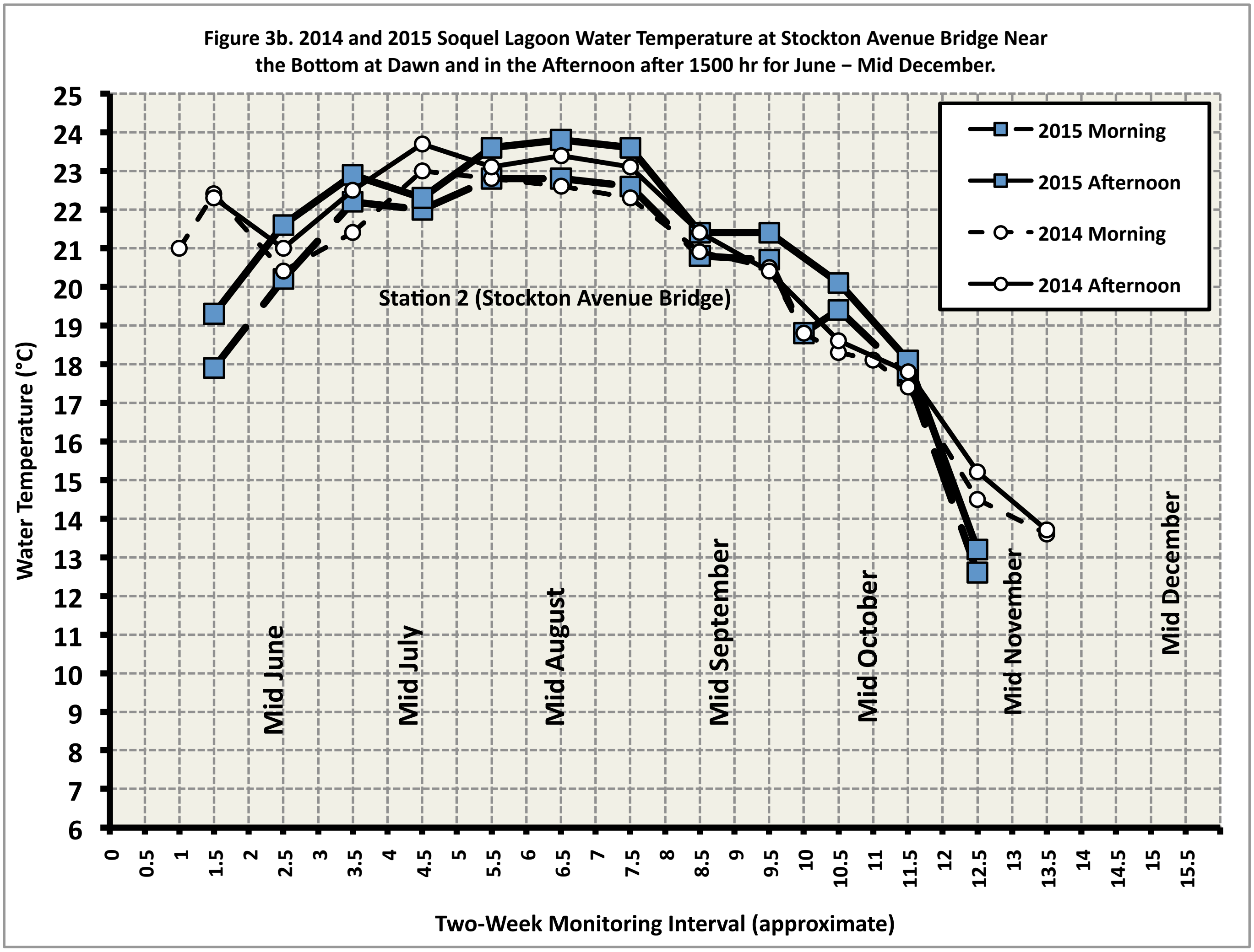


Figure 3b. 2014 and 2015 Soquel Lagoon Water Temperature at Stockton Avenue Bridge Near the Bottom at Dawn and in the Afternoon after 1500 hr for June − Mid November.

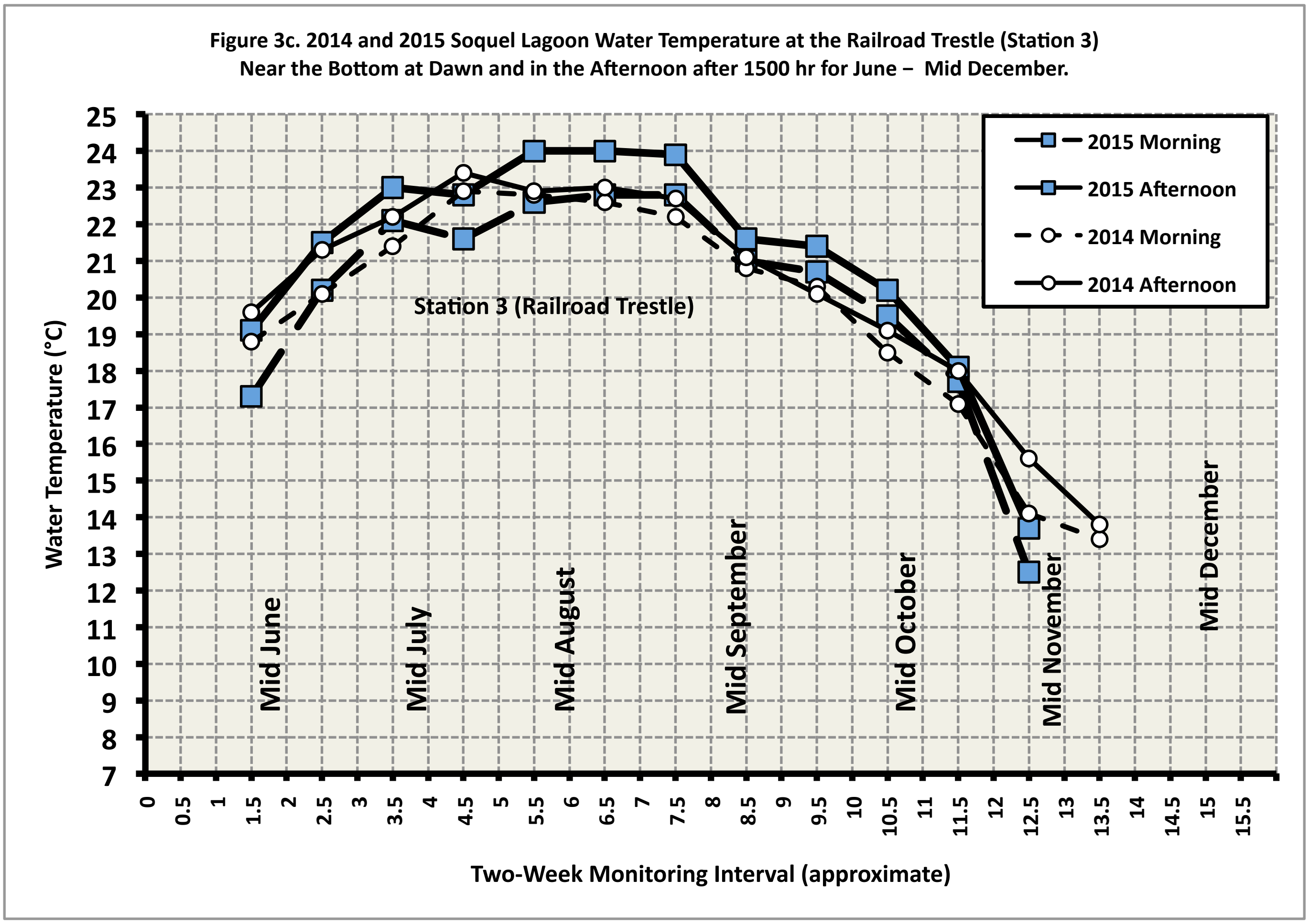


Figure 3c. 2014 and 2015 Soquel Lagoon Water Temperature at the Railroad Trestle (Station 3) Near the Bottom at Dawn and in the Afternoon after 1500 hr for June− Mid November.

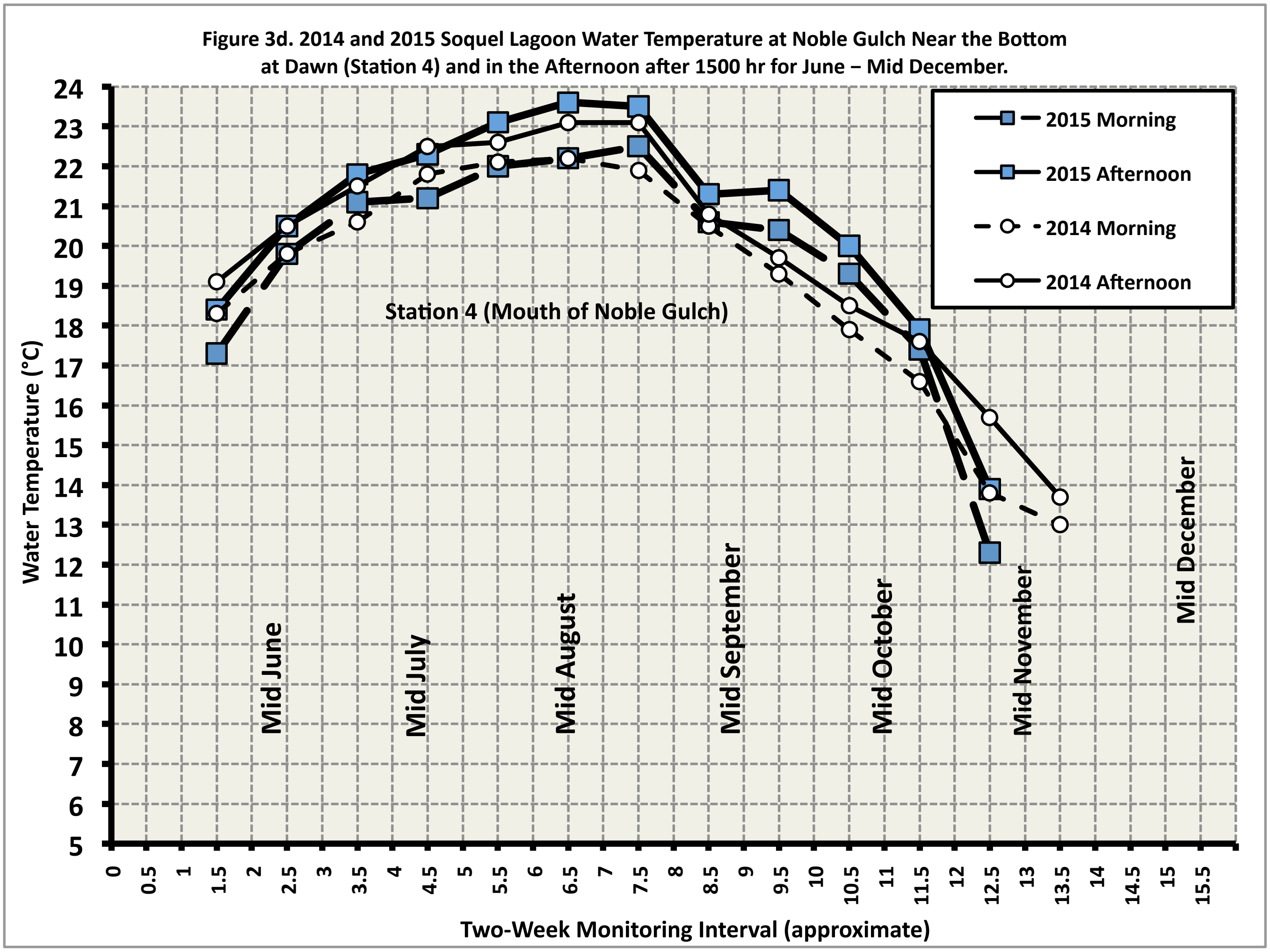


Figure 3d. 2014 and 2015 Soquel Lagoon Water Temperature at Noble Gulch Near the Bottom at Dawn (Station 4) and in the Afternoon after 1500 hr for June – Mid-November.

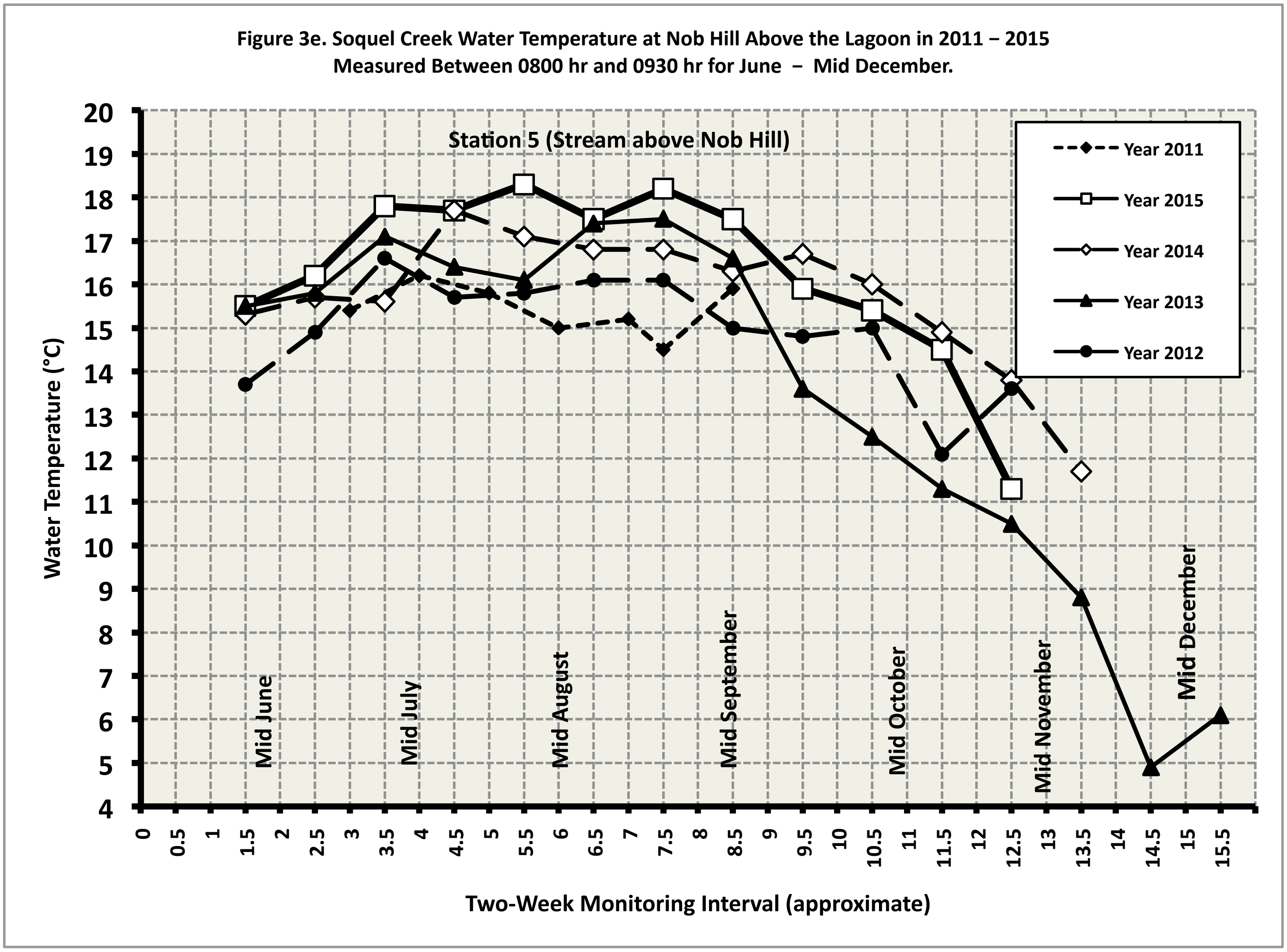


Figure 3e. Soquel Creek Water Temperature at Nob Hill Above the Lagoon in 2011−2015 Measured Between 0800 hr and 0930 hr for June − Mid-December.

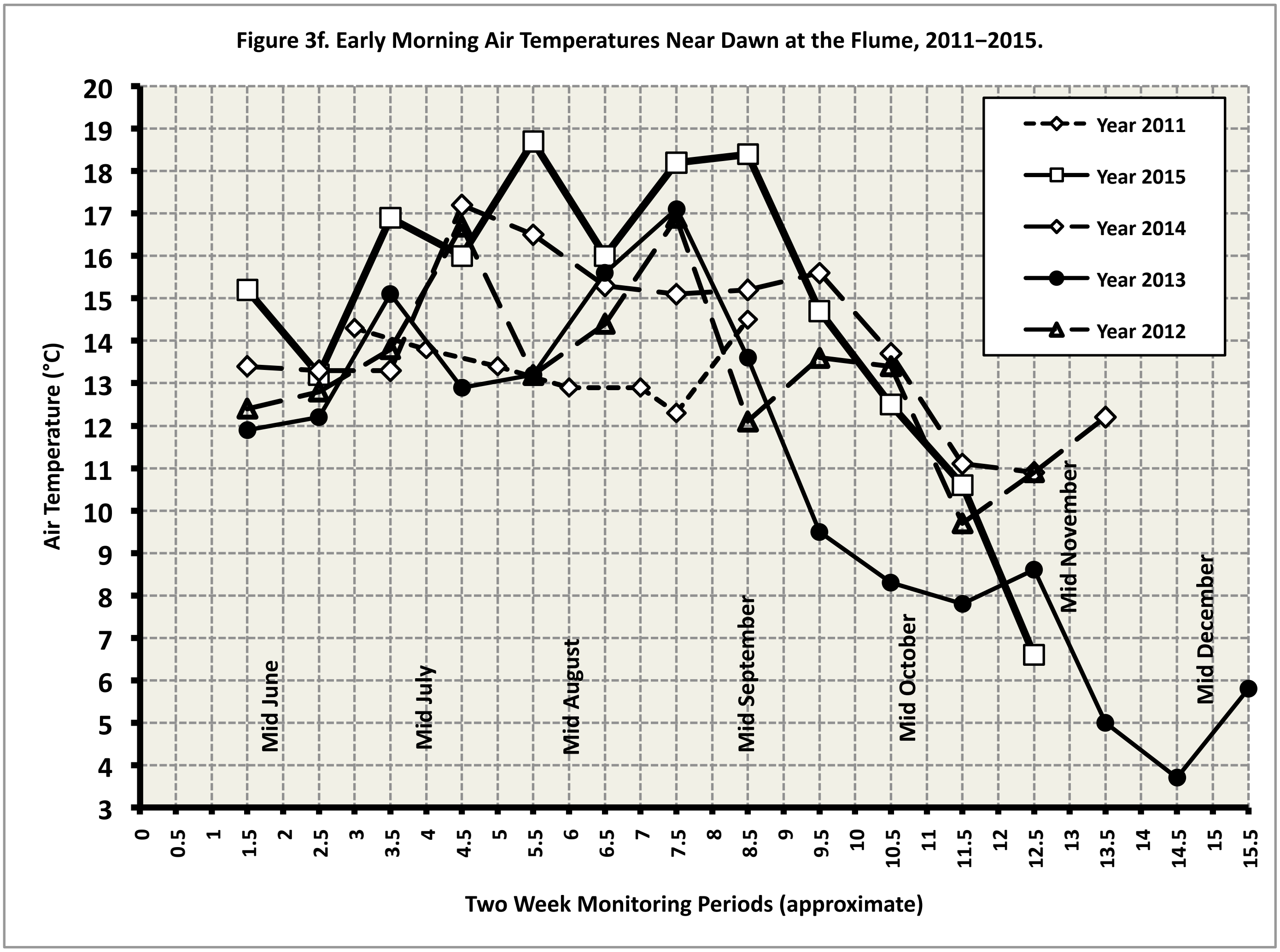


Figure 3f. Early Morning Air Temperatures Near Dawn at the Flume, 2011−2015.

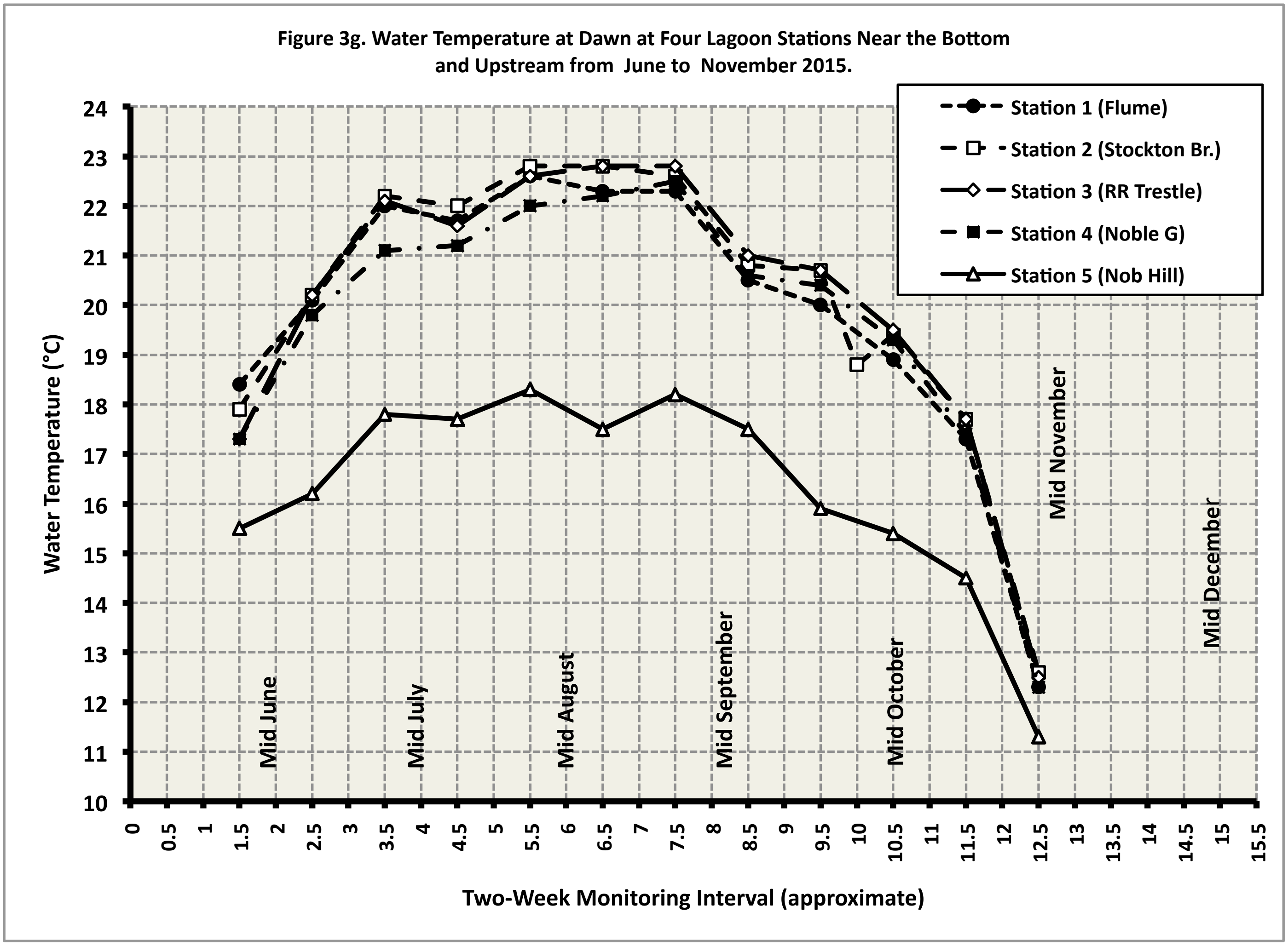


Figure 3g. Water Temperature at Dawn at Four Lagoon Stations Near the Bottom and Upstream from June to November 2015.

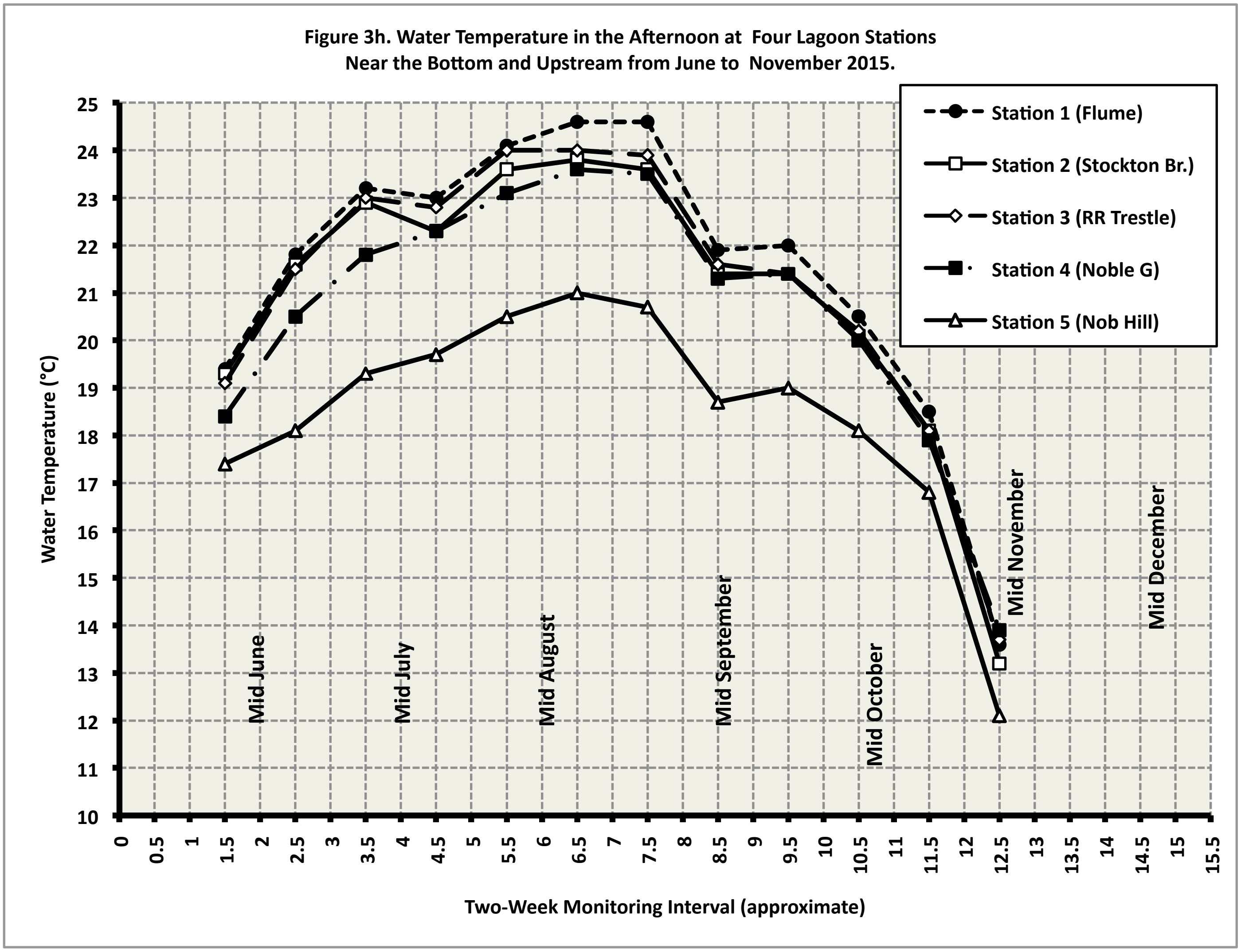


Figure 3h. Water Temperature in the Afternoon at Four Lagoon Stations Near the Bottom and Upstream from June to November 2015.

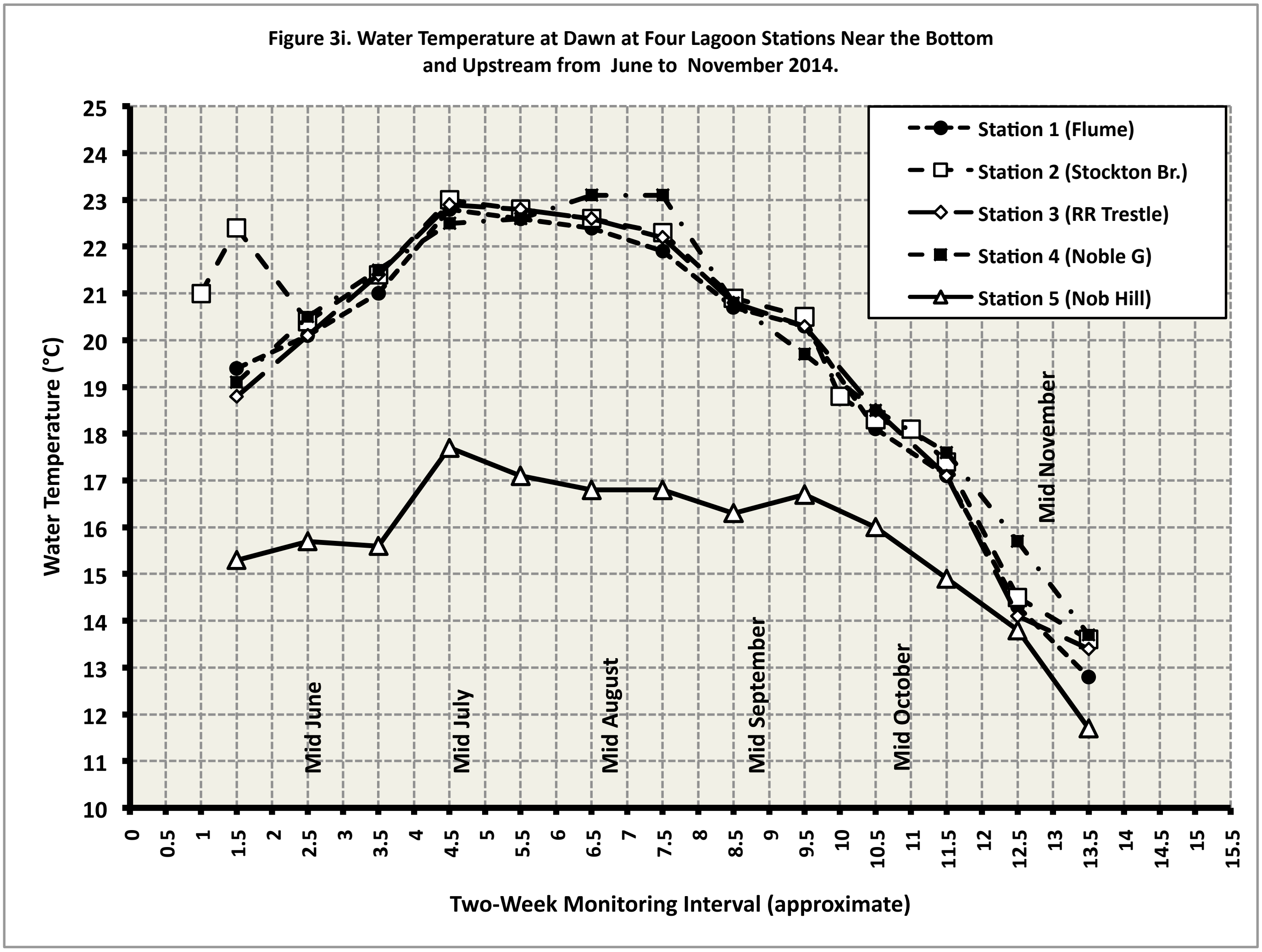


Figure 3i. Water Temperature at Dawn at Four Lagoon Stations Near the Bottom and Upstream from June to November 2014.

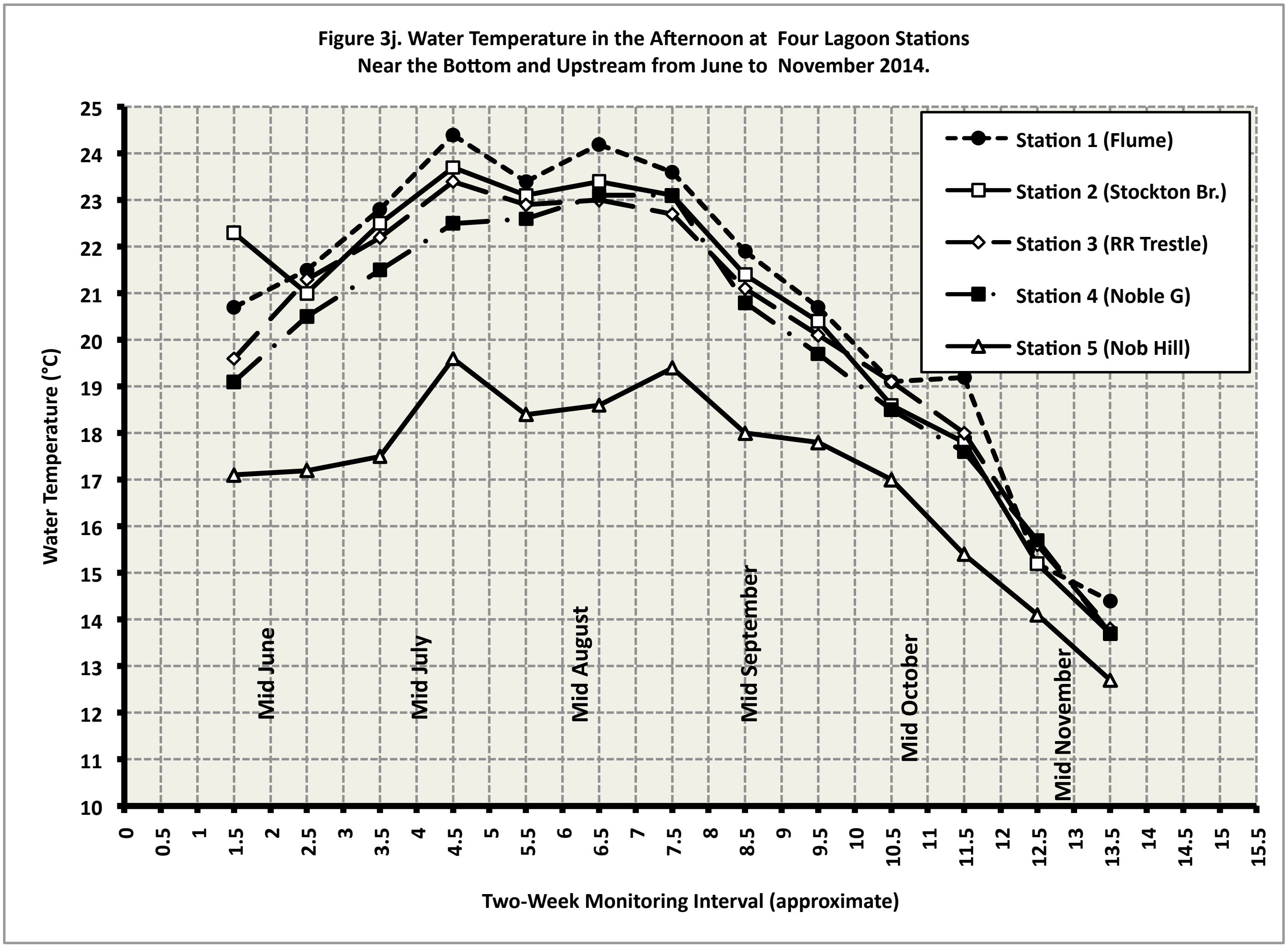


Figure 3j. Water Temperature in the Afternoon at Four Lagoon Stations Near the Bottom and Upstream from June to November 2014.

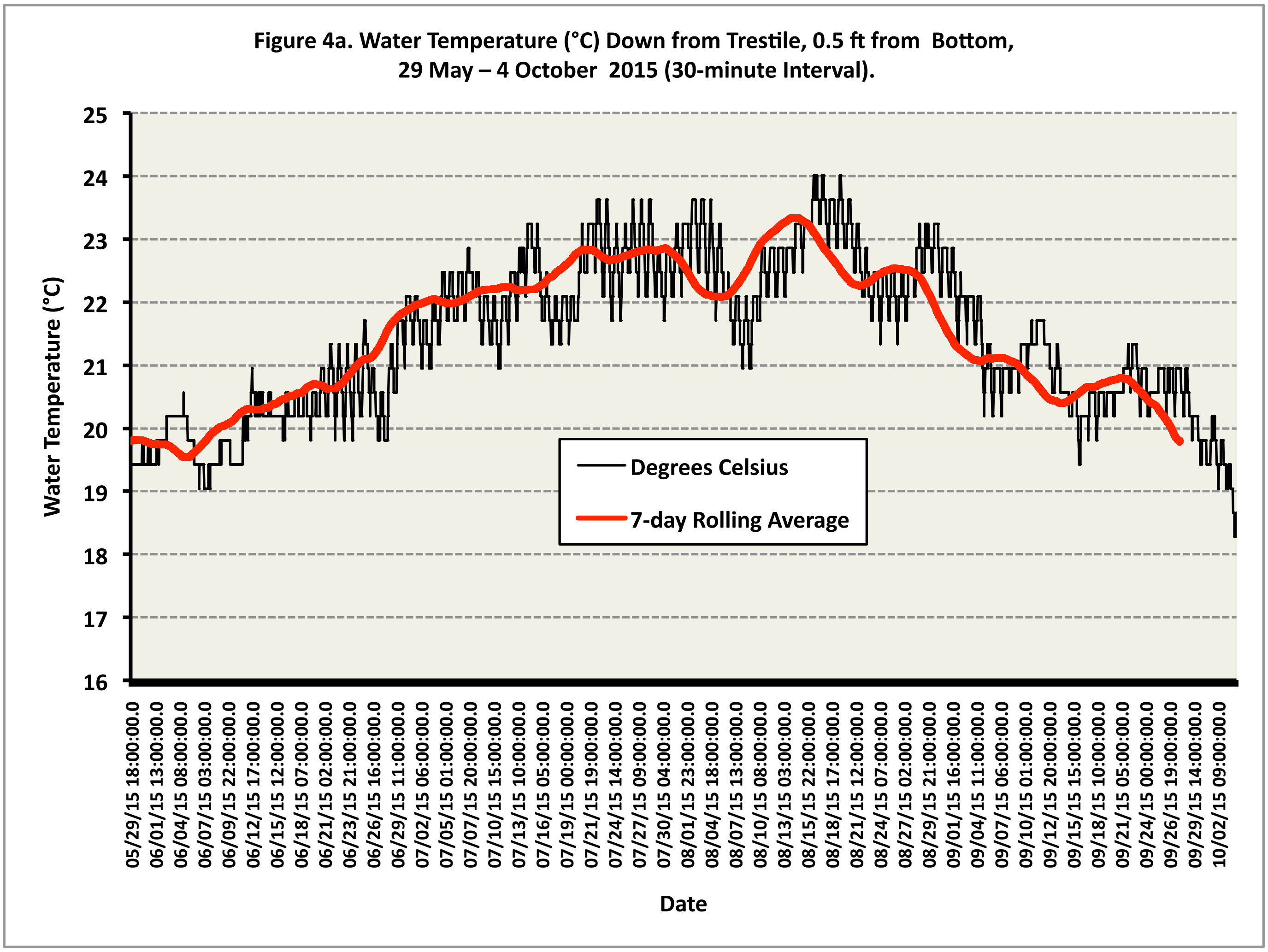


Figure 4a. Water Temperature (°C) Down from Trestile, 0.5 ft from Bottom,
29 May – 4 October 2015 (30-minute Interval).

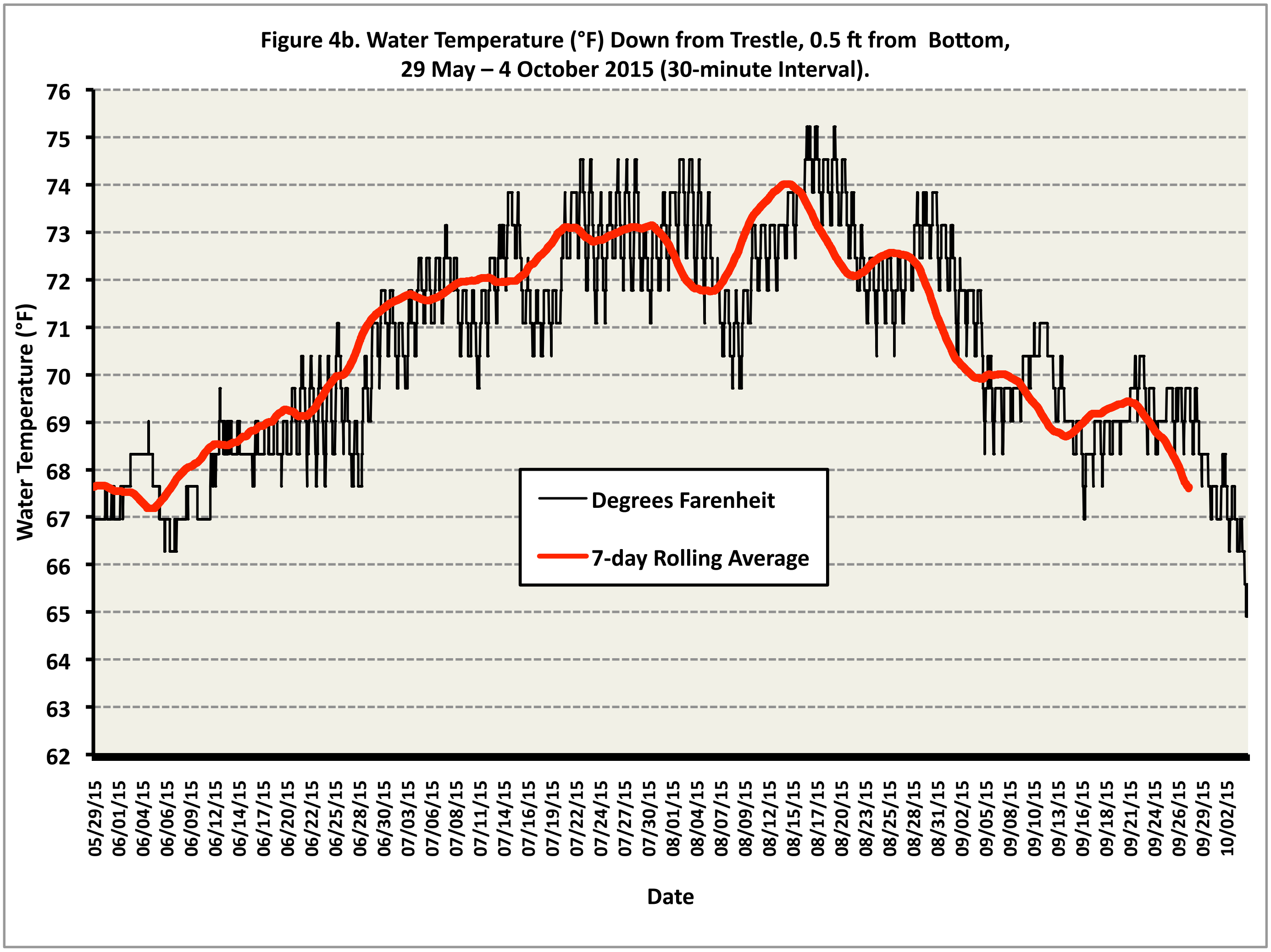


Figure 4b. Water Temperature (°F) Down from Trestle, 0.5 ft from Bottom, 29 May – 4 October 2015 (30-minute Interval).

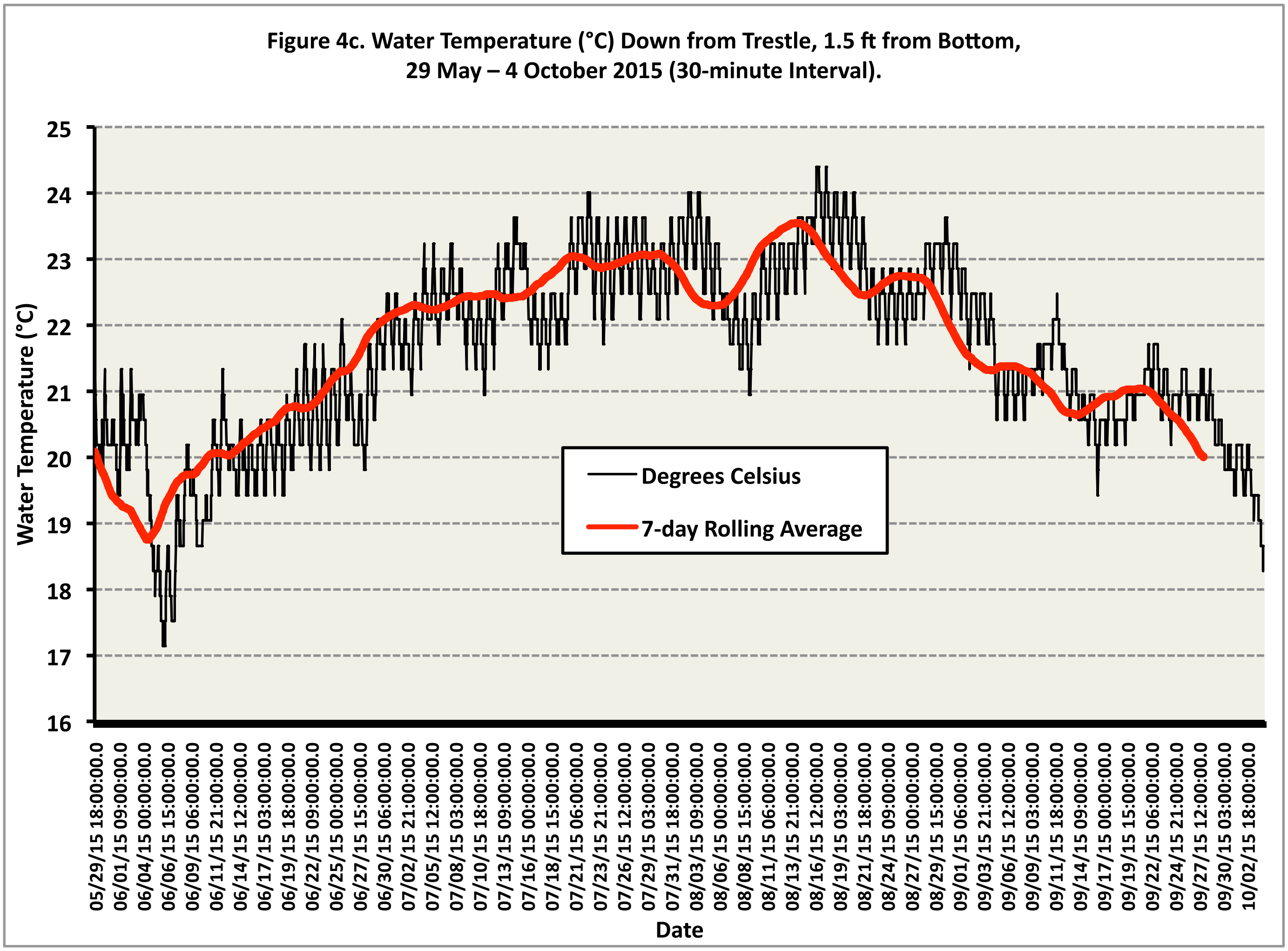


Figure 4c. Water Temperature (°C) Down from Trestle, 1.5 ft from Bottom, 29 May – 4 October 2015 (30-minute Interval).

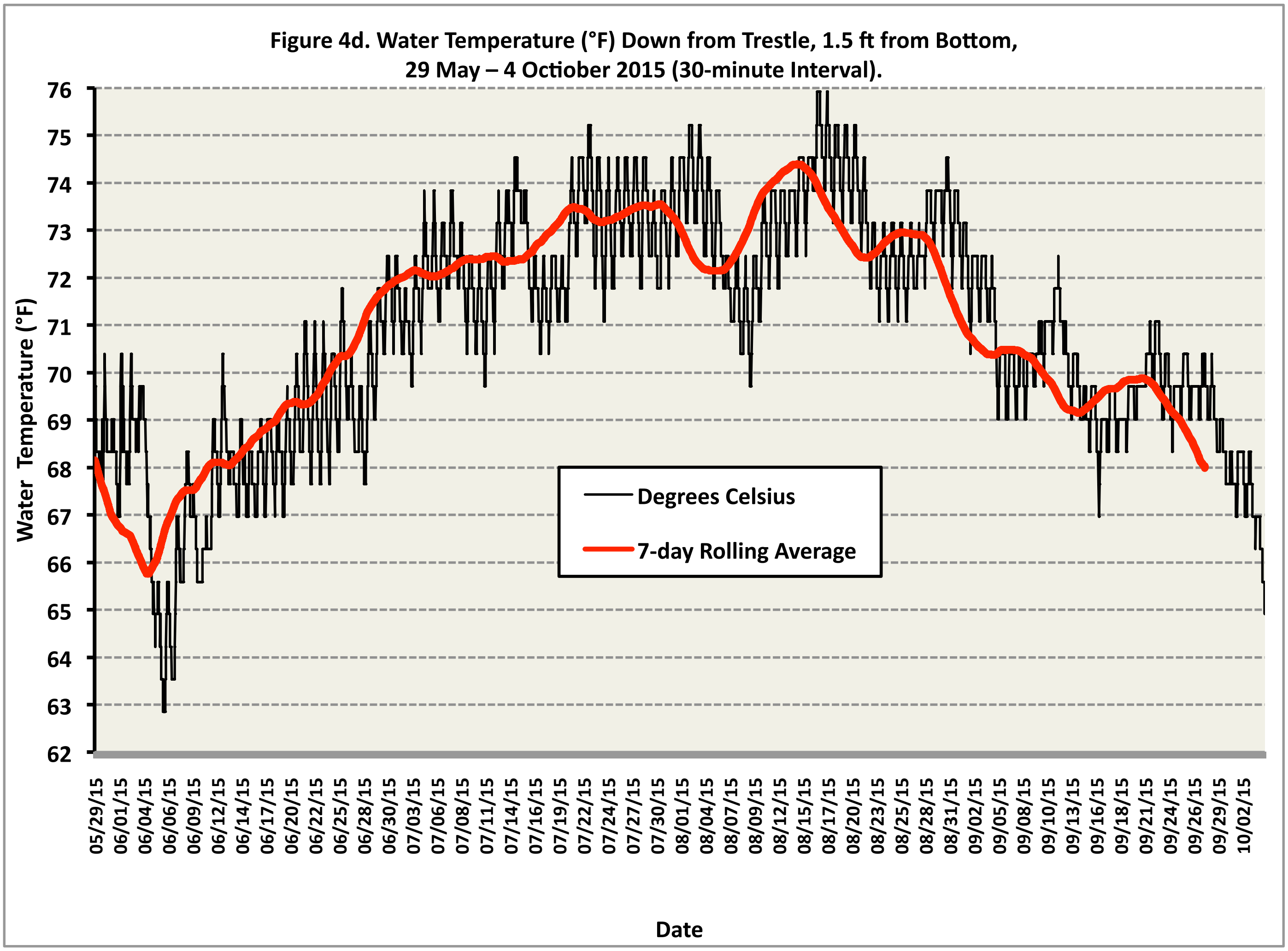


Figure 4d. Water Temperature (°F) Down from Trestle, 1.5 ft from Bottom,
29 May – 4 October 2015 (30-minute Interval).

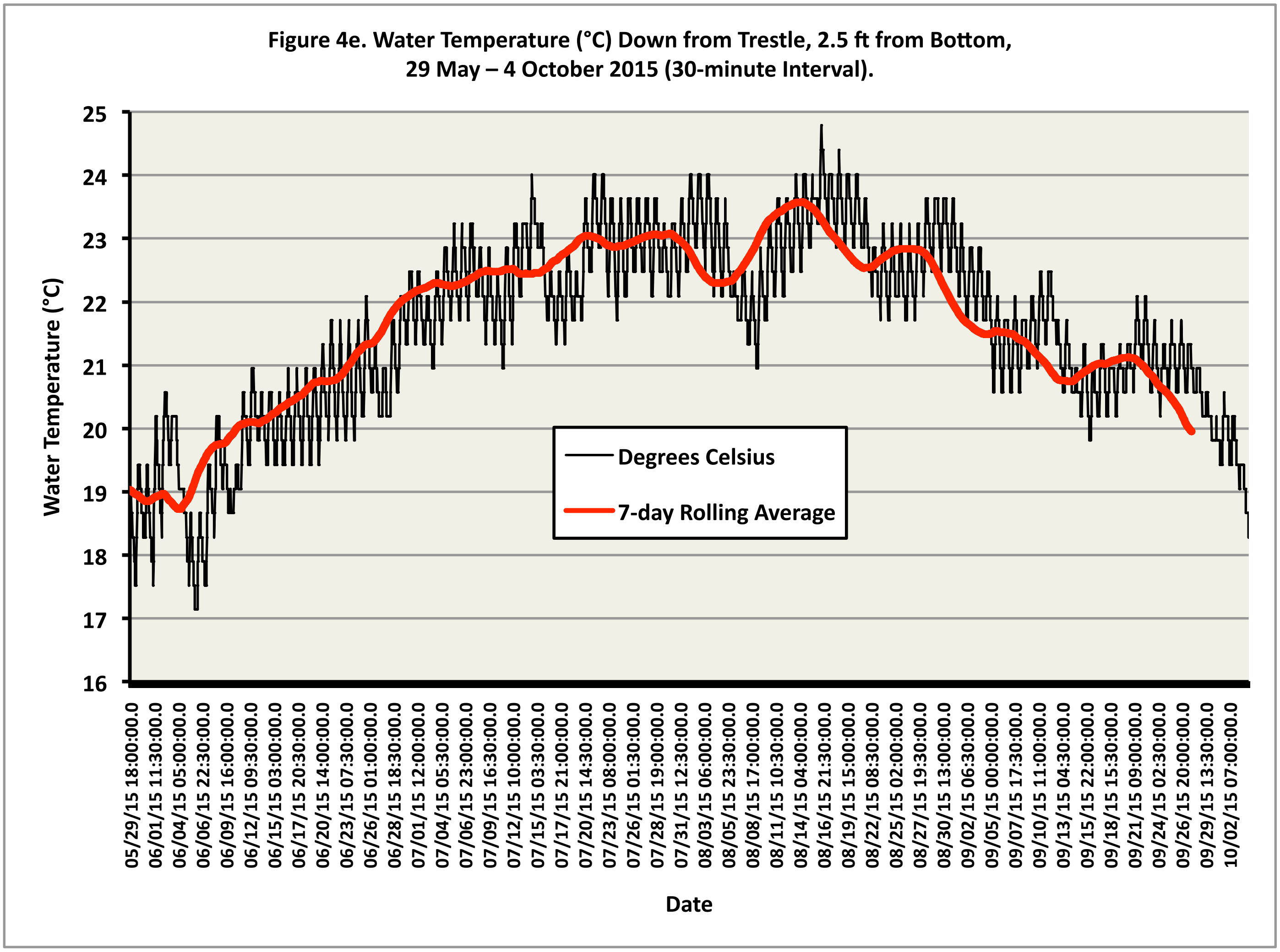


Figure 4e. Water Temperature (°C) Down from Trestle, 2.5 ft from Bottom, 29 May – 4 October 2015 (30-minute Interval).

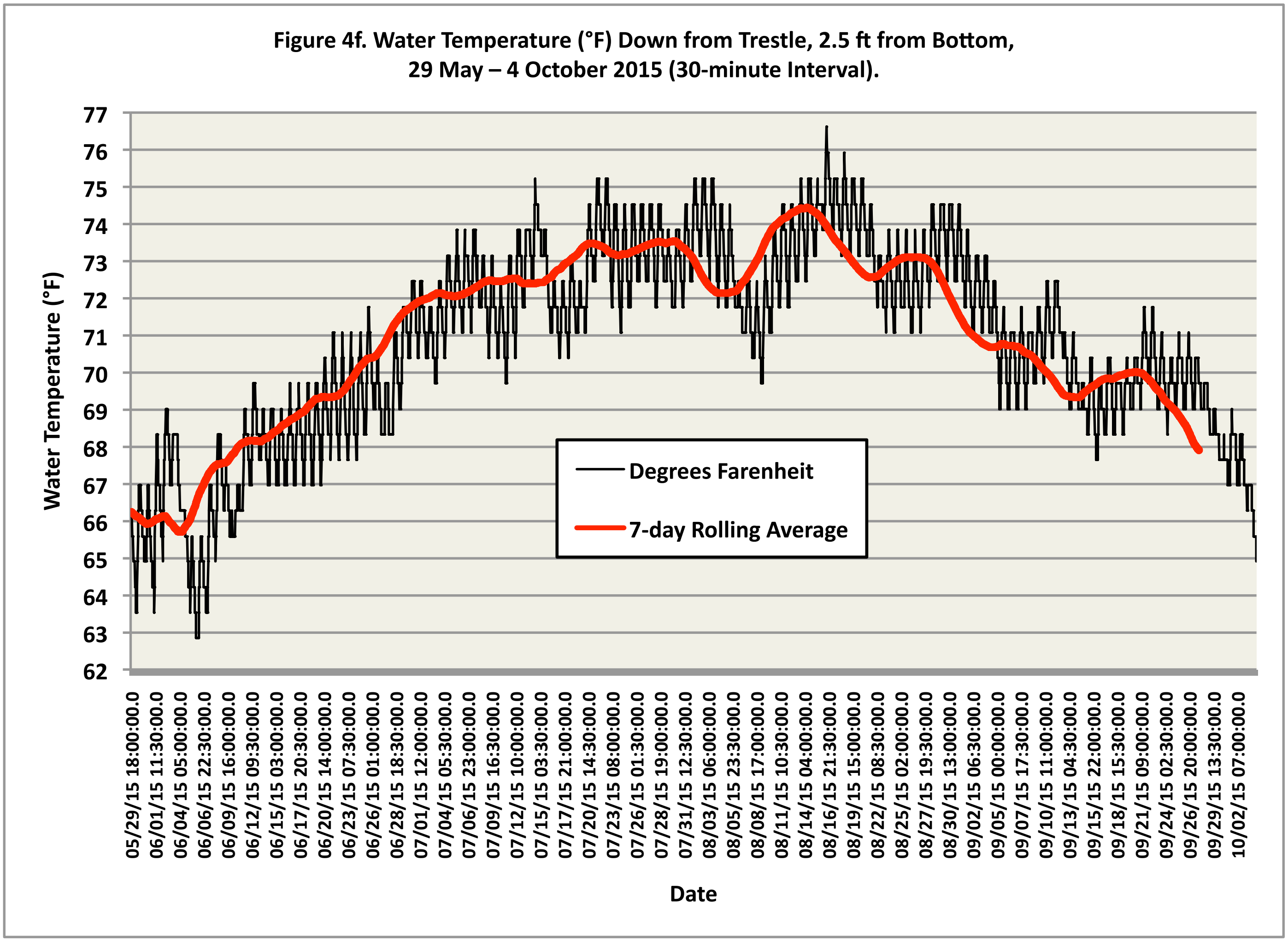


Figure 4f. Water Temperature (°F) Down from Trestle, 2.5 ft from Bottom, 29 May – 4 October 2015 (30-minute Interval).

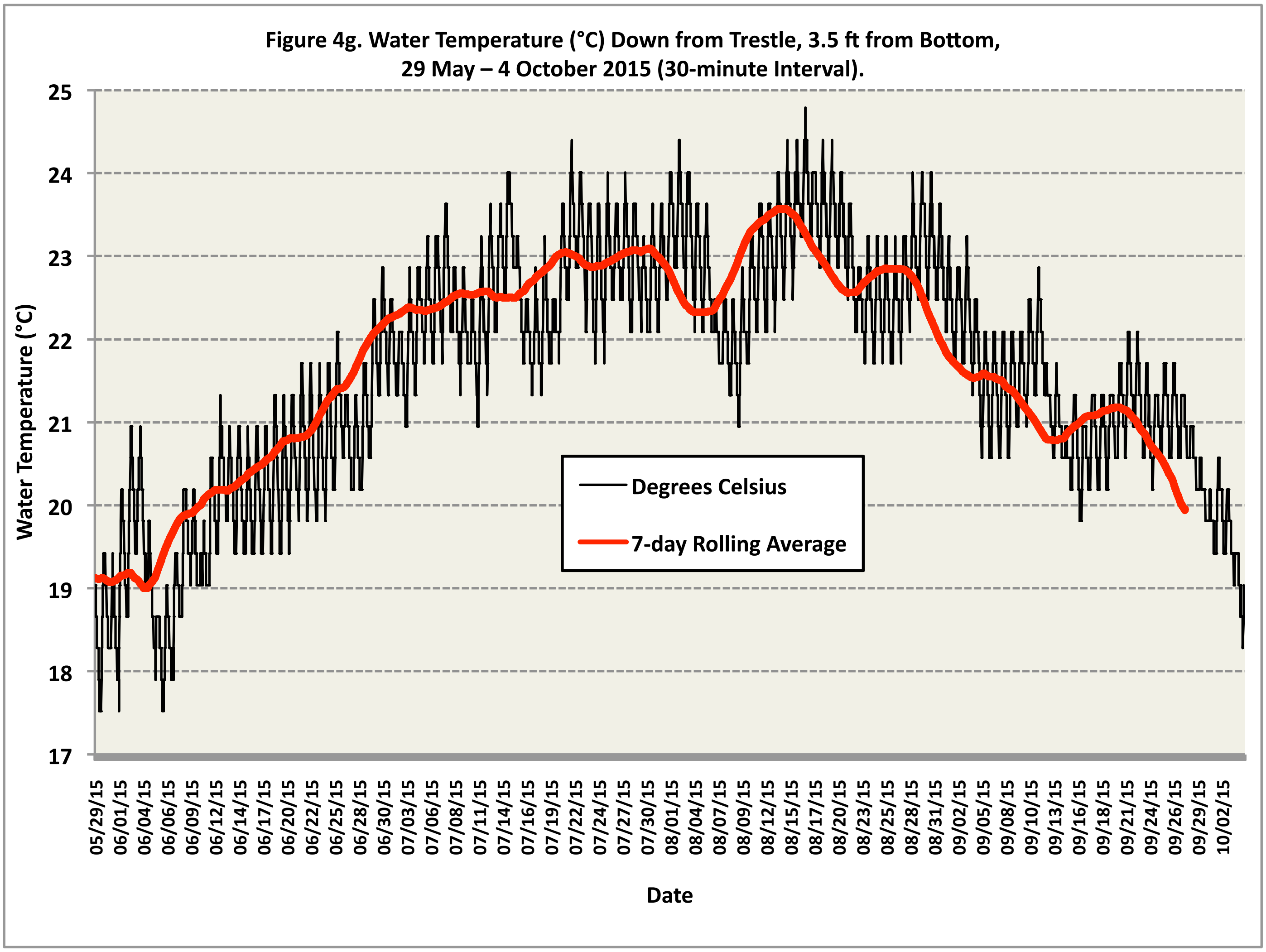


Figure 4g. Water Temperature (°C) Down from Trestle, 3.5 ft from Bottom, 29 May – 4 October 2015 (30-minute Interval).

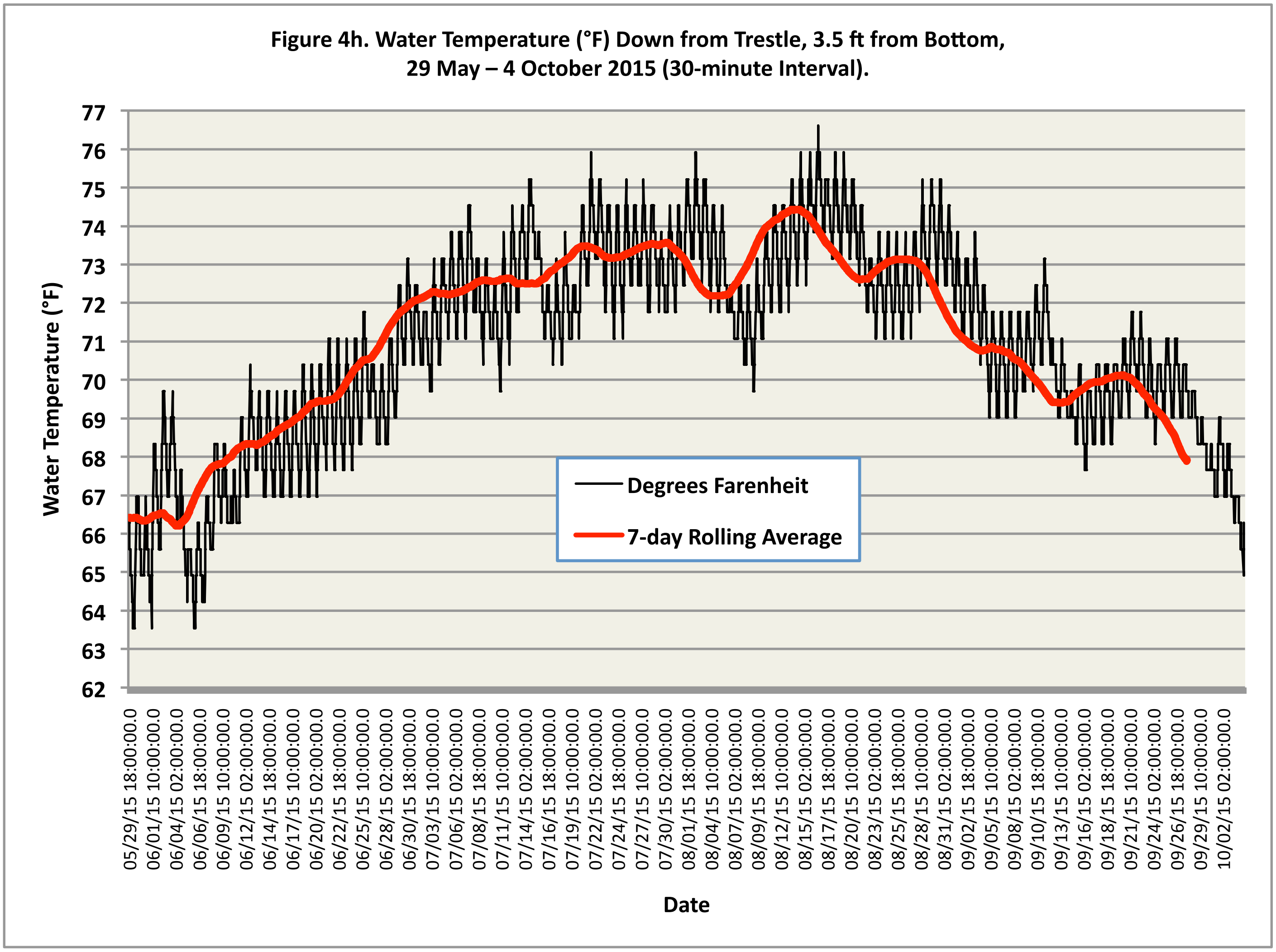


Figure 4h. Water Temperature (°F) Down from Trestle, 3.5 ft from Bottom, 29 May – 4 October 2015 (30-minute Interval).

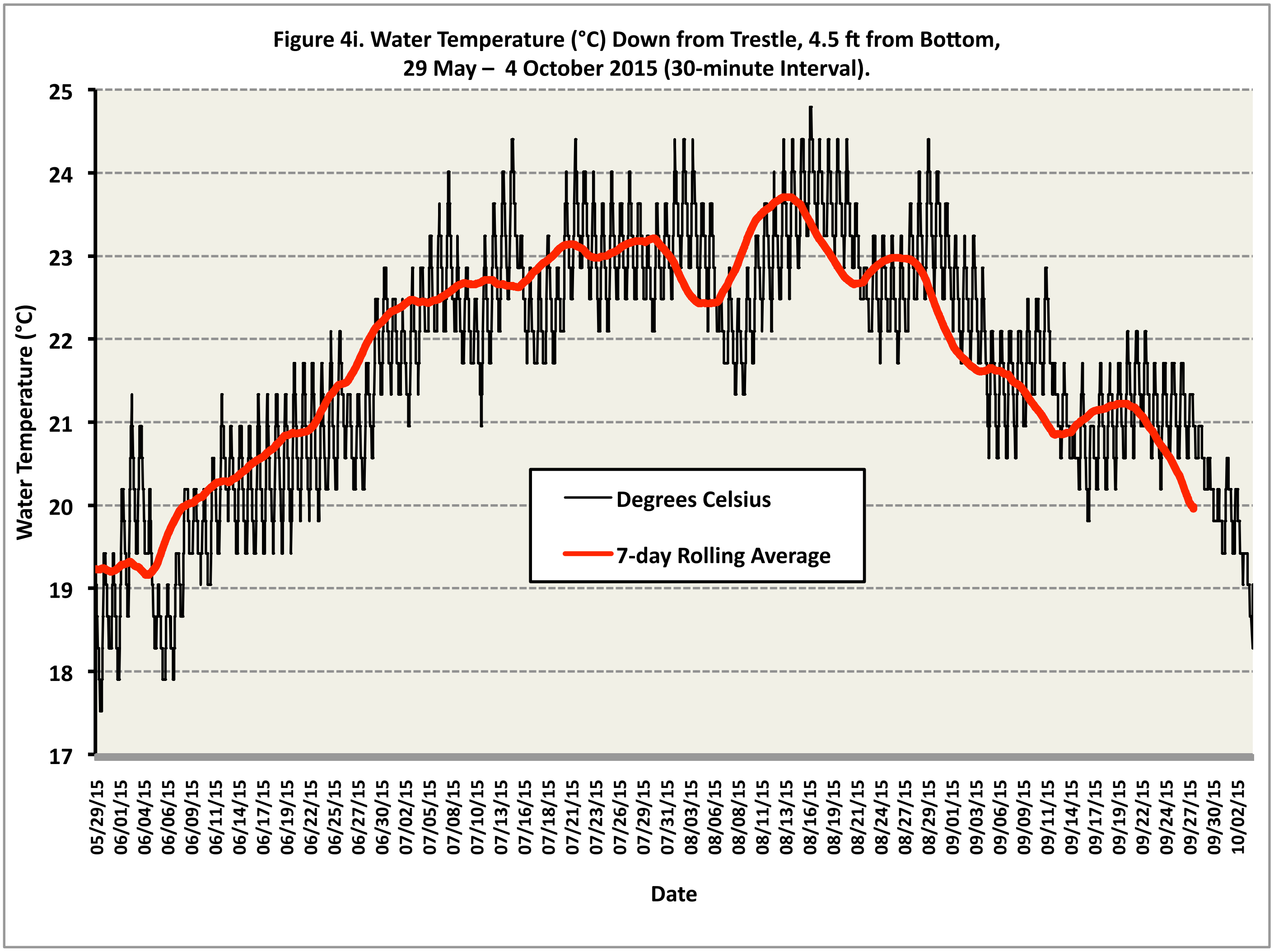


Figure 4i. Water Temperature (°C) Down from Trestle, 4.5 ft from Bottom, 29 May – 4 October 2015 (30-minute Interval).

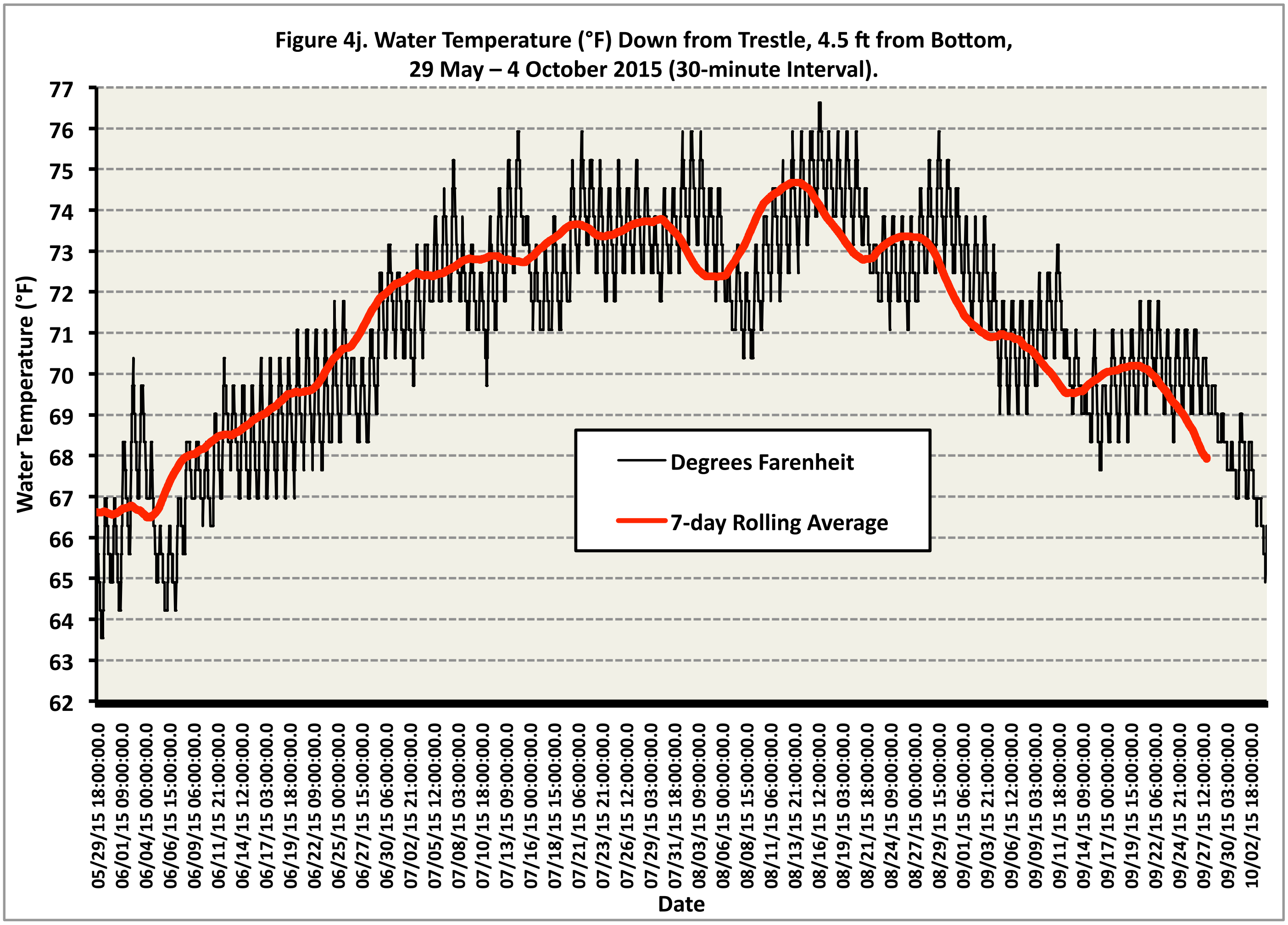


Figure 4j. Water Temperature (°F) Down from Trestle, 4.5 ft from Bottom, 29 May – 4 October 2015 (30-minute Interval).

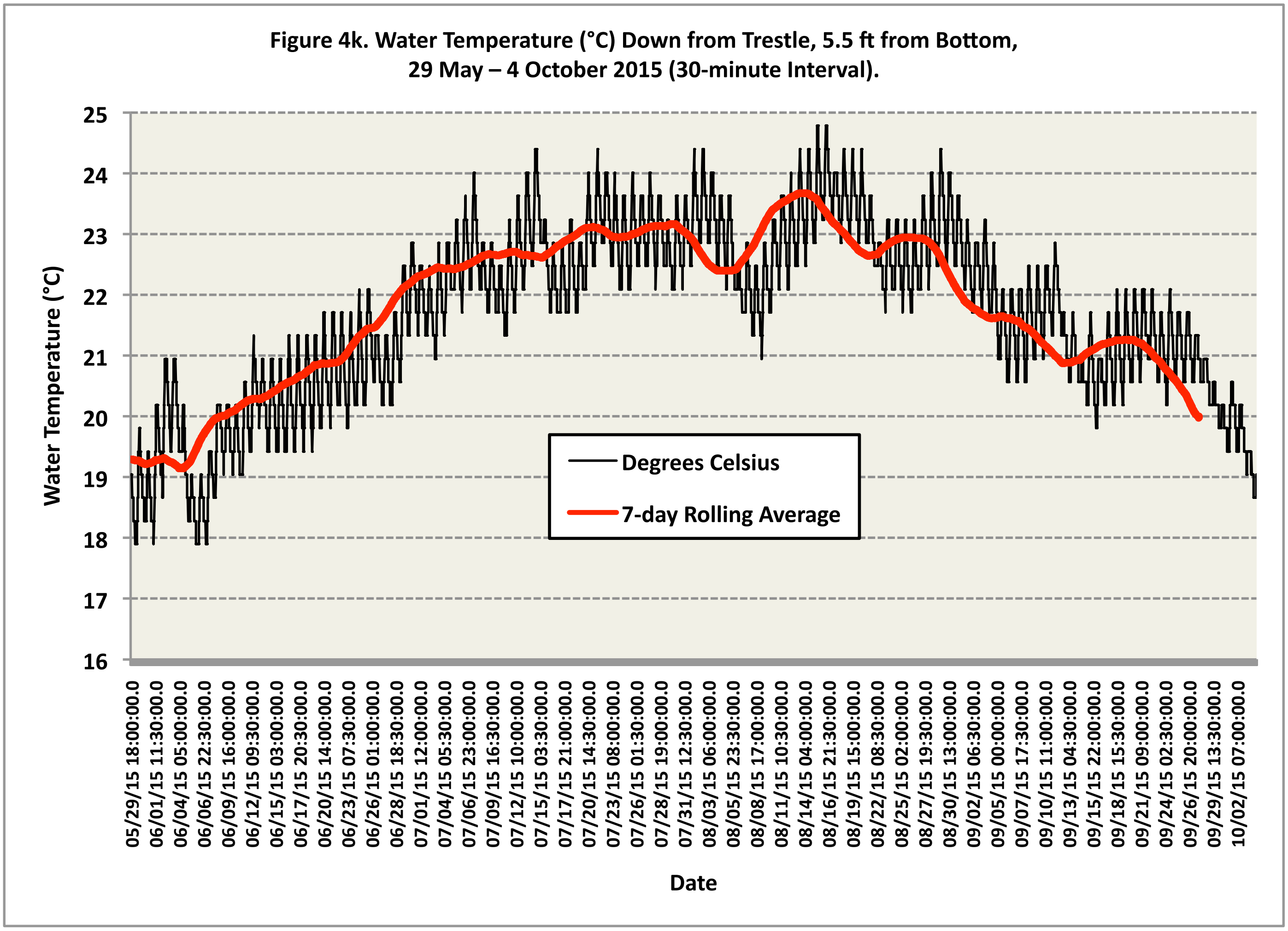


Figure 4k. Water Temperature (°C) Down from Trestle, 5.5 ft from Bottom, 29 May – 4 October 2015 (30-minute Interval).

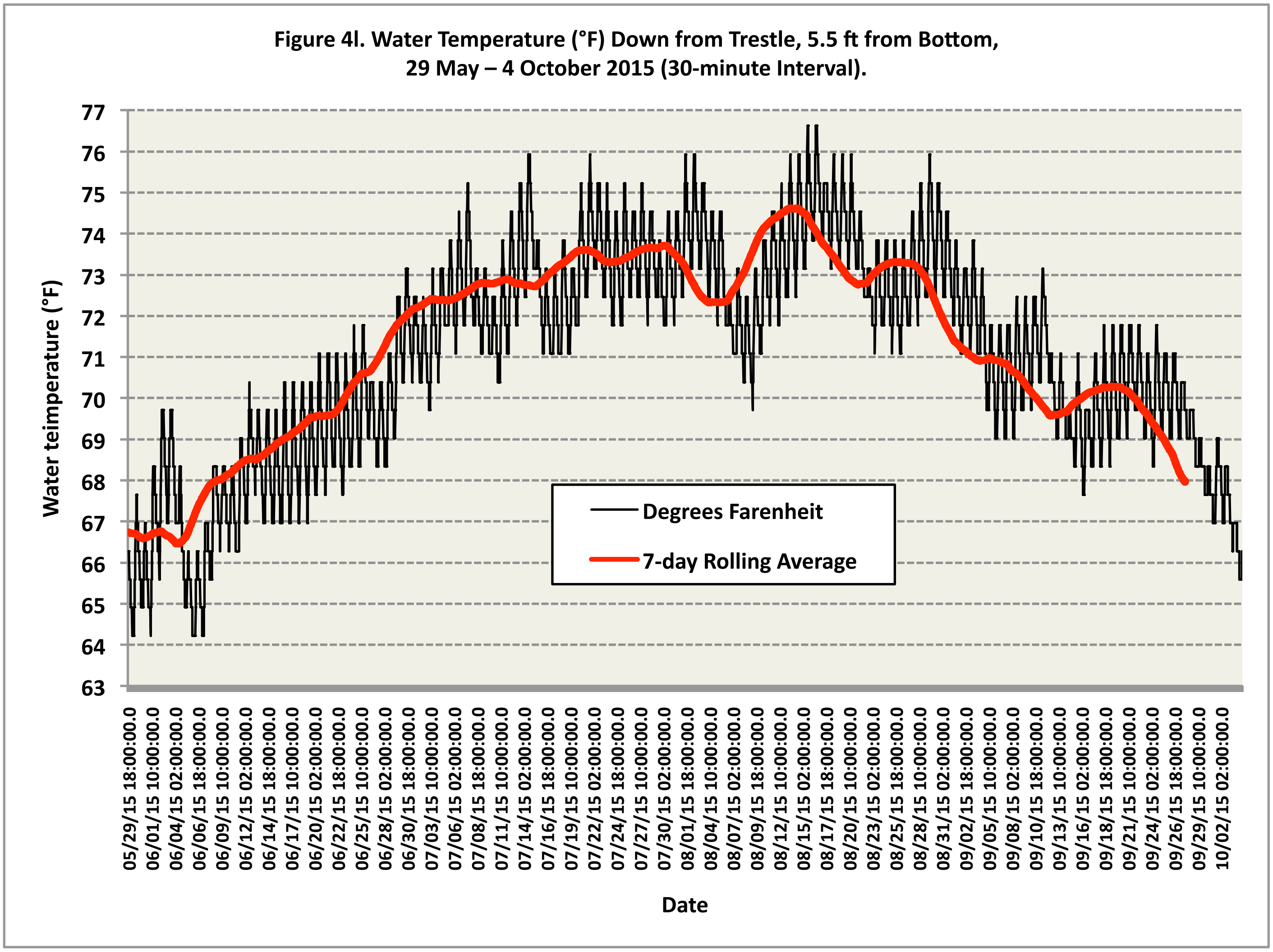


Figure 4l. Water Temperature (°F) Down from Trestle, 5.5 ft from Bottom, 31 May – 19 October 2014 (30-minute Interval).

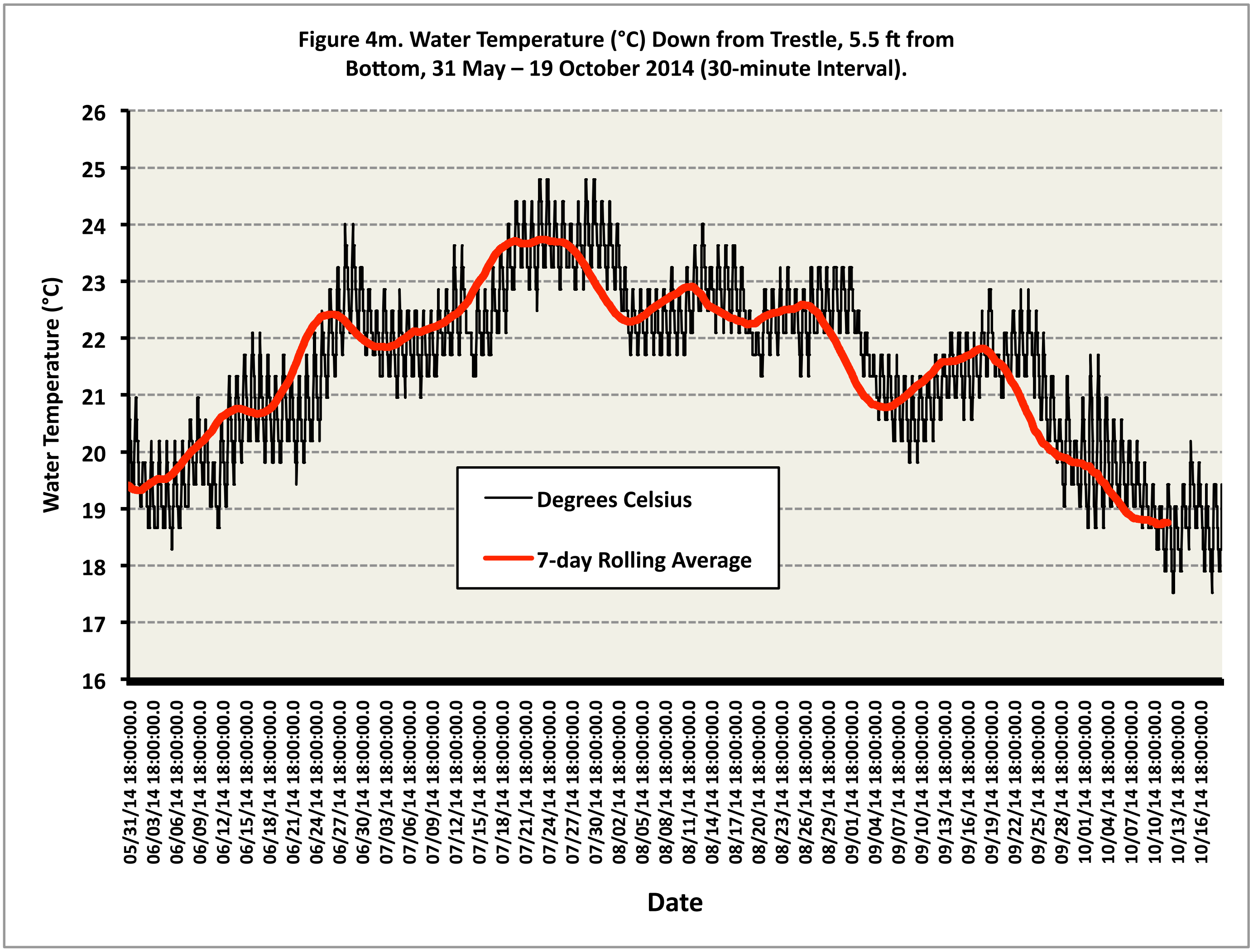


Figure 4m. Water Temperature (°C) Down from Trestle, 5.5 ft from Bottom, 31 May – 19 October 2014 (30-minute Interval).

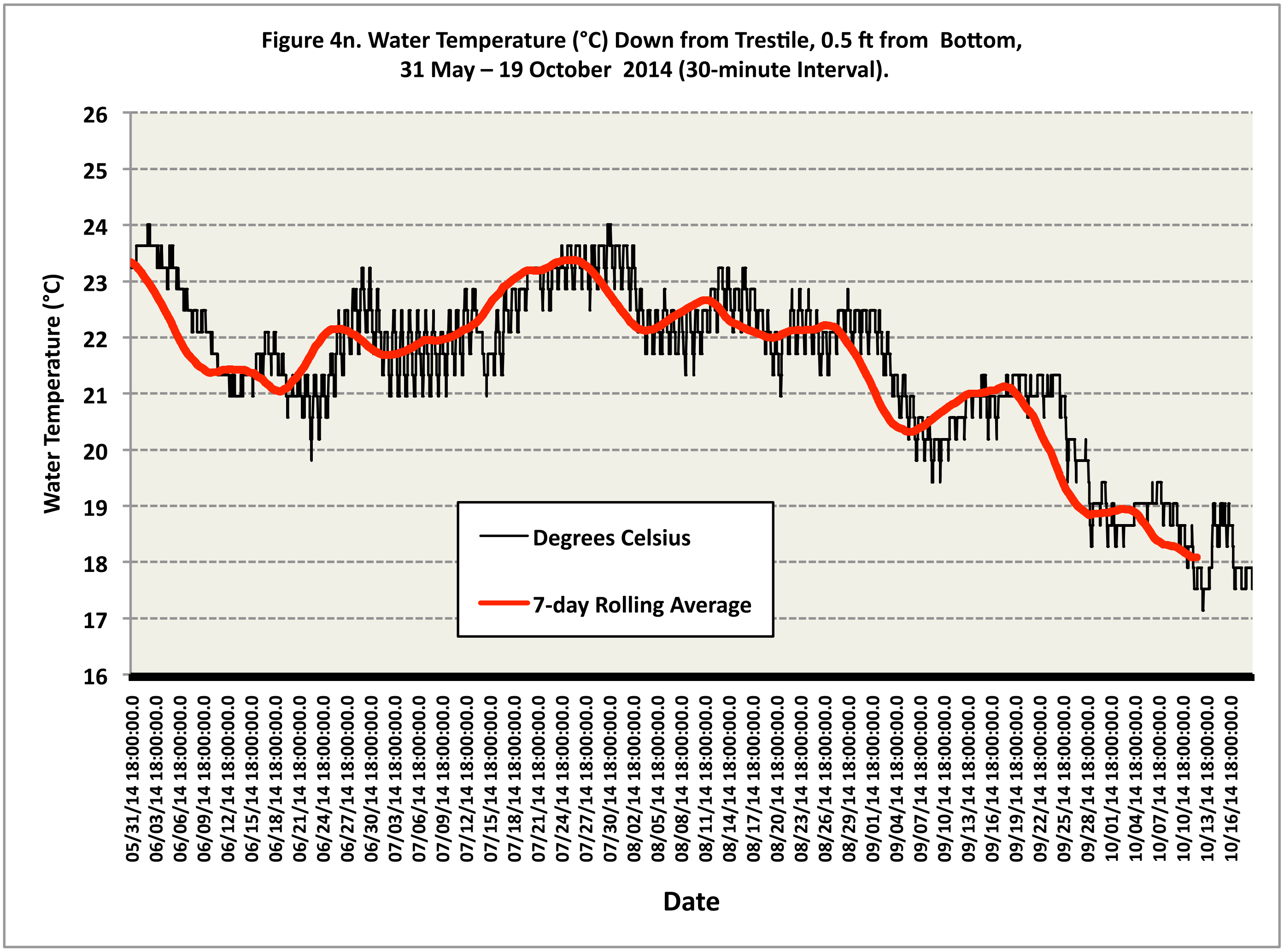


Figure 4n. Water Temperature (°C) Down from Trestile, 0.5 ft from Bottom, 31 May – 19 October 2014 (30-minute Interval).

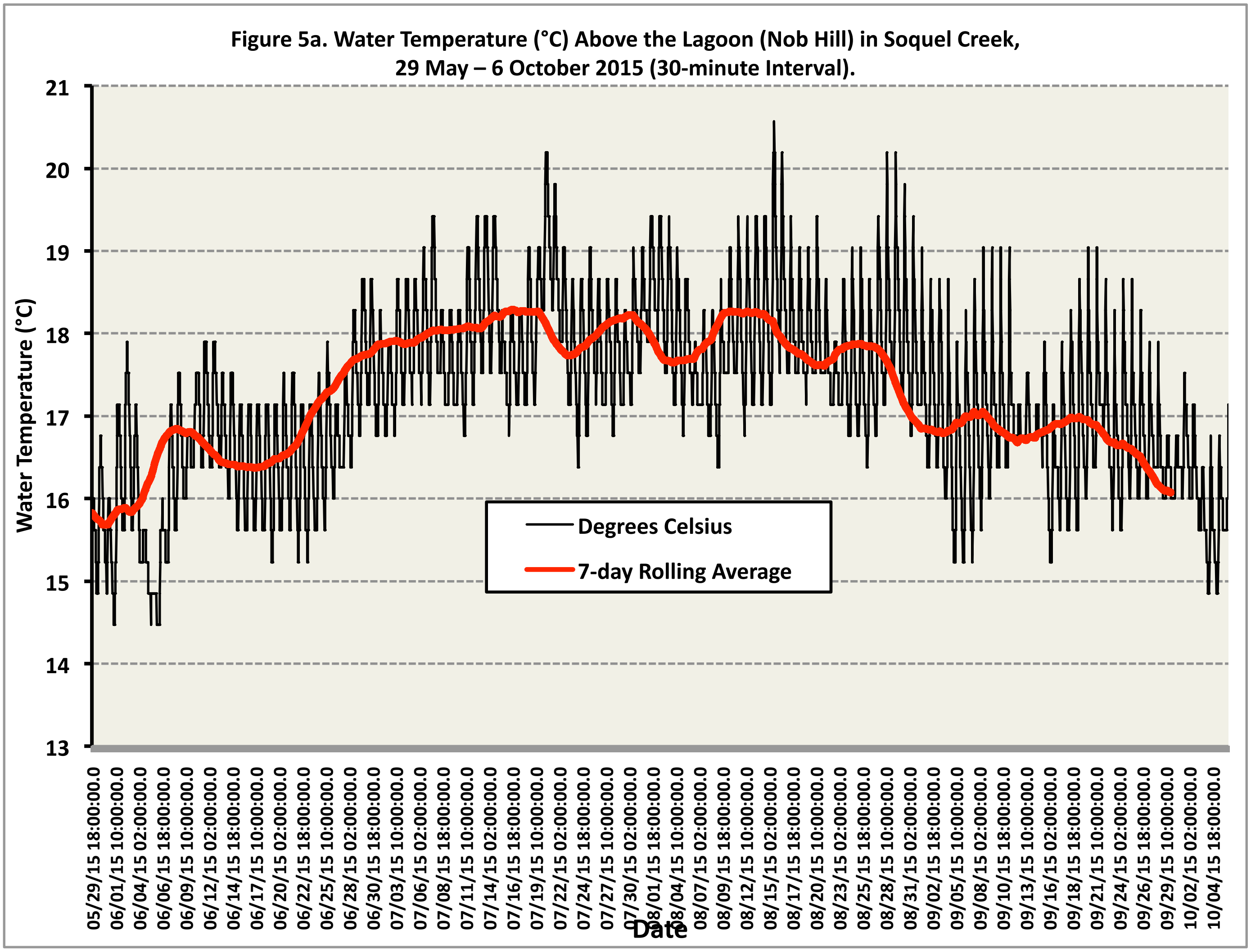


Figure 5a. Water Temperature (°C) Above the Lagoon (Nob Hill) in Soquel Creek, 29 May – 6 October 2015 (30-minute Interval).

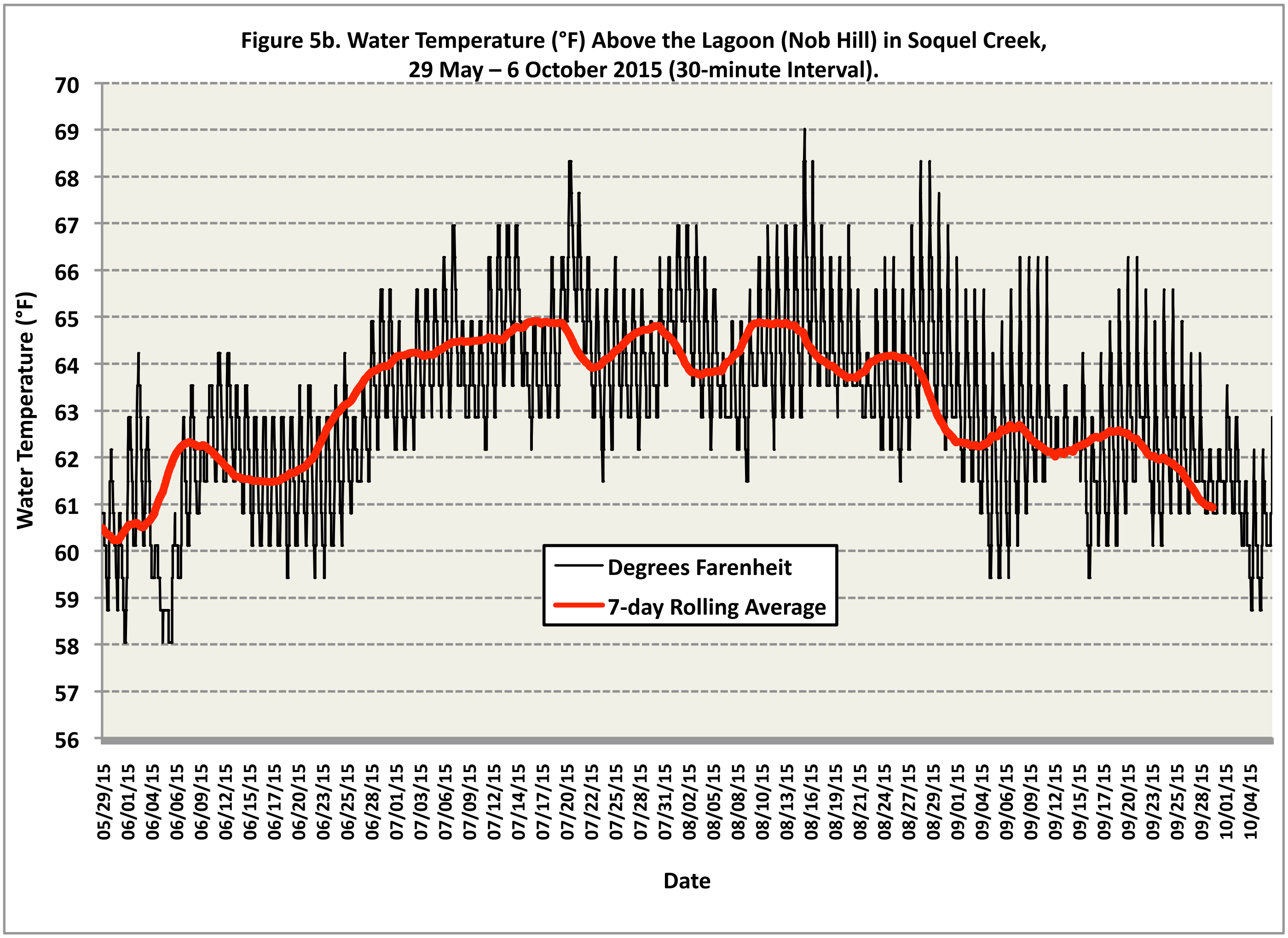


Figure 5b. Water Temperature (°F) Above the Lagoon (Nob Hill) in Soquel Creek, 29 May – 6 October 2015 (30-minute Interval).

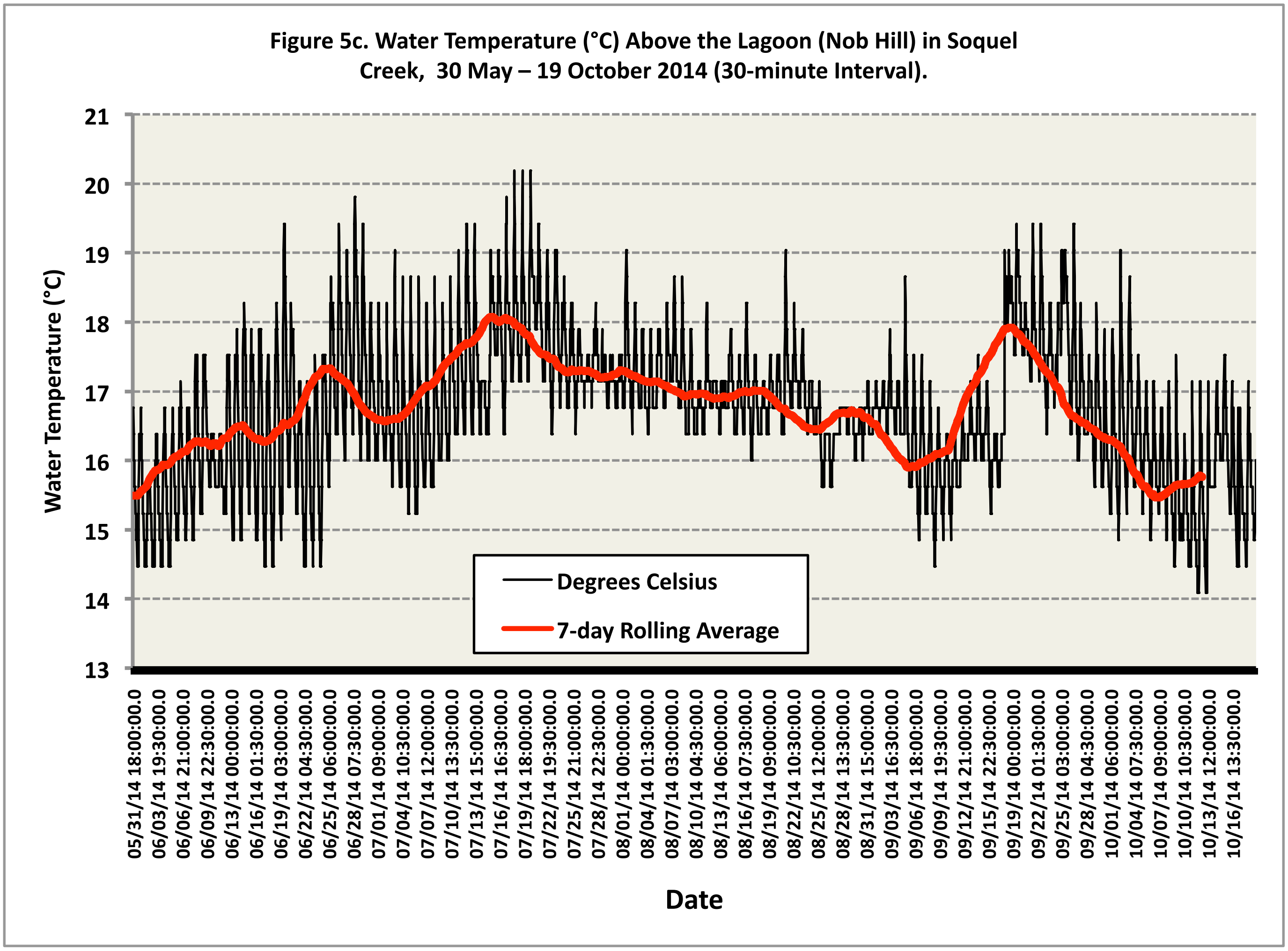


Figure 5c. Water Temperature (°C) Above the Lagoon (Nob Hill) in Soquel Creek, 31 May – 19 October 2014 (30-minute Interval).

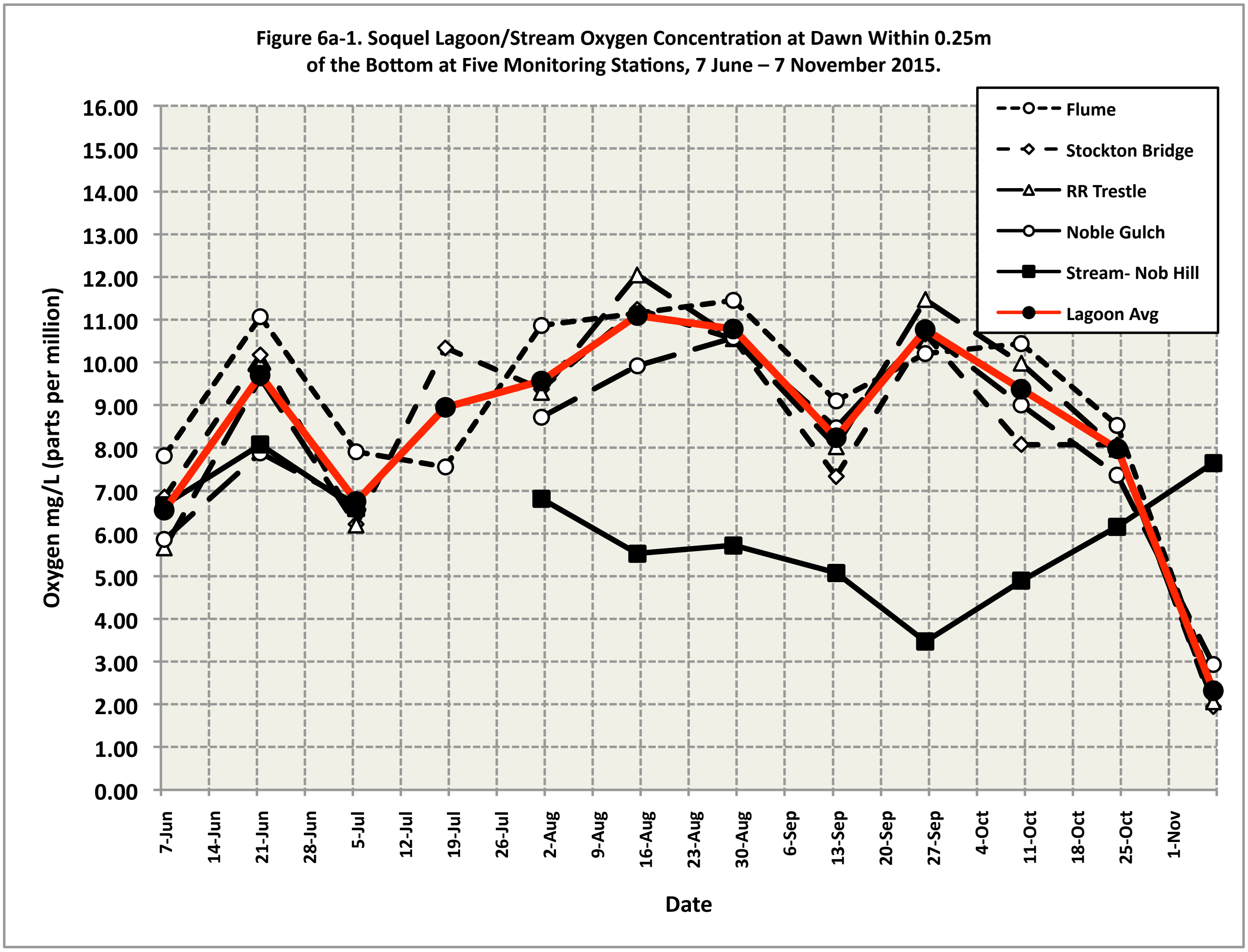


Figure 6a-1. Soquel Lagoon/Stream Oxygen Concentration at Dawn Within 0.25m of the Bottom at Five Monitoring Stations, 7 June – 7 November 2015.

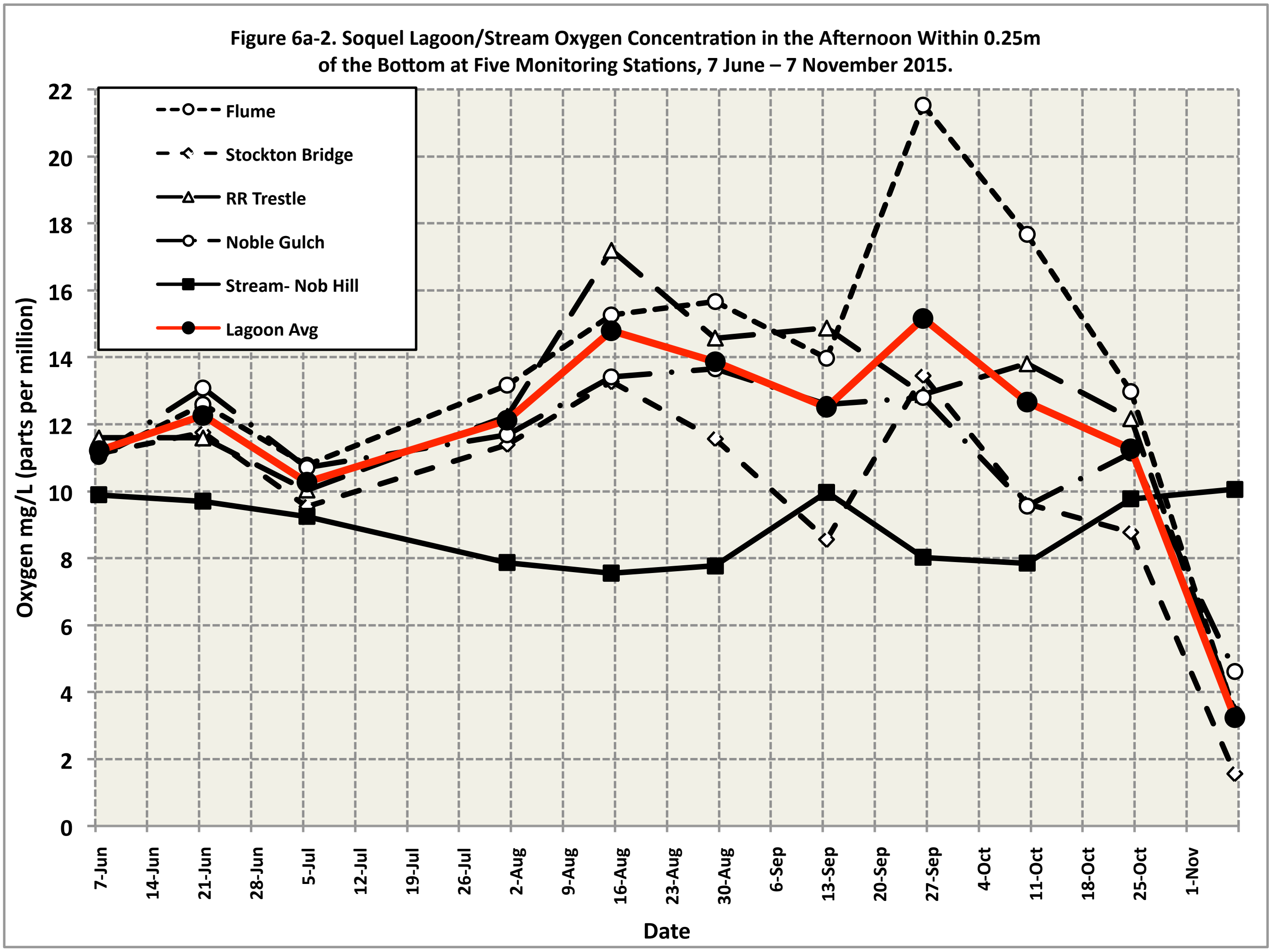


Figure 6a-2. Soquel Lagoon/Stream Oxygen Concentration in the Afternoon Within 0.25m of the Bottom at Five Monitoring Stations, 7 June – 7 November 2015.

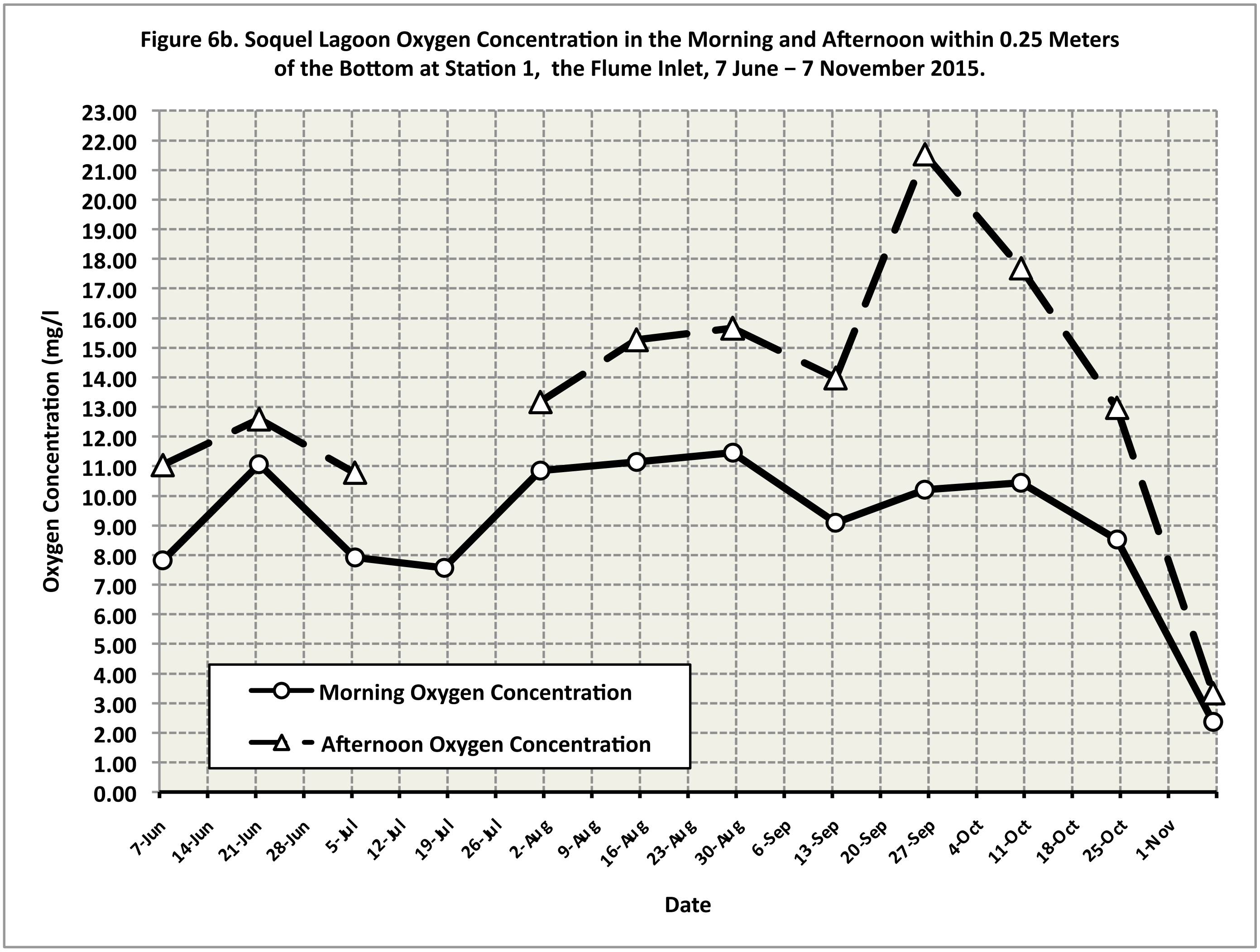


Figure 6b. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 1, the Flume Inlet, 7 June – 7 November 2015.

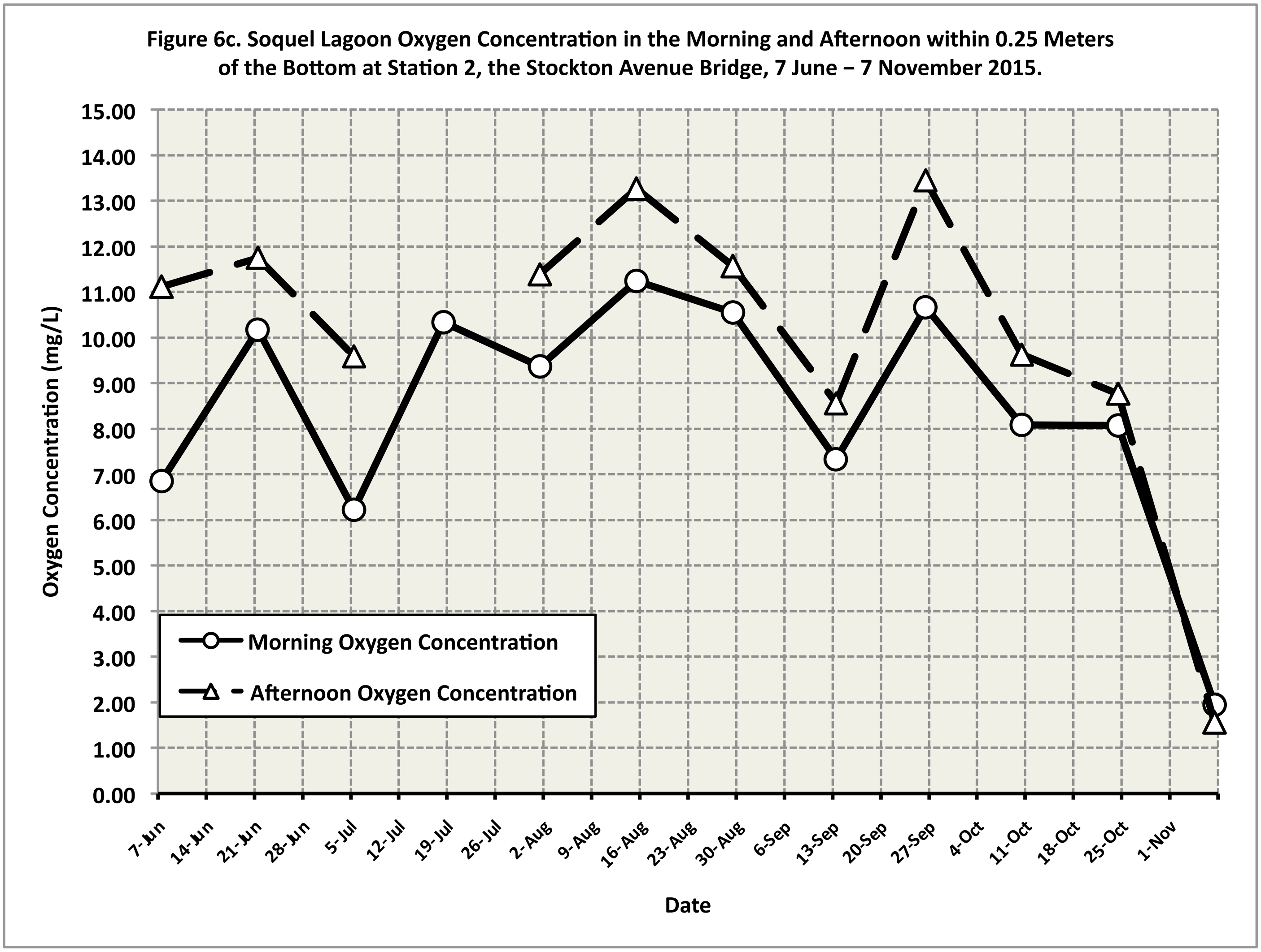


Figure 6c. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 2, the Stockton Avenue Bridge, 7 June – 7 November 2015.

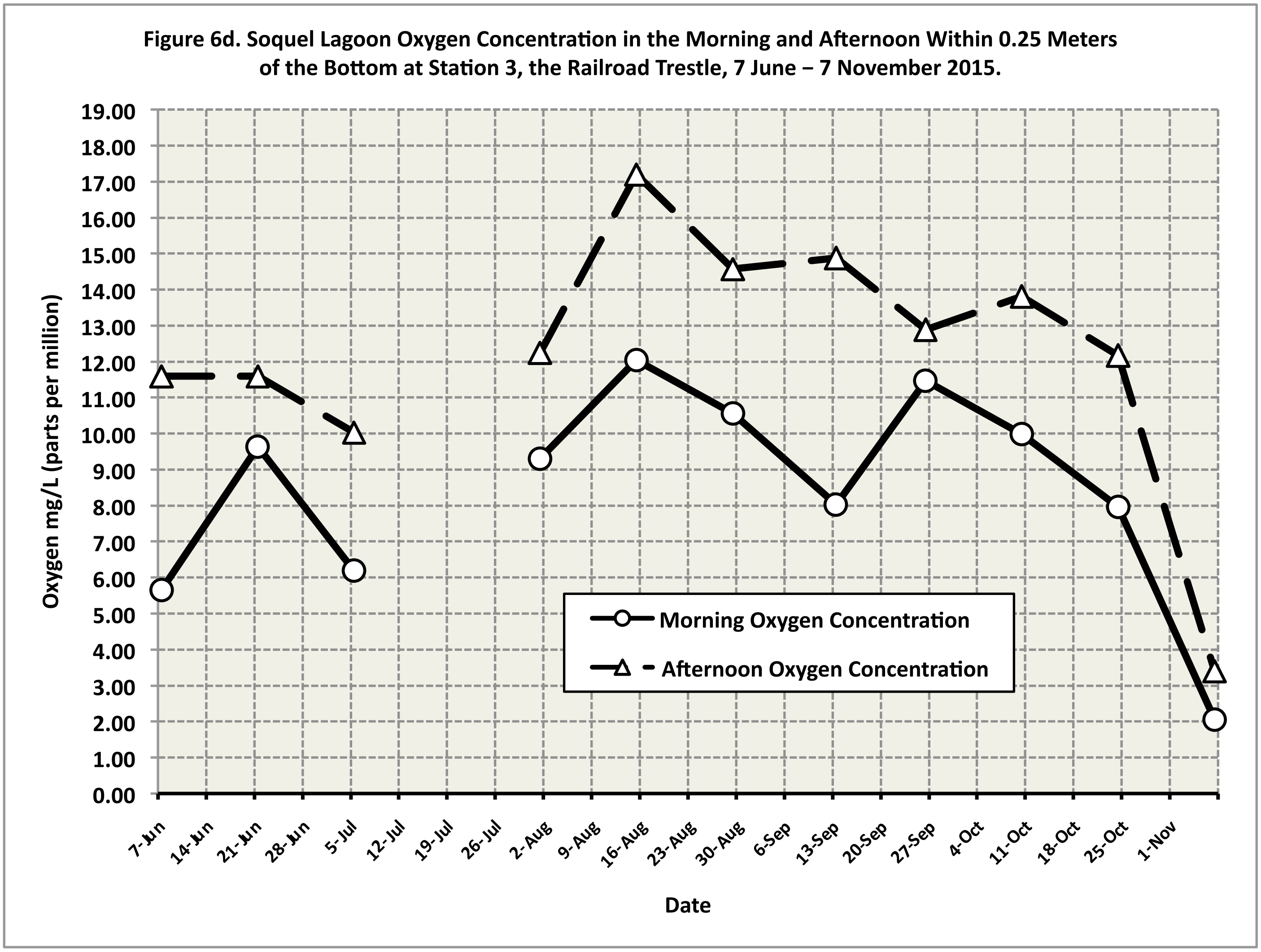


Figure 6d. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon Within 0.25 Meters of the Bottom at Station 3, the Railroad Trestle, 7 June – 7 November 2015.

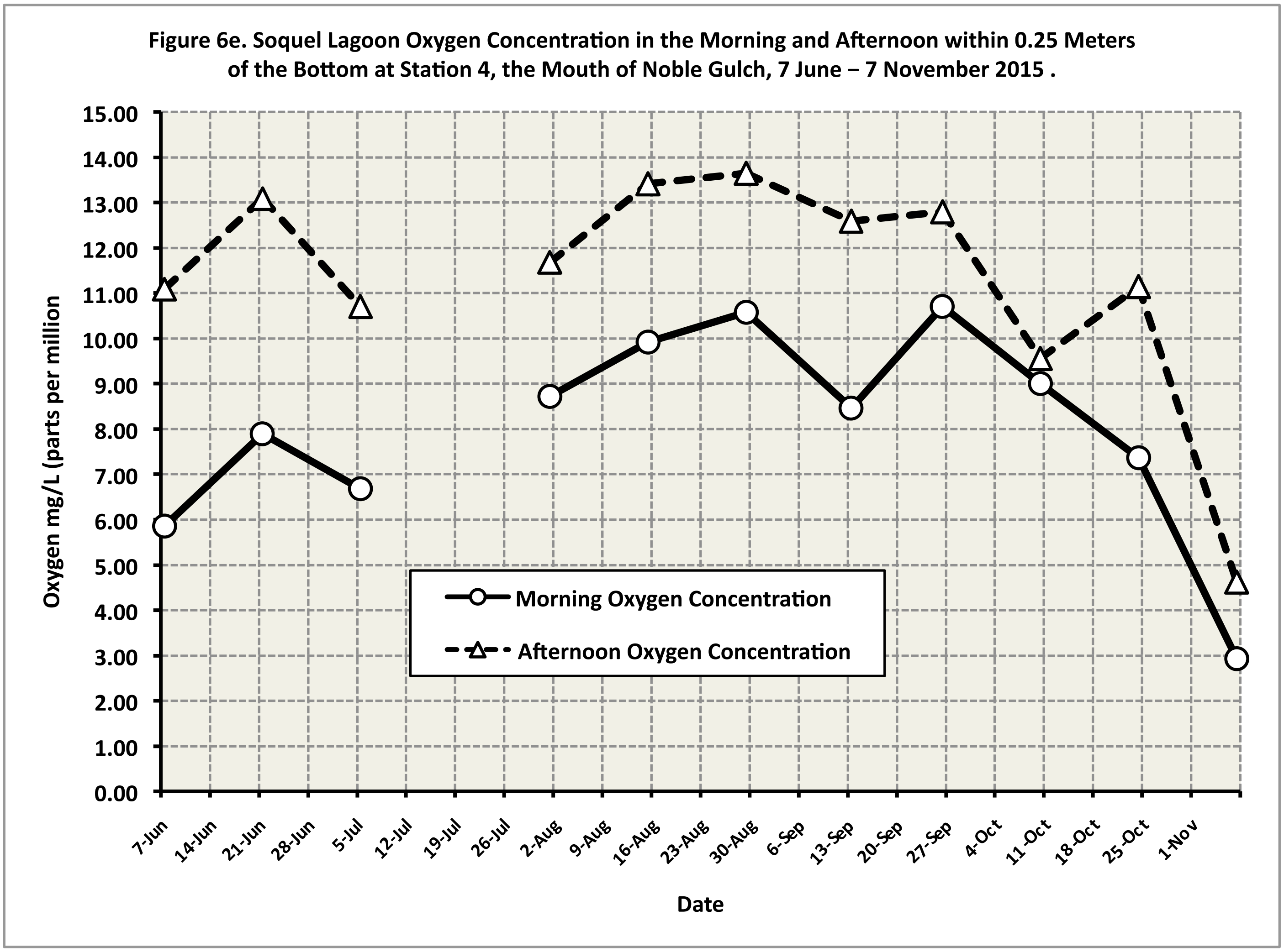


Figure 6e. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 4, the Mouth of Noble Gulch, 7 June – 7 November 2015.

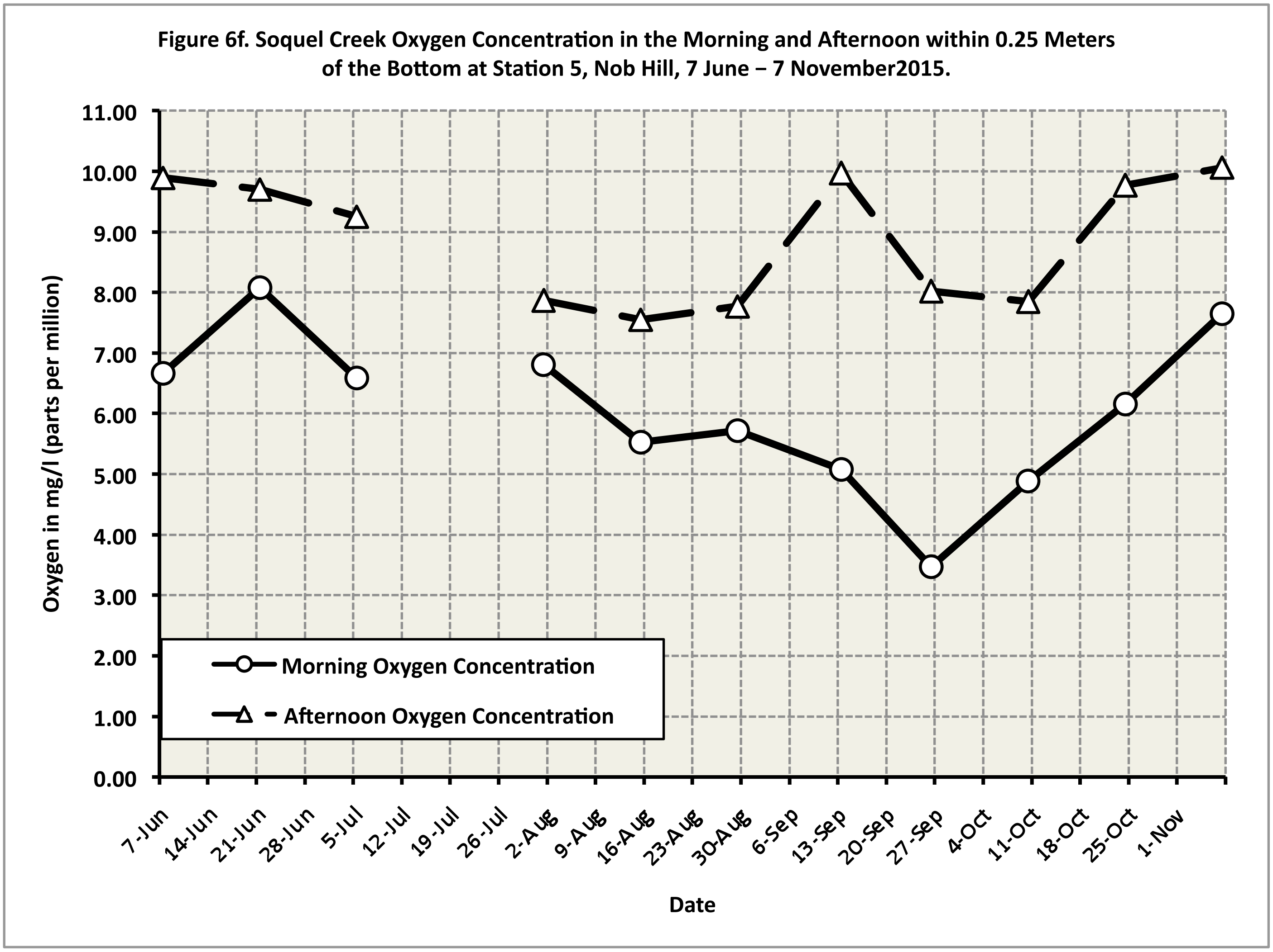


Figure 6f. Soquel Creek Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 5, Nob Hill, 7 June – 7 November 2015.

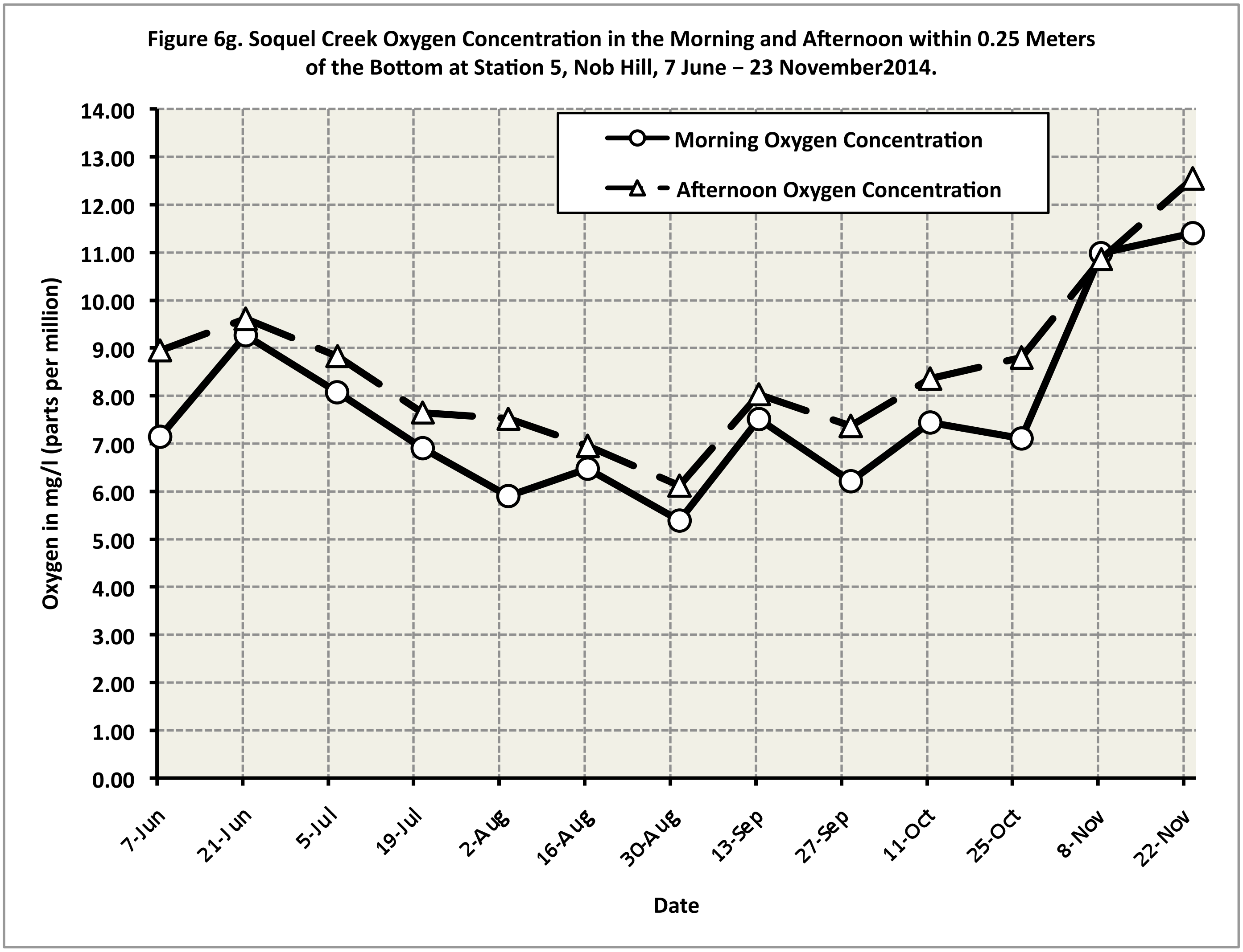


Figure 6g. Soquel Creek Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 5, Nob Hill, 7 June – 23 November 2014.

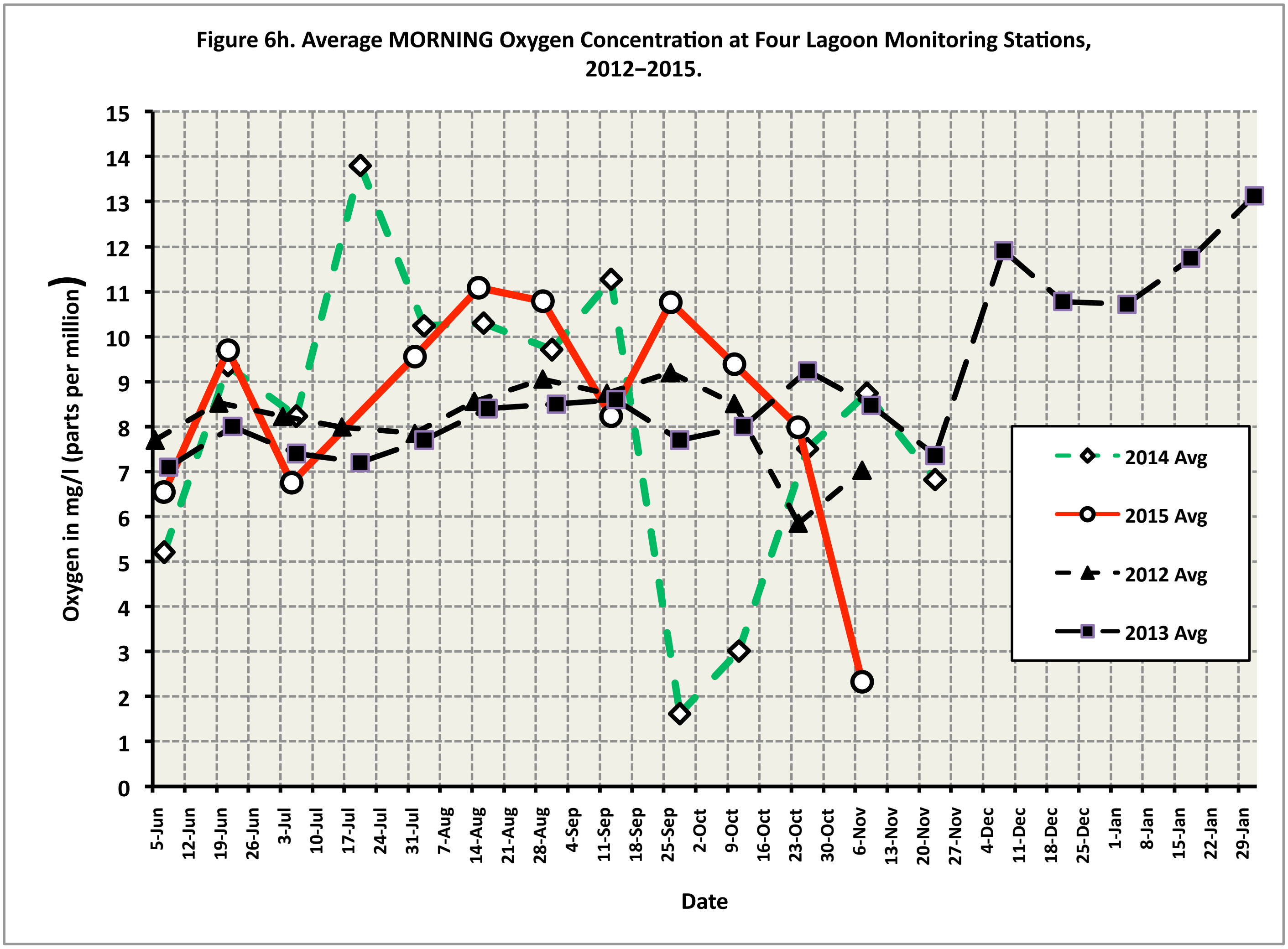


Figure 6h. Average MORNING Oxygen Concentration at Four Lagoon Monitoring Stations, 2012–2015.

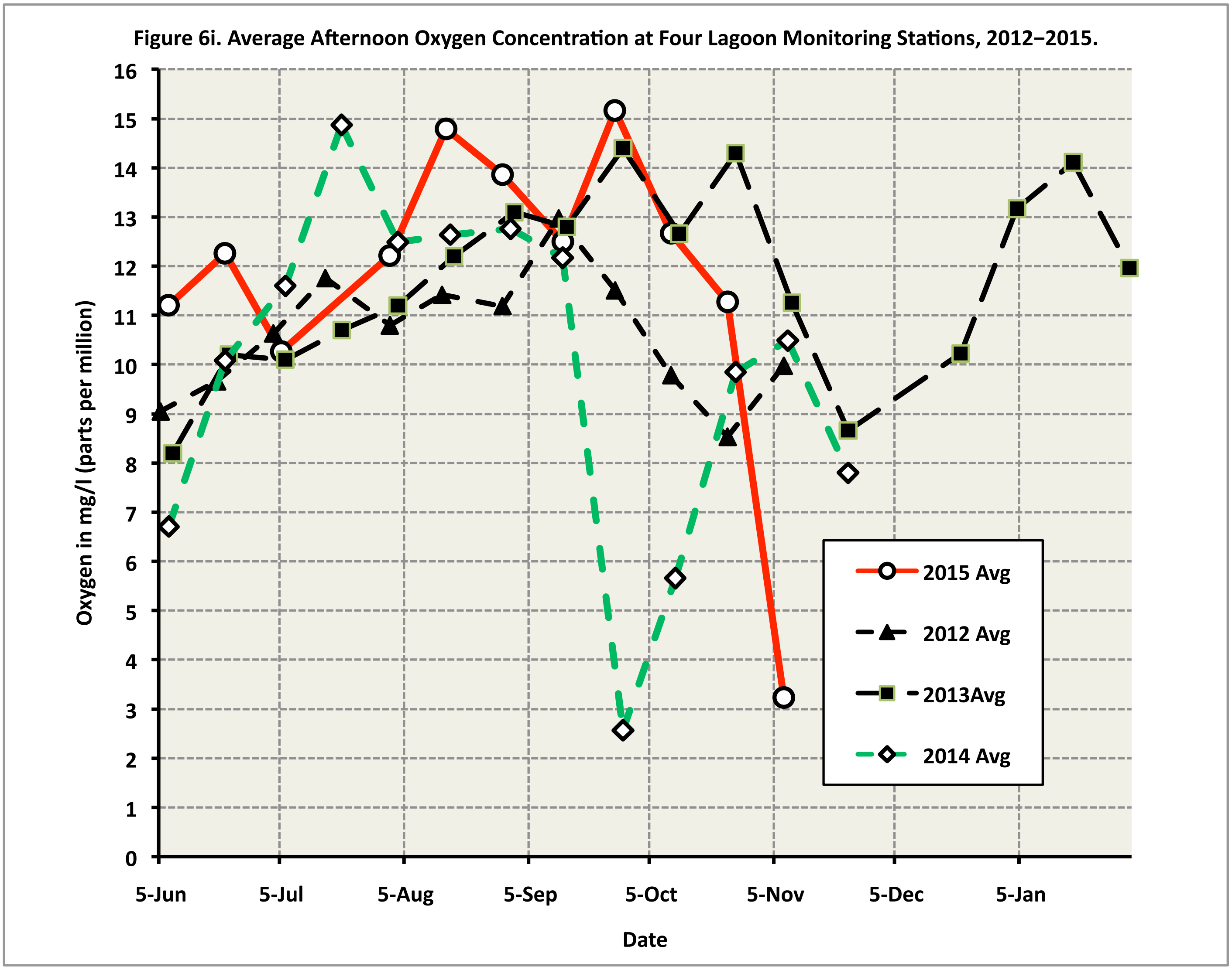


Figure 6i. Average AFTERNOON Oxygen Concentration at Four Lagoon Monitoring Stations, 2012–2015.

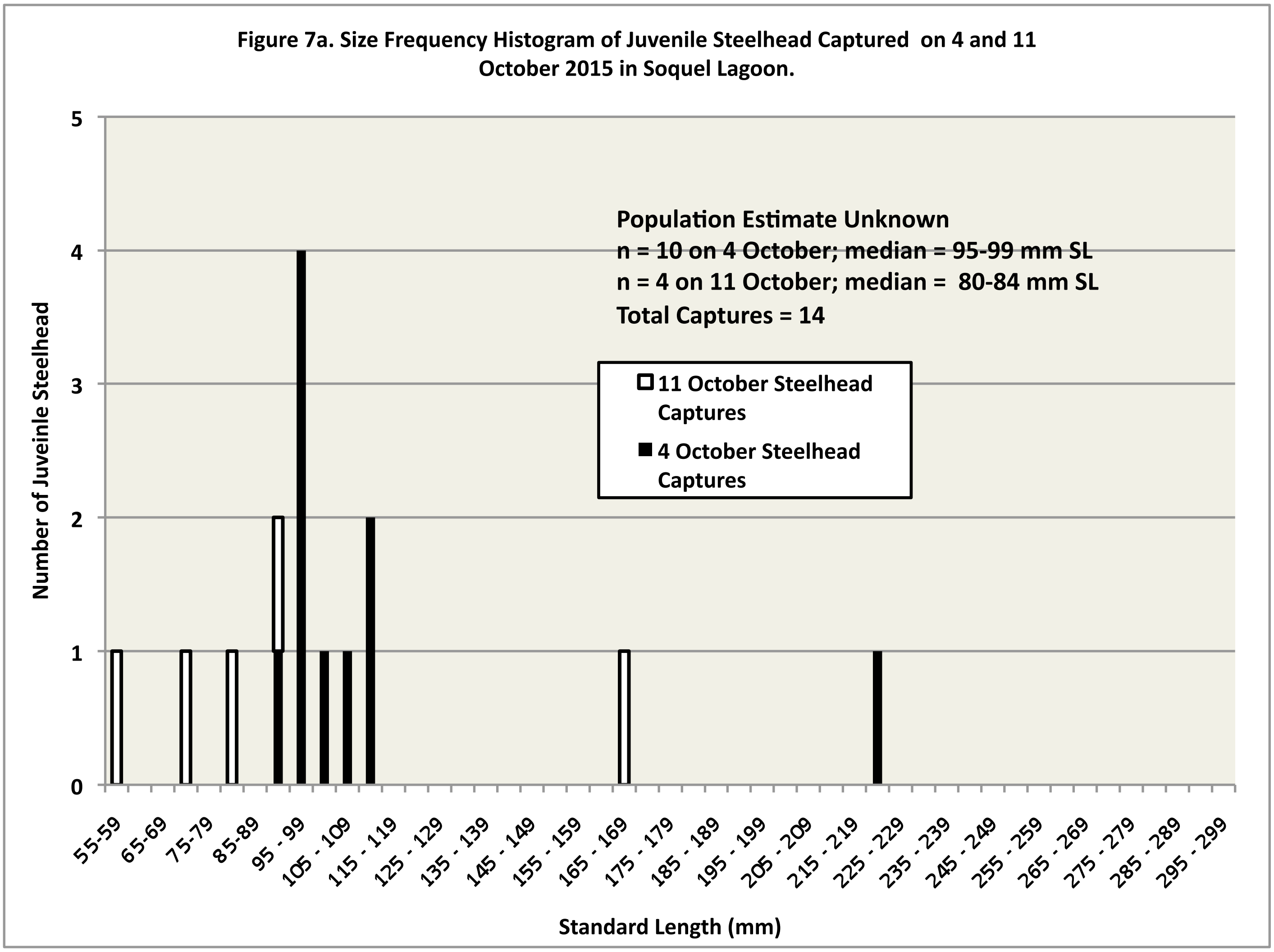


Figure 7a. Size Frequency Histogram of Juvenile Steelhead Captured on 4 and 11 October 2015 in Soquel Lagoon.

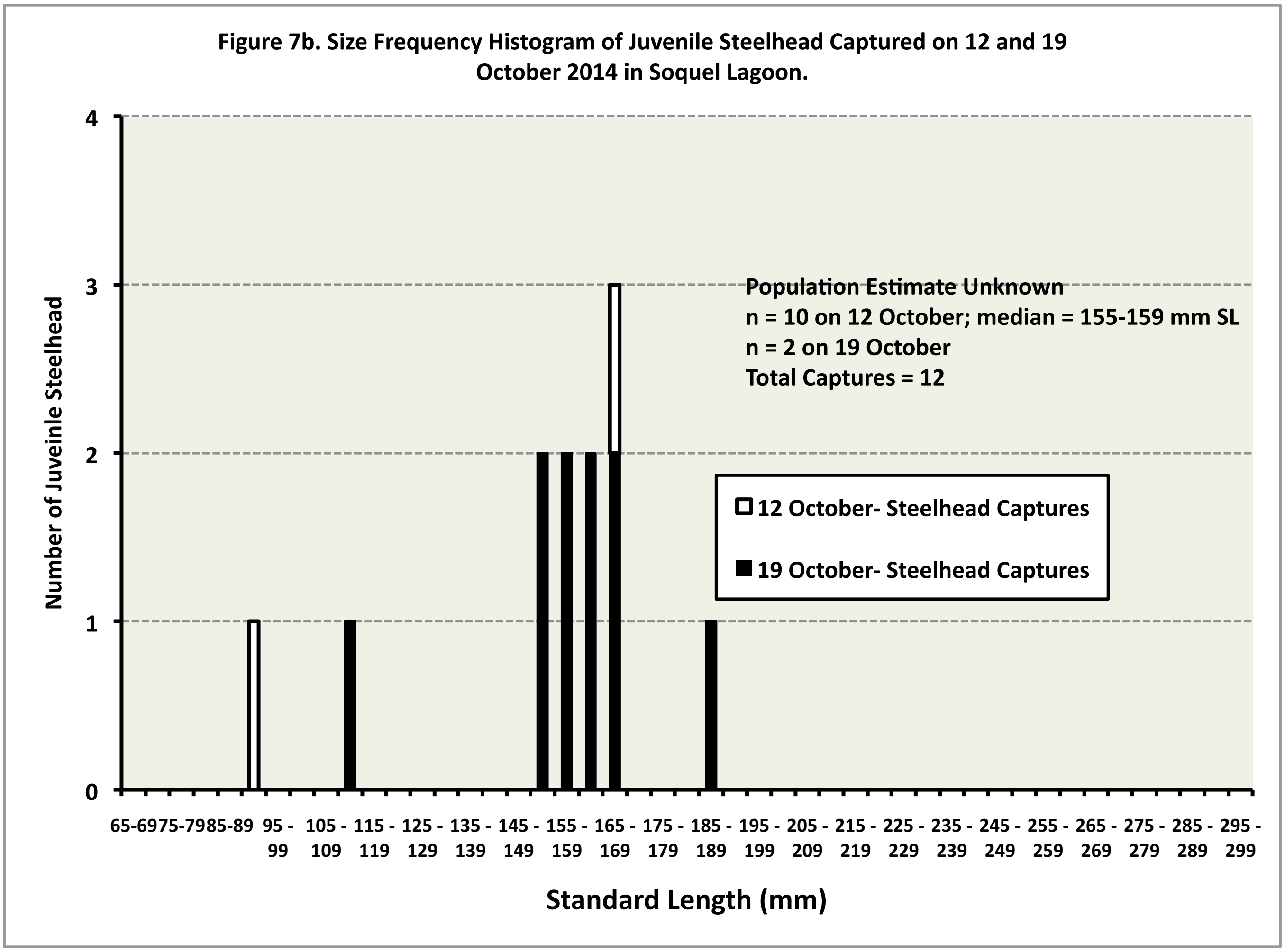


Figure 7b. Size Frequency Histogram of Juvenile Steelhead Captured on 12 and 19 October 2014 in Soquel Lagoon.

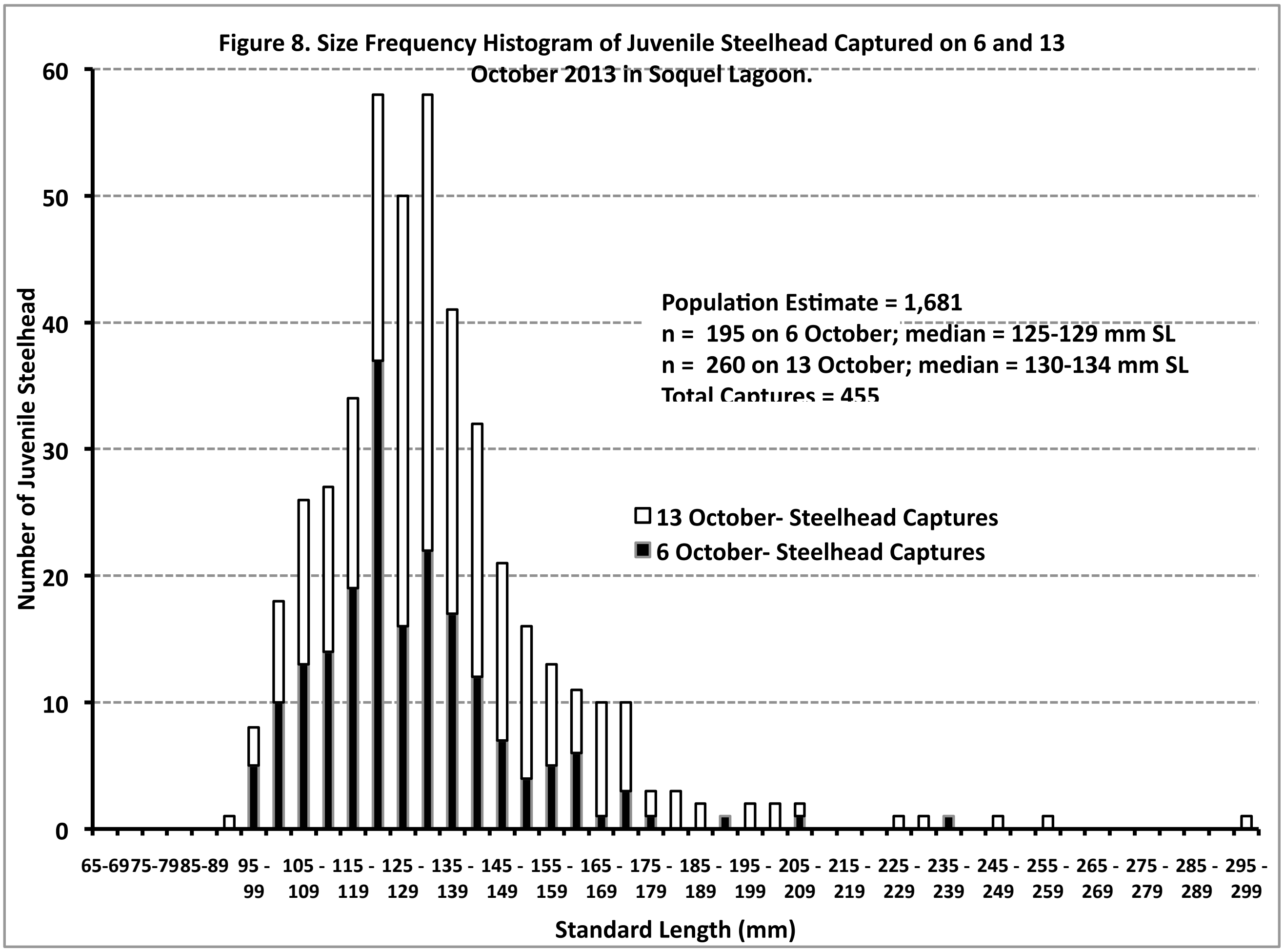


Figure 8. Size Frequency Histogram of Juvenile Steelhead Captured on 6 and 13 October 2013 in Soquel Lagoon.

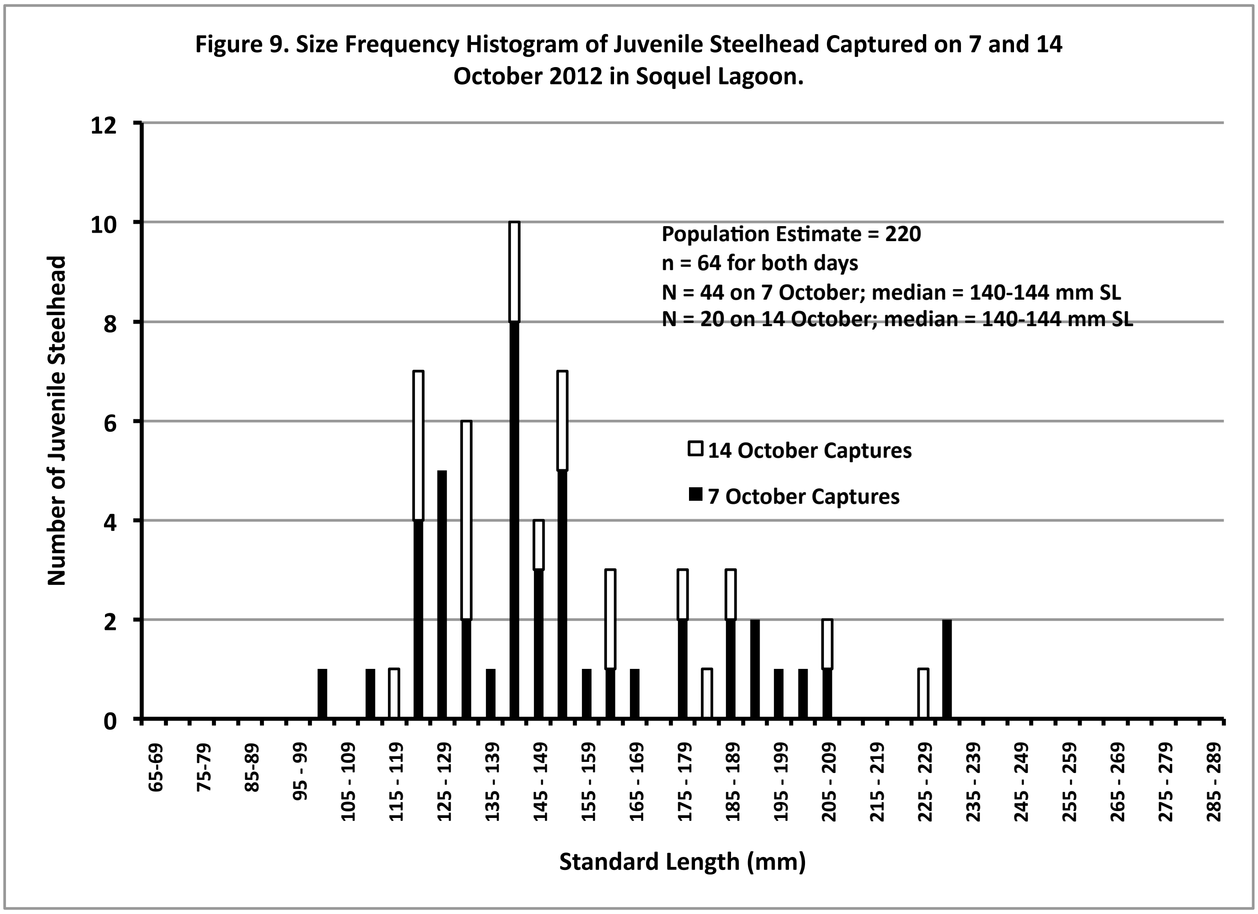


Figure 9. Size Frequency Histogram of Juvenile Steelhead Captured on 7 and 14 October 2012 in Soquel Lagoon.

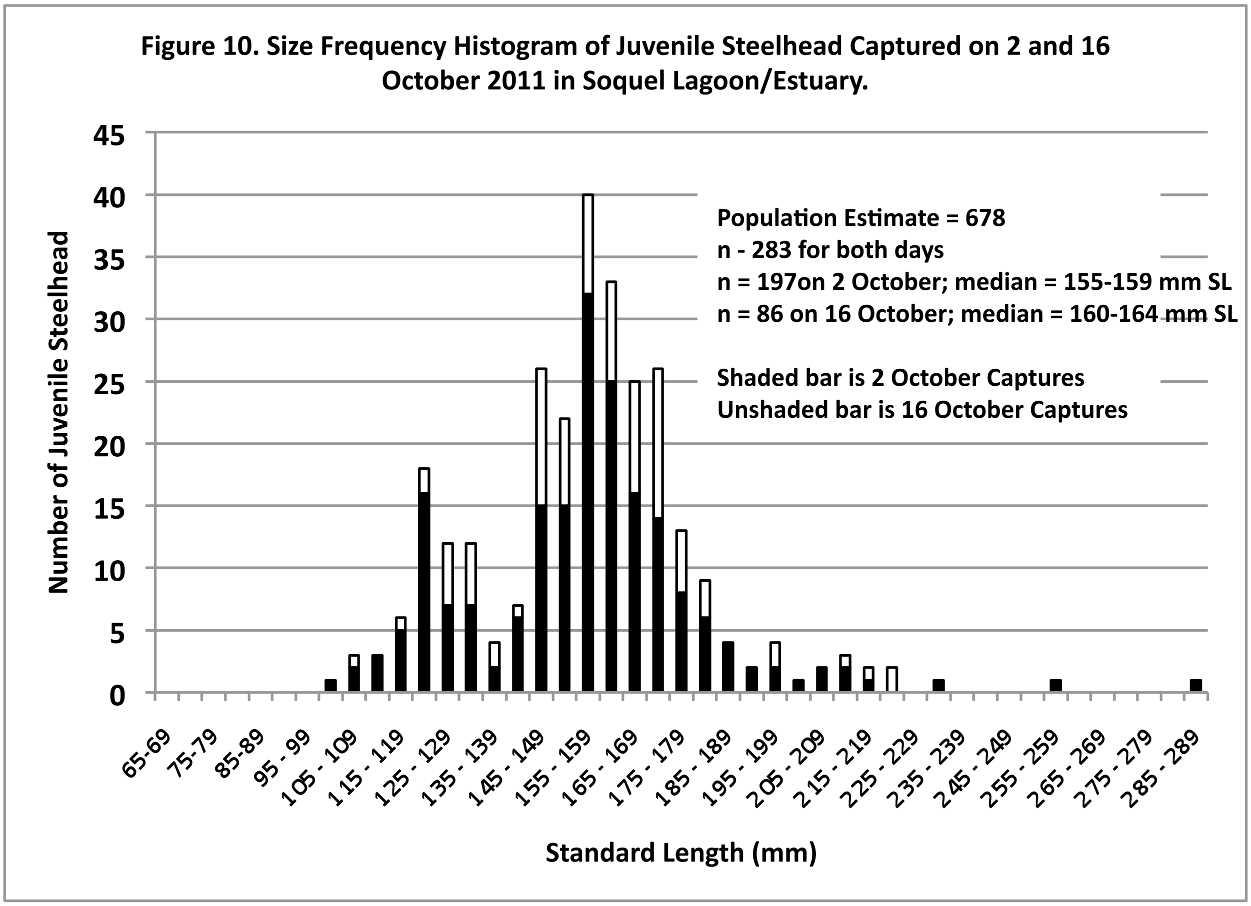


Figure 10. Size Frequency Histogram of Juvenile Steelhead Captured on 2 and 16 October 2011 in Soquel Lagoon/Estuary.

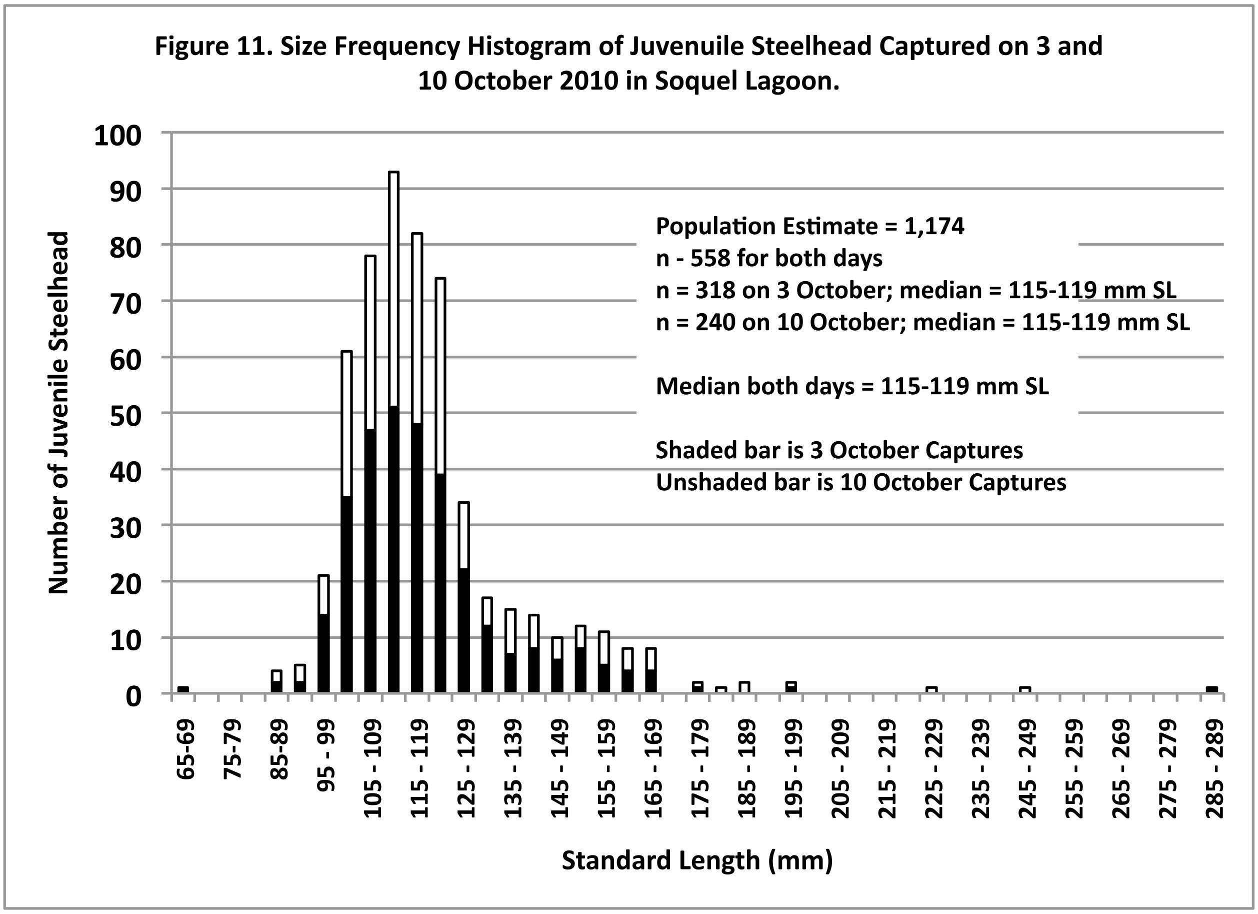


Figure 11. Size Frequency Histogram of Juvenuile Steelhead Captured on 3 and 10 October 2010 in Soquel Lagoon.

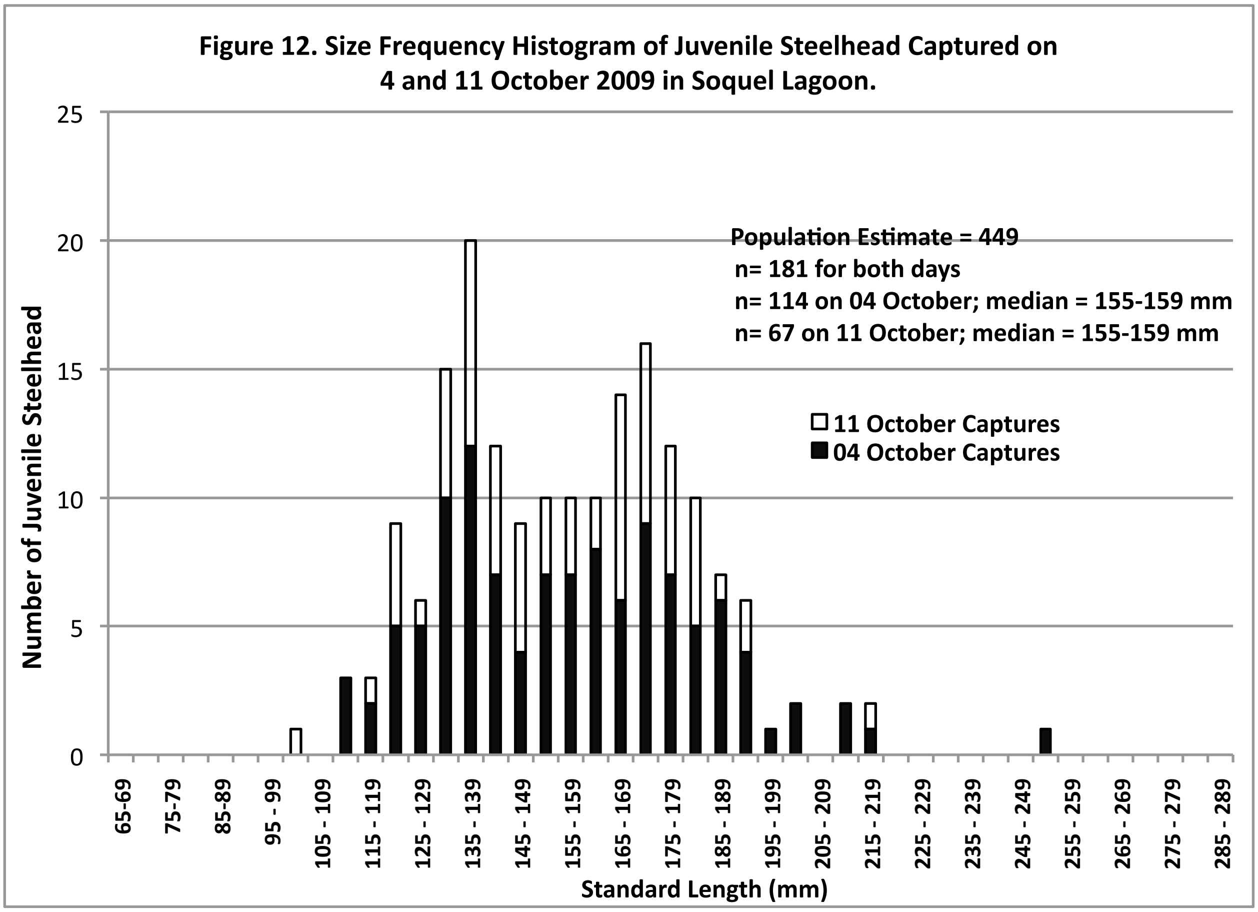


Figure 12. Size Frequency Histogram of Juvenile Steelhead Captured on 4 and 11 October 2009 in Soquel Lagoon.

Figure 13. Size Frequency Histogram of Juvenile Steelhead Captured on 27 September 2008 in the Soquel Lagoon.

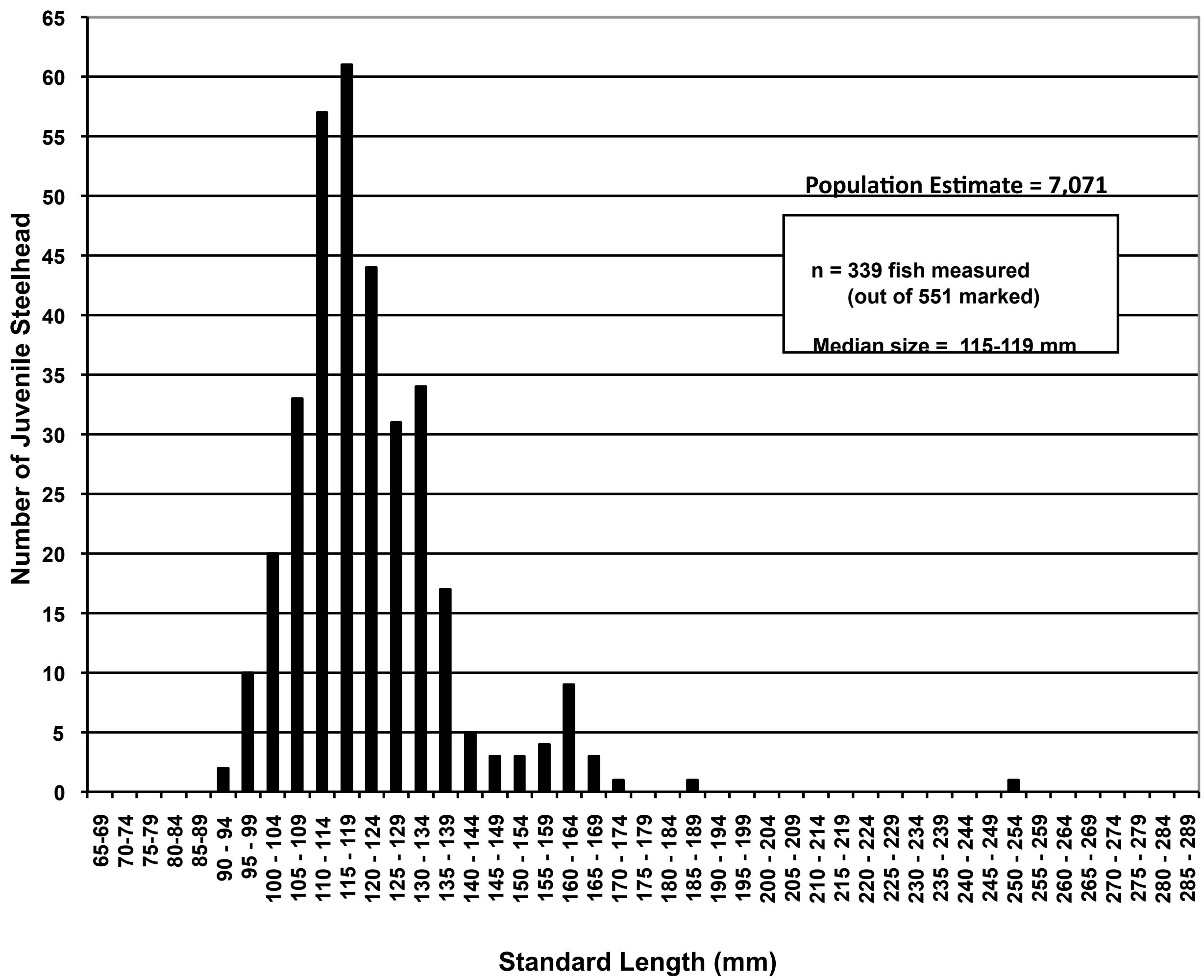


Figure 13. Size Frequency Histogram of Juvenile Steelhead Captured on 27 September 2008 in the Soquel Lagoon.

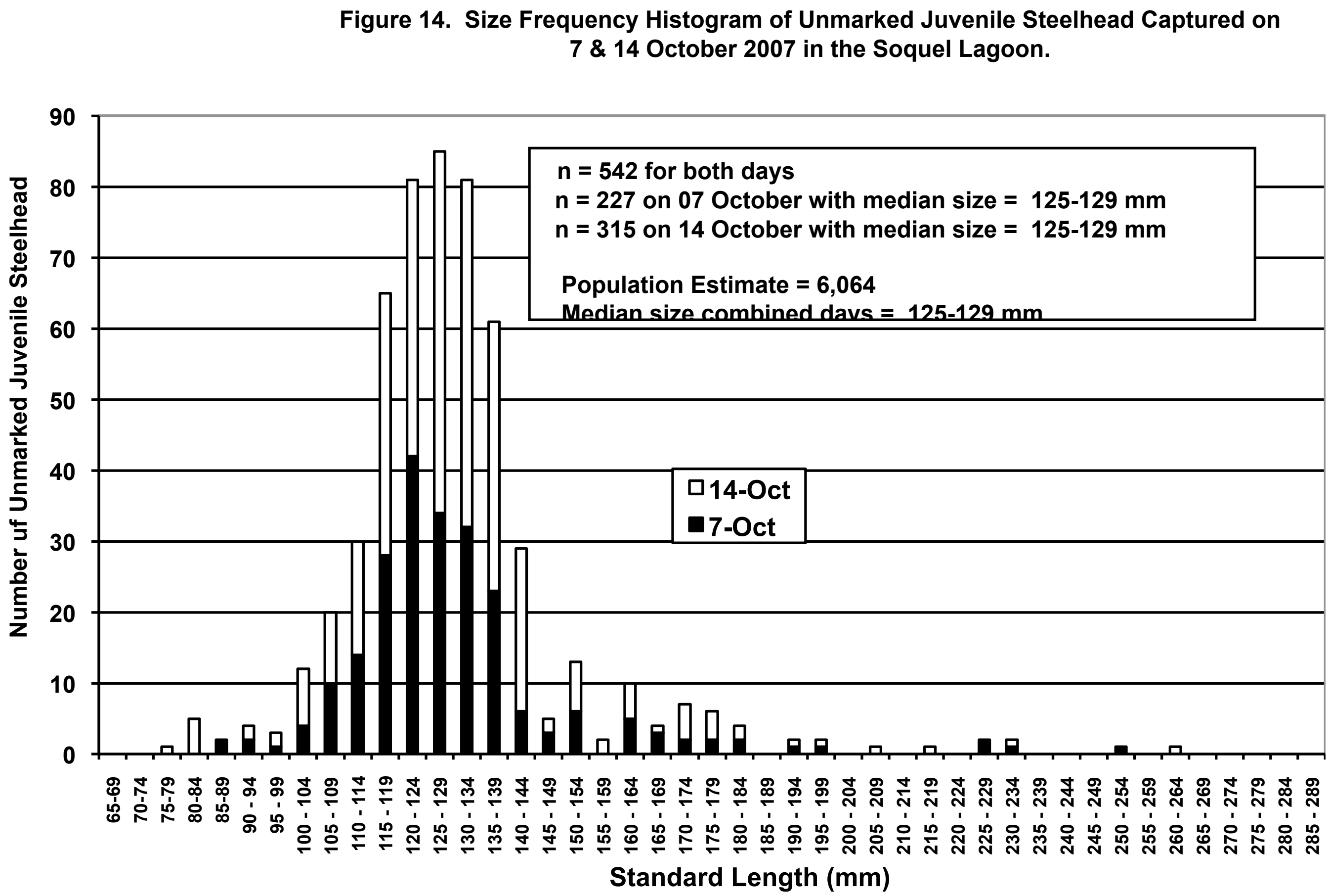


Figure 14. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on
7 & 14 October 2007 in the Soquel Lagoon.

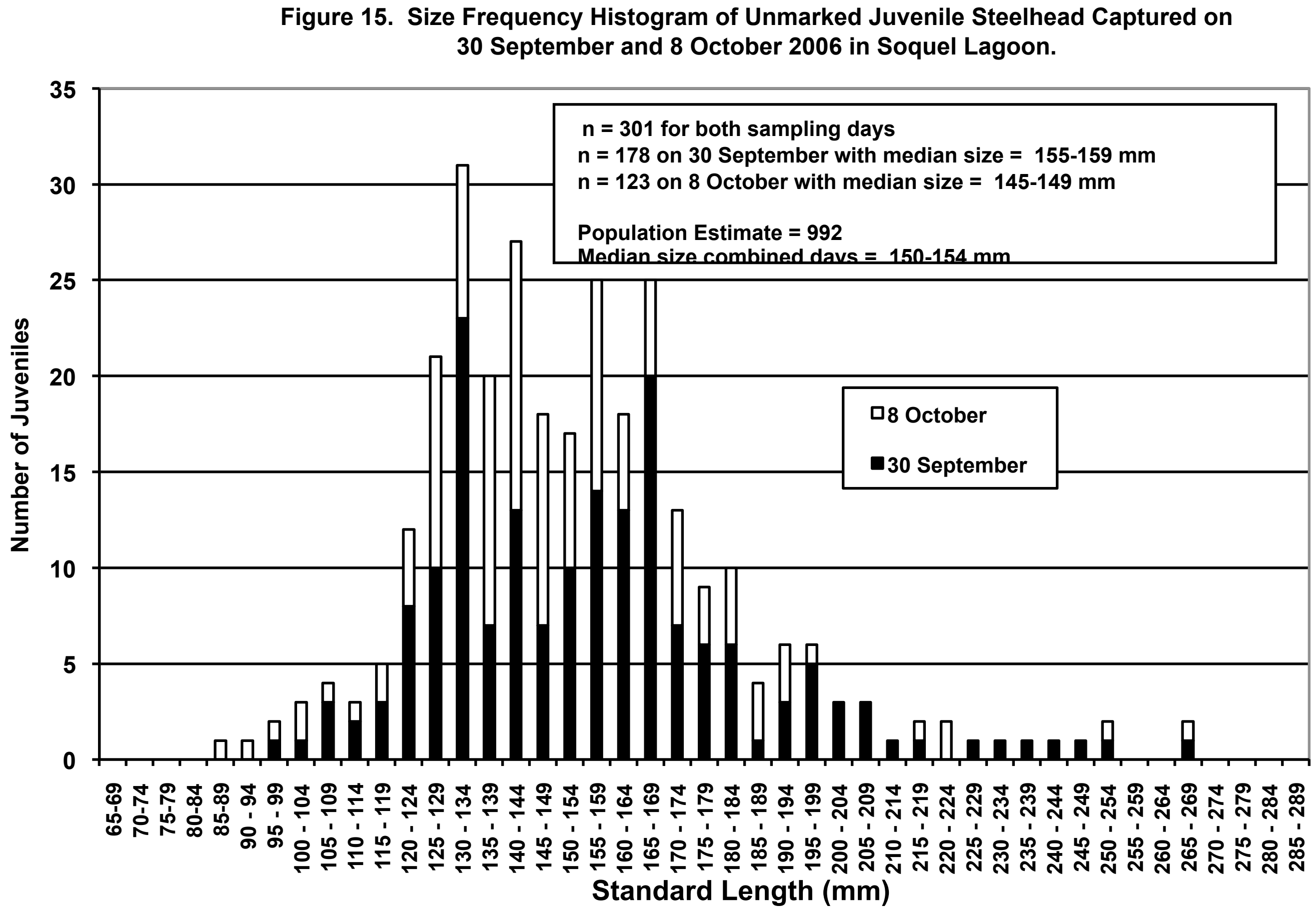


Figure 15. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 30 September and 8 October 2006 in Soquel Lagoon.

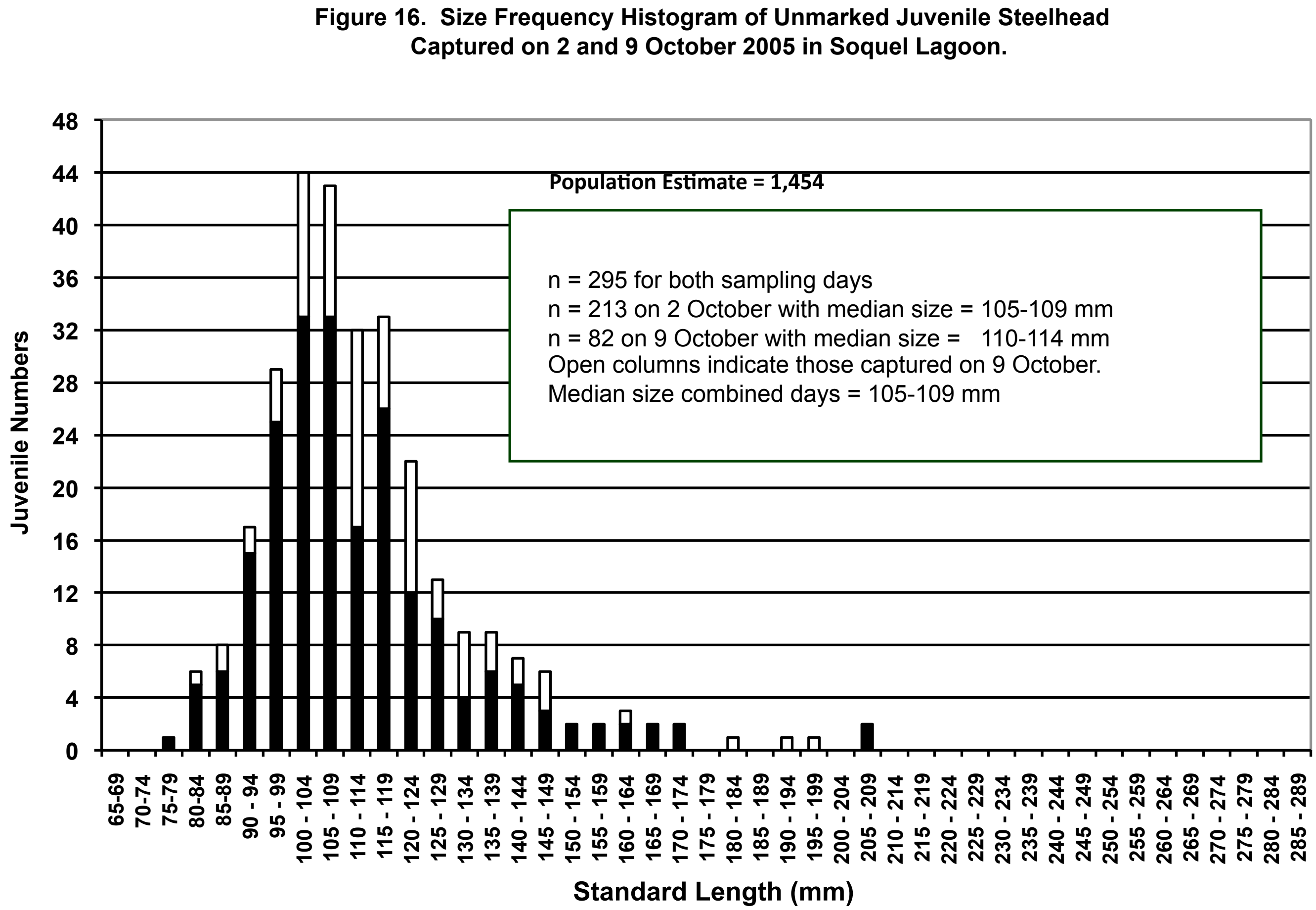


Figure 16. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 2 and 9 October 2005 in Soquel Lagoon.

Figure 17. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 and 12 October 2004 in Soquel Lagoon.

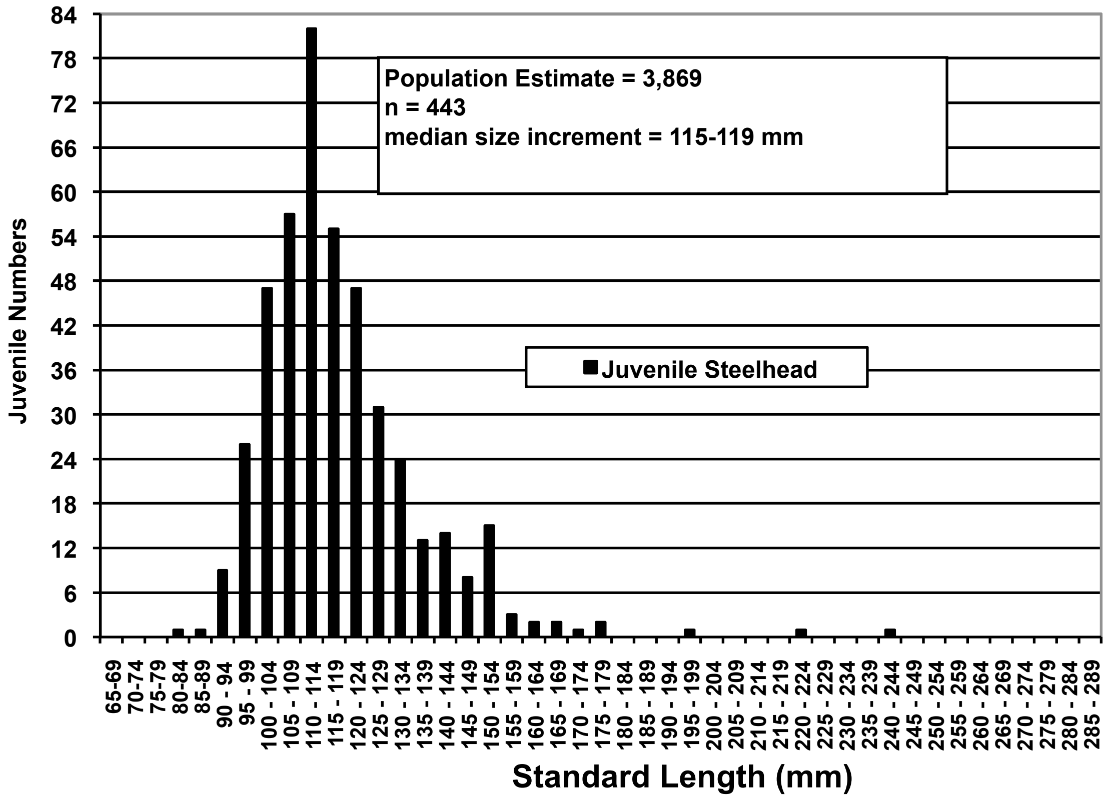


Figure 17. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 and 12 October 2004 in Soquel Lagoon.

Figure 18. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 5 and 12 October 2003 in Soquel Lagoon.

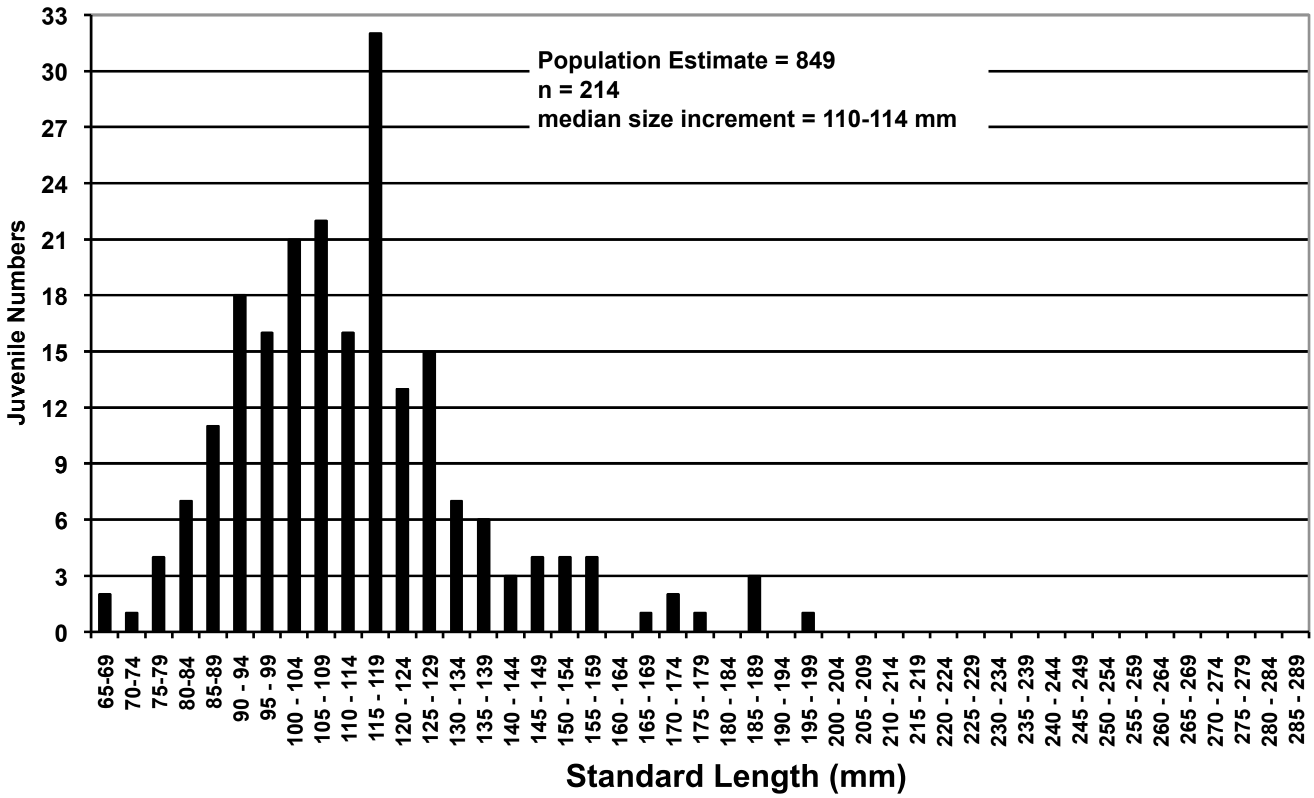


Figure 18. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 5 and 12 October 2003 in Soquel Lagoon.

Figure 19. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 6 October 2002 in Soquel Lagoon.

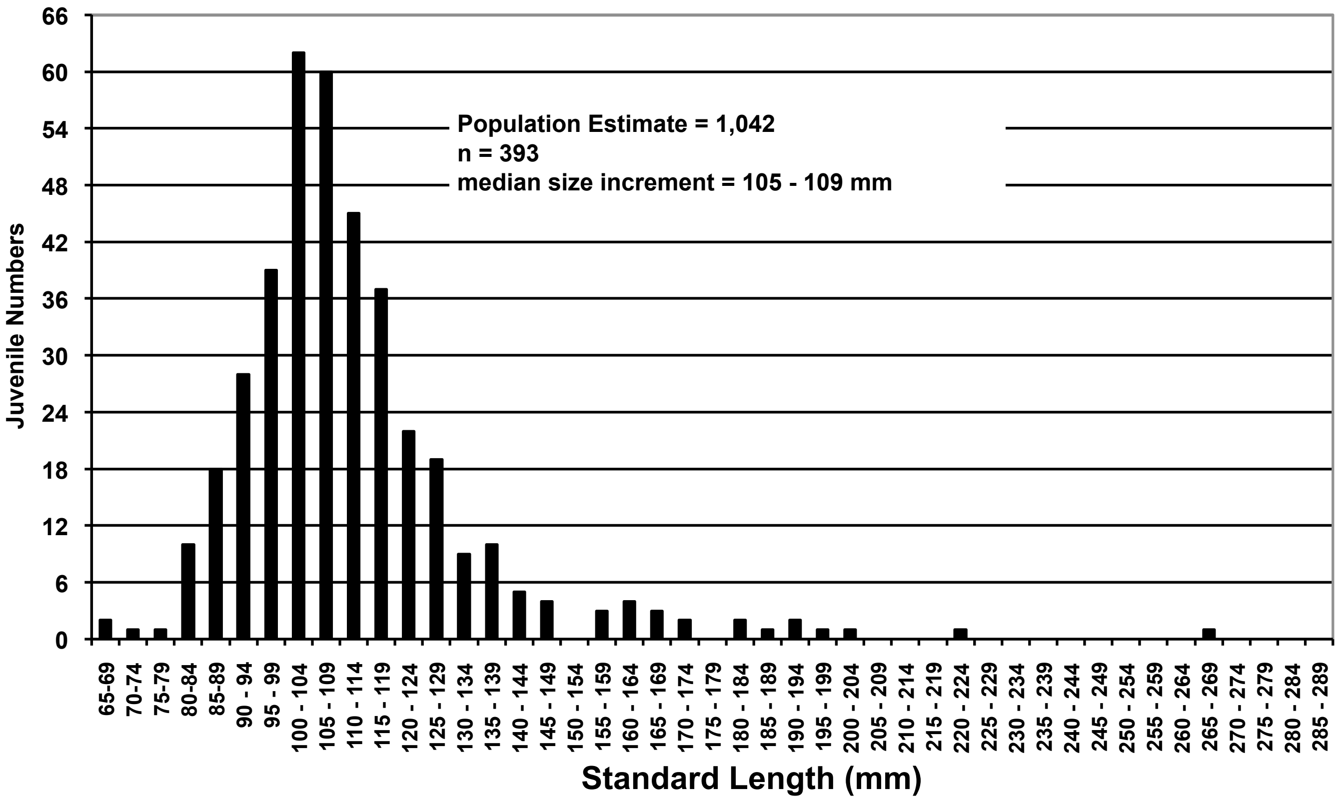


Figure 19. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 6 October 2002 in Soquel Lagoon.

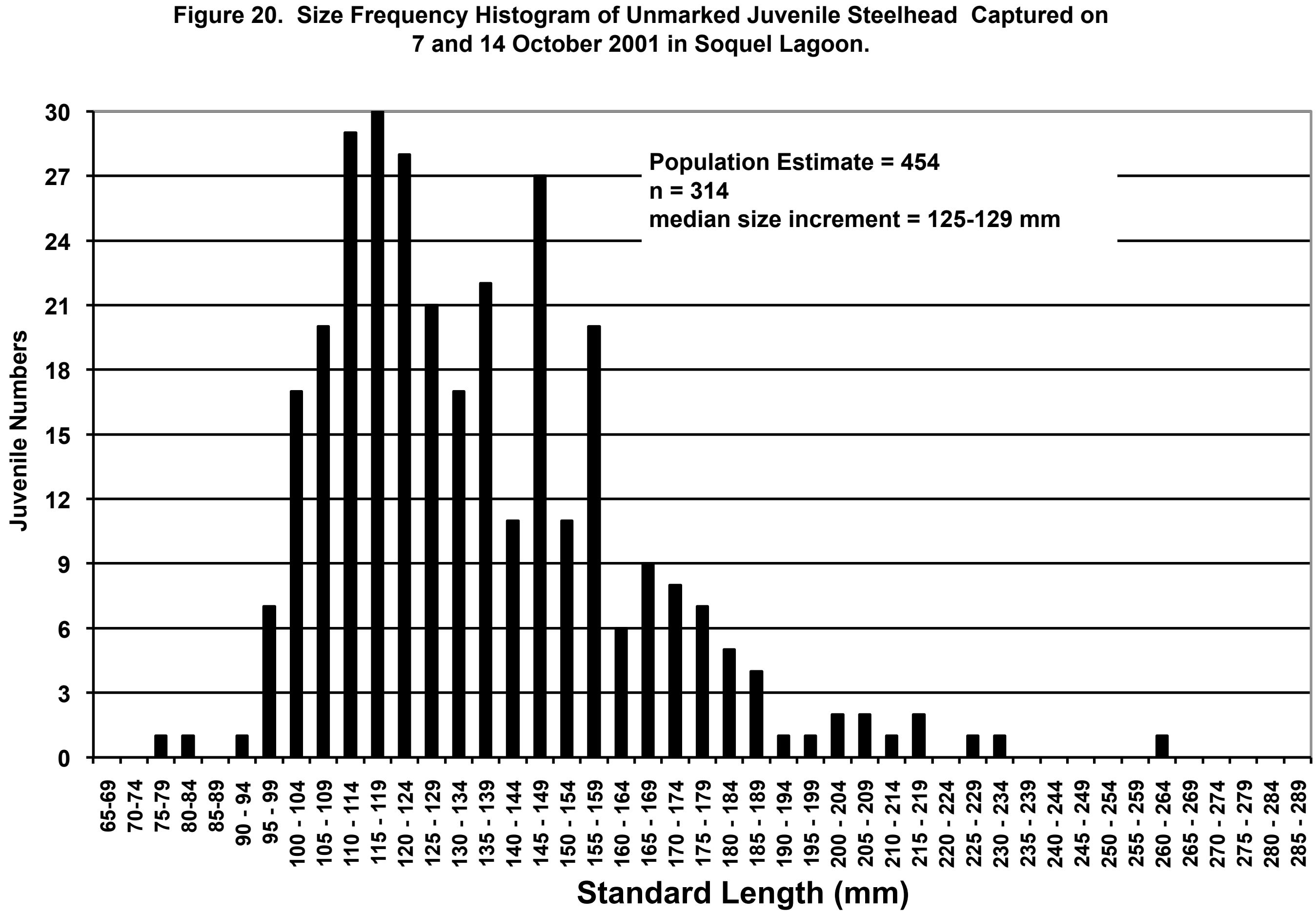


Figure 20. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 7 and 14 October 2001 in Soquel Lagoon.

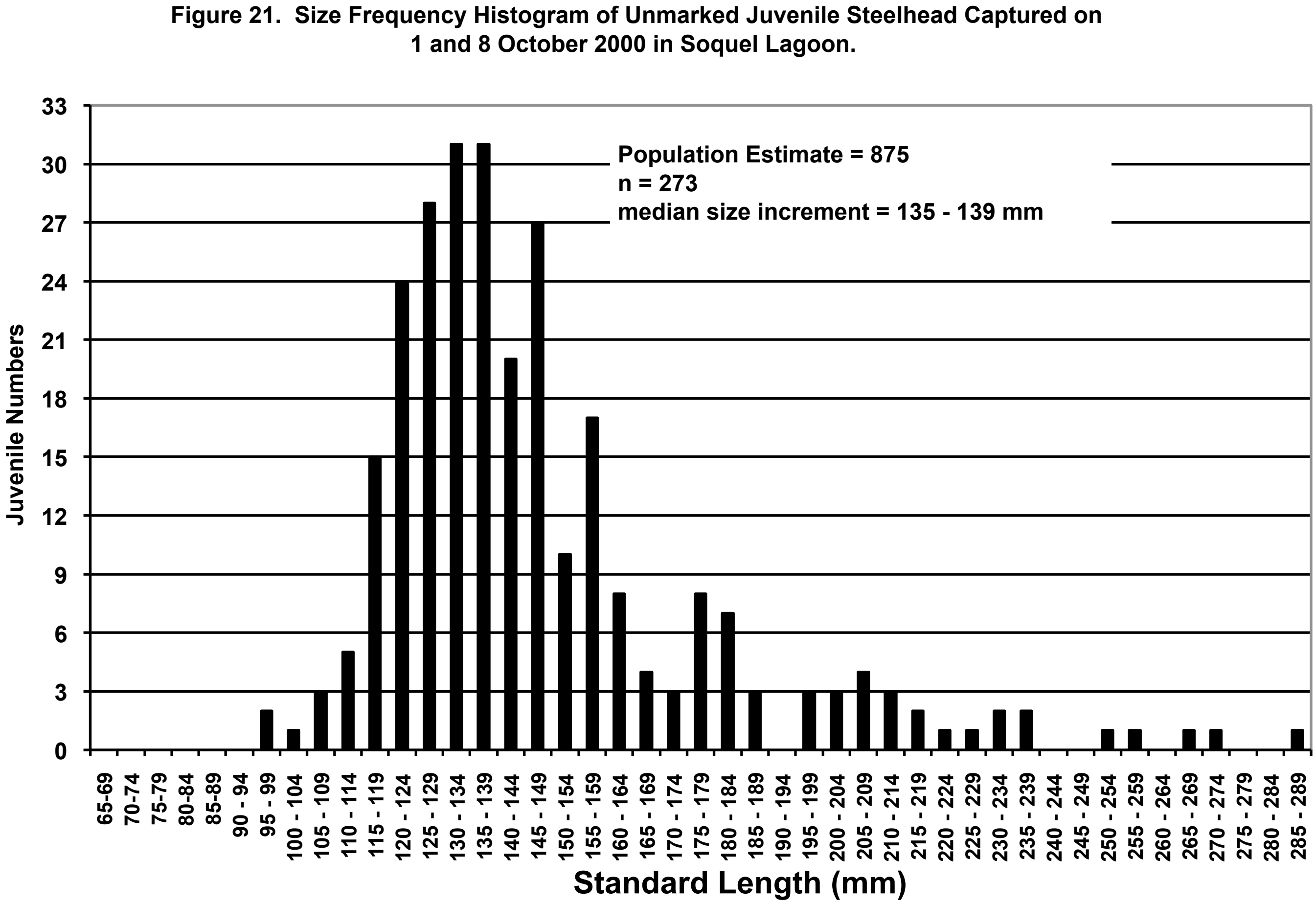


Figure 21. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 1 and 8 October 2000 in Soquel Lagoon.

Figure 22. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 and 10 October 1999 in Soquel Lagoon.

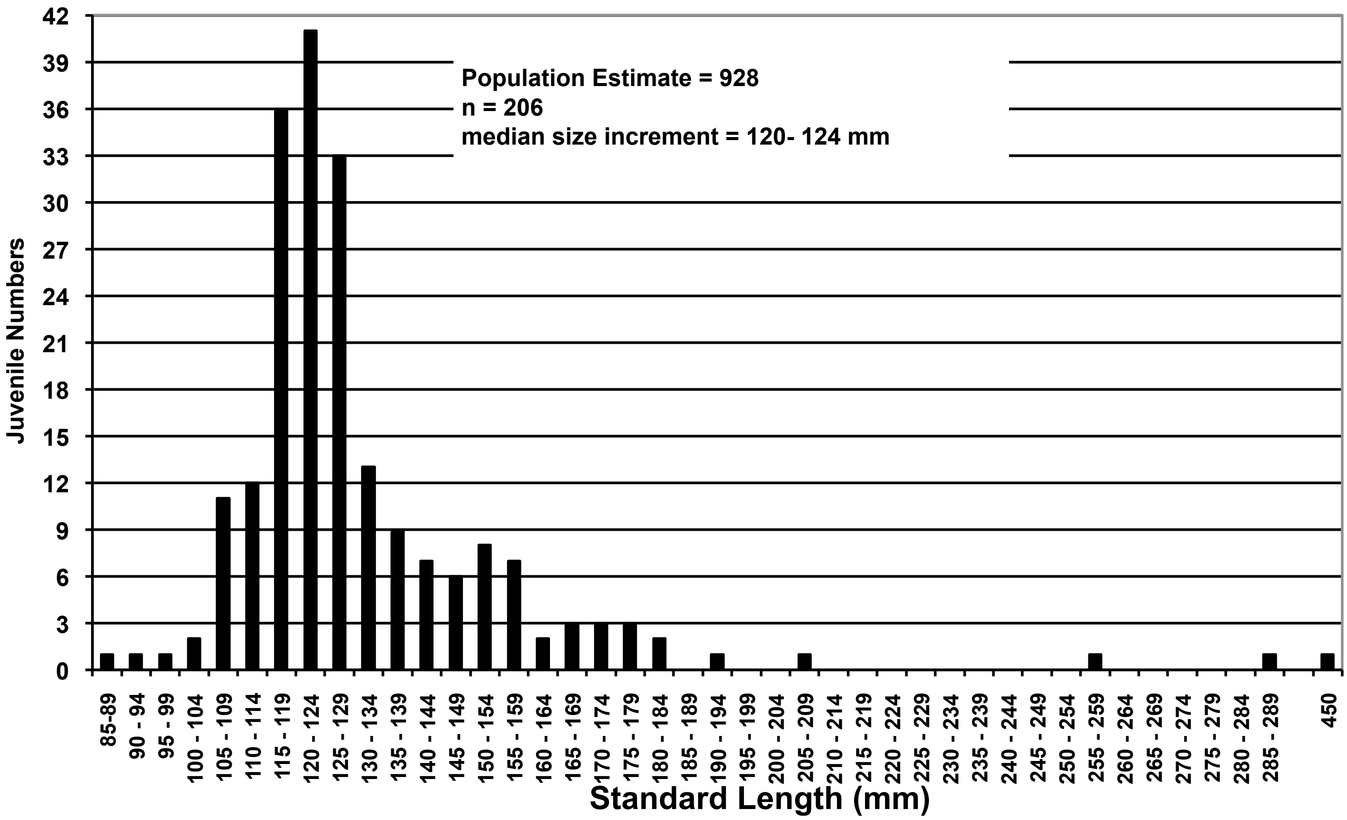


Figure 22. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 and 10 October 1999 in Soquel Lagoon.

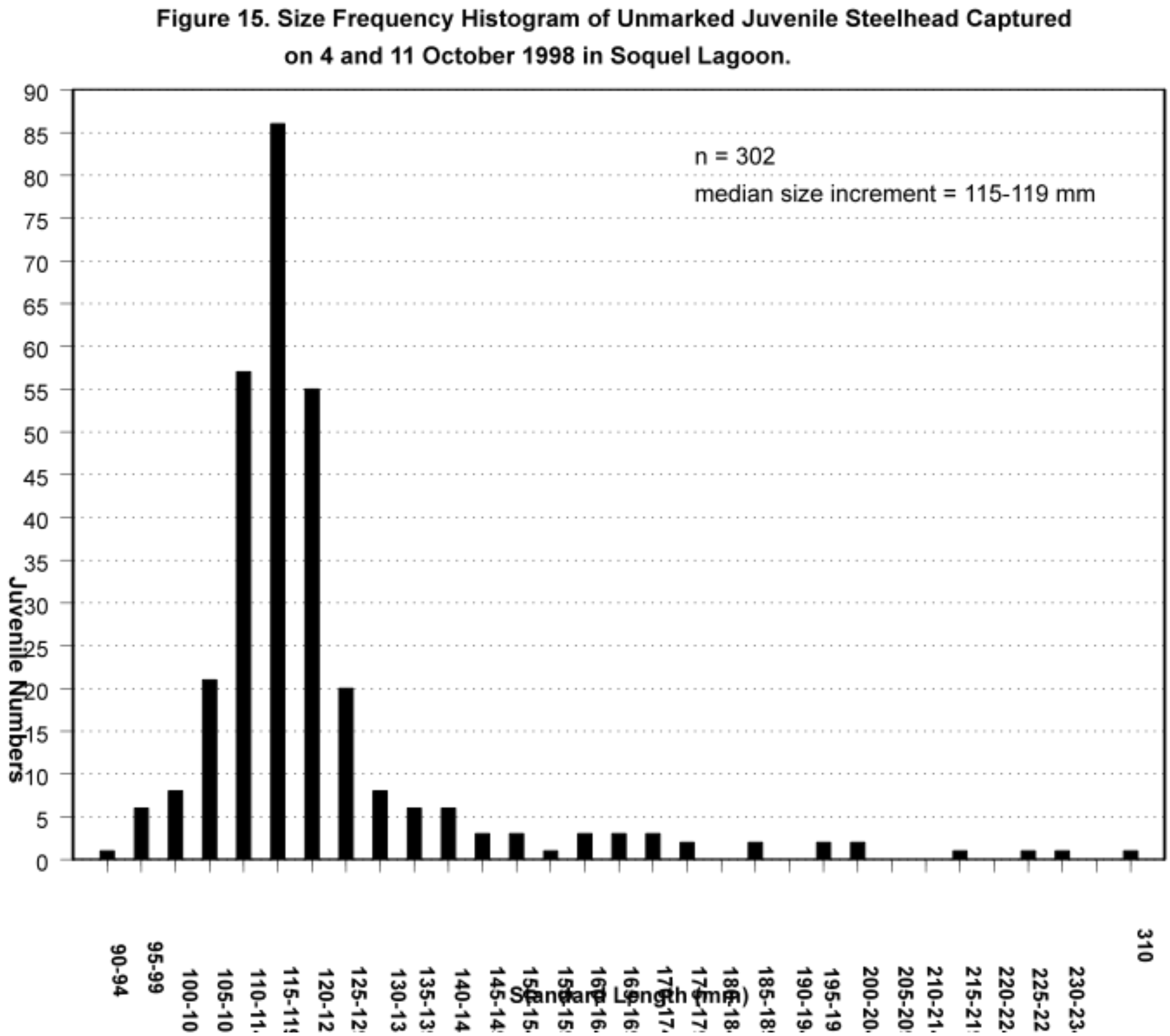


Figure 23. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 4 and 11 October 1998 in Soquel Lagoon.

Population Estimate = 671.

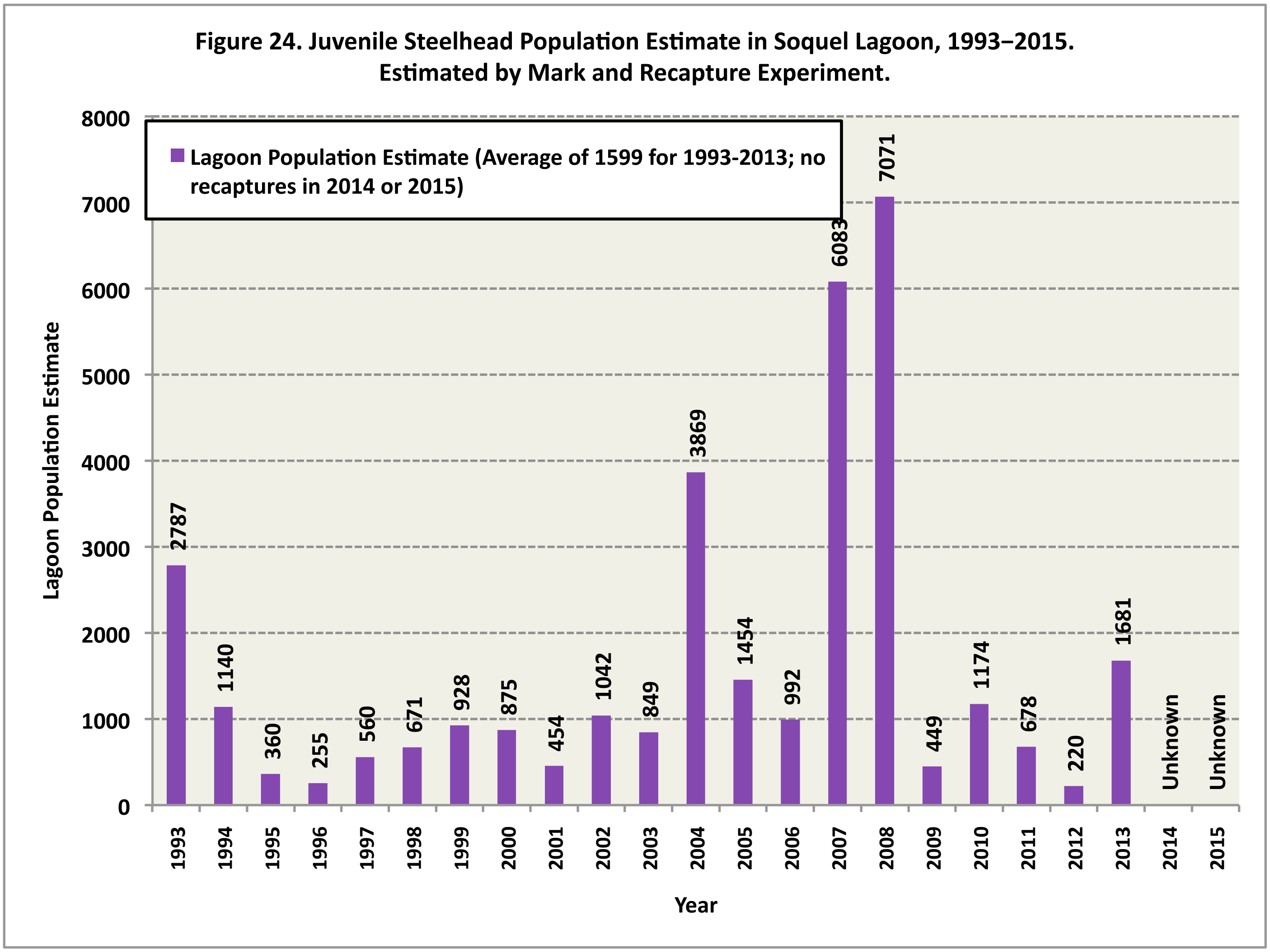


Figure 24. Juvenile Steelhead Population Estimate in Soquel Lagoon, 1993−2015. Estimated by Mark and Recapture Experiment.

Figure 25. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2015.

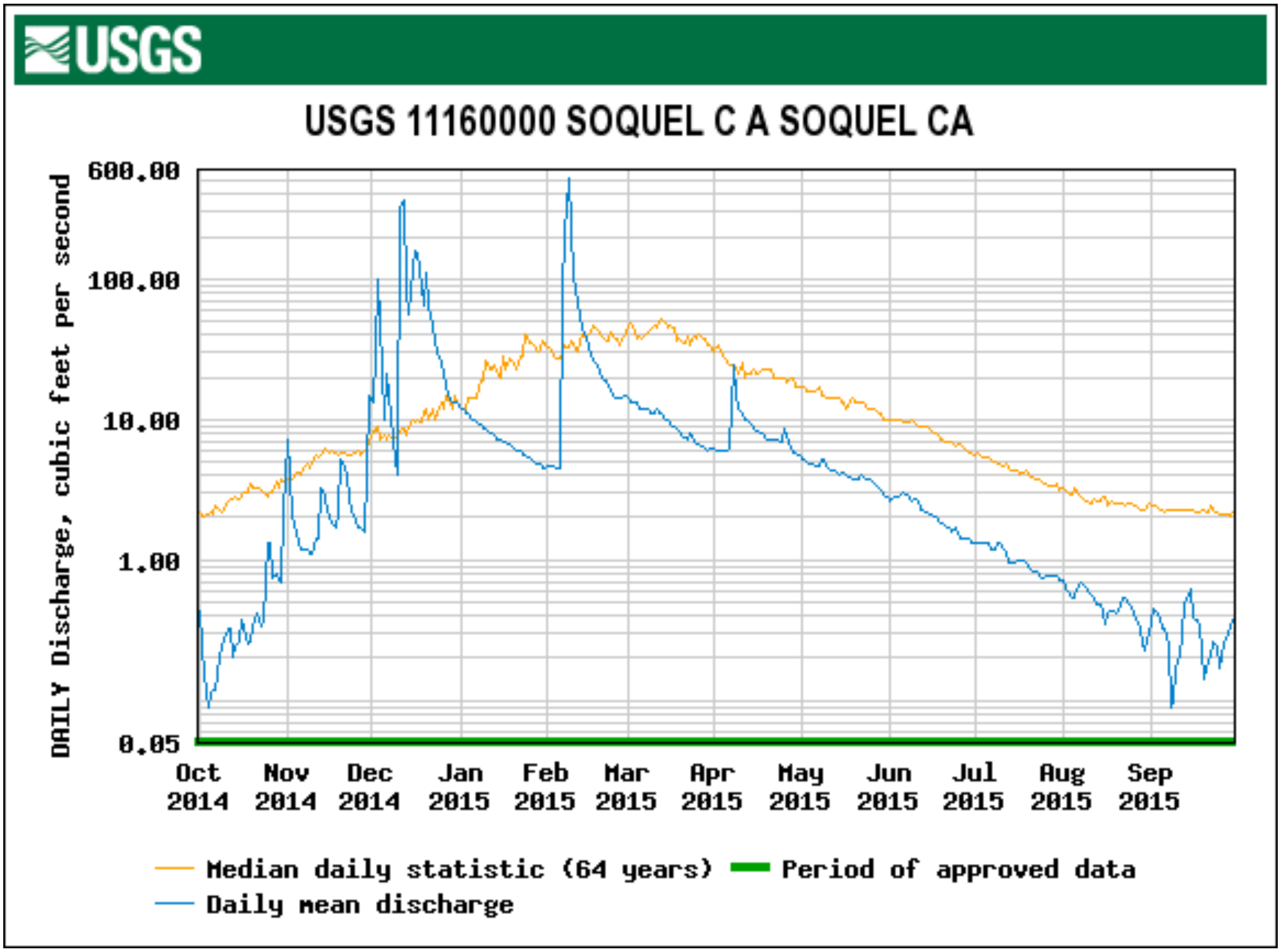


Figure 26. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2015.

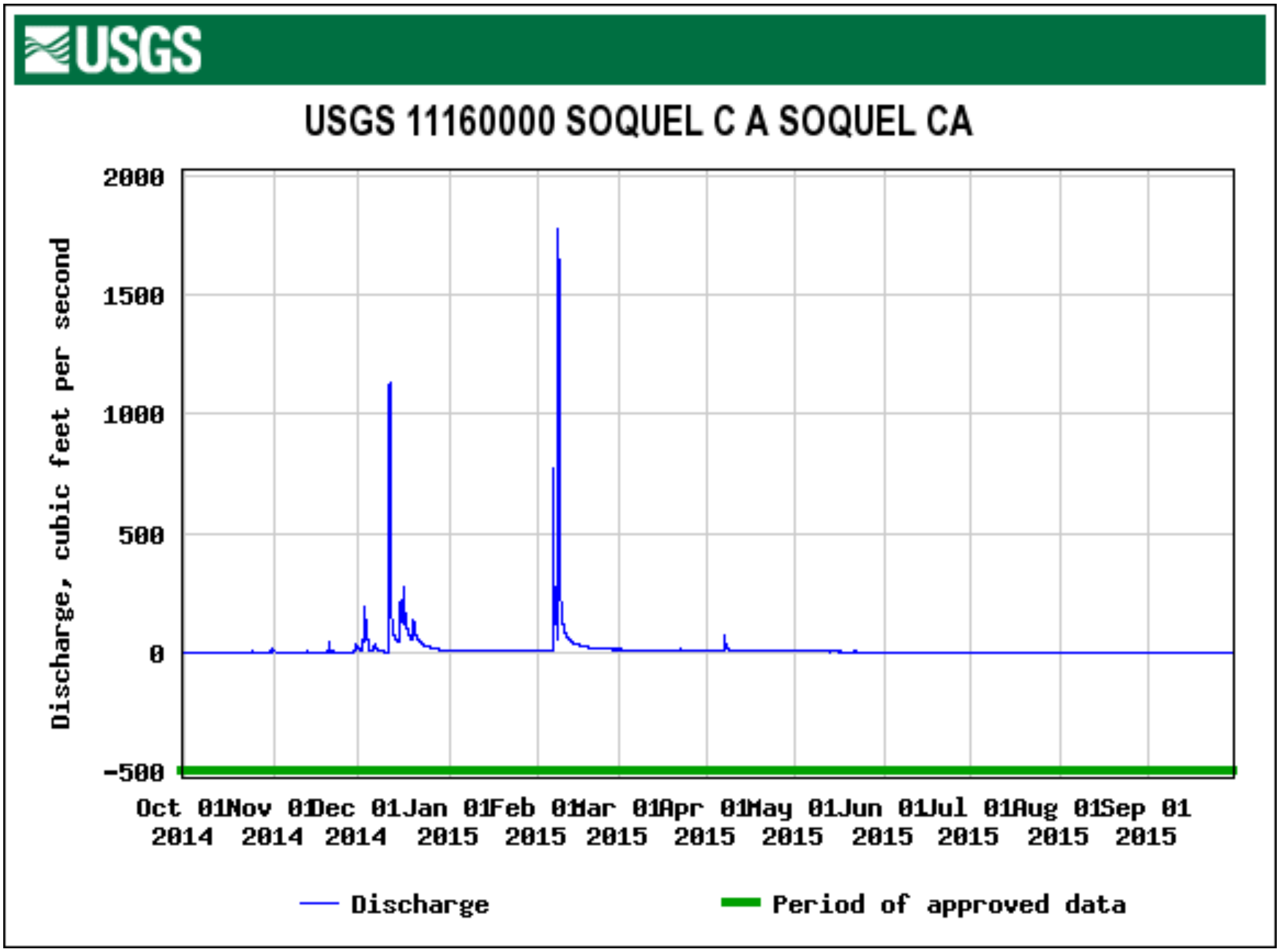


Figure 27. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 15 May 2015 – 15 November 2015.

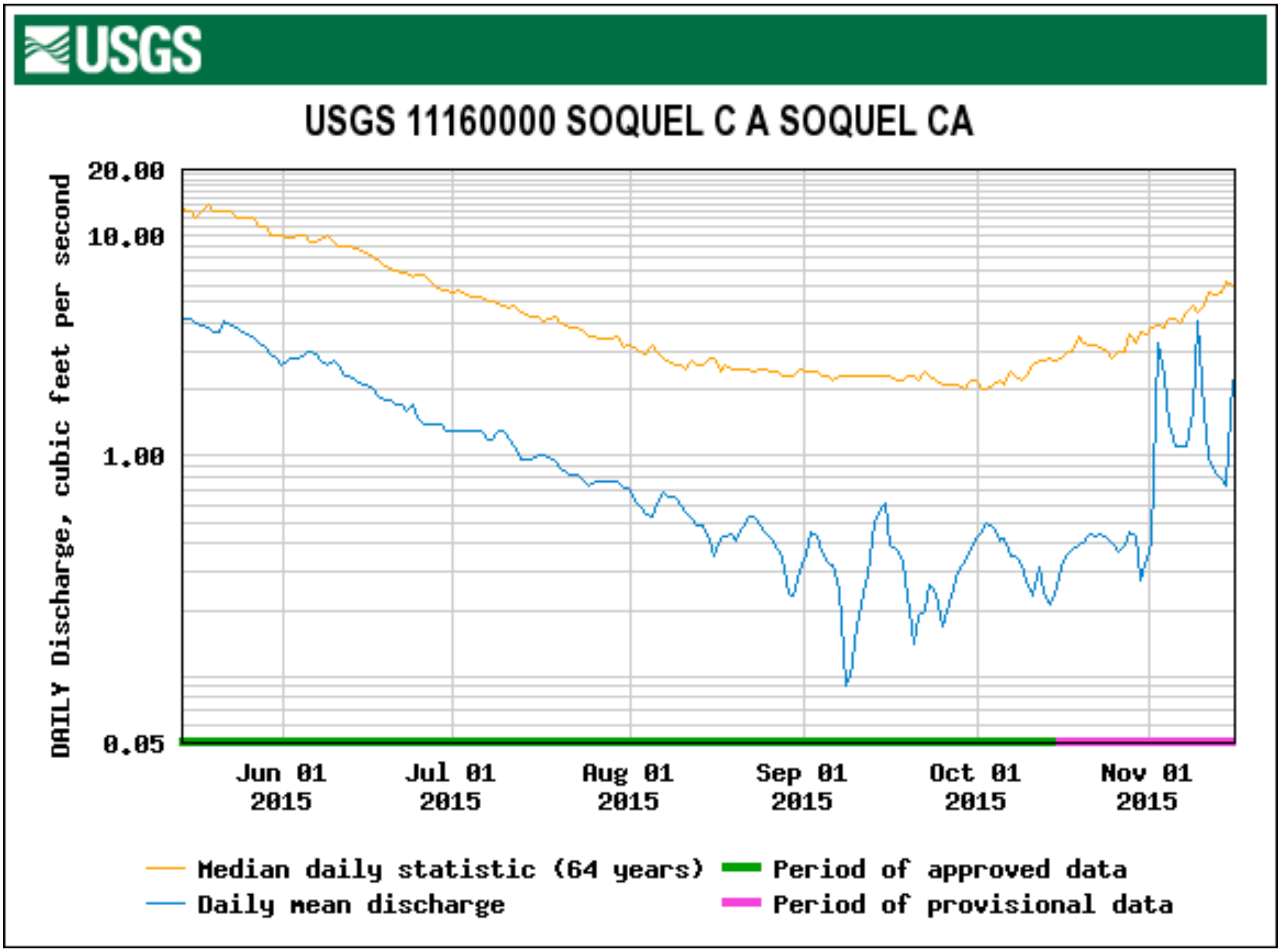


Figure 28. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, 15 May 2015 – 15 November 2015.

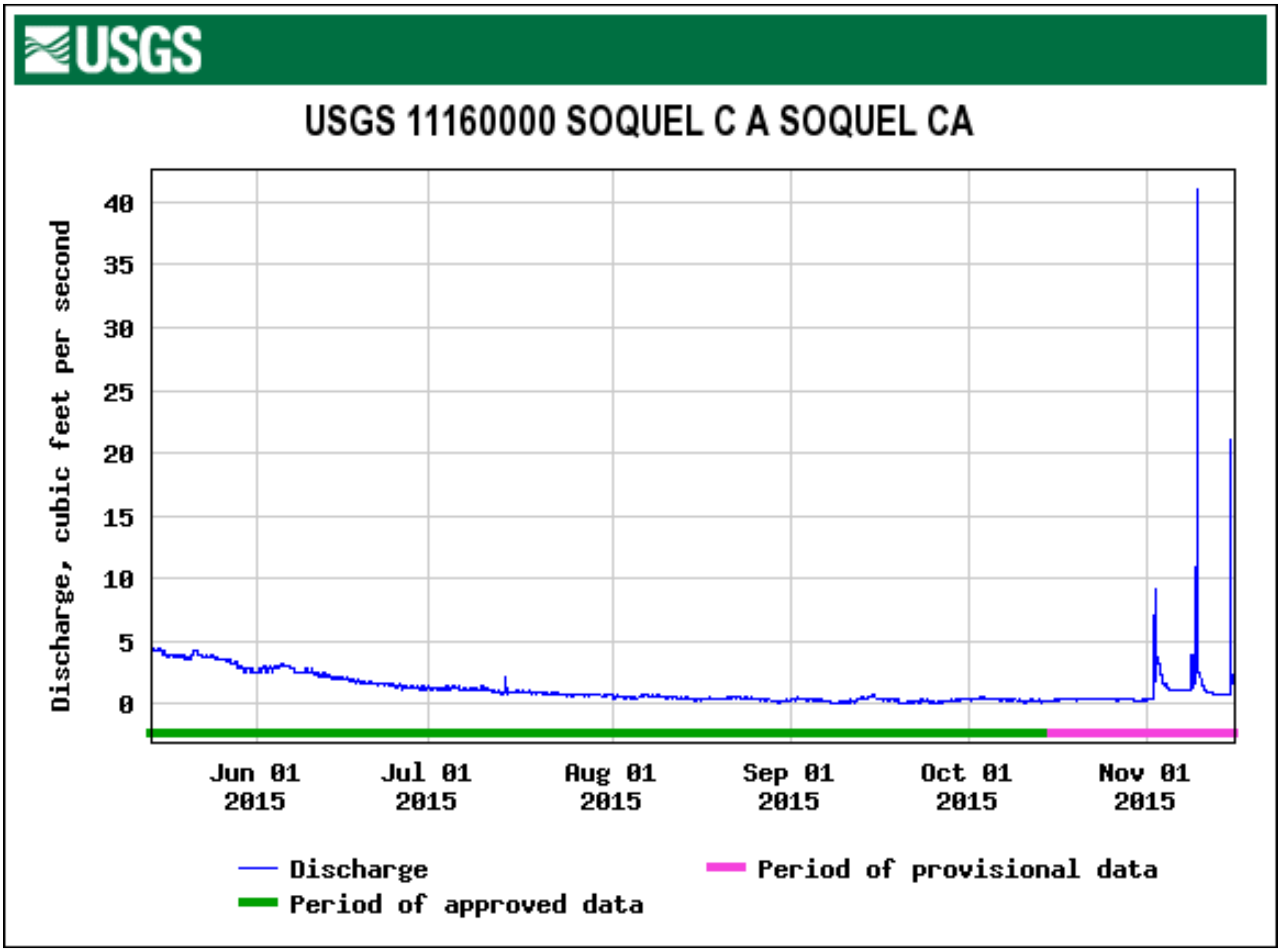


Figure 29. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 15 May 2014 – 10 December 2014.

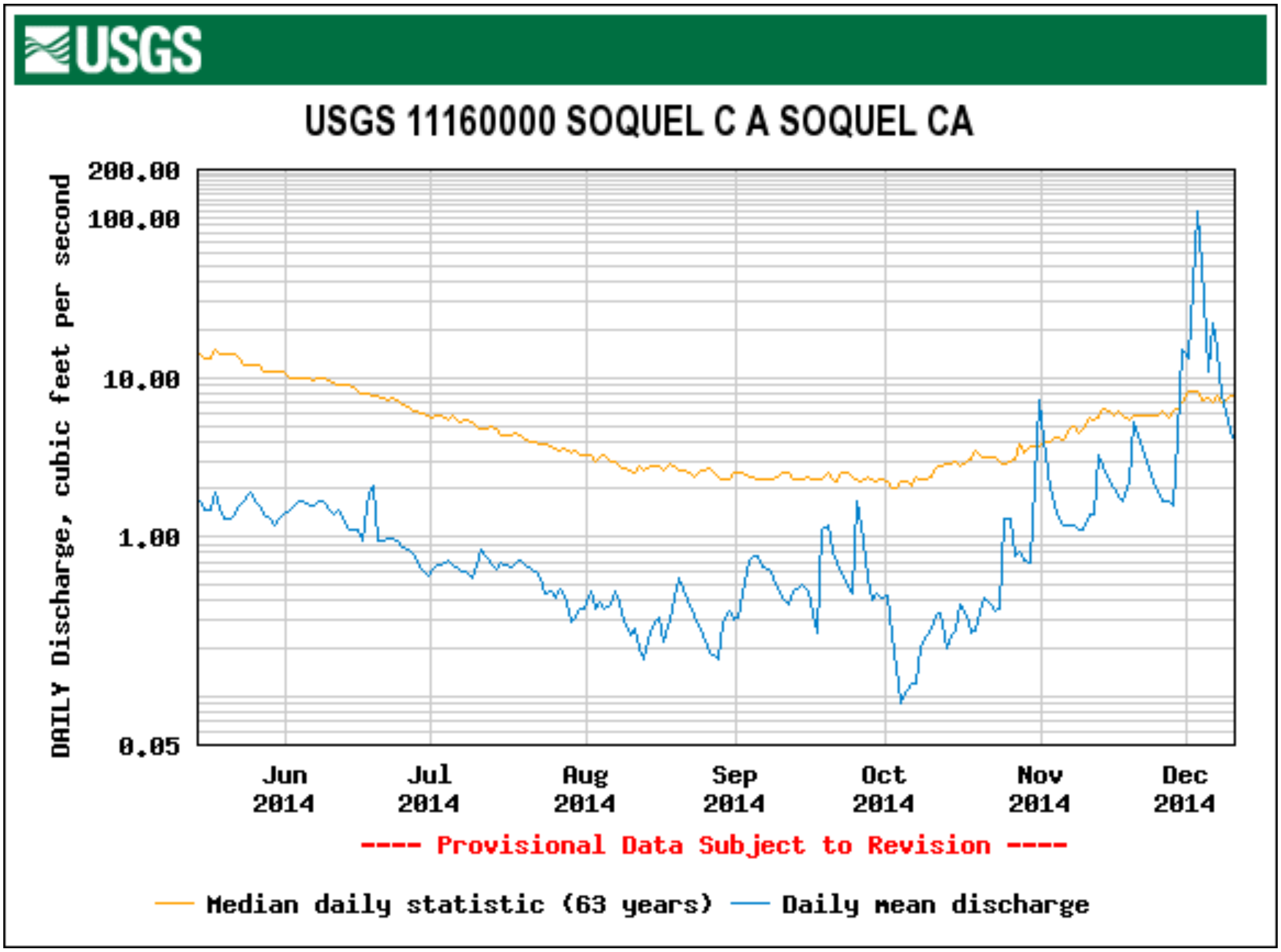


Figure 30. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2014.

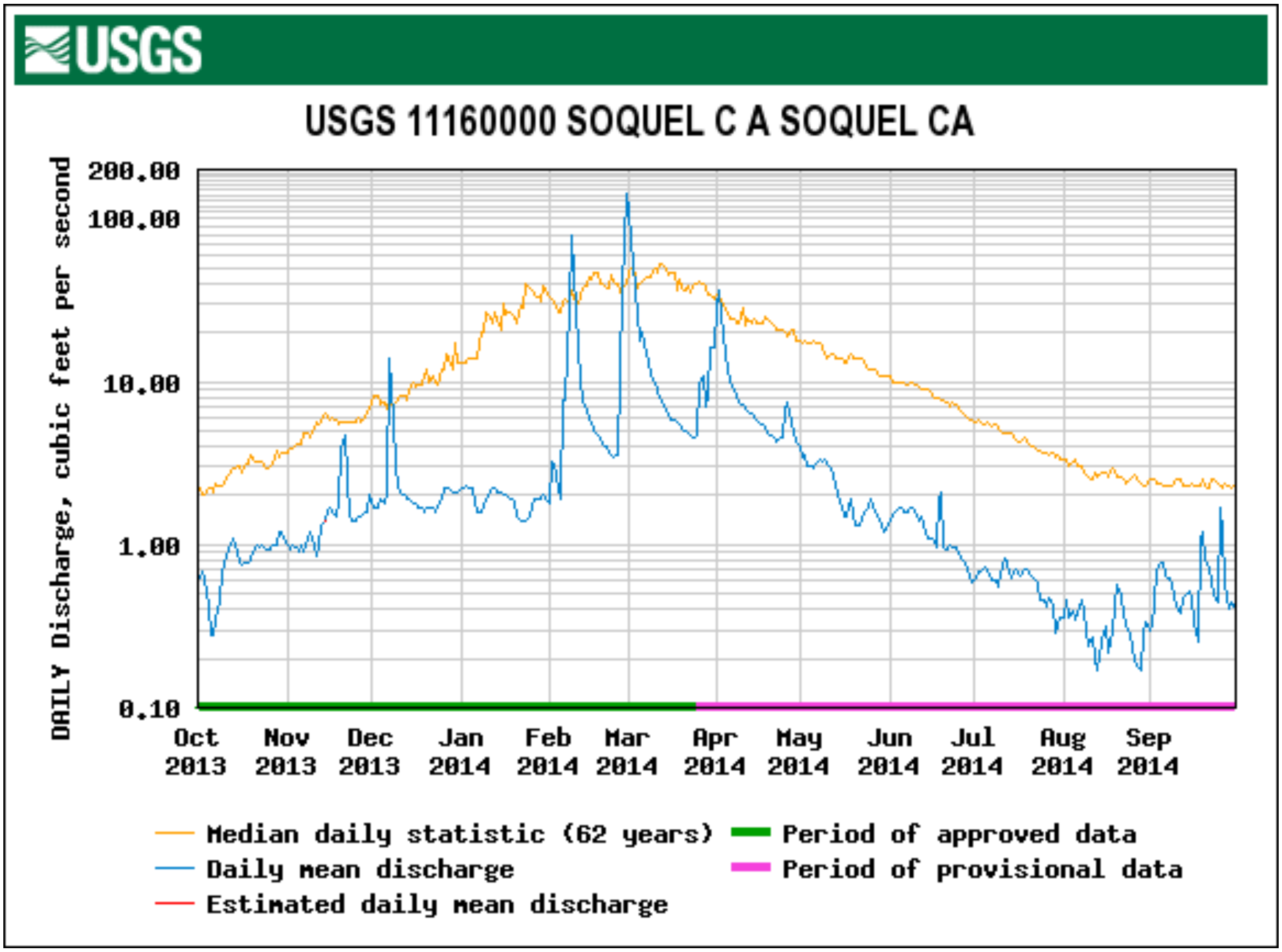


Figure 31. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2014.

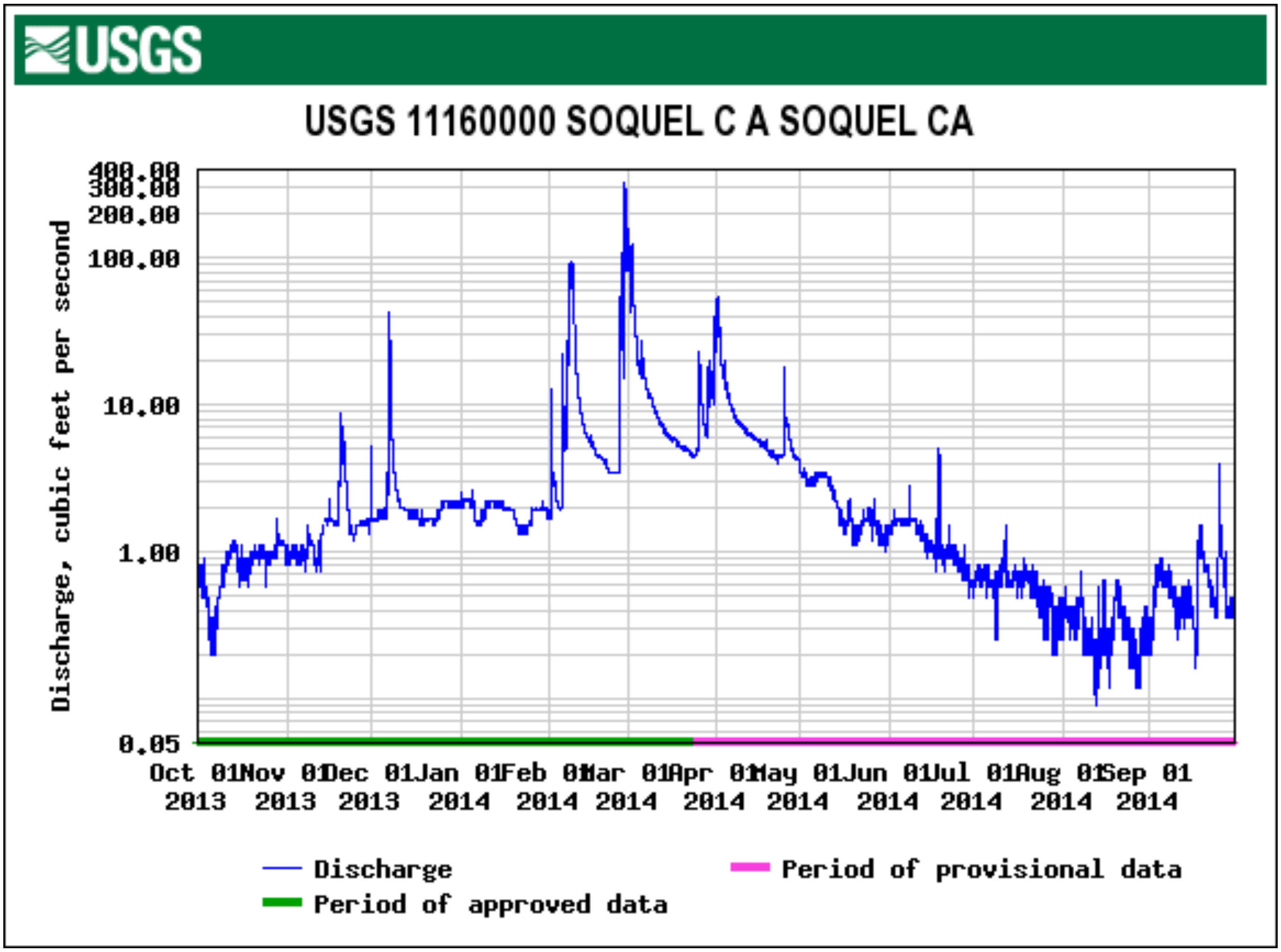


Figure 32. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2013.

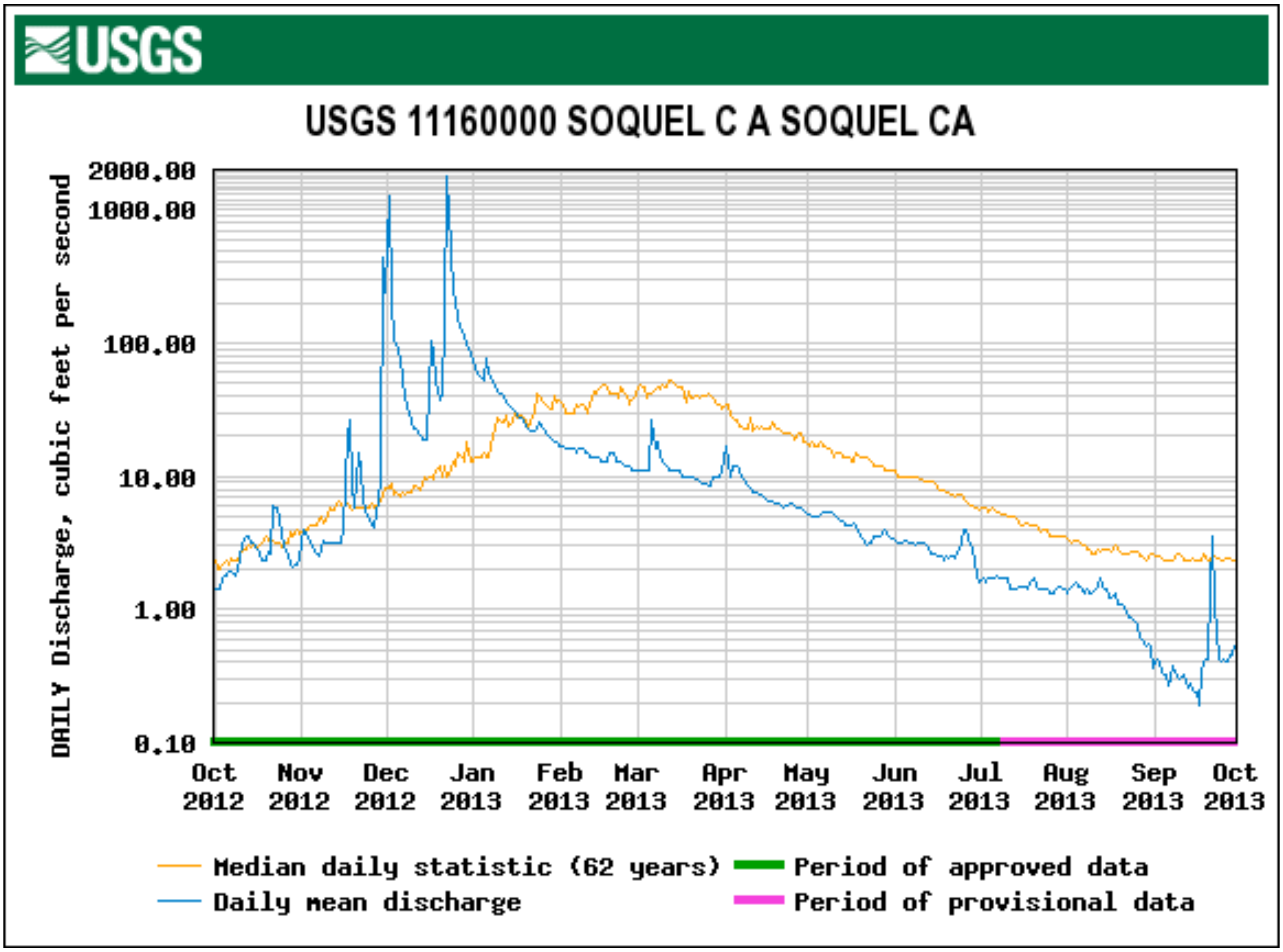


Figure 33. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, October 2012 – May 2013.

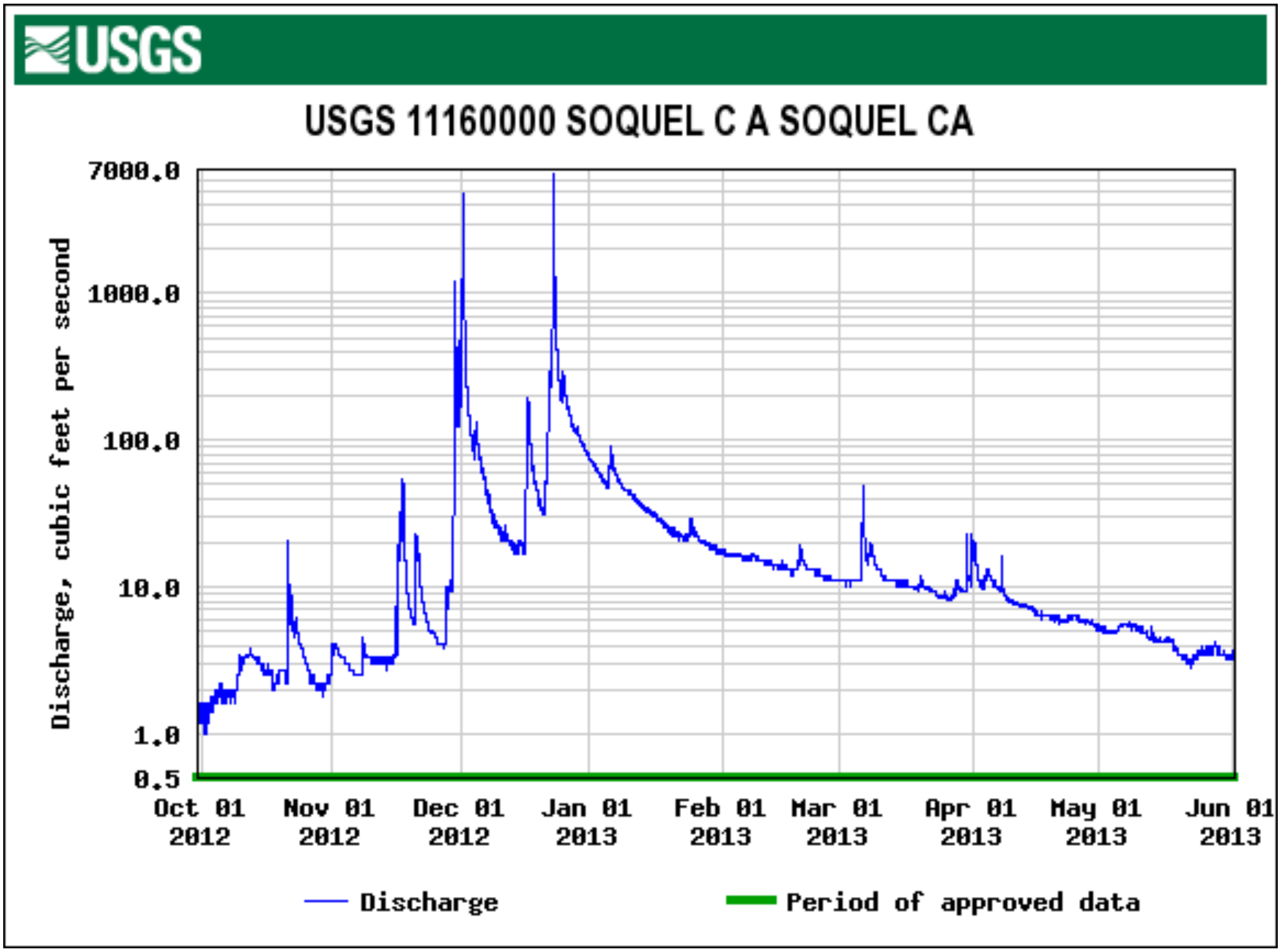


Figure 34. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2012.

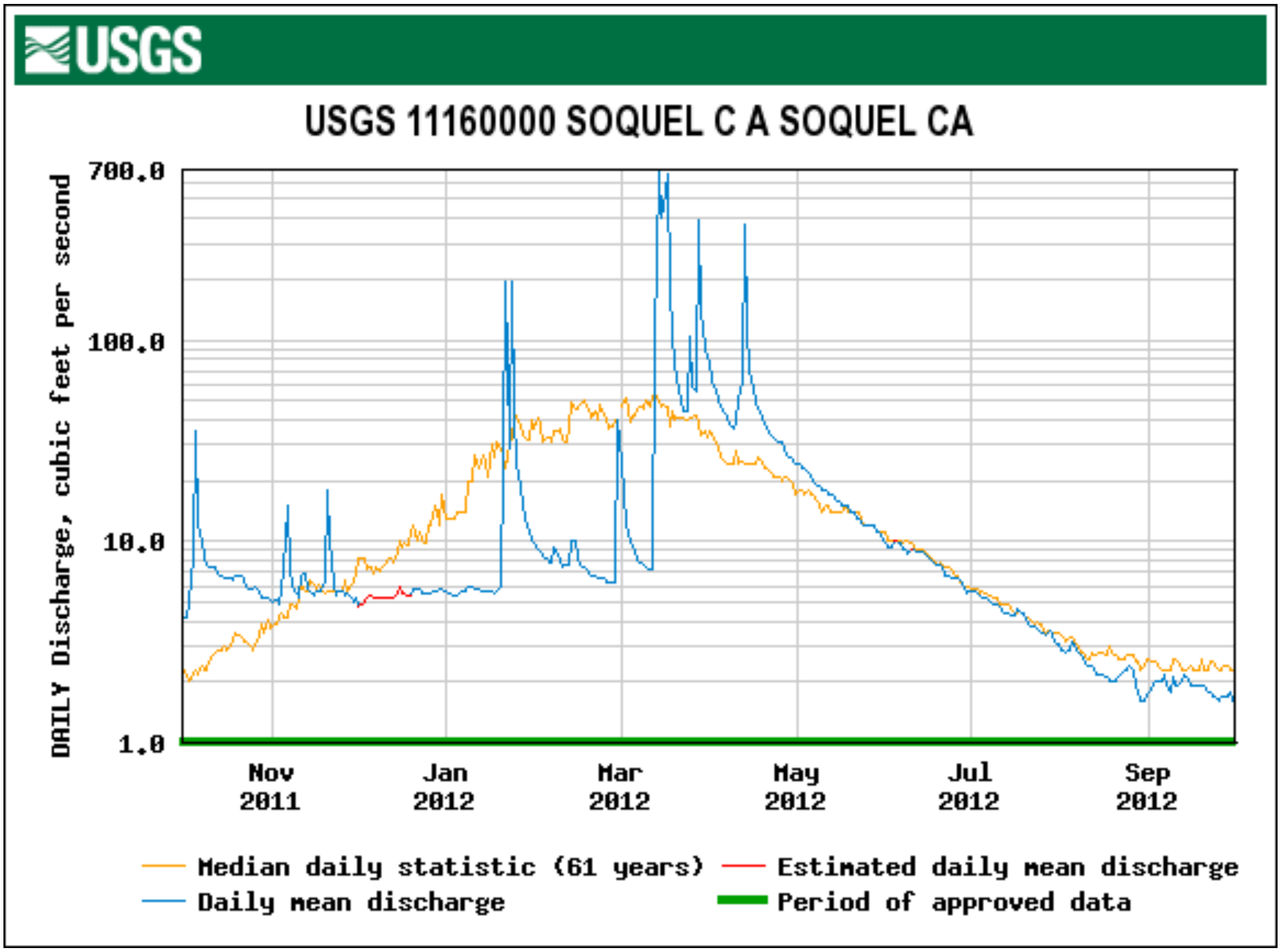


Figure 35. Soquel Creek Actual Measured Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2012.

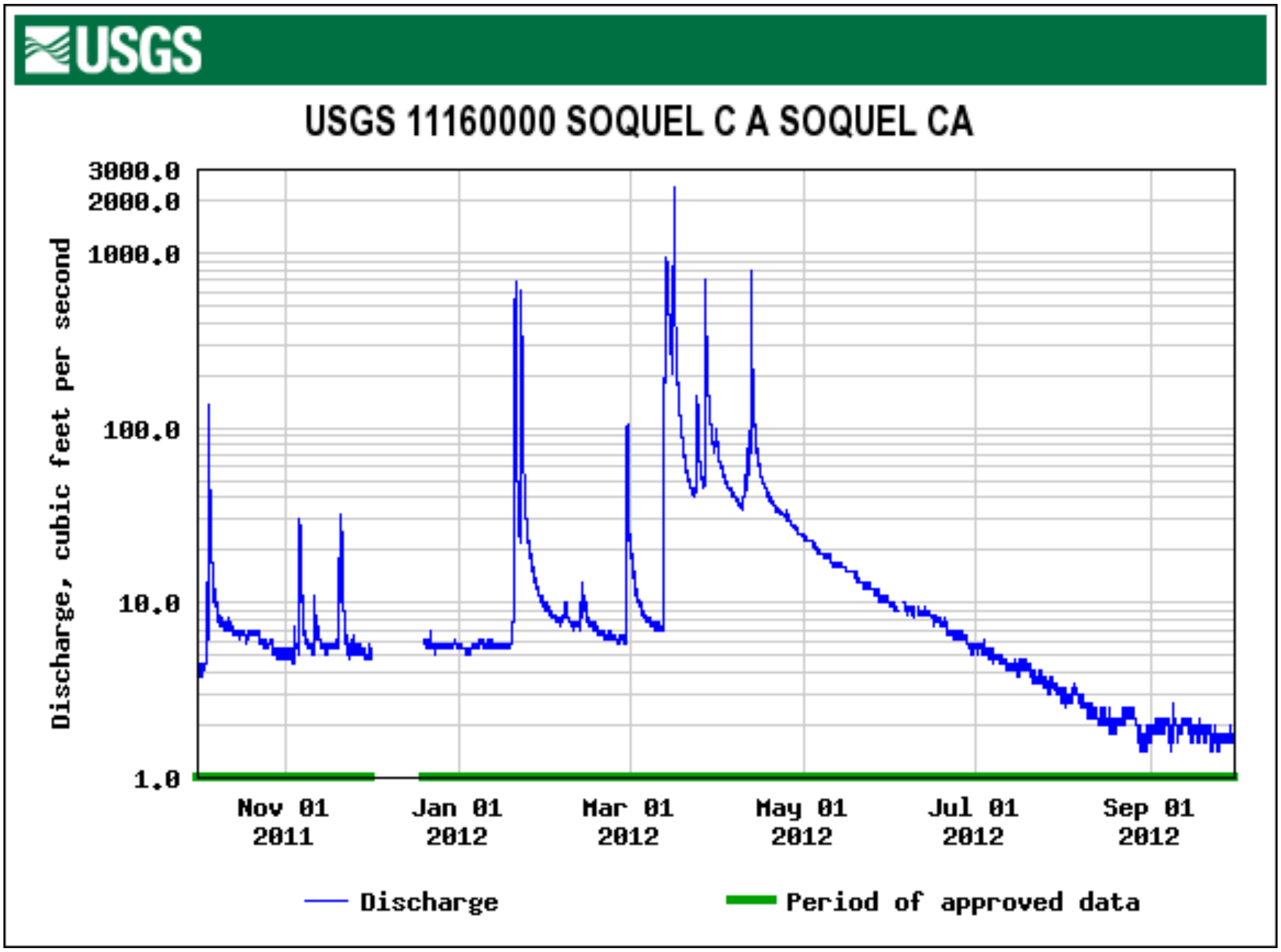


Figure 36. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 15 May 2012 – 20 November 2012.

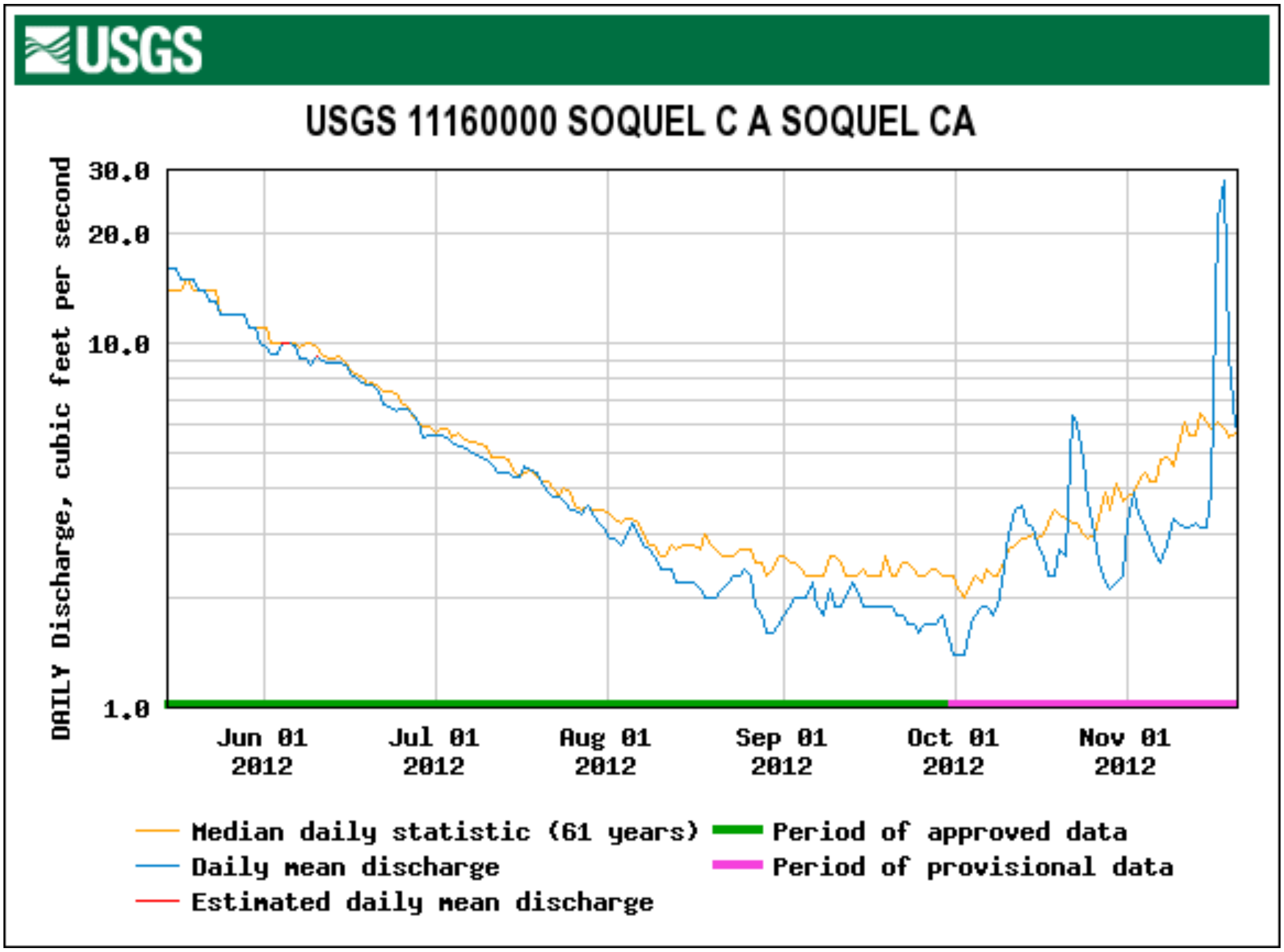


Figure 37. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2011.

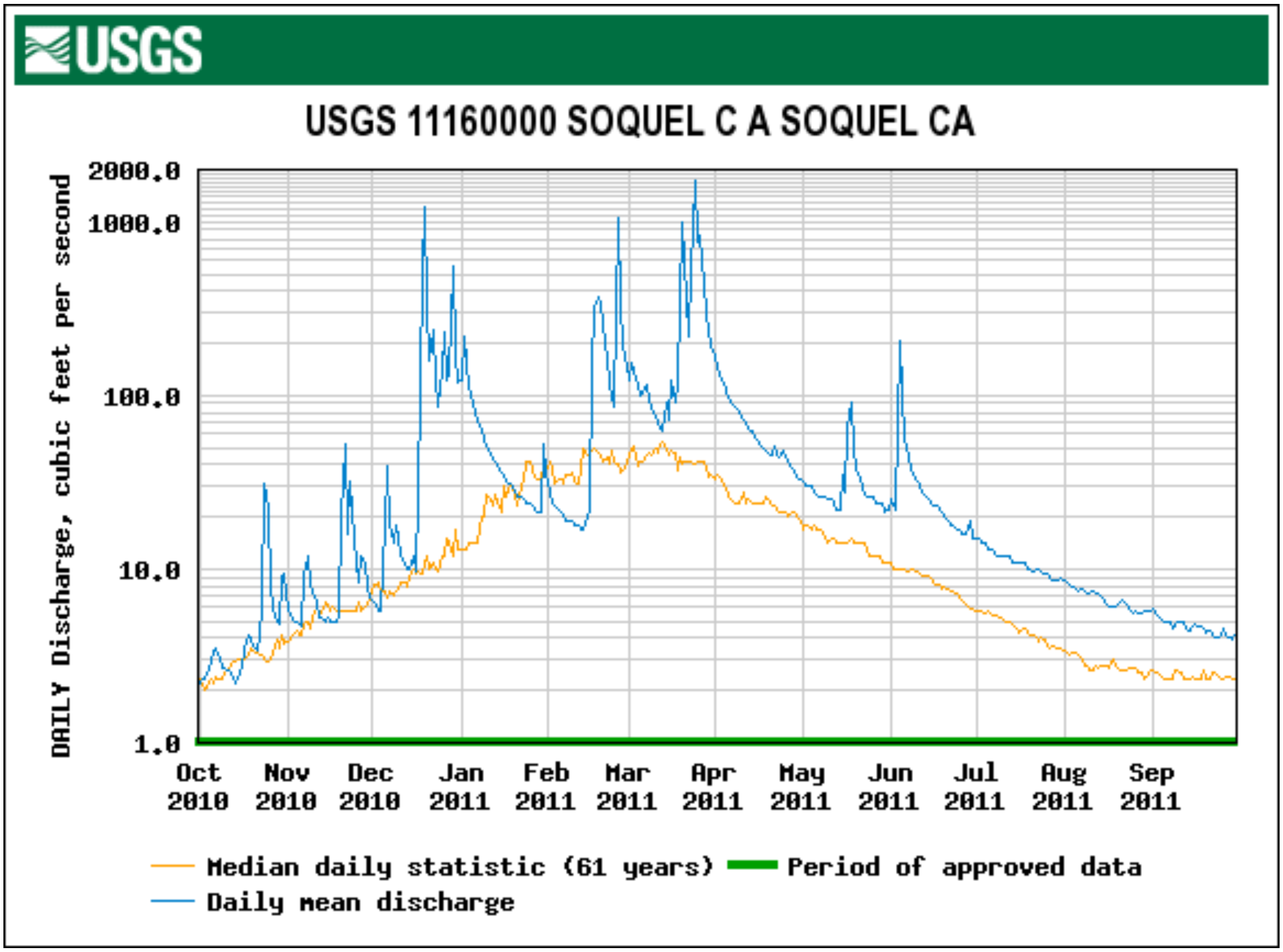


Figure 38. Soquel Creek Actual Measured Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2011.

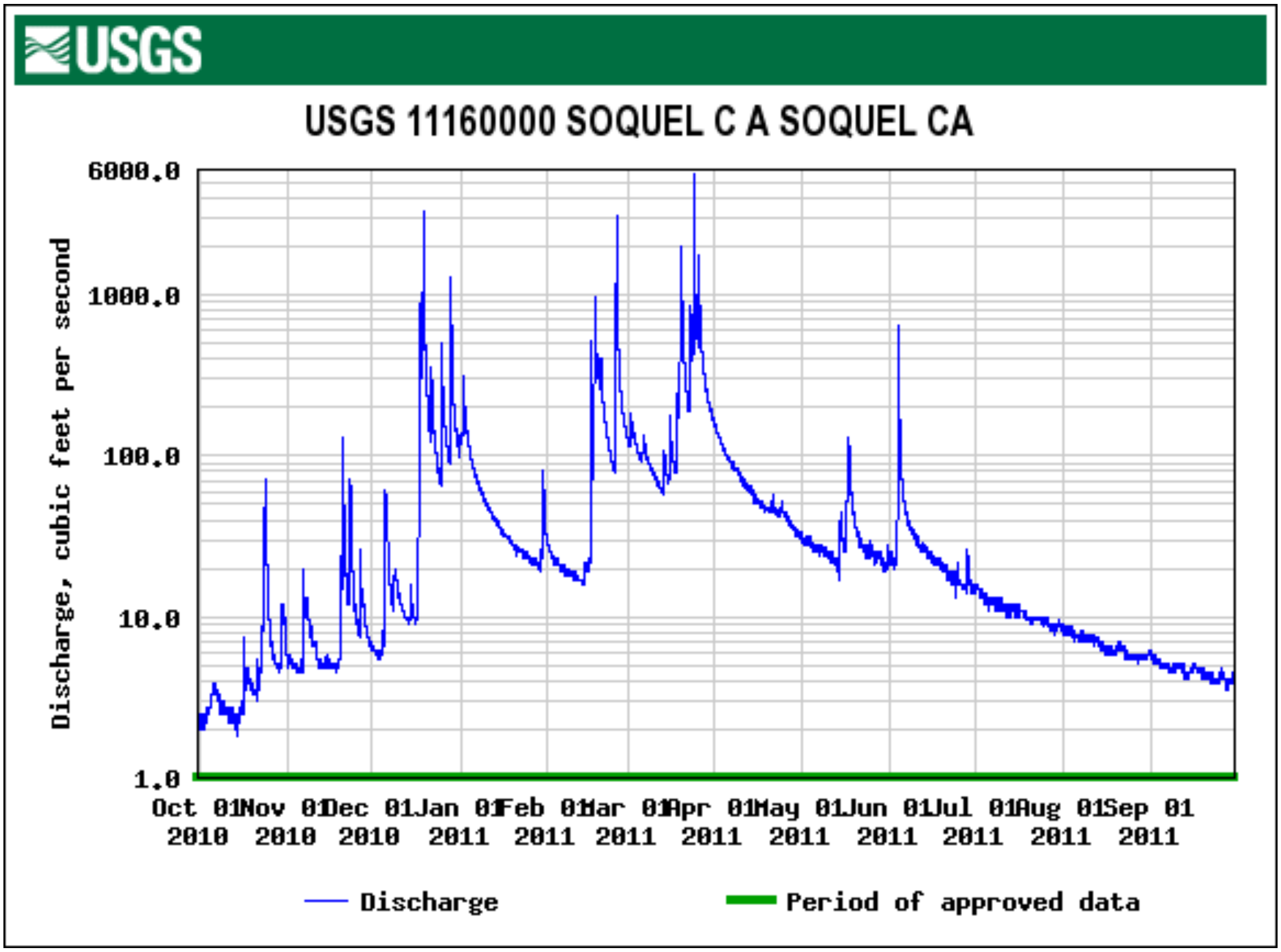


Figure 39. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2010.

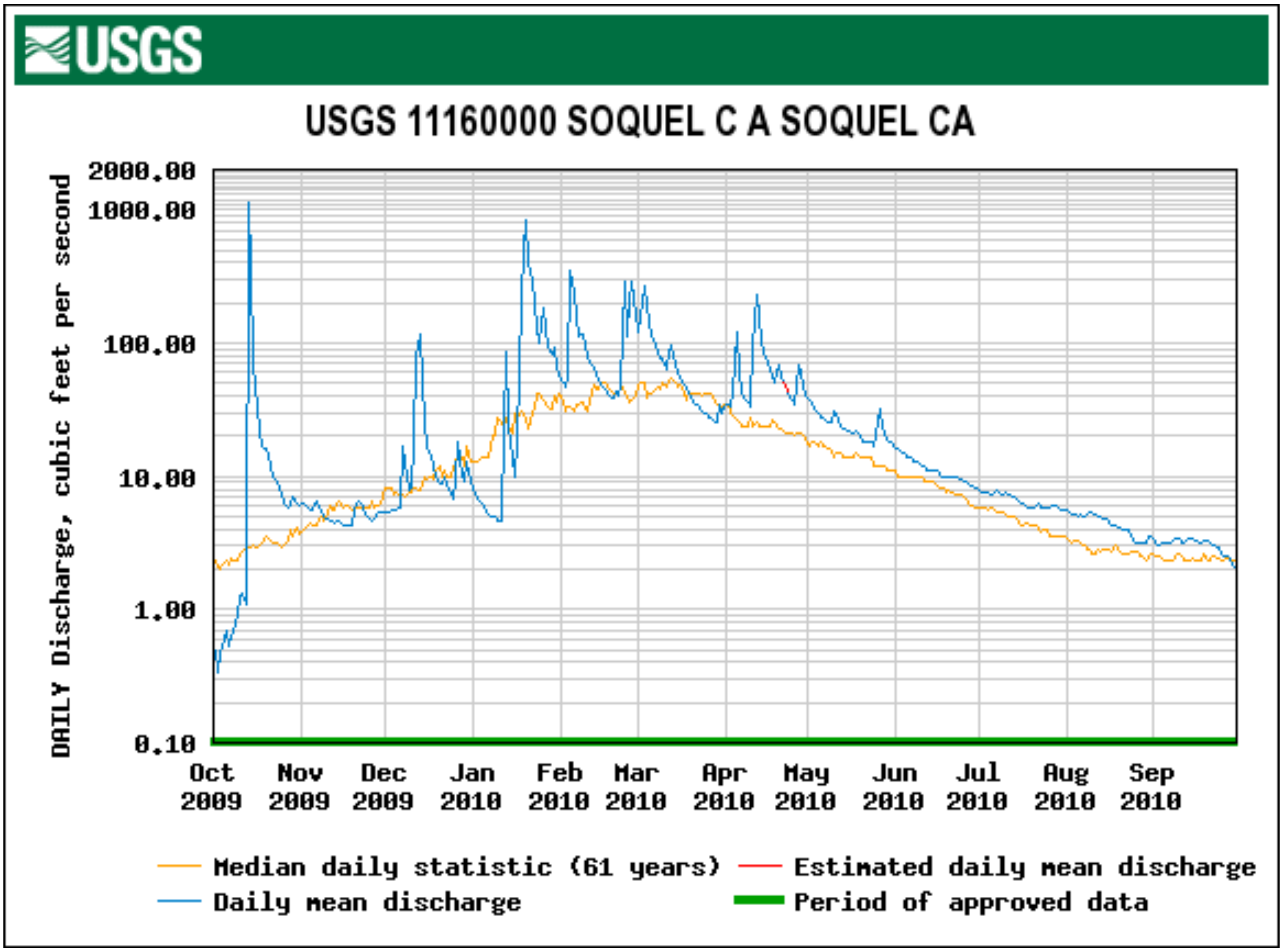


Figure 40. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2009.

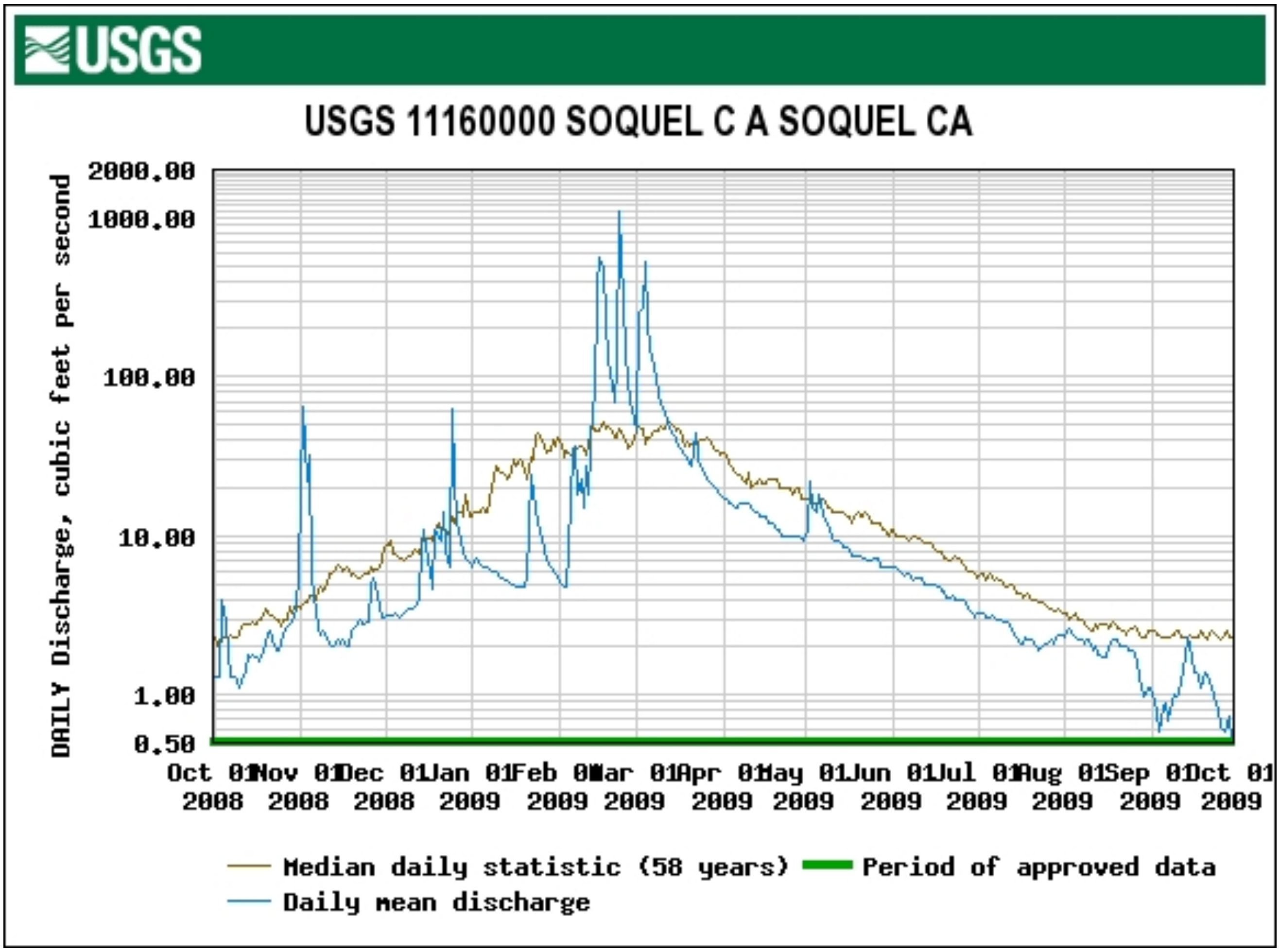


Figure 41. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2008.

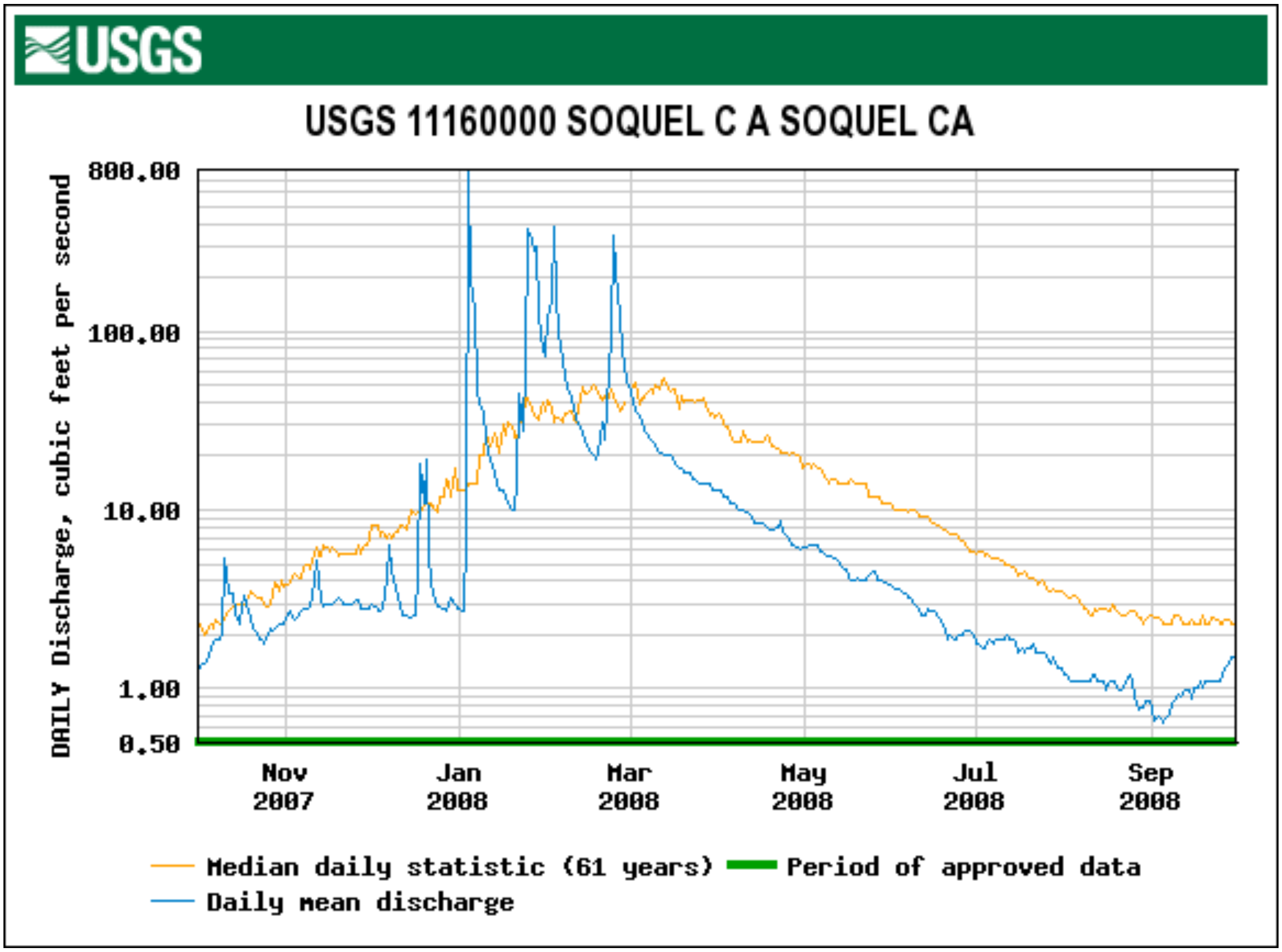
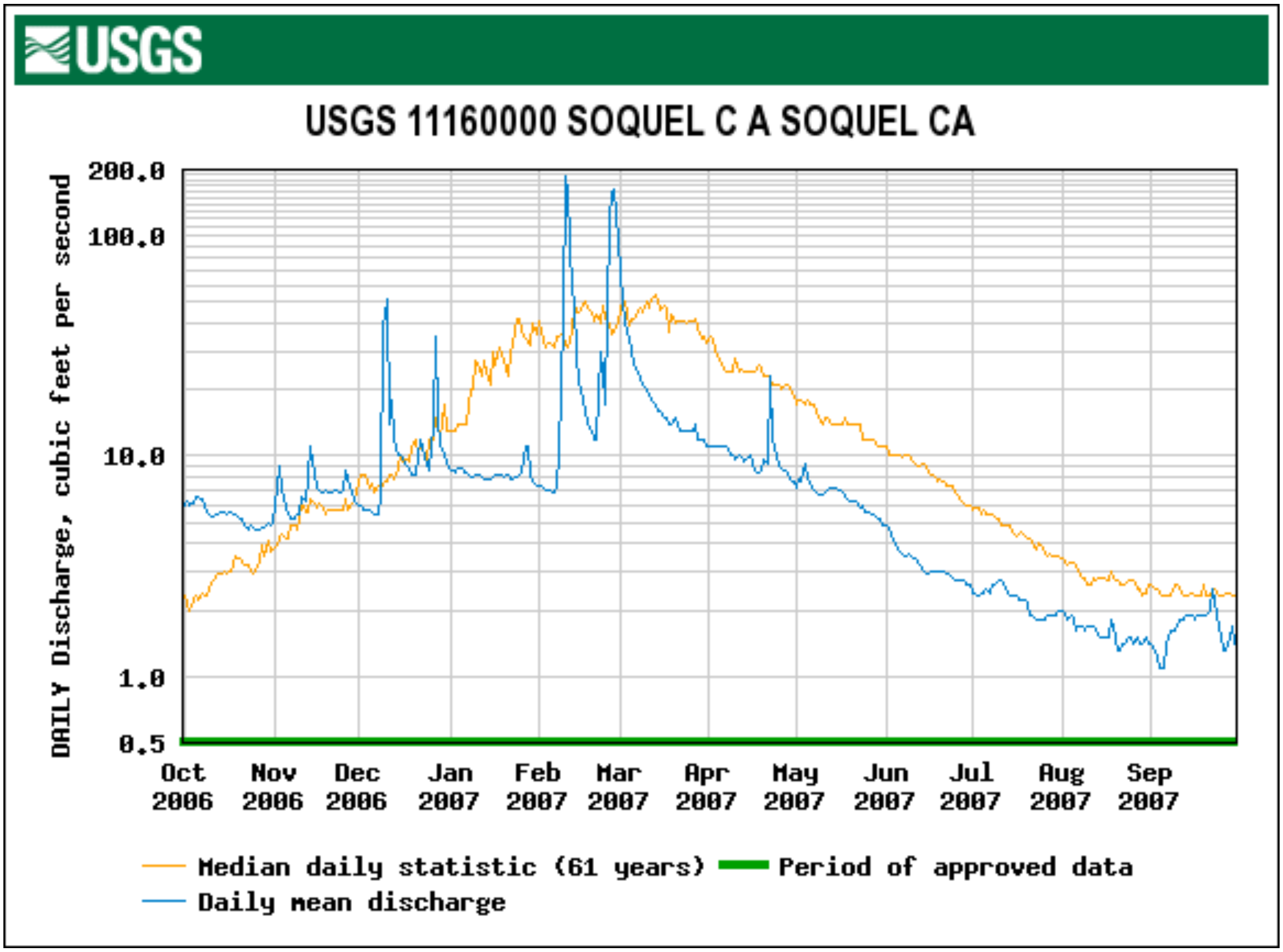


Figure 42. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2007.



APPENDIX A. Water Quality Data and General Observations of Birds and Aquatic Vegetation.

28 May 2014– 9 November 2015.

28 May 2015. The sandbar had been closed since 21 May. Temperature probes were launched on 29 May in the lagoon and upstream. The lagoon water surface was within 4 inches of the top of the flume on 27 May. Five of 8 inches of the adult portal were underwater. Plywood was tacked to the lower portion of the flume inlet boards. Gage height was 2.32. Saltwater was detected along the Venetian Court wall on 28 May with elevated temperature (see table below). The biologist recommended that a shroud be placed on the flume inlet. This was accomplished.

			28-May 2015					
	Stockton Bridge 1230 hr				**Venetian Court Wall 1245 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	18.6	0.6	10.56	1056				
0.25	18.6	0.6	10.54	1054				
0.50	18.6	0.6	10.60	1049				
0.75	18.5	0.6	10.65	1043				
1.00	18.4	0.6	10.72	1033				
1.25	18.3	0.6	10.78	1025				
1.50	18.3	0.6	10.91(116%)	1025				
1.75	21.9	3.4	15.82	5669		0.7		
2.00b	22.4	19.6	over	29399	21.4	13.3		
2.25b					21.7	23.0		
2.50								
2.75								
3.0								

29 May 2015. Temperature probes were launched into the lagoon and upstream at Nob Hill.

			7-June 15					
	Flume		0735 hr		**Stockton Avenue Bridge**			0745 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	18.4	0.5	7.80	934	18.4	0.5	7.97	924
0.25	18.4	0.5	7.79	933	`8.4	0.5	7.91	928
0.50	18.4	0.5	7.83	936	18.4	0.5	7.85	928
0.75	18.4	0.5	7.82 (83%)	934	18.4	0.5	7.90	928
1.00b	18.5	0.5	7.55	919	18.4	0.5	7.86	927
1.25					18.4	0.5	7.84	925
1.50					18.1	0.5	6.85	917
1.75b					17.9	0.5	1.89	892
2.5b Venetian					19.1	19.8	Over- algae 1" thick	28151
	Railroad Trestle			0807 hr	**Mouth of Noble Gulch**			0821 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	18.2	0.5	7.77	920	17.9	0.5	7.44	900
0.25	18.2	0.5	7.77	921	17.9	0.5	7.41	904
0.50	18.2	0.5	7.75	921	17.9	0.5	7.40	904
0.75	18.2	0.5	7.77	921	17.9	0.5	7.41	902
1.00	18.2	0.5	7.51	921	17.3	0.5	5.86 (61%)	896
1.25b	17.3	0.5	5.66 (58%)	889	17.3	0.8	1.87	1421
1.33b	17.3	0.5	5.20	843				
1.50								
1.75								
2.00								

7 June 2015. Starting time delayed with change in membrane and batteries to the meter. The first complete water quality monitoring was accomplished. Water quality was warm for the time of year, and a slightly warmer saltwater layer existed along the Venetian wall. Water temperature was 18.5-20 ° C in the afternoon in the lagoon in the freshwater layer. Oxygen was 58-83% full saturation in the morning near the bottom. Inflow oxygen in the morning was only 67% full saturation at Nob Hill. Oxygen was supersaturated in the afternoon at all stations. The city did a good job of raising the gage height to 2.59 with less than 3 cfs inflow. The water was flowing through the shroud as intended.

			7-June 2015					
	Flume		1547 hr		**Stockton Avenue Bridge**			1535 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	19.9	0.5	10.63	952	19.8	0.5	10.47	947
0.25	20.0	0.5	10.67	953	19.8	0.5	10.47	948
0.50	19.9	0.5	10.66	953	19.7	0.5	10.55	947
0.75	19.4	0.5	11.04 (120%)	940	19.7	0.5	10.38	944
1.00b	19.5	0.5	11.07	943	19.6	0.5	10.42	942
1.25					19.5	0.5	10.53	940
1.50					19.3	0.5	11.12(121%)	934
1.75b					19.2	0.5	9.46	937
2.00								
2.25								
	Railroad Trestle			1520 hr	**Mouth of Noble Gulch**			1455 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	19.7	0.5	10.46	943	20.0	0.5	10.15	953
0.25	19.7	0.5	10.42	942	19.9	0.5	10.03	949
0.50	19.6	0.5	10.40	942	19.8	0.5	9.80	945
0.75	19.5	0.5	10.51	939	19.6	0.5	9.65	943
1.00	19.4	0.5	11.01	934	18.4	0.5	11.09(118%)	901
1.25b	19.1	0.5	11.59 (125%)	926	18.5	0.5	10.98	953
1.33b	19.0	0.5	11.01	916				

7 June 2014. Gage height of 2.58 in morning and 2.59 in afternoon. Inlet shroud in place. Overcast in morning and sunny in afternoon.
Station 1: Flume at 0735 hr- Air temp. 15.2 C. no surface algae. 9 gulls bathing. At 1547 hr- Air temp. 17.0 C. <1% surface algae. Thick phytoplankton bloom underway, no bottom algae. Reach 1- 52 gulls bathing and 1 mallard.
Station 2: Stockton Avenue Bridge at 745 hr- No surface algae. Secchi depth to bottom. 2 mallards roosting on bulkhead. At 1535 hr- no surface algae, thin film of algae on 20% of bottom. No waterfowl in Reach 2.
Station 3: Railroad Trestle at 0807 hr- no surface algae. Reach 3- 1 cormorantt. At 1520 hr- no surface algae25% of bottom thin film of algae <0.1 ft thick. Reach 3- , 3 mallards in water.
Station 4: Mouth of Noble Gulch at 0821. No surface algae. 2 mallards on downed cottonwood, 1 mallard on redwood stump. 1455 hr. No surface algae. Bottom algal film on 50% of bottom. 3 mallards roosting on cottonwood and redwood stump.
Station 5: Nob Hill at 0849 hr/ 1634 hr- Water temp. =15.5/17.4 C, oxygen= 6.66 (67%) saturation/9.89 mg/L (102%), cond. = 754/766 umhos. Salinity =0.5/0.5 ppt. Streamflow 2.3 cfs

21 June 2014. Water temperature was warmer than usual for this time of year (similar to the past 2 years in the afternoon), with afternoon water temperature above 21 C near the bottom in the afternoon except at Noble Gulch mouth, even though salinity was absent under the Stockton Bridge. Oxygen levels were good. Lagoon depth remained good.

			21-June-2015				
	Flume			0705 hr	**Stockton Avenue Bridge**		0717 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	20.1	0.5	10.95	975	20.2	0.5	10.74	965
0.25	20.1	0.5	11.14	977	20.3	0.5	10.75	981
0.50	20.2	0.5	11.07	977	20.3	0.5	10.75	982
0.75	20.1	0.5	11.07(121%)	978	20.3	0.5	10.63	982
0.87b	20.2	0.5	10.65	978				
1.00					20.3	0.5	10.77	982
1.25					20.3	0.5	10.76	982
1.50					20.3	0.5	10.64	982
1.75					20.2	0.5	10.18(113%)	981
1.80b					20.2	0.5	7.94	982
2.00								
2.25								
	Railroad Trestle			0738 hr	**Mouth of Noble Gulch**			0750 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	20.1	0.5	9.66	972	20.0	0.5	9.86	964
0.25	20.2	0.5	9.66	974	20.0	0.5	9.86	965
0.50	20.2	0.5	9.67	973	20.0	0.5	9.83	965
0.75	20.2	0.5	9.66	973	20.0	0.5	9.77	965
1.00	20.2	0.5	9.64(107%)	973	19.8	0.5	7.89 (84%)	967
1.25b	20.2	0.5	7.12	972	18.4	0.5	1.51	972
1.50								

21 June 2015. Gage height of 2.33 in morning. Overcast/misty at 0705 hr. Air temperature of 13.2 C.
Station 1: Flume 0705 hr. Reach 1- 10 gulls bathing, 4 mallards in water, 1 merganser and 5 mallards roosting on Venetian margin. No surface algae.
Station 2: Stockton Bridge 0717 hr. Reach 2-no waterfowl and no surf. algae.
Station 3: Railroad trestle 0738 hr. Reach 3- 1 female and 2 mallard ducklings and 1 mallard in water. .
Station 4: Noble Gulch 0750 hr. 2 mallards on Golino wood. No surface algae. 8 steelhead hits/ minute.
Station 5: Nob Hill at 0823 hr. Water temperature 16.2^{o} C. Conductivity 756 umhos. Salinity 0.5 ppt. Oxygen 8.08 mg/l (82% saturation). - 1.2 cfs

			21 June 2015					
	Flume			1604 hr	**Stockton Avenue Bridge**			1540 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	21.9	0.5	12.01	1013	22.1	0.5	11.84	1016
0.25	21.9	0.5	12.24	1015	22.0	0.5	11.81	1016
0.50	21.9	0.5	12.31	1014	22.0	0.5	11.85	1015
0.75	21.8	0.5	12.59(144%)	1011	21.8	0.5	11.90	1012
1.00b	21.8	0.5	12.34	1010	21.7	0.5	11.89	1009
1.25					21.6	0.5	11.95	1008
1.50					21.6	0.5	11.97	1005
1.75					21.6	0.5	11.75(133%)	1005
1.80b					21.5	0.5	10.41	1006
2.00								
	Railroad Trestle			1525 hr	**Mouth of Noble Gulch**			1505 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	22.2	0.5	11.04	1019	22.2	0.5	1053	1016
0.25	22.0	0.5	11.12	1018	22.1	0.5	10.64	1019
0.50	22.0	0.5	11.12	1016	21.8	0.5	9.93	1015
0.75	21.8	0.5	11.04	1015	21.5	0.5	9.94	1002
1.00	21.5	0.5	11.59(119%)	1007	20.5	0.6	13.09(146%)	1008
1.25b	21.3	0.5	9.48	1003	20.5	0.6	13.06	1013
1.50								

<u>21 June 2015.</u> Gage height of 2.33 in afternoon. Sunny/breezy. Air temperature of 17.4^{o} C at 1604 hr. Flume inlet = 1.2 ft. Flume outlet = 0.6 ft estimate.
Station 1: Flume 1604 hr. Reach 1- 68 gulls bathing. 100% bottom algae 0.2 ft thick. No surface algae. Planktonic algae bloom. 7 paddle boarders.
Station 2: Stockton Bridge 1540 hr. Reach 2- phytoplankton bloom; no surface algae, no waterfowl. 30% bottom algae 0.5 ft thick; 70% algae 0.1-0.2 ft thick.
Station 3: Railroad trestle 1525 hr. Reach 3- 1 female mallard with 7 ducklings; 10 other mallard, No surface algae. 95% bottom algae 0.1-0.2 ft thick; 5% bottom algae 0.5 ft.
Station 4: Noble Gulch 1505 hr. 5 mallard on cottonwood and redwood stump. 3 mergansers on Golino wood. 1 merganser in water. 60% bottom algae 0.5 ft thick; 40% algae 1.2 ft thick. No surface algae.
Station 5: Nob Hill at 1650 hr. Water temperature 18.1^{o} C. Conductivity 782 umhos. Salinity 0.4 ppt. Oxygen 9.70 mg/l (103%).

			5 July 2015					
	Flume 0710 hr				**Stockton Avenue Bridge** 0725hr			
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	21.9	0.5	7.68	1025	22.2	0.5	7.32	1009
0.25	21.9	0.5	7.91	1026	22.3	0.5	7.24	1036
0.50	21.9	0.5	7.91	1028	22.3	0.5	7.23	1036
0.75	22.0	0.5	7.91 (91%)	1028	22.3	0.5	7.24	1036
1.00b	22.0	0.5	7.49	1028	22.3	0.5	7.11	1036
1.25					22.3	0.5	7.12	1036
1.50					22.2	0.5	6.27	1036
1.75					22.2	0.5	6.22(72%)	1037
1.87b					22.2	0.5	4.16	1038
2.00								
	Railroad Trestle 0740hr				**Mouth of Noble Gulch**			0755hr
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	22.1	0.5	7.22	1029	21.7	0.5	7.54	1021
0.25	22.1	0.5	7.17	1033	21.7	0.5	7.60	1024
0.50	22.1	0.5	7.06	1033	21.7	0.5	7.56	1024
0.75	22.1	0.5	6.73	1034	21.7	0.5	7.59	1024
1.00	22.1	0.5	6.38	1034	21.6	0.5	7.47	1023
1.25	22.1	0.5	6.19(71%)	1035	21.1	0.5	6.69(75%)	1001
1.30b					21.1	0.6	2.95	1171
1.50b	22.1	0.5	5.40	1035				

5 July 2015. Gage height of 2.58 in morning. Overcast/misty/ calm. Air temp. = 16.9° C at 0710 hr. Shroud had been removed.
Station 1: Flume 0710 hr. Reach 1- 11 mallards roosting at Venetian margin, 2 mallards roosting under bridge, 15 gulls bathing. No surface algae.
Station 2: Stockton Bridge 0725 hr. Reach 2- 3adult mallards, 1 female mallard and 2 ducklings.
Station 3: Railroad trestle 0740 hr. Reach 3- In water- 1 female mallard and 1 duckling, 5 unattended ducklings, 1 female and 5 ducklings. No surface algae.
Station 4: Noble Gulch 0802 hr. 1 female and 5 ducklings roosting on Arthur dock; 2 mallards on redwood stump and cottonwood. No surface algae.
Station 5: Nob Hill at 0830 hr. Water temperature 17.8° C. Conductivity 754 umhos. Salinity 0.4 ppt. Oxygen 6.59 mg/l (70% saturation). – 0.8 cfs estimate.

			5 July 2015					
	Flume			1556 hr	**Stockton Avenue Bridge**			1530 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	23.3	0.5	10.48	1057	23.3	0.5	9.94	1057
0.25	23.2	0.5	10.44	1056	23.3	0.5	9.98	1057
0.50	23.2	0.5	10.55	1055	23.4	0.5	10.00	1058
0.75	23.2	0.5	10.78(127%)	1054	23.3	0.5	9.91	1057
1.00b	23.2	0.5	10.56	1062	23.3	0.5	9.82	1056
1.25					23.2	0.5	9.80	1054
1.50					23.0	0.5	9.84	1050
1.75					22.9	0.5	9.54(111%)	1047
1.85b					22.9	0.5	8.17	1046
2.00								
	Railroad Trestle			1516 hr	**Mouth of Noble Gulch**			1500 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	23.1	0.5	9.72	1050	23.4	0.5	9.34	1060
0.25	23.1	0.5	9.66	1051	23.4	0.5	9.30	1058
0.50	23.1	0.5	9.71	1050	23.3	0.5	9.23	1056
0.75	23.3	0.5	9.72	1050	23.2	0.5	9.11	1055
1.00	23.0	0.5	9.74	1050	22.1	0.5	10.98(126%)	1040
1.25	23.0	0.5	10.03(117%)	1048	21.8	0.5	10.71(122%)	1047
1.30b					22.1	0.6	15.22(173%)	1182
1.37b	22.7	0.5	9.08	1040				
1.50								

5 July 2015. Gage height of 2.59 in afternoon. Partly cloudy. Air temperature of 19.3°C at 1556 hr. Flume inlet approx. 1.0 ft depth. Flume exit depth could not be determined with incoming tide. 8-inch gap below boards in flume outlet.

Station 1: Flume at 1556 hr. Reach 1- Bottom invisible due to thick planktonic algal bloom. 28 gulls bathing, 2 mallards looking for handouts at Margaritaville. No surface algae.

Station 2: Stockton Avenue Bridge at 1530 hr. Secchi depth to bottom. Reach 2- No surface algae, too soupy to see bottom vegetation. 1 female mallard and 2 ducklings.

Station 3: Railroad Trestle at 1516 hr. Reach 3- No surface algae, too soupy to observe bottom vegetation. 11 mallards, 1 female mallard and 5 ducklings; 1 female mallard and 3 large ducklings; 3 youths swimming; 3 kayaking paddle boats.

Station 4: Mouth of Noble Gulch at 1500 hr. 1 mallard on downed cottonwood. Too soupy to see bottom vegetation. No surface algae.

Station 5: Nob Hill at 1633 hr. Water temperature 19.3°C. Conductivity 781 umhos. Salinity 0.4 ppt. Oxygen 9.25 mg/l (101%).

			18-July-15					
	Flume 0704 hr				**Stockton Avenue Bridge** 0736 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**mg/l (% sat.)**	**umhos**	**(C)**	**(ppt)**	**mg/l (% sat.)**	**Umhos**
0.00	21.7	0.6	7.58	1046	22.0	0.5	10.86	1042
0.25	21.7	0.6	7.53	1047	22.0	0.6	10.96	1051
0.50	21.7	0.6	7.61	1047	22.0	0.6	10.91	1051
0.75	21.7	0.6	7.56(86%)	1048	22.0	0.6	10.96	1052
0.95b	21.7	0.6	7.13	1047				
1.00					22.0	0.6	10.83	1052
1.25					22.0	0.6	10.66	1052
1.50					22.0	0.6	10.52	1052
1.75					22.0	0.6	10.34(118%)	1052
1.95b					22.0	0.6	9.39	1052
2.00								
			18-July-15					
	Railroad Trestle 0751 hr				**Mouth of Noble Gulch**			0813 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**mg/l (% sat.)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	21.7	0.6	Meter malfunction	1036	21.2	0.5		1025
0.25	21.7	0.6		1040	21.2	0.5		1026
0.50	21.7	0.6		1039	21.2	0.5		1026
0.75	21.7	0.6		1039	21.2	0.5		1026
1.00	21.7	0.6		1037	21.2	0.5		1025
1.25b	21.6	0.5		1033	21.5	1.0		1835
1.35b	21.6	0.5		1027				

18 July 2015. Gage height of 2.58 in morning. Cloud cover. Air temperature of 16.0°C at 0704 hr.
Station 1: Flume at 0704 hr. Reach 1- No gulls bathing, 5 gulls on margin, 12 mallards in water with 1 female mallard and 5 ducklings; 10 mallards on Venetian margin. No surface algae.
Station 2: Stockton Avenue Bridge at 0736 hr. Reach 2- 4 mallards moved in from Reach 1. 1 female and 3 large ducklings moved from Reach3. No surface algae. Oxygen meter damaged while cord was untangled on the bridge after retrieving probe.
Station 3: Railroad Trestle at 0751 hr. Reach 3- 3 mallards near trestle abutment from Reach 1. Female mallard and 5 ducklings from Reach 1, 1 female with 4 ducklings; 1 female and 4 larger ducklings. Turtle observed by paddle boarder upstream. 4 steelhead hits/ minute. No surface algae.
Station 4: Mouth of Noble Gulch at 0813 hr. no waterfowl on redwood stump or cottonwood. No surface algae.
Station 5: Nob Hill at 0840 hr. Water temperature 17.7° C. Conductivity 743 umhos. Oxygen meter malfunction. Salinity 0.4 ppt. Estimated streamflow = - 0.5 cfs.

			18-July-15					
	Flume 1607 hr				**Stockton Avenue Bridge** 1552 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**mg/l (% sat.)**	**umhos**	**(C)**	**(ppt)**	**mg/l (% sat.)**	**Umhos**
0.00	23.4	0.6		1077	23.6	0.6		1079
0.25	23.3	0.6		1069	23.6	0.6		1079
0.50	23.2	0.5		1066	23.5	0.6		1079
0.75	23.0	0.5		1064	23.4	0.6		1077
0.95b	22.9	0.5		1064				
1.00					23.0	0.6		1071
1.25					22.7	0.5		1055
1.50					22.6	0.6		1057
1.75					22.3	0.6		1053
1.95b					22.2	0.6		1052
2.00								
			18-July-15					
	Railroad Trestle 1536 hr				**Mouth of Noble Gulch** 1520 hr			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**mg/l (% sat.)**	**umhos**	**(C)**	**(ppt)**	**mg/l (% sat.)**	**Umhos**
0.00	23.5	0.6		1079	24.0	0.6		1116
0.25	23.5	0.6		1077	23.6	0.6		1090
0.50	23.5	0.6		1078	23.7	0.6		1084
0.75	23.4	0.6		1076	22.6	0.6		1065
1.00	23.0	0.6		1071	22.3	0.6		1069
1.25b	22.8	0.6		1065	22.6	0.6		1201
1.37b	22.6	0.6		1064				
1.50								

18 July 2015. Gage height of 2.57 in afternoon. Sunny and warm. Air temp. = 20.8^{o} C at 1607 hr.
Station 1: Flume at 1607 hr. Reach 1- 17 gulls. Could not observe bottom. No surface algae.
Station 2: Stockton Avenue Bridge at 1552 hr. Secchi depth to bottom. Reach 2- No surface algae. 30% of the bottom algae 2 ft thick, remainder film. 4 mallards being fed at Stockton Bridge. Others in water: 1 female mallard and 9 ducklings, 2 female mallards and 3 ducklings each, 1 female mallard and 1 duckling.
Station 3: Railroad Trestle at 1520 hr. Reach 3- No surface algae. Could not observe bottom. 8 mallards in water.
Station 4: Mouth of Noble Gulch at 1520 hr. Could not observe bottom. No surface algae. 5 mallards on Arthur dock; 2 mallards on redwood stump.
Station 5: Nob Hill at 1640 hr. Water temperature 19.7 ^{o}C. Conductivity 773 umhos. Oxygen meter malfunction. Salinity 0.4 ppt. - cfs.

			1-Aug-15					
	Flume 0732 hr				**Stockton Avenue Bridge** 0744 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	22.6	0.5	10.96	990	22.6	0.5	9.70	996
0.25	22.6	0.5	10.94	993	22.8	0.5	9.78	1000
0.50	22.7	0.5	10.94	994	22.8	0.5	9.73	1002
0.75	22.6	0.5	10.86	994	22.8	0.5	9.72	1002
1.00b	22.6	0.5	10.64	989	22.8	0.5	9.66	1002
1.25					22.8	0.5	8.25	1001
1.50					22.8	0.5	9.37	998
1.75b					22.7	0.5	9.20	999
2.00								
			1-Aug-15					
	Railroad Trestle 0805 hr				**Mouth of Noble Gulch** 0820 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	22.6	0.5	9.84	995	22.0	0.5	8.59	998
0.25	22.7	0.5	9.83	996	22.0	0.5	8.61	1002
0.50	22.7	0.5	9.84	996	22.0	0.5	8.61	1002
0.75	22.7	0.5	9.77	996	22.0	0.5	8.62	1016
1.00	22.6	0.5	9.30	996	22.0	1.0	8.72	1854
1.25b	22.6	0.5	9.06	994	22.5	2.8	4.88	4307
1.50								

1 August 2015. Gage height of 2.57 (morning) and 2.57 (afternoon). Overcast/warm at 0732 hr with air temperature of 18.7 °C. Air temperature 21.3º C at 1558 hr and sunny. Flume inlet 1 ft. Flume outlet 0.5 ft in afternoon.

Station 1: Flume at 0732 hr. Reach 1- In water 16 gulls bathing, 1 female mallard and 3 ducklings and 2 other mallards. 14 mallards and 4 mergansers roosting on Venetian margin. No surface algae.

Station 2: Stockton Avenue Bridge at 0744 hr. Secchi depth to the bottom. Reach 2-1 mallard in water; No surface algae. Steelhead hitting surface near trestle.

Station 3: Railroad trestle at 0805 hr. Reach 3- 6 mallards in water. 1% surface algae. Steelhead hitting surface up to Shadowbrook Restaurant (75 hits/ minute).

Station 4: Mouth of Noble Gulch at 0820 hr. No surface algae. No waterfowl on redwood stump or cottonwood.

Station 5: Nob Hill at 0904 hr. Water temperature at 18.3°C. Conductivity 674 umhos, Oxygen 6.81 mg/L. Salinity 0.4 ppt. Estimated streamflow = 0.1 cfs.

1558 hr			1-Aug-15					1540 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	24.4	0.5	23.42	1018	24.4	0.5	11.79	1027
0.25	24.2	0.5	13.24	1016	24.4	0.5	11.89	1025
0.50	24.2	0.5	13.30	1016	24.3	0.5	11.91	1025
0.75	24.1	0.5	13.17	1013	24.2	0.5	11.73	1021
0.90b	24.2	0.5	13.30	975				
1.00					23.8	0.5	11.69	1014
1.25					23.6	0.5	11.38	1011
1.50					23.6	0.5	11.39	989
1.75b					23.5	0.5	10.57	1004
2.00								
1525hr			1-Aug-15					1504 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	24.2	0.5	12.32	1030	24.6	0.5	10.75	1034
0.25	24.2	0.5	12.33	1023	24.4	0.5	10.76	1025
0.50	24.2	0.5	12.30	1022	24.2	0.5	10.84	1018
0.75	24.1	0.5	12.32	1021	23.3	0.5	12.10	1013
1.00	24.0	0.5	12.24	1014	21.1	0.5	11.68	1021
1.25b	23.5	0.5	11.60	1008	25.9	3.1	17.68	5760
1.50								

Station 1: Flume at 1558 hr. Reach 1- 26 gulls. 5 mallards looking for handouts at Margaritaville. No surface algae. Too soupy to see bottom. No secchi depth measured.
Station 2: Stockton Avenue Bridge at 1540 hr. Reach 2- 30% pondweed and algae 2-5 ft thick; avg 4 ft. 70% algae 1-4 ft thick; avg 2 ft. No surface algae. 3 mallards in water.
Station 3: Railroad trestle at 1525 hr. Reach 3- No surface algae. 80% of bottom covered by algae 1-4 ft thick, averaging 2.0 ft; 20% pondweed + algae 2-5 ft thick, averaging 4 ft. Reach 3- 1 female and 8 large ducklings and 9 other mallards in water, 1 gull.
Station 4: Mouth of Noble Gulch at 1504 hr. No surface algae. 100% of bottom covered by algae 1 – 4.0 ft thick, averaging 1.5 ft. No waterfowl on redwood stump or cottonwood.
Station 5: Nob Hill at 1650 hr. Water temperature at 20.5°C. Conductivity 720 umhos, Oxygen 7.87 mg/l). Salinity 0.4 ppt.

			15-Aug-15					
	Flume 0739 hr				**Stockton Avenue Bridge** 0753 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	22.2	0.5	11.14	986	22.9	0.5	11.91	994
0.25	22.3	0.5	11.08	988	22.9	0.5	11.57	999
0.50	22.3	0.5	11.16	988	22.9	0.5	11.75	997
0.75	22.3	0.5	11.15	989	22.9	0.5	11.62	999
1.00	22.3	0.5	11.14	989	22.9	0.5	11.79	999
1.25					22.9	0.5	11.41	999
1.50					22.8	0.5	11.24	999
1.75b					22.8	0.5	11.34	999
2.00								
2.25								
			16-Aug-14					
	Railroad Trestle 0822 hr				**Mouth of Noble Gulch** 0835 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	22.8	0.5	12.01	1005	22.2	0.5	9.88	999
0.25	22.8	0.5	12.03	1006	22.2	0.5	9.95	999
0.50	22.8	0.5	12.02	1006	22.2	0.5	9.91	1002
0.75	22.8	0.5	12.09	1006	22.2	0.5	9.92	1003
1.00	22.8	0.5	12.05	1005	22.2	0.9	9.92	1027
1.25b	22.8	0.5	11.75	1006	22.6	5.1	8.63	9470
1.50								

15 August 2015. Gage height of 2.57 (morning) and 2.57 (afternoon). Clear at 0739 hr with air temperature of 16.0 ^{o}C. Air temperature 26.4º C at 1609 hr and clear/hot. Flume inlet 1.0 ft. Flume outlet 0.3 ft in afternoon.

Station 1: Flume at 0739 hr. Reach 1- 22 gulls bathing with 5 mallards and 1 merganser in water. 21 mallards on Venetian margin. No surface algae.

Station 2: Stockton Avenue Bridge at 0753 hr. Reach 2- 97 mallards in water from Reach 1. 2 mallards on trestle abutment. No surface algae.

Station 3: Railroad trestle at 0822 hr. Reach 3- 2 mallards in water initially. Later- 17 mallards from Venetian margin. No surface algae.

Station 4: Mouth of Noble Gulch at 0835 hr. No surface algae. 2 mallards on redwood stump. 1 red-ear slider turtle near Noble Gulch.

Station 5: Nob Hill at 0910 hr. Water temperature at 17.5°C. Conductivity 635 umhos, Oxygen 5.53 mg/l. Salinity 0.4 ppt. Estimated streamflow = < 0.1 cfs.

1609 hr			15-Aug-15					1550 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	24.8	0.5	14.84	1023	24.7	0.5	13.44	1024
0.25	24.7	0.5	14.98	1023	24.7	0.5	13.57	1023
0.50	24.7	0.5	15.09	1021	24.6	0.5	13.48	1019
0.75	24.6	0.5	15.27	1021	24.1	0.5	13.23	1013
1.00b	24.6	0.5	15.30	1019	24.0	0.5	13.34	1012
1.25					23.9	0.5	13.23	1008
1.50					23.8	0.5	15.27	994
1.75b					23.7	0.5	12.38	994
2.00								
2.25								
1535hr			15-Aug-15					1504 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	25.1	0.5	14.14	1036	25.4	0.5	12.99	1064
0.25	25.1	0.5	14.33	1036	25.2	0.5	12.84	1050
0.50	24.8	0.5	15.01	1013	24.3	0.5	12.50	1033
0.75	24.1	0.5	15.72	1009	23.7	0.5	14.03	1041
1.00	24.0	0.5	17.20	1009	23.6	0.5	13.42	1039
1.25b	23.7	0.5	16.03	1002	25.8	4.6	13.49	8430
1.50								

<u>15 August 2015.</u>
Station 1: Flume at 1609 hr. Reach 1- 120+ gulls bathing and 1 merganser. No surface algae mostly in cove. 95% bottom algal coverage 2 – 5 ft thick, avg. = 3 ft. 5% pondweed + algae 5 ft thick.
Station 2: Stockton Avenue Bridge at 1550 hr. Secchi depth to the bottom. Reach 2- No surface algae. 60% of bottom covered by algae 2 – 3 ft thick, averaging 2.3 ft. 40% pondweed + algae 2 – 4 ft thick; averaging 3.5 ft. 38 mallards in water.
Station 3: Railroad trestle at 1535 hr. Reach 3- No surface algae. 70% of bottom covered by algae 2 - 4 ft thick, averaging 2.5 ft. 30% pondweed + algae 2.0 – 5 ft thick, averaging 4 ft. 16 mallards in water. 1 merganser.
Station 4: Mouth of Noble Gulch at 1504 hr. No surface algae. 30% of bottom covered with pondweed and algae 1-4 ft thick; averaging 3 feet; 70% of bottom as algae 1-3 ft; averaging 2 ft. No waterfowl on redwood stump or cottonwood.
Station 5: Nob Hill at 1654 hr. Water temperature at 21.0°C. Conductivity 653 umhos, Oxygen 7.55 mg/l. Salinity 0.3 ppt.

			29-Aug-15					
	Flume 0722 hr				**Stockton Avenue Bridge** 0741 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	22.3	0.5	11.46	1006	22.6	0.5	11.38	1013
0.25	22.3	0.5	11.49	1006	22.6	0.5	11.34	1015
0.50	22.3	0.5	11.42	1006	22.7	0.5	11.18	1015
0.75	22.3	0.5	11.45	1006	22.7	0.5	10.87	1017
1.00b	22.3	0.5	11.14	1004	22.7	0.5	11.01	1017
1.25					22.7	0.5	10.77	1017
1.50					22.6	0.5	10.55	1017
1.75b					22.6	0.5	5.07	1017
2.00								
2.25								
			29-Aug-15					
	Railroad Trestle 0802 hr				**Mouth of Noble Gulch** 0815 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	22.6	0.5	10.36	1023	22.4	0.5	10.59	1050
0.25	22.8	0.5	10.47	1023	22.4	0.5	10.64	1055
0.50	22.8	0.5	10.38	1023	22.4	0.5	10.63	1056
0.75	22.8	0.5	10.49	1023	22.4	0.5	10.60	1057
1.00	22.8	0.5	10.56	1023	22.5	0.6	10.58	1076
1.25b	22.9	0.5	10.43	1022	22.6	5.8	9.13	10013
1.50								
1.75								

29 August 2015. Gage height of 2.56 (morning) and 2.56 (afternoon). Cloudy morning. At 0722 hr- air temperature of 18.2 °C. Air temperature 27.5º C at 1605 hr and clear/breezy.

Station 1: Flume at 0722 hr. Reach 1- 17 gulls. 4 mallards and 1 merganser in water, 3 mallards and 1 cormorant along Venetian periphery. No surface algae.

Station 2: Stockton Avenue Bridge at 0741 hr. Reach 2-4 mallards and 1 cormorant moved up from Reach 1No surface algae. .

Station 3: Railroad trestle at 0802 hr. Reach 3- 12 mallards in water. Cormorant moved up from Reach 2. No surface algae. Kingfisher hit surface. 37 steelhead hits/ minute.

Station 4: Mouth of Noble Gulch at 0815 hr. No waterfowl on wood.

Station 5: Nob Hill at 0847 hr. Water temperature at 18.2°C. Conductivity 682 umhos, Oxygen 5.72 mg/l. Salinity 0.4 ppt. Estimated streamflow = < 0.1 cfs.

1605 hr			29-Aug-15					1541 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	24.9	0.5	14.3	1043	24.2	0.5	11.43	1045
0.25	24.8	0.5	14.97	1040	24.2	0.5	12.75	1042
0.50	24.8	0.5	14.82	1036	24.2	0.5	12.70	1041
0.75	24.6	0.5	15.66	1034	24.1	0.5	12.52	1038
0.87b	24.5	0.5	15.94	1032				
1.00					24.0	0.5	12.15	1037
1.25					23.7	0.5	11.81	1033
1.50					23.6	0.5	11.57	1032
1.75b					23.6	0.5	10.40	1021
2.00								
2.25								
1524 hr			29-Aug-15					1503 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	24.2	0.5	15.74	1056	24.9	0.5	12.51	1083
0.25	24.4	0.5	16.02	1056	24.7	0.5	12.77	1080
0.50	24.3	0.5	15.73	1053	24.0	0.5	13.12	1077
0.75	24.2	0.5	15.57	1050	23.6	0.5	13.71	1083
1.00	23.5	0.5	15.57	1045	23.5	0.6	13.65	1186
1.25b	23.6	0.5	14.47	1038	25.3	5.7	15.01	9640
1.50								

Station 1: Flume at 1605 hr. Reach 1- In water- 63 gulls, 3 mallards and 1 cormortant. No surface algae. 70% bottom algal coverage at 2 -4 ft thick, avg. =32 ft. 30% pondweed + algae at 3 - 5 ft thick; averaging 4.5 ft.
Station 2: Stockton Avenue Bridge at 1541 hr. Secchi depth to the bottom. Reach 2- 5 mallards in water. 1 cormorant on floating boat launch near trestle. Bottom algae 60% coverage; avg. 2.0 thick. Pondweed + algae 40% coverage 2 – 5 ft. thick, 4 ft average. No surface algae.
Station 3: Railroad trestle at 1524 hr. Reach 3- 9 mallards in water near Noble Gulch; 15 mallards roosting on a lawn and deck; 1 merganser on rocks near deck. 50% bottom algae 1-3 ft thick; avg 2 ft. 50% pondweed and algae 3-5 ft thick; avg 4 ft. No surface algae.
Station 4: Mouth of Noble Gulch at 1503 hr. No surface algae. 70% bottom algae averaging 2 ft thick. 30% pondweed + algae 3 –4 ft thick, averaging 3.5 ft.
Station 5: Nob Hill at 1642 hr. Water temperature at 20.7°C. Conductivity 717 umhos, Oxygen 7.77 mg/l. Salinity 0.4 ppt. Streamflow approx. cfs.

			6-Sep-15				
	Flume				Stockton Avenue Bridge 1015 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					20.7	0.5	13.31	996
0.25					20.8	0.5	12.92	994
0.50					20.7	0.5	12.07	993
0.75					20.7	0.5	13.23	990
1.00					20.6	0.5	13.53	985
1.25					20.4	0.5	12.96	984
1.50					20.4	0.5	13.24	980
1.75b					20.4	0.5	13.02	979
2.00								
2.25								
			6-Sep-15					
	Railroad Trestle				**Mouth of Noble Gulch** 1040 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					20.7		11.66	1057
0.25					20.6		11.47	1056
0.50					20.5		11.40	1056
0.75					20.4		11.21	1058
1.00					20.3		11.00	1062
1.25b					22.1		8.68	9030
1.50								
1.75								

6 September 2015. Begonia Festival Day. Gage height of 2.59 (morning) and 2.59 (afternoon). Clear day.
Aside from 5 electric motor-powered floats, there were 40 other personal boats, kayaks, paddle boards and barges. 1 cormorant continued to fish below Stockton Bridge until late morning. One mother mallard and 6 ducklings remained in the water prior to procession. One drone was present to film the Festival. The only mishap occurred with a staff kayaker flipping his kayak and then waded to shore. The lagoon level was kept high. Water temperature was considerably cooler than the previous week. The secchi depth (water clarity) was to the lagoon bottom after the float procession. There was no smell of hydrogen sulfide. Conductivity increased slightly from disturbance during the procession but was not a problem. Conductivity in the afternoon at Stockton Bridge was slightly less than the previous week. Begonias were cleaned out of the lagoon in the succeeding days.

			6-Sep-15					1420 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					22.0		14.74	1016
0.25					21.9		14.58	1014
0.50					21.9		12.92	1012
0.75					21.8		13.24	1009
1.00					21.6		12.39	1012
1.25					21.4		13.71	1007
1.50					21.4		14.48	1002
1.75b					21.3		13.96	1001
2.00								
2.25								
			6-Sep-15					1440 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					22.3	0.6	14.10	1114
0.25					22.2	0.6	14.09	1114
0.50					22.2	0.6	14.37	1113
0.75					22.0	0.7	14.68	1112
1.00					21.8	1.4	14.19	2138
1.25b					21.7	5.1	13.51	8700
1.50								

			13-Sep-15					
	Flume			0815 hr	Stockton Avenue Bridge			0833 hr
Depth	Temp 1	Salin 1	O2 1	Cond 1	Temp 2	Salin 2	O2 2	Cond 2
(m)	(C)	(ppt)	(mg/l)	umhos	(C)	(ppt)	(mg/l)	umhos
0.00	20.5	0.5	9.14	963	20.9	0.5	9.20	953
0.25	20.5	0.5	9.02	962	20.9	0.5	9.16	970
0.50	20.5	0.5	9.09	962	20.9	0.5	9.05	970
0.75	20.5	0.5	9.10	962	20.9	0.5	9.03	970
0.90b	20.5	0.5	8.90	961				
1.00					20.9	0.5	8.62	969
1.25					20.8	0.5	8.61	968
1.50					20.8	0.5	7.33(82%)	969
1.75b					20.8	0.5	7.13	969
2.00								
2.25								
	Railroad Trestle			0858 hr	Mouth of Noble Gulch			0908 hr
Depth	Temp 3	Salin 3	O2 3	Cond 3	Temp 4	Salin 4	O2 4	Cond 4
(m)	(C)	(ppt)	(mg/l)	umhos	(C)	(ppt)	(mg/l)	umhos
0.00	21.0	0.5	8.33	981	20.6	0.6	8.36	1031
0.25	21.0	0.5	8.28	980	20.7	0.6	8.37	1034
0.50	21.0	0.5	8.24	980	20.7	0.6	8.30	1034
0.75	21.0	0.5	8.09	980	20.6	0.6	8.49	1033
1.00	21.0	0.5	8.10	980	20.6	0.6	8.47(95%)	1033
1.25b	21.0	0.5	8.03(90%)	980	22.1	2.2	0.06	3705
1.40b	21.0	0.5	7.50	980				

13 September 2015. Gage height of 2.54 (morning) and 2.54 (afternoon). Partly cloudy in morning and high cirrus clouds in afternoon. Air temperature of 18.4˚ C at 0815 hr and 19.3º C at 1603 hr. Flume inlet 0.3 ft (debris present). Flume exit 0.3 ft in afternoon.
Station 1: Flume at 0815 hr- Reach 1- 104 gulls bathing, 6 mallards in water. 8 mallards and a pelican on Venetian margin. Hermann's gulls common on beach. No surface algae. Flume at 1603 hr- Reach 1- 57 gulls bathing. No surface algae. 30% pondweed + algae 3-5 ft thick, averaging 4.5 ft thick. 70% bottom algae averaging 2 ft thick.
Station 2: Stockton Avenue Bridge at 0833 hr- Reach 2- 1 coot. No surface algae. Reach 2 at 1548 hr- . Secchi depth to bottom. 2 mallards, 1 gull in water. No surface algae. 60% of bottom covered with algae, averaging 1ft thick. 40% pondweed + algae 2 – 4.5 ft thick, averaging 4 ft.
Station 3: Railroad trestle at 0858 hr- Reach 3- 9 mallards dabbling near Noble Gulch. No surface algae. At 1528 hr- 10 mallards, 1 pied-billed grebe, 1 coot in water. 1 merganser on redwood stump. No surface algae. 70% of bottom covered with algae 1 ft thick. 30% pondweed + algae 2- 4 ft thick, averaging 3.0 ft.
Station 4: Mouth of Noble Gulch at 0830 hr- 1 mallard on redwood stump. 5% surface algae. At 1504 hr- 7 mallards on redwood stump near cottonwood. 2% surface algae. 20% pondweed + algae coverage 3 ft thick.
Station 5: Nob Hill at 0908 hr. Water temperature at 17.5°C. Conductivity 622 umhos, Oxygen

5.08 mg/l (53% saturation). Salinity 0.4 ppt. Nob Hill at 1645 hr. Water temperature 18.7° C. Oxygen 9.97 mg/l (78%). Conductivity 647 umhos. Salinity 0.4 ppt. Streamflow estimate- < 0.1 cfs.

			13-Sep-15					
	Flume			1603 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	22.0	0.5	13.79	982	22.8	0.5	22.36	987
0.25	21.9	0.5	13.86	980	21.7	0.5	11.04	988
0.50	21.9	0.5	13.91	980	21.6	0.5	10.79	985
0.75	21.9	0.5	13.88(160%)	980	21.5	0.5	10.38	985
0.90b	21.9	0.5	13.34	980				
1.0					21.4	0.5	9.95	984
1.25					21.4	0.5	9.79	983
1.50					21.4	0.5	9.56	982
1.75					21.4	0.5	8.56(96%)	983
1.80b					21.3	0.5	7.10	983
2.00								
			13-Sep-15					
	Railroad Trestle			1528 hr	**Mouth of Noble Gulch**			1514 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	21.9	0.5	12.75	999	22.2	0.6	11.59	1064
0.25	21.9	0.5	12.83	1000	22.1	0.6	11.57	1055
0.50	21.8	0.5	12.96	1003	21.8	0.6	11.53	1051
0.75	21.8	0.5	14.61	1009	21.4	0.6	12.56	1049
1.00	21.6	0.5	15.02	1004	21.3	0.6	12.59(141%)	1056
1.25b	21.6	0.5	14.88(169%)	999	22.7	4.8	0.45	8272
1.40b	21.6	0.5	14.62	995				

			26-Sep-15				
	Flume			0748 hr	**Stockton Avenue Bridge**			0758 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	19.9	0.5	10.11	984	20.6	0.5	11.39	993
0.25	20.0	0.5	10.20	985	20.6	0.5	11.21	999
0.50	20.0	0.5	10.20	986	20.7	0.5	11.31	1000
0.75	20.0	0.5	10.21(112%)	986	20.8	0.5	10.91	1001
1.00b	20.0	0.5	10.03	985	20.7	0.5	11.09	1001
1.25					20.7	0.5	10.87	1000
1.50					20.7	0.5	11.04	1000
1.75					20.7	0.5	10.66(119%)	1000
1.80b					20.7	0.5	9.57	1000
2.00								
			26-Sep-15					
	Railroad Trestle			0818 hr	**Mouth of Noble Gulch**			0830 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	20.7	0.5	10.31	1008	20.4	0.6	10.66	1030
0.25	20.7	0.5	10.50	1013	20.4	0.6	10.64	1035
0.50	20.7	0.5	10.40	1014	20.4	0.6	10.54	1036
0.75	20.7	0.5	11.40	1014	20.4	0.6	10.71	1036
1.00	20.7	0.5	11.30	1013	20.4	0.6	10.71(119%)	1037
1.25b	20.7	0.5	11.47(128%)	1014	21.8	2.0	0.12	3665
1.38b	20.7	0.5	10.52	1013				

26 September 2015. Gage height of 2.56 (morning) and 2.56 (afternoon). Clear morning and clear/breezy in afternoon. Air temperature of 14.7˚C at 0748 hr and 19.5 ºC at 1550 hr. Flume inlet 0.1 ft (sand and debris) and flume exit 0.1 ft in afternoon.
Station 1: Flume at 0748 hr- Reach 1- 17 gulls bathing. No surface algae. Flume at 1602 hr- Reach 1- 150+ gulls bathing with 2 mallards. 10% surface algae and pondweed fragments. 70% bottom algae avg 1.0 ft thick; 30% pondweed with algae 4-6 ft thick, avg 5 ft.
Station 2: Stockton Avenue Bridge at 0758 hr- Reach 2- 10 mallards and 2 gulls being feed at Stockton Bridge. 2 other mallards, 30 coots and 1 cormorant present. <1% surface. Reach 2 at 1536 hr- Secchi depth to bottom under bridge in the afternoon. 2 mallards and 25 coots in water. 5% surface algae and pondweed fragments. 50% algae 0.5 ft thick; 50% pondweed and algae 2-5 ft thick, averaging 4 ft..
Station 3: Railroad trestle at 0818 hr- Reach 3- 10 mallards dabbling, 5 coots, 2 gulls in water. 1 kingfisher above Shadowbrook Restaurant. <1% surface algae. At 1515 hr- Reach 3- 4 mallards, 8 coots in water. 5% surface algae and pondweed fragments; 30% bottom algae averaging 2 ft thick; 70% pondweed with algae 2-5 ft thick, avg 3.5 ft.

Station 4: Mouth of Noble Gulch at 0830 hr- 1 mallard on redwood stump. <1% surface algae. At 1502 hr- No waterfowl on emergent wood. 5% surface algae and pondweed fragments; 50% algae averaging 2 ft thick; 50% pondweed with algae 2-4 ft thick, avg 4 ft..
Station 5: Nob Hill at 0844 hr- Water temperature at 16.7°C. Conductivity 662 umhos, Oxygen 6.62 mg/l (64% saturation). Salinity 0.4 ppt. Nob Hill at 1640 hr- Water temperature 17.8° C. Oxygen 7.37 mg/l. Conductivity 652 umhos. Salinity 0.4 ppt. Streamflow estimate- <0.1 cfs.

			26-Sep-15					
	Flume			1550 hr	**Stockton Avenue Bridge**			1536 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	22.2	0.5	20.67	1017	22.2	0.5	17.03	1022
0.25	22.1	0.5	21.22	1017	22.0	0.5	16.74	1026
0.50	22.0	0.5	21.42	1015	21.9	0.5	16.27	1025
0.75	22.0	0.5	21.53(247%)	1014	21.8	0.5	15.40	1023
0.87b	22.0	0.5	21.09	1014				
1.00					21.6	0.5	14.70	1023
1.25					21.5	0.5	14.33	1022
1.50					21.4	0.5	13.45(153%)	1020
1.75b					21.1	0.5	4.84	1019
2.00								
			26-Sep-15					
	Railroad Trestle			1515 hr	**Mouth of Noble Gulch**			1502 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	22.8	0.5	13.26	1046	23.1	0.6	12.61	1089
0.25	22.8	0.5	12.67	1048	22.7	0.6	12.35	1070
0.50	22.2	0.5	12.51	1042	21.9	0.6	12.13	1059
0.75	21.9	0.5	12.71	1037	21.6	0.6	11.82	1054
1.00	21.6	0.5	12.83	1033	21.4	0.6	12.80(145%)	1053
1.25b	21.4	0.5	12.89(146%)	1027	22.3	1.0	2.93	2001
1.37b	21.4	0.5	11.90	1026				

			4-Oct-15					0752 hr
	Flume				**Stockton Avenue Bridge**			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00					18.7	0.6	9.29	995
0.25					18.7	0.6	9.44	996
0.50					18.8	0.6	9.46	996
0.75					18.8	0.6	9.45	996
1.00					18.9	0.6	9.09	997
1.25					18.8	0.6	8.92	996
1.50					18.8	0.6	9.14(98%)	997
1.70b					18.8	0.6	8.62	996
1.75								
2.00								
2.25								
	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								

4 October 2015. Monitoring prior to fish sampling. Air temperature = 10.9 C at 0752 hr.

			11-Oct-15				0720 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					19.5	0.5	10.91	989
0.25					19.6	0.6	10.86	993
0.50					19.6	0.6	10.66	994
0.75					19.7	0.6	10.39	995
1.00					19.6	0.6	10.49	993
1.25					19.6	0.6	9.81	994
1.50					19.5	0.6	9.97(109%)	993
1.75b					19.6	0.6	5.24	995
2.00								
2.25								
	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								

11 October 2015. Monitoring prior to fish sampling.

0730 hr			10-Oct-15					0744 hr
	Flume				**Stockton Avenue Bridge**			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.8	0.6	10.05	981	19.4	0.6	10.73	990
0.25	18.8	0.6	10.14	984	19.4	0.6	1-.74	993
0.50	18.9	0.6	10.32	984	19.4	0.6	10.83	994
0.75	18.9	0.6	10.44(113%)	984	19.4	0.6	10.82	994
0.87b	18.9	0.6	10.03	983				
1.00					19.5	0.6	10.77	995
1.25					19.5	0.6	10.40	995
1.50					19.4	0.6	8.08(88%)	995
1.75b					19.5	0.6	4.31	1001
2.00								
2.25								
0807 hr			10-Oct-15					0825 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.5	0.6	9.93	993	19.2	0.5	9.24	978
0.25	19.5	0.6	9.89	993	19.2	0.6	9.19	991
0.50	19.5	0.6	10.06	993	19.2	0.6	9.51	988
0.75	19.5	-.6	10.03	993	19.2	0.6	9.51	985
1.00	19.5	0.6	9.96	993	19.3	0.6	9.01(97%)	989
1.25b	19.5	0.6	9.98(108%)	993	20.4	1.3	1.42	2292
1.50b	19.6	0.6	7.43	993				

10 October 2015. Gage height of 2.58 (morning; pondweed around inlet grate) and 2.55 (afternoon). Clear/cool in morning. Clear in afternoon. Air temperature of 12.5º C at 0730 hr. Flume inlet 0.3 ft (debris at flume entrance); flume outlet 0.3 ft.

Station 1: Flume at 0730 hr. Reach 1- 2 gulls bathing, 3 mallards in water, 59 coots, 1 cormorant. No surface algae. Flume at 1600 hr. Reach 1- 5% surface algae and pondweed fragments. 60% bottom algae avg 2 ft thick; 40% pondweed and algae 4-5 ft thick, avg 4.5 ft. 64 gulls bathing, cormorant moved downstream from other reaches.

Station 2: Stockton Avenue Bridge at 0744 hr. Reach 2- No surface algae; some coots moved upstream from R-1; 3 mallards on trestle abutment; 1 gull on trestle. Reach 2 at 1535 hr. 1% surface algae and pondweed fragments. 1 mallard, 24 coots, 1 gull; 1 mallard and 1 cormorant on trestle abutment. 70% bottom algae avg 1 ft thick; 30% pondweed with algae 3.5-5 ft thick, avg 4 ft.

Station 3: Railroad trestle at 0807 hr. Reach 3- No surface algae; 39 coots, 4 mallards, 1 pied-billed grebe in water. At 1517 hr, Reach 3- 5% surface algae and pondweed fragments; 60% bottom algae

avg 1 ft thick; 40% pondweed with algae 3-5 ft thick, avg 4 ft. 35 coots.
Station 4: Mouth of Noble Gulch at 0805 hr. No surface algae. No waterfowl on emergent wood. At 1500 hr. 10% surface algae and pondweed fragments. No waterfowl on emergent wood. Thick algal bloom made bottom invisible. 30% pondweed with algae 3-4 ft thick; avg 3.5 ft. Location for water quality measurements closer to Noble Gulch mouth because canvas painter was set up in usual water quality spot. The lagoon was shallower at the new spot.
Station 5: Nob Hill at 0902 hr. Water temperature 15.4 C. Oxygen 4.89 mg/l (49% saturation). Conductivity 587 umhos. Salinity 0.4 ppt. Nob Hill at 1645 hr. Water temperature 18.1 ˚C. Oxygen 7.85 mg/l (83% saturation). Conductivity 632 umhos. Salinity 0.4 ppt. Streamflow <0.1 cfs.

1600 hr			10-Oct-15					1535 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	20.7	0.5	15.70	1010	21.1	0.6	13.13	1020
0.25	20.6	0.5	16.20	1011	20.9	0.6	12.84	1021
0.50	20.5	0.5	17.36	1006	20.8	0.6	12.87	1020
0.75	20.5	0.5	17.68(197%)	1003	20.6	0.6	11.81	1017
0.87b	20.5	0.5	16.49	1000				
1.00					20.4	0.6	11.39	1010
1.25					20.2	0.6	10.96	1007
1.50					20.1	0.6	9.63 (106%)	1004
1.75b					20.0	0.6	10.13	1003
2.00								
2.25								
1517 hr			10-Oct-15					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	21.4	0.6	13.27	1031	21.7	0.6	12.89	1038
0.25	21.4	0.6	13.12	1030	21.5	0.5	11.82	1029
0.50	21.0	0.6	13.03	1024	20.7	0.5	11.47	1003
0.75	20.7	0.6	12.98	1017	20.0	0.5	9.56(105%)	970
1.00b	20.5	0.6	12.44	1011	20.0	0.6	2.11	1120
1.25	20.2	0.5	13.81(151%)	1001			(Not same spot as morning measurements)	
1.35b	20.1	0.5	12.35	997				

0749 hr			24-Oct-15					0758 hr
	Flume				**Stockton Avenue Bridge**			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.2	0.6	8.55	949	17.6	0.6	8.65	953
0.25	17.3	0.6	8.51	952	17.7	0.6	8.66	960
0.50	17.3	0.6	8.54	952	17.7	0.6	8.63	960
0.75	17.3	0.6	8.53	951	17.7	0.6	8.06	961
0.87b	17.3	0.6	8.20	952				
1.00					17.7	0.6	8.52	961
1.25					17.7	0.6	8.39	961
1.50					17.7	0.6	8.07(85%)	961
1.75b					17.9	0.6	3.82	961
2.00								
2.25								
0813 hr			24-Oct-15					0828 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.7	0.5	8.06	946	17.3	0.6	7.39	950
0.25	17.7	0.6	8.02	959	17.4	0.6	7.27	951
0.50	17.7	0.6	7.98	959	17.4	0.6	7.34	951
0.75	17.7	0.6	7.98	959	17.4	0.6	7.35	950
1.00	17.7	0.6	7.99	959	17.4	0.6	7.37(77%)	948
1.25b	17.7	0.6	7.97 (84%)	958	18.8	1.2	0.65	2058
1.37b	17.7	0.6	7.47	958				

<u>24 October 2015.</u> Gage height of 2.61 (morning) and 2.66 (afternoon). Partly cloudy in morning and sunny/hazy in afternoon. Air temperature of 10.6º C at 0749 hr and 18.9º C at 1550 hr. Sandbar notched with inner and outer berm.

Station 1: Flume at 0810 hr. Reach 1- In water- 14 gulls, 35 coots, 3 mallards, 1 merganser. No surface algae. Flume at 1550 hr. Reach 1- No surface algae. Bottom invisible. 49 gulls bathing, 48 coots, 2 cormorants. Flume inlet 0.8 ft; flume outlet 0.2 ft.

Station 2: Stockton Avenue Bridge at 0758 hr. Reach 2- No surface algae; 11 coots (some from Reach 1), 4 mallards in water. Reach 2 at 1534 hr. Secchi depth to bottom but bottom vegetation invisible.

Station 3: Railroad trestle at 0813 hr. Reach 3- No surface algae; 46 coots, 5 mallards, 1 pied-billed grebe, 1 cormorant, 1 kingfisher near Noble Gulch. At 1516 hr, Reach 3- 49 coots in water.

Station 4: Mouth of Noble Gulch at 0828 hr. No surface algae. 9 coots and 2 mallards on redwood stump. Black-crowned night heron and greenback heron on willows near Shadowbrook. Then greenback heron moved to redwood stump. At 1502 hr, 4 coots on redwood stump and 1 mallard on cottonwood. No surface algae. Bottom vegetation invisible.

Station 5: Nob Hill at 0910 hr. Water temperature 14.5 ° C. Oxygen 6.16 mg/l (60% saturation). Conductivity 567 umhos. Salinity 0.3 ppt. Nob Hill at 1626 hr. Water temperature 16.8° C. Oxygen 9.77 mg/l (101% saturation). Conductivity 609 umhos. Salinity 0.4 ppt. Streamflow < 0.1 cfs.

1550 hr			24-Oct-15					1534 hr
	Flume				**Stockton Avenue Bridge**			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.5	0.6	12.98	979	18.8	0.6	12.62	980
0.25	18.5	0.6	12.90	975	18.7	0.6	12.47	978
0.50	18.5	0.6	12.94	973	18.6	0.6	11.74	977
0.75	18.8	0.6	12.97(138%)	973	18.3	0.6	11.43	977
0.87b	18.5	0.6	12.60	973				
1.00					18.4	0.6	10.76	974
1.25					18.3	0.6	10.17	972
1.50					18.1	0.6	8.77(93%)	968
1.75b					18.1	0.6	7.90	967
2.00								
2.25								
1516 hr			24-Oct-15					1502 hr
	Railroad Trestle				**Mouth of Noble Gulch**			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.4	0.6	11.83	994	19.4	0.6	11.07	998
0.25	19.2	0.6	11.47	991	19.4	0.6	10.67	988
0.50	19.0	0.6	11.32	985	18.9	0.5	9.80	970
0.75	18.6	0.6	11.59	980	18.3	0.5	9.62	956
1.00	18.3	0.6	12.14	968	17.9	0.5	11.15(117%)	955
1.25	18.1	0.6	12.17(129%)	962	19.2	0.7	23.02	1245
1.37b	18.2	0.6	11.89	962				

			7-Nov-15				
	Flume			0729 hr	**Stockton Avenue Bridge**			0743 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	12.2	0.3	2.54	510	12.7	0.3	2.30	518
0.25	12.3	0.3	2.37	512	12.7	0.3	2.05	520
0.50	12.3	0.3	2.36 (22%)	512	12.7	0.3	1.92	518
0.63b	12.3	0.3	2.29	512				
0.75					12.6	0.3	1.95	518
1.00					12.6	0.3	1.93	518
1.25					12.6	0.3	1.95	517
1.32b					12.7	0.3	1.78	518
1.50								
1.75								
2.00								
			7-Nov-15					
	Railroad Trestle			0808hr	**Mouth of Noble Gulch**			0822 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	12.5	0.3	2.34	536	12.3	0.4	3.14	577
0.25	12.5	0.3	2.19	538	12.3	0.4	2.91	580
0.50	12.5	0.3	2.14	538	12.3	0.4	2.88	592
0.75	12.5	0.3	2.12	538	12.3	0.4	2.93(27%)	590
1.00b	12.5	0.3	2.06(19%)	538	13.4	0.7	0.32	1095
1.12b	12.6	0.3	1.93	539				
1.25								
1.50								

7 November 2015. After time change. Gage height of 1.71 (morning) and 1.71 (afternoon). Clear in morning and afternoon. Air temperature a cool 6.6 ^{o}C at 0729 hr and 14.0 C in afternoon. Flume inlet 1.0 ft; Flume exit 0.3 ft. **It had rained on 2 November with stormflow maximum of 9 cfs at Soquel Village.** Inner and outer berms and beach channel freshly dressed. Cautionary tape positioned to block access to flume inlet. Boards half-covering flume exit on one side; fully boarded up on other side. 2 4x4 boards removed from flume entrance on one side.

Station 1: Flume at 0729 hr- Reach 1- 5 gulls bathing, 13 coots and 1 mallard dabbling, 1 snowy egret on periphery. No surface algae. Flume at 1552 hr- Reach 1- 71 gulls bathing, 23 coots. No surface algae. Bottom invisible.

Station 2: Stockton Avenue Bridge at 0743 hr- Secchi depth = 1.25 m; 1.50 m to bottom. Reach 2- No surface algae. 12 coot, 1 pied-billed grebe, 1 cormorant. Reach 2 at 1540 hr- No surface algae. 12 coots, 1 gull. 1 cormorant on trestle abutment.

Station 3: Railroad trestle at 0808 hr- Reach 3- 22 mallards being fed, 43 coots, 1 pied-billed grebe from R-1. At 1523 hr, Reach 3- No surface algae; 20 mallards being fed at same location as morning, 33 coots, 2 gulls, 1 pied-billed grebe.

Station 4: Mouth of Noble Gulch at 0822 hr- 2 mallards and 3 coots on redwood stump and

cottonwood. 2 cormorants on Golino wood. No surface algae. At 1508 hr- No surface algae. 3 coots on redwood stump. Too dark to observe vegetation.
Station 5: Nob Hill at 0910 hr- Water temperature at 11.3 ° C. Conductivity 507 umhos, Oxygen 7.65 mg/l (70%). Salinity 0.3 ppt. Nob Hill at 1623 hr- Water temperature 12.1° C. Oxygen 10086 mg/l (94%). Conductivity 533 umhos. Salinity 0.3 ppt. Streamflow estimated at 0.6 cfs.

			7-Nov-15					
	Flume			1552 hr	**Stockton Avenue Bridge**			1540 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	13.6	0.3	3.59	537	13.9	0.3	3.74	546
0.25	13.7	0.3	3.47	536	13.8	0.3	3.39	544
0.50	13.6	0.3	3.42(33%)	536	13.8	0.3	3.15	544
0.63b	13.5	0.3	3.42	536	13.7	0.3	3.11	543
1.00					13.7	0.3	3.09	543
1.25					13.5	0.3	2.32	542
1.50					13.2	0.3	1.56 (15%)	549
1.65b					13.2	0.4	1.03	555
1.75								
2.00								
2.25								
			7-Nov-15					
	Railroad Trestle			1524hr	**Mouth of Noble Gulch**			1508 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	14.2	0.4	3.98	580	14.4	0.4	4.44	622
0.25	14.2	0.4	3.73	579	14.4	0.4	4.23	620
0.50	14.2	0.4	3.64	583	14.2	0.4	4.15	606
0.75	14.1	0.4	3.47	586	13.9	0.4	4.62	629
1.00b	13.7	0.4	3.40(33%)	607	13.9	0.6	3.24	944
1.10b	13.6	0.4	3.33	620				
1.25								

9 November 2015. The biologist (Alley) arrived at the open creekmouth at 1145 hr after communication with Morrison that morning at 1050 hr. The lagoon was rising quickly at that time and had to be emergency breached at 1100 hr. The storm had passed by the time the biologist reached the lagoon, with blue sky overhead. The Soquel Village gage, 2 miles upstream, jumped from 6 to 40 cfs between readings. Inflow from Noble Gulch was estimated at 10-15 cfs after biologist's arrival, making the estimated flow at the beach in the range of 50-60 cfs at the time of the breach. The flume capacity is approximately 25–30 cfs. The stream had overtopped the bulkhead below the trestle by approximately 6 inches after the breach. The pathway had flooded with a water line 3-4 inches high on fence beside pathway. Water surface had reached the second bolt on the piling, 1 foot above first bolt at its highest. Exit channel width at the flume inlet was 40 feet; it was 60 feet wide at the flume outlet, with a 60-foot deflection south from the flume. The backwater between the Stockton Bridge and the railroad trestle remained 1.5 feet deep with the water surface of the estuary 2 feet below base of flume. The flume inlet had three 4x4 inch boards removed on one side. All boards were removed from one side of flume outlet and all but 1 board appeared removed on the other side.

APPENDIX B. 2015 Drain Line Test for Restaurants Contiguous with Soquel Creek Lagoon.

2015 DRAIN LINE TEST FOR RESTAURANTS CONTIGUOUS WITH SOQUEL CREEK				
RESTAURANT	INITIAL CONTACT	TEST DATE	COMMENTS	SIGN OFF
MY THAI BEACH	15-Apr-15 Albert-RotoRooter	4/15/2015	Approved	4/15/2015 Van Son
BAY BAR	4/15/2015 Left Letter in Door	4/27/2015	Approved	4/27/2015 Van Son
PIZZA MY HEART	15-Apr-15 Benjamin Pavlik 475-5714	4/27/2015	Approved	4/27/2015 Van Son
SAND BAR	15-Apr-15 Jeff Lantis 415-710-1937	4/23/2015	Approved	4/23/2015 Van Son
PARADISE BAR & GRILL	15-Apr-15 Kristie Flowers 476-4900	4/22/2015 4/27/2015	Leaking trap primer @ womens restroom floor drain--Failed Approved	4/27/2015 Van Son
ZELDA'S	15-Apr-15 Jill Ealy 475-4910	4/28/2015	Approved	4/28/2015 Van Son