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Soquel Lagoon Monitoring Report- 2016

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ACKNOWLEDGMENTS

Ed Morrison and the Capitola Public Works Department did well in creating and maintaining the lagoon in 2016. Extending the plywood above the flashboards on the flume inlet succeeded in maintaining the deepest lagoon possible. We appreciate 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.

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 and placement/retrieval of temperature probes.

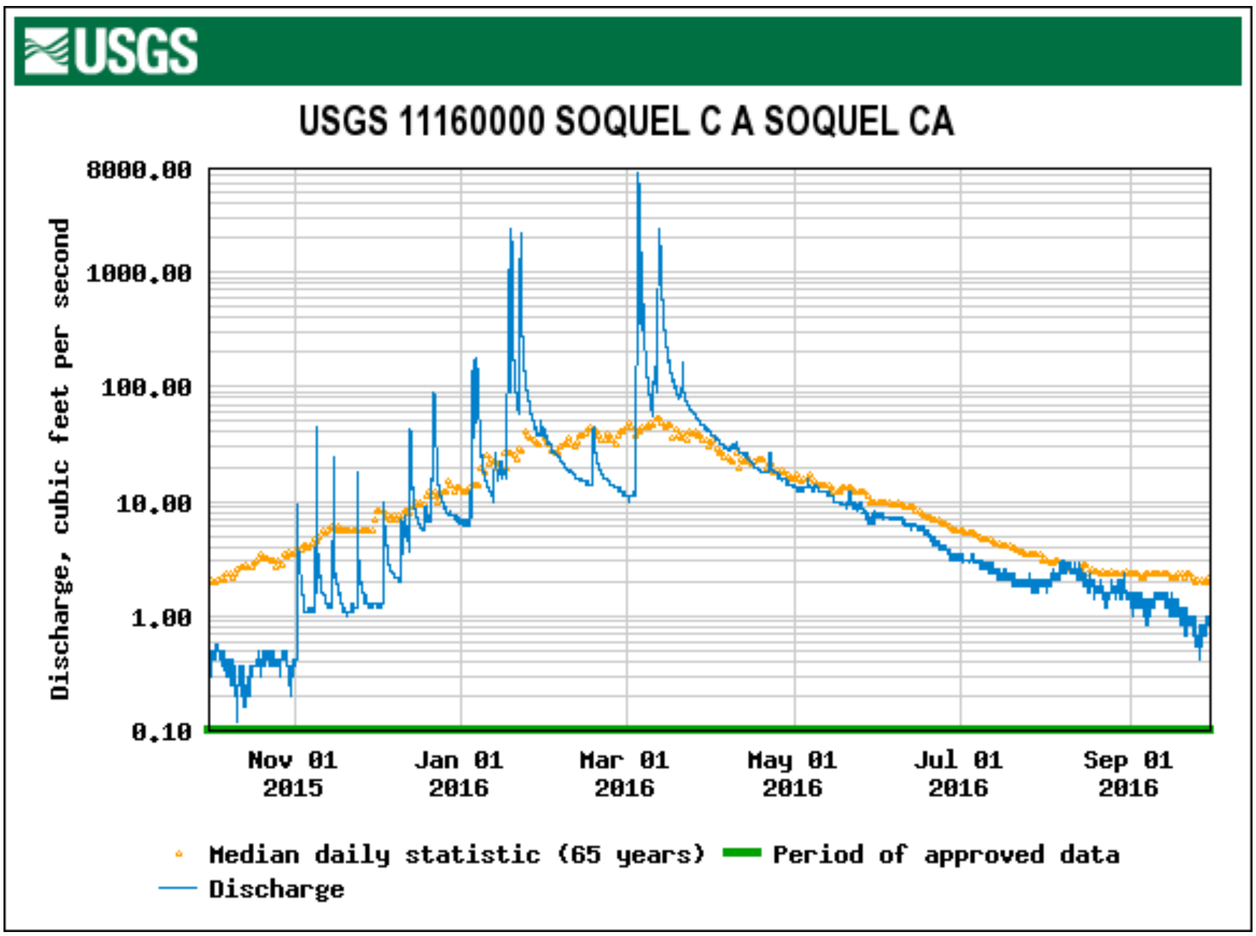
We were grateful to the volunteers who assisted in the annual fish censusing at the lagoon. There were local residents and Coastal Watershed staff (Alev Bilginsoy) and other volunteers. Three fishermen active with the Monterey Bay Salmon and Trout Project helped on the first weekend. Robin Aston, math teacher at Soquel High, brought her students on the second weekend of fish sampling. They were very important in providing enough help. The fish data were sent to her afterwards for use in her classes. Bruce Ashley of the Santa Cruz Fly Fishers and Gary Quayle, a Capitola resident, assisted. Nancy Scarborough (former Coastal Watershed staff member) assisted in seining and data collection on the second weekend. A UCSC student and his parents also assisted. Biologists, Josie Moss and Inger Marie Laursen, again provided their positive energy in managing the seine and recording data. Chad Steiner was key to setting the seine and capturing fish. Chad brought both his daughters, who helped 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. No negative impacts to steelhead were detected during sandbar construction in 2016. 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 2016. 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. The entire estuary reach was surveyed for steelhead spawning redds, including the glide above estuary influence. No steelhead redds were found. As required in the permit, a fisheries biologist was present during all sandbar construction activities that could affect fish habitat in the lagoon/estuary. This was year 26 of our monitoring and activities associated with sandbar construction. Annual monitoring reports for the first 25 years are available at the City (**Alley 1991-2015**).

Previous winter storms consisted of numerous small storms leading to bankfull event (1000+ cfs) in January and then a large stormflow in early March (8000 cfs), after which streamflow steadily declined with little precipitation after that. Stream inflow during sandbar construction was good at 10 cfs when construction began.



On May 23 the creekmouth ran laterally across the beach from Zelda's Restaurant to the jetty before sandbar construction. The lateral channel was seined to rescue fish prior to it being covered over with sand. During seining, only 1 small, young-of-the-year cyprinid was captured and relocated in the cove adjacent to Margaritaville Restaurant. It was identified as a juvenile California roach (*Hesperoleucus symmetricus*). During the next 4 days of artificial breaching of the sandbar, care was taken to rescue fish from an eastern side-channel that became isolated between the railroad trestle and Stockton Bridge. Juvenile steelhead (*Oncorhynchus mykiss*), prickly sculpins (*Cottus asper*), threespine sticklebacks (*Gasterosteus aculeatus*) and tidewater gobies (*Eucyclogobius newberryi*) were rescued from this side-channel during lagoon drawdown and placed in adjacent, deeper slackwater on the west side of the estuary. During the day of raking, while Alley was searching for stranded fish upstream, a school of 15-20 steelhead smolts were observed in the area below Stockton Bridge where Public Works staff were raking. Morrison then observed them swimming near the surface. An adult lamprey was also observed. Morrison ordered raking to stop with everyone out of the water to allow the water to clear. The steelhead disappeared. They resumed raking after about 10 minutes. No fish mortality was observed. Alley and Morrison later walked the lower estuary, searching for remaining steelhead and saw none. Presumably, they exited the estuary through the channel adjacent to the flume.

On the fourth day of sandbar construction, May 26, the flume inlet was opened at 0650 hr. The sandbar was opened at 0709 hr but then closed soon after with hand shovels. This was because the bulldozer had developed a hydraulic leak out on the beach at 0715 hr. Messages were left with NOAA Fisheries and CDFW, notifying them of the leak (**Danielle Uharriet, Environmental Projects Manager, pers. communication**). The hydraulic fluid was contained in holding pools and collected with absorbent skimming booms on hand. Fluid leaking from the bull dozer was also collected with absorbent pads. The bull-dozer was repaired and driven up the beach to the parking area above high tide before the tide came in. The cleanup was completed at 1048 hr. The breakdown did not occur in close proximity of the lagoon/estuary, and no fish mortalities were noted. This was the first such leak occurring during sandbar construction in 26 years of biological monitoring.

Kelp and seagrass were at a minimum in the lower estuary, downstream of the Stockton Bridge. The streambed was firm throughout the estuary. At least 90% of the plant material was removed from Reach 1 below Stockton Avenue Bridge during just 1 day of hand-raking (10 personnel) and 3 artificial drawdowns of the lagoon during sandbar construction. 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 sandbar was closed for the season on 27 May. Plywood remained under the flume pilings and perpendicular to underflow to successfully reduce seepage under the flume during the summer lagoon phase. Morrison reported that the lagoon was full on the evening of 29 May with plywood covering the boards of the flume inlet and with the adult portal in place. The flume outlet and lagoon was not open at night to juvenile steelhead smolt passage during most of the sandbar construction (5 nights without smolt passage through the flume; 3 nights in succession with an open night and then 2 more nights in succession without passage until the lagoon filled). The lagoon had filled by end of the second day after final sandbar closure. No mergansers were observed during the week of sandbar preparation, except on the first morning when there was one in the lower lagoon. No steelhead predation was observed. We suspect that the flume inaccessibility temporarily delayed some smolt outmigration during sandbar construction. However, most smolt migration had likely occurred before late May, based on data collected on smolt outmigration in the San Lorenzo River in the late 1980's (**Alley, personal observation**).

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. With the exception of the side channel between Stockton Bridge and the trestle, a well defined, bathtub-like margin existed in the upper estuary in 2016, allowing easy retreat to deeper water. Three tidewater gobies were rescued and relocated to slackwater between Stockton Bridge and the trestle on the second day of sandbar opening. The biologist was present at this location each day as water receded. We detected no tidewater mortalities during sandbar preparation, though daily habitat disturbance occurred.

Sandbar Breaching. The lagoon was rising slowly on the morning of 16 October, requiring a facilitated breach by Kotila just before 0500 hr. The stream gage reading at Soquel Village had been 55 cfs at 0430 hr, with a flume capacity of 25-30 cfs. Considerably more rain was forecasted later in the day, causing stormflow to exceed 1,000 cfs. The monitoring biologist, Don Alley, was notified by Jesberg prior to the breaching, and Alley was present when it occurred. Morrison notified CDFW and NOAA Fisheries of the emergency breaching. At the time of the breach, the flume inlet had the equivalent of at least three 4x4 inch boards removed on one side. All boards were removed from flume. The estuary remained open for the wet season, despite the relatively early loss of the sandbar in 2016.

Stream Inflow to the Lagoon. Despite near average rainfall over the winter/spring, streamflow declined rapidly during the summer after a series of previous drought years that apparently left aquifers still depleted. However, there was an increase in August during the period of lower air temperature that may have reduced water consumption by nurseries and for landscaping in the watershed. But streamflow fell quickly in September and was below the median baseflow for most of the summer/fall. However, with the increase in baseflow and cooler air temperatures over night in 2016 compared to previous drought years, 2016 lagoon water temperatures in the afternoon were typically 2°C or more cooler than in 2015. The management goal of maintaining early morning minimum temperature below 20°C near the bottom was not met for 80% of the monitoring period until 13 October. Baseflow at the time of sandbar closure was less than 1.5 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 well within the tolerance range of steelhead in 2016 and was likely not stressful much of the summer and early fall. At the location of the continuous data loggers at 0.5 feet from the bottom, the warmest water temperature was 21.3°C on 3 days during the last week in July 2016 (**Figure 4a**). Daily lagoon water temperatures through the summer/fall lagoon phase were 2-3°C cooler in 2016 than in 2015 (commonly in the 17−21˚C range in 2016 near the bottom at the continuous logger location).

In 2016 at 2-week monitoring sites, *water temperatures near the lagoon bottom in the early morning* were rated either most commonly "good" (<=20°C) or "fair" (<= 21.5°C) at all stations during 2-week monitoring (**Tables 2 and 3**). The "fair" ratings occurred primarily in July.

As in past years, no stratification or lagoon thermocline was detected in 2016 by the data loggers. As in past years, lagoon water temperatures near the bottom in 2016 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 1999-2016 (**Table 4**). In 2016 from 4 June to 15 September, the maximum and minimum 7-day rolling average temperatures were 2.5°C (5.4°C in 2015) and 2.5°C (3.5°C in 2015) cooler, respectively, in the stream than near the lagoon bottom near the trestle, as was substantiated by seasonal maxima (21°C vs. 21.3°C) and minima (13.7°C vs. 16.8°C) (**Table 4**). Consistently, the difference in 7-day rolling averages, day by day, was also approximately 2−3°C warmer in the lagoon near the bottom compared to that in the stream inflow (**Figures 4a and 5a**). Stream inflow temperature in 2016, as in other years, had much greater daily fluctuation than near the lagoon bottom. In the stream it daily fluctuated 3−4°C in June and July and 1.5−2.5°C in August and September.

In 2016, the lagoon steelhead management goal of maintaining early morning temperature below 20°C near the bottom was met (**Figure 4a**). Days when lagoon water temperatures exceeded 22º C (71.6º F) near the lagoon bottom would likely be stressful for juvenile steelhead. Therefore, another lagoon management goal is to maintain water temperature below 22ºC. In 2016, water temperature did not reach 22º C at 0.5 feet above the bottom at the data logger location (maximum of 21.3°C), while in 2015 it was above 22°C for 64 straight days.

Aquatic Vegetation. In 2016 at the time of sandbar construction on 27 May, approximately 90% of the decomposing kelp and seagrass had been raked out of the lower lagoon, downstream of Stockton Bridge. In 2015 and 2016, the lagoon bottom was firm without a thick layer of detritus. There was the least detritus in 2016 of any year in memory. In 2016, the thickness of algae and the coverage and thickness of pondweed was less than in 2015 and even less so than in 2014 (**Tables 5−7**). The pondweed came on late in the season in 2016 but had much more restricted coverage than in 2014 and 2015. In 2016, the average percent of the bottom with algae and the average surface algae were greater at Station 4 at the mouth of Noble Gulch than elsewhere. However, average algae thickness was not greater, and pondweed was absent at the mouth of Noble Gulch in 2016.

Pondweed had limited distribution in 2016 (highest in Reach 1). It ranged between 15 and 20% coverage and ranged between 2 and 3 ft thickness in the three reaches from late August through September 2016. By comparison, 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 was prominent at the mouth of Noble Gulch in 2015 but was absent in 2016.

Surface algae with floating pondweed fragments were similarly relatively uncommon in 2016, as it had been in 2015. Regarding season averages for surface algae (and pondweed fragments), in Reaches 1–3 for 2016, it was 0.7, 0.8 and 0.8 % of the surface covered. In 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 24-year high (since 1990) between 30 and 50% coverage at all stations.

Oxygen Concentration. 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 2016, the average oxygen level and oxygen concentration at each of the 4 stations near dawn and in the afternoon remained "good" (greater than 7 mg/l at dawn) for steelhead *near the bottom* during all 9 of the two-week monitoring to October 1 (**Table 2; Figures 6a-1; 6a-2; 6b−6e**). Morning oxygen concentration near the bottom ranged from 7.2 to 10.5 mg/L at the 4 lagoon stations during the 9 monitorings. Afternoon oxygen concentrations near the bottom ranged from 9.2 (100% full saturation) to 18.4 mg/L (200% full saturation) at the 4 lagoon stations.

In comparing morning and afternoon oxygen levels in the lagoon, usually oxygen concentration was higher in the afternoon than morning through the years and on all monitoring days in 2016 except at the mouth of Noble Gulch on 6 August (**Figures 6b-e**). Oxygen concentration typically increases through the day, despite warmer water temperature in the afternoon, which has a lower oxygen saturation point. The lowest oxygen concentration registered in the afternoon was on 6 August, when it was overcast and misty in the morning, and the cloud layer burned off late in the day. At or above fully saturated oxygen levels existed near the bottom in afternoon throughout the lagoon from 25 June to 1 October 2016. Oxygen concentrations at the stream Station 5 at Nob Hill near dawn were usually within the range of oxygen concentrations at lagoon stations in 2016 (**Figure 6a-1**). However, Station 5 had lower oxygen concentrations in the afternoon than any of the lagoon stations during 7 of the 9 two-week monitoring (**Figure 6a-2**). In 2016, the lowest morning oxygen concentration at Station 5 was 79% of full saturation (1 October) (**Appendix A**). However, all afternoon oxygen concentrations were more than fully saturated (**Appendix A**). Stream oxygen levels were much higher in 2016 than in 2015, which had lower baseflow during drought.

Salinity. In 2016, saline conditions were only detected in a thin, dilute layer a short time after sandbar closure (3 June) in the deeper lagoon area along the wall at Venetian Court (**Appendix A**). Saline conditions resulted from a small amount of saltwater being trapped in the lagoon at the time of sandbar closure on 27 May, which created a stagnant layer along the lagoon bottom that heated up. The saline layer was so thin and dilute that the flume inlet shroud was not needed in 2016. No salinity was detected on 12 June at the monitoring stations. A freshwater lagoon was maintained throughout the period of sandbar closure until sandbar breaching on 16 October during the first storm period of the season. No tidal overwash was allowed to occur through the dry season in 2016, 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 in 2016. The City's fishery biologist (Donald Alley) was present before, during and after the Begonia Festival procession of floats on 4 September. The day of the parade was clear in the morning and afternoon. Water temperatures near the bottom were similar to 2 weeks previous and rated "good" in the morning (between 18.4˚C at the mouth of Noble Gulch and 19.9˚C near the Stockton Bridge), which met the management goal of maintaining water temperature below 20°C in the morning. Early afternoon (1500−1600 hr) temperatures ranged from 20.1˚C at the mouth of Noble Gulch to 21.1˚C at the flume inlet, 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 20.2˚C near the bottom that day (**Figure 4a**). It is unlikely that the maximum afternoon water temperature near the bottom reached 22˚C anywhere in the lagoon near the bottom. Oxygen concentrations were very good and supersaturated in the morning and afternoon at measured stations except at the mouth of Noble Gulch in the morning where it was still rated "good" at 7.8 mg/L. Lagoon water surface elevation was excellent and maintained high at 2.62. The procession included 7 floats (4 powered by electric motor, 2 powered by boat paddlers, 1 powered by paddle boarders). No people waded. 16 other paddleboards, kayaks and canoes were on the water with 3 barges with people onboard. One drone was present to film the Festival. 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 more than the previous week, ranging from 779 to 788 umhos in the afternoon compared to 768 to 783 umhos in the morning. 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 after fewer were left floating on the lagoon than previous years. There was a Begonia shortage in 2016.

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 17 September detected no oxygen depletion resulting from decomposing begonias (**Figure 6a-1; Appendix A**).

Fish Sampling Results. Fall sampling for steelhead occurred on 2 and 9 October 2016, from just upstream of the Stockton Avenue Bridge to the beach. The lagoon population estimate was 237 juvenile steelhead (**Table 13**). Juveniles were relatively large (**Table 14; Figure 7a**), but the population size was relatively small compared to the average of 1,537 (**Figure 24**). Scale analysis indicated that juveniles greater than 150 mm SL were yearlings and older. Based on the bimodal histogram in 2016 and scale analysis, the cutoff for YOY was 140-145 mm SL. This indicated that the majority of juveniles in the lagoon were likely yearlings and older. The bimodal shape of the size frequency histogram in 2016 was very similar to that found in 2011, though the population estimate was nearly 3 times that of 2016. Other species captured with the large seine on both days combined were threespine stickleback, staghorn sculpins and small adult Sacramento suckers.

On 9 October 2016, 4 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. A total of 98 tidewater gobies were captured without mortality. Numerous threespine stickleback were captured (350+). 309 tidewater gobies were captured in 2015 (dry winter). 481 tidewater gobies were captured in 2014 (dry winter). Ten tidewater gobies were captured in 2013 (dry winter).

Pollution Sources and Solutions. The lagoon near the beach was closed to human contact due to bacterial levels above the maximum acceptable level. However, increased human use of the lagoon was observed in 2016. Paddle-boarders became common (7 of 9 afternoon weekend monitorings), along with more occasional kayakers, canoers and barge users (3 occasions and they were feeding ducks) throughout the lagoon. For the first time, waders and swimmers were commonly observed in the lagoon (usually near the beach in Reach 1; 6 of 9 afternoon weekend monitorings). This human contact with the lagoon occurred despite warning signs in close proximity. A teen-age boy was observed fishing from a paddleboat in Reach 3 near the Shadowbrook in the morning of 6 August. The game warden was notified. High-volume bird feeding was observed on 2 occasions at Noble Gulch, despite warning signs nearby. One lady said that she fed them daily and had large bags of bird seed. She attracted more than 30 ducks, as well as gulls. Ducks were more attracted to the monitoring biologist along the periphery in 2016 compared to past years, perhaps due to increased bird feeding. In 2016, algae production was much reduced, and pondweed was scarce except in Reach 1. Thus, the ducks had less aquatic vegetation to process to obtain invertebrate food from. Humans feeding the birds attracted gulls further up the lagoon where they usually did not go. Gulls are a threat to duckling survival.

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 parallel wires strung across the roof of the Paradise Grill and other restaurants have been effective in discouraging roosting. 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 are urban storm drains leading to Noble Gulch. This would prevent pollutants from anthropogenic sources of street and sidewalk runoff from reaching the lagoon. Surface algae was thicker at the mouth of Noble Gulch than other stations on occasion in 2016, and the highest estimates of 10% and 15% surface coverage occurred there (**Table 5**). Bottom algae coverage was slightly greater at Noble Gulch than at other lagoon stations, but the average thickness was no greater. Thus, there were limited indications of nutrient pollution and slightly increased eutrophication at the mouth of Noble Gulch in 2016. However, it was much reduced from 2015 and other drought years. 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.

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 2016, 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. An automatic pump switch is connected to a float to activate the pump.

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.

Bird Counts. Piscivorous birds observed at Soquel Lagoon in 2016 included mergansers, pied-billed grebes, green-back herons, one cormorant and one black-crowned night heron. Mallards and gulls were common. Mallard numbers tend to be lowest in the early lagoon season and decline in October in most years as the coots become common (**Figure 43**). Mallard numbers have been higher in 2014-2016 than in 2012-2013. In 2016, the mallard population remained in the 30-40 bird range from late June to late August. Mallards were more numerous in 2015 than in 2016 on some monitorings, with them reaching 54 birds in August 2015 (23 were ducklings). In fall 2016, the sandbar was breached relatively early, and only 13 coots were counted on 1 October, compared to higher numbers in 2015 (as many as 113 on 24 October 2015 and 71 by 7 November 2015). Gulls commonly bathed in Reach 1, downstream of the Stockton Bridge (as many as 65 on 4 September) (**Figure 44**). However, when people were feeding the ducks in upstream reaches, a few gulls were attracted to the food source. 2016 gull counts were the lowest since 2013, with them ranging between 20 and 65 during afternoon monitoring. The increased human waders and paddle boarders in 2016 may have reduced gull bathing numbers on the weekends when monitoring took place.

New and Continuing Recommendations

1. Water quality monitoring should be conducted along Noble Gulch, including accessible storm drain inlets, to pinpoint potential anthropogenic pollution sources. Noble Gulch should also be monitored upstream of urban storm drains to establish a baseline. Once identified, source control efforts should be made to control illicit discharges or, where

feasible, to direct dry weather flows from storm drains to sanitary sewers.

2. Remove three 4x4-inch flashboards from the flume inlet on one side immediately 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. 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.

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, continue to 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, continue to 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, continue to 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 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.

10. 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.

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

12. 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.

13. 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.

14. 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.

15. 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.

16. 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.

17. Continue to 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**).

18. 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.

19. 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.

20. Continue to 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 2013−2015, 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.

21. Continue to maintain the 1-foot high baffle inside the flume until July 1 for safe entrance of out-migrating steelhead smolts into the flume inlet.

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

23. 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.

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

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

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

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

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

29. 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.

30. Support the ban on alcohol consumption by float participants and rowdy behavior on Begonia Festival floats.

31. 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.

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

33. 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.

34. 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.

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

36. As stated in previous reports, if the streamflow in Soquel Creek in the vicinity of Soquel Village approaches the point of losing all 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.

37. 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.

38. 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.

39. 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.

40. 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.

41. 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.

42. 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.

43. 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.

44. 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.

45. 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.

46. 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.

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

LAGOON AND ESTUARY FORMATION

Fishery Rescue Actions Required Prior to Construction Activities

23 May 2016. The estuary margin was surveyed up to the mouth of Noble Gulch for coho salmon juveniles at 0630–0645 hr. No salmonids were observed. A lateral channel went across the beach from Zelda's Restaurant to the jetty. Fish rescue activities occurred 0745–0900 hr. Ten seine hauls were made with a 30-foot, 1/8-inch mesh beach seine throughout the lateral channel. City Public Works staff member, Cooper Sanden, assisted Alley in seining. Four hauls were made before the channel was dammed and 6 were made as it drained. Only 1 small, YOY cyprinid was captured and relocated in the cove adjacent to Margaritaville Restaurant. It was identified as a juvenile California roach. Objects of cover were probed thoroughly for fishes as the lateral channel drained once it was dammed at its head, indicating an absence of other fish fauna. Water was re-directed out an artificial channel adjacent to the flume, allowing the estuary to partially drain slowly. On the Venetian Court side of the estuary, the 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-sixth 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 1991-2016**). 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

23 May 2016. The fishery biologist, Alley, arrived at 0628 hr. The equipment operator, Matt Kotila, began moving sand on the beach beyond water contact and adjacent to the lateral channel that extended from Zelda's Restaurant across to the jetty. The flume inlet was completely boarded up the outlet had been closed with a metal plate. A merganser was fishing in the lower estuary. First thing upon his arrival at the site, the biologist inspected the estuary margin upstream as far as Noble Gulch and observed no coho or other salmonids. The stream inflow to the lagoon was approximately 10 cfs (9.5 cfs gage reading at Soquel Village). The outlet channel was cut by Matt Kotila after the lateral channel was dammed at 0745 hr. Refer to the previous results of fish seining of the lateral channel for details. The flume had been clear of sand enough to pass water 2 weeks previous to this day but had filled up with sand in the meantime. Public Works staff, with adequate screening of the intake hose for water, pumped water into the flume through its ceiling portals to clear out the sand. The generator was adequately positioned in a tray to catch any potential contaminants. The flume was passing water by 1145 am. The estuary only partially evacuated this day, requiring no survey upstream for potentially stranded fish. The flume inlet was boarded up so that head could be established overnight. The sandbar was closed in early afternoon. The biologist left at 1400hr.

Soquel Estuary and flume inlet before construction activities began. 23 May 2016

24 May 2016. The biologist arrived at 0640 hr and walked the periphery of the lagoon up to Noble Gulch at 0645−0700 hr, 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 not flowing through the flume overnight except for leakage, and smolt passage was prevented. Kotila opened the sandbar at 0705 hr. The lagoon drained rapidly at a rate of approximately 2 foot per hour. The estuary had drained to 2 feet below the flume's top by 0810 hr. The lateral boards remained under the flume to discourage and seepage under the flume after final sandbar closure. Ten personnel including Ed Morrison and Don Alley, began raking kelp and seagrass from the lower lagoon within approximately 150 feet of the flume inlet. The moderate head of water that had developed overnight helped 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 (0815−0920 hr). The slackwater pool between Stockton Bridge and the railroad trestle averaged 2.5 feet, with a maximum depth of 3.5 feet. Alley rescued 2 prickly sculpin juveniles and 6 larger adult as a side channel dewatered next to the eastern bulkhead between the railroad trestle and Stockton Bridge. Fish were relocated to the adjacent, slackwater pool on the west side. No isolated pools or other stranded fishes were found upstream of the railroad trestle. 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. Spawning substrate was very poor, it being armored and dominated by cobbles 4-8 inches in diameter (80%), gravel (10%) and sand (10%).

While Alley was searching for stranded fish upstream, Sanden observed a school of 15-20 steelhead smolts in the area below Stockton Bridge where Public Works staff were raking. Morrison then observed them swimming near the surface. An adult lamprey was also observed. Morrison ordered raking to stop with everyone out of the water at about 0900 hr to allow the water to clear. The steelhead disappeared. They resumed raking after about 10 minutes. No fish mortality was observed. Raking then resumed until 0920 hr. When Alley returned to the lower lagoon, he and Morrison walked the lower estuary and upstream into the slackwater above the bridge, observing no fishes. Presumably the smolts went on out to the bay through the exit channel. Kotila closed the sandbar adjacent to the flume at 0950 hr after the water in the lower estuary had cleared. Kotila covered over with sand the remainder of the channel near the jetty after that. Prior to covering over, Alley used a dipnet to thoroughly probe the isolated pool that had developed overnight, searching for fishes. None were observed. Alley monitored the filling in of the pool with sand. Kotila continued to work along the lagoon periphery afterwards. The biologist left at 1405 hr.

25 May 2016. The fishery biologist arrived at 0645 hr. Alley 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 was still closed. The lagoon surface had not reached the top of the boards in the flume inlet, thus preventing smolt passage overnight. The sandbar was opened at 0835 hr. It drained slowly at about 1 foot per hour. Raking occurred this day with 8 personnel. The biologist surveyed upstream in the estuary for stranded fish, during 0847−0940 hr. The survey ended at Noble Gulch because no isolated pools existed upstream. As the eastern side channel between Stockton Avenue Bridge and the trestle became dewatered, 3 adult prickly sculpins, 3 tidewater gobies and 1 steelhead smolt were rescued and relocated to the adjacent slackwater pool. The tidewater gobies were found in small puddles along the bulkhead where the bulkhead support beams entered the streambed. Each puddle was dipnetted to check for fishes. Eight YOY sticklebacks were also rescued from these small puddles. The raking had ended at 0930 hr. An estimated 90% of the decomposing kelp and seagrass had been raked out of the lower lagoon, downstream of Stockton Bridge. The lagoon margin was deepened by bull-dozer grading adjacent to the restaurants, above the estuary surface elevation. Kotila closed the sandbar at 1026 hr. The biologist confirmed that the weir inside the flume was still intact. Alley requested that boards be removed from the flume inlet to allow smolt passage overnight. He left the site at 1315 hr, with sand being moved from the surf line up toward the lagoon margin.

Lagoon deepened adjacent to restaurants (work done above estuary water surface)
25 May 2016

Isolated eastern side channel where fish rescues occurred. 24-27 May 2016

Slackwater pool between Stockton Bridge and railroad trestle (with overhanging willows) during artificial estuary fluctuation   24 May 2016

26 May 2016. The fishery biologist arrived at 0534 hr after being told the previous day that the sandbar would be opened early this morning. 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 was still closed. Boards had not been removed from the flume inlet, and the lagoon had not reached the top of the boards in the flume inlet, thus preventing smolt passage overnight. The flume inlet was opened at 0650 hr. The sandbar was opened at 0709 hr but then closed soon after with hand shovels. This was because the bulldozer had developed a hydraulic leak out on the beach at 0715 hr. Messages were left with NOAA Fisheries and CDFW, notifying them of the leak (**Danielle Uharriet, Environmental Projects Manager, pers. communication**). The hydraulic fluid was contained in holding pools and collected with absorbent skimming booms on hand. Fluid leaking from the bull dozer was also collected with absorbent pads as it dripped off the housing containing the hydraulic fluid filter that had leaked. The Peterson heavy equipment mechanic repaired the bull-dozer and partially refilled it with fluid on hand. It was then driven up the beach to the parking area above high tide before the tide came in. After the bull-dozer was completely refilled with fluid, work was resumed the next day. The cleanup was completed at 1048 hr. The breakdown did not occur in close proximity of the lagoon/estuary, and no fish mortalities were noted. This was the first such leak occurring during sandbar construction in 26 years of biological monitoring. The biologist left the site at 1215 hr, with the sandbar in place and the flume open for fish passage overnight. The dam across the outlet channel was reinforced and packed with the backup loader that day.

27 May 2016. The biologist arrived at 0648 hr. Alley 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 bull dozer was checked for fluid leaks before it was operated this day, and none were found. The sandbar was opened slightly at 0810 hr, and the estuary drained slowly. Alley walked upstream, looking for stranded fishes 0915−1008 hr. As the side channel between Stockton Bridge and the railroad trestle dewatered, 1 steelhead smolt, 3 prickly sculpins and 10 YOY sticklebacks were relocated to the adjacent, main channel, slackwater pool. The stream channel through the beach to the Bay was closed at 1037 hr. The inlet pad was prepared with visquine and sandbags by 1135 hr. An underwater portal for juvenile and adult steelhead was created in the flume inlet. Alley left the site at 1145 hr.

Preparation of the flume inlet. 27 May 2016

Preparation of the flume inlet. 27 May 2016

29 May 2016. Morrison reported that the lagoon was full in the evening after 2 days of filling.

3 June 2016. The biologist visited the lagoon to detect any remaining salinity in the lagoon. A thin 0.1-meter layer of dilute saline water (5.4 ppt) was detected at the bottom along the Venetian Court wall. Water was fresh down to 1.75 meters, with salinity at 1.85 meters. No salinity was detected under Stockton Bridge. There was no stratification of water temperature or oxygen in the upper 1.75 m of the lagoon water column at the wall. The lagoon water surface was at the top of the flume, with a gage height of 2.48. Water temperature was already above 18 C in the unstratified portion by 0923 hr, and oxygen concentration was above 9 mg/l (near full saturation) through the water column down to 1.75 m where oxygen was 5.64 mg/l (59% saturated). At the bottom, oxygen was only 1.4 mg/l at a temperature of 21.2 C. 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 sheet metal covers had been installed along the sidewalk drains of the Esplanade. We recommended that the shroud need not be installed because the saline layer was thin and very dilute.

4 June 2016. Temperature probes were installed in the lagoon and upstream.

Effect of Sandbar Construction on Tidewater Gobies and Steelhead in 2016

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 along the beach berm that included the flume inlet, despite an 8,000 cfs stormflow in March 2016.

Tidewater gobies were detected and relocated from puddles along the bulkhead between Stockton Bridge and the railroad trestle during estuary drawdown. Isolated puddles and habitat were restricted to this area in 2016. Three sandbar openings were required during sandbar preparation, not including the redirection of the opening on the first day. The last 2 daily openings during sandbar construction closely mimicked normal tidal fluctuations of the estuary. After the first day of sandbar opening, slow, artificial water level fluctuations were created during sandbar construction activities on succeeding days. The lagoon filled partially overnight during sandbar preparation.

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. With the exception of the side channel between Stockton Bridge and the trestle, a well defined, bathtub-like margin existed in the upper estuary in 2016, allowing easy retreat to deeper water. Three tidewater gobies were rescued and relocated to slackwater between Stockton Bridge and the trestle on the second day of sandbar opening. The biologist was present at this location each day as water receded. We detected no tidewater mortalities during sandbar preparation, though daily habitat disturbance occurred.

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, 2013−2016 may be transitory.

No salmonids were observed along the margin of the lower lagoon prior to each daily sandbar opening. A school of steelhead smolts was observed in the creek below Stockton Bridge on the first day of raking. The temporary cessation of raking allowed water quality to improve there and time for the smolts to leave the area. No steelhead mortalities were observed. During sandbar construction, two steelhead smolts were rescued and relocated to slackwater as the eastern side channel dewatered between Stockton Bridge and the railroad trestle. The biologist was there as flow went down, and no steelhead mortalities occurred. Steelhead smolts move downstream at night. The flume outlet and lagoon was not open at night to juvenile steelhead smolt passage during most of the sandbar construction (5 nights without smolt passage through the flume; 3 nights in succession with an open night and then 2 more nights in succession without passage until the lagoon filled). The lagoon had filled by end of the second day after final sandbar closure. No mergansers were observed during the week of sandbar preparation, except on the first morning when there was one in the lower lagoon. No steelhead predation was observed. We suspect that the flume inaccessibility temporarily delayed some smolt outmigration during sandbar construction. However, most smolt migration had likely occurred before late May, based on data collected on smolt outmigration in the San Lorenzo River in the late 1980's (**Alley, personal observation**).

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.

Standard 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 Public Works staff should capture and relocate the fish with available dip nets or seine and buckets filled with fresh estuary/ lagoon water, after consultation with the biologist. (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 is 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. If steelhead are detected in the raking area while the biologist is upstream, searching for stranded fish in isolated pools, then stop raking, leave the water and contact him via cell phone. The biologist will return to the lower lagoon as soon as isolated pools upstream are cleared. Do not resume raking until water turbidity in the raked area has dissipated and salmonids have left the immediate area.

5. Closing the sandbar in late May is better than mid-June or later because streamflow is usually sufficient to rapidly fill the lagoon in most years (not 2013−2015), and the juvenile steelhead most likely to be present in the lagoon are out-migrating smolts. Late May is prior to down-migration of most YOY steelhead from spawning sites above the lagoon. Small steelhead fry remain near spawning sites before moving down to 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.

6. The management solution to minimize time 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, it may be delayed as late as 4-5 days before the Memorial Day weekend and may still satisfy the tradition of lagoon formation beforehand.

7. 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.

8. 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**).

9. 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.

10. 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.

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

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

13. 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.

14. Maintain an underwater portal in the flume intake for out-migration of adult steelhead until June 15, while maintaining a notched top plank for out-migration of smolts until 1 July. However, in dry years such as 2007−2009 and 2014−2015, when stream inflow is insufficient to fill an underwater portal and allow lagoon filling, opt for a large notch in the upper boards/screen to accommodate smolts and kelts, if possible, instead of a deeper underwater portal for kelts. If kelts are observed in the lagoon in these dry years without the underwater portal or large notch at the top, provide a larger opening in the top of the flume inlet temporarily to allow kelts the opportunity to exit the lagoon.

15. Maintain the 1-foot high weir/ baffle inside the flume until July 1 for safe flume entrance of out-migrating steelhead smolts as they migrate to the Monterey Bay.

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

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

18. In very dry years, such as 2013−2015, when stream inflow is low and no stream outflow occurs through the flume 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. The partial closure of the flume outlet worked well in 2015.

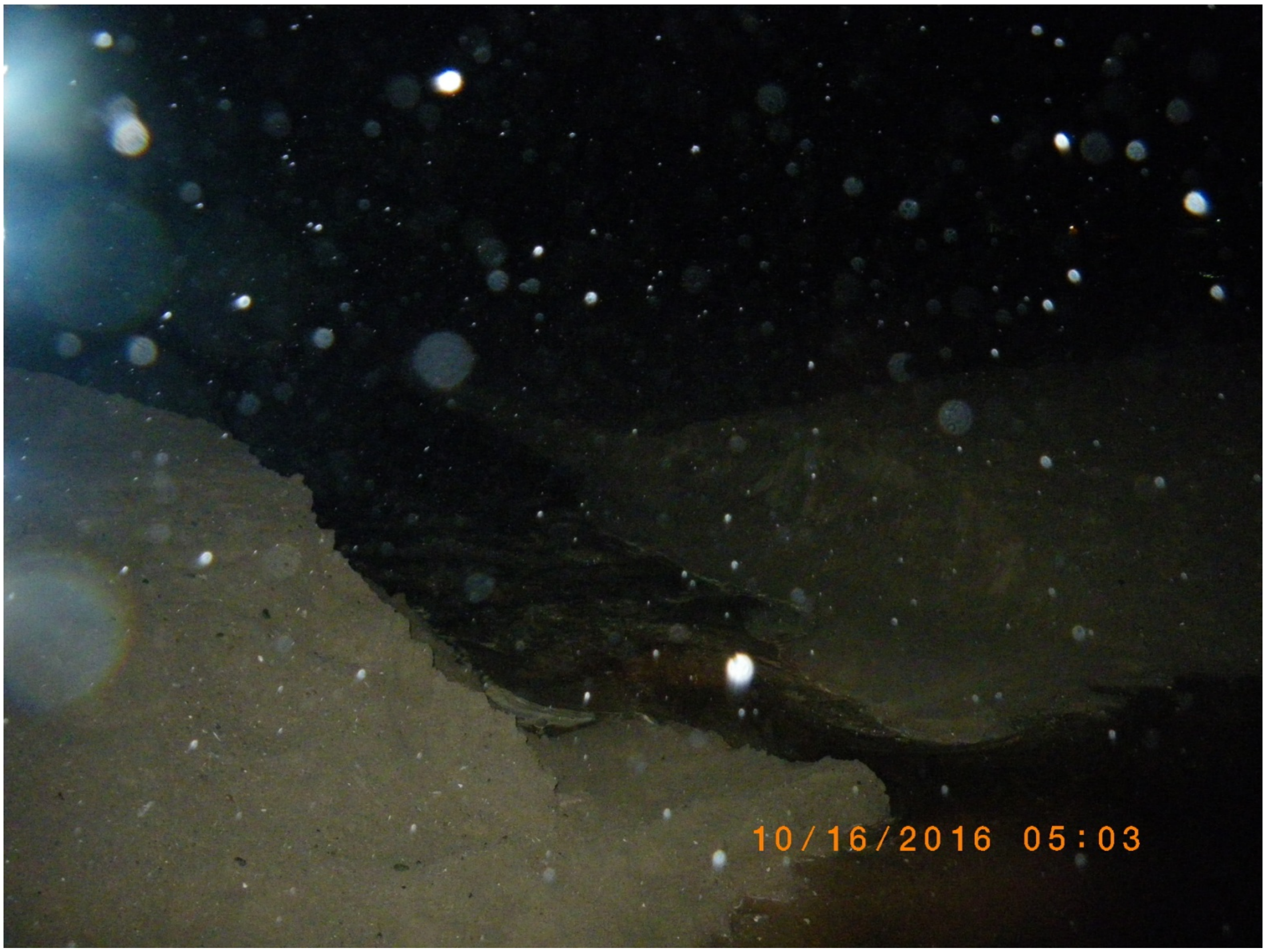
Procedure for Emergency Sandbar Breaching at Soquel Lagoon by the City of Capitola

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. That bolt is now bent. 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. A red line 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 2016-2017 Rainy Season.

The biologist (Alley) arrived at the lagoon at 0330 hr, October 16, after a previous call from Steve Jesberg, Public Works Director, at 0230 hr. He predicted a potential breaching within an hour or so. The lagoon was rising slowly at the time of Alley's arrival and continued to rise until breaching was facilitated just before 0500 hr. The berm closest to the lagoon in the notch that led across the beach had been lowered in anticipation of a facilitated breach to prevent flooding. A notch in the outer berm near the surf was made by Kotila at 0430 hr. The inner berm was over topped at 0454 hr (see photo), with the water surface rising steadily. The stream gage reading was 55 cfs at 0430 hr, 2 miles upstream at Soquel Village and was expected to continue rising. The lagoon water surface was rising because inflow was greater than the flume capacity of approximately 25−30 cfs. When the breach occurred, the lagoon water surface was about 8 inches below the new red mark on the piling (see photo), designating the point when flooding would occur over the lagoon bulkhead, downstream of the railroad trestle. A flat area became ponded between the inner and outer berms prior to the outer berm washing away. Within 15 minutes of the inner berm breaching, the exit channel width at the flume inlet was 20 feet; it was 30 feet wide at the flume outlet, with a 15-foot deflection south from the flume. The flume inlet had the equivalent of four 4x4 inch boards removed on one side. All boards were removed from the flume outlet. The decision was made to facilitate the breach because the lagoon was expected to steadily rise above flood stage with heavy rain forecasted throughout the day. It was also advantageous from a safety standpoint to facilitate the breach prior to visitors arriving and walking the beach later in the morning. By 1615 hr on 16 October, the stormflow at the Soquel Village gage had reached 1,040 cfs. The precipitation total in the upper watershed was 7.5 inches. This was the first storm of the season, and was significant due to effects of a typhoon that brought flooding to Oregon and Washington.



Inner berm at 0503 hr at the lagoon margin after breaching at 0454 hr.
Water entering notch in beach from right to left.
16 October 2016.

Lagoon water surface shortly after the facilitated breach (red line indicated point of flooding).
16 October 2016

Open creekmouth the day after the facilitated breach. 17 October 2016

Standard 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 2016

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 CDFW permit for 2016, 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 just downstream 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 CDFW permit for 2016, 6 HOBO temperature loggers were launched on 4 June 2016, just downstream of the railroad trestle in Reach 2 (as in 2008−2015) 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 and one stream logger were removed on 9 October 2016 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. Only a very thin layer of saltwater was detected in 2016 along the Venetian Court wall after the sandbar closure. The biologist judged that the inlet shroud was unneeded to pull saltwater off of the bottom.

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, the temperature management goal for steelhead should be to maintain water temperature below 20ºC (68ºF) at dawn within 0.25 m of the bottom and below 22ºC (71.6ºF) near the bottom in the afternoon. 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 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 Toulumne 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.

Until systematic water temperature monitoring occurs near sites where coho salmon are found in Soquel Creek, 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 Matthole River 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 (DWA) in Reach 9 of the East Branch, supporting the potential for coho recovery in Soquel Creek. These two groups also detected them in East Branch Soquel Creek in 2015. DWA also detected them at the upper mainstem Soquel Creek site (Reach 8) near the Soquel Creek Road Bridge in 2015.

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 a week after sandbar closure (3 June) and 9 times in 2-week intervals from 12 June 2016 to 1 October 2016, including the day or the Begonia Festival. **Table 3** rates habitat conditions according to a rating scale (**Table 2**). The lagoon level was rated “fair” on 12 June and then maintained in the “good” range for the remaining summer and during the Begonia Festival. The sandbar breach was facilitated on 16 October due to stormflow that exceeded the capacity of the flume.

Gage height in 2016 was consistently near the highest recorded through the dry period of the last 4 years (**Figure 2**), with the exception of mid-June. Extension of plywood above the flashboards helped to elevate water surface elevation somewhat. This good management maintained lagoon depth as high as possible in 2016. 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.

A thin layer of saltwater was trapped on the lagoon bottom near the Venetian Court wall at the time of sandbar closure, as measured on 3 June. Shroud installation was judged unnecessary by the biologist. On 12 June, no salinity was detected near the Stockton Bridge and Venetian Court wall, and temperature monitoring near the trestle indicated no saltwater near the bottom in 2016 (**Figure 4a**).

No vandalism of the flume inlet was detected in 2016. 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 2016. But sand had returned to the lower flume by the time of sandbar construction, requiring additional clearing. The flume outlet and lagoon was not open at night to juvenile steelhead smolt passage during most of the sandbar construction (5 nights without smolt passage through the flume; 3 nights in succession with an open night and then 2 more nights in succession without passage until the lagoon filled). The lagoon had filled by end of the second day after final sandbar closure, 29 May. No mergansers were observed during the week of sandbar preparation, except on the first morning when there was one in the lower lagoon. No steelhead predation was observed. We suspect that the flume inaccessibility temporarily delayed some smolt outmigration during sandbar construction. However, most smolt migration had likely occurred before late May, based on data collected on smolt outmigration in the San Lorenzo River in the late 1980's (**Alley, personal observation**).

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 plywood extended above the flashboards and was notched to provide smolt passage afterwards to 1 July. The flume outlet remained open throughout the summer/fall. Prior to the rainy season, a notch was constructed across the beach, approximately 30 feet wide and oriented slightly away from the flume. Inner and outer berms were constructed in the notch. The inner berm across the beach was notched to initiate a facilitated sandbar breach on 16 October during the first stormy period of the season. The streamflow at the Soquel Village USGS gage was 55 cfs at the time of the breach, with stormflow reaching an estimated 1040 cfs that day. The flume capacity is 25-30 cfs at best. Two small storms followed during the next month, and the sandbar remained open as of 17 November.

Water Temperature Results from Two-Week Monitoring

In 2016, early morning water temperature of stream inflow was an estimated 1.5 to 2.5 °C cooler than in 2015 after mid-June (**Figure 3e**). *Comparisons between years were approximate because data were not collected on the same date between years.* The 2016 morning temperature was also cooler than in the two previous drought years of 2013 and 2014. It was similar to temperatures in 2012. 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. During the last 26 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 comparing 2016 to 2015 for lagoon water temperature near the bottom, the differences between years increased in the morning from Site 1 upstream to Site 4 after mid-June and into September. At Site 1 at the flume inlet, 2016 morning temperature was 1.5−2.5°C cooler and afternoon temperature was 1.5−4°C cooler (**Figure 3a**). At Site 2 near the Stockton Bridge, 2016 morning temperature was 1.5−3°C cooler and afternoon temperature was 1.5−4°C cooler (**Figure 3b**). At Site 3 near the trestle, 2016 morning temperature was 1.5−4°C cooler, as were afternoon temperatures (**Figure 3c**). At Site 4 at the mouth of Noble Gulch, 2016 morning temperature was 1.5−4°C cooler and afternoon temperature was 1.5−4.5°C cooler (**Figure 3d**). Daily fluctuation between morning and afternoon was much less in 2016 than 2015. The cooler lagoon temperatures in 2016 may be attributed primarily to cooler inflow water, higher lagoon inflow (**Table 12**) and usually cooler air temperatures overnight (**Figure 3f**).

The warmest MORNING water temperature measured during 2-week monitoring in 2016 near the bottom was 20.7°C (69.3°F) on 23 July near Stockton Bridge (**Figure 3g**). Surprisingly, there was a cooling dip in the August monitorings. Both 6 and 21 August had heavy morning overcast with mist. Though clear by afternoon, clearing may have been later in the day. In contrast, the warmest morning water temperature measured in 2015 near the bottom was at the Stockton Bridge (22.8˚C (73˚F) on 15 August (**Figure 3i**). The warmest early morning temperature near the bottom in 26 years was 24˚C (75.2˚F) in 1992 at Stockton Bridge.

The warmest afternoon water temperature measured during 2-week monitoring in 2016 near the bottom was 21.6°C (70.9°F) on 23 July at the flume inlet (**Figures 3h**). By contrast, the warmest afternoon water temperature recorded in 2015 near the bottom was 24.6 C on 15 and 29 August at the flume (**Figure 3j**) compared to 24.4˚C in 2014 compared to 23.5°C in 2013, 21.2°C in 2012, 19.4°C on 26 July 2011, 19.6°C in 2010, 21.9° C in 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 in 2016 was 22.4°C on 23 July at the mouth of Noble Gulch. The warmest surface water temperature recorded in 26 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 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.

In 2016, *water temperatures near the lagoon bottom in the early morning* were rated either most commonly "good" (<=20°C) or "fair" (<= 21.5°C) at all stations during 2-week monitoring (**Tables 2 and 3**). The "fair" ratings occurred primarily in July. In 2015, ratings of "poor" (21.5−23°C) were most common with some "fair" (20−21.5°C) ratings. From 5 July to 29 August 2015 (5 consecutive monitorings) the ratings were "poor" (21.5–23˚C) at all stations in the morning. In 2014 there were 4 such consecutive monitorings that started later in July. 2014 and 2015 were drought years.

At the mouth of Noble Gulch in 2016, 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 September and usually 2−2.5°C cooler than the surface (**Figure 3h; Appendix A**). The higher conductivity at the bottom at this site was less pronounced in 2016 than the two previous years and did not cause elevated water temperature at the bottom.

Unlike in past years, lagoon water temperatures in 2016 did not closely reflect those of the stream inflow in August and September and were 3–4˚C warmer than stream inflow temperature in the morning during the June−September monitoring period (**Figure 3g**). The especially cool lagoon temperatures on 21 August were likely due to fog and late burn-off of overcast clouds that day. 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. However, in 2016 Site 2 was generally the warmest rather than Site 1 (**Figure 3g**). By afternoon in 2016, we saw the typical pattern of warming at downstream monitoring stations, the difference usually being approximately 1° C cooler at Station 4 than Station 1 (**Figure 3h**). In 2016, no water temperature stratification was detected in the morning due to thorough nightly mixing and cooling of the water column at monitoring stations afterwards (**Appendix A**).

Table 3. 2016 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 Esti-mated @ 0.5 cfs less than Soquel Village Gage Readings (cfs)
3June16 (Staton 2 only)	open	2.48	good	fair	good	6.8 cfs
12June16	open	1.96 fair	good*	good	good	5.5 cfs
25June16	open	2.47 good	good fair good good	good good good good	good good good good	3.6 cfs
09Jul16	open	2.66 good	fair fair good good	good good good good	good good good good	2.4 cfs
23Jul16	open	2.62 good	fair fair fair good	good good good good	good good good good	1.6 cfs
06Aug16	open	2.61 good	good fair good good	good good good good	good good good good	1.8 cfs
21Aug16	open	2.60 good	good	good	good	1.4 cfs
04Sep16 Begonia Festival	open (morning)	2.60 good	good	good	good	1.1 cfs
17Sep16	open	2.60 good	good	good	good	0.9 cfs
01Oct15	open	2.59 good	good	good	good	0.5 cfs

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

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 26 years. 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 2016 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 1999-2016 (**Table 4**). In 2016 from 4 June to 15 September, the maximum and minimum 7-day rolling average temperatures were 2.5°C (5.4°C in 2015) and 2.5°C (3.5°C in 2015) cooler, respectively, in the stream than near the lagoon bottom near the trestle, as was substantiated by seasonal maxima (21°C vs. 21.3°C) and minima (13.7°C vs. 16.8°C) (**Table 4**). Consistently, the difference in 7-day rolling averages, day by day, was also approximately 2−3°C warmer in the lagoon near the bottom compared to that in the stream inflow (**Figures 4a and 5a**). Stream inflow temperature in 2016, as in other years, had much greater daily fluctuation than near the lagoon bottom. In the stream it daily fluctuated 3−4°C in June and July and 1.5−2.5°C in August and September. Near the lagoon bottom the daily fluctuation was 1.5−2.5°C in June through September. The stream was generally about 2−6°C cooler in the morning and 1−2°C cooler in the afternoon than near the lagoon bottom. The lagoon did not cool down as much as the stream at night but did increase in temperature during the day as the stream. We see from comparisons of the 7-day rolling average for 2016 versus 2015 near the bottom that it was 1−4˚C cooler in 2016 than 2015 and commonly 2−3°C cooler throughout the summer/fall (**Figures 4a and 4n**). The greatest divergence was in the latter half of August. The 2015 season consistently had the warmest 7-day rolling averages heretofore recorded, with 2014 being the next warmest (**Alley 2015; 2016**).

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 2016 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 in a very thin layer on the bottom during sandbar closure. The only saltwater detected was along the Venetian Court wall and not under the Stockton Bridge. It was only 0.1 ft thick on 4 June, 7 days after sandbar closure and was likely dissipated within 10 days of sandbar closure. There was no hot saltwater layer detected at 0.5 ft off the bottom from 4 June on at the data logger location down from the trestle in 2016.

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 measurements 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 2016, water temperature did not reach 22º C at 0.5 feet above the bottom at the data logger location (maximum of 21.3°C), while in 2015 it was above 22°C 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; 2016**). 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. In 2010−2012, water temperature did not rise above 21°C near the bottom, with a maximum in 2012 of 21°C. 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 2010–2016. (Rolling averages were averaged for the 7 days forward from the date they were recorded on the graphs.)

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
2016	Maximum Water Temperature °C	**21.0 (19 June)**	**21.7 (20-23 June, 25 June, 9-13 July, 20-24 July, 31 Aug)**	**21.3 (24 and 29 July, 2 Aug)**
2016	Minimum Water Temperature °C	**13.7 (15-16 June)**	**17.1 (14 Sep)**	**16.8 (16 June)**
2016	Maximum 7-Day Rolling Average	**17.7 (18 June)**	**20.8 (19 July)**	**20.2 (18-20 July)**
2016	Minimum 7-Day Rolling Average	**15.4 (11 Sep)**	**18.4 (10 Sep)**	**17.9 (11 Sep)**
2016	**Average 7-Day Rolling Average**	**16.7**	**19.9**	**19.3**
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 Temperature °C	20.3	21.0	19.8
2011	Minimum Water Temperature °C	14.1	16.0	15.6
2011	Maximum 7-Day Rolling Average	17.3	19.0	18.2
2011	Minimum 7-Day Rolling Average	15.4	16.8	16.2
2011	**Average 7-Day Rolling Average**	**16.4**	**18.0**	**17.2**
2010	Maximum Water Temperature °C	19.8	21.0	20.6
2010	Minimum Water Temperature °C	13.7	15.2	15.2
2010	Maximum 7-Day Rolling Average	17.5	19.5	18.8
2010	Minimum 7-Day Rolling Average	14.8	16.7	16.3
2010	**Average 7-Day Rolling Average**	**16.0**	**17.9**	**17.4**

In 2016, the lagoon steelhead management goal of maintaining early morning MINIMUM temperature below 20°C near the bottom was met (**Figure 4a**). This occurred despite relatively low baseflow (**Table 12**). Overall cooler air temperatures overnight in 2016 encouraged cooler water temperatures (**Figure 3f**). 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%) (**Alley 2016**). 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 (**Alley 2015**). 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 2016, the coho management goal of keeping MAXIMUM water temperatures below 20ºC (68ºF) near the bottom in the presence of steelhead was NOT met for 50 of 127 days (39%) that were monitored. It 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 monitored 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 for steelhead to have *no more than 4 hours a day at greater than 20ºC (68ºF)* was met in 2016 (except for 1 day of the 2 days it went over 20°C), in 2015 (except for 2 days; 5 days reaching 20°C), in all of 2014 (3 days reaching 20°C) and in 2013 (except for 1 day; 7 days reaching 20°C) (**Figures 5a and 5c; Alley 2015a; 2016**). In 2009−2012, the stream management goal for steelhead was met (**Alley 2014**) and failed on only 1 day in 2008 (**Alley 2013**). 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**).

The Soquel Creek water temperature goal for coho salmon in stream habitat just upstream of the lagoon is to have an average weekly temperature (7-day rolling average) of 16.7º C (62º F) or cooler, based on the Mattole River study (**Welsh et al. 2001**). In 2016, the management goal was NOT met on 52 of 121 monitored days (43%; reaching a maximum of 17.6°C) compared to 114 of 122 days (93%; reaching a maximum of 18.3˚C) in 2015; 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 of 93 days (25%; 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 2016, which was typical for previous years except 2010. The maximum daily lagoon water temperature typically occurred between 1600 and 2100 hr each day.

<u>Aquatic Vegetation Monitoring</u>

In 2016 at the time of sandbar construction on 27 May, approximately 90% of the decomposing kelp and seagrass had been raked out of the lower lagoon, downstream of Stockton Bridge (70% in 2015). In 2015 and 2016, the lagoon bottom was firm without a thick layer of detritus. There was the least detritus in 2016 of any year in memory. It was soft with a thick layer of detritus 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 2016 and previous years. In 2016, the thickness of algae and the coverage and thickness of pondweed was less than in 2015 and even less so than in 2014 (**Tables 5−7**). The pondweed came on late in the season in 2016 but had much more restricted coverage than in 2014 and 2015.. The planktonic algae bloom that made the bottom vegetation indistinguishable in 2015 was nearly absent in 2016. There was less surface algae in 2016 than 2015 and much less than in 2014 (**Tables 5−7**). 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 2016, the average percent of the bottom with algae and the average surface algae were greater at this station than elsewhere. However, average algae thickness was not greater, and pondweed was absent at the mouth of Noble Gulch in 2016.

Filamentous algae was first noted on the first monitoring on 12 June 2016, compared to 21 June in 2015, 7 June in 2014 and to mid-June 2013. However, its coverage did not reach more than 50% of the bottom covered until 9 July, which was later than in 2015. Regarding relative algal thickness over the past 8 years, from most to least the years were ranked 2014, 2013, 2009, 2015, 2010, **2016**, 2011 and 2012. In 2016, bottom algae thickness in Reaches 1−3 and at the mouth of Noble Gulch averaged 0.8 ft, 0.8 ft, 0.6 ft and 0.6 ft, respectively (**Table 5**) compared to 1.4 ft, 1.3 ft, 1.1 ft and 1.2 ft, respectively in 2015 (**Table 6**), to 2.0 ft, 1.8 ft, 1.4 ft and 1.5 ft, respectively in 2014 (**Table 7**) and 2.0 ft, 1.1 ft, 1.2 ft and 1.2 ft, respectively in 2013, (**Table 8**) and 0.5 ft, 0.4 ft, 0.4 ft and 0.5 ft, respectively in 2012 (**Table 9**). This was compared to 2011 averages of 0.6 ft, 0.6 ft, 0.3 ft and 1.1 ft, respectively (**Table 10**), 2010 averages of 0.8 ft, 0.8 ft, 0.8 ft and 2.2 ft, respectively (**Table 11**), and 2009 averages of 1.7 ft, 1.2 ft, 0.9 ft and 1.4 ft, respectively (**Alley 2014**).

Pondweed had limited distribution in 2016 (highest in Reach 1). It had nearly disappeared in 2011, but flourished in 2012–2015 with the thickest growth in 2015 of the past 8 years, with 2014 a close second. Pondweed was first detected 23 July 2016. It ranged between 15 and 20% coverage and ranged between 2 and 3 ft thickness in the three reaches from late August through September. By comparison, 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 was prominent at the mouth of Noble Gulch in 2015 but was absent in 2016.

Surface algae with floating pondweed fragments were similarly relatively uncommon in 2015 and 2016. There were scarce floating pondweed fragments in 2016. Floating plant material was slightly less common in 2016 compared to 2015, on average, in Reaches 1 and 3 and slightly more common in Reach 2 and the mouth of Noble Gulch. In 2014 it had reached a 24-year high (since 1990). Floating plant material varied between 0 and 4% in Reach 1 (between 0 and 10% in 2015; between 0 and 15% in 2014; between 0 and 7% in 2012 and 2013). It varied between 0 and 7% in Reach 2 (between 0 and 5% in 2015; 0 and 30% in 2014; 0 and 5% in 2012 and 2013). It varied between 0 and 5% in Reach 3 (between 0 and 5% in 2015; 0 and 40% in 2014; 0 and 10% in 2013 and 0 and 25% in 2012). It varied between 0 and 15% at the mouth of Noble Gulch in 2016 (between 0 and 10% in 2015; 0 and 50% in 2014; 0 and 30% in 2013 and 0 and 15% in 2012) (**Tables 5–9**). Regarding season averages for surface algae (and pondweed fragments), in Reaches 1–3 for 2016, it was 0.7, 0.8 and 0.8 % of the surface covered. In 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 24-year high (since 1990) between 30 and 50% coverage at all stations.

Table 5. Visually Estimated Algae/ Pondweed Coverage and Thickness in the 2016 Lagoon.

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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**
6-12	**0.1**	**10**	**0**	**0.2**	**15**	**0**	**0.1**	**5**	**0**	**0.2**	**10**	**0**
6-25	0.7	15	0	0.7	25	0	0.3	20	0	0.4	25	<1
7-9	0.3	80	0	0.2	60	0	0.1	40	0	0.2	70	5
7-23	0.3	70	0	0.5	50	0	0.3 (1.0 Pond-weed)	30 (<1 pond-weed)	0	0.3	80	0
8-6	1.0	90	0	0.4	100	0	0.3 (1.0 pond-weed)	90 (<1 pond-weed)	0	0.5	90	0
8-21	1.0 (2.0 pond-weed)	45 (15 pond-weed)	0	1.5	100	0	1.0 (2.0 pond-weed)	98 (1 pond-weed)	0	1.0	80	0
9-4	2.0 (2.5 Pond-weed)	50 (20 Pond-weed)	<1	1.5	95	<1	1.5 (2.0 pond-weed)	95 (1 pond-weed)	2	0.8	65	15
9-17	1.0 (3.0 pond-weed)	80 (15 pond-Weed)	2	1.0 (2.5 pond-weed)	80 (15 pond-weed)	2	0.5 (2.0 pond-weed)	80 (15 pond-weed)	<1	1.5	80	<1
10-1	1.0 (3.0 pond-weed)	60 (15 pond-Weed)	4	1.5 (2.0 pond-weed)	60 (15 pond-Weed)	7	1.0 (2.0 pond-weed)	50 (15 pond-Weed)	5	0.6	60	10
Avg- 6-12 – 10-1	**0.8 algae (1.2 pond-Weed)**	**56 Algae (6 Pond-Weed)**	**0.7**	**0.8 algae (0.5 Pond-Weed)**	**46 algae (0.3 Pond-Weed)**	**0.8**	**0.6 algae (1.0 Pond-Weed)**	**44 algae (4.0 Pond-weed)**	**0.8**	**0.6**	**62**	**3.3**

Table 6. Visually Estimated Algae/ Pondweed Coverage and Thickness in the 2015 Lagoon

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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 7. Visually Estimated Algae/ Pondweed Coverage and Thickness in the 2014 Lagoon.

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 8. Visually Estimated Algae/ Pondweed Coverage and Thickness in the 2013 Lagoon.

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 9. Visually Estimated Algae Coverage and Thickness in the 2012 Lagoon.

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 10. Visually Estimated Algae Coverage and Thickness in the 2011 Lagoon.

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 11. Visually Estimated Algae Coverage and Thickness in the 2010 Lagoon.

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 2016, the average oxygen level and oxygen concentration at each of the 4 stations near dawn and in the afternoon remained "good" (greater than 7 mg/l at dawn) for steelhead *near the bottom* during all 9 of the two-week monitoring to October 1 (**Table 2; Figures 6a-1; 6a-2; 6b−6e**). Morning oxygen concentration near the bottom ranged from 7.2 to 10.5 mg/L at the 4 lagoon stations during the 9 monitorings. Afternoon oxygen concentrations near the bottom ranged from 9.2 (100% full saturation) to 18.4 mg/L (200% full saturation) at the 4 lagoon stations.

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. No low oxygen concentrations were detected in 2016, and average oxygen levels at dawn and in the afternoon were within the range of measurements over the past 4 years (**Figures 6h and 6i**). Oxygen concentrations varied less in 2016 than in the 3 previous years, without depletion associated with turbid conditions after early storms in past years that did not breach the sandbar. The lowest oxygen concentration registered in the afternoon was on 6 August, when it was overcast and misty in the morning, and the cloud layer burned off late in the day. 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 in November 2015.

In comparing morning and afternoon oxygen levels in the lagoon, usually oxygen concentration was higher in the afternoon than morning through the years and on all monitoring days in 2016 except at the mouth of Noble Gulch on 6 August (**Figures 6b-e**). Oxygen concentration typically increases through the day, despite warmer water temperature in the afternoon, which has a lower oxygen saturation point. At or above fully saturated oxygen levels existed near the bottom in afternoon throughout the lagoon from 25 June to 1 October 2016. Oxygen concentrations at the stream Station 5 at Nob Hill near dawn were usually within the range of oxygen concentrations at lagoon stations in 2016 (**Figure 6a-1**). However, Station 5 had lower oxygen concentrations in the afternoon than any of the lagoon stations during 7 of the 9 two-week monitoring (**Figure 6a-2**). In stream settings, oxygen is typically at or close to full saturation due to water turbulence in riffles. In 2016, the lowest morning oxygen concentration at Station 5 was 79% of full saturation (1 October) (**Appendix A**). However, all afternoon oxygen concentrations were more than fully saturated (**Appendix A**). Stream oxygen levels were much higher than in the previous 2015, which had lower baseflow during drought.

Salinity Results

In 2016, saline conditions were only detected in a thin, dilute layer a short time after sandbar closure (3 June) in the deeper lagoon area along the wall at Venetian Court (**Appendix A**).

Saline conditions resulted from a small amount of saltwater being trapped in the lagoon at the time of sandbar closure on 27 May, which created a stagnant layer along the lagoon bottom that heated up. The saline layer was so thin and dilute that the flume inlet shroud was not needed in 2016. No salinity was detected on 12 June at the monitoring stations. A freshwater lagoon was maintained throughout the period of sandbar closure until sandbar breaching on 16 October during the first storm period of the season. No tidal overwash was allowed to occur through the dry season in 2016, with the elevated berm around the lagoon.

Conductivity Results

Measured conductivity remained low throughout 2016, except in the Venetian Court's wall-hole early on when thin saltwater layer was present at the bottom for a week or so. Otherwise, it ranged between 720 and 810 umhos at the various monitoring stations (**Appendix A**), with a lower range than in 2015 (**Alley 2016**). Conductivity was not stressful to steelhead in 2016. As in other years, 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 2016 started out higher than the 3 previous drought years and similar to 2001 (**Tables 2 and 12**). But baseflow declined more rapidly in 2016 than 2001 and at a similar rate as in 2009 which followed 2 dry years, too. The 2016 lagoon cooled down more at night than in the 3 previous drought years, as indicated by the minimum water temperatures and minimum 7-day rolling averages compared to 2013−2015 (**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 2009−2016, perhaps resulting from partial boarding of the flume exit in 2014 and 2015 and the use of plywood over the flashboards. The year 2001 was most affected by tidal overwash in the last 15 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 Water Year 2016 was below the median except during stormflow events and declined well below median baseflow in September (**Figures 25 and 27**). But it was an improvement over 2015 baseflow, which was the lowest since the drought of 1987-92 and 1994 from August onward (**Table 12; Figure 28**). In 2016, the lagoon steelhead management goal of maintaining early morning MINIMUM temperature below 20°C near the bottom was met (**Figure 4a**). This occurred despite relatively low baseflow (**Table 12**). Overall cooler air temperatures overnight in 2016 encouraged cooler water temperatures (**Figure 3f**). 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%) (**Alley 2016**). Baseflow in Capitola (approximately 0.5 cfs less than the Soquel Village gage reading) at the time of sandbar closure was approximately 8 cfs compared to less than 3 cfs compared in 2015 and 1.5 cfs in 2014, 2–3 cfs in 2013, 10 cfs in 2012 and 25 cfs in 2011) (**Table 12**). By 1 September, prior to any fall rainfall, 2016 streamflow had declined to 1.4 cfs at the Soquel Village USGS gage, compared to 0.4 cfs in 2015, 0.35 cfs in 2014, 0.4 cfs in 2013, 1.8 cfs in 2012 and 5.8 cfs in 2011. By 1 October without rainfall, the 2016 baseflow had dropped to 0.7 cfs, the 8th lowest in 26 years. A record of annual hydrographs since 2007 are provided in **Figures 25−42**.

In 2016 the sandbar had to undergo a facilitated breach early, in mid-October from the first storm system of the season. On the day of the sandbar opening, streamflow at the Soquel Village gage reached 1,040 cfs. With this significant rainfall early, flow in Soquel Creek remained above 6 cfs until smaller storms ensued and maintained baseflow above 10 cfs and an open sandbar until the time of this writing on 1 December.

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

The 6 restaurants that were contiguous with Soquel Creek Lagoon were tested for leaks and deficiencies in plumbing connections and repaired as necessary. Confirmation is contained in **Appendix B**.

Table 12. Daily Mean Discharge Recorded at the USGS Stream Gage (11160000) in Soquel Village, At One Month Intervals from 1 June to 1 October, 1991-2016.

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
2016	7.3	3.1	1.8	1.4	0.7

Begonia Festival Observations and Water Quality Findings

No negative impacts to fish were detected during the Begonia Festival in 2016. The City's fishery biologist (Donald Alley) was present before, during and after the Begonia Festival procession of floats on 4 September. The day of the parade was clear in the morning and afternoon. Water temperatures near the bottom were similar to 2 weeks previous and rated "good" in the morning (between 18.4˚C at the mouth of Noble Gulch and 19.9˚C near the Stockton Bridge), which met the management goal of maintaining water temperature below 20°C in the morning. Early afternoon (1500–1600 hr) temperatures ranged from 20.1˚C at the mouth of Noble Gulch to 21.1˚C at the flume inlet, 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 20.2˚C near the bottom that day (**Figure 4a**). It is unlikely that the maximum afternoon water temperature near the bottom reached 22˚C anywhere in the lagoon near the bottom. Oxygen concentrations were very good and supersaturated in the morning and afternoon at measured stations except at the mouth of Noble Gulch in the morning where it was still rated "good" at 7.8 mg/L. Lagoon water surface elevation was excellent and maintained high at 2.62. The procession included 7 floats (4 powered by electric motor, 2 powered by boat paddlers, 1 powered by paddle boarders). No people waded. 16 other paddleboards, kayaks and canoes were on the water with 3 barges with people onboard. One drone was present to film the Festival. 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 more than the previous week, ranging from 779 to 788 umhos in the afternoon compared to 768 to 783 umhos in the morning. 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 after fewer were left floating on the lagoon than previous years. There was a Begonia shortage in 2016.

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 17 September detected no oxygen depletion resulting from decomposing begonias (**Figure 6a-1; Appendix A**).

Pollution Sources and Solutions

During sandbar construction on 26 May, the bulldozer developed a hydraulic leak out on the beach at 0715 hr. The sandbar had been opened a few minutes prior to the leak and was closed quickly with shovel work. Messages were left with NOAA Fisheries and CDFW, notifying them of the leak (**Danielle Uharriet, Environmental Projects Manager, pers. communication**). The hydraulic fluid was contained in holding pools and collected with absorbent skimming booms on hand. Fluid leaking from the bull dozer was also collected with absorbent pads as it dripped off the housing containing the hydraulic fluid filter that had leaked. Additional absorbent pads and rolls were obtained from the fire department. The Peterson heavy equipment mechanic repaired the bull-dozer and partially refilled the fluid reservoir with fluid on hand, and it was driven up the beach to the parking area above high tide before the tide came in. The cleanup was completed at 1048 hr. The breakdown did not occur in close proximity of the lagoon/estuary, and no fish mortalities were noted. This was the first such leak to occur during sandbar construction in 26 years of biological monitoring. After the bull-dozer was completely refilled, work was resumed. The lagoon near the beach was closed to human contact during the summer due to bacterial levels above the maximum acceptable level. However, increased human use of the lagoon was observed in 2016. Paddle-boarders became common (7 of 9 afternoon weekend monitorings), along with more occasional kayakers, canoers and barge users (3 occasions and feeding ducks) throughout the lagoon. For the first time, waders and swimmers were commonly observed in the lagoon (usually near the beach in Reach 1; 6 of 9 afternoon weekend monitorings). This human contact with the lagoon occurred despite warning signs in close proximity. On the morning of 6 August, a teen-age boy was observed fishing from a paddleboat in Reach 3 near the Shadowbrook Restaurant. The game warden was notified. High-volume bird feeding was observed on 2 occasions at Noble Gulch, despite warning signs nearby. One lady said that she fed them daily and had large bags of bird feed. She attracted more than 30 ducks, as well as gulls. Ducks were more attracted to the monitoring biologist along the periphery in 2016 compared to past years. In 2016, algae production was much reduced, and pondweed was scarce except in Reach 1. Thus, the ducks had less aquatic vegetation to process to obtain invertebrate food from. Human bird-feeding attracted gulls further up the lagoon where they usually did not go. Gulls are a threat to ducklings.

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 and other restaurants have been effective in discouraging roosting. 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 would be storm drains emptying into Noble Gulch. Significant quantities of gray water and oily slicks have consistently emptied into the lagoon from Noble Gulch, though none was detected during 2-week monitorings in 2014−2016. Water quality monitoring should be conducted along Noble Gulch, including accessible storm drain inlets, to pinpoint potential anthropogenic pollution sources. Noble Gulch should also be monitored upstream of urban storm drains to establish a baseline. Once identified, source control efforts should be made to control illicit discharges or, where feasible, to direct dry weather flows from storm drains to sanitary sewers. The thick planktonic algal bloom present much of the summer of 2015 at the mouth of Noble Gulch was absent in 2016. Oxygen depletion was detected on the very bottom at dawn there on 6 and 21 August and 4 September 2016 (2.42 mg/L; 4.24 mg/L and 3.75 mg/L, respectively), and slightly elevated conductivity was detected at the bottom on 17 September (**Appendix A**). However, within 0.25 m of the bottom the oxygen concentration ranged between 7.8 and 9.4 mg/L on those days, indicating no stress to steelhead. Surface algae was thicker at the mouth of Noble Gulch than other stations on occasion, and the highest estimates of 10% and 15% surface coverage occurred there (**Table 5**). Bottom algae coverage was slightly greater at Noble Gulch than at other lagoon stations, but the average thickness was no greater. Thus, there were limited indications of nutrient pollution and slightly increased eutrophication at the mouth of Noble Gulch in 2016. However, it was much reduced from 2015 and other drought years 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 but not in 2016. 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 2016, 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.

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

1. Water quality monitoring should be conducted along Noble Gulch, including accessible storm drain inlets, to pinpoint potential anthropogenic pollution sources. Noble Gulch should also be monitored upstream of urban storm drains to establish a baseline. Once identified, source control efforts should be made to control illicit discharges or, where feasible, to direct dry

weather flows from storm drains to sanitary sewers.

2. Prior to sandbar breaching in the fall, continue to 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.

3. 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.*

4. Continue to 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.

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

6. To provide cover for juvenile fishes and to scour deeper habitat, continue to 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.

7. Continue to allow a clear path from under the bridge to the beach at Venetian Court to enable seining for juvenile steelhead during fall censusing.

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

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

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

11. 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.

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

13. 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.

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

15. 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.

16. Continue to maximize lagoon depth through 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 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.

17. After July 1, leave the flume exit closed once it closes, unless flooding is eminent. Continue to 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.

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

19. 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.

20. 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.

21. 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.

22. Continue not to reduce the lagoon level for the Begonia Festival's nautical parade.

23. 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 CDFW 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.

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

25. "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**).

26. 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.

27. 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.

28. 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 2016, as was the case in 2003–2015. 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 2 and 9 October 2016, from just upstream of the Stockton Avenue Bridge to the beach. A bag-seine with dimensions 106 feet long by 6 feet tall 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. A total of only 161 juvenile steelhead were captured and marked on 2 October after 4 seine hauls. There were no mortalities. A total of 56 juvenile steelhead was captured on 9 October in 6 seine hauls. There were 38 recaptures and no mortalities. The lagoon population estimate was 237 juvenile steelhead (**Table 13**). Juveniles were relatively large (**Table 14; Figure 7a**), but the population size was relatively small compared to the average of 1,537 (**Figure 24**). Scale analysis indicated that juveniles greater than 150 mm SL were yearlings and older. Size histograms of steelhead captured from the lagoon in 2016 and other years back to 1998 may be found in **Figures 7a–23**. Based on the bimodal histogram in 2016 and scale analysis, the cutoff for YOY was 140-145 mm SL. This indicated that the majority of juveniles in the lagoon were likely yearlings and older. The bimodal shape of the size frequency histogram in 2016 was very similar to that found in 2009 and 2011, when the 2009 and 2011 population estimates were nearly 2 and 3 times that of 2016, respectively. Results from most years lack the bimodal distribution, making it difficult to ascertain the YOY cutoff without scale analysis. The median size of juvenile steelhead captured on 2 Oct 2016 was 155-159 mm SL (**Figure 7a; Table 14**). It was 165-169 mm SL on 9 October. No population estimates were possible in 2014 or 2015 due to the small number of juveniles in the lagoon and the absence of recaptures during fish sampling. The 2013 lagoon population estimate was 1,681 compared to 220 in 2012 and 678 in 2011 (**Table 13; Figure 24**) (methods in **Ricker 1971**). Other species captured with the large seine in 2016 were hundreds of threespine stickleback, 4 staghorn sculpins and 13 small adult Sacramento suckers.

On 9 October 2016, 4 seine hauls were made to capture tidewater gobies with a 30-foot x 4-foot x 1/8-inch mesh beach seine in lower Soquel Lagoon near the beach. A total of 98 tidewater gobies were captured without mortality. Numerous threespine stickleback were also captured (350+). 309 tidewater gobies were captured in 2015 (dry winter) in 5 seine hauls. 481 tidewater gobies were captured in 2014 in 6 seine hauls (dry winter). Ten tidewater gobies were captured in 2013 (dry winter) (**Table 15**). 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 refuge 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). It was surprising to find good numbers in the 2016 lagoon despite an 8,000 cfs stormflow the previous winter. Tidewater gobies were also detected upstream of the Stockton Avenue Bridge during sandbar construction in 2016. Perhaps they had immigrated from adjacent lagoons after the high stormflow in March 2016. 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 or 2016 because CDFW was supposed to.

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 estimated 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 2007–2016 population estimates for the entire Soquel Creek watershed, the lagoon population of larger smolt-sized fish has likely been a significant portion 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, 1998−2016 (**Table 14**), 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. In 2016, the lagoon population was a combination of YOY and yearlings, with those larger than 145 mm SL likely being yearlings, based on scale analysis (**Figure 7a**). We suspect from the size distributions of juveniles captured, that steelhead grew faster in 2006, 2009, 2011, 2014 and 2016 than in either 2007 or 2008 because of less competition for food with much smaller populations (**Table 14**). 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.

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

Table 13. Estimates of Juvenile Steelhead Numbers in Soquel Creek Lagoon for the Years 1988 and 1992-2016.

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.
2016-	237 +/- 19 (standard error). 161 fish marked from 4 effective seine hauls.

Table 14. Summary of Annual Fish Sampling Dates, Population Estimates, Steelhead Size and Lagoon Growth Period Prior to Sampling, 1998−2016.

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	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
2016	27 May	2/9 Oct	19.1	134	237	155-159 & 165-169

Table 15. Number of Tidewater Gobies Captured at Soquel Lagoon in October.

Year	# of Tidewater Gobies Captured in Soquel Lagoon	# of Seine Hauls (30-foot Seine)
1988	102	2
1992	2	?
1993	0	4
1994	35	4
1995	0	8
1996	0	6
1997	1	8
1998	0	4
1999	0	5
2000	0	5
2001	0	5
2002	0	5
2003	0	5
2004	0	5
2005	0	4
2006	0	5
2007	0	5
2008	33	4
2009	8	4
2010	0	6
2011	0	6
2012	0	5
2013	10	7
2014	481	6
2015	309	5
2016	98	4

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 of 2015, which would have increased metabolic costs and reduced dietary intake that could be used for growth.

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. This 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 and 2016 than in the warmer lagoons of 2008, 2009, 2012 and 2013−2015 (more pondweed) (**Tables 5-11; Alley 2016**), indicating less food in 2011 and 2016. There may have been a higher proportion of yearlings in the lagoon population in 2011 and 2016 compared to other years due to overall low YOY survival in the watershed. In 2016, juvenile densities were extremely low in the lower mainstem Soquel Creek. 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 2016 lagoon was similar in depth to 2015 and shallower than in 2013 and 2014. There was likely limited sedimentation over the very mild winter of 2014-2015, though the February storm likely exceeded bankfull. In 2016 there was a large stormflow of 8,000 cfs in March. However, the lagoon bottom was firm at the time of sandbar closure, and had similar depths at monitoring stations compared to 2015 except slightly deeper at the trestle station (0.15 feet deeper). In Reach 1 above the lagoon, average pool depth increased slightly in 2016 compared to 2014 (about 0.1 feet deeper). Therefore, sedimentation did not appear to occur in 2016.

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 2013−2016. 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 2016. There were periods during the 2016 summer when no threat of sink holes existed and no areas were flagged on the beach. The lagoon water surface was kept at the top of the flume inlet throughout the summer/ fall until the facilitated breach was required in mid-October. Extending the plywood above the flashboards with a notch in it in after 1 July 2016 had increased water depth as much as 0.1 ft, which was significant. 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. In 2015, the lagoon opened and closed repeatedly after the early breaching on 9 November because streamflow was low. But succeeding storms prevented closure for extended times that would lead to anoxic conditions. In 2016 the sandbar was opened even earlier on 16 October. However, the first stormflow of the season reached 1,040 cfs at Soquel Village, and baseflow was sufficient afterwards to prevent sandbar re-closure until more stormflows occurred in November. Minimization of pollutant input from early fall storms is also important for reducing biological oxygen demand and avoiding fish kills.

Piscivorous Birds and other Waterfowl. Predation may be a factor in population size and body 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. Maximizing lagoon depth is important to make feeding more difficult for piscivorous animals.

Mergansers were less common in 2016 than in 2013−2016. The most we observed at a time was four in 2016 compared to three in 2015 and as many as 6 in earlier years. In 2016, mergansers were observed on 3 of 9 monitoring days (33%), compared to 6 of 12 monitoring days (50%) in 2015 (**Appendix A**). They were observed on 6 of 13 monitoring days (46%) in 2014 compared to 9 of the 18 two-week monitoring days (50%) in 2013. In 2012, one merganser was observed on only 3 days of monitoring days (25% of the time). Snowy egrets were not observed in 2016 and 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 2016, a cormorant was observed on one occasion. In 2015, a cormorant made the lagoon its home. It was observed on 7 of 12 two-week monitoring days 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 seen on 4 of 9 monitoring days (44%) beginning on 9 July. However, only one was observed the first 3 times, with 2 pied-billed grebes observed on the final monitoring day, 1 October. Pied-billed grebes are commonly seen in pairs. They were less common in 2015, having been observed on only 4 of 12 monitoring days (33%) 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 in 2013, 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). No brown pelicans were observed in the lagoon in 2016. A black-crowned night heron was observed on one occasion on 16 September 2016, at which time a greenback heron was observed along with 2 other observed flying toward the beach on 6 August and one on 1 October roosting on an overhanging willow in Reach 2 . In 2015, 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.

No western pond turtles were observed in 2013−2016, although a paddle-boarder observed a turtle in the upper lagoon in 2015. 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 2016 the cottonwood had moved upstream a few feet and was still partially submerged. In 2012, as many as 3 pond turtles were observed at one time on the cottonwood log and another nearby log.

Mallards were common in the 2016 lagoon, as usual. Mallard numbers tend to be lowest in the early lagoon season and decline in October in most years as the coots become common (**Figure 43**). Mallard numbers have been higher in 2014-2016 than in 2012-2013. In 2016, the mallard population remained in the 30-40 bird range from late June to late August. Mallards were sometimes more numerous in 2015 than in 2016, with them reaching 54 birds in August 2015 (23 were ducklings). In fall 2016, the sandbar was breached relatively early, and only 13 coots were counted on 1 October, compared to higher numbers in 2015 (as many as 113 on 24 October 2015 and 71 by 7 November 2015). Gulls commonly bathed in Reach 1, downstream of the Stockton Bridge (as many as 65 on 4 September) (**Figure 44**). However, when people were feeding the ducks in upstream reaches, a few gulls were attracted to the food source. 2016 gull densities were the lowest since 2013, with them ranging between 20 and 65 during afternoon monitoring. The increased human waders and paddle boarders in 2016 may have reduced gull bathing numbers on the weekends when monitoring took place.

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 so that direct surface water diversion 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. Avoid complete loss of surface flow.

4. Continue to maximize lagoon depth by maximizing flashboards in the flume inlet and by sealing the boards with visquine and/or plywood.

5. Continue to 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. Design and installation of a louver system on one side of the flume inlet would eliminate the need to deal with boards all summer and is recommended.

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

7. Continue not to remove flume boards for the Begonia Festival's nautical parade.

8. Continue to 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 boards afterwards.

9. Maintain the lagoon in fall until streamflow has increased enough (25-30 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 fall season creates turbidity, remove at least three 4x4-inch flashboards as soon as possible after the storm to insure that light penetrates to the bottom of the intact lagoon. If the bottom is still invisible, remove more boards as necessary to see the bottom with a secchi disc. 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. As the lagoon clears up, add boards to eventually 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 adult steelhead or coho salmon to pass through the flume Bay.

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

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Soquel Lagoon Post-Venetian Court Construction- Older Stockton Avenue Bridge visible and prior to expanded development on eastern margin of the Lagoon, upstream and downstream of 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 upstream of Stockton Bridge since 1931 photo; circa 1955-56 after the flood.
(Courtesy of the Capitola Historical Museum)

FIGURES

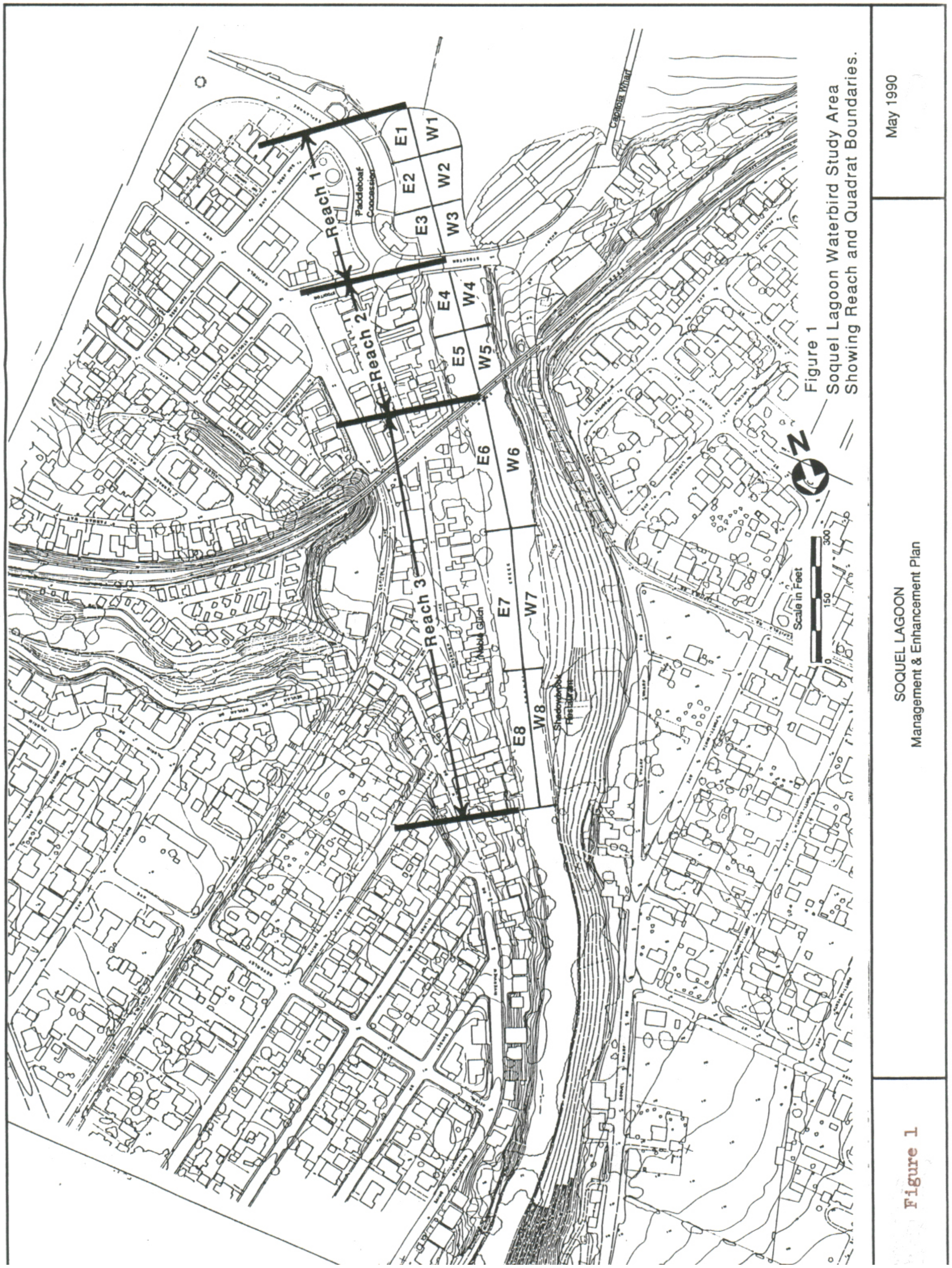

Figure 1. Map of Reaches in Soquel Creek Lagoon

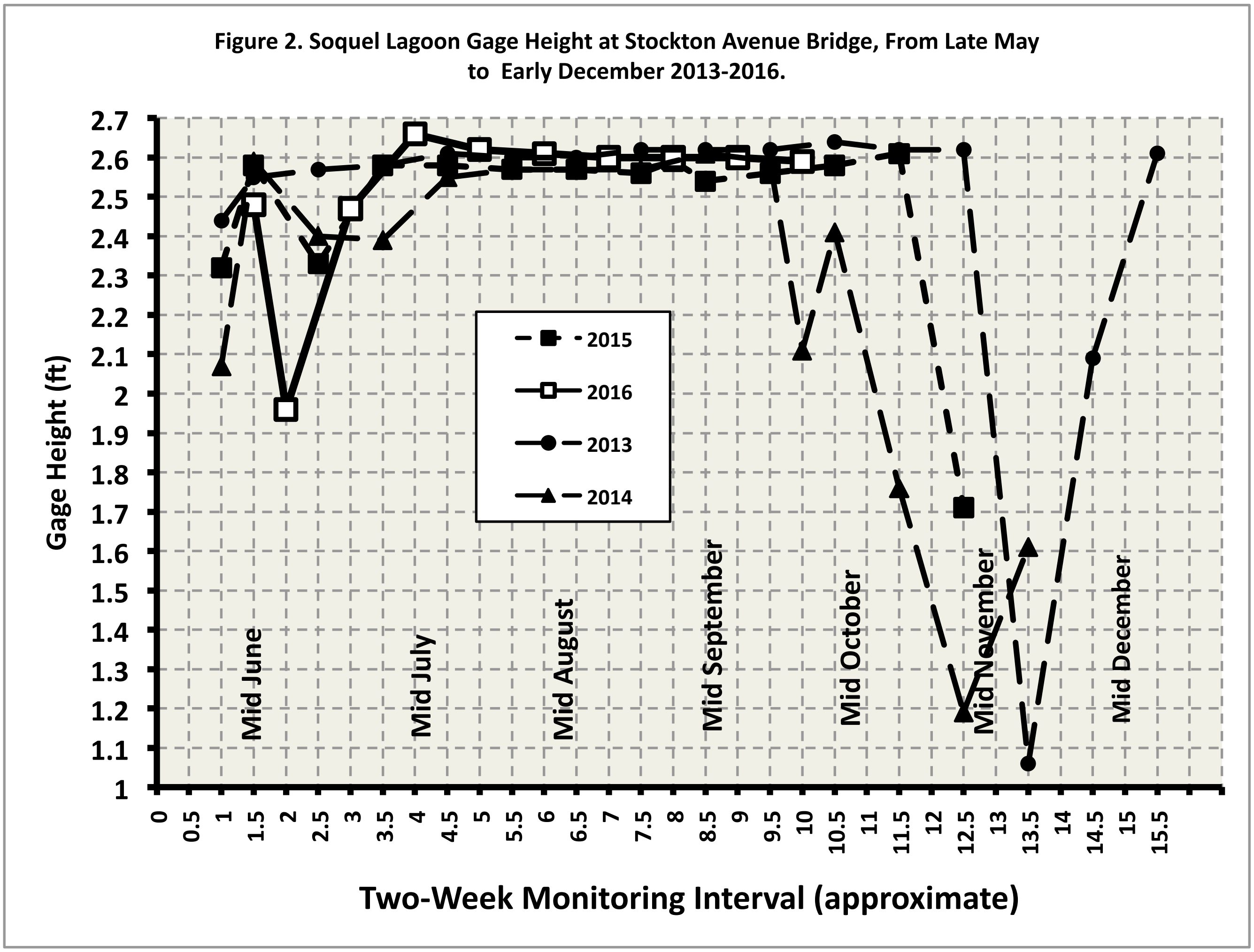

Figure 2. Soquel Lagoon Gage Height at Stockton Avenue Bridge, From Late May to Early December 2013-2016

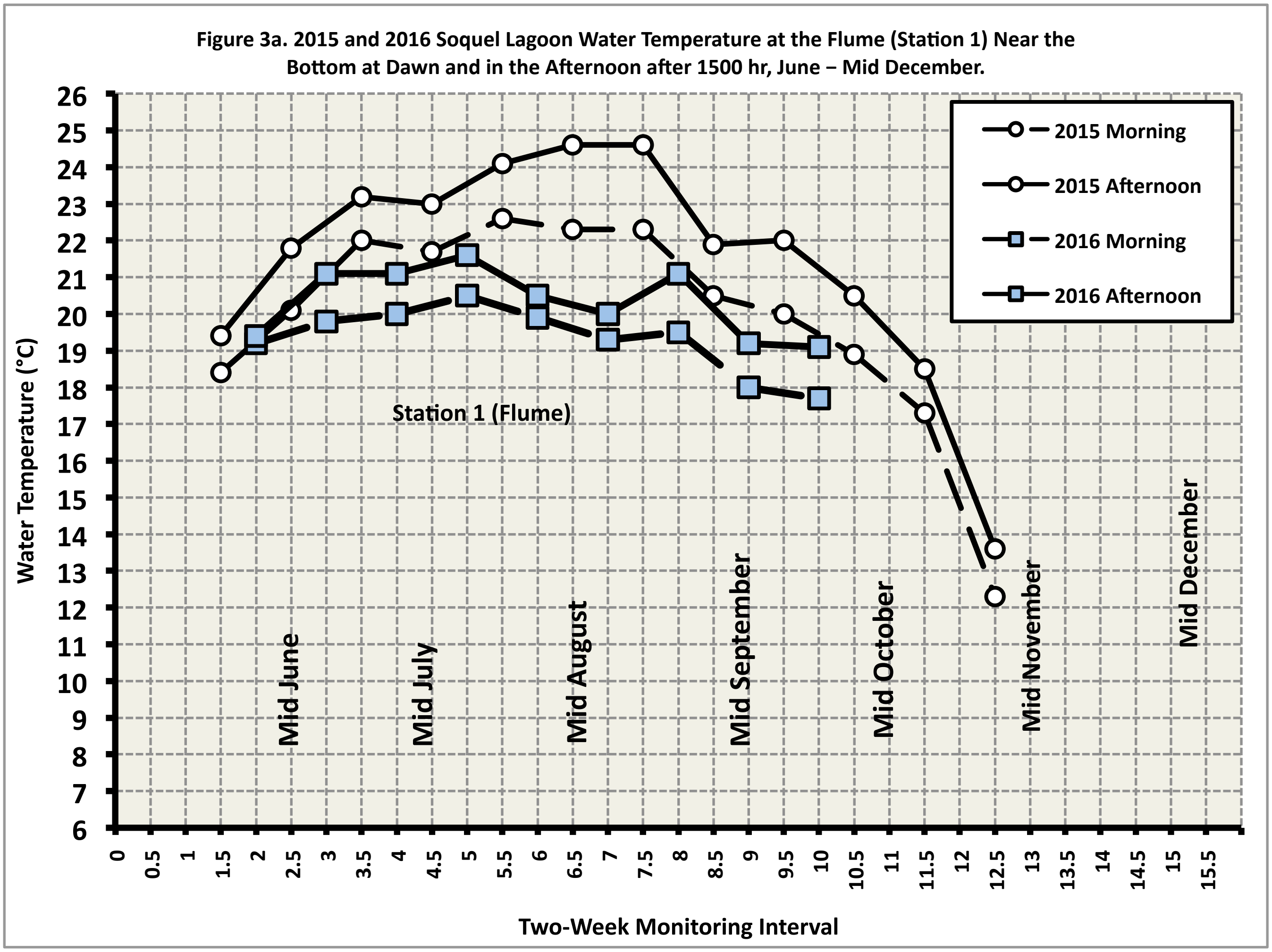

Figure 3a. 2015 and 2016 Soquel Lagoon Water Temperature at the Flume (Station 1) Near the Bottom at Dawn and in the Afternoon after 1500 hr, June – Mid-November.

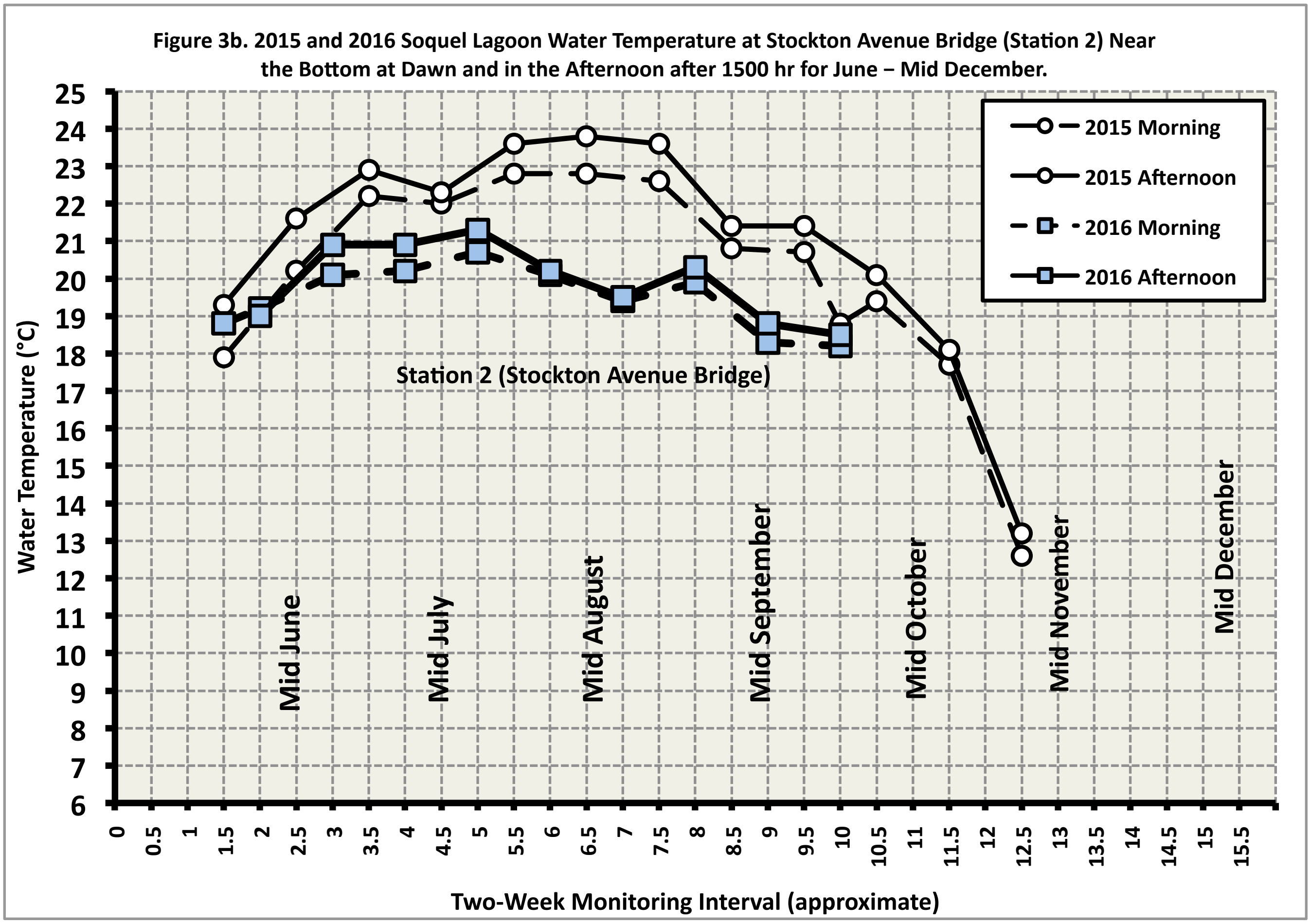

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Figure 3b. 2015 and 2016 Soquel Lagoon Water Temperature at Stockton Avenue Bridge Near the Bottom at Dawn and in the Afternoon after 1500 hr for June – Mid-November.

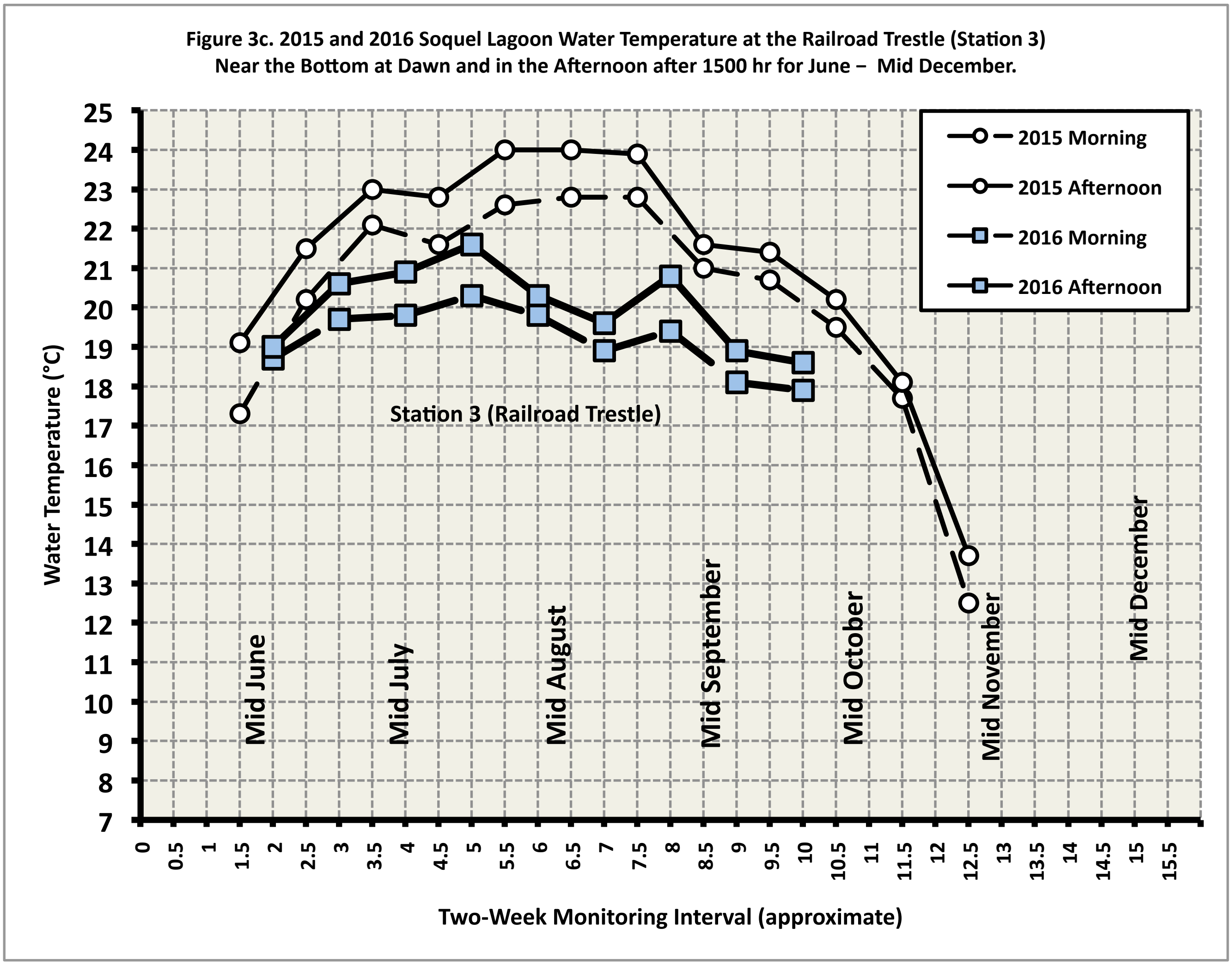

Figure 3c. 2015 and 2016 Soquel Lagoon Water Temperature at the Railroad Trestle (Station 3) Near the Bottom at Dawn and in the Afternoon after 1500 hr for June− Mid-November.

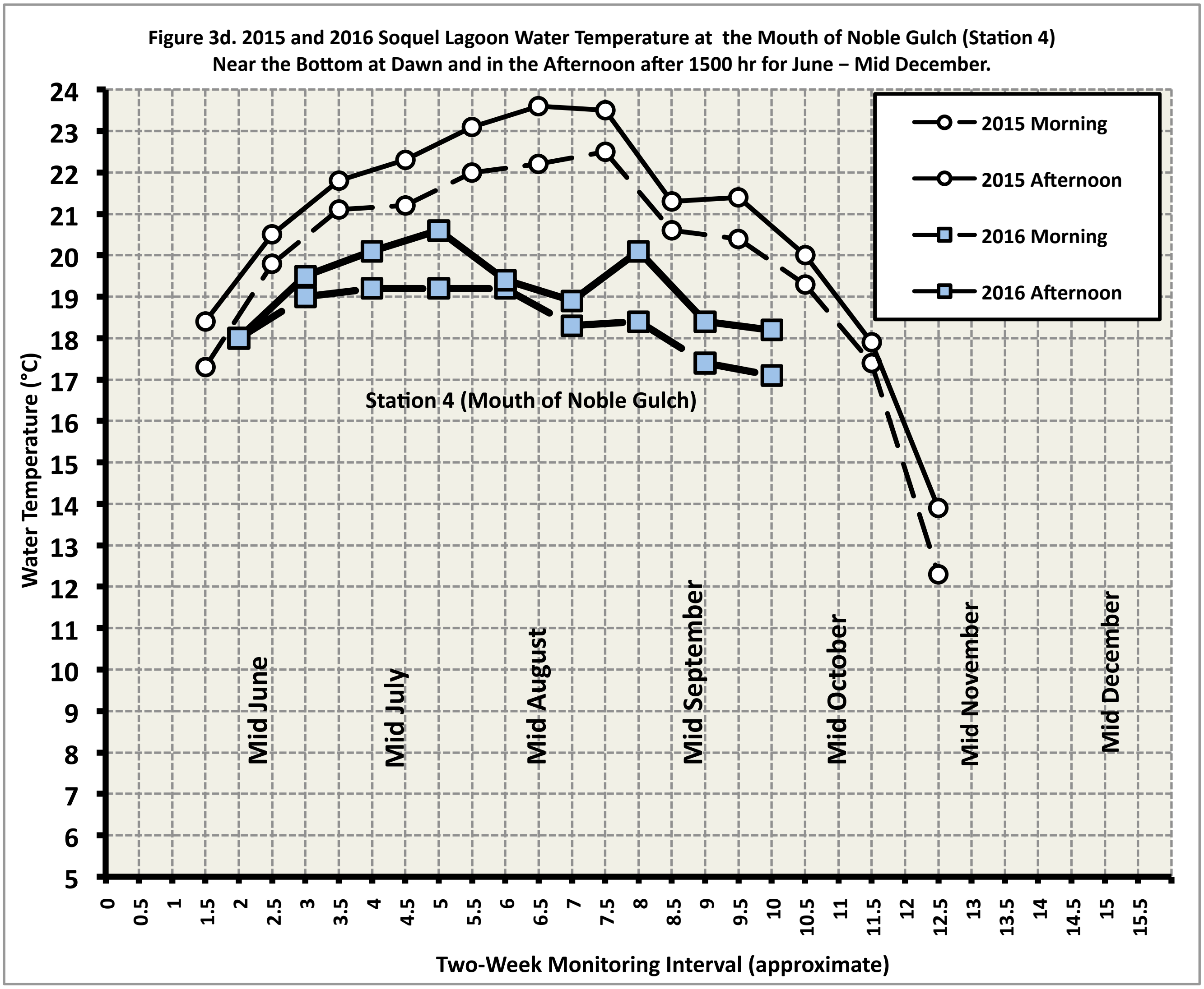

Figure 3d. 2015 and 2016 Soquel Lagoon Water Temperature at Noble Gulch Near the Bottom at Dawn (Station 4) and in the Afternoon after 1500 hr for June – Mid-November.

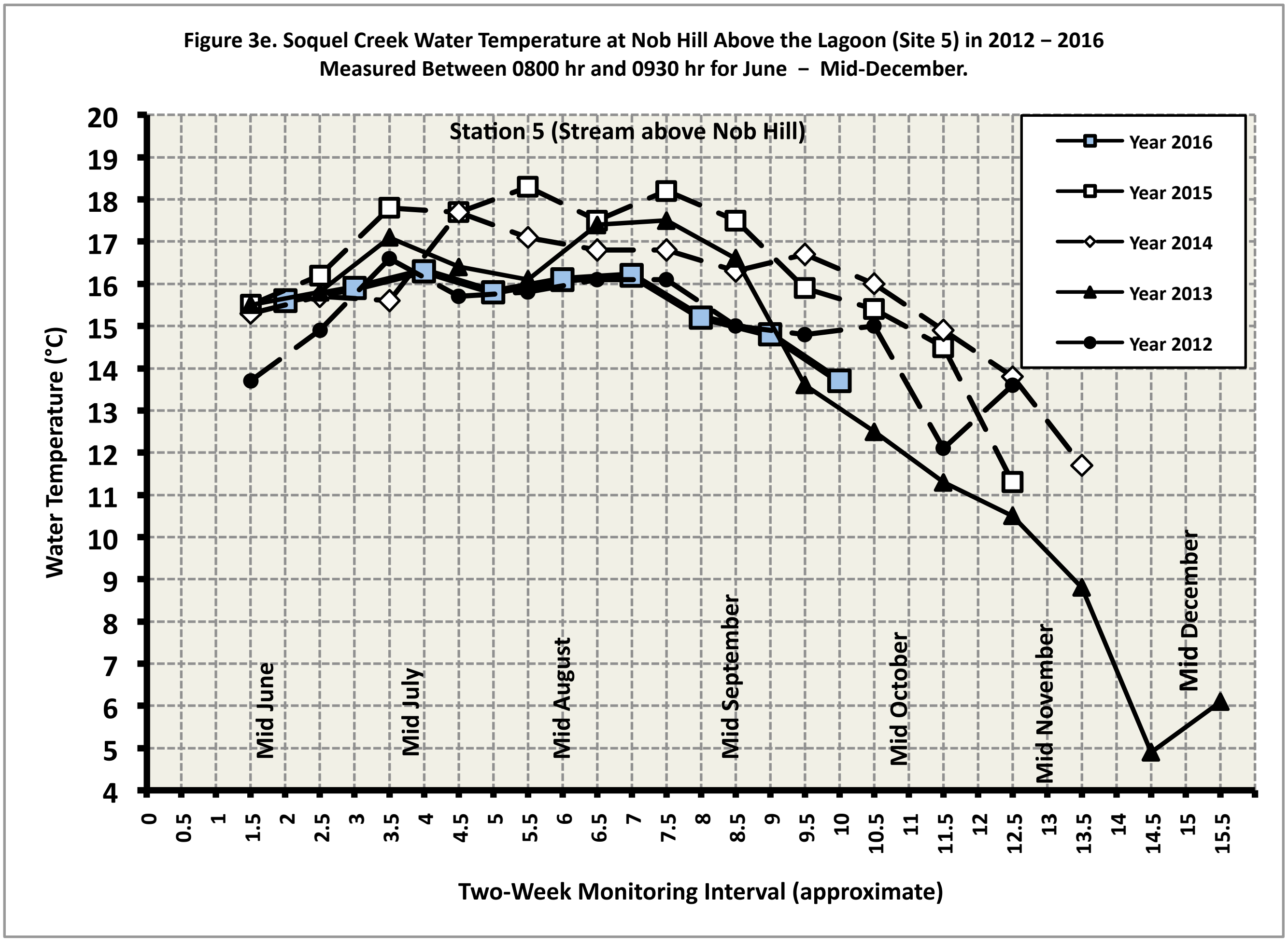

Figure 3e. Soquel Creek Water Temperature at Nob Hill Above the Lagoon in 2012−2016 Measured Between 0800 hr and 0930 hr for June − Mid-December.

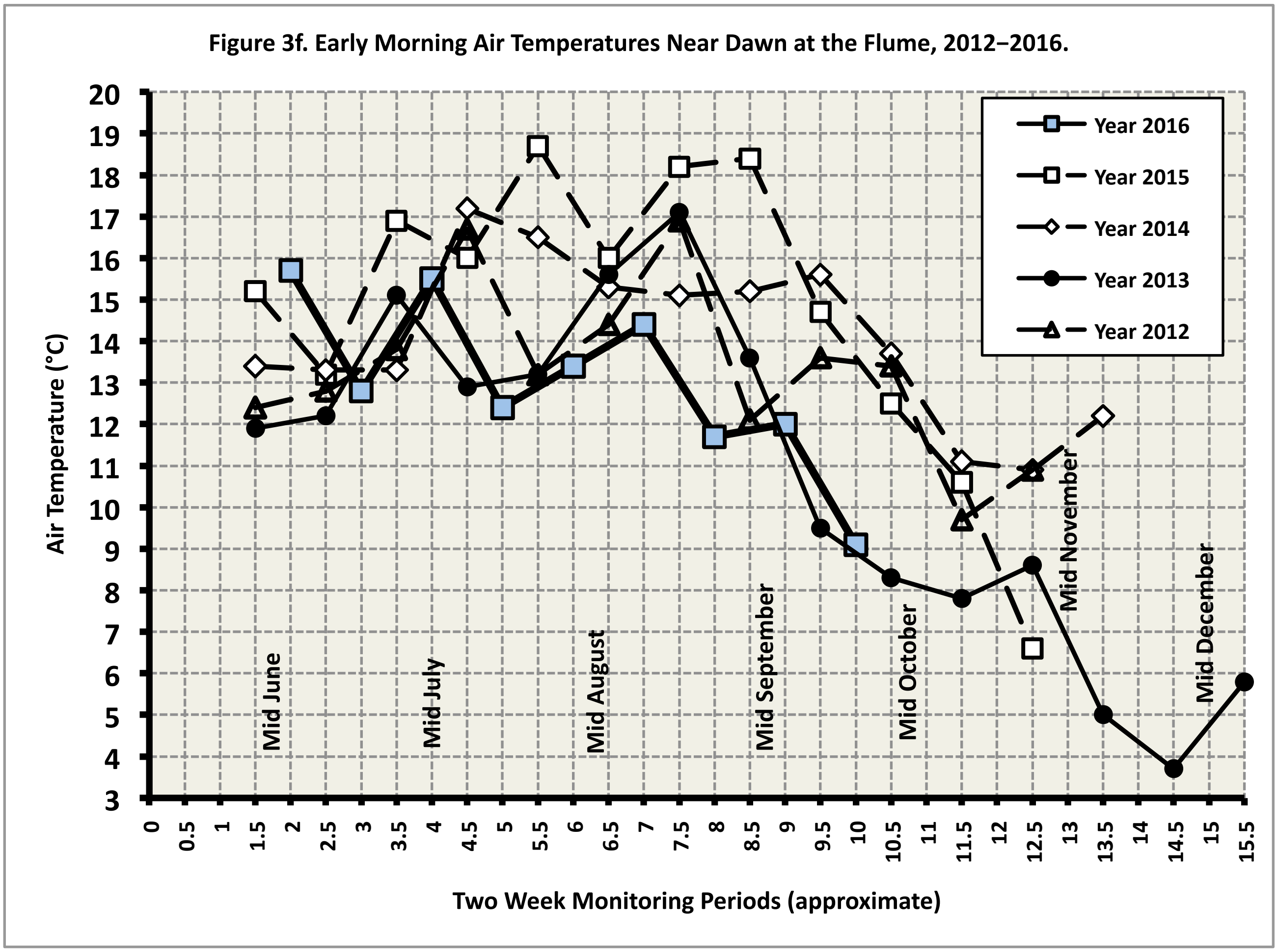

Figure 3f. Early Morning Air Temperatures Near Dawn at the Flume, 2012−2016.

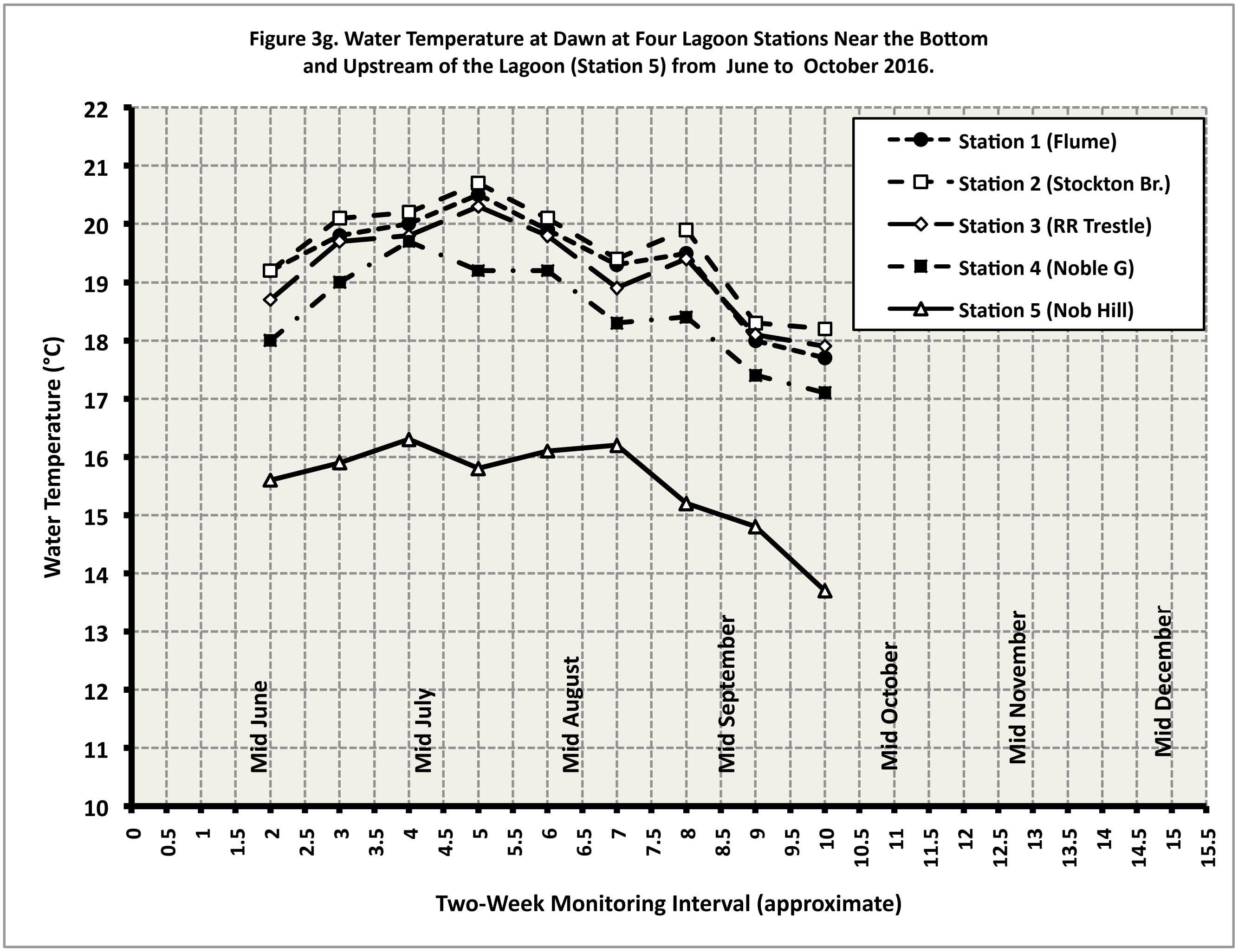

Figure 3g. Water Temperature at Dawn at Four Lagoon Stations Near the Bottom and Upstream from June to October 2016.

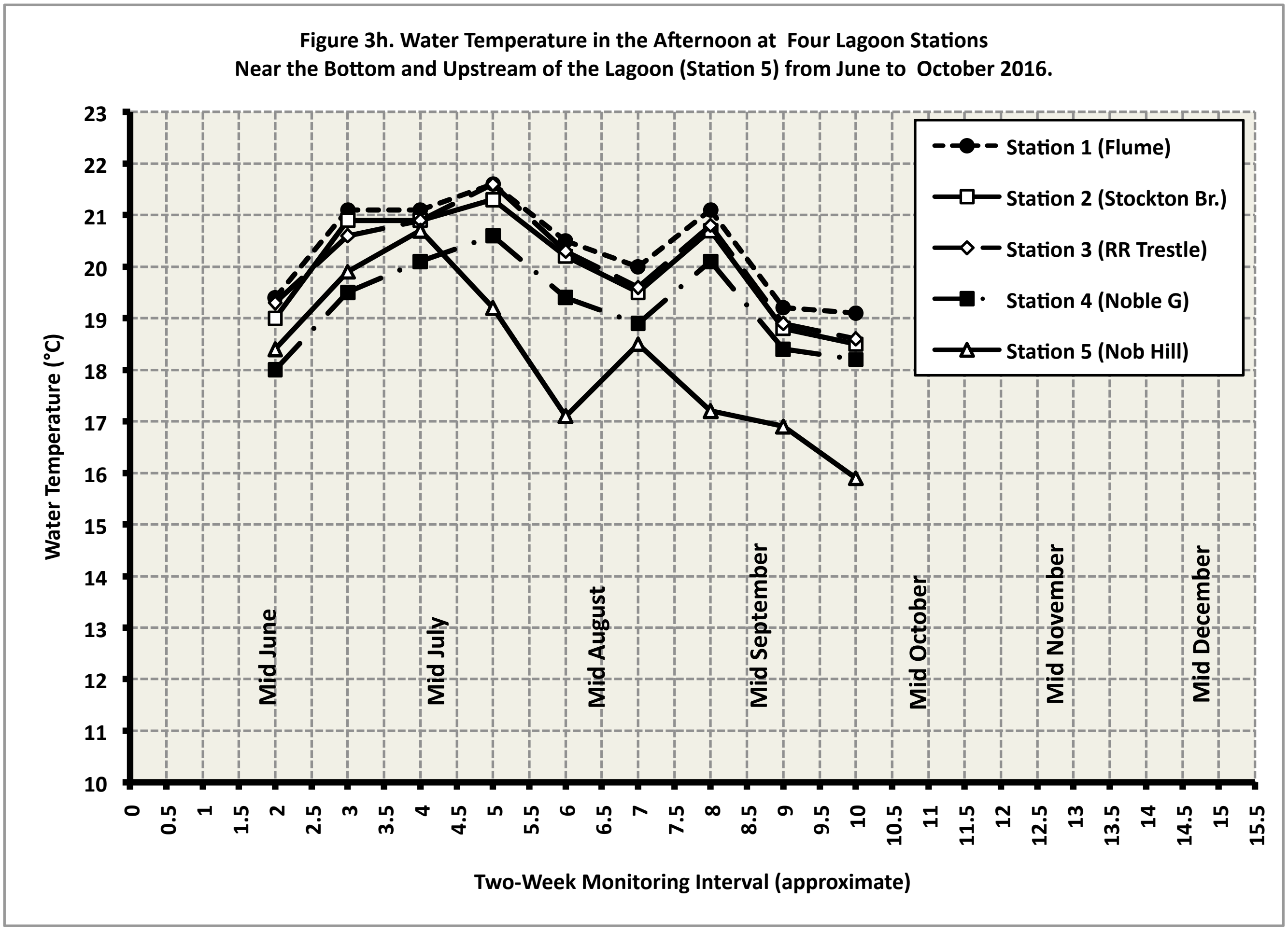

Figure 3h. Water Temperature in the Afternoon at Four Lagoon Stations Near the Bottom and Upstream from June to October 2016.

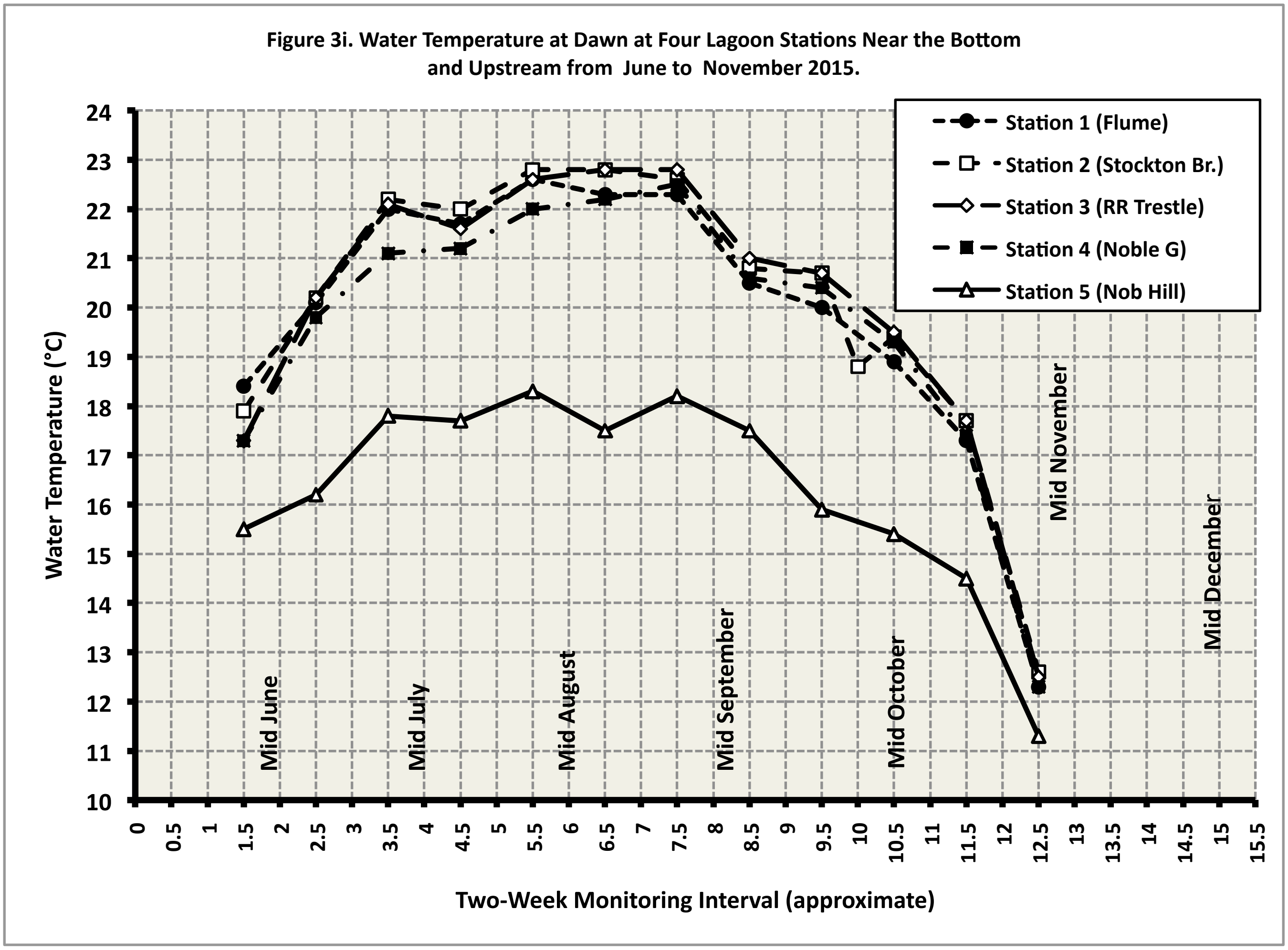

Figure 3i. Water Temperature at Dawn at Four Lagoon Stations Near the Bottom and Upstream from June to November 2015.

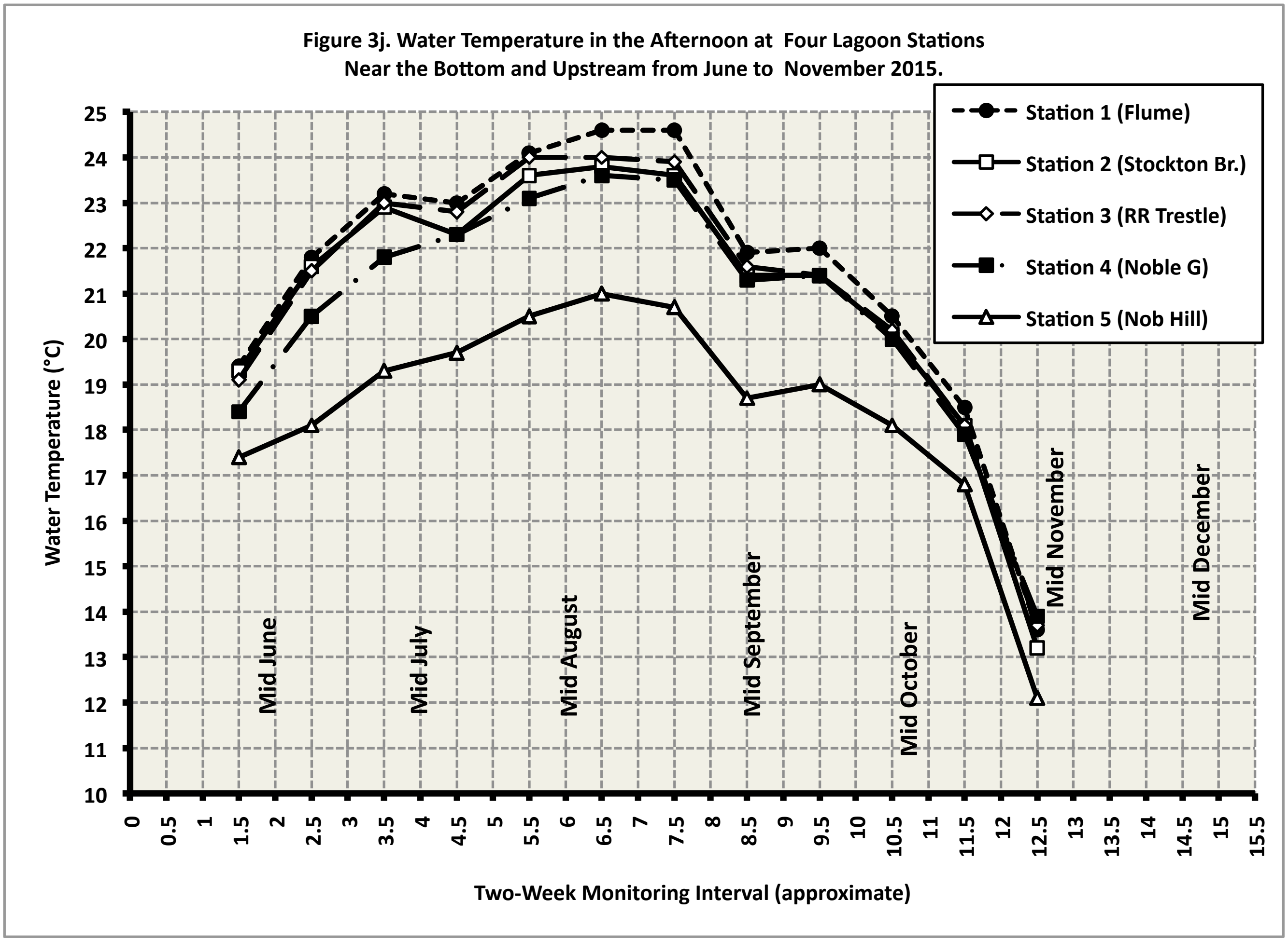

Figure 3j. Water Temperature in the Afternoon at Four Lagoon Stations Near the Bottom and Upstream from June to November 2015.

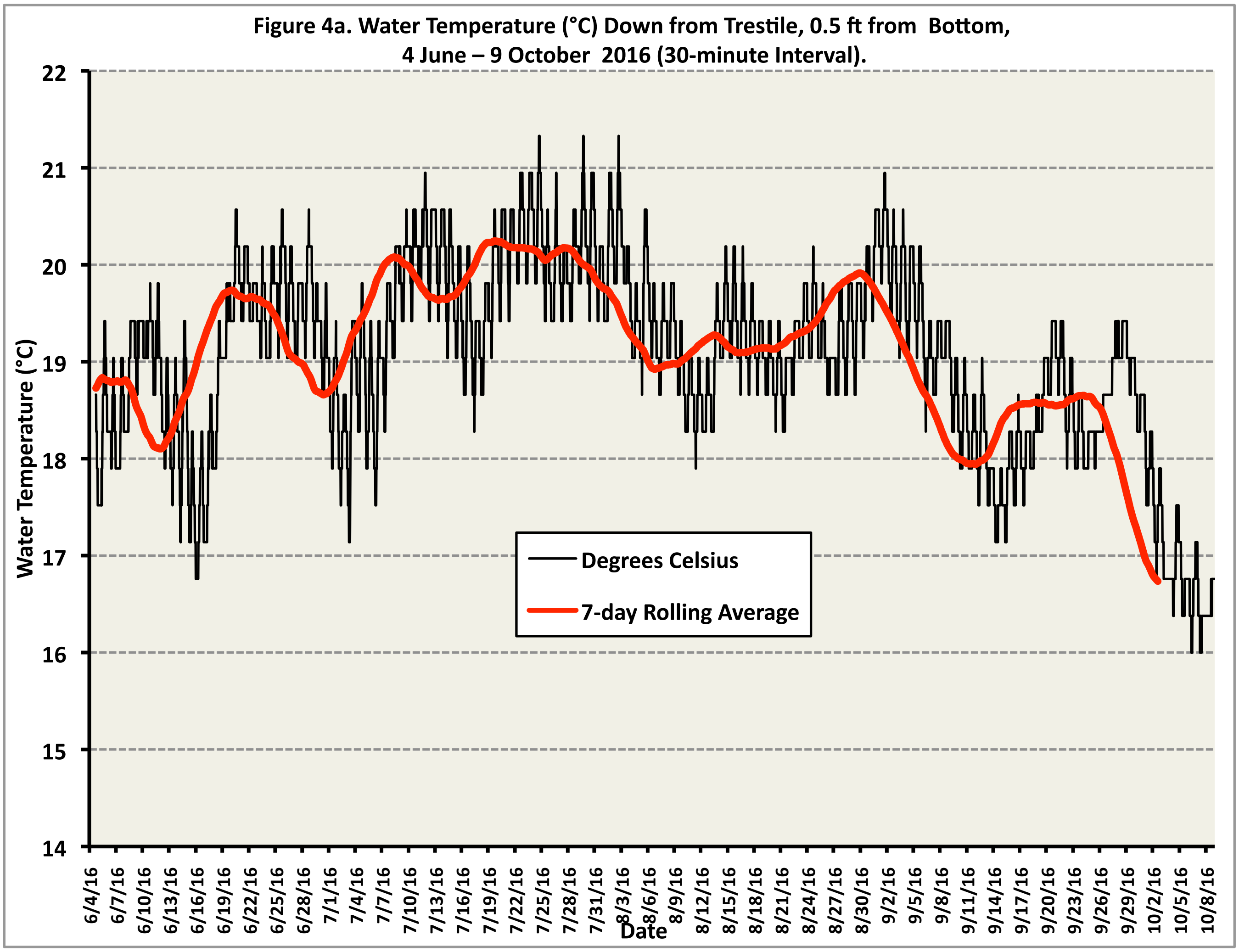

Figure 4a. Water Temperature (°C) Down from Trestile, 0.5 ft from Bottom,
4 June – 9 October 2016 (30-minute Interval).

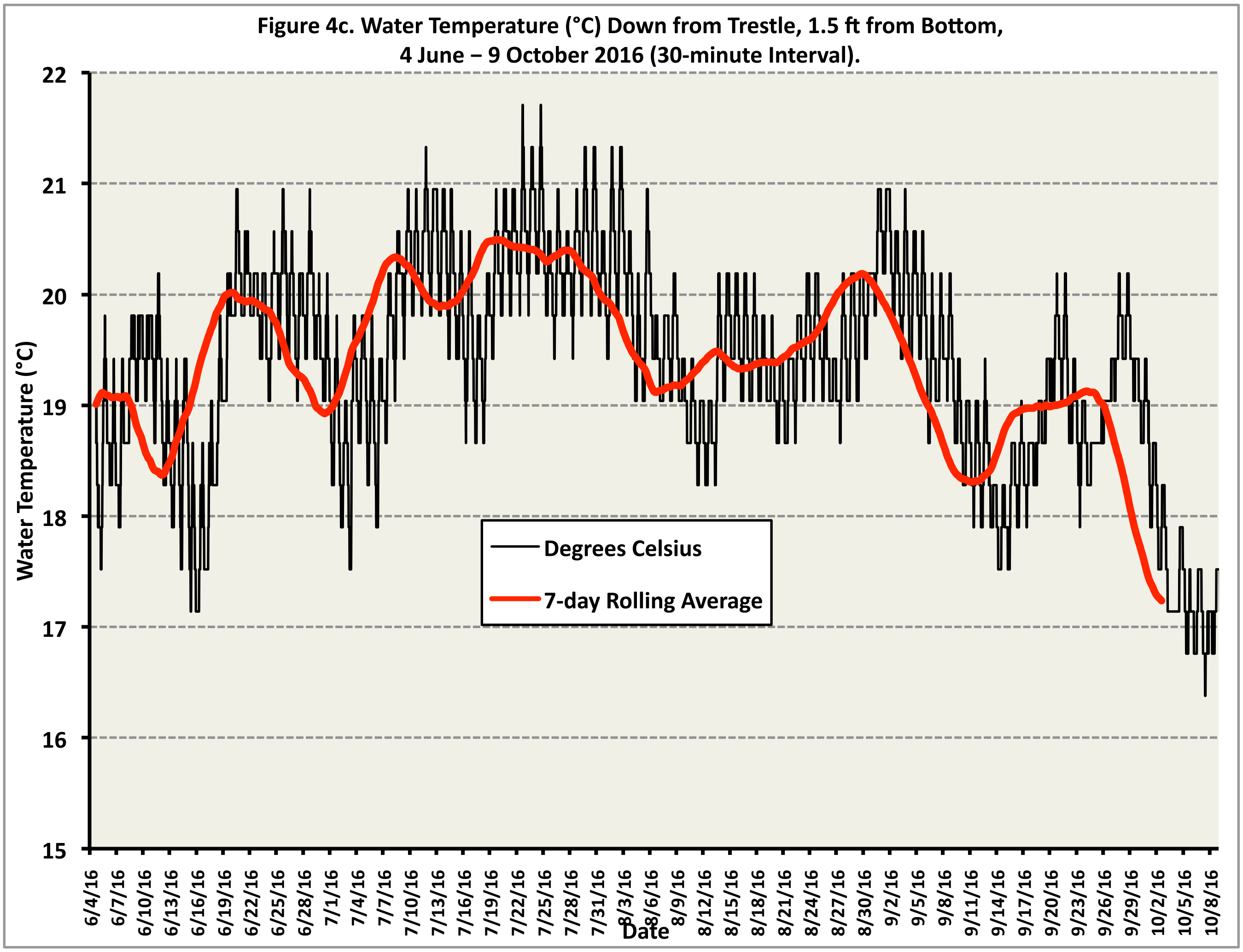

Figure 4b. Water Temperature (°C) Down from Trestle, 1.5 ft from Bottom, 4 June – 9 October 2016 (30-minute Interval).

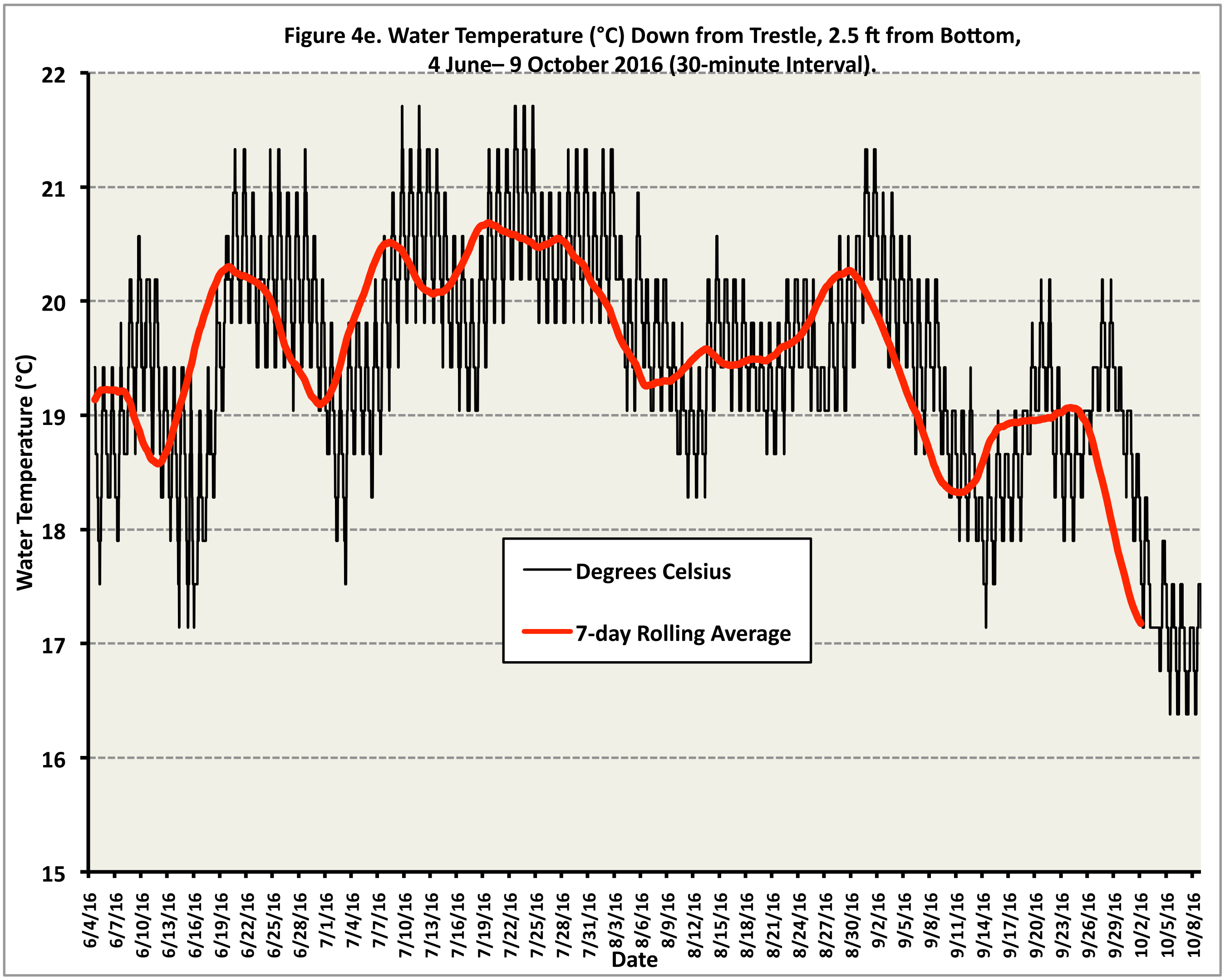

Figure 4c. Water Temperature (°C) Down from Trestle, 2.5 ft from Bottom, 4 June – 9 October 2016 (30-minute Interval).

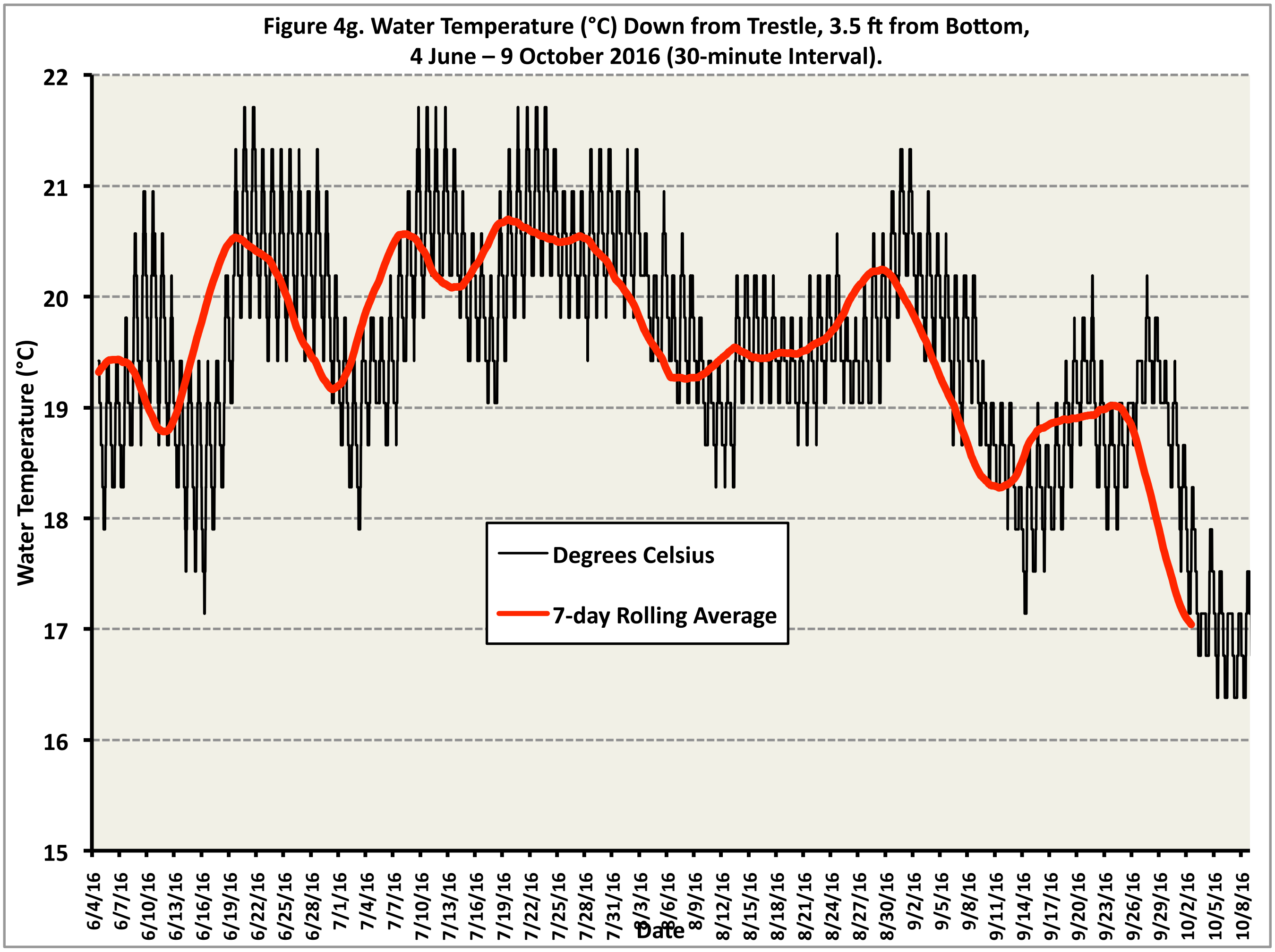

Figure 4d. Water Temperature (°C) Down from Trestle, 3.5 ft from Bottom, 4 June – 9 October 2016 (30-minute Interval).

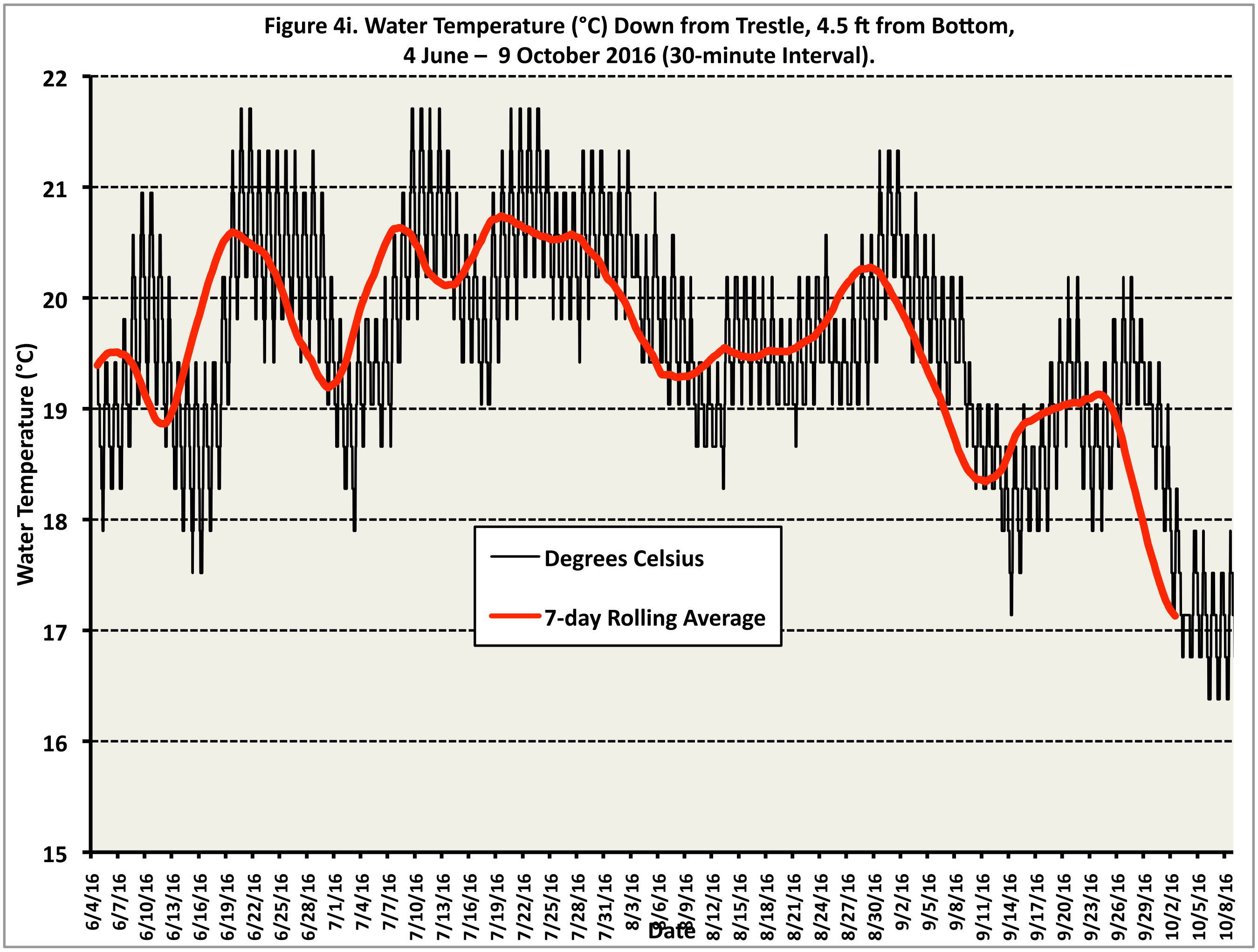

Figure 4e. Water Temperature (°C) Down from Trestle, 4.5 ft from Bottom, 4 June – 9 October 2016 (30-minute Interval).

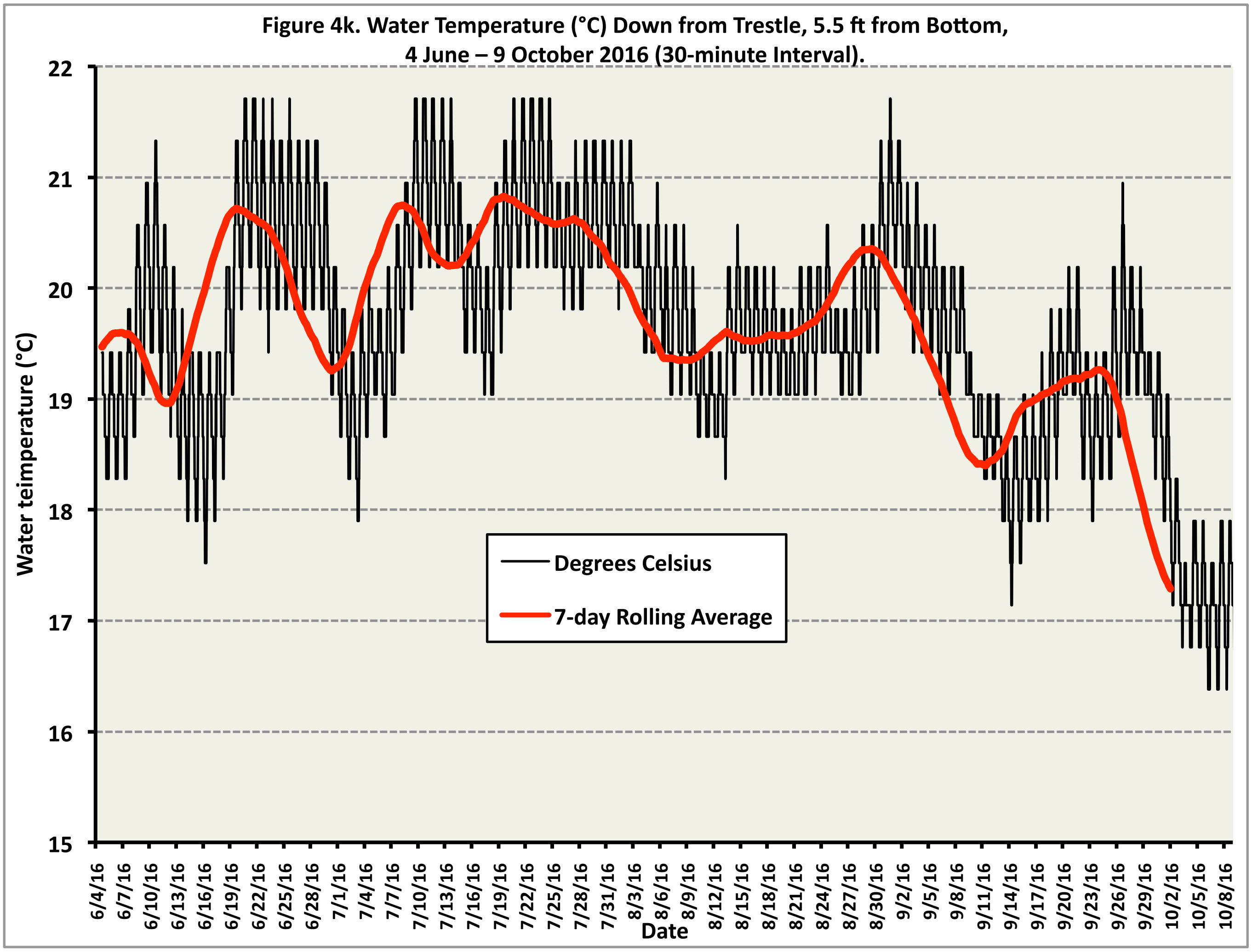

Figure 4f. Water Temperature (°C) Down from Trestle, 5.5 ft from Bottom, 4 June – 9 October 2016 (30-minute Interval).

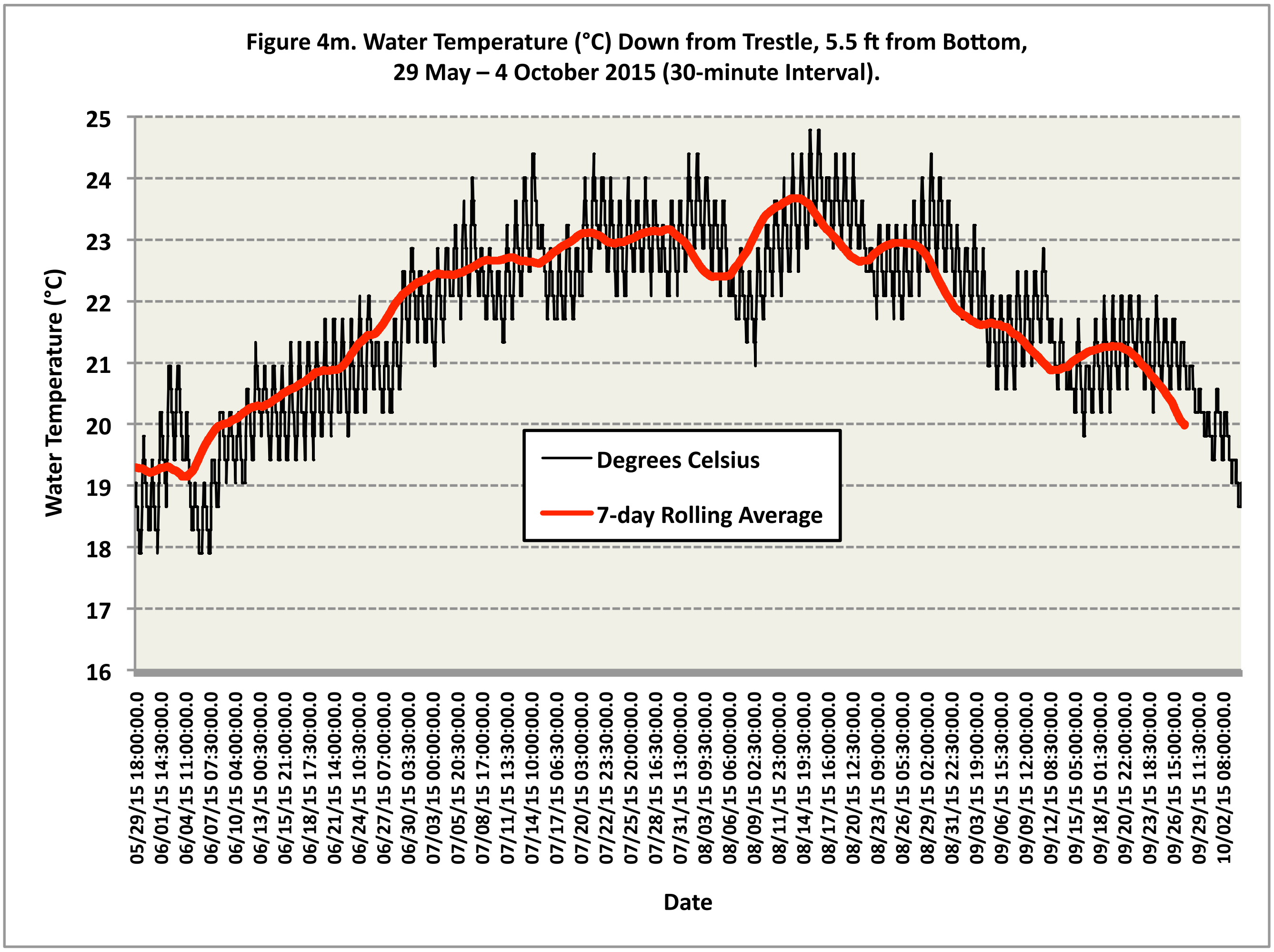

Figure 4g. Water Temperature (°C) Down from Trestle, 5.5 ft from Bottom, 29 May – 4 October 2015 (30-minute Interval).

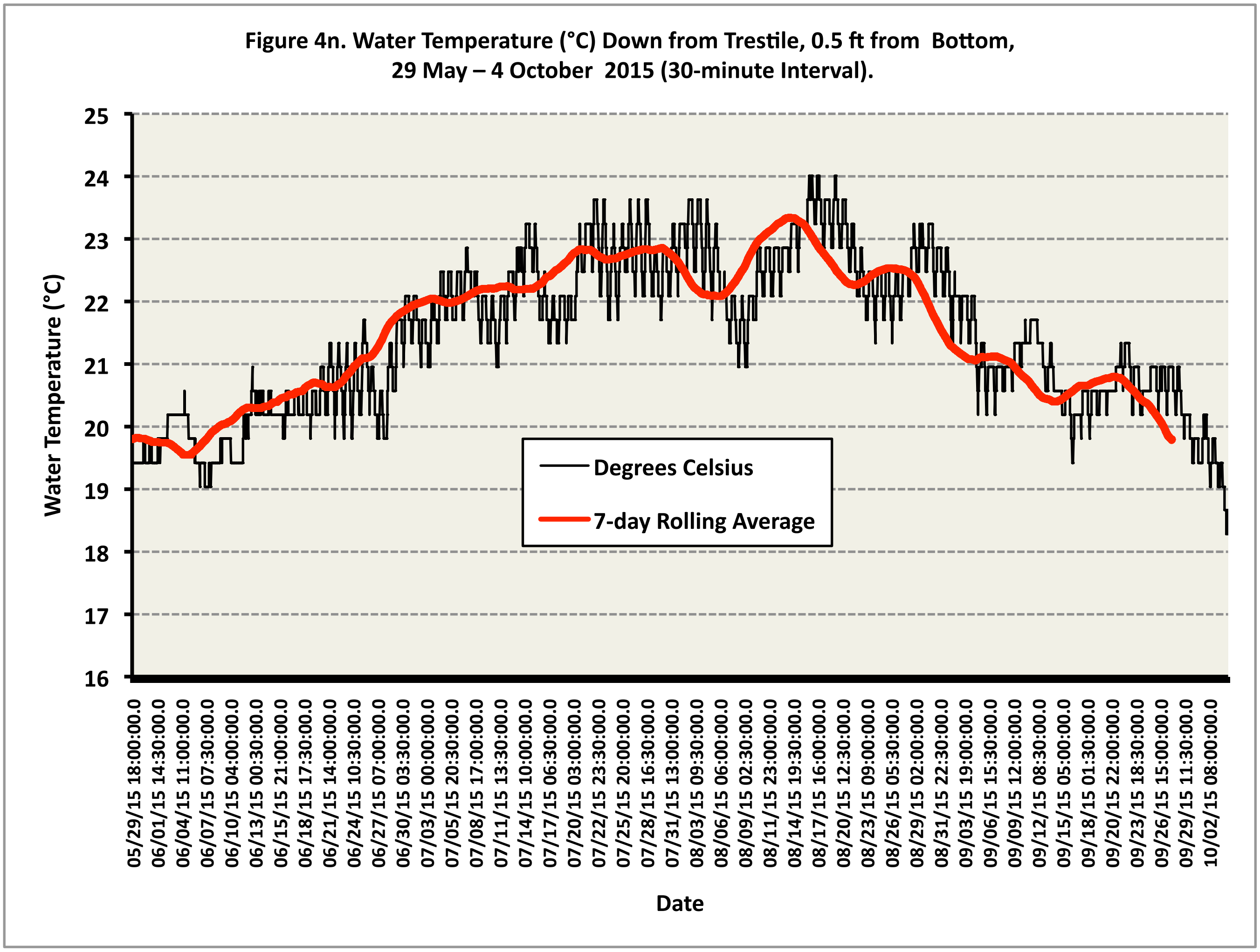

Figure 4h. Water Temperature (°C) Down from Trestile, 0.5 ft from Bottom,
29 May – 4 October 2015 (30-minute Interval).

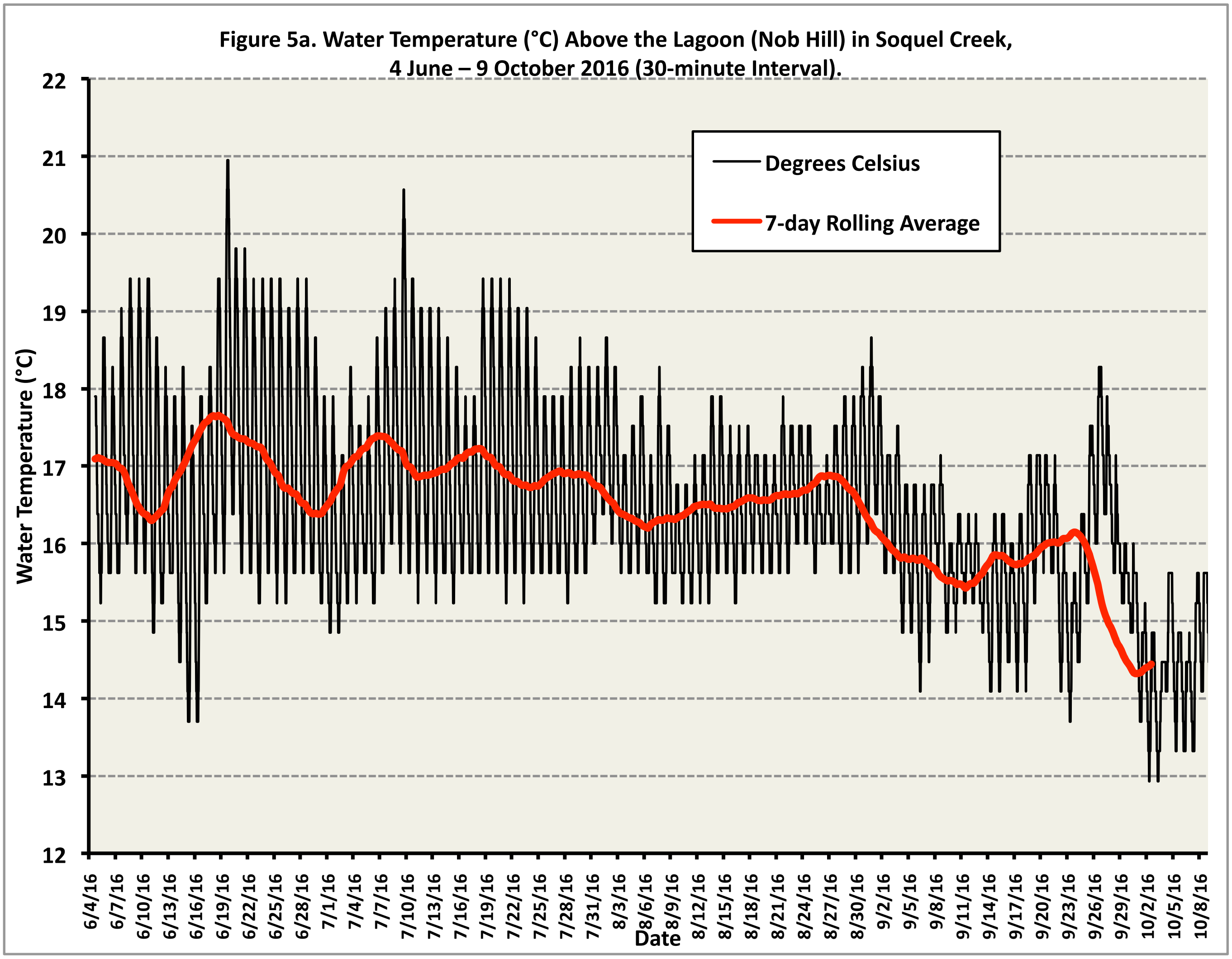

Figure 5a. Water Temperature (°C) Above the Lagoon (Nob Hill) in Soquel Creek, 4 June – 9 October 2016 (30-minute Interval).

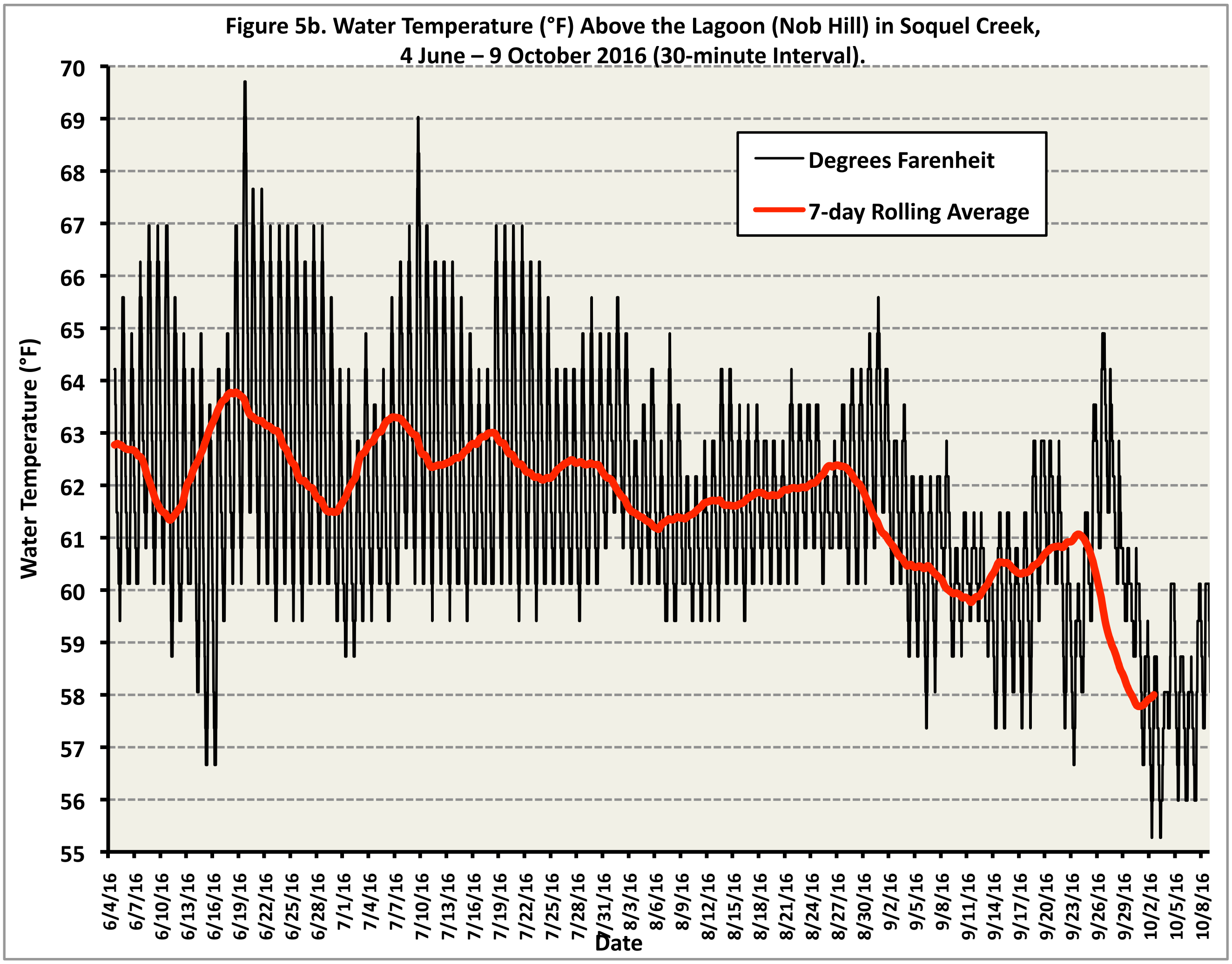

Figure 5b. Water Temperature (°F) Above the Lagoon (Nob Hill) in Soquel Creek, 4 June – 9 October 2016 (30-minute Interval).

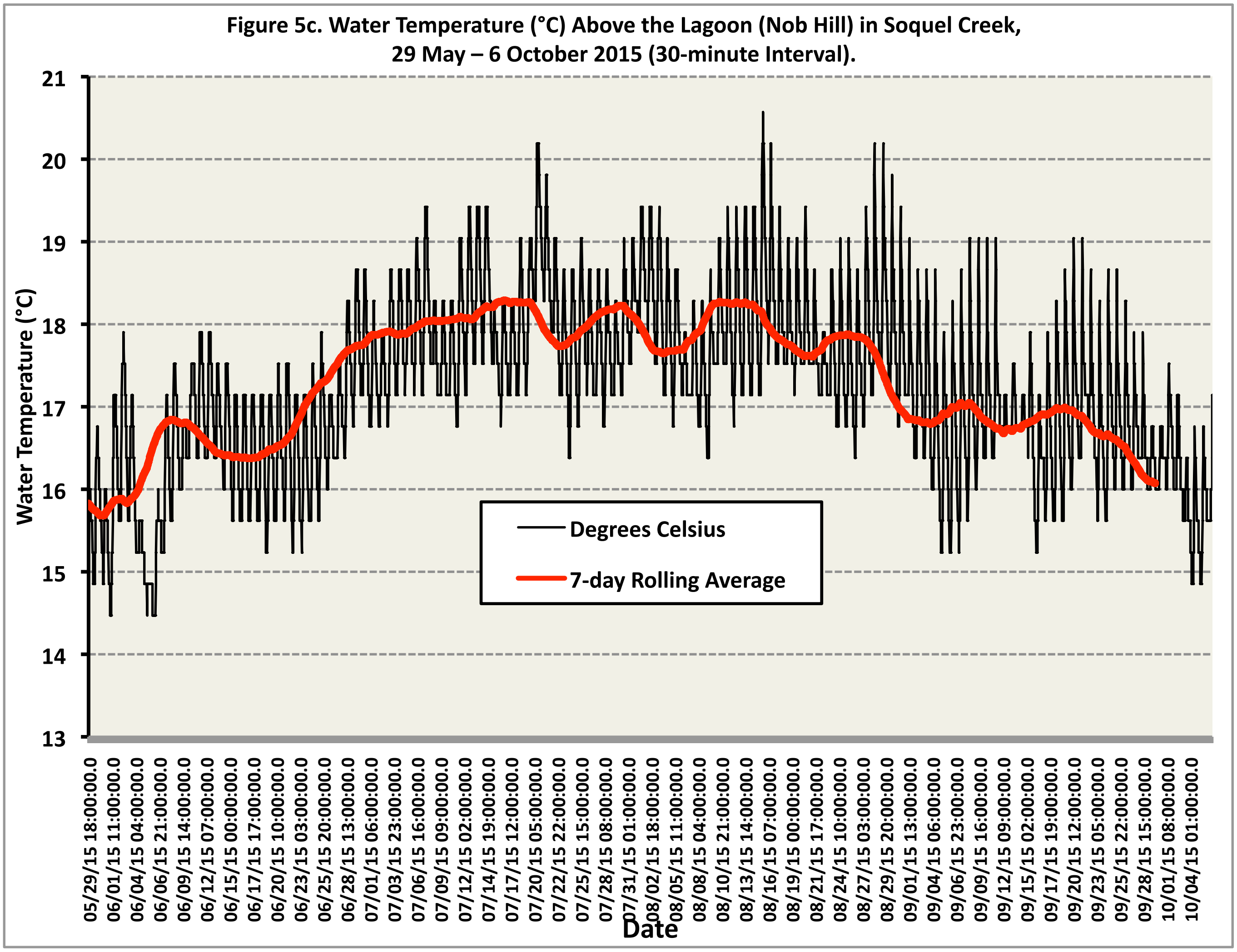

Figure 5c. Water Temperature (°C) Above the Lagoon (Nob Hill) in Soquel Creek, 29 May – 4 October 2015 (30-minute Interval).

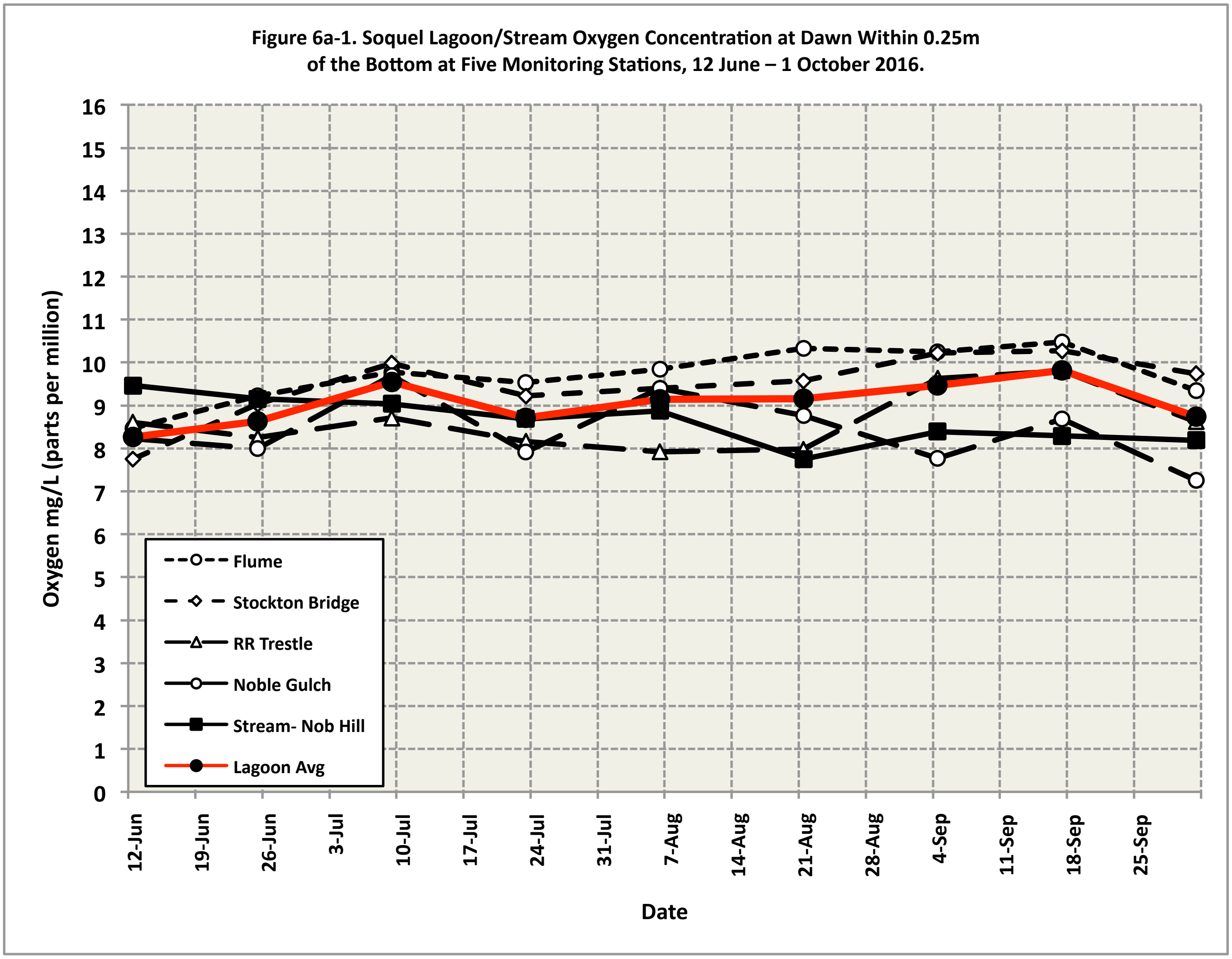

Figure 6a-1. Soquel Lagoon/Stream Oxygen Concentration at Dawn Within 0.25m of the Bottom at Five Monitoring Stations, 12 June – 1 October 2016.

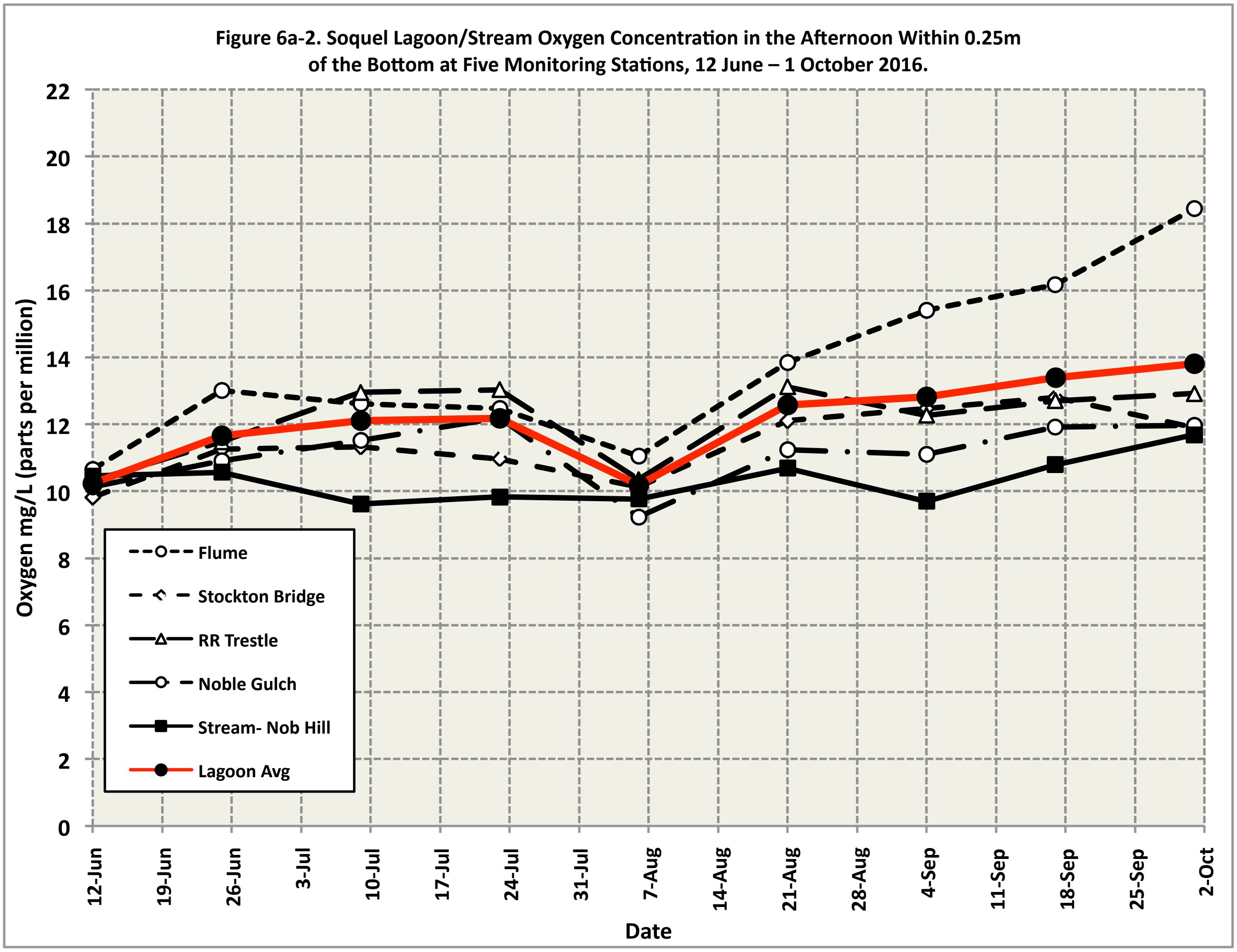

Figure 6a-2. Soquel Lagoon/Stream Oxygen Concentration in the Afternoon Within 0.25m of the Bottom at Five Monitoring Stations, 7 June – 7 November 2015.

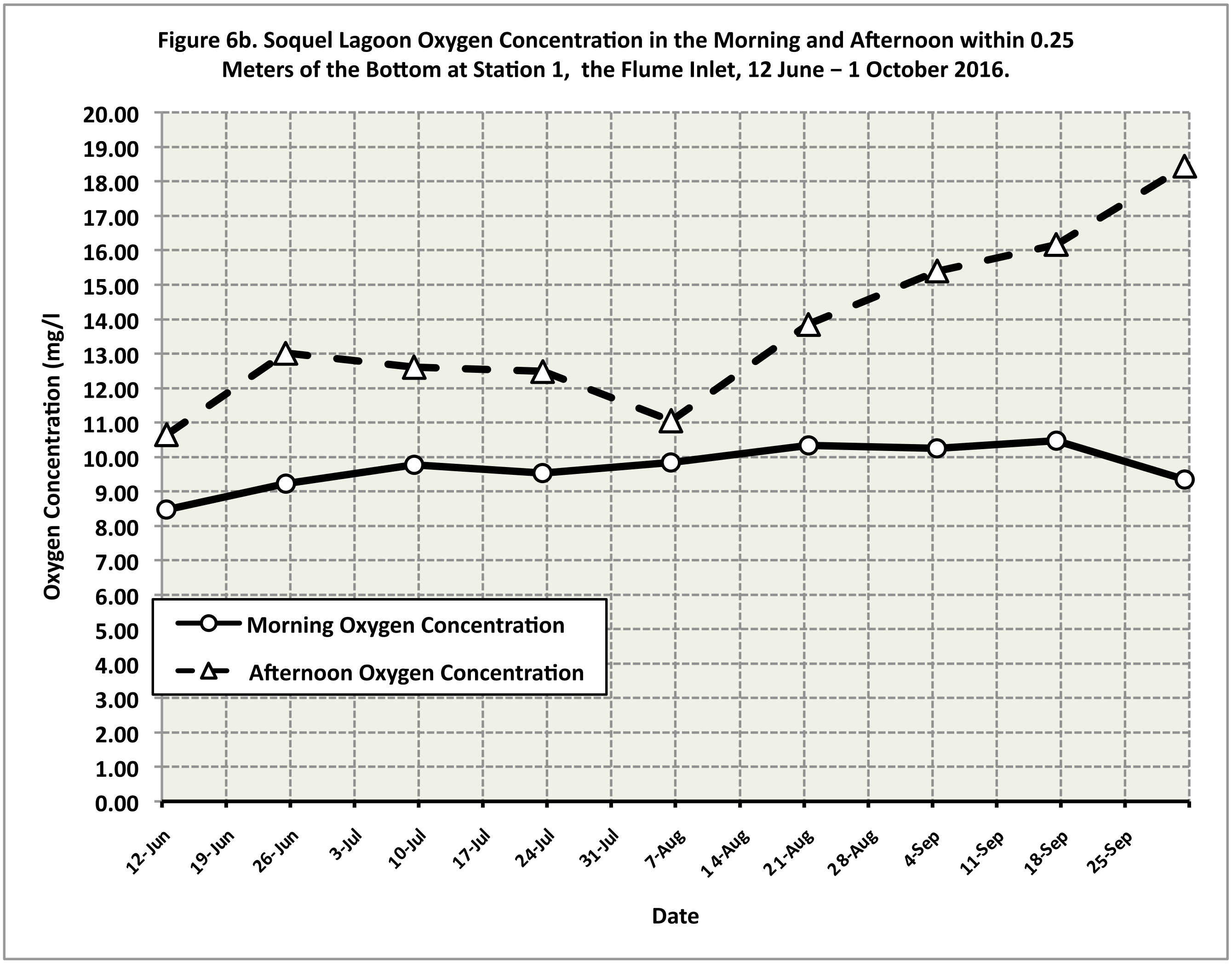

Figure 6b. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 1, the Flume Inlet, 7 June – 7 November 2015.

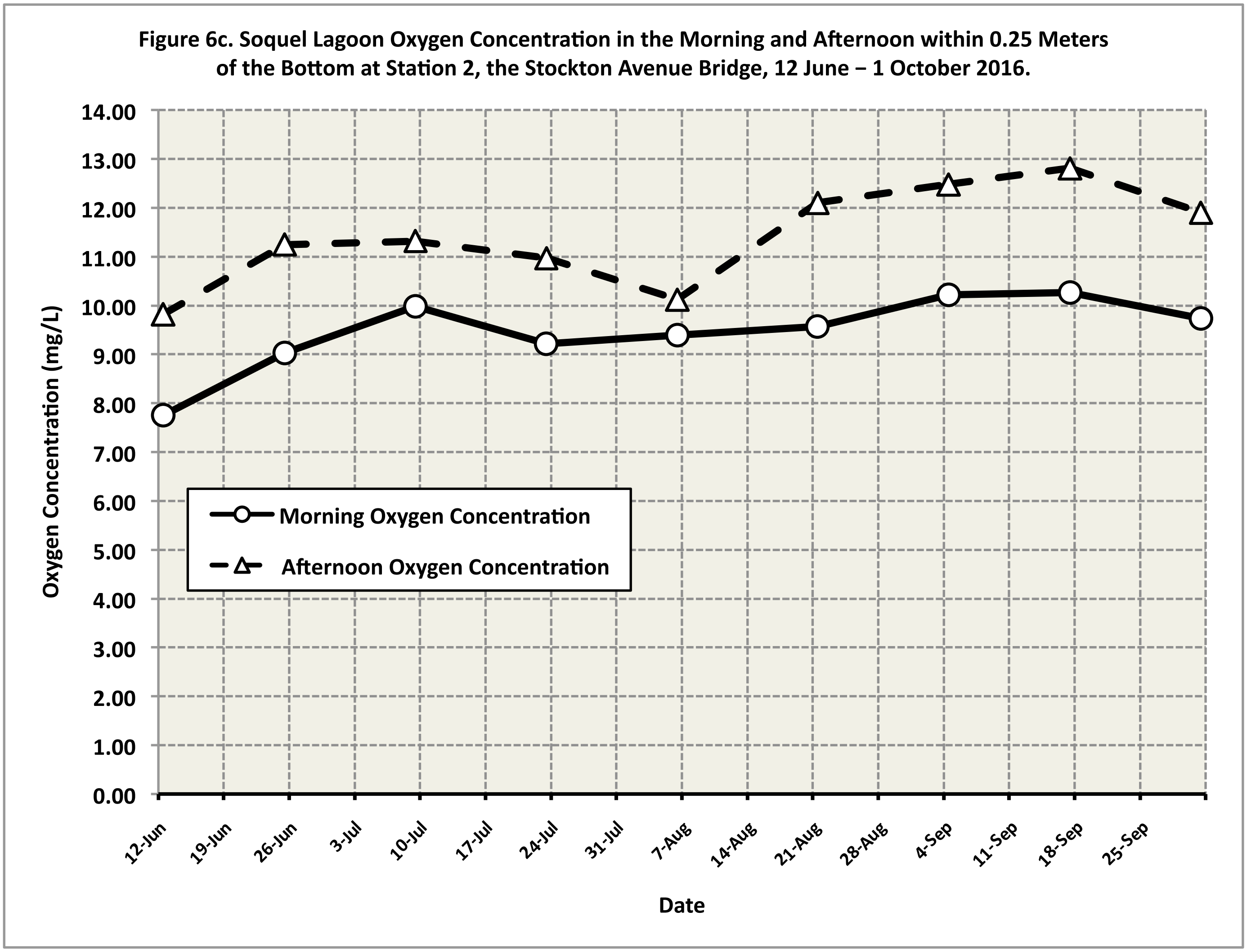

Figure 6c. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 2, the Stockton Avenue Bridge, 12 June – 1 October 2016.

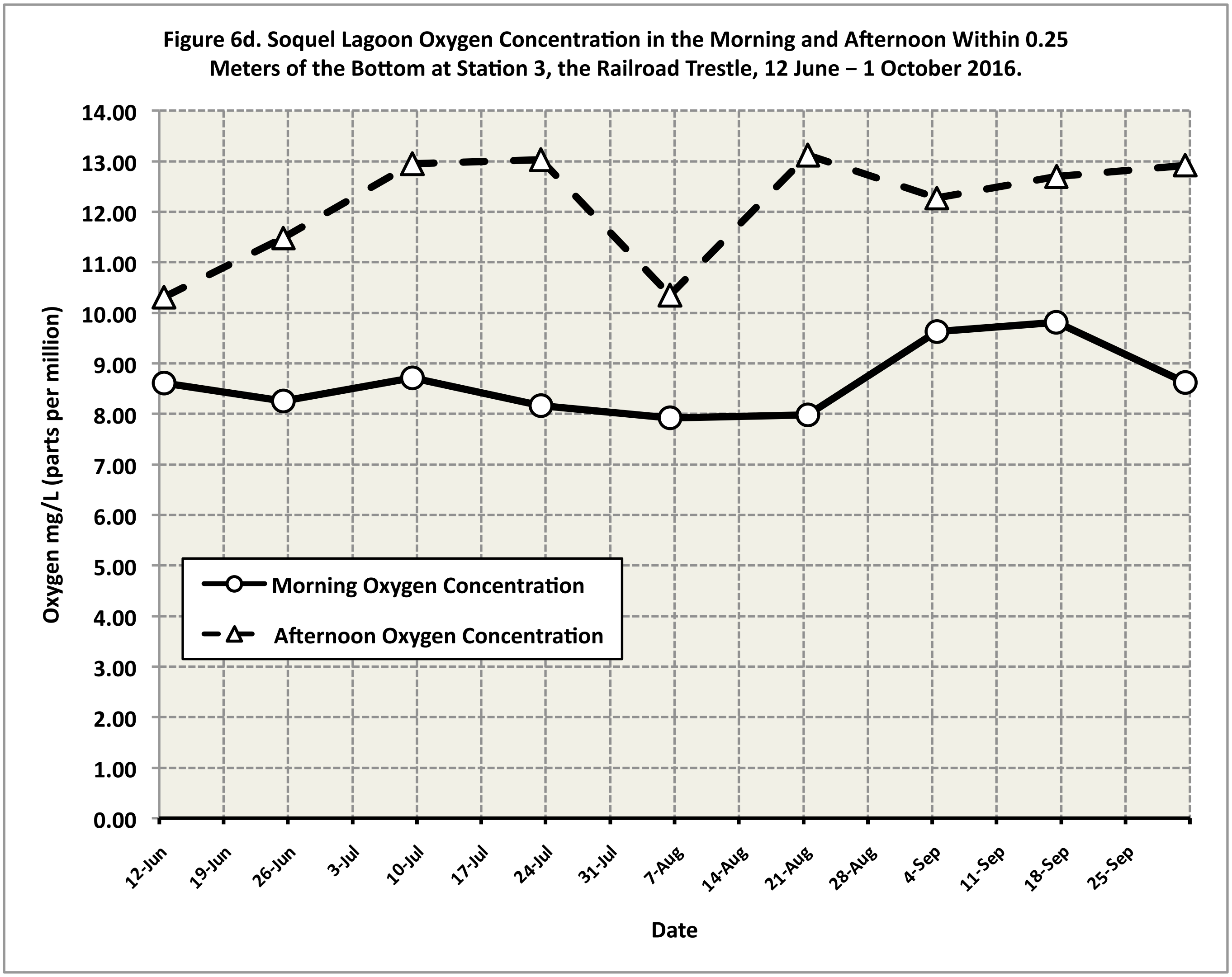

Figure 6d. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon Within 0.25 Meters of the Bottom at Station 3, the Railroad Trestle, 12 June – 1 October 2016.

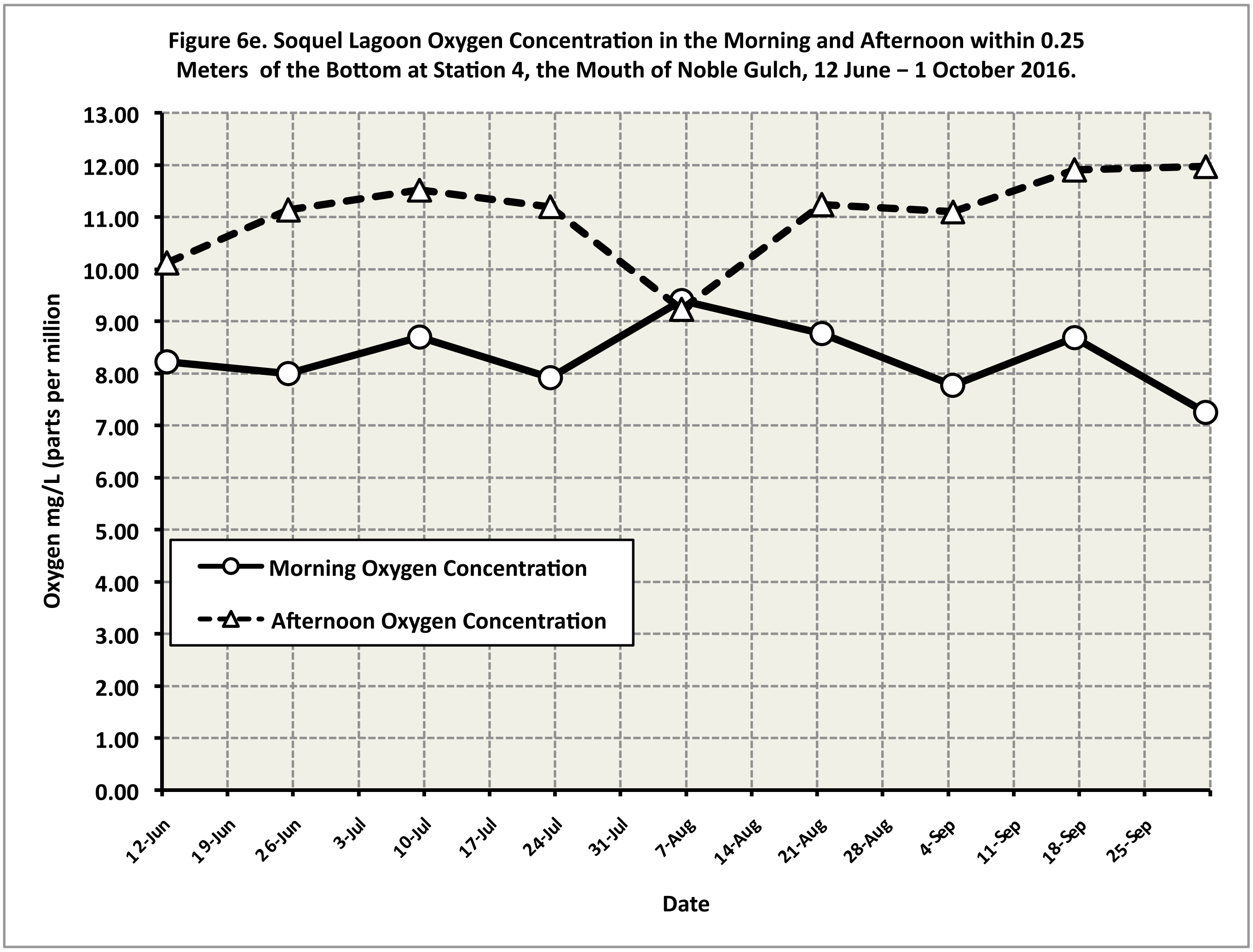

Figure 6e. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 4, the Mouth of Noble Gulch, 12 June – 1 October 2016.

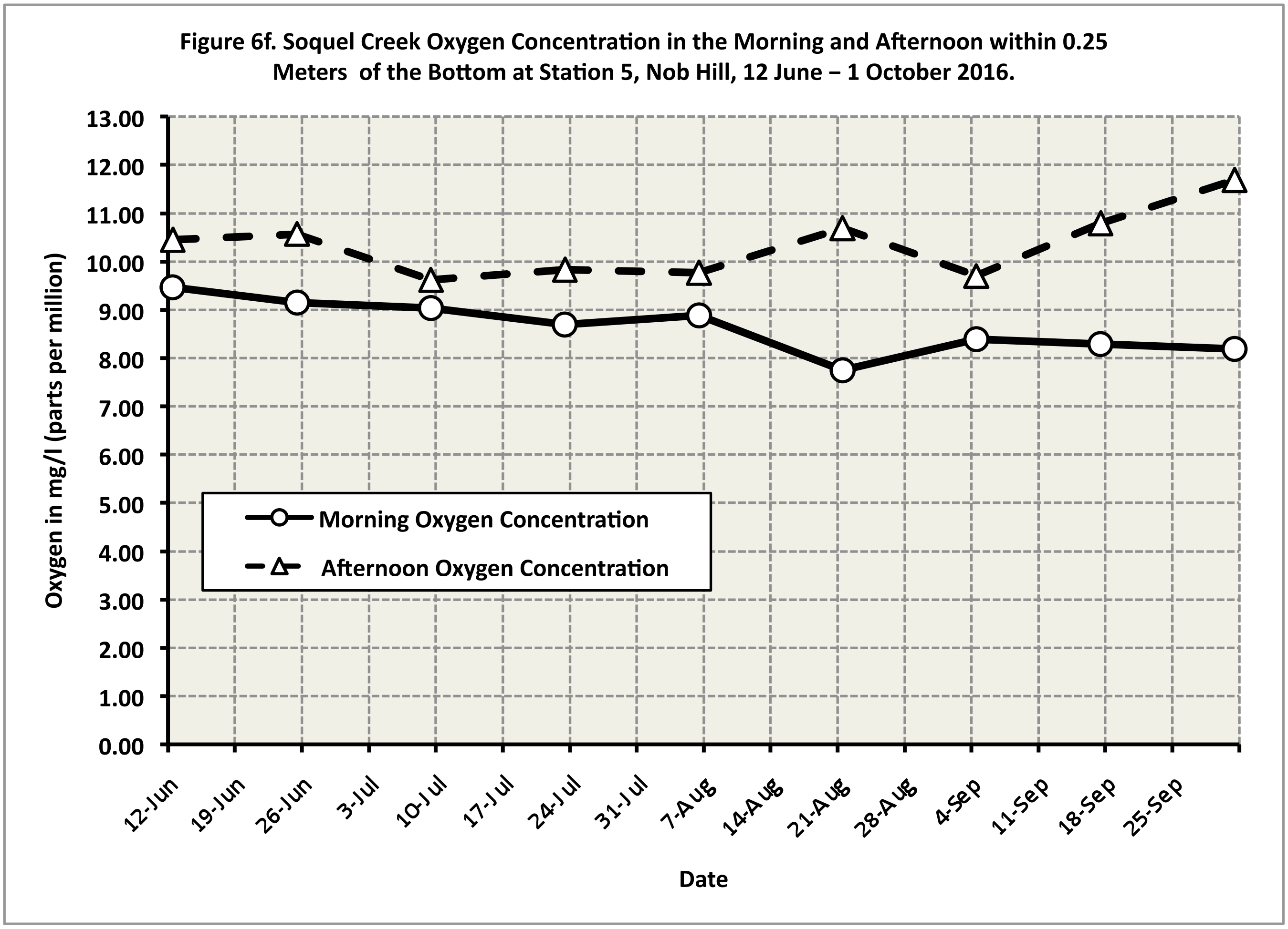

Figure 6f. Soquel Creek Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 5, Nob Hill, 12 June – 1 October 2016.

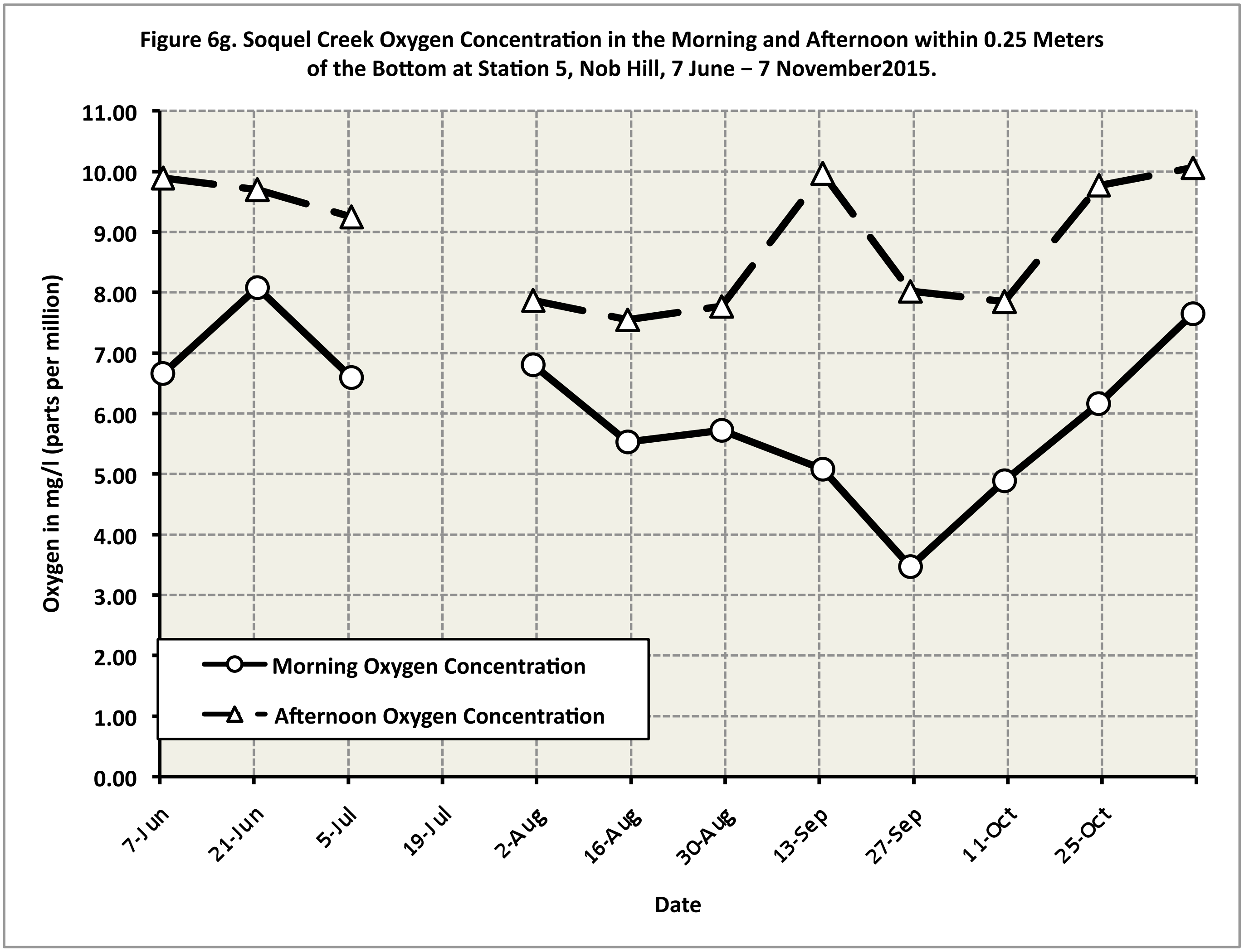

Figure 6g. Soquel Creek Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 5, Nob Hill, 7 June – 7 November 2015.

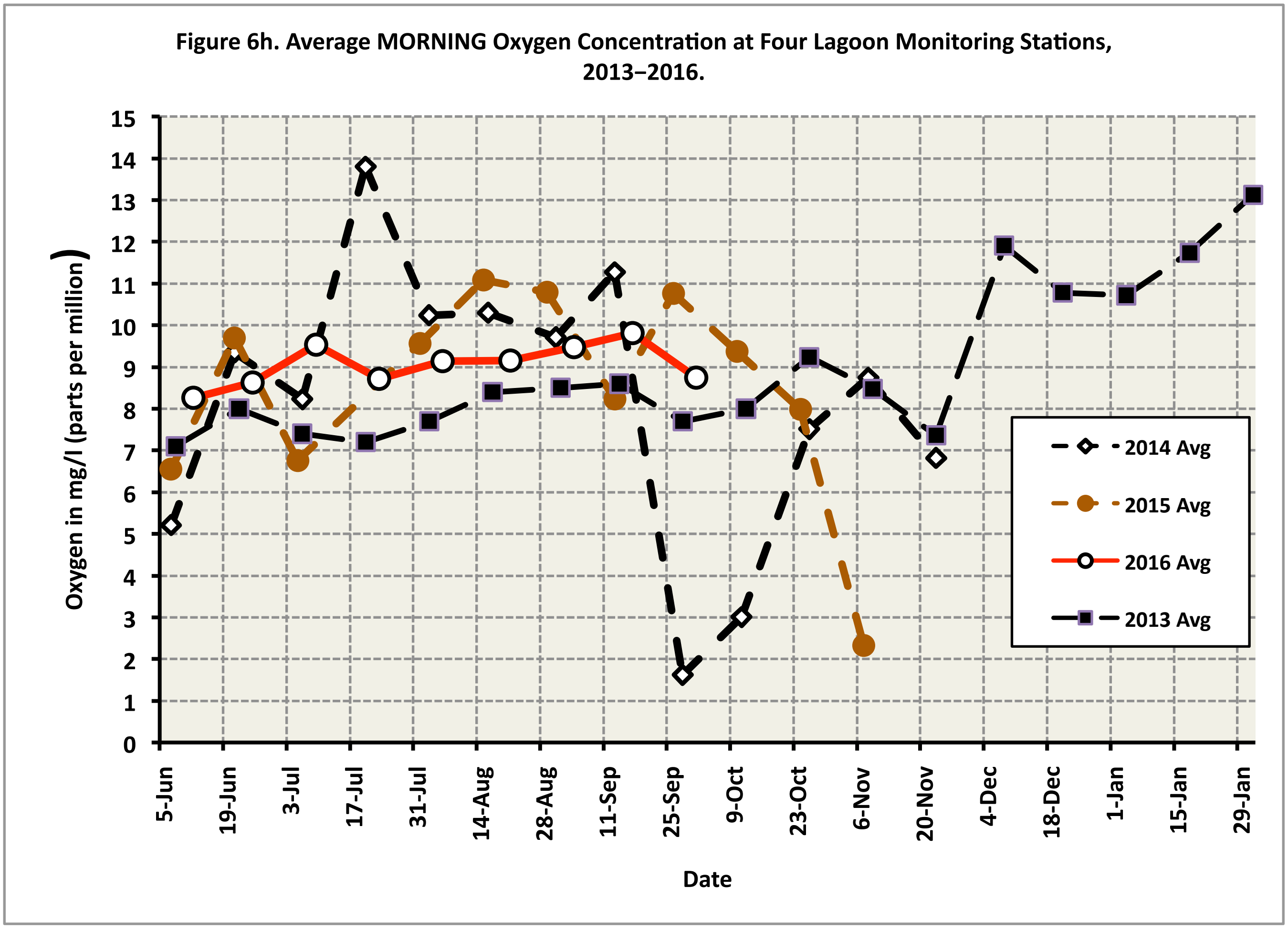

Figure 6h. Average MORNING Oxygen Concentration at Four Lagoon Monitoring Stations, 2013−2016.

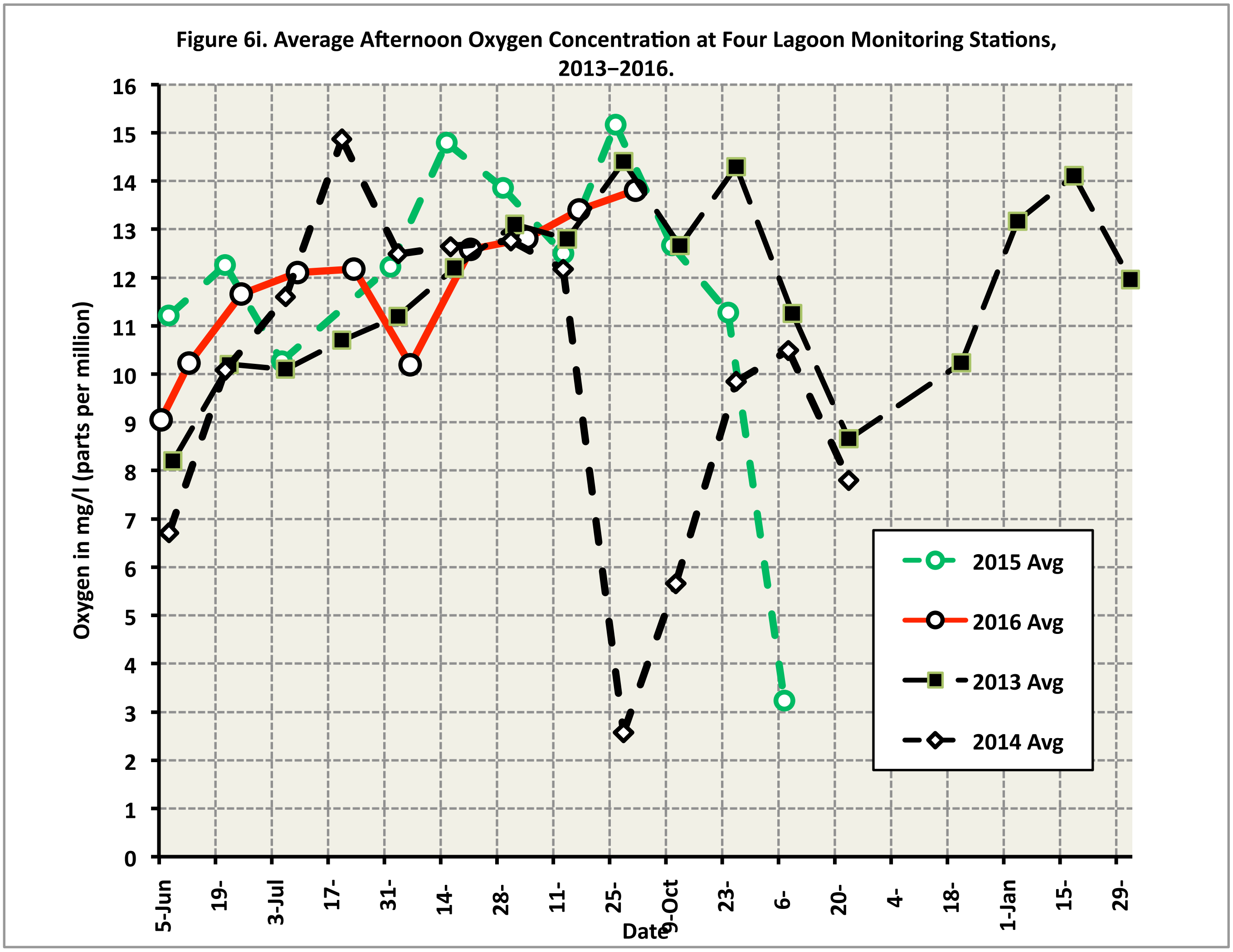

Figure 6i. Average AFTERNOON Oxygen Concentration at Four Lagoon Monitoring Stations, 2013−2016.

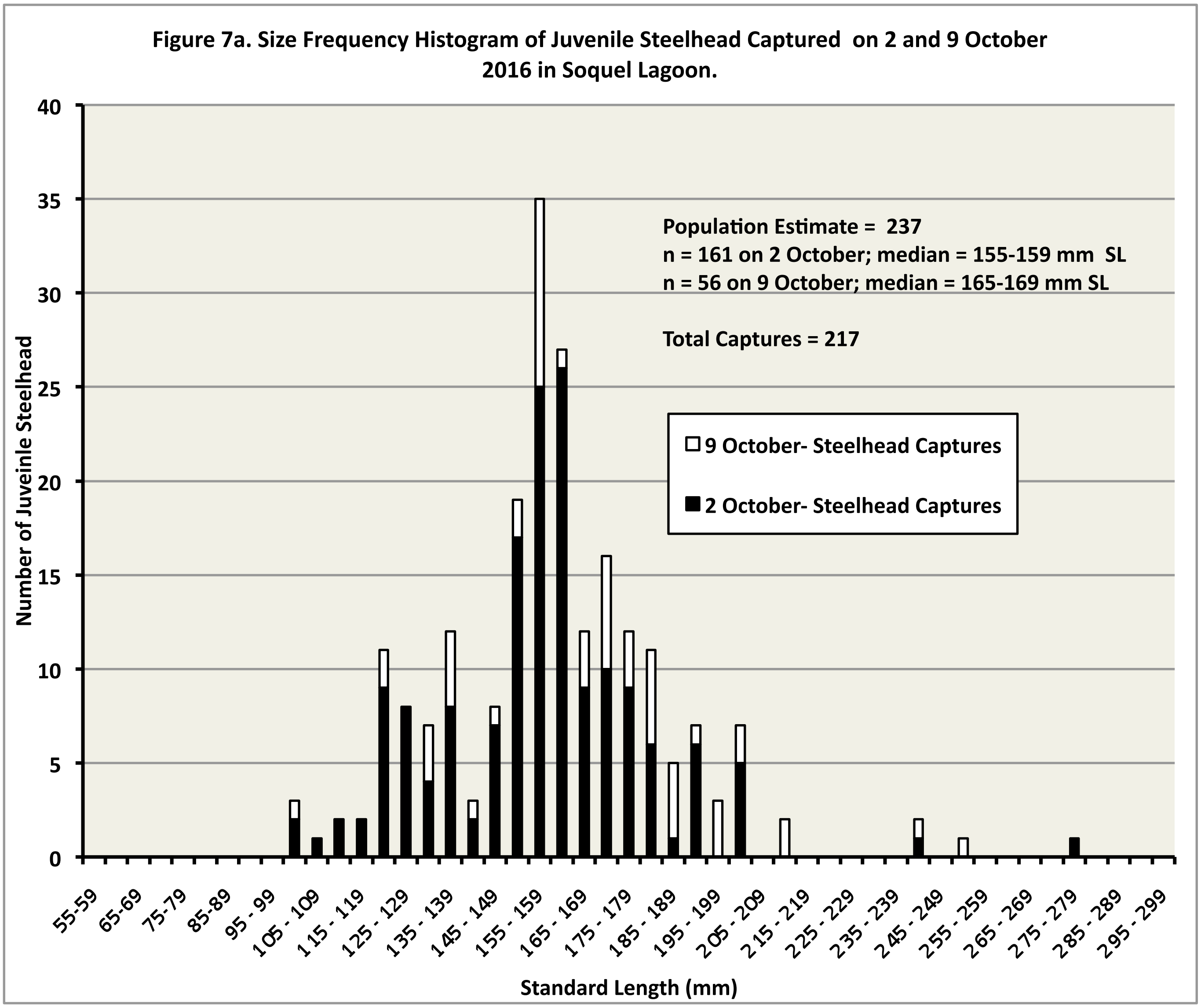

Figure 7a. Size Frequency Histogram of Juvenile Steelhead Captured on 2 and 9 October 2016 in Soquel Lagoon.

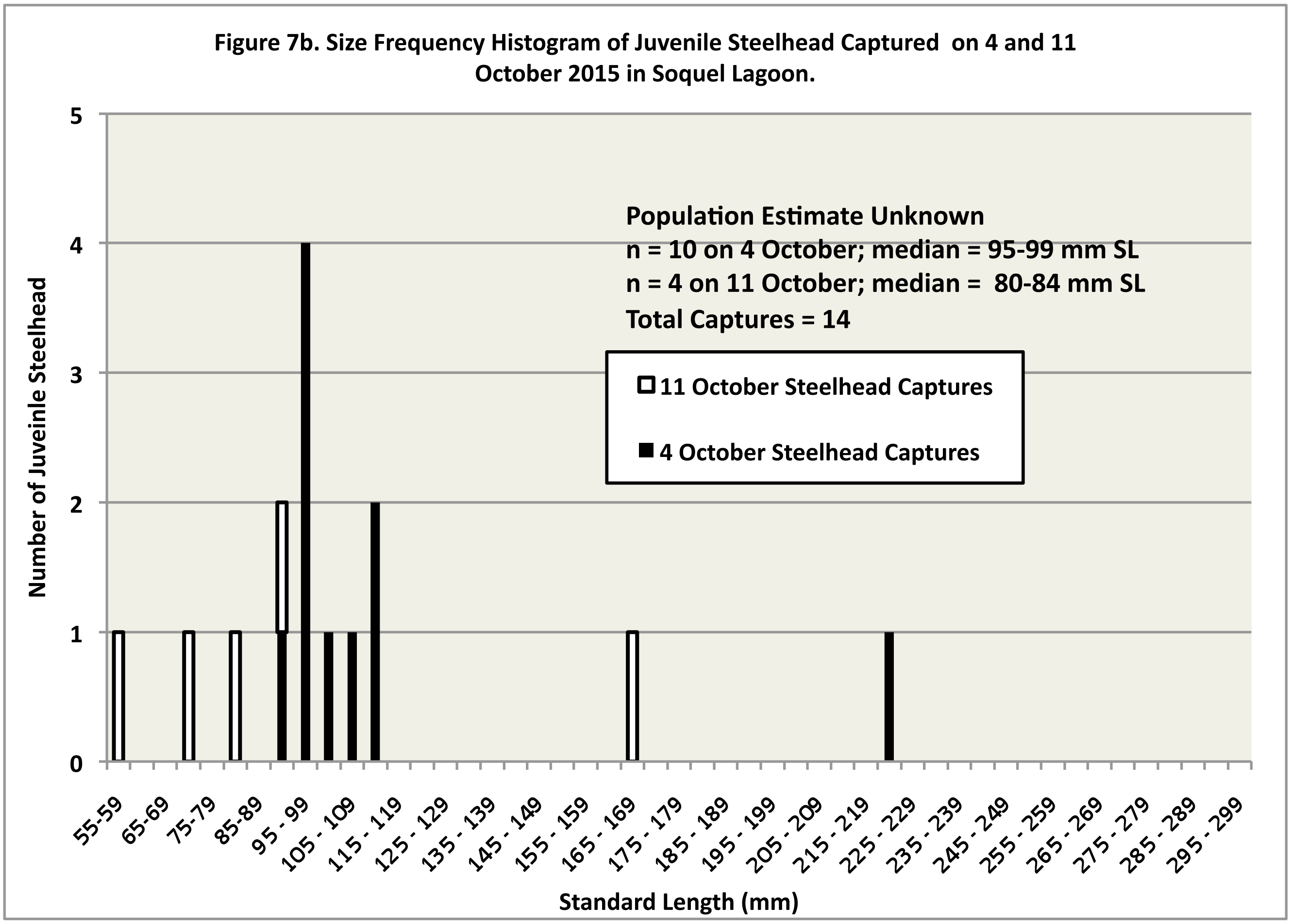

Figure 7b. Size Frequency Histogram of Juvenile Steelhead Captured on 4 and 11 October 2015 in Soquel Lagoon.

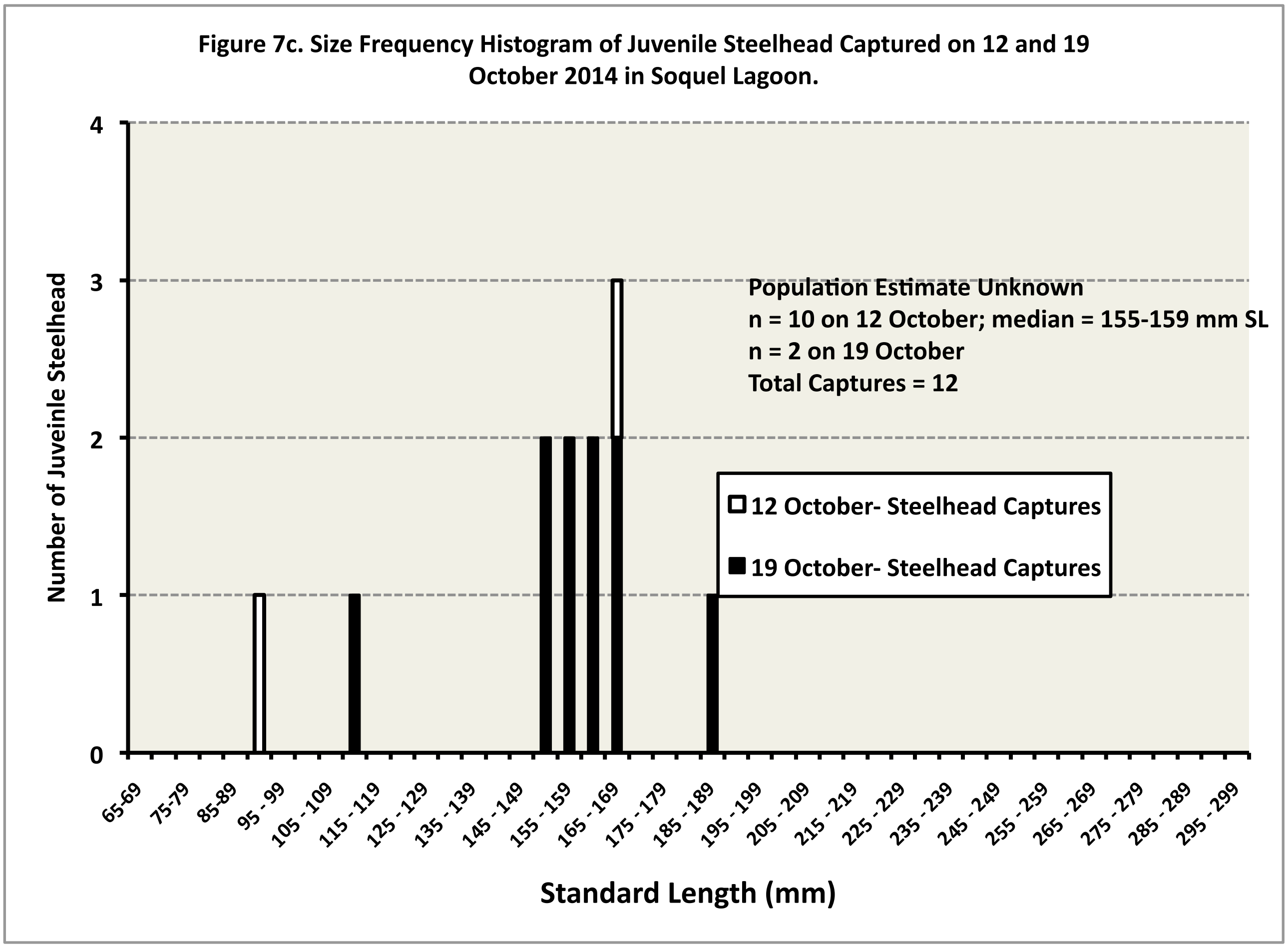

Figure 7c. Size Frequency Histogram of Juvenile Steelhead Captured on 12 and 19 October 2014 in Soquel Lagoon.

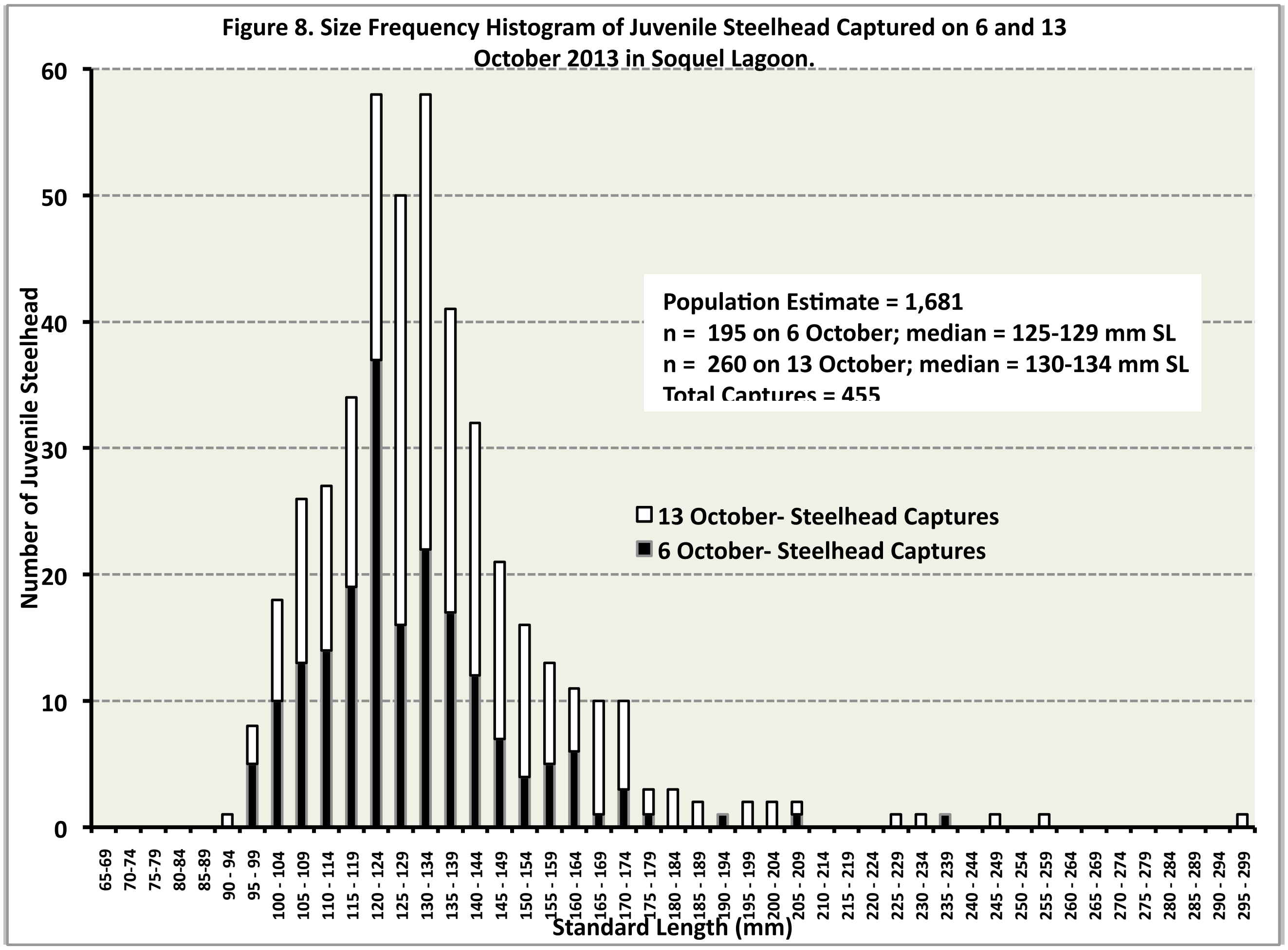

Figure 8. Size Frequency Histogram of Juvenile Steelhead Captured on 6 and 13 October 2013 in Soquel Lagoon.

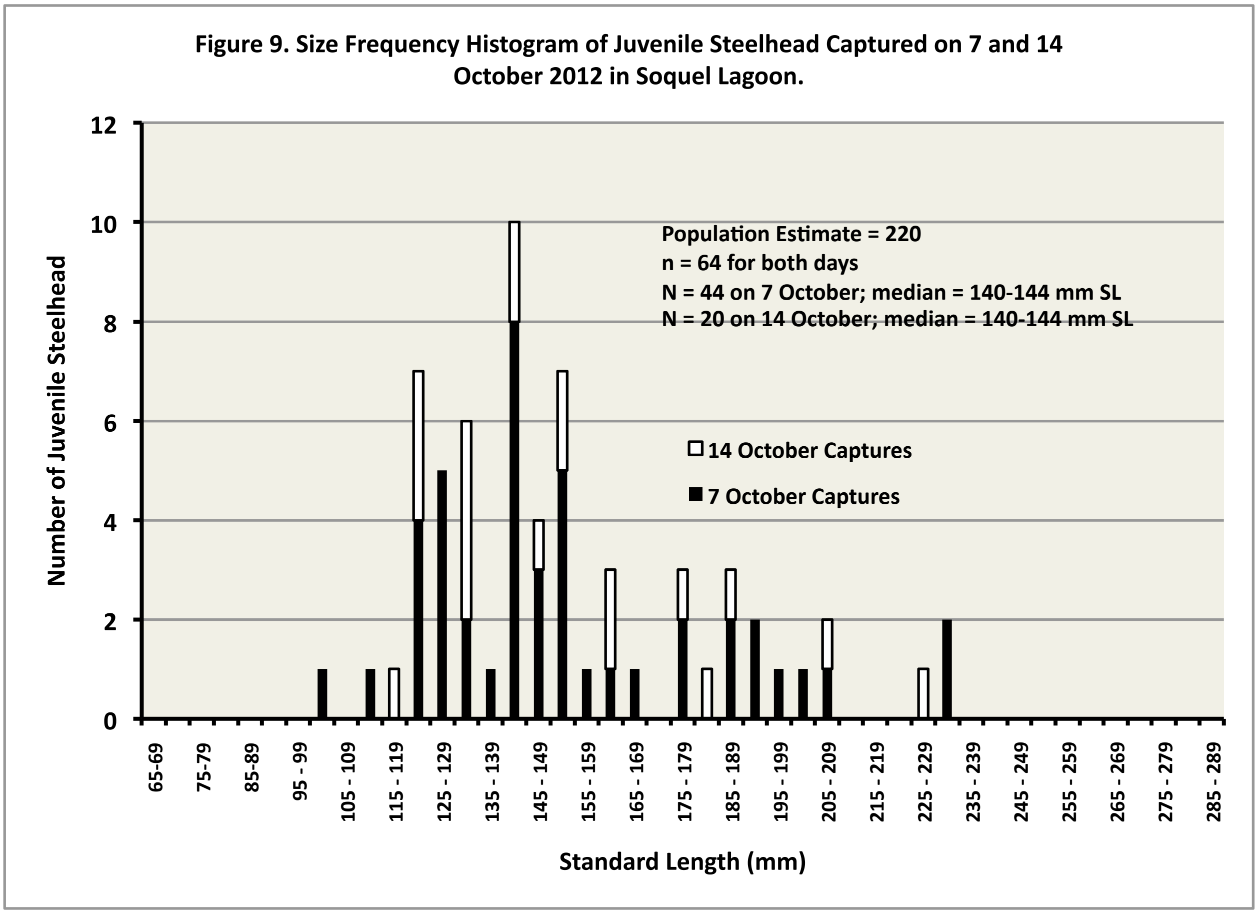

Figure 9. Size Frequency Histogram of Juvenile Steelhead Captured on 7 and 14 October 2012 in Soquel Lagoon.

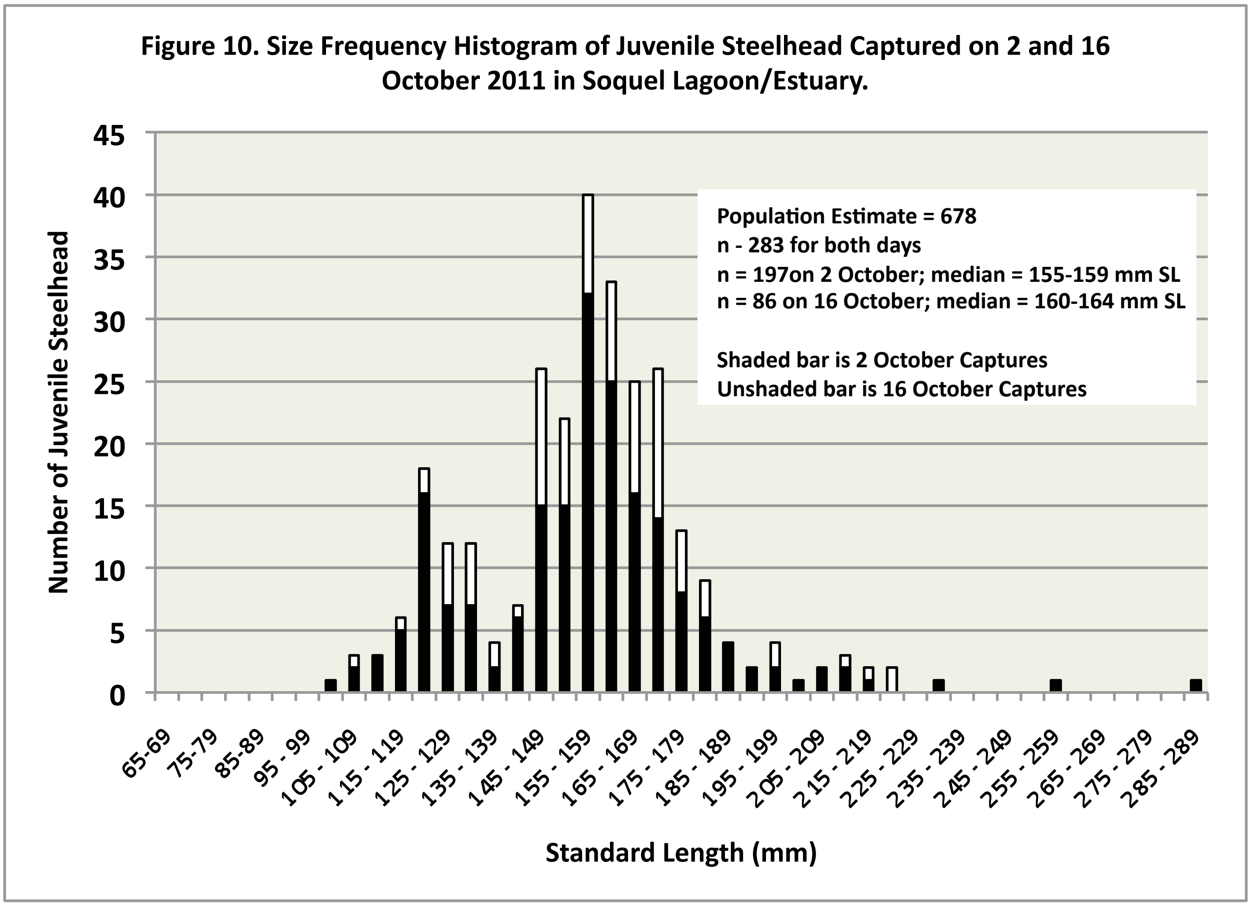

Figure 10. Size Frequency Histogram of Juvenile Steelhead Captured on 2 and 16 October 2011 in Soquel Lagoon/Estuary.

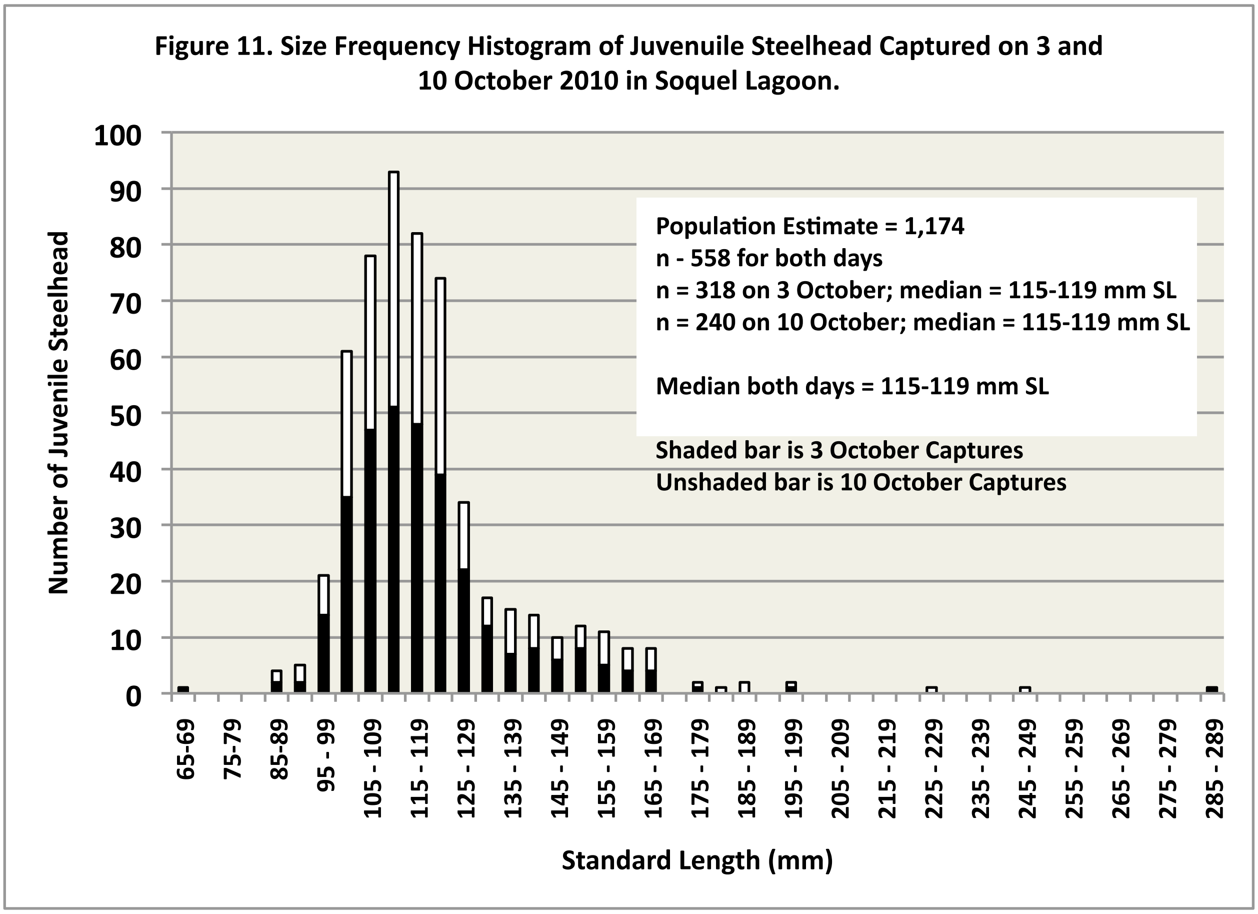

Figure 11. Size Frequency Histogram of Juvenuile Steelhead Captured on 3 and 10 October 2010 in Soquel Lagoon.

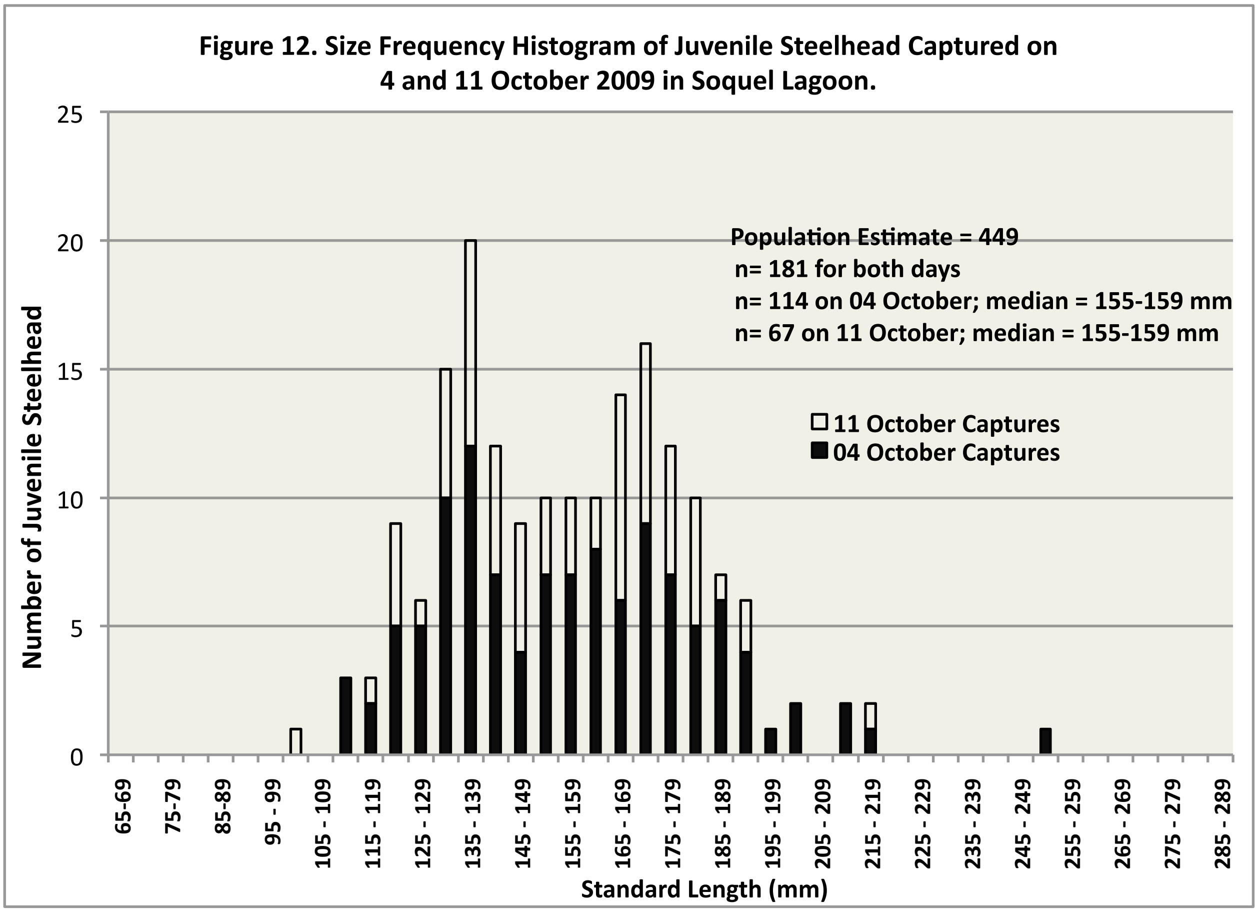

Figure 12. Size Frequency Histogram of Juvenile Steelhead Captured on 4 and 11 October 2009 in Soquel Lagoon.

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

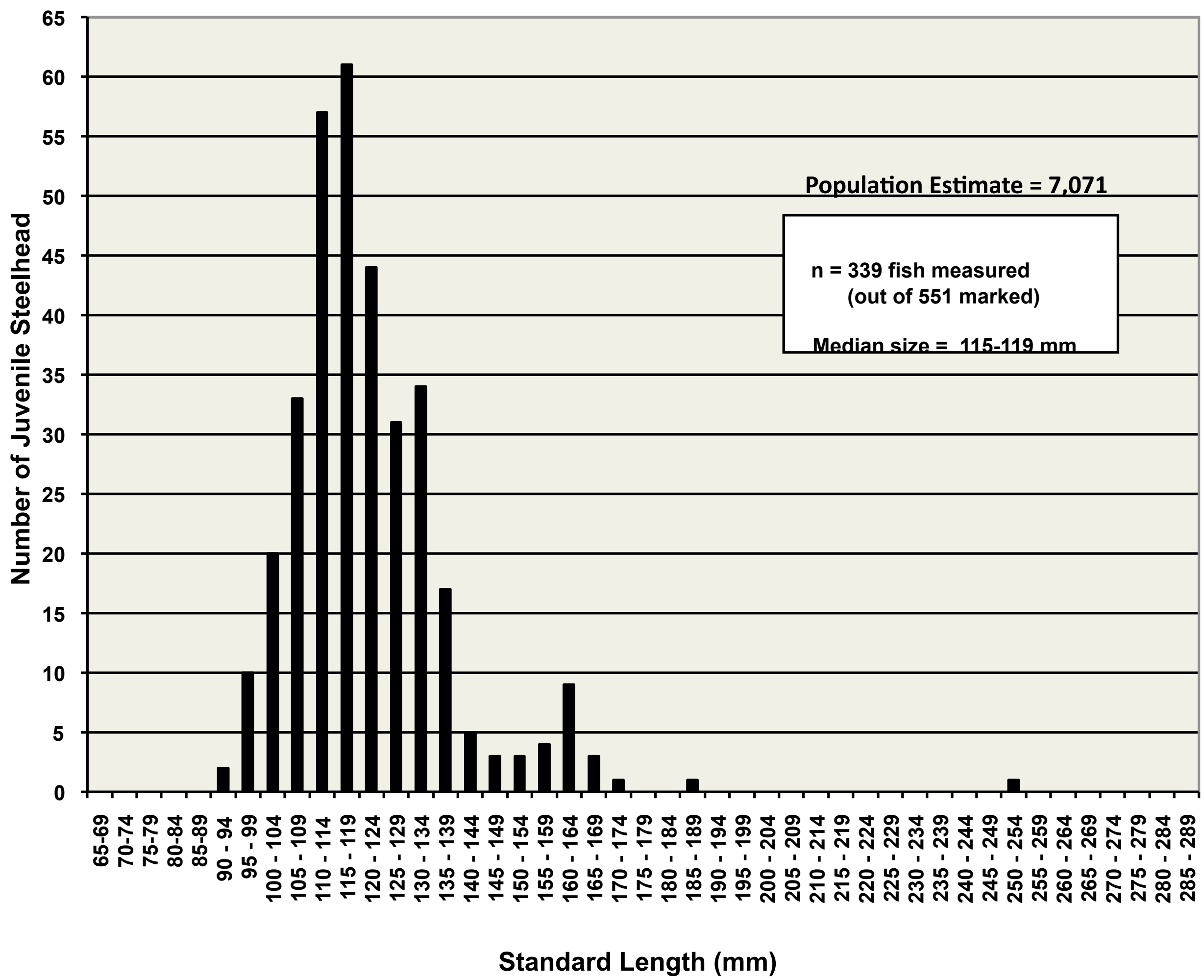

Figure 13. Size Frequency Histogram of Juvenile Steelhead Captured on 27 September 2008 in the Soquel Lagoon.

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

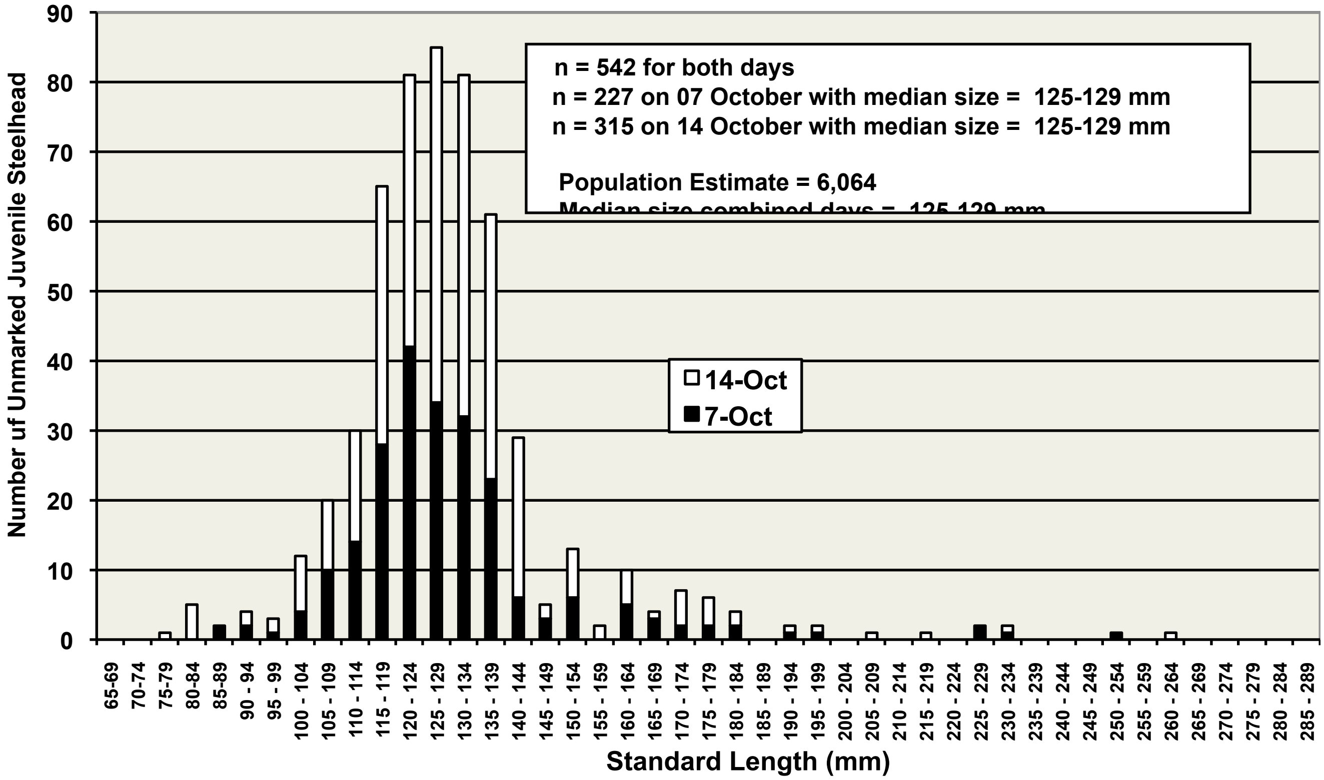

Figure 14. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 7 & 14 October 2007 in the Soquel Lagoon.

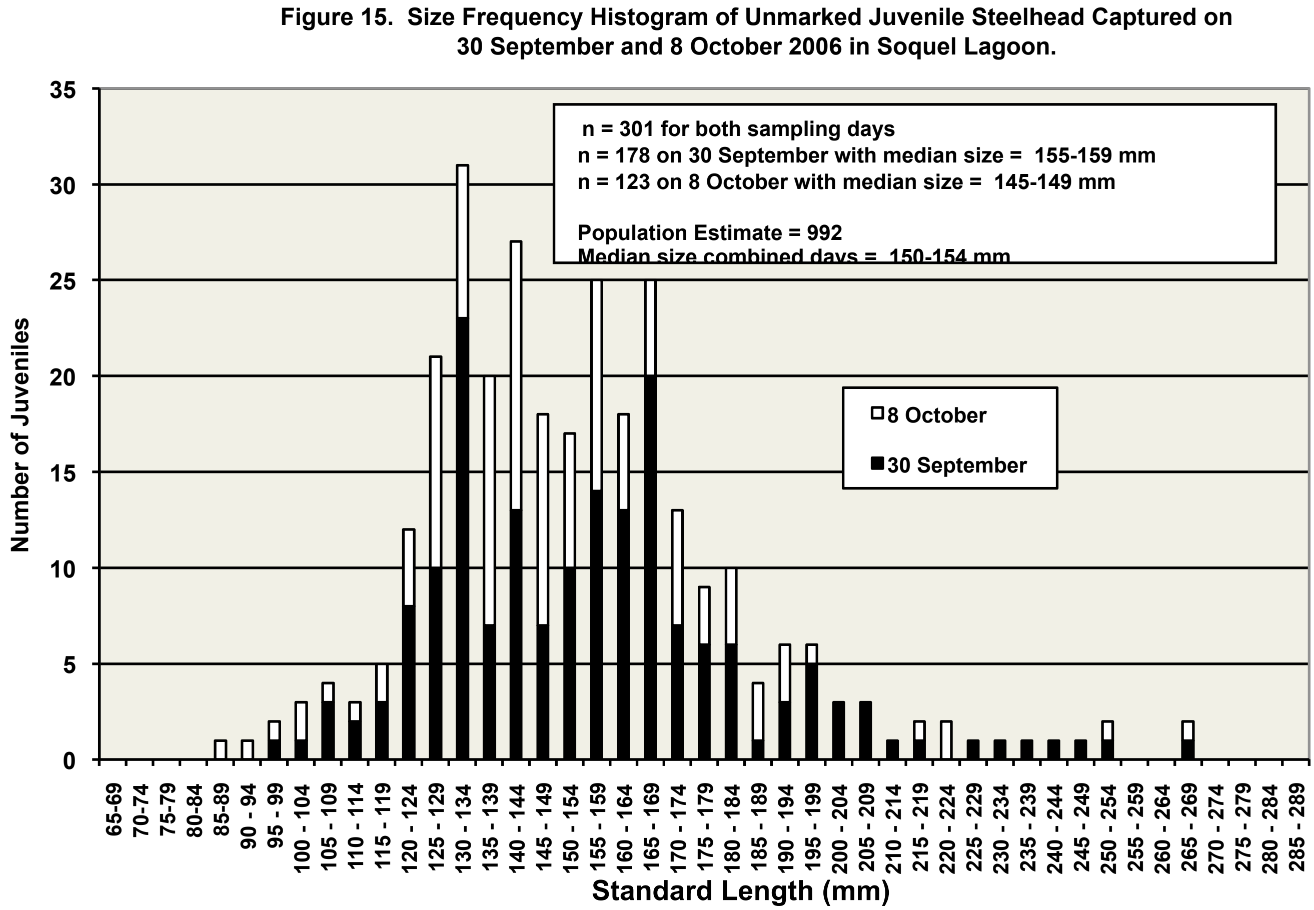

Figure 15. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 30 September and 8 October 2006 in Soquel Lagoon.

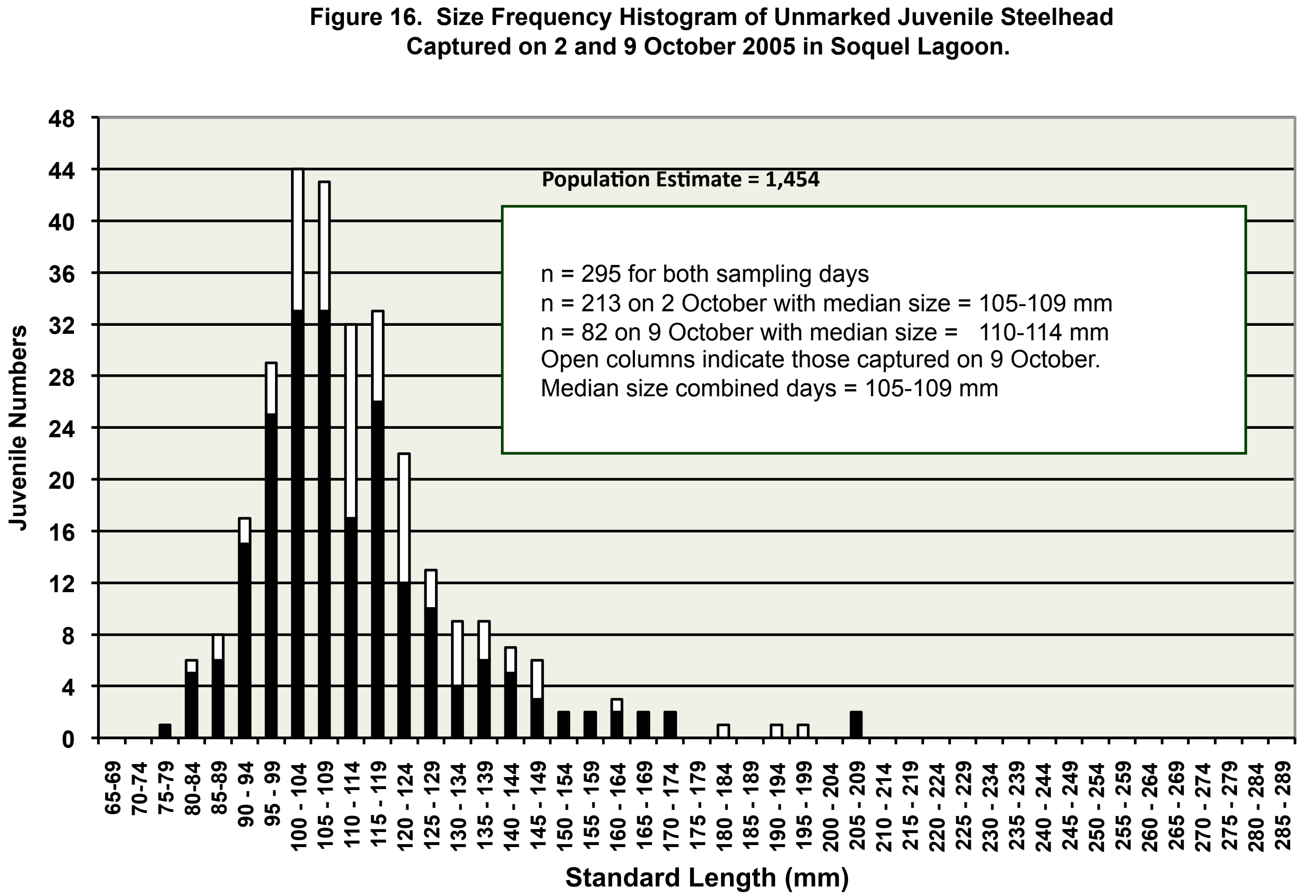

Figure 16. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 2 and 9 October 2005 in Soquel Lagoon.

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

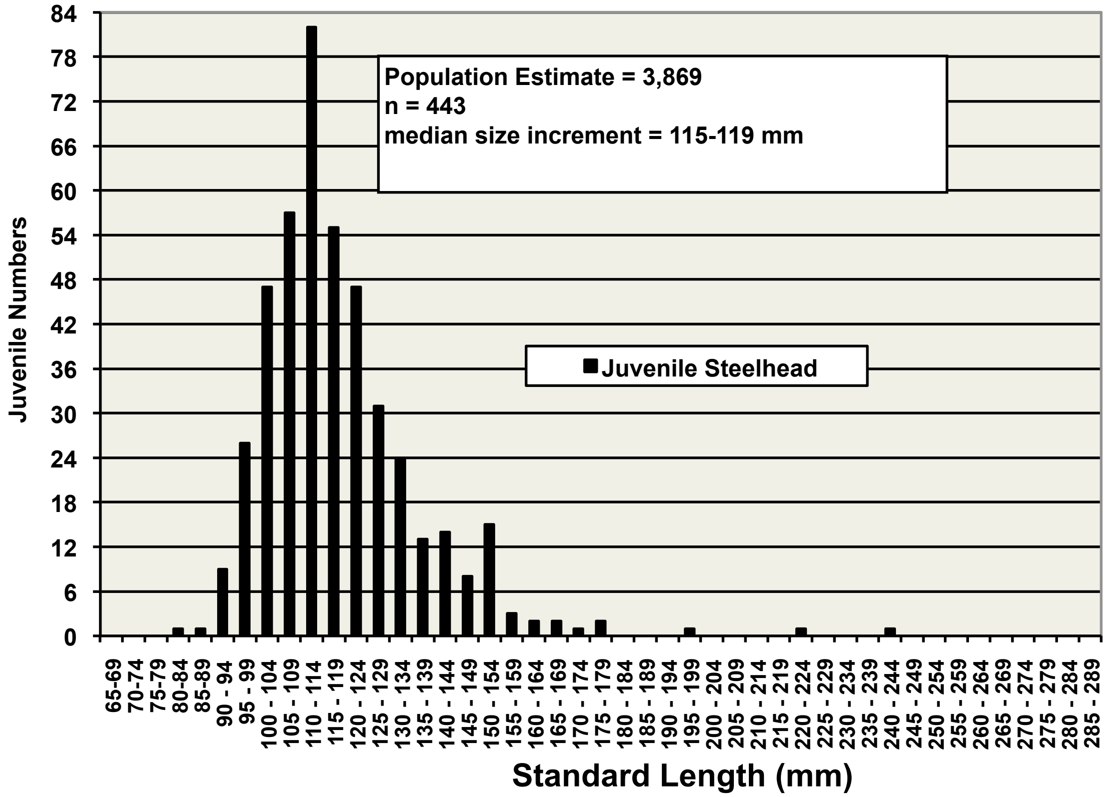

Figure 17. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 and 12 October 2004 in Soquel Lagoon.

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

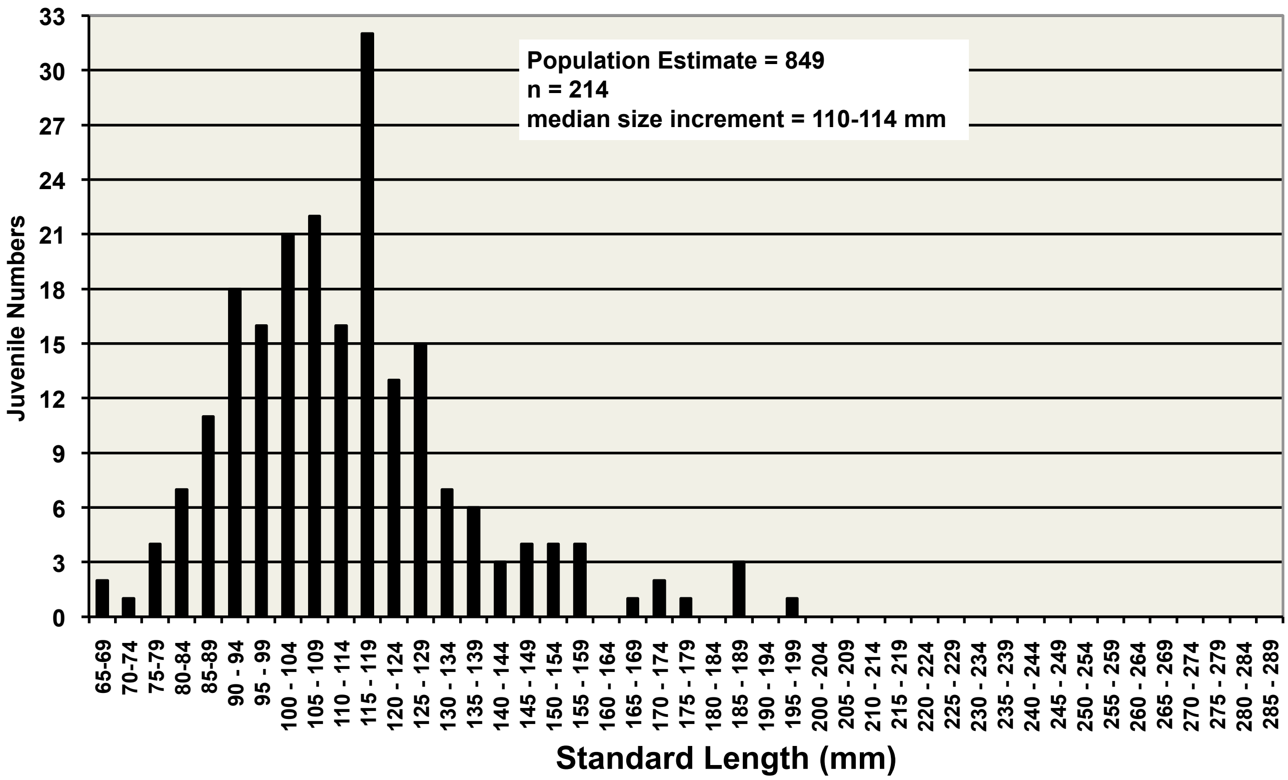

Figure 18. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 5 and 12 October 2003 in Soquel Lagoon.

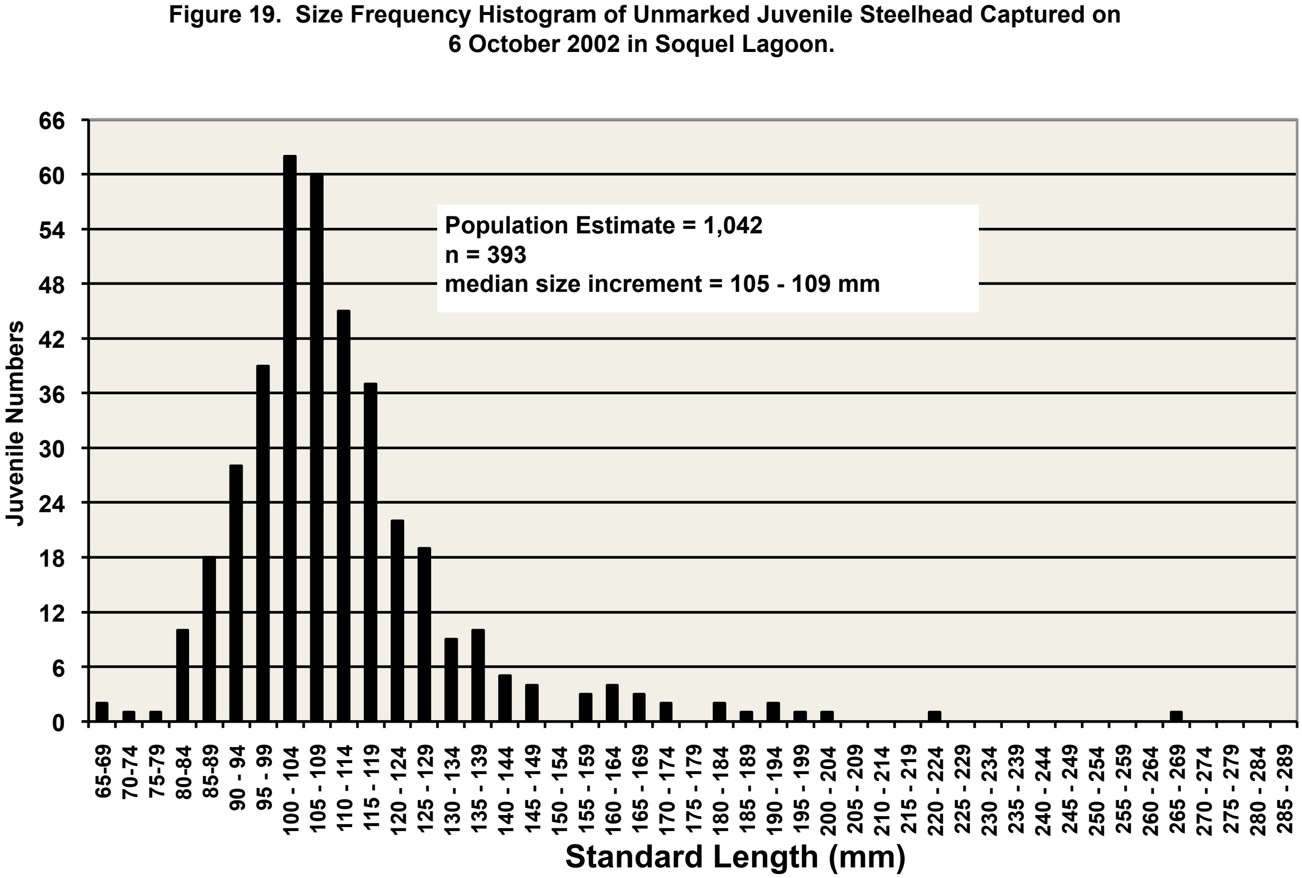

Figure 19. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 6 October 2002 in Soquel Lagoon.

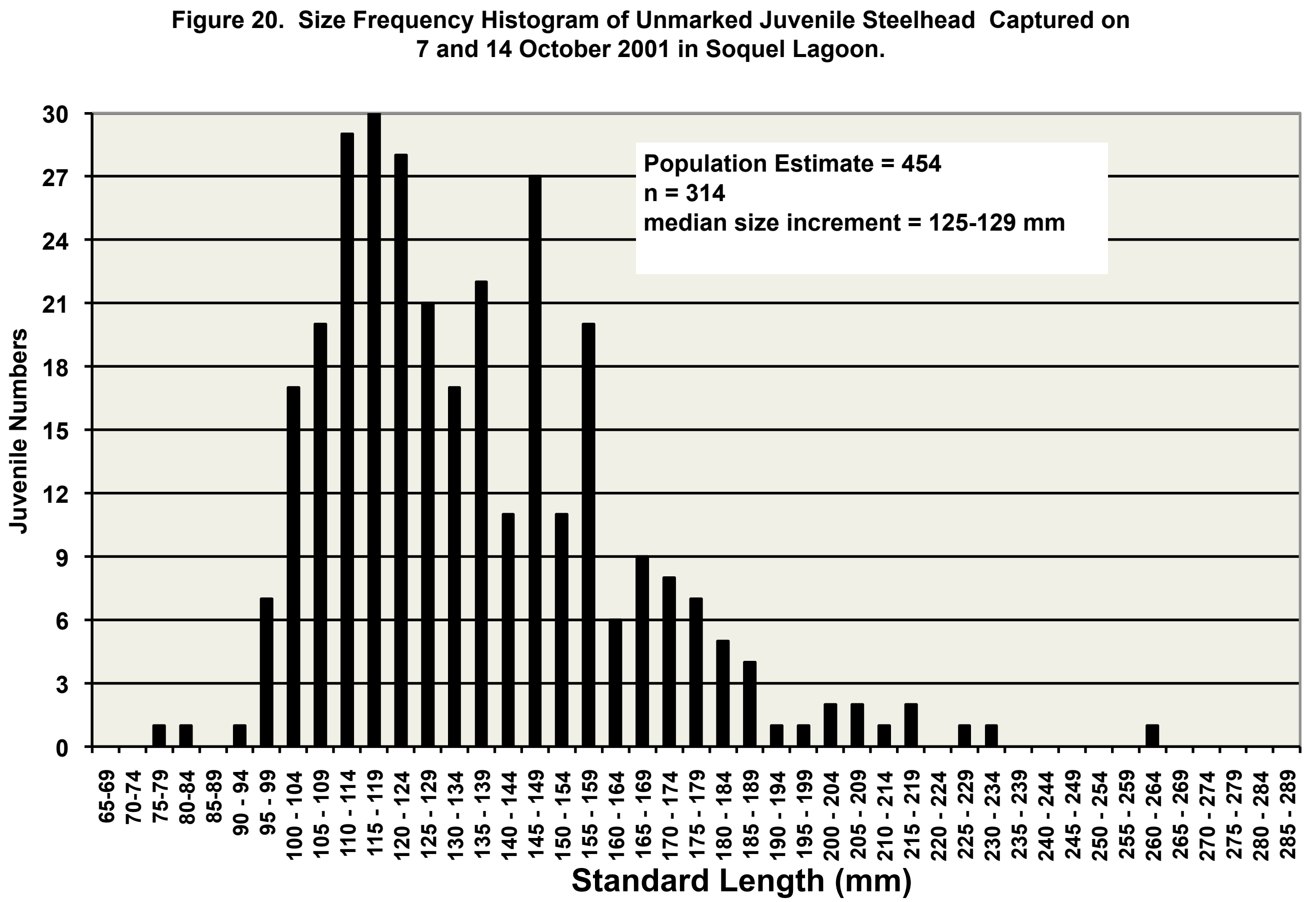

Figure 20. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 7 and 14 October 2001 in Soquel Lagoon.

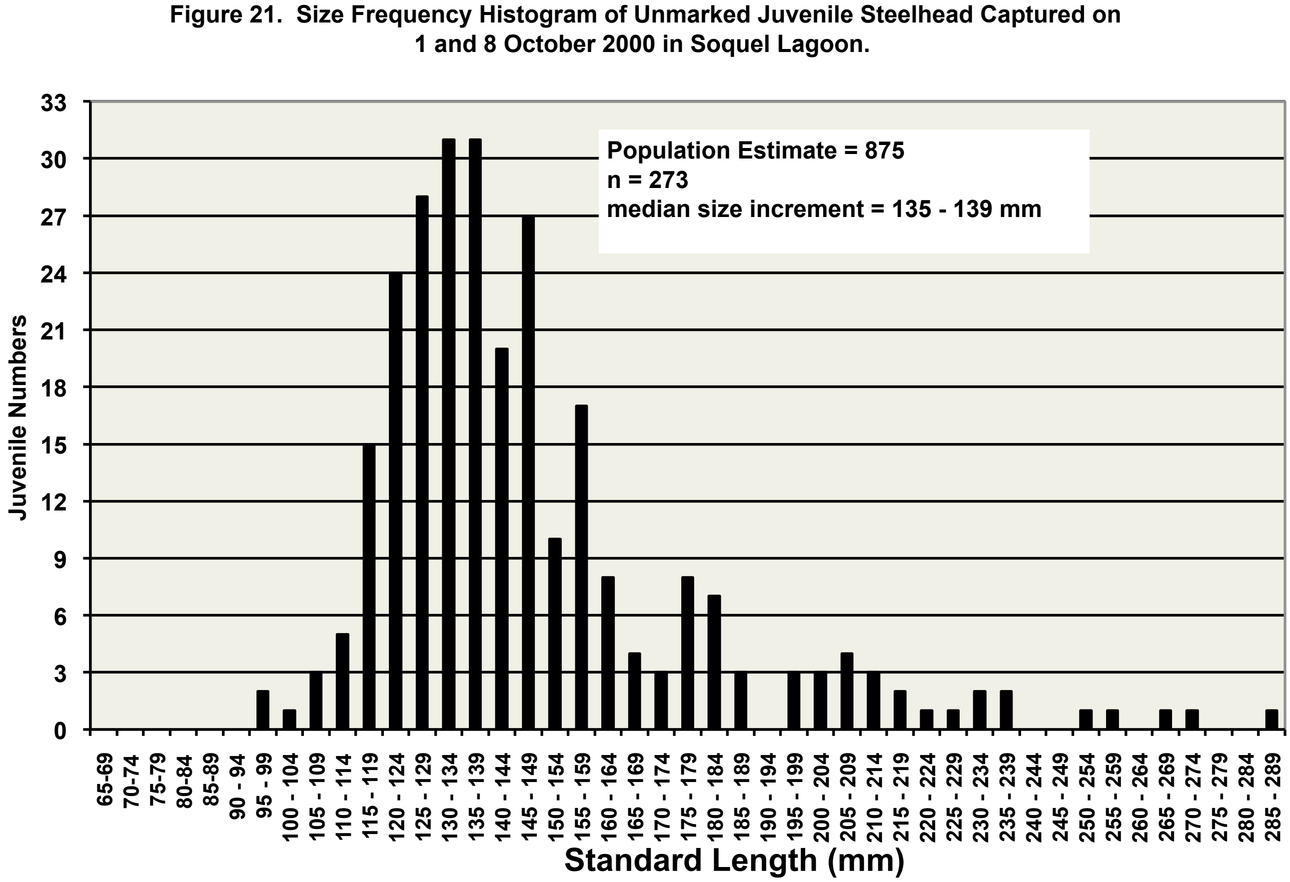

Figure 21. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 1 and 8 October 2000 in Soquel Lagoon.

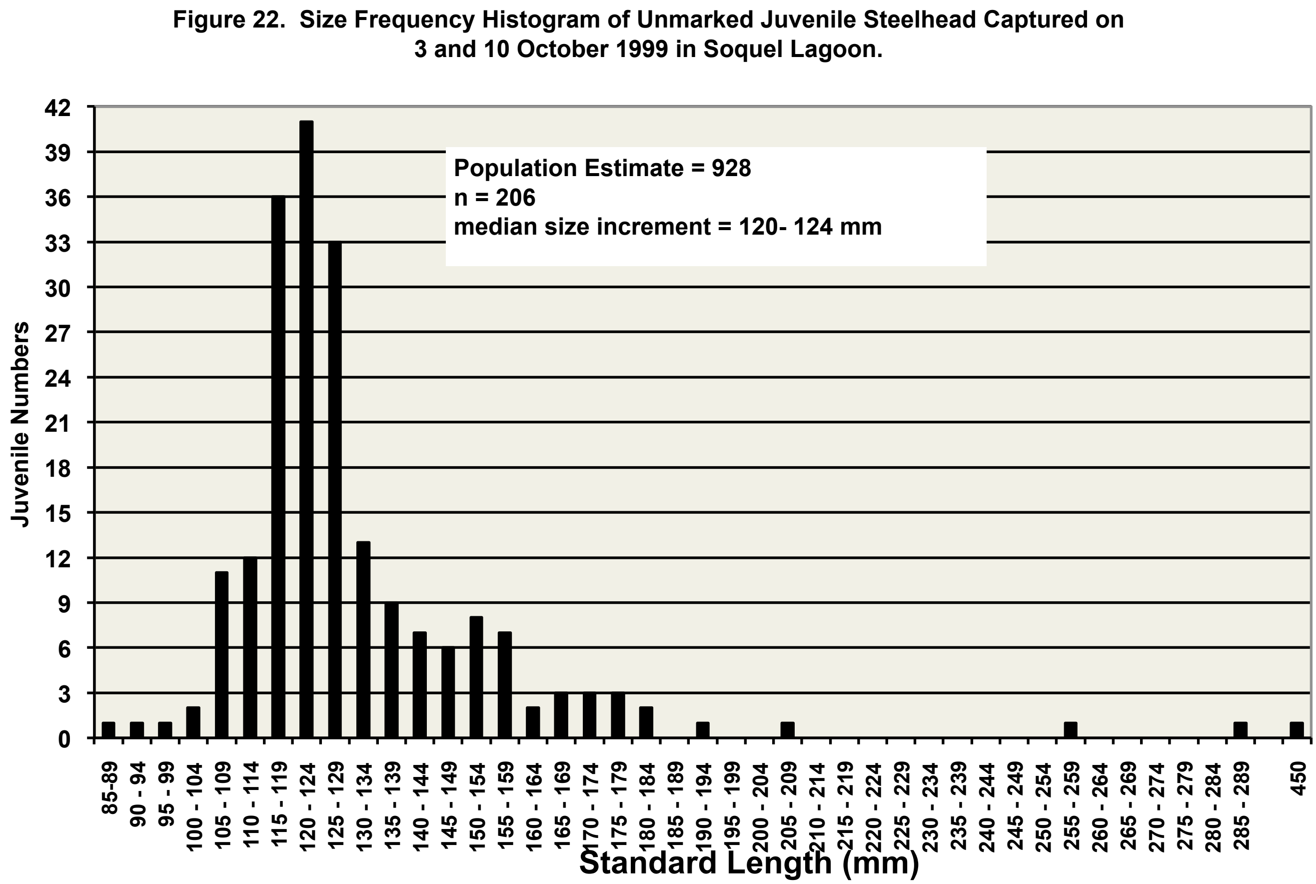

Figure 22. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 and 10 October 1999 in Soquel Lagoon.

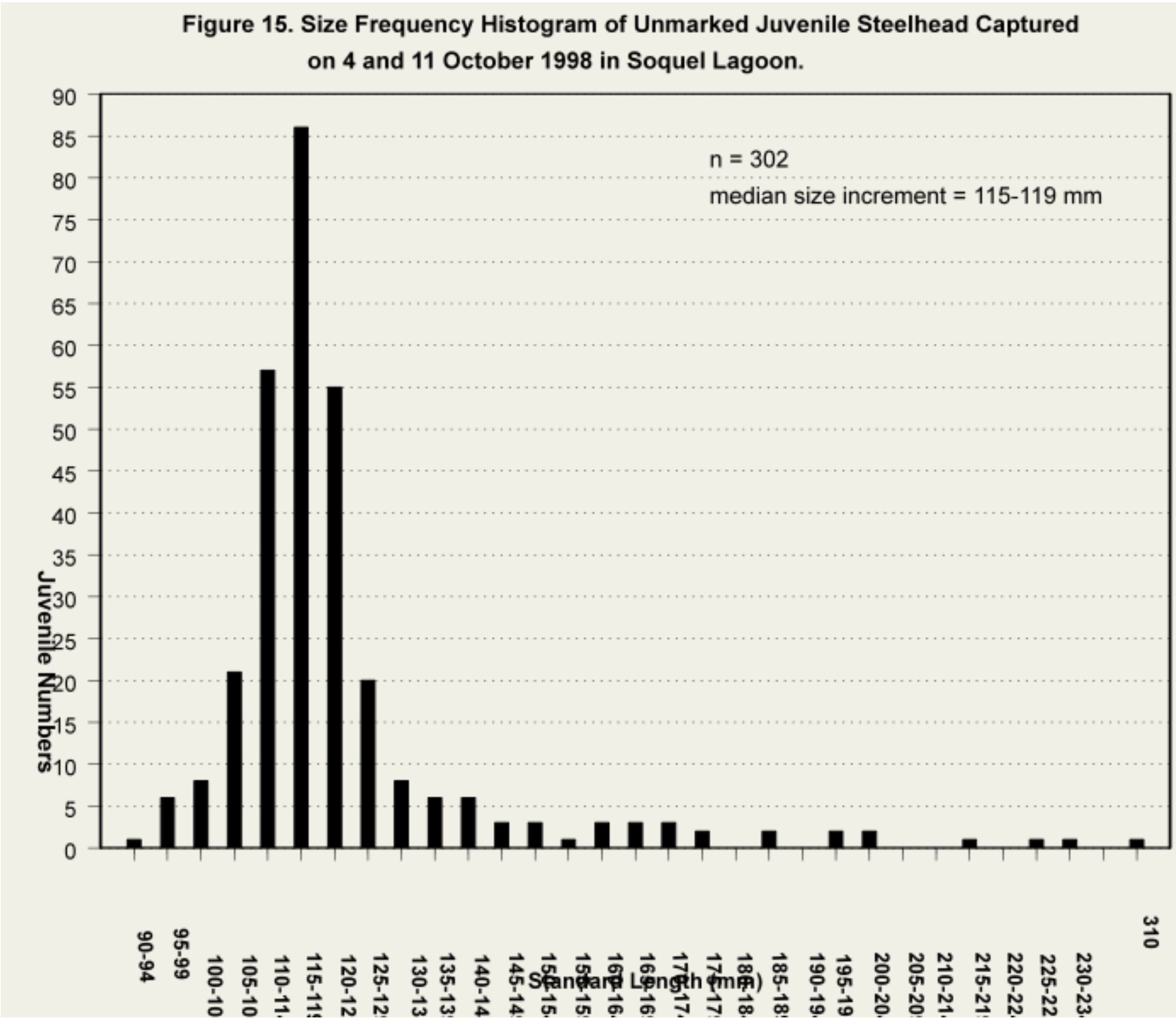

Figure 23. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 4 and 11 October 1998 in Soquel Lagoon.

Population Estimate = 671.

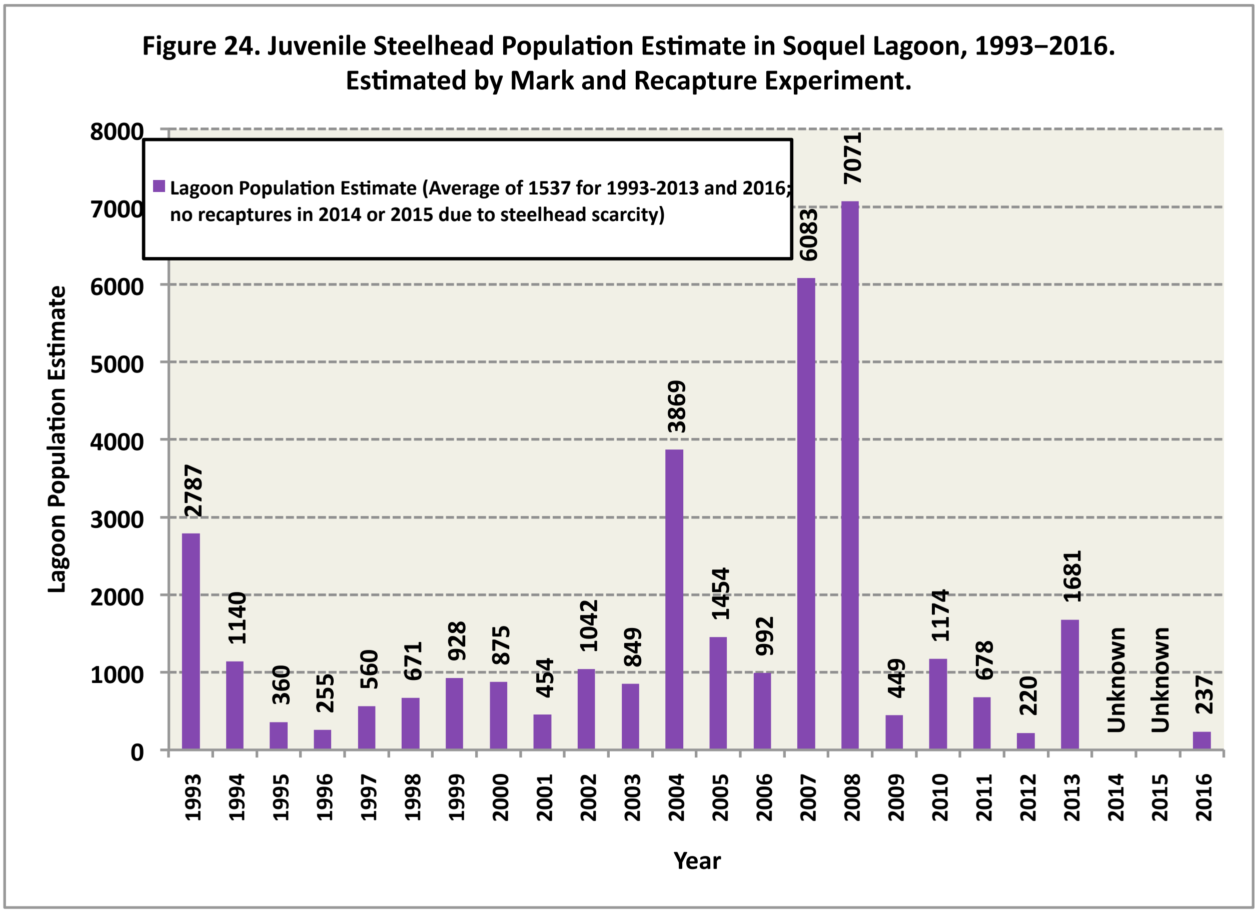

Figure 24. Juvenile Steelhead Population Estimate in Soquel Lagoon, 1993−2016. Estimated by Mark and Recapture Experiment.

Figure 25. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2016

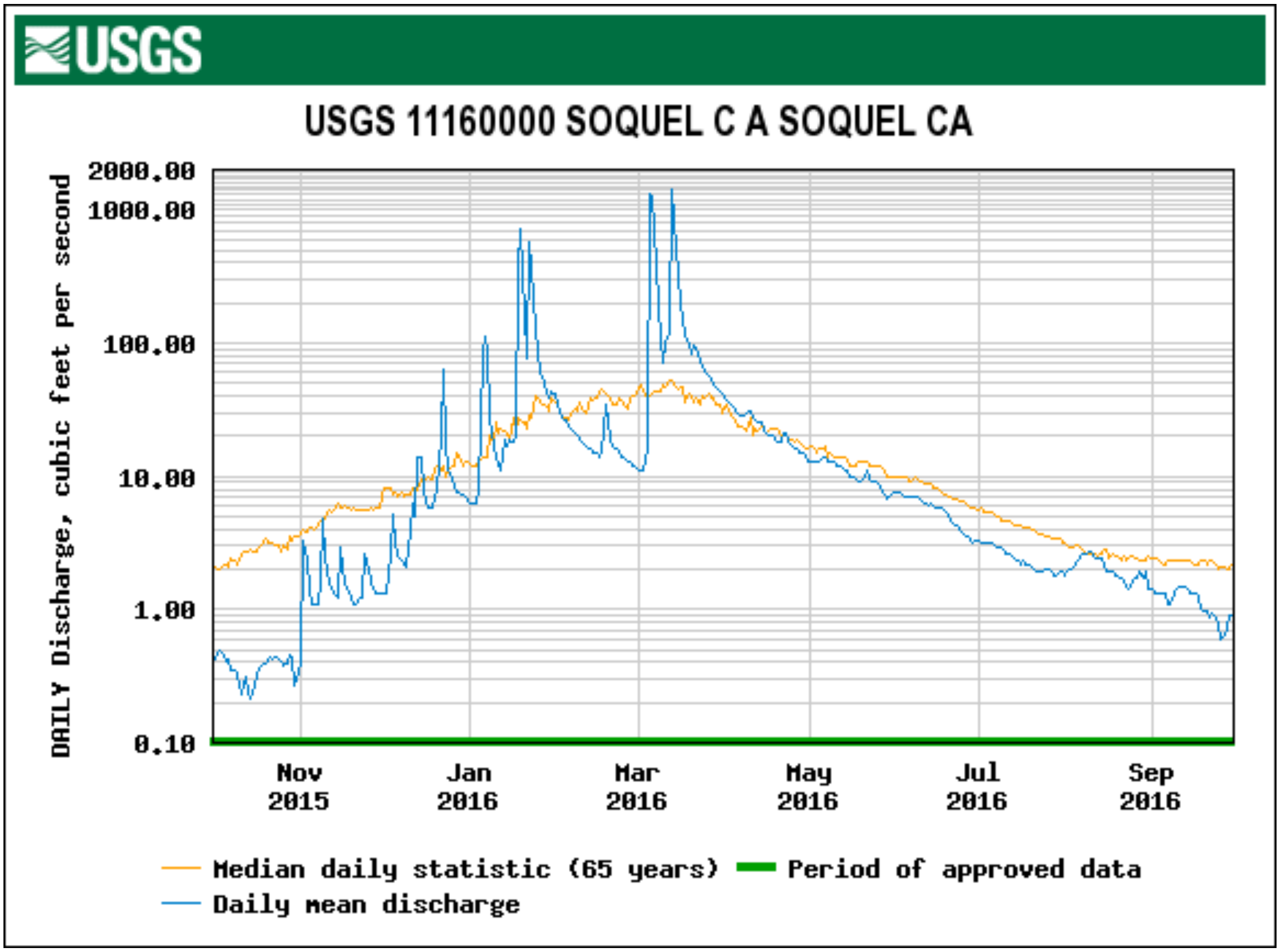

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Figure 26. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2016.

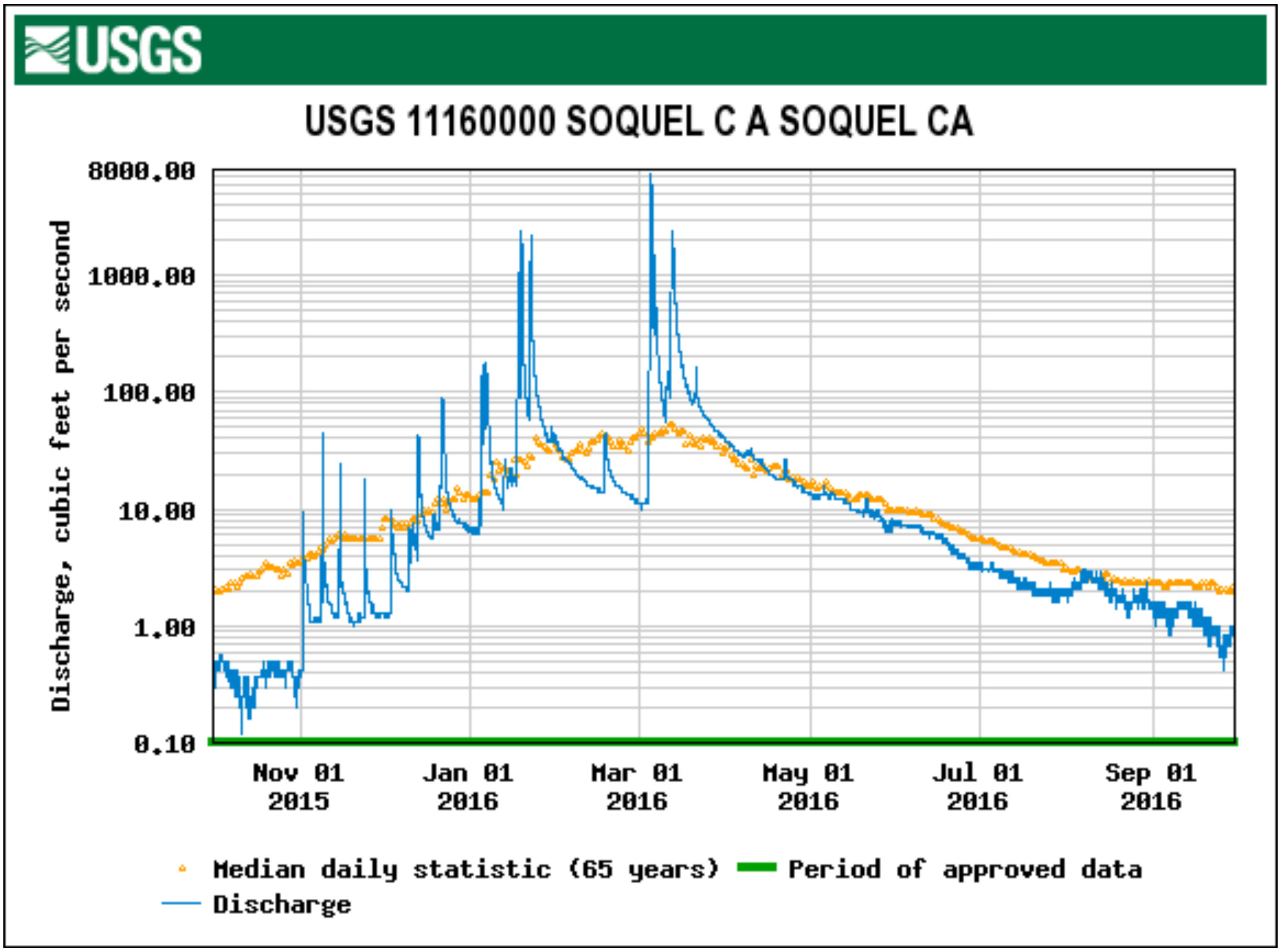


Figure 27. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 15 May 2016 – 11 October 2016.

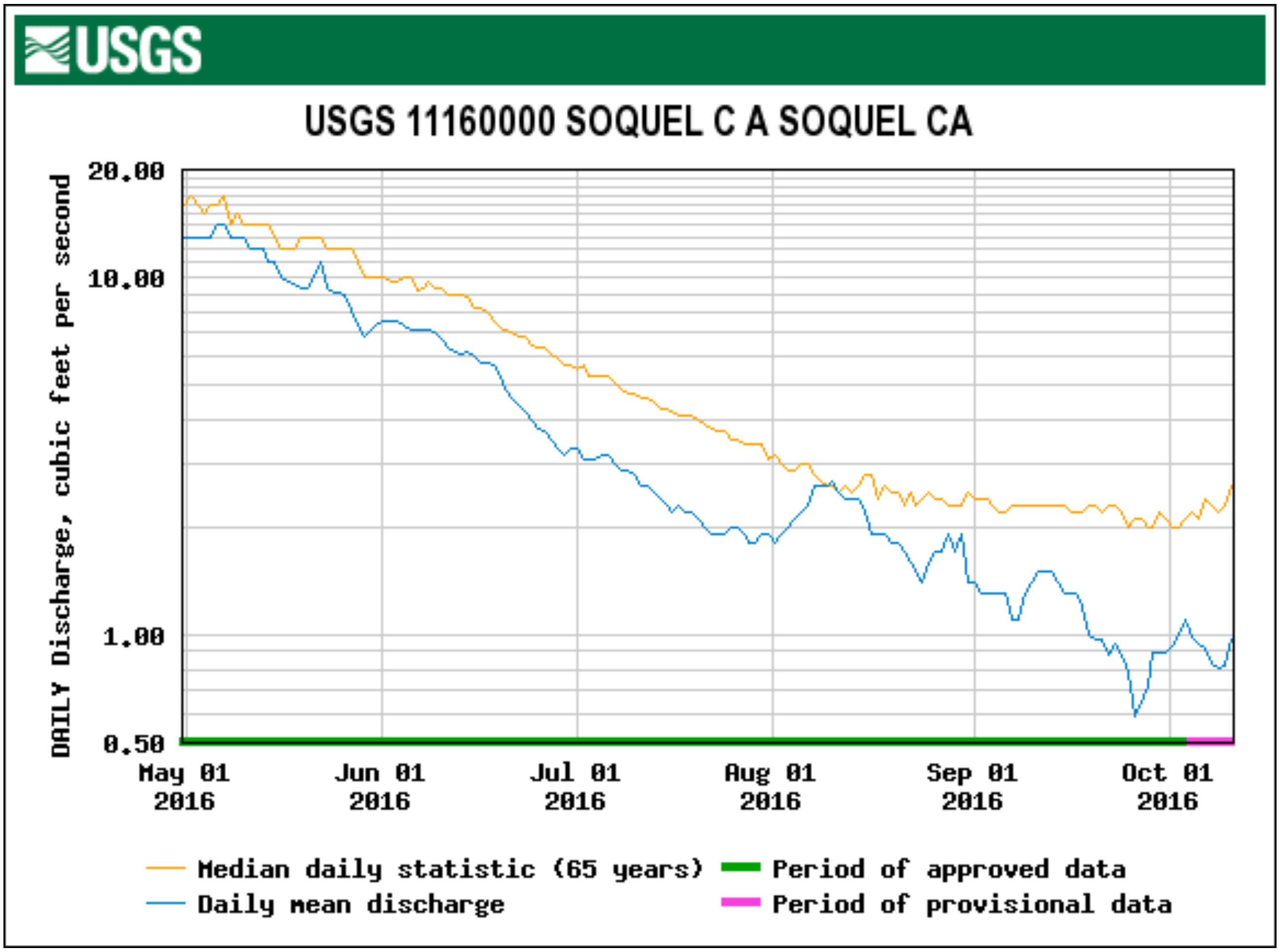


Figure 28. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2015.

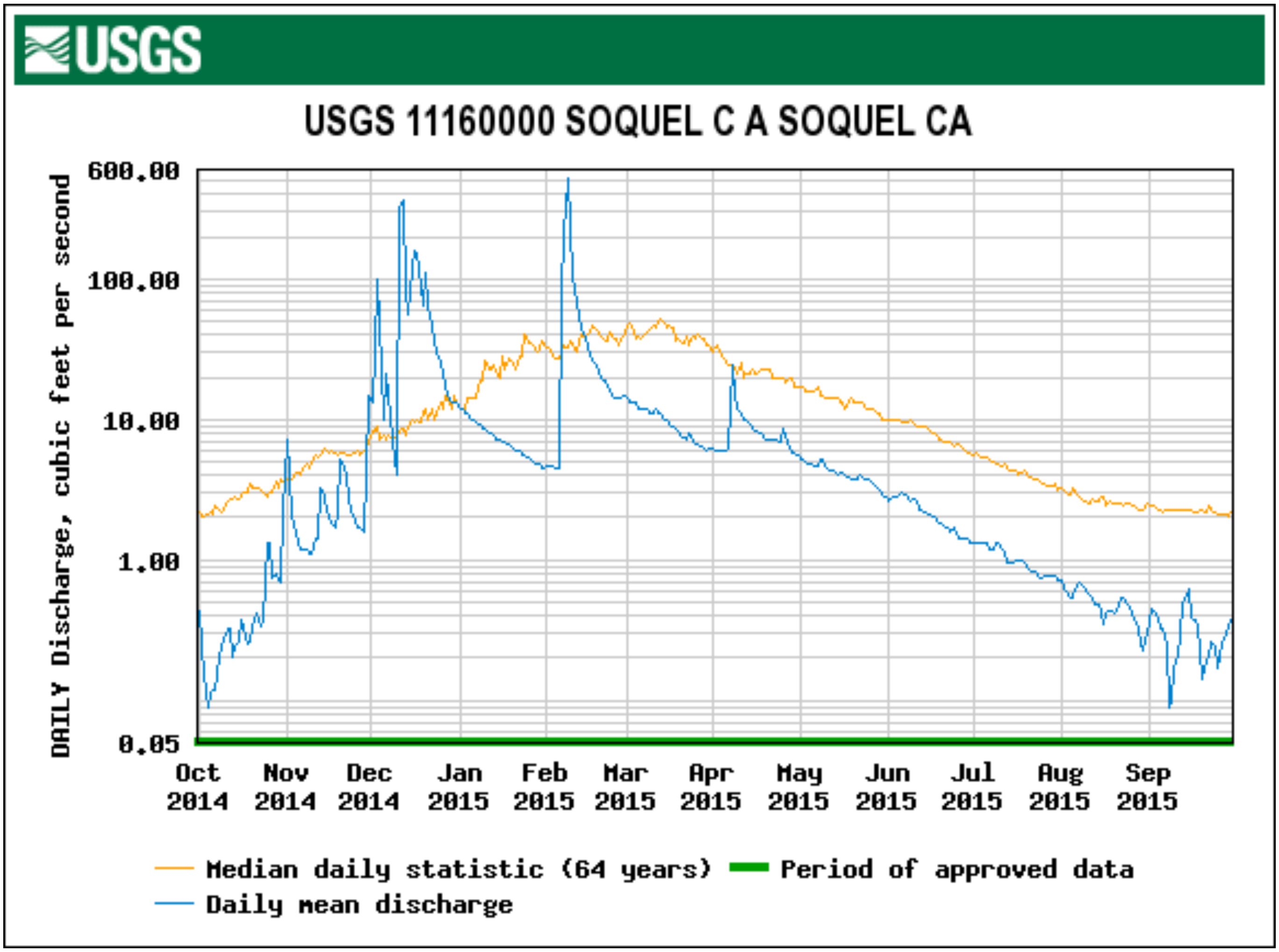


Figure 29. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2015.

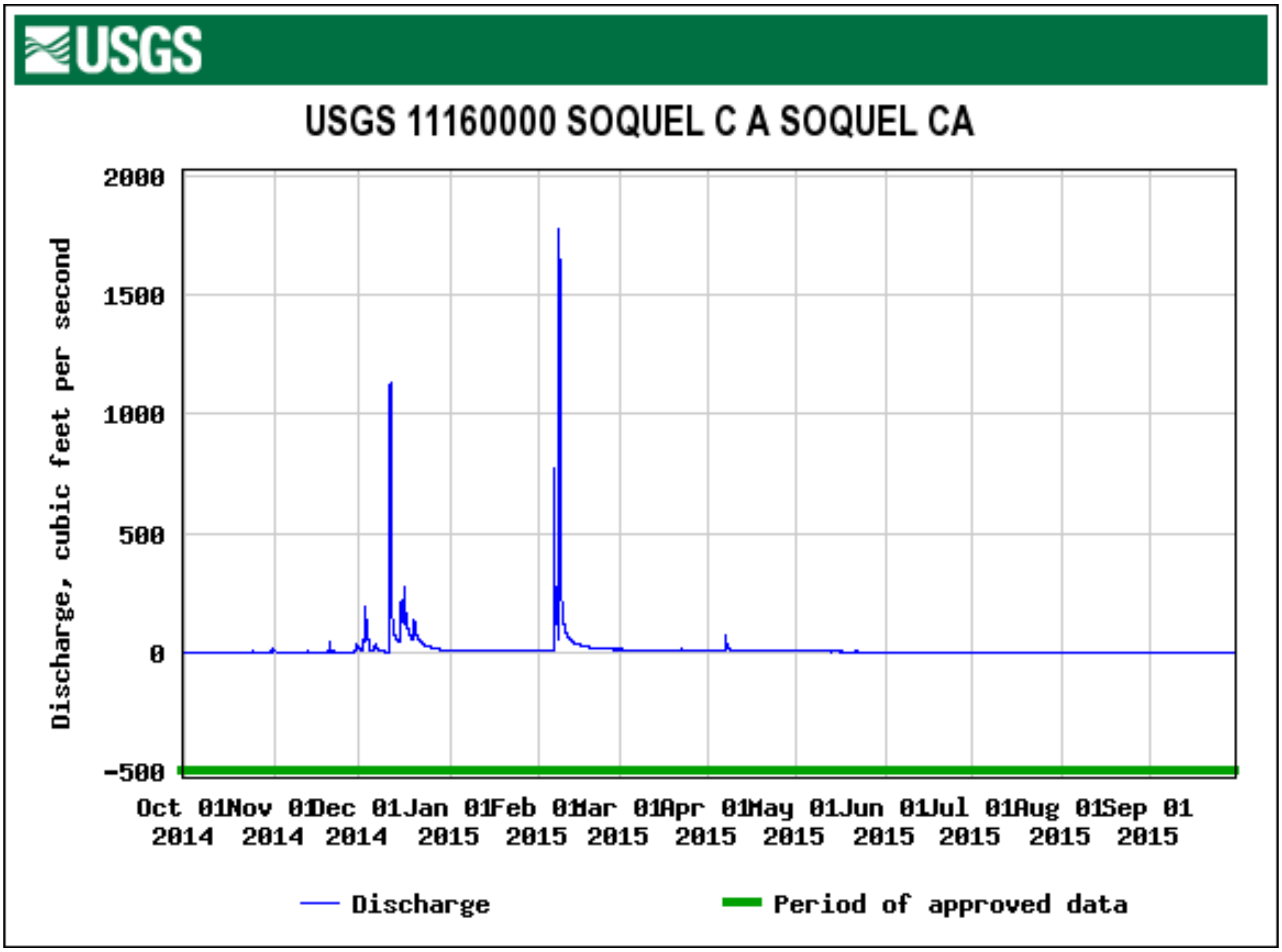


Figure 30. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 15 May 2015 – 15 November 2015.

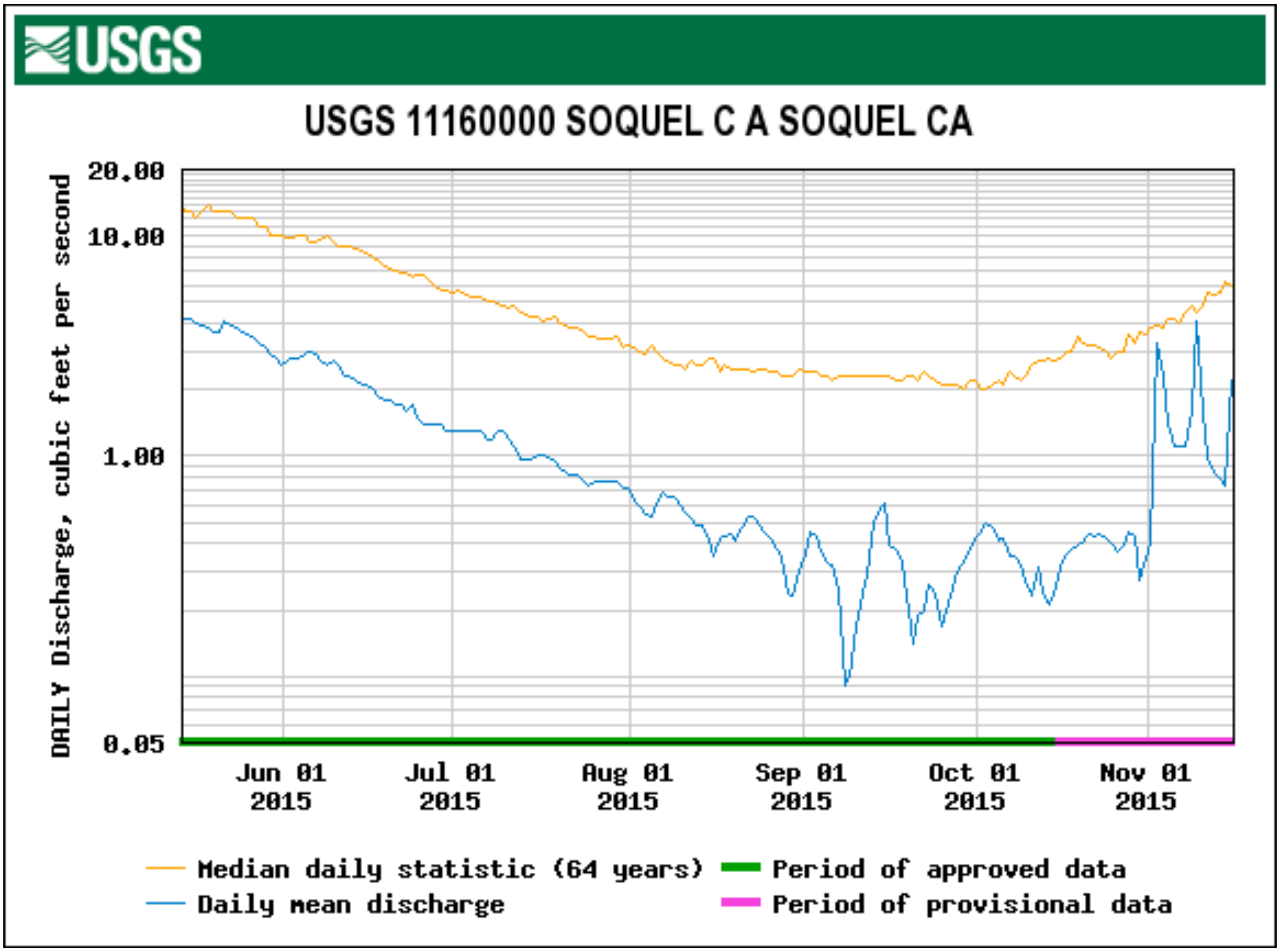


Figure 31. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2014.

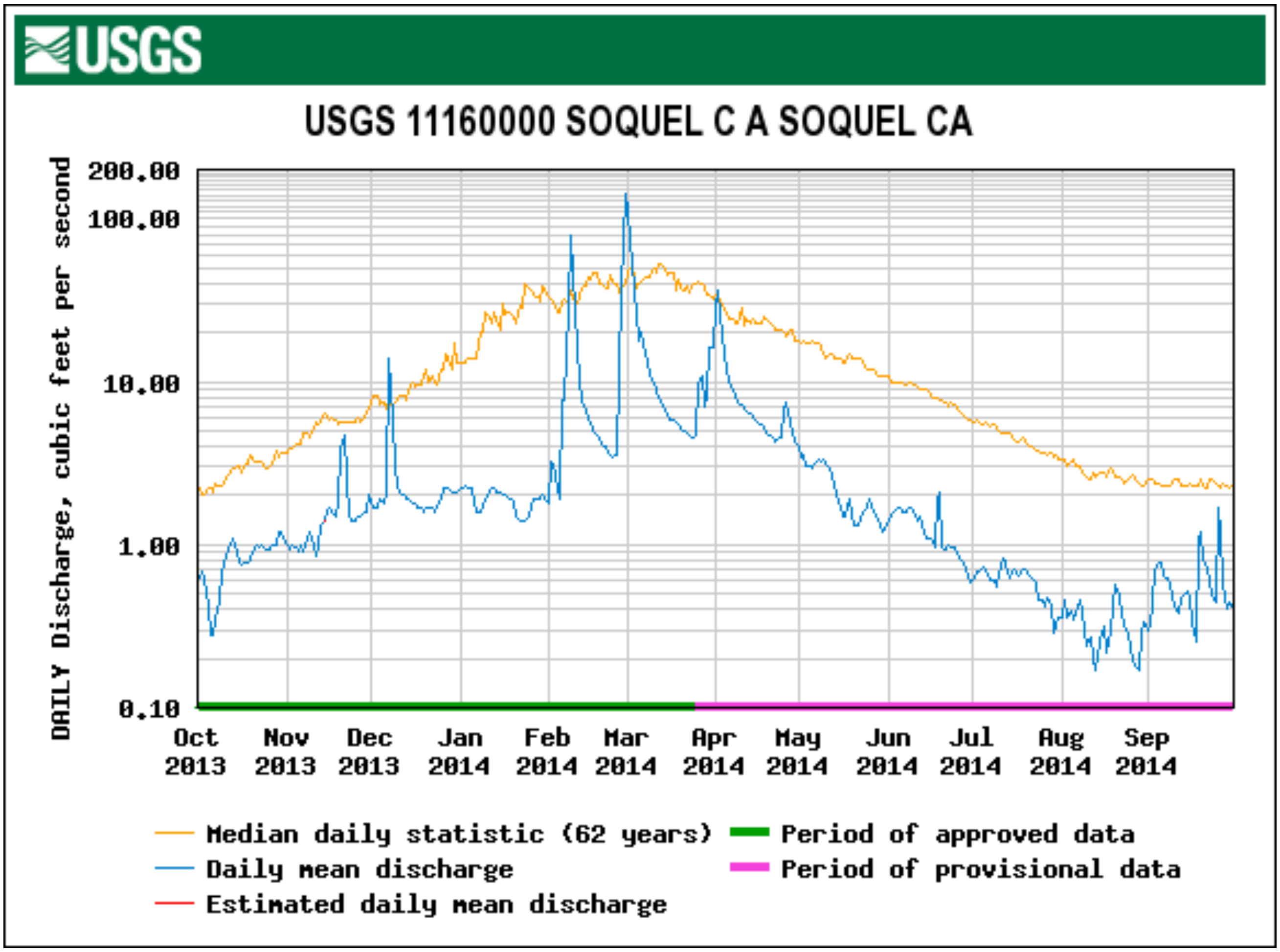


Figure 32. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2014.

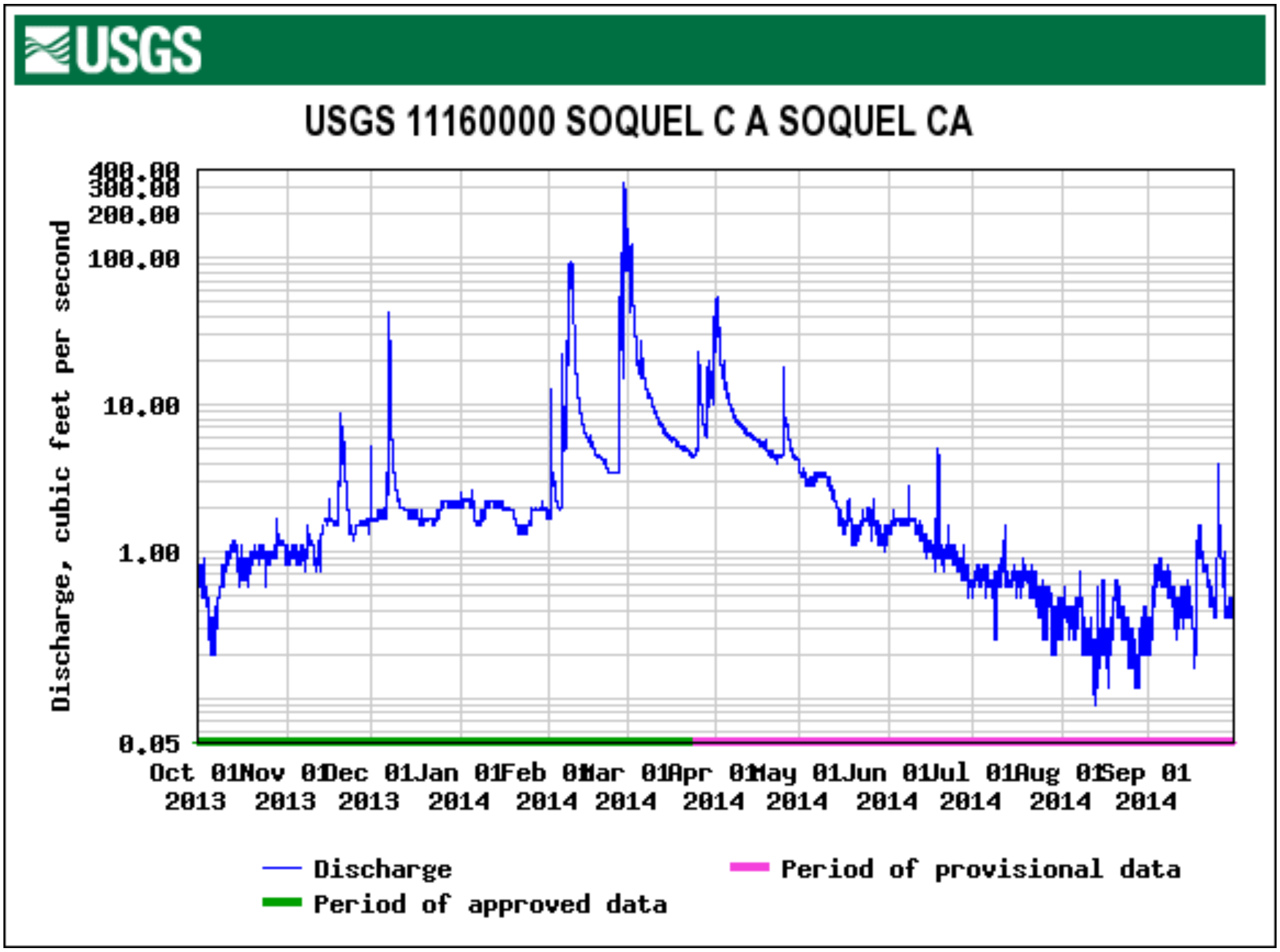


Figure 33. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2013.

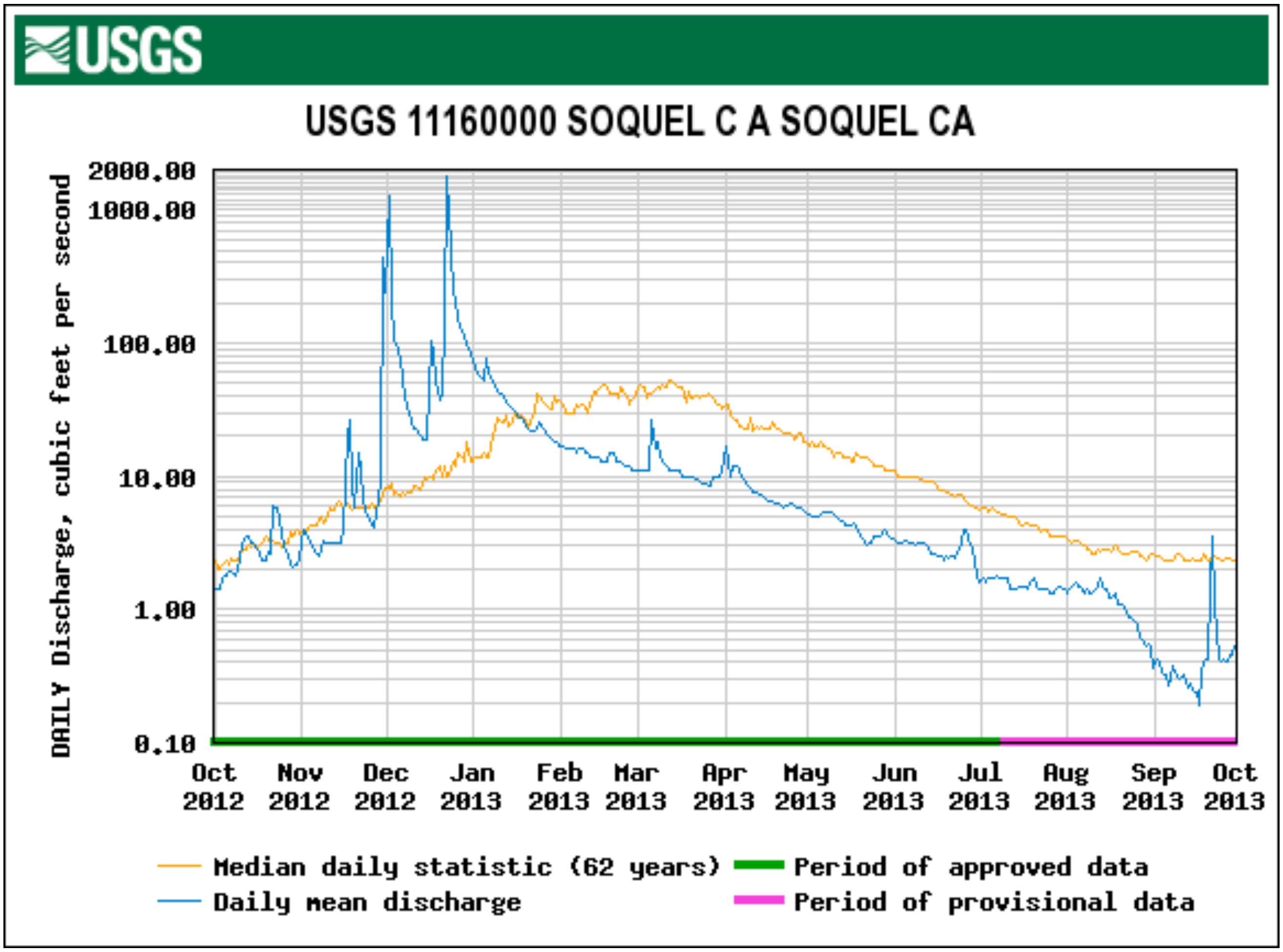


Figure 34. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, October 2012 – May 2013.

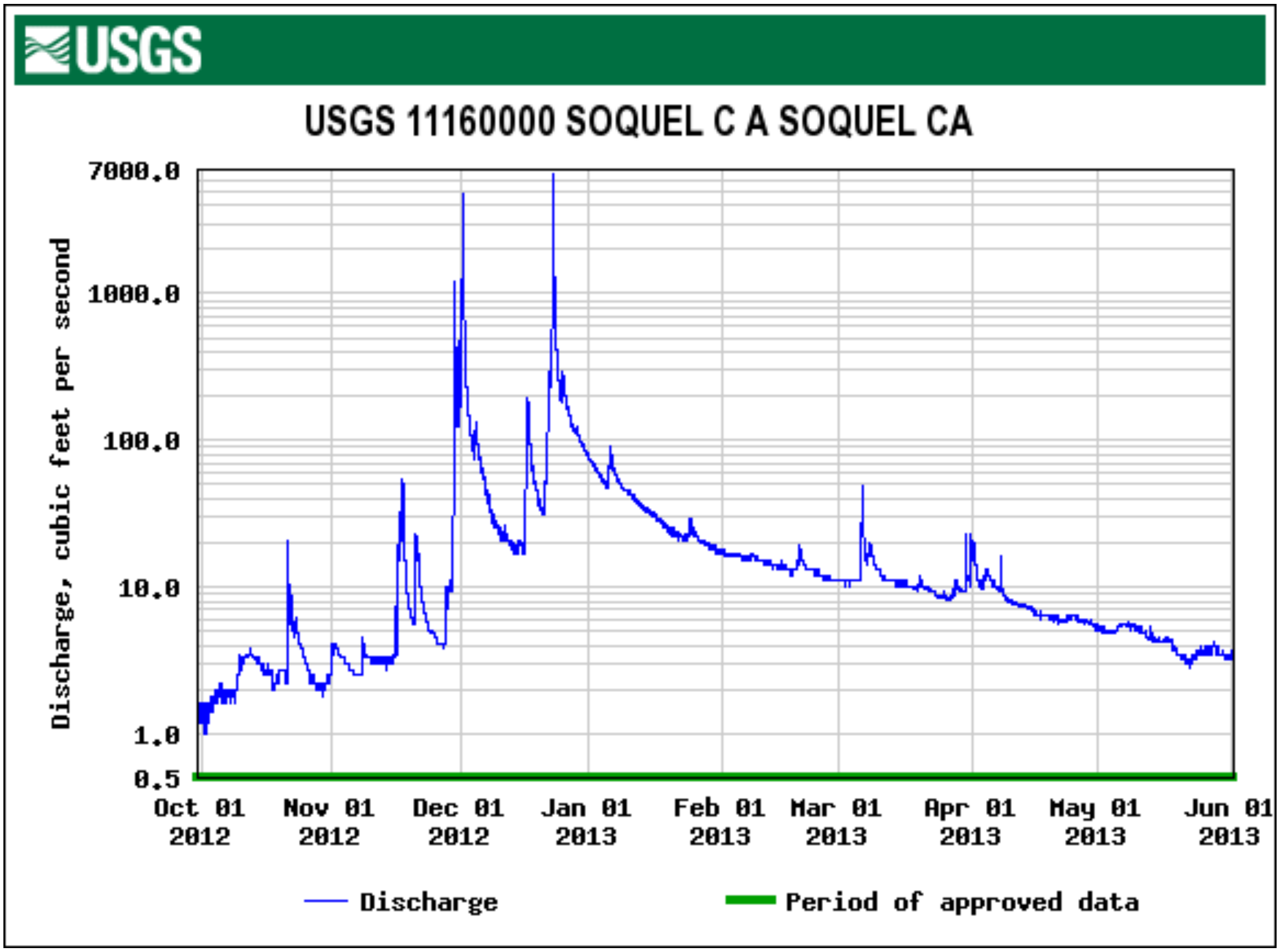


Figure 35. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2012.

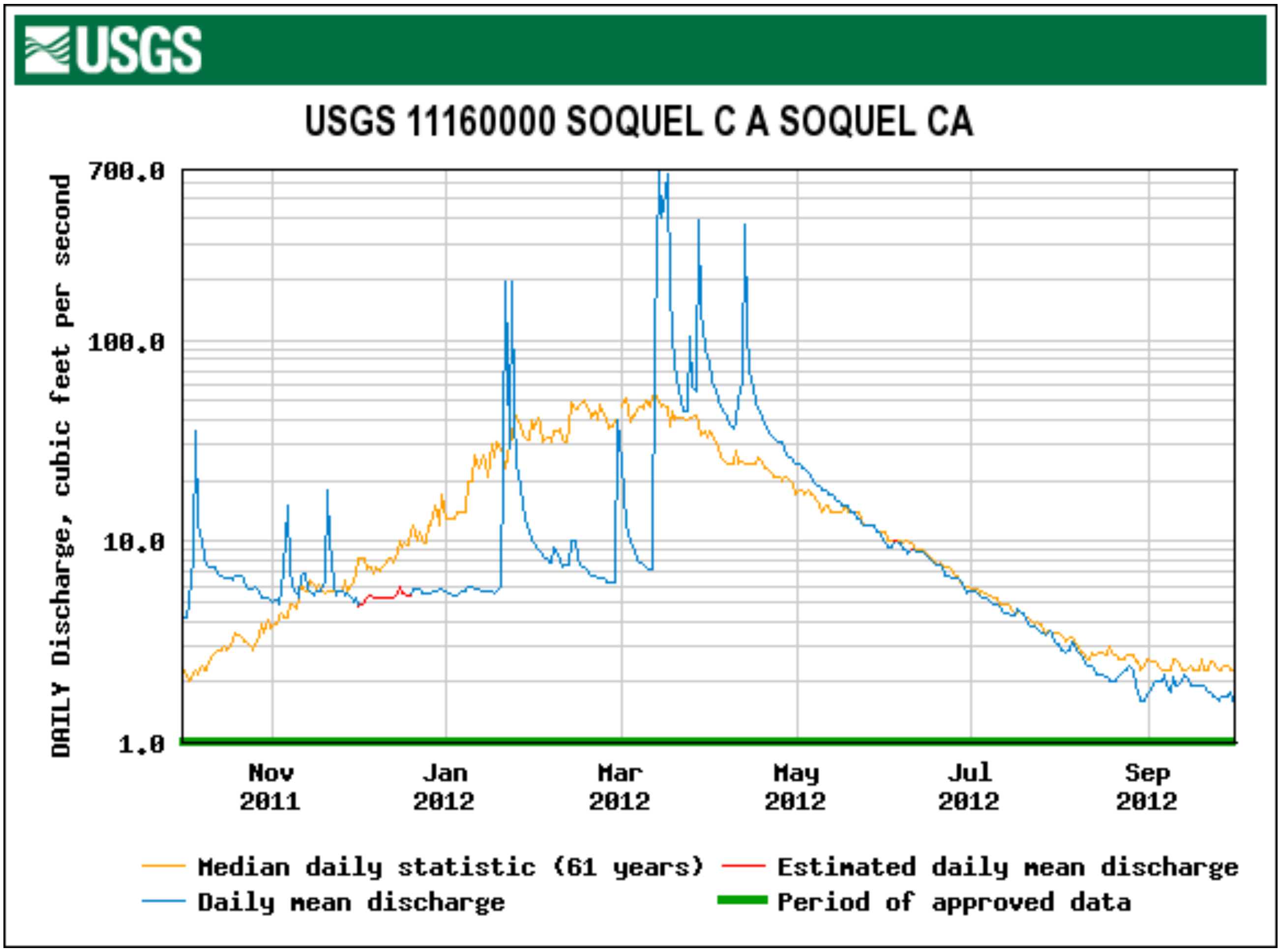


Figure 36. Soquel Creek Actual Measured Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2012.

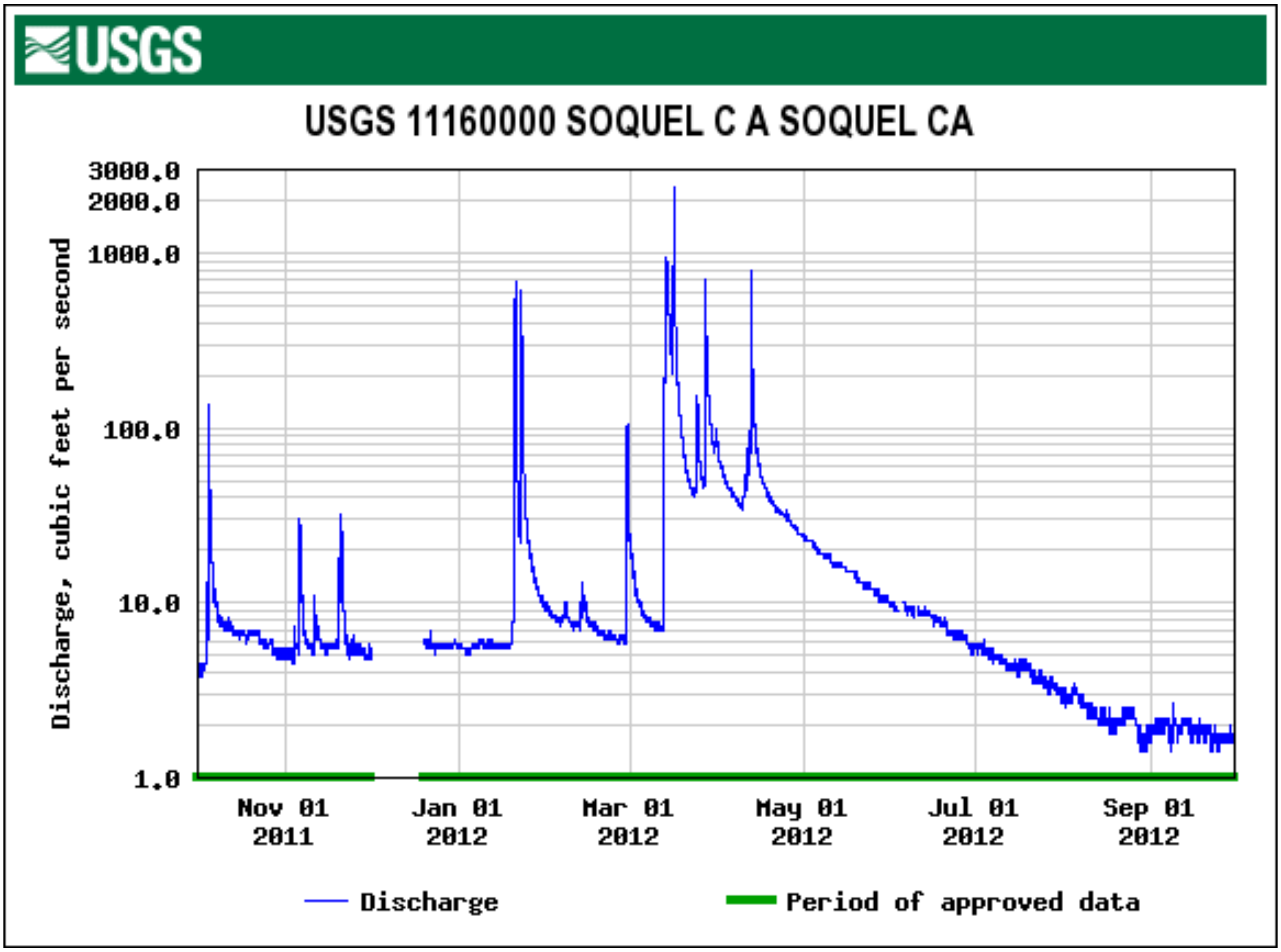


Figure 37. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2011.

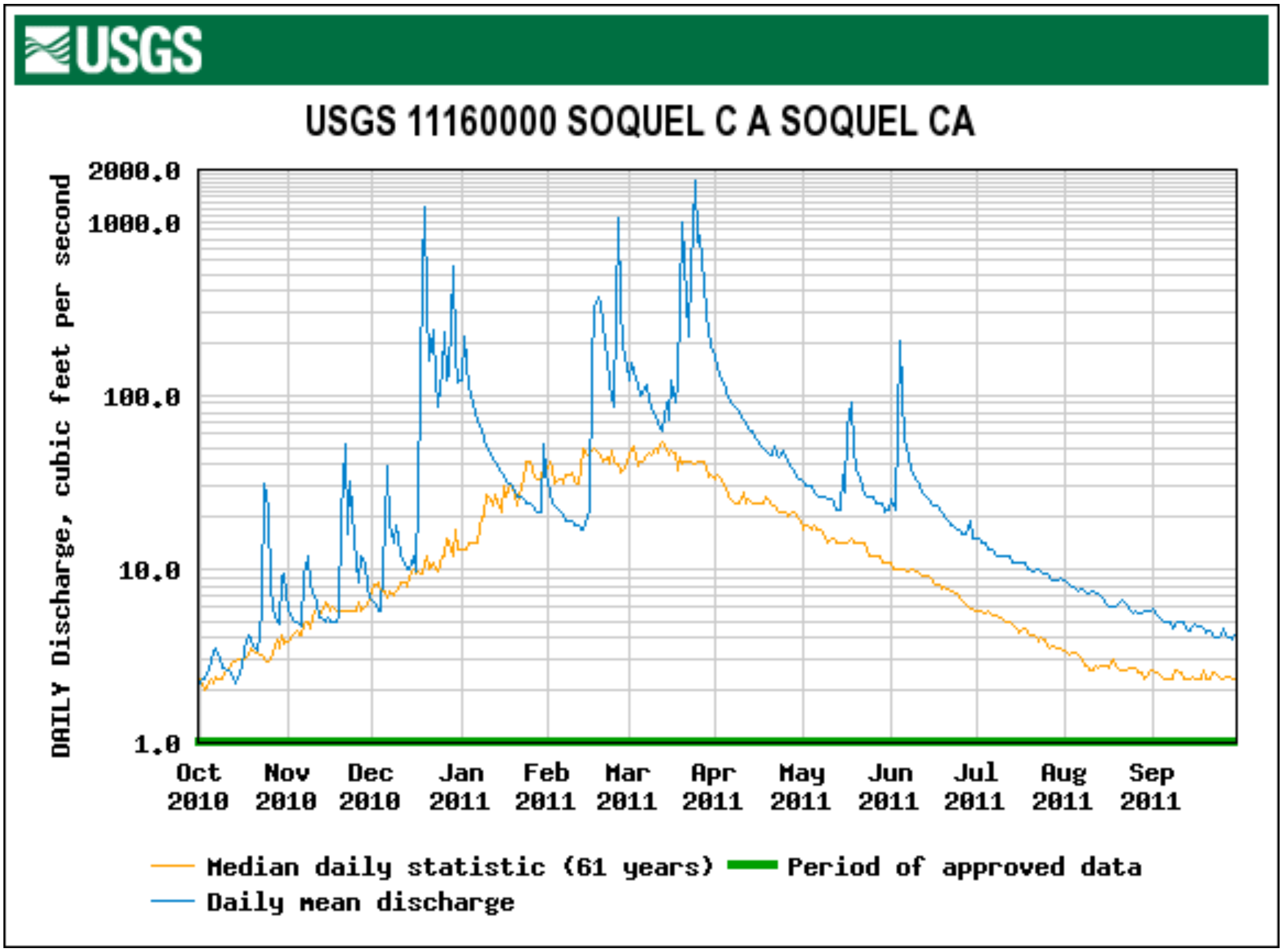


Figure 38. Soquel Creek Actual Measured Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2011.

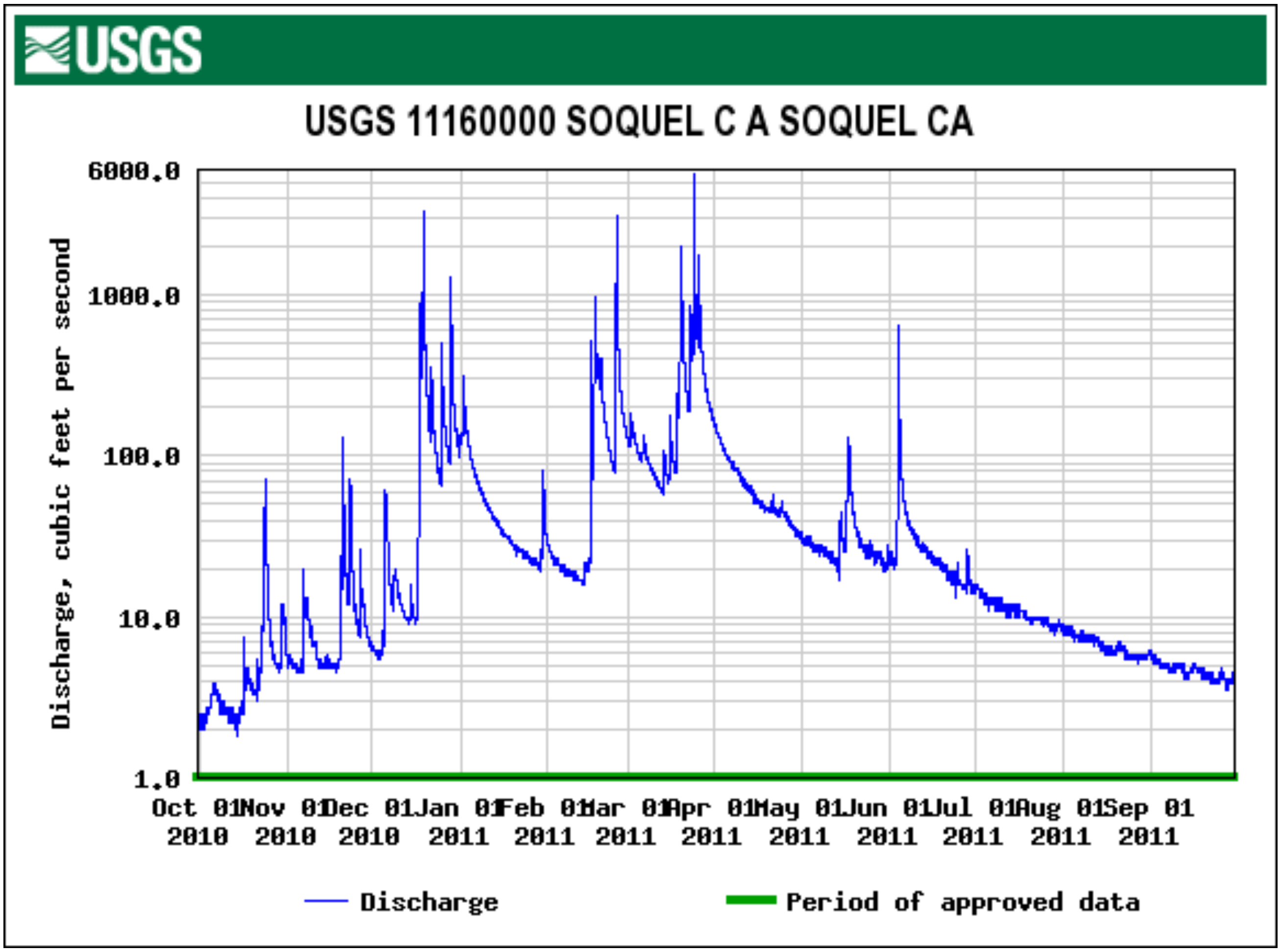


Figure 39. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2010.

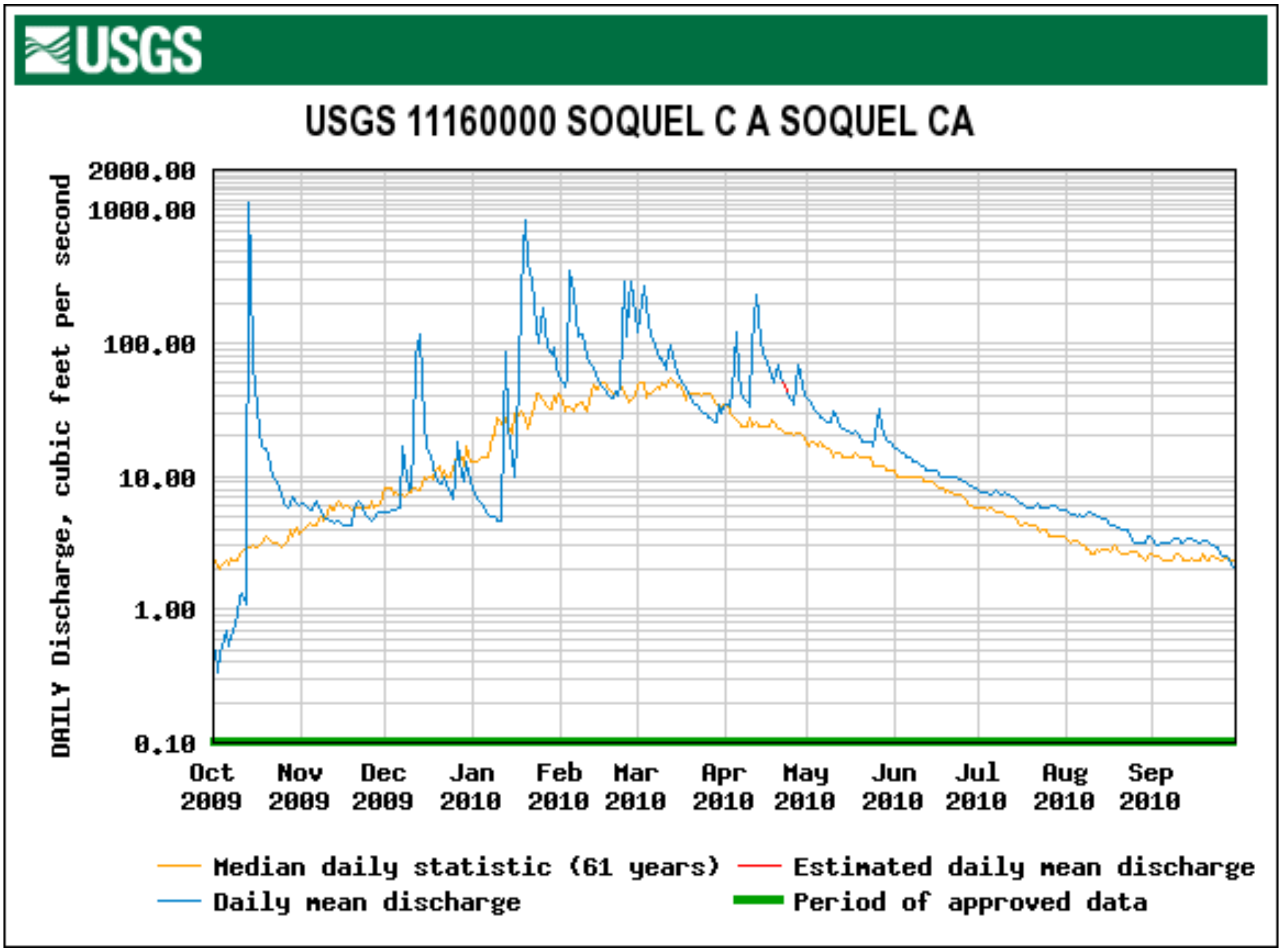


Figure 40. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2009.

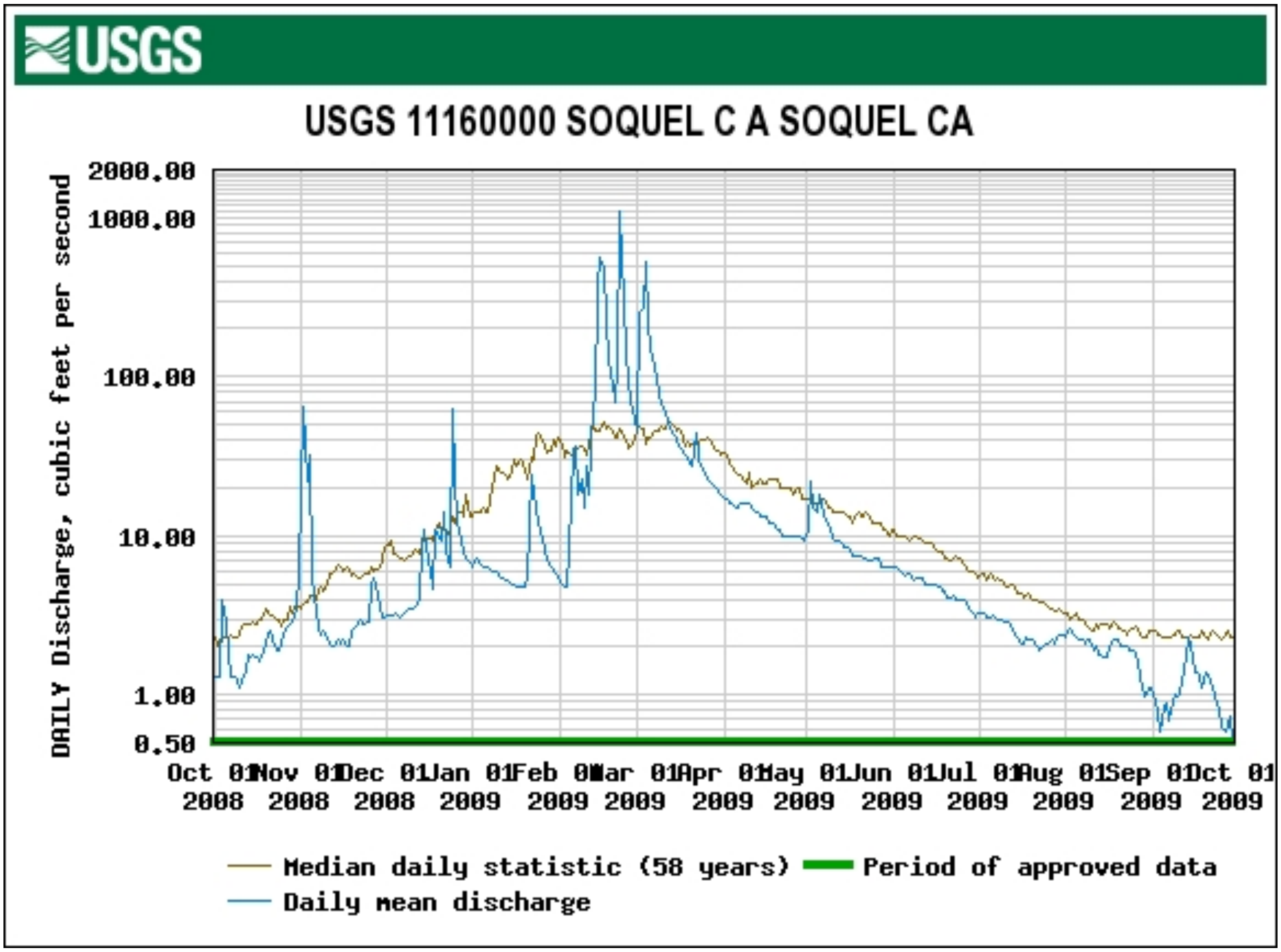


Figure 41. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2008.

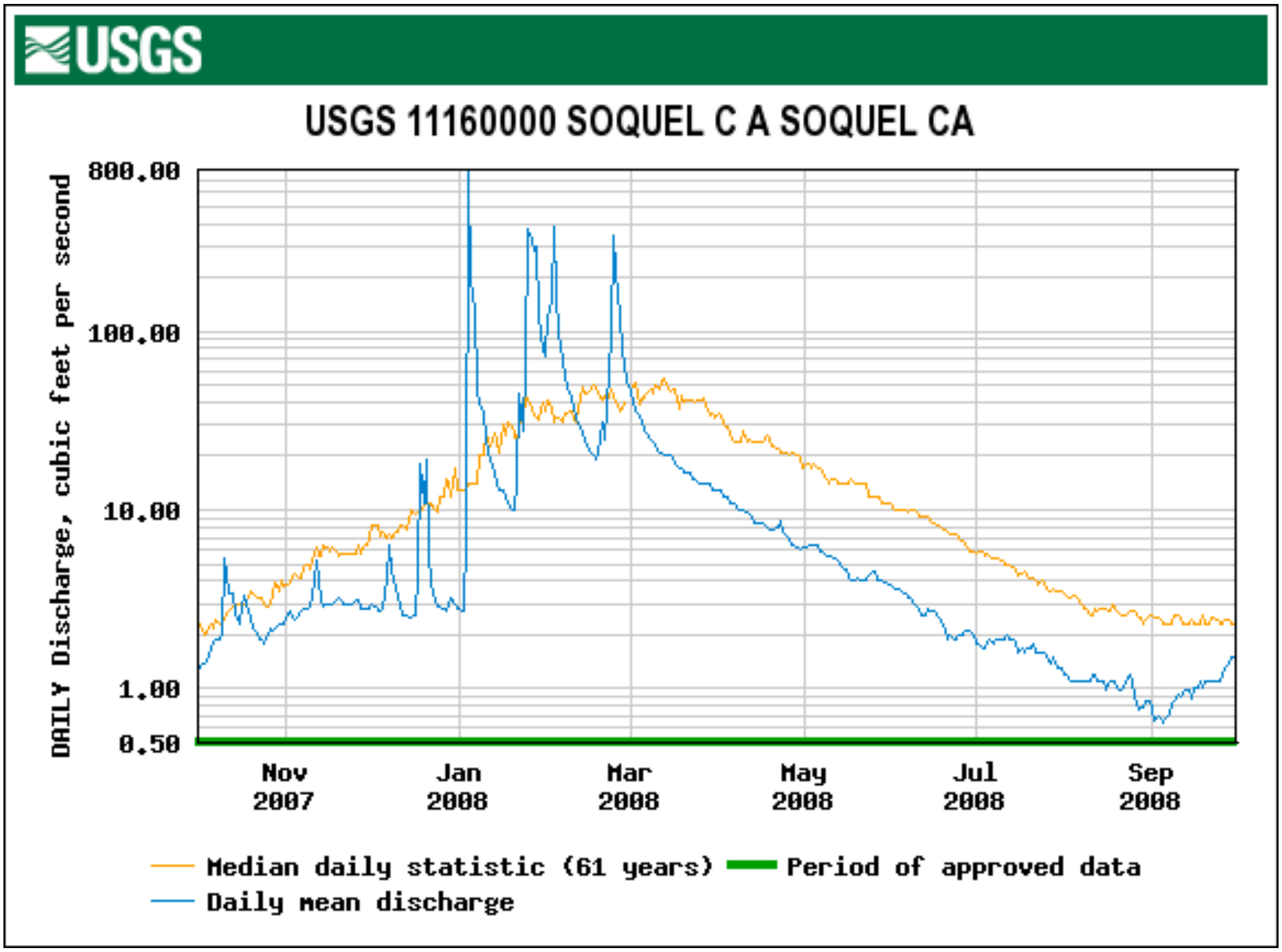


Figure 42. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2007.

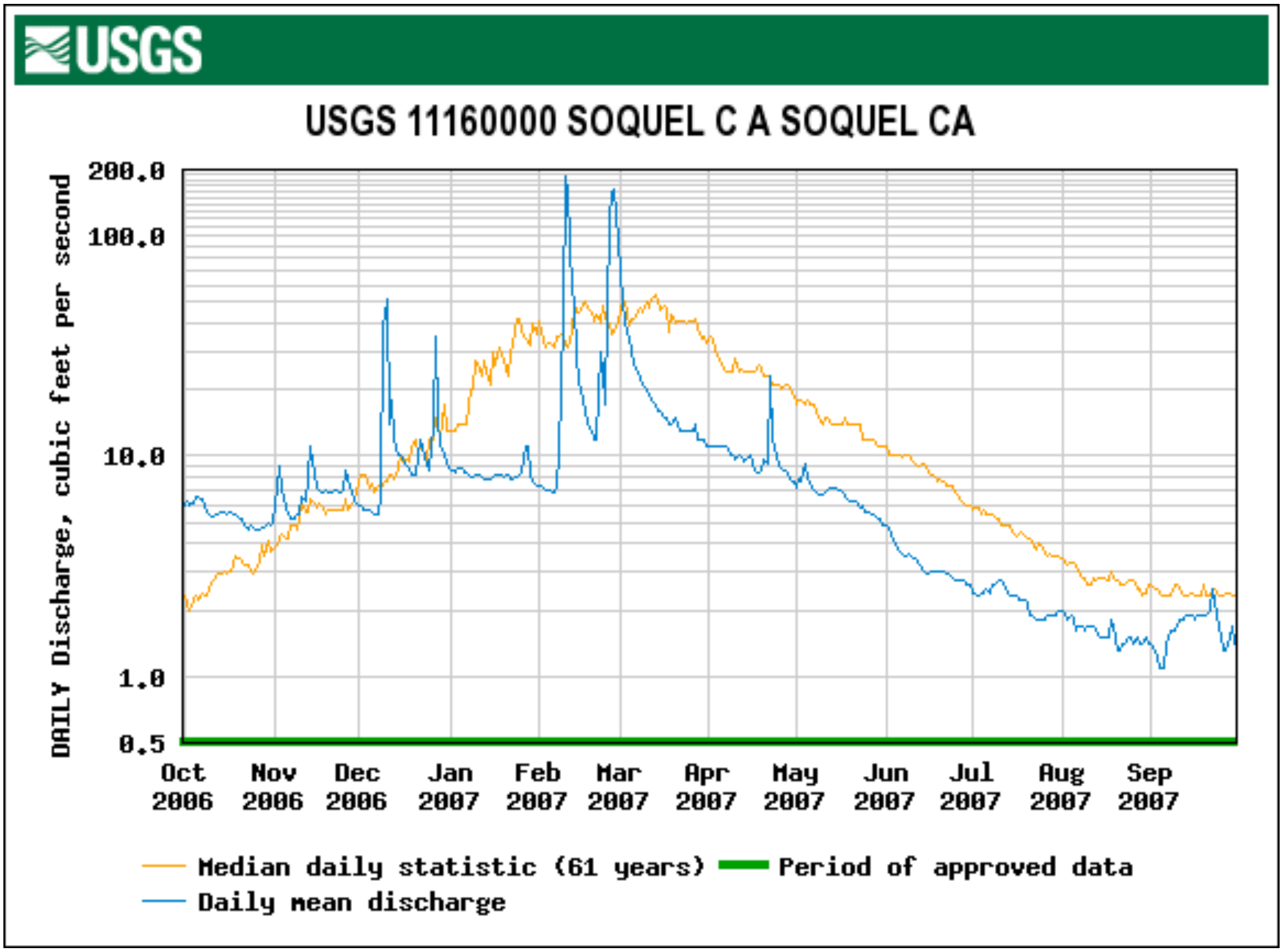


Figure 43. Maximum Visual Mallard Counts on Days of Water Quality Monitoring with a Closed Sandbar at Soquel Lagoon, 2012−2016.

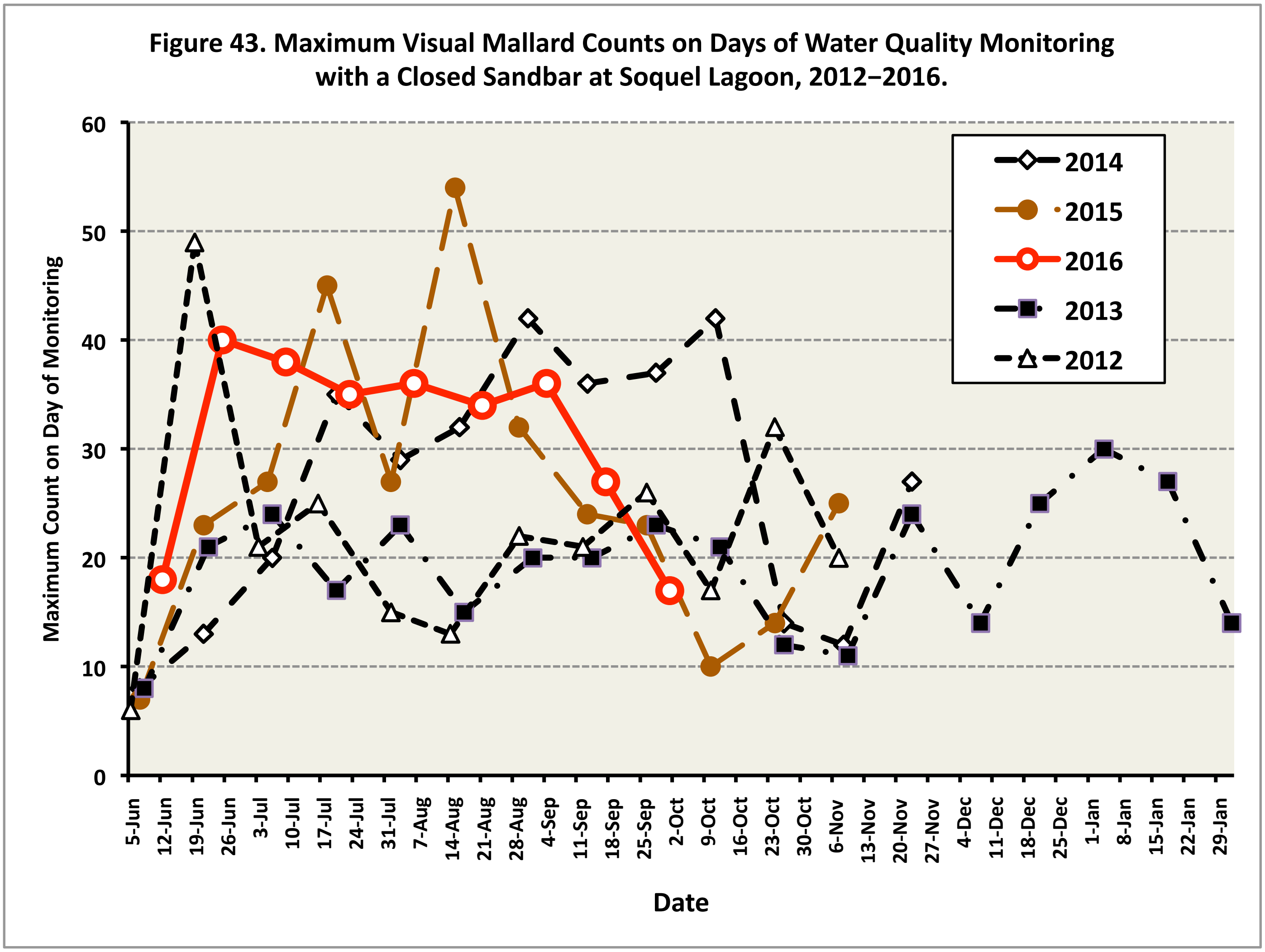
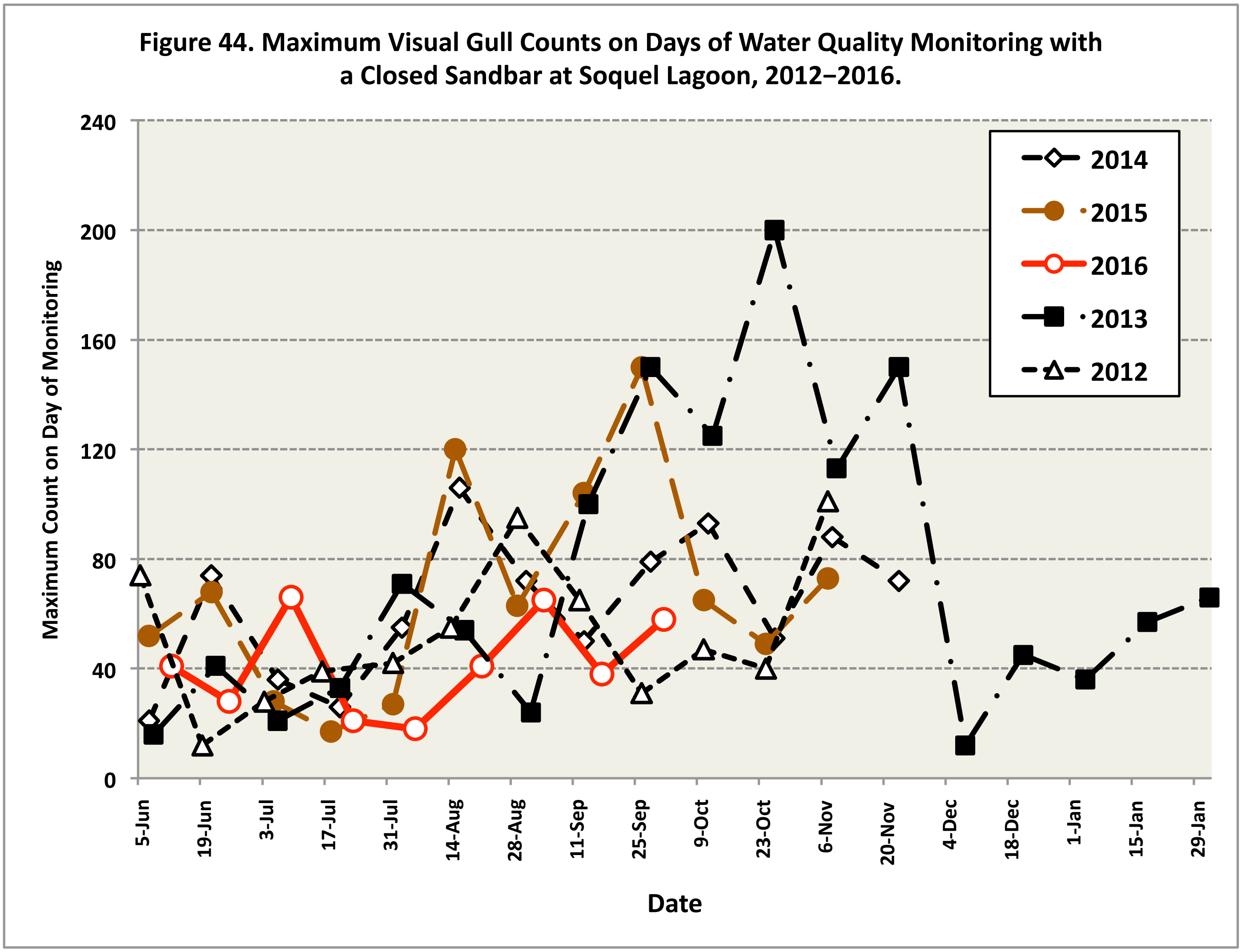


Figure 44. Maximum Visual Gull Counts on Days of Water Quality Monitoring with a Closed Sandbar at Soquel Lagoon, 2012–2016.



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

3 June 2016– 16 October 2016.

3 June 2016. The sandbar had been closed since 27 May. Temperature probes were launched on 4 June in the lagoon and upstream. The lagoon water surface was near the top of the flume on 3 June. An underwater portal was present for adult out-migrants. Gage height was 2.48. A very thin layer of dilute saltwater was detected along the Venetian Court wall on 3 June with elevated temperature at the bottom (see table below). The biologist recommended that a shroud was unnecessary for the flume inlet and it was not installed.

			3 June 2016					
	Venetian Court Wall 0923 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	18.7	0.4	9.17	703				
0.25	18.5	0.4	9.02	702				
0.50	18.5	0.4	9.07	698				
0.75	18.6	0.4	9.43	702				
1.00	18.5	0.4	9.75	714				
1.25	18.3	0.4	9.03	715				
1.50	18.3	0.4	8.82	714				
1.75	18.8	0.5	5.64	810				
1.85b	21.2	5.4	1.40	8952				
2.00								
2.25								
2.50								
2.75								

4 June 2016. Temperature probes were launched into the lagoon and upstream at Nob Hill.

			12-June 2016					
	Flume		0704 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	19.2	0.4	8.60	733	19.2	0.4	8.69	732
0.25	19.1	0.4	8.52	733	19.2	0.4	8.57	737
0.50	19.2	0.4	8.49	733	19.2	0.4	8.55	738
0.75	19.2	0.4	8.47 (92%)	734	19.3	0.4	8.30	749
1.00b	19.2	0.4	8.37	730	19.3	0.4	8.22	750
1.25					19.3	0.4	8.12	760
1.50					19.2	0.4	7.75 (84%)	744
1.60b					19.2	0.4	6.96	785
	Railroad Trestle			0735 hr	**Mouth of Noble Gulch**			0748 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	18.8	0.4	9.07	725	18.0	0.4	8.76	710
0.25	18.7	0.4	8.90	725	18.0	0.4	8.50	713
0.50	18.7	0.4	8.81	725	18.0	0.4	8.40	714
0.75	18.7	0.4	8.70	725	18.0	0.4	8.29	715
1.00	18.7	0.4	8.61 (92%)	724	18.0	0.4	8.22 (86%)	715
1.19b	17.6	0.4	8.22	720				
1.25b					17.9	0.4	8.00	713
1.50								
1.75								
2.00								

12 June 2016. The first complete water quality monitoring was accomplished after the sandbar had been closed on 27 May. The previous thin saltwater layer had dissipated along the Venetian wall. Water temperature was 18.2-20.4 ° C in the afternoon in the lagoon. Oxygen was 84-92% full saturation in the morning near the bottom and good. Inflow oxygen in the morning was 95% full saturation at Nob Hill. Oxygen was supersaturated in the afternoon at all stations measured near the bottom in the lagoon at the stream site near Nob Hill.

			12-June 2016					
	Flume		1547 hr		**Stockton Avenue Bridge**			1526 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	0.4	10.06	749	20.1	0.4	9.94	754
0.25	19.7	0.4	10.30	745	20.1	0.4	9.87	749
0.50	19.7	0.4	10.27	745	19.9	0.4	9.85	746
0.75	19.4	0.4	10.65 (116%)	740	19.8	0.4	9.92	741
1.00b	19.4	0.4	10.58	740	19.5	0.4	9.91	743
1.25					19.3	0.4	9.92	740
1.50					19.0	0.4	9.82 (106%)	741
1.75b					18.9	0.4	8.96	747
2.00								
2.25								
	Railroad Trestle			1511 hr	**Mouth of Noble Gulch**			1500 hr
Depth	**Temp 3**	**Salin 3**	**O2 3(sat.)**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4(sat.)**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	20.4	0.4	9.56	753	20.3	0.4	9.49	750
0.25	20.3	0.4	9.48	752	20.1	0.4	9.24	746
0.50	20.3	0.4	9.43	750	19.7	0.4	9.36	738
0.75	19.9	0.4	9.48	748	18.5	0.4	9.95	705
1.00	19.3	0.4	10.31(112%)	740	18.0	0.4	10.12	726
1.05b					18.2	0.4	9.31	722
1.20b	19.2	0.4	10.21	738				

12 June 2016. Gage height had declined from 3 June to 1.96 in morning and afternoon. Partly cloudy in morning and sunny in afternoon.
Station 1: Flume at 0704 hr- Air temp. 15.7 C. no surface algae. Reach 1- 10 gulls bathing; 1 female mallard and 7 ducklings. At 1547 hr- Air temp. 18.1 C. no surface algae. No phytoplankton bloom underway, 10% bottom algae 0.1-0.2 ft thick; averaging 0.1 ft. Reach 1- 41 gulls bathing. Three waders near beach berm. Flume entrance 1.0 ft deep; flume exit 0.8 ft deep.
Station 2: Stockton Avenue Bridge at 0717 hr- No surface algae. Secchi depth to bottom. Reach 2- 2 mallards in water. At 1526 hr- no surface algae, 15% bottom algae 0.1-0.3 ft thick, averaging 0.2 ft. No waterfowl in Reach 2. Four steelhead smolts observed near submerged log near bridge abutment.
Station 3: Railroad Trestle at 0735 hr- no surface algae. Reach 3- 2 mallards in water. At 1511 hr- no surface algae; 5% bottom algae 0.1-0.2 ft thick, averaging 0.1 ft. Reach 3- 8 adult mallards and 3 ducklings in water. Reach 3- 5 paddle boarders and 1 canoe.
Station 4: Mouth of Noble Gulch at 0748 hr. No surface algae. 2 mallards on downed cottonwood across from Gulch. 1500 hr. 10% bottom algae 0.1-0.3 ft thick, avg 0.2 ft. 1 female mallard and 6 ducklings roosting on cottonwood.
Station 5: Nob Hill at 0825 hr/ 1630 hr- Water temp. =15.6/18.4 C; oxygen= 9.46 (95%) saturation/10.45 mg/L (111%); cond. = 642/685 umhos. Salinity =0.4/0.4 ppt. Streamflow 6 cfs at Soquel Village gage.

25 June 2016. Afternoon water temperature cooler near the bottom than previous drought years. Morning oxygen levels were very good (87-101% full saturation). Lagoon depth was good. Inflow oxygen in the morning was 93% full saturation at Nob Hill. Afternoon oxygen was supersaturated in at all lagoon stations measured near the bottom and at the stream site near Nob Hill, more so than 2 weeks earlier.

			25-June-2016				
	Flume			0700 hr	**Stockton Avenue Bridge**		0712 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.8	0.4	9.02	753	20.1	0.4	9.07	757
0.25	19.8	0.4	9.20	752	20.1	0.4	9.02	759
0.50	19.8	0.4	9.22	754	20.1	0.4	9.24	759
0.75	19.8	0.4	9.24	753	20.1	0.4	9.21	759
1.00	19.8	0.4	9.23 (101%)	753	20.1	0.4	9.16	758
1.12b	19.8	0.4	9.11	753				
1.25					20.1	0.4	9.11	759
1.50					20.1	0.4	9.03 (99%)	758
1.75b					20.1	0.4	8.94	759
2.00								
2.25								
	Railroad Trestle			0730 hr	**Mouth of Noble Gulch**			0745 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.7	0.4	8.76	743	19.0	0.4	8.55	727
0.25	19.7	0.4	8.58	749	19.1	0.4	8.28	733
0.50	19.7	0.4	8.48	748	19.1	0.4	8.23	734
0.75	19.7	0.4	8.39	748	19.0	0.4	8.20	733
1.00	19.7	0.4	8.32	748	19.0	0.4	8.00 (87%)	732
1.25b	19.7	0.4	8.25 (90%)	748	18.9	0.4	7.71	732
1.32b	19.7	0.4	8.03	748				

25 June 2016. Gage height of 2.47 in morning. Clear at 0700 hr. Air temperature of 12.8 C.
Station 1: Flume 0700 hr. Reach 1- 3 gulls bathing, 4 mallards roosting on Venetian margin, 1 merganser in water. No surface algae.
Station 2: Stockton Bridge 0712 hr. Reach 2-1 mallard in water; 10 mallards and 1 cormorant roosting on trestle abutment. No surf. algae.
Station 3: Railroad trestle 0730 hr. Reach 3- 3 female and 12 mallard ducklings and 1 male mallard in water. One female with her 7 ducklings swam into Noble Gulch culvert.
Station 4: Noble Gulch 0745 hr. 2 mallards on cottonwood. No surface algae.
Station 5: **N**ob Hill at 0826 hr. Water temperature 15.9^{o} C. Conductivity 656 umhos. Salinity 0.4 ppt. Oxygen 9.15 mg/l (93% saturation). - 4.1 cfs at Soquel Village.

			25 June 2016					
	Flume			1558 hr	**Stockton Avenue Bridge**			1538 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	21.2	0.4	12.29	774	21.6	0.4	11.63	780
0.25	21.2	0.4	12.84	773	21.6	0.4	11.68	781
0.50	21.2	0.4	13.05	774	21.5	0.4	11.57	780
0.75	21.2	0.4	13.02	774	21.4	0.4	11.21	779
1.00	21.1	0.4	13.01 (146%)	773	21.3	0.4	11.38	777
1.05b	21.1	0.4	12.89	773				
1.25					21.3	0.4	11.27	776
1.50					20.9	0.4	11.25(126%)	772
1.75b					20.6	0.4	9.62	769
2.00								
	Railroad Trestle			1520 hr	**Mouth of Noble Gulch**			1500 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	21.9	0.4	10.83	785	22.2	0.4	10.51	806
0.25	21.7	0.4	11.07	784	22.0	0.4	10.44	793
0.50	21.6	0.4	11.10	783	21.8	0.4	10.45	787
0.75	21.6	0.4	11.08	782	21.4	0.4	10.40	779
1.00	21.3	0.4	10.91	781	19.5	0.4	11.14 (122%)	742
1.25b	20.6	0.4	11.48 (128%)	777	19.3	0.4	10.91	758
1.32b	20.5	0.4	11.15	776				

25 June 2016. Gage height of 2.50 in afternoon. Sunny/breezy. Air temperature of 18.4^{o} C at 1558 hr. Flume inlet = 1.1 ft. Flume outlet = 0.8 ft estimate with incoming tide.
Station 1: Flume 1558 hr. Reach 1- 28 gulls bathing; 2 paddle boarders; 8 waders. 15% bottom algae 0.5-1.0 ft thick, avg 0.7 ft. No surface algae.
Station 2: Stockton Bridge 1538 hr. Reach 2- no surface algae; 25% bottom algae 0.5-1.0 ft thick, avg 0.7 ft. 2 females with 8 ducklings.
Station 3: Railroad trestle 1520 hr. Reach 3- 1 female mallard with 6 ducklings; 19 other mallards in water, No surface algae. 20% bottom algae 0.2-0.5 ft thick; avg 0.3 ft. No surface algae.
Station 4: Noble Gulch 1500 hr. 4 mallard on cottonwood. 25% bottom algae 0.1-0.8 ft thick; avg 0.4 ft. <1% surface algae.
Station 5: Nob Hill at 1637 hr. Water temperature 19.9^{o} C. Conductivity 717 umhos. Salinity 0.4 ppt. Oxygen 10.57 mg/l (116%). 3.8 cfs at Soquel Village.

			9 July 2016					
	Flume 0658 hr				**Stockton Avenue Bridge** 0709 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	20.0	0.4	9.47	776	20.2	0.4	9.78	678
0.25	20.0	0.4	9.75	764	20.2	0.4	9.94	678
0.50	20.0	0.4	9.78 (108%)	763	20.2	0.4	9.96	767
0.70b	20.0	0.4	9.76	691				
0.75					20.2	0.4	9.95	768
1.00					20.2	0.4	9.96	768
1.25					20.2	0.4	9.93	768
1.50					20.2	0.4	9.98 (108%)	768
1.75					20.2	0.4	9.30	768
2.00								
	Railroad Trestle 0730 hr				**Mouth of Noble Gulch**			0748 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	0.4	9.11	761	19.3	0.4	9.12	740
0.25	19.9	0.4	9.19	763	19.3	0.4	8.93	745
0.50	20.0	0.4	9.12	764	19.3	0.4	8.87	746
0.75	19.9	0.4	9.07	763	19.3	0.4	8.94	746
1.00	19.9	0.4	8.86	762	19.2	0.4	8.70 (95%)	746
1.25b	19.8	0.4	8.71 (96%)	761	18.8	0.4	7.46	726
1.33b	19.8	0.4	8.34	760				
1.50								

9 July 2016. Gage height of 2.66 in morning. Clear. Air temp. = 15.5° C at 0658 hr.

Station 1: Flume 0658 hr. Reach 1- 7 mallards roosting at Venetian margin, 3 mallards in water, 5 gulls bathing. No surface algae.
Station 2: Stockton Bridge 0709 hr. Reach 2- 8 adult mallards roosting on trestle abutment, 4 ducklings without mother and 1 gull in water. No surface algae.
Station 3: Railroad trestle 0730 hr. Reach 3- In water- 1 female mallard found her 4 ducklings from Reach 2. 3 other adult mallards in water. 1 pied billed grebe near Noble Gulch. <1% surface algae.
Station 4: Noble Gulch 0748 hr. 3 mallards on cottonwood. No surface algae.
Station 5: Nob Hill at 0835 hr. Water temperature 16.3° C. Conductivity 667 umhos. Salinity 0.4 ppt. Oxygen 9.04 mg/l (92% saturation). 3.1 cfs at Soquel Village.

			9 July 2016					
	Flume			1555 hr	**Stockton Avenue Bridge**			1535 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	21.3	0.4	11.44	783		0.4	11.38	786
0.25	21.2	0.4	12.35	781		0.4	11.61	787
0.50	21.1	0.4	12.61 (142%)	779		0.4	11.68	787
0.75b	21.1	0.4	12.60	779		0.4	11.64	787
1.00						0.4	11.45	785
1.25						0.4	11.30	785
1.50						0.4	11.32 (127%)	777
1.75b						0.4	11.54	776
2.00								
	Railroad Trestle			1515 hr	**Mouth of Noble Gulch**			1501 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	0.4	10.83	807	22.8	0.4	10.10	812
0.25	22.1	0.4	11.01	799	22.3	0.4	10.36	805
0.50	21.9	0.4	11.04	797	21.9	0.4	10.47	798
0.75	21.7	0.4	11.05	794	21.2	0.4	10.59	794
1.00	21.1	0.4	12.55	788	20.1	0.4	11.52 (127%)	764
1.25b	20.9	0.4	12.95 (145%)	789	19.8	0.4	12.00	769
1.32b	20.7	0.4	12.87	784				
1.50								

9 July 2016. Gage height of 2.69 in afternoon. Clear. Air temperature of 20.4°C at 1555 hr. Flume inlet approx. 1.2 ft depth. Flume exit depth 0.6 ft.

Station 1: Flume at 1555 hr. Reach 1- 64 gulls bathing, 1 female and 4 small ducklings (likely from Reach 3). 4 waders near flume. No surface algae. 80% bottom algae 0.2-1.0 ft thick, avg 0.3 ft.
Station 2: Stockton Avenue Bridge at 1535 hr. Secchi depth to bottom. Reach 2- No surface algae. 1 female mallard and 6 ducklings in water (likely from Reach 4) with 1 pied billed grebe. 60% bottom algae 0.1-1.0 ft, avg 0.2 ft. Remainder thin algal film
Station 3: Railroad Trestle at 1515 hr. Reach 3- No surface algae. 40% bottom algae 0.1-0.4 ft thick, avg 0.1 ft. Remainder thin algal film. 2 gulls, 33 adult mallards and 5 ducklings being fed a Noble Gulch and then from a barge with 6 people.
Station 4: Mouth of Noble Gulch at 1501 hr. 70% bottom algae 0.1-0,3 ft thick, avg 0.2 ft. 5% surface algae. No waterfowl on downed cottonwood.
Station 5: Nob Hill at 1635 hr. Water temperature 20.7°C. Conductivity 739 umhos. Salinity 0.4 ppt. Oxygen 9.62 mg/l (107%). 2.6 cfs at Soquel Village.

			23-July-2016					
	Flume 0700 hr				**Stockton Avenue Bridge** 0715 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**mg/l (% sat.)**	**umhos**	**(C)**	**(ppt)**	**mg/l (% sat.)**	**Umhos**
0.00	20.4	0.4	9.29	777	20.6	0.4	9.45	782
0.25	20.5	0.4	9.44	779	20.6	0.4	9.46	786
0.50	20.5	0.4	9.54 (106%)	778	20.7	0.4	9.44	785
0.75b	20.5	0.4	9.39	779	20.7	0.4	9.37	786
1.00					20.7	0.4	9.34	786
1.25					20.7	0.4	9.21	785
1.50					20.7	0.4	9.22 (100%)	788
1.75b					20.9	0.4	7.11	786
2.00								
	Railroad Trestle 0732 hr				**Mouth of Noble Gulch**			0749 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	20.4	0.4	9.11	775	19.7	0.4	9.18	748
0.25	20.4	0.4	8.98	781	19.7	0.4	9.04	762
0.50	20.4	0.4	8.91	781	19.7	0.4	8.86	762
0.75	20.4	0.4	8.87	781	19.7	0.4	8.87	761
1.00	20.4	0.4	8.87	780	19.7	0.4	8.88 (97%)	759
1.25b	20.3	0.4	8.16 (90%)	779	19.2	0.4	7.92 (86%)	741
1.30b					19.2	0.4	6.39	735
1.40b	20.3	0.4	7.48	779				

23 July 2016. Gage height of 2.62 in morning. Light fog. Air temperature of 12.40°C at 0700 hr.

Station 1: Flume at 0700 hr. Reach 1- 21 gulls bathing, 7 mallards in water No surface algae.
Station 2: Stockton Avenue Bridge at 0715 hr. Reach 2- 2 mallards and 1 pied billed grebe in water. No surface algae. Pondweed under trestle east side 1 ft thick.
Station 3: Railroad Trestle at 0732 hr. Reach 3- 6 mallards, 1 pied-billed grebe and 1 cormorant in water. 40 steelhead hits/ minute. No surface algae.
Station 4: Mouth of Noble Gulch at 0749 hr. 3 mallards on cottonwood. No surface algae.
Station 5: Nob Hill at 0830 hr. Water temperature 15.8° C. Conductivity 656 umhos. Oxygen 8.69 mg/1 (88% full saturation). Salinity 0.4 ppt. 2.1 cfs at Soquel Village.

			23-July-2016					
	Flume 1608 hr				**Stockton Ave Bridge** 1547 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**mg/l (% sat.)**	**umhos**	**(C)**	**(ppt)**	**mg/l (% sat.)**	**Umhos**
0.00	21.7	0.4	12.19	796	21.9	0.4	11.66	799
0.25	21.6	0.4	12.34	795	21.9	0.4	11.62	801
0.50	21.6	0.4	12.48 (142%)	794	21.9	0.4	11.69	803
0.75b	21.6	0.4	12.44	795	21.9	0.4	11.65	802
1.00					21.8	0.4	11.48	802
1.25					21.7	0.4	11.18	802
1.50					21.3	0.4	10.97 (124%)	797
1.75b					21.1	0.4	10.74	789
2.00								
	Railroad Trestle 1534 hr				**Mouth of Noble Gulch** 1500 hr			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**mg/l (% sat.)**	**umhos**	**(C)**	**(ppt)**	**mg/l (% sat.)**	**Umhos**
0.00	22.2	0.6	11.31	810	22.4	0.4	10.40	817
0.25	22.3	0.6	11.40	809	22.2	0.4	10.33	810
0.50	22.2	0.6	11.51	809	21.9	0.4	10.41	807
0.75	22.0	0.6	11.80	807	21.6	0.4	10.40	800
1.00	21.8	0.6	13.14	804	20.6	0.4	11.20	790
1.25b	21.6	0.6	13.03 (148%)	810	20.4	0.4	12.19	804
1.40b	21.2	0.6	11.72	803				
1.50								

<u>23 July 2016.</u> Gage height of 2.62 in afternoon. Clear. Air temp. = 18.6^{o} C at 1608 hr.

Station 1: Flume at 1608 hr. Reach 1- 14 gulls. No surface algae. 70% bottom algae 0.2-1.5 ft thick, avg 0.3 ft. 1 canoe. 1 kayak. 8-14 swimmers/waders near flume.
Station 2: Stockton Avenue Bridge at 1547 hr. Secchi depth to bottom. Reach 2- No surface algae. 50% of the bottom algae 0.2-1.5 ft thick, remainder film. 2 mallards in water. Later 8 mallards from Reach 3. No surface algae.
Station 3: Railroad Trestle at 1534 hr. Reach 3- No surface algae. 30% bottom algae 0.2-1.0 ft thick, avg 0.3 ft. <1% pondweed with attached algae 1 ft thick. 30 adult mallards and 3 ducklings in water with 1 pied billed grebe. 2 kayaks and 4 paddle boarders. 1 barge feeding ducks.
Station 4: Mouth of Noble Gulch at 1500 hr. No surface algae. 80% bottom algae 0.2-1.5 ft thick, avg 0.3. Remainder algal film. No waterfowl on cottonwood. 2 people feeding ducks at Noble Gulch.
Station 5: Nob Hill at 1657 hr. Water temperature 19.2 ^{o}C. Conductivity 701 umhos. Oxygen 9.83 mg/L (107% full saturation). Salinity 0.4 ppt. 1.8 cfs at Soquel Village.

			6-Aug-2016					
	Flume 0722 hr				**Stockton Avenue Bridge** 0735 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.8	0.4	9.77	773	20.0	0.4	9.65	780
0.25	19.9	0.4	9.79	778	20.0	0.4	9.59	783
0.50	19.9	0.4	9.84 (108%)	778	20.1	0.4	9.37	783
0.70b	19.9	0.4	9.78	778				
0.75					20.1	0.4	9.34	784
1.00					20.1	0.4	9.48	784
1.25					20.1	0.4	9.50	783
1.50					20.1	0.4	9.40 (104%)	784
1.75b					20.1	0.4	8.93	785
2.00								
	Railroad Trestle 0752 hr				**Mouth of Noble Gulch** 0807 hr			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	19.8	0.4	8.81	778	19.1	0.4	9.75	748
0.25	19.8	0.4	8.47	783	19.2	0.4	9.51	759
0.50	19.8	0.4	8.22	783	19.2	0.4	9.48	760
0.75	19.8	0.4	8.03	782	19.2	0.4	9.41	760
1.00	19.8	0.4	7.88	782	19.2	0.4	9.40 (102%)	760
1.25b	19.8	0.4	7.92 (82%)	782	19.0	0.4	2.45	762
1.37b	19.8	0.4	7.49	782				

6 August 2016. Gage height of 2.61 (morning) and 2.61 (afternoon). Overcast/misty at 0722 hr with air temperature of 13.4 ° C at flume. Air temperature cool 17.5 ° C at 1619 hr at flume and clear. Flume inlet 1 ft deep. Flume outlet 0.5 ft deep in afternoon.

Station 1: Flume at 0722 hr. Reach 1- In water 18 gulls bathing, 18 mallards came to me at Venetian margin from Reach 2 during measurements. No surface algae.
Station 2: Stockton Avenue Bridge at 0735 hr. Secchi depth to the bottom. Reach 2- 13 mallards in water; No surface algae.
Station 3: Railroad trestle at 0752 hr. Reach 3- 5 mallards and 1 cormorant in water. No surface algae.
Station 4: Mouth of Noble Gulch at 0807 hr. No surface algae. No waterfowl on cottonwood.
Station 5: Nob Hill at 0840 hr. Water temperature at 16.1°C. Conductivity 644 umhos, Oxygen 8.88 mg/L (90%). Salinity 0.4 ppt. Estimated streamflow = 2.1 cfs at Soquel Village. (Fluctuated between 1.8 and 2.1 cfs throughout day.)

			6-Aug-2016					
	Flume 1619 hr				**Stockton Avenue Bridge** 1607 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	0.4	10.02	782	20.6	0.4	10.34	786
0.25	20.5	0.4	10.75	785	20.6	0.4	10.57	790
0.50	20.5	0.4	11.05 (123%)	785	20.6	0.4	10.51	790
0.70b	20.6	0.4	11.09	786				
0.75					20.6	0.4	10.51	790
1.00					20.4	0.4	10.36	789
1.25					20.2	0.4	10.18	785
1.50					20.2	0.4	10.12 (111%)	785
1.75b					20.0	0.4	9.23	783
2.00								
	Railroad Trestle 1554 hr				**Mouth of Noble Gulch** 1537 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	20.5	0.4	10.16	788	20.3	0.4	8.67	783
0.25	20.5	0.4	10.22	789	20.3	0.4	9.58	782
0.50	20.5	0.4	10.18	788	20.1	0.4	9.48	779
0.75	20.4	0.4	10.28	787	19.8	0.4	9.49	776
1.00	20.4	0.4	10.30	787	19.4	0.4	9.23 (100%)	770
1.25b	20.3	0.4	10.35 (115%)	785	19.4	0.4	9.09	797
1.37b	20.3	0.4	10.15	784				

6 August 2016.

Station 1: Flume at 1619 hr. Reach 1- 12 gulls. 8 waders near flume. No surface algae. 90% bottom algae 0.5-1.5 ft thick; avg 1.0 ft.

Station 2: Stockton Avenue Bridge at 1607 hr. Reach 2- Water soup green from planktonic algal bloom. 100% bottom algae 0.1-2 ft thick; avg 0.4 ft. No surface algae. 1 mallard in water.

Station 3: Railroad trestle at 1554 hr. Reach 3- No surface algae. 90% bottom algae 0.1-2 ft thick, averaging 0.3 ft; <1% pondweed + algae 1 ft thick. 20 mallards, 2 mergansers in water. 2 kayaks, 1 paddleboard.

Station 4: Mouth of Noble Gulch at 1537 hr. No surface algae. 90% of bottom covered by algae 0.2 – 1.0 ft thick, averaging 0.5 ft. 1 mallard roosting on cottonwood. 1 mallard roosting on boulder riprap near Noble Gulch.

Station 5: Nob Hill at 1709 hr. Water temperature at 17.1°C. Conductivity 648 umhos, Oxygen 9.77 mg/l (102%). Salinity 0.4 ppt. 1.8 cfs at Soquel Village

			21-Aug-2016					
	Flume 0716 hr				**Stockton Avenue Bridge** 0729 hr			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 umhos**
0.00	19.3	0.4	10.16	765	19.3	0.4	9.94	763
0.25	19.3	0.4	10.28	767	19.3	0.4	9.96	767
0.50	19.3	0.4	10.33 (112%)	676	19.3	0.4	10.04	767
0.75b	19.3	0.4	10.20	766	19.4	0.4	9.43	770
1.00					19.4	0.4	9.29	770
1.25					19.4	0.4	9.19	770
1.50					19.4	0.4	9.57 (104%)	768
1.75b					19.4	0.4	9.27	676
2.00								
2.25								
	Railroad Trestle 0745 hr				**Mouth of Noble Gulch** 0800 hr			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	19.1	0.4	8.79	763	18.4	0.4	9.35	740
0.25	19.1	0.4	8.43	771	18.4	0.4	9.41	744
0.50	19.1	0.4	8.36	772	18.4	0.4	9.39	743
0.75	19.1	0.4	8.30	772	18.4	0.4	9.37	743
1.00	19.0	0.4	7.98 (86%)	770	18.3	0.4	8.76 (93%)	742
1.25b	18.9	0.4	6.33 (68%)	778	17.8	0.4	4.24	762
1.32b	18.9	0.4	5.59	778				

21 August 2016. Gage height of 2.60 (morning) and 2.62 (afternoon). Overcast/fog at 0716 hr with air temperature of 14.4 °C at flume. Air temperature 19.0 °C at 1559 hr and clear. Flume inlet 0.9 ft. Flume outlet 0.4 ft in afternoon at flume.
Station 1: Flume at 0716 hr. Reach 1- 26 gulls bathing with 10 mallards and 2 mergansers in water. 21 mallards on Venetian margin. No surface algae. Ducks seem hungry and seen foraging on beach.
Station 2: Stockton Avenue Bridge at 0729 hr. Reach 2- 3 mallards in water. 2 greenback herons flue toward beach. No surface algae.
Station 3: Railroad trestle at 0745 hr. Reach 3- 5 mallards and 1 pied-billed grebe in water. No surface algae.
Station 4: Mouth of Noble Gulch at 0800 hr. No surface algae. 1 mallard roosting on cottonwood.
Station 5: Nob Hill at 0839 hr. Water temperature at 16.2°C. Conductivity 640 umhos, Oxygen 7.75 mg/l (79%). Salinity 0.4 ppt. Estimated streamflow = 1.8 cfs at Soquel Village.

			21-Aug-2016					
	Flume 1559 hr				**Stockton Avenue Bridge** 1534			
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	20.4	0.4	11.80	788	20.3	0.4	12.08	783
0.25	20.2	0.4	12.99	784	20.3	0.4	12.21	783
0.50	20.0	0.4	13.85 (153%)	776	20.2	0.4	12.34	782
0.75b	20.0	0.4	13.44	775	20.2	0.4	12.69	782
1.00					20.0	0.4	12.59	778
1.25					19.9	0.4	12.31	778
1.50					19.5	0.4	12.10 (131%)	772
1.75b					19.2	0.4	9.78	768
2.00								
2.25								
	Railroad Trestle 1516 hr				**Mouth of Noble Gulch** 1501 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	20.3	0.4	11.93	783	20.7	0.4	11.27	796
0.25	20.2	0.4	12.14	783	20.4	0.4	11.53	786
0.50	20.2	0.4	12.22	783	20.1	0.4	11.67	783
0.75	20.2	0.4	12.36	781	19.3	0.4	11.42	769
1.00	20.1	0.4	12.38	780	18.9	0.4	11.24 (121%)	791
1.25b	19.6	0.4	13.12 (143%)	774	18.9	0.4	10.91	794
1.35b	19.5	0.4	12.54	770				

21 August 2016.

Station 1: Flume at 1559 hr. Reach 1- 41 gulls bathing. No surface algae; 45% bottom algal coverage 0.5 – 1.5 ft thick, avg. = 1 ft. 15% pondweed + algae 1.5-2.5 ft thick, avg 2 ft.

Station 2: Stockton Avenue Bridge at 1534 hr. Secchi depth to the bottom. Reach 2- No surface algae. 100% of bottom covered by algae 0.5 – 3 ft thick, averaging 1.5 ft. 2 cormorants in water.

Station 3: Railroad trestle at 1516 hr. Reach 3- No surface algae. 99% of bottom covered by algae 0.3 - 2 ft thick, averaging 1.0 ft. <1% pondweed + algae 2.0 ft thick. 11 mallards in water. 2 paddle boards, 2 kayaks, 1 barge.

Station 4: Mouth of Noble Gulch at 1501 hr. No surface algae. 80% of bottom covered with algae 0.2- 1.5 ft thick; averaging 1 feet. Soupy planktonic algal bloom. No waterfowl on cottonwood.

Station 5: Nob Hill at 1637 hr. Water temperature at 18.5°C. Conductivity 675 umhos, Oxygen 10.69 mg/l (114%). Salinity 0.4 ppt. 1.8 cfs at Soquel Village.

			4-Sep-2016					
	Flume 0731 hr				**Stockton Avenue Bridge** 0745 hr			
Depth (m)	**Temp 1 (C)**	**Salin 1 (ppt)**	**O2 1 (mg/l)**	**Cond 1 umhos**	**Temp 2 (C)**	**Salin 2 (ppt)**	**O2 2 (mg/l)**	**Cond 2 umhos**
0.00	19.4	0.4	9.76	760	19.8	0.4	10.06	761
0.25	19.5	0.4	10.14	764	19.9	0.4	10.33	771
0.50	19.5	0.4	10.25 (112%)	764	19.9	0.4	10.45	772
0.75b	19.5	0.4	10.22	764	20.0	0.4	10.58	772
1.00					20.0	0.4	10.26	773
1.25					20.0	0.4	10.24	772
1.50					19.9	0.4	10.22 (113%)	772
1.75b					19.9	0.4	10.25	778
2.00								
2.25								
	Railroad Trestle 0800 hr				**Mouth of Noble Gulch** 0814 hr			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)**	**Cond 4 umhos**
0.00	19.4	0.4	9.74	765	18.4	0.4	8.27	746
0.25	19.4	0.4	9.80	765	18.4	0.4	7.95	758
0.50	19.4	0.4	9.82	766	18.4	0.4	7.66	758
0.75	19.4	0.4	9.82	766	18.4	0.4	7.76	758
1.00	19.4	0.4	9.53	767	18.4	0.4	7.77 (83%)	758
1.25b	19.4	0.4	9.63 (105%)	767	18.4	0.4	3.75	760
1.32b	19.4	0.4	9.34	767				
1.50								

4 September 2016. **Begonia Festival Day.** Gage height of 2.60 (morning) and 2.62 (afternoon). Clear morning. At 0731 hr- air temperature of 11.7 ° C. Air temperature 17.8 ° C at 1556 hr and clear/breezy.

Procession with 7 floats (4 powered by electric motor, 2 powered by boat paddlers, 1 powered by paddle boarders). No people wading. 16 other paddleboards, kayaks and canoes. 3 barges with people onboard. Boy Scout Troop 609 will clean up begonias and dismantle floats. The trestle was labeled with no trespassing stenciling. Police tape was strung across both entrances of the trestle. These were broken by spectators on the trestle.

Station 1: Flume at 0731 hr. Reach 1- 33 gulls. 9 mallards in water. I kayak. No surface algae.
Station 2: Stockton Avenue Bridge at 0745 hr. Reach 2-9 mallards on trestle abutment and 2 mallards moved up from Reach 1in water. 2 kayaks. <1% surface algae.
Station 3: Railroad trestle at 0800 hr. Reach 3- 15 mallards and 1 coot in water. <1% surface algae.
Station 4: Mouth of Noble Gulch at 0814 hr. 2 mallards on cottonwood. 10% surface algae.
Station 5: Nob Hill at 0901 hr. Water temperature at 15.2°C. Conductivity 625 umhos, Oxygen 8.39 mg/l (84%). Salinity 0.4 ppt. Estimated streamflow = 1.4 cfs at Soquel Village.

			4-Sep-2016					
	Flume 1556 hr				**Stockton Avenue Bridge** 1537 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	21.1	0.4	13.73	783	21.1	0.4	13.28	
0.25	21.1	0.4	14.78	784	21.1	0.4	13.46	
0.50	21.1	0.4	15.40 (173%)	783	21.2	0.4	13.43	
0.75b	21.1	0.4	15.68 (177%)	783	21.0	0.4	12.83	
1.00					20.9	0.4	13.22	
1.25					20.8	0.4	12.97	
1.50					20.7	0.4	12.48 (139%)	
1.75b					20.2	0.4	9.61	
2.00								
2.25								
	Railroad Trestle 1515 hr				**Mouth of Noble Gulch** 1500 hr			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	21.1	0.4	12.42	792	21.0	0.4	11.05	812
0.25	21.1	0.4	12.85	792	20.8	0.4	11.17	804
0.50	21.0	0.4	13.00	791	20.6	0.4	11.34	20.6
0.75	20.9	0.4	13.01 (146%)	791	20.3	0.4	10.90	20.3
1.00	20.8	0.4	12.84 (145%)	792	20.1	0.4	11.10 (121%)	20.1
1.25b	20.8	0.4	12.27 (137%)	791	19.9	0.4	10.67	19.9
1.34b	20.5	0.4	11.50	789				

4 September 2016. Very few blossoms in the water after procession.

Station 1: Flume at 1556 hr. Reach 1- In water- 65 gulls. <1% surface algae. 15% bottom algal coverage at 1 -4 ft thick, avg. =1.5 ft. 20% pondweed + algae at 2 - 3 ft thick. 2 boats, 2 paddle boards.
Station 2: Stockton Avenue Bridge at 1537 hr. Secchi depth to the bottom. Reach 2- no waterfowl in water. Bottom algae 95% coverage 0.5-4 ft thick; avg. 1.5 ft. <1% surface algae.
Station 3: Railroad trestle at 1515 hr. Reach 3- 4 mergansers in water, 2 swimmers, 5 boats, 3 paddle boards. 95% bottom algae 0.5-4 ft thick, avg 1.5ft. 1% pondweed with attached algae 2 ft thick. 2% surface algae.
Station 4: Mouth of Noble Gulch at 1500 hr. 15% surface algae. 65% bottom algae 0.2 – 3.5 ft thick, averaging 0.8 ft.
Station 5: Nob Hill at 1650 hr. Water temperature at 17.2°C. Conductivity 648 umhos, Oxygen 9.70 mg/l (101%). Salinity 0.4 ppt. Streamflow 1.2 cfs at Soquel Village.

			17-Sep-2016					
	Flume			0713 hr	**Stockton Avenue Bridge**			0725 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.9	0.4	10.25	730	18.1	0.4	10.63	729
0.25	18.0	0.4	10.45	732	18.2	0.4	10.77	736
0.50	18.0	0.4	10.48 (111%)	732	18.2	0.4	10.79	737
0.70b	17.9	0.4	10.41	732				
0.75					18.3	0.4	10.17	737
1.00					18.3	0.4	10.39	737
1.25					18.3	0.4	10.44	739
1.50					18.3	0.4	10.27 (111%)	739
1.75b					18.3	0.4	10.18	738
	Railroad Trestle			0744 hr	**Mouth of Noble Gulch**			0756 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.0	0.4	9.72	737	17.3	0.4	8.98	725
0.25	18.0	0.4	9.86	737	17.4	0.4	8.73	729
0.50	18.1	0.4	9.87	738	17.4	0.4	8.85	727
0.75	18.1	0.4	9.90	738	17.4	0.4	8.74	728
1.00	18.1	0.4	9.87	738	17.4	0.4	8.69 (91%)	729
1.25b	18.1	0.4	9.81 (104%)	738	17.8	0.4	4.72	881
1.35b	18.1	0.4	9.23	738				

17 September 2016. Gage height of 2.60 (morning) and 2.60 (afternoon). Foggy in morning and clear in afternoon. Air temperature of 12.0˚ C at 0713 hr and 16.8 ° C at 1601 hr. Flume inlet 1.0 ft and exit 0.5 ft in afternoon. Notch constructed in sandbar with berms near lagoon margin and out near surf. A berm has been elevated around the lagoon margin.

Station 1: Flume at 0713 hr- Reach 1- 26 gulls bathing, 2 mallards in water, 5 mallards on Venetian margin. No surface algae. Flume at 1601 hr- Reach 1- 38 gulls bathing, 10 mallards in water (8 were begging at Margaritaville). 2% surface algae. 30% pondweed + algae 3-5 ft thick, averaging 4.5 ft thick. 80% bottom algae 0.5-2.0 ft thick, averaging 1 ft.

Station 2: Stockton Avenue Bridge at 0725 hr- Reach 2 mallards and 2 coots in water. No surface algae. Reach 2 at 1549 hr-. Secchi depth to bottom. 4 mallards, 1 gull in water. No surface algae. 80% of bottom covered with algae 0.3-3.0 ft thick, averaging 1ft thick. 15% pondweed + algae 2 – 5.0 ft thick, averaging 3 ft. 2% surface algae.

Station 3: Railroad trestle at 0744 hr- Reach 3- 8 mallards dabbling in water; greenback heron and black crown night heron in riparian. No surface algae. At 1526 hr- 12 mallards, 1 coot, 2 gulls, 1 merganser in water. <1% surface algae. 80% of bottom covered with algae 0.2-3.0 ft thick, avg 0.5 ft. 15% pondweed + algae 0.5- 2 ft thick, averaging 1.0 ft.

Station 4: Mouth of Noble Gulch at 0830 hr- 1 mallard on cottonwood. No surface algae. At 1501 hr- 1 mallard and 1 merganser on cottonwood. <1% surface algae. 80% bottom algae coverage 1-3 ft thick, avg 15.5 ft.

Station 5: Nob Hill at 0828 hr. Water temperature at 14.8 °C. Conductivity 607 umhos, Oxygen 8.29 mg/l (82% saturation). Salinity 0.4 ppt. 1.4 cfs at Soquel Village in the morning. Nob Hill at 1632 hr. Water temperature 16.9 ° C. Oxygen 10.79 mg/l (101%). Conductivity 648 umhos. Salinity 0.4 ppt. Streamflow estimate- 1.2 cfs at Soquel Village in the afternoon.

			17-Sep-2016					
	Flume			1601 hr	**Stockton Avenue Bridge**			1549 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.2	0.4	14.42	746	19.4	0.4	13.78	752
0.25	19.2	0.4	15.53	747	19.4	0.4	14.05	753
0.50	19.2	0.4	16.17 (175%)	746	19.4	0.4	14.12	752
0.70b	19.2	0.4	16.14	746				
0.75					19.3	0.4	14.03	752
1.0					19.0	0.4	13.58	750
1.25					18.9	0.4	13.31	748
1.50					18.8	0.4	12.81 (138%)	748
1.75b					18.5	0.4	9.40	745
2.00								
	Railroad Trestle			1526 hr	**Mouth of Noble Gulch**			1501 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	20.0	0.4	12.24	769	20.7	0.4	11.19	784
0.25	20.0	0.4	12.46	766	20.2	0.4	11.45	775
0.50	19.7	0.4	12.42	764	19.7	0.4	11.52	764
0.75	19.3	0.4	12.82	758	18.5	0.4	12.07	755
1.00	19.0	0.4	12.97	753	18.4	0.4	11.91 (127%)	752
1.25b	18.9	0.4	12.70 (137%)	753	18.6	0.4	8.49	758
1.35b	18.8	0.4	11.29	752				

			1-Oct-2016					
	Flume			0720 hr	**Stockton Avenue Bridge**			0730 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.6	0.4	9.25	740	18.0	0.4	9.72	748
0.25	17.7	0.4	9.31	741	18.1	0.4	9.77	750
0.50	17.7	0.4	9.34 (97%)	741	18.1	0.4	9.77	751
0.75b	17.7	0.4	9.27	741	18.2	0.4	9.64	752
1.00					18.2	0.4	9.57	753
1.25					18.2	0.4	9.64	753
1.50					18.2	0.4	9.74 (104%)	752
1.75b					18.3	0.4	3.88	754
	Railroad Trestle			0746 hr	**Mouth of Noble Gulch**			0805 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.8	0.4	8.94	749	17.1	0.4	7.80	739
0.25	17.8	0.4	8.73	752	17.1	0.4	7.45	744
0.50	17.8	0.4	8.66	751	17.1	0.4	7.35	744
0.75	17.8	0.4	8.62	751	17.1	0.4	7.28	742
1.00	17.8	0.4	8.66	751	17.1	0.4	7.25 (75%)	741
1.25b	17.9	0.4	8.62 (91%)	751	17.2	0.4	6.09	753
1.30b	17.9	0.4	8.20	751				

1 October 2016. Gage height of 2.59 (morning) and 2.60 (afternoon). Clear/ cool/ breezy in morning and clear/breezy in afternoon. Air temperature of 9.1˚C at 0720 hr and 20.0 ° C at 1605 hr. Flume inlet 0.9 ft (sand and debris) and flume exit 0.3 ft in afternoon.
Station 1: Flume at 0748 hr- Reach 1- 31 gulls bathing, 4 mallards and 3 coots in water. <1% surface algae. Flume at 1605 hr- Reach 1- 58 gulls bathing with 4 mallards in water. 4% surface algae. 60% bottom algae 0.5-3 ft thick, avg 1.0 ft ; 15% pondweed with algae 2-4 ft thick, avg 3 ft.
Station 2: Stockton Avenue Bridge at 0730 hr- Reach 2- 8 coots in water, greenback heron in willows. <1% surface algae. Reach 2 at 1544 hr- Secchi depth to bottom. 8 coots in water. 7% surface algae. 60% algae 0.3-4 ft thick, avg 1.5 ft. 15% pondweed with algae 2 ft thick. Thin algae film on remainder.
Station 3: Railroad trestle at 0746 hr- Reach 3- 3 mallards dabbling, 2 coots, 2 pied-billed grebes. <1% surface algae. At 1530 hr- Reach 3- 13 mallards, 2 coots and 2 pied-billed grebes in water. 5% surface algae; 50% bottom algae 0.2-4 ft thick, averaging ft; 15 % pondweed with algae 2 ft thick.
Station 4: Mouth of Noble Gulch at 0805 hr- 1 mallard on cottonwood. <1% surface algae. At 1514 hr- No waterfowl on cottonwood. 10% surface algae; 60% algae 0.2-3 ft, averaging 0.6 ft thick.
Station 5: Nob Hill at 0838 hr- Water temperature at 13.7°C. Conductivity 576 umhos, Oxygen 8.19 mg/l (79% saturation). Salinity 0.4 ppt. 1 cfs in the morning. Nob Hill at 1635 hr- Water temperature 15.9 ˚C. Oxygen 11.69 (118%) mg/l. Conductivity 618 umhos. Salinity 0.4 ppt. Streamflow estimate- 1 cfs in afternoon.

			1-Oct-2016					
	Flume			1605 hr	**Stockton Avenue Bridge**			1544 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	19.2	0.4	17.22	760	19.6	0.4	14.60	769
0.25	19.1	0.4	17.97	757	19.3	0.4	14.71	769
0.50	19.1	0.4	18.44 (200%)	756	19.0	0.4	14.31	776
0.75	19.2	0.4	18.50	756	18.9	0.4	14.01	765
1.00					18.9	0.4	13.69	764
1.25					18.7	0.4	13.32	763
1.50					18.5	0.4	11.90 (127%)	762
1.75b					18.4	0.4	9.57	762
2.00								
	Railroad Trestle			1530 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	19.7	0.4	12.95	777	20.0	0.4	11.50	786
0.25	19.6	0.4	13.15	777	19.7	0.4	11.68	782
0.50	19.5	0.4	13.12	777	19.1	0.4	11.43	774
0.75	19.0	0.4	13.50	777	18.2	0.4	12.11	686
1.00	18.8	0.4	13.43	775	18.2	0.4	11.97 (127%)	772
1.25b	18.6	0.4	12.92 (138%)	771	18.2	0.4	11.81	778
1.30b	18.5	0.4	12.03	770				

			2-Oct-16					0815 hr
	Flume				**Stockton Avenue Bridge**			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00					17.5	0.4	12.0	742
0.25					17.7	0.4	12.15	743
0.50					17.5	0.4	13.37	743
0.75					17.6	0.4	13.5	744
1.00					17.7	0.4	12.53	746
1.25					17.6	0.4	12.95	744
1.50					17.6	0.4	13.29 (135%)	744
1.75b					17.7	0.4	12.61	744
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								

2 October 2016. Monitoring prior to fish sampling.

			9-Oct-16					0831 hr
	Flume				**Above Stockton Avenue Bridge**			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00					16.7	0.4	11.47	732
0.25					16.7	0.4	11.84	726
0.50					16.7	0.4	11.94	725
0.75					16.7	0.4	12.03	725
1.00					16.7	0.4	12.08	725
1.25					16.8	0.4	11.37	726
1.50								
1.75b								
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								

9 October 2016. Monitoring prior to fish sampling.

16 October 2016. The biologist (Alley) arrived at the lagoon at 0330 hr, October 16, after a previous call from Steve Jesberg, Public Works Director, at 0230 hr. He predicted a potential breaching within an hour or so. The lagoon was rising slowly at the time of Alley's arrival and continued to rise until breaching was facilitated just before 0500 hr. The berm closest to the lagoon in the notch that led across the beach had been lowered in anticipation of a facilitated breach to prevent flooding. A notch in the outer berm near the surf was made by Kotila at 0430 hr. The inner berm was over topped at 0454 hr (see photo), with the water surface rising steadily. The stream gage reading was 55 cfs at 0430 hr, 2 miles upstream at Soquel Village and was expected to continue rising. The lagoon water surface was rising because inflow was greater than the flume capacity of approximately 25−30 cfs. When the breach occurred, the lagoon water surface was about 8 inches below the new red mark on the piling (**see photo**), designating the point when flooding would occur over the lagoon bulkhead, downstream of the railroad trestle. A flat area became ponded between the inner and outer berms prior to the outer berm washing away. Within 15 minutes of the inner berm breaching, the exit channel width at the flume inlet was 20 feet; it was 30 feet wide at the flume outlet, with a 15-foot deflection south from the flume. The flume inlet had the equivalent of four 4x4 inch boards removed on one side. All boards were removed from the flume outlet. The decision was made to facilitate the breach because the lagoon was expected to steadily rise above flood stage with heavy rain forecasted throughout the day. It was also advantageous from a safety standpoint to facilitate the breach prior to visitors arriving and walking the beach later in the morning. By 1615 hr on 16 October, the stormflow at the Soquel Village gage had reached 1,040 cfs. The precipitation total in the upper watershed was 7.5 inches. This was the first storm of the season, and was significant due to effects of a typhoon that brought flooding to Oregon and Washington.

APPENDIX B. 2016 Drain Line Test for Restaurants Contiguous with Soquel Creek Lagoon.

2016 DRAIN LINE TEST FOR RESTAURANTS CONTIGUOUS WITH SOQUEL CREEK				
RESTAURANT	**INITIAL CONTACT**	**TEST DATE**	**COMMENTS**	**SIGN OFF**
MY THAI BEACH	Moonie; 925-588-4179 8-Apr-16	5-May-16	Static pressure held- Test Passed	5/5/2016 Nelson Membreno
BAY BAR	M. Lynn; 209-915-4550 4/8/2016	4/27/2016	Bathroom floor leaks and needs to be repaired or sealed- Test Failed Test Passed-No Leaks	5/19/2016 Van Son
PIZZA MY HEART	Cooper Ganzert 8-Apr-16 Britteny; 475-5714	4/27/2016	Static pressure held- Test Passed	4/27/2016 Van Son
SAND BAR	Bentar Shakeh 8-Apr-16 Jeff; 818-6496	5/9/2016	Static pressure held- Test Passed	5/9/2016 Van Son
PARADISE BAR & GRILL	Scott Cater; 476-4900 8-Apr-16	5/11/2016	Static pressure held- Test Passed	5/11/2016 Van Son
ZELDA'S	P. Edmonds; 475-4900 8-Apr-16	5-May-16	Static pressure held- Test Passed	5/5/2016 Nelson Membreno