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DRAFT Soquel Lagoon Monitoring Report- 2019

Prepared for the
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ACKNOWLEDGMENTS

Ed Morrison and the Capitola Public Works Department did well in constructing and maintaining the lagoon in 2019. We appreciate that Matt Kotila, as heavy equipment operator and field supervisor, and Ed Morrison, as consultant contractor and former Public Works supervisor, teamed to daily observe the lagoon and adjust the flume inlet as needed to maximize lagoon depth as baseflow declined and as storms were forecasted. Quick decisions were required to avoid flooding during a pre-Thanksgiving deluge in late November 2019. Every year is different, and we are grateful for their attentiveness, along with that of other Public Works staff. We thank Cooper Sanden for assisting the fish biologist in relocating fish from the lateral channel prior to sandbar construction in May and for operating the tractor during emergency sandbar breaching just prior to Thanksgiving. We thank Steve Needens for weekend beach and sand berm maintenance and for keeping the flume inlet and outlet clear through the summer and fall.

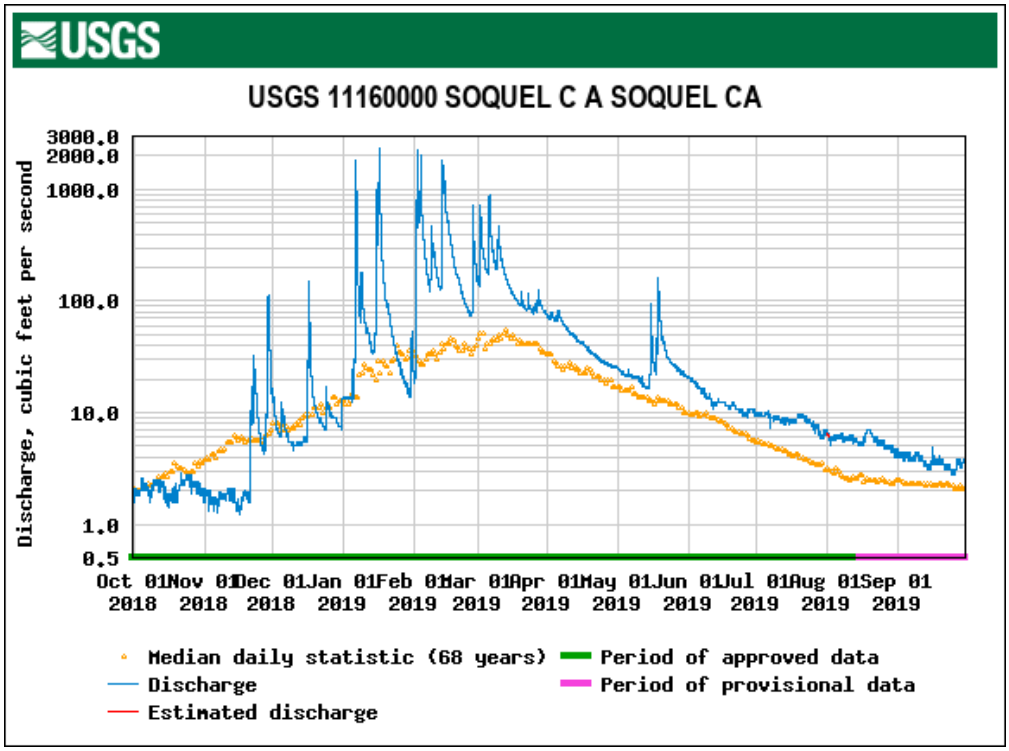
We again thank Nels and Susan Westman for the loan of their vintage Sears-Roebuck rowboat for fish censusing and placement/ retrieval of temperature probes.

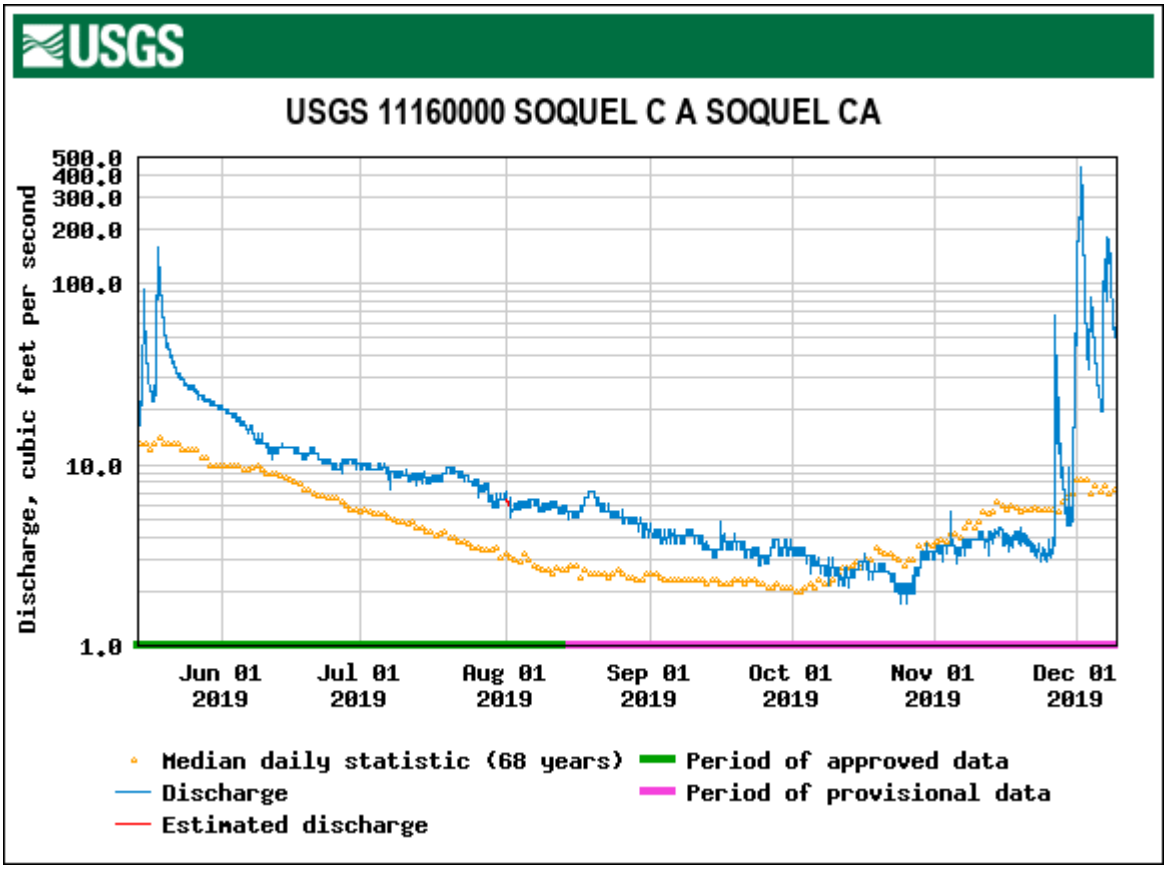
We were grateful to the volunteers who assisted in annual fish censusing at the lagoon. They were local residents and other volunteers interested in preserving the steelhead population in Soquel Creek. Robin Aston, math teacher at Soquel High, brought her students and children. They were important in providing enough help. Avid angler, Bobby Ceja, and his family joined us again this year to work the seine and process the captured steelhead. Bruce Ashley, world-traveled fisherman and photographer, also joined in again this year. Nancy Scarborough (former Coastal Watershed staff member) assisted in seining and data collection. Biologists Josie Moss (and her husband Amine), Inger Marie Laursen and Tyler Suttle provided their positive energy in working the seine and recording data. Chad Steiner was key to setting the seine, capturing fish and assisting in measuring them. Both of Chad's daughters helped with the seining and recording data. Local environmental activist, Tom Mader provided encouragement and contributed the book, Stronghold, devoted to preserving salmon on the planet. Volunteers are greatly appreciated and always 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 2019. Sandbar construction and creation of a freshwater lagoon of maximal depth represented habitat enhancement. Sandbar construction commenced after Memorial Day weekend in late May 2019. Sandbar construction has been permitted by the California Department of Fish and Wildlife (1600-2017-0411-R3), the Army Corps of Engineers (2000-25714S), California Coastal Commission (CDP 3-90-041-A9) the Regional Water Quality Control Board (Certification No. 34417WQ01) and the National Marine Sanctuary (MBNMS-2004-033-A1 and MBNMS-2011-007). 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 29 of our monitoring of activities associated with sandbar construction. Annual monitoring reports for the first 28 years are available from the City of Capitola (**Alley 1991-2019**).

Previous winter stormflows had been significant, with 4 likely greater than bankfull stormflows (more than 1500 cfs) between 1 January and 1 March, providing good migrational salmonid passage and above average baseflows for steelhead spawning and egg incubation until late in the spawning season. But the early bankfull events likely destroyed redds that may have been created recently before them. A small, late spring stormflow occurred in mid-May to delay sandbar construction until after Memorial Day. When sandbar construction began, streamflow had declined slowly after that storm to 24 cfs at Soquel Village gage on 28 May. Baseflow was well above the median throughout the dry season until mid-November, according to the Soquel Village gage (which sometimes registers inaccurately high flows in November due to leaf accumulation at shallow hydraulic controls and damming before the first stormflow).





The typical lateral stream channel formed across the beach in spring, with the outlet channel exiting along the jetty. After the flume was cleared of sand on 28 May, streamflow passed through the flume. Seven very small YOY steelhead (*Oncorhynchus mykiss*) were rescued from the lateral channel and relocated under the Stockton Bridge. Other species present and relocated included threespine sticklebacks (*Gasterosteus aculeatus*) and staghorn sculpins (*Leptocottus armatus*). No tidewater gobies (*Eucyclogobius newberryi*) were observed or were observed to have suffered mortality in the estuary/ lagoon and upstream during sandbar construction activities. The lateral channel was covered over and buried after the fish rescue was completed. The channel was slowly covered from upstream to downstream toward the jetty. Upstream of the railroad trestle, threespine stickleback were rescued and relocated during the two drawdowns associated with sandbar construction.

Prior to sandbar construction, the plumbing of Esplanade businesses was inspected for leaks by City staff and none were found. Steelhead passage was maintained at night through the flume during sandbar construction that was completed on 30 May. On 30 May, the pad around the flume inlet was covered with clear visquine and secured with sandbags. Sandbags were stacked around the flume inlet. Sand was hand-broadcasted by shovel to cover the visquine by 1310 hr. The tules planted two years previously in the cove beneath the railroad trestle had survived the relatively stormy winter.

Sandbar Breaching. A facilitated sandbar breach was required on 26 November 2019 due to rapid increase in streamflow from storm activity and rapid rise in lagoon water surface elevation. The fish biologist was present during the emergency breaching. The California Department of Fish and Wildlife had been notified of the potential need for an emergency breaching of the sandbar. By 2030 the gage reading in Soquel Village had reached 51 cfs due to very heavy rainfall, and the lagoon water surface was rising quickly. The flume capacity was in the range of 25-30 cfs. Four flashboards had previously been removed from the flume inlet to provide 12 inches of vertical opening prior to the storm. The joint decision was made to facilitate the breaching of the sandbar to avoid imminent flooding. A 10-foot wide notch was cut through the berm at the lagoon periphery. This was accomplished by 2045 hr. Water began spilling through the notch at 2052 hr. The stream gage reading at 2045 hr was 71.8 cfs. The lagoon water surface had increased 6 inches in 15 minutes to above the top of the flume inlet (which is at 7.48 ft mllw) prior to the breaching. Rainfall ceased abruptly soon after the breaching, and stormflow at Soquel Village rapidly declined to a minimum of 13.9 cfs at 2315 hr. However, rainfall resumed later that evening, with stormflow again rising to 40 cfs by 0115 hr on 27 November. Stormflow was sustained above 30 cfs at the gage and above the flume capacity to convey water from 0015 hr to 0545 hr on 27 November, which would have again caused flooding along the lagoon margin without the earlier facilitated breach. No fish mortality or water quality problems were observed during the facilitated breaching. Streamflow at the lagoon was somewhat higher than in Soquel Village due to surface runoff in Capitola and contributions from Noble Gulch. Kotila collected a water sample in the lagoon earlier in the afternoon on 26 November, prior to breaching, and another on the morning of 27 November in the surf near the exiting stream channel from the estuary and delivered the 2 samples to Monterey Analytical. Lab analysis indicated that the pre-breach enterococcus bacterial count was 10 cfu/100 ml. The post-breach count was 1012 cfu/100 ml, necessitating additional weekly water sampling until the count declined below 104 cfu/100 ml.

Stream Inflow and Influence on Lagoon Water Temperature. Lagoon water quality is generally best with higher summer baseflow. Stream inflow in 2019 at the time of sandbar construction was relatively high (above the median baseflow for the period of record), and Soquel Creek maintained a baseflow through the dry season above the median flow until November (**Table 9; Figures 25−27**). The 2019 water year was relatively wet, with 4 likely greater than bankfull stormflows between 1 January to 1 March 2019 and 4 more moderate stormflows between 1 and 15 March. After that, little precipitation occurred until a minor, mid-May stormflow occurred during the steelhead smolting period, which would have encouraged larger juveniles (=> 75 mm SL) to smolt. 2019 streamflow on 1 June at the Soquel Village gage was 21.1 cfs. By 1 October, baseflow had declined to 3.5 cfs.

Higher summer baseflow improves habitat conditions in the lagoon. The lagoon mixes and cools more quickly overnight when inflow is higher. Lagoon water temperature heats up more during the day with less inflow, as indicated by average lagoon water temperature during drought years of low inflow rates. However, warmer air temperature can overshadow the effect of greater inflow to cool the lagoon. The annual trend in 7-day rolling temperature averages with respect to the maximum, average and minimum for the dry season indicates the inverse relation between stream inflow rate and average lagoon temperatures (**Figure 4h**). However, the trend is less evident for the relatively high baseflow year of 2017, when the maximum water temperature, the maximum 7-day rolling average and the average 7-day rolling averages are similar or higher than

in 2016 and 2018, despite their lower baseflow. We judge this was because 2016 and 2018 had relatively cooler air temperature in late summer and fall and possibly more stream shading than after a wet 2016-2017 winter that would have contributed to warmer inflow in 2017 with loss of streamside vegetation leading to less shade.

With proper flume management and the grated flume ceiling installed in 2003, it has been 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.

Water Temperature. Lagoon water temperature was well within the tolerance range of steelhead in 2019 and was not likely stressful at any time during the season of sandbar closure. Days when lagoon water temperatures exceeded 22º C (71.6º F) near the lagoon bottom would likely be stressful for juvenile steelhead, making that a management goal to maintain a daily water temperature maximum below 22ºC near the bottom. This goal was met in 2019 at the data logger location and at all 4 stations monitored at 2-week intervals twice a day. (**Figures 3a-3d; 4a**). In 2019 the daily maximum stayed below 21°C and was below 20.2°C most of the time at the data logger location. Another lagoon management goal is to maintain early morning maximum water temperature below 20°C near the bottom. In 2019, this management goal was met at the data logger location and at all monitoring stations except on 1 September at Station 2 where it was 20.1°C. The warmest early morning water temperature at the data logger location was 19.5°C. A third lagoon management goal is to maintain the daily 7-day rolling average at 21°C or less near the bottom. This goal was also met at the data logger location. The highest 7-day rolling average value was 19.8°C in 2019.

In 2019, early morning water temperature of stream inflow at Nob Hill was cooler for the higher baseflow year of 2019 (well above the median) than in the much lower baseflow year of 2018 (slightly below the median) by 1−2°C for most of June and July, but mostly warmer than 2018 by 1−2°C in August and September (**Figure 3e**). Water temperature near the bottom at lagoon monitoring stations followed the same pattern, being cooler in 2019 in June and July and warmer than in 2018 in August and September (**Figures 3a-3d**). These annual differences in water temperature directly paralleled differences in early morning air temperatures between the years (**Figure 3f**).

Aquatic Vegetation. Kelp and seagrass were abundant in the estuary prior to sandbar construction in 2019. Recent high tides and swells had brought considerable plant material inland as far as the Noble Gulch confluence. Raking out of decomposing plant material was required. Sand had been deposited midway between the flume and Stockton Bridge during the spring, creating a shallow area in the center of the estuary and a deep channel alongside the restaurants on the eastside. A backwater was created above the sand deposit on the westside adjacent to the Venetian Court wall. The streambed downstream of the sand deposit and over the sand deposit was firm. The streambed above the sand deposit was soft with considerable kelp and seagrass deposits. An estimated 70% of the decomposing plant material was raked from the lagoon in 2019 (90% in 2018, none present in 2017, 90% in 2016 and 70% in 2015). There were more nutrients available for plant growth in 2019 upstream of the shallow center area than in

2015−2018. In 2019, algae developed quickly but lost thickness in September and October when pondweed was most prevalent (**Table 6**). Pondweed was most abundant and algae the thickest in Reach 2 between Stockton Bridge and the railroad trestle. Algae coverage of the lagoon bottom became less in 2019 in Reaches 2 and 3 compared to 2017 and 2018 (**Tables 6-8**). Surface algae was scarce in 2019 with <1% coverage in Reach 1 and as much as 5% in Reaches 2 and 3 in late September. Surface algae was more abundant at the mouth of Noble Gulch than elsewhere, with a maximum of 15% coverage in mid-September. There was less surface algae in 2016−2019 compared to the warmer lagoon in 2015 during drought and much less than in 2014, which was also a drought year. Evidence of nutrient inputs from Noble Gulch in 2013−2015 and 2017-2019 was expressed by recurrent thick planktonic algae blooms and sporadically high levels of surface algae nearby, with bottom algae thicker on average than at other sites in 2019.

Oxygen Concentration. Typically, oxygen concentration was lowest at dawn near the bottom, or soon after, because oxygen was depleted by cell respiration overnight before plant photosynthesis could begin producing oxygen with the light (**Figures 6b-6f**). It was measured at 2-week intervals at 4 monitoring stations twice a day. Near dawn is when oxygen concentrations are most importantly measured and rated. In 2019, the average oxygen level and oxygen concentration *near the bottom* at Stations 1 and 4 near dawn and in the afternoon remained "good" (greater than 7 mg/l at dawn) for steelhead throughout the monitoring period (**Table 3; Figures 6a-1, 6a-2 6b and 6e**). Station 2, the deepest monitoring station and located just down from the Stockton Bridge had "critical" rating *near the bottom* a week after sandbar closure on 8 June because of a saltwater lens present there and "fair" ratings at dawn on 24 June, 6 July and 1 September (between 5 and 7 mg/l at dawn) (**Figure 6c**). A "good" rating was made at the other 9 monitored times at Station 2. Station 3 below the trestle had "fair" ratings on 24 June and 1 September and "good" ratings at the other 11 monitoring times (**Figure 6d**). Aside from the low oxygen concentration of 1.47 mg/L at Station 2 on 8 June, oxygen concentrations at dawn at the 4 monitoring stations ranged between 6.54 mg/L (69% full saturation) and 11.02 mg/L (120% full saturation). Afternoon oxygen concentrations near the bottom ranged between 7.32 mg/L (68% full saturation) and 13.64 mg/L (134% full saturation) on 12 October.

Average morning lagoon oxygen concentration for the 4 lagoon stations ranged between 7.34 mg/L on 1 September and 9.95 mg/L on 15 September (**Figure 6g**) and were mostly lower than the 3 previous years until mid-September. In the afternoon, oxygen concentration for the 4 lagoon stations averaged between 8.98 on 23 November and 12.5 mg/L on 12 October (**Figure 6h**). Oxygen concentration typically increased 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 at all 4 stations in afternoon throughout the 2019 monitoring period except sometimes at Station 2 (6 of 13 monitoring days) and except at all stations on 9 and 23 November when the days shortened and shade hit the lagoon earlier in the day than previously.

Salinity. In 2019, no saline conditions were detected in the lagoon except along the Venetian Court wall in a 30-foot long pocket about 0.5 feet thick in early June after sandbar closure. The highest salinity measured in this layer was 13.7 ppt at the bottom on 4 June, 5 days after sandbar closure. The warmest water temperature measured in this layer was 18.6°C (1-2°C warmer than above), which was not stressful to steelhead. A shroud was placed on the flume inlet to suck

water from the lagoon bottom through the flume. Thus, by 24 June the saline layer had dissipated, and a freshwater lagoon was maintained through the remainder of the period of sandbar closure until emergency sandbar breaching on 26 November. No tidal overwash was allowed to occur through the dry season in 2019, with an elevated berm maintained around the lagoon periphery.

Nautical Parade Observations. The nautical parade occurred at night on 28 September. No negative effects to fish and wildlife were observed during the evening. Seven floats took part in the procession. The lagoon water level was maintained during the event. All floats were powered by electric motor. A motorized, mobile, unlit barge was also present among the floats and appeared to be a collision threat because it was unlit and moving around unpredictably. Well lit water marshals were present in kayaks. Prior to the procession, a marshal was unable to prevent one float from traveling over a portion of the tules in the railroad trestle cove as it maneuvered around another float to avoid a collision. The tules showed no apparent damage from the incident in future days. There were no mishaps in the lagoon during or after the procession that might lead to wading in the lagoon. At this later date for the procession than the previous daytime parades, water temperature was cooler and in the "good" range for steelhead. Oxygen levels were supersaturated prior to the procession (**Appendix A**). On September 30, no parade debris was observed in the lagoon.

Fish Sampling Results. . A total of 299 steelhead were captured and marked on 6 October after 3 seine hauls. There were no mortalities. A total of 300 steelhead were captured on 13 October in 3 seine hauls. There were 27 recaptures and no mortalities. The lagoon population estimate was 3,322 juvenile steelhead (5th highest in 27 years), using the Lincoln index for a closed population (**Table 10;** methods in **Ricker 1971**). Steelhead were relatively small and dominated by small YOY juveniles (**Table 11; Figure 7a**), consistent with the preponderance of small YOY captured at stream sites. But the population size was large compared to the 25-year average of 1,498 (**Figure 24**). This relatively large lagoon population was consistent with improved, higher densities of juvenile steelhead detected at most stream sampling sites in 2019 compared to recent years (**Alley 2020**). Examination of the size histogram of captured fish in 2019 indicated no clear-cut demarcation between age classes. The large bell-shaped curve indicated that most juveniles were YOY, with most juveniles larger than 124 mm SL likely being yearlings. One steelhead was either a small adult at 355 mm Standard Length (400 mm Fork Length; 16 inches FL) or an older resident soon to become anadromous (and ocean dwelling). With the large steelhead population in the lagoon, competition for food was undoubtedly high and likely slowed growth. Other species captured in 2019 with the large seine were 1,000+ threespine stickleback, 32 staghorn sculpins, 6 prickly sculpins (*Cottus asper*) and Sacramento suckers (6 adults and 14 YOY). Sticklebacks were abundant in the lagoon in 2019.On 6 October 2019, 5 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. One tidewater goby was captured (**Table 11**). Overwintering cover is scarce at Soquel Lagoon. Tules were planted in summer 2017 in the cove beneath the railroad trestle to improve cover. Threespine stickleback (100+), juvenile Sacramento suckers and staghorn sculpins were captured with the goby seine.

Recreational Use, Pollution and Solutions. The lagoon near the beach was posted with warning signs about potential health risks. However, increasing human use of the lagoon has

been observed since 2016, when a paddle-board concession began in the village. Paddle-boarders have become commonplace (observed 5 of 13 afternoon weekend monitorings in 2019, along with more kayakers, pedal boaters, row boaters, canoers and barge users on the lagoon. The most paddle boarders counted in a reach were 6 in Reach 1, though usually they traveled in pairs. The most boat/paddleboard traffic was observed during the 3 separate monitoring days in September, especially on the day of the Nautical Parade (28 September). Waders and swimmers (typically young children) were commonly observed in the lagoon (usually near the beach in Reach 1; 6 of 13 afternoon monitorings in 2019). The most waders seen at one time in 2019 was 6 in Reach 1. On 21 July, two high school age boys jumped off the Stockton Bridge and swam over to Venetian Court wall. This was the first time it was observed in 29 years of monitoring. No waders or boaters/paddle boarders were observed during October and November monitorings.

Illegal fishing was observed on one occasion in 2019. Bird feeding along the lagoon and from the restaurants occurred more in 2019 than previously. High-volume bird feeding was observed on 2 occasions at the mouth of Noble Gulch where as many as 58 mallards and 5 gulls congregated. Bird feeding was observed 5 times along the lagoon and twice from restaurant decks. Ducks patrolled the lagoon next to Margaritaville in the afternoon, indicating that feeding went on regularly there. 2019 was the first year in 29 years of monitoring that rafts of gulls (as many as 24 birds) were commonly observed in Reach 3. They were using Reach 3 even during the sandbar construction and before lagoon formation. Before that, they congregated in Reach 1 only. They were also observed perching in groups on lagoon-side house roofs in Reach 3. Gulls are a threat to ducklings, and their waste is a pollution source. Previously, individual gulls were occasionally observed beyond Reach 1 when someone was feeding the ducks. The gulls may have decided to use the upper estuary more because the center of Reach 1 was very shallow at low tide before the sandbar was constructed in 2019.

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 is 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.**). City building permit conditions of future remodeling will require addition of roof deterrents (**Steve Jesberg, Public Works Director, pers. comm.**). The increased presence of paddle boarders and boaters since 2016 interfered with gull use in Reach 1. Gulls took wing when visitors appeared on their floatation devices and returned quickly to bathe and raft after they passed. Gulls avoided waders along the periphery near the flume. Human impact from disturbance on the rate of gull defecation is unknown.

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. Gray water and oily slicks have been noted emptying into the lagoon from Noble Gulch in the past. Two incidences of gray turbidity were observed at the mouth of Noble Gulch during monitoring in 2019, the most prominent occurring on 9 November with an associated oily slick on the surface. Though no gray water was detected during 2-week monitorings in 2014−2016 and 2018, gray

water plumes were observed on 6 of 12 monitoring days in 2017, especially in the latter weeks of the monitoring period. Another drain into the lagoon exists under the railroad trestle, where slight oxygen depletion has been detected in recent years but not in 2018 or 2019. This drain could be capped if summer runoff was re-directed into the sewer. 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.

Central Coast lagoons are naturally productive steelhead habitats with abundant aquatic plant populations. Juvenile steelhead grow rapidly in these lagoons where food is abundant. Plant life is the base of the food web and translates into food abundance for fast-growing juvenile steelhead in Soquel Lagoon. Also, abundant pondweed creates a forest that predators must negotiate to prey upon juvenile steelhead, offering some refuge from piscivorous birds like mergansers and pied billed grebes. Eutrophication from a biological perspective occurs when excessive nutrients induce overgrowth of plants and algae that cause oxygen depletion and fish kills if severe enough. In regard to steelhead habitat, habitat-degrading eutrophication indicated by stressfully low oxygen concentrations seldom occurs at the Noble Gulch creekmouth and has never occurred lagoon-wide in the last 27 year of Soquel Creek Lagoon monitoring during the dry season.

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. In 2017, as a pilot project, tules were planted in the cove under the railroad trestle. Some of the original plantings survived the relatively mild winter of 2017-2018. City staff will continue to monitor and augment tule planting in the pilot area.

Bird Counts. Mergansers were uncommon in 2019 and much less common than in 2013−2015 (**Table 13**), although 7 were observed by Morrison on the day after sandbar construction. Other piscivorous birds observed in 2019 included pied-billed grebe, cormorant and common golden eye (23 November).

2019 gull densities fluctuated between 15 and 115 on monitoring days (**Figure 52**). On 9 November 2019, more than 100 pelicans and even more gulls congregated just beyond the creekmouth and were actively feeding, resulting in the highest gull count (115) in the lagoon for the season. Numbers in 2018 ranged between 23 and 87. Numbers in 2017 ranged between 18 and 85 (20 and 65 in 2016) during afternoon monitorings, when they are most common. The average gull count per monitoring day for 2014−2019 has been 63, 68, 42, 40, 46 and 63, respectively. The increased human waders, boats, barges and paddle boarders in 2016−2019 may have reduced gull bathing numbers on the weekends when monitoring took place. Mallard numbers tend to be lowest in June before ducklings become common in July − September, with a decline in October at a time when coots become common (**Figure 53**). In 2019, mallard counts ranged between 5 and 62 birds on monitoring days. The average mallard count per monitoring day for 2014−2019 has been 27, 26, 31, 18, 30 and 21, respectively. Mallards no longer had the

cottonwood log across from Noble Gulch to roost on or congregate around because it was washed away during the wet 2016−2017 winter. Coots were common in 2019 in fall. Although a lone coot was observed earlier in the summer, their numbers began to multiply beginning 28 September, as coots typically arrive in late September and October. The maximum number of coots counted on a monitoring day in 2015−2019 was 113, 13 (early breach), 34, 147 and 58, respectively. One brown pelican was observed in Reach 1 on 12 October. What were likely Cackling geese (*Branta hutchinsii*) were observed on the bulkhead and a lawn adjacent to the lagoon in Reach 2 on 9 and 23 November. They looked like small Canada geese. Three geese were observed the first day and 2 the next. A lagoon resident reported seeing as many as 12 on his lawn at one time.

LAGOON AND ESTUARY FORMATION

Fish Rescue Activities Required before Sandbar Construction

28 May 2019. The typical lateral channel developed across the beach just days prior to sandbar construction, and went diagonally across the beach to the outer end of the jetty. The lateral channel was blocked off at 0800 hr. Nine seine hauls were made through the lateral channel with a fine-meshed (1/8-inch), 30-foot long beach seine from 0810 hr to 1100 hr. The ninth seine haul yielded no fish. Cooper Sanden of Public Works assisted Don Alley in the seining, capture of fish and relocation. Seven small young-of-the-year (YOY) steelhead were rescued from the lateral channel and relocated under the Stockton Bridge. Other species present and relocated included 16 threespine sticklebacks and 14 staghorn sculpins (**Table 1**). No tidewater gobies (*Eucyclogobius newberryi*) were observed or were observed to have suffered mortality in the estuary/ lagoon and upstream during sandbar construction activities. After the flume was cleared of sand by 1030 hr on 28 May, streamflow passed through the flume. The lateral channel and a log on the beach were covered over and buried after the fish rescue was completed. The channel was slowly covered from upstream to downstream toward the jetty.

Table 1. Observations and Relocations of Fish During Sandbar Construction.

Date	Location	Tidewater goby (Observed/ Relocated)	Juvenile Steelhead (Observed/ Relocated)	Threespine stickleback (Observed/ Relocated)	Staghorn sculpin (Observed/ Relocated)	Prickly sculpin (Observed/ Relocated)
5-28-2019	Lateral Channel	0/0	7/7	16/16	14/14	0/0
5-29-2019	Upstream of Stockton Ave Bridge	0/0	0/0	1000+/100+	0/0	1/0
5-30-2019	Upstream of Stockton Ave Bridge	0/0	0/0	500+/100+	0/0	1/0

Small YOY steelhead captured and relocated from lateral channel. 28 May 2019

Monitoring of Flume Maintenance and Sandbar Construction

28 May 2019. The fishery biologist, Alley, arrived at 0608 hr. The gauged discharge at Soquel Village was 24.2 cfs at 0600 hr. There was a relatively small amount of sand deposited on the beach after a wet winter/spring. The typical lateral channel developed across the beach just days prior to sandbar construction, and went diagonally across the beach to the outer end of the jetty. The bull-dozer was checked for fluid leaks before it was operated this day, and none were found. The beach around the bull-dozer was inspected with a flashlight for animals before it was moved. The lagoon periphery was surveyed for salmonids up to Noble Gulch, 0615 hr – 0640 hr, with none observed. A log with rootwad attached was located in the Margaritaville Restaurant cove. During the survey, 19 gulls were bathing in Reach 3. Five mergansers and 6 mallards were observed in Reaches 1 and 2. Mallards were in low numbers, and no young were observed. The lateral channel was blocked off at 0800 hr and seined for fish, with captured fish relocated to underneath the Stockton Bridge. The bull-dozer operator, Matt Kotila, did not cut a drainage channel along the flume this day. Therefore, no raking of kelp or seagrass occurred. After the flume was cleared of sand, the stream flowed through the flume by 1030 hr. Kotila stockpiled sand from the lower beach as he graded it to the upper beach around the lagoon periphery. This would prevent tidal overwash overnight. The biologist left at 1510 hr as the lateral channel was being covered over with sand.

Soquel Estuary prior to sandbar construction. 28 May 2019

Lateral channel flowing diagonally across the beach to the end of the jetty. 28 May 2019

29 May 2019. The biologist arrived at 0616 hr. The lower half of the beach had been washed away by high swells. The outer 50 feet of the flume was exposed. Bull-dozer work was delayed until the tide lowered enough by 0905 hr. The bull-dozer was checked for fluid leaks before it was operated this day, and none were found. The beach around the bull-dozer was inspected for animals before it was moved. The gauged discharge at Soquel Village was 23.2 cfs at 0600 hr. The sand berm around the lagoon margin held overnight, and the lagoon had filled up and spilled over the screened frame with underwater portal in the flume inlet. Adult and smolt steelhead passage through the flume was maintained through the night. The lagoon periphery was walked by the fishery biologist, 0655 hr – 0725 hr, and no fish were observed. The lagoon gage height was high at 2.55. During the early morning survey, 6 gulls were bathing in a group in Reach 3. Two mergansers and 4 gulls were observed in Reach 1. Only 2 mallards were observed in Reach 2. The drainage channel was cut alongside the flume, and the sandbar was opened by Kotila at 1015 hr. The outlet channel was flowing alongside the flume on the east side. The lagoon evacuated slowly at a rate of 1.0 feet loss in elevation per hour for the first hour but rapidly after that to a partially evaluated state. A deep, slackwater zone existed from the Venetian Court wall upstream 100 m beyond Stockton Bridge. A large sand deposit in the center of Reach 1 became exposed as the estuary drew down, creating a deeper, flowing channel on the eastside adjacent to the restaurants. Six Public Works staff and the biologist began raking at 1100 hr. The biologist surveyed the estuary margin for isolated pools and stranded fish from 1220 hr to 1258 hr. Over 1,000 threespine stickleback and one prickly sculpin were observed in the main channel during the survey. No salmonids were observed. More than 100 small YOY sticklebacks were relocated from an isolated pool downstream of the Golino cabin and Noble Gulch in Reach 3. Isolated pools were lacking elsewhere in the estuary with a down-sloping margin. During the upstream survey to Nob Hill, no salmonid or lamprey redds were observed. Several clumps of cattails survived the heavy streamflow winter in the backwater under the railroad trestle. More scour had occurred there over the winter/spring, and the bottom was boulder and cobble strewn. During the walk upstream, 30 gulls were bathing as a group in Reach 3, and 6 mallards were observed in Reaches 1 and 2. It was unusual for gulls to congregate in Reach 3. After the sand deposit in the center of Reach 1 became exposed above the water line, Kotila graded it to the west to create a deeper lagoon and to create a sand berm along the western periphery of the lagoon. The log in the Margaritaville cove was pulled to the western margin of the lagoon and secured in place with ropes from Stockton Bridge. The bull-dozer did not enter the water during this process. T-posts were erected and flagging was strung between them to isolate the beach from the lagoon margin between the walkway between the restaurants to the flume inlet. The sandbar was closed at 1405 hr. The biologist left at 1530 hr.

Lagoon filled overnight with steelhead adult and smolt passage through screened portal.
29 May 2019

Kotila grading sand deposit from the exposed estuary to the lagoon periphery.
29 May 2019

Cattails survived the wet winter in the railroad trestle cove. 29 May 2019

Estuary looking upstream from Stockton Bridge at maximum estuary drawdown.
29 May 2019

Kotila building the berm around the lagoon periphery. 29 May 2019

30 May 2019. The fishery biologist arrived at 0618 hr. The gauged discharge at Soquel Village was 22.1 cfs at 0600 hr. Sheetmetal covers had been installed over sidewalk drains previously. The sandbar was intact with the lagoon filled overnight and spilled over the screened frame with underwater portal in the flume inlet. Smolt and adult steelhead passage through the flume was maintained through the night. The biologist inspected the lagoon periphery for salmonids, 0630 hr – 0706 hr. None were observed. However, a group of 13 gulls were bathing in Reach 3, and 2 mallards were also observed in Reach 3. The lagoon surface gage height was 2.42. The bull-dozer was checked for fluid leaks before it was operated this day, and none were found. The beach around the bull-dozer was inspected for animals before it was moved. A large group of middle school students had arrived on the beach before the bull-dozer was operated. The bull-dozer was backed slowly along the floodwall to avoid the students, and grading began around 0900 hr with a spotter to prevent human interference. Kotila opened the sandbar at 1055 hr. The outlet channel was flowing alongside the flume on the east side. As on the previous day, the lagoon evacuated slowly at a rate of 1.0 feet loss in elevation per hour for the first hour but rapidly drew down after that to a partially evaluated state. A deep, slackwater zone existed from the Venetian Court wall upstream 100 m beyond Stockton Bridge. The sand deposit in the center of Reach 1 became exposed as the estuary drew down, creating a deeper flowing channel on the eastside adjacent to the restaurants. Ed Morrison and 8 Public Works staff raked kelp and seagrass from the estuary from 1115 to 1310 hr. The biologist assisted in raking until 1215 hr when he surveyed upstream for stranded fish along the estuary periphery until 1300 hr. Over 500 threespine stickleback were observed in the main channel during the survey. One prickly sculpin (*Cottus asper*) was observed in a side-channel near the Shadowbrook Restaurant that would remain watered during the drawdown. No salmonids were observed. More than 100 sticklebacks were relocated from an isolated pool downstream of the Golino cabin and Noble Gulch in Reach

3. Isolated pools were lacking elsewhere in the estuary with a down-sloping margin. During the survey, a group of 32 gulls were bathing in Reach 3 below Noble Gulch, and 10 mallards were counted in Reaches 2 and 3. It was unusual for gulls to congregate in Reach 3. The pad was prepared around the flume. Under the supervision of Ed Morrison and Matt Kotila, clear visquine was spread over the pad. Sandbags were piled along the edge of the visquine sheets and around the flume inlet. The visquine was covered with sand by shovel. The weir inside the flume was confirmed to be in place. Kotila closed the sandbar for the summer at low tide at 1415 hr. He continued to compact sand around the lagoon periphery and pack sand under the flume with the bull-dozer. The biologist left at 1600 hr. After the lagoon had filled sufficiently, the log that originally been in the Margaritaville cove became buoyant was secured by Morrison and Public Works staff near the Stockton Bridge on the west side.

Lagoon filled overnight with steelhead adult and smolt passage through screened portal.
30 May 2019

Western margin of the lagoon after overnight filling. 30 May 2019

Previously graded sandbar viewed in the morning after tidal action overnight to the east of the flume where the lateral channel had been buried. 30 May 2019

Visquine being spread over the flume inlet pad. 30 May 2019

Weir intact inside the flume. 30 May 2019

Public Works Staff covering the visquine with sand. 30 May 2019

Sandbags placed around the flume inlet to prevent leakage of sand along the flume after sandbar closure. 30 May 2019

Kotila packing sand under the flume during sandbar closure. 30 May 2019

Lagoon filling after sandbar closure. 30 May 2019

31 May 2019. The fishery biologist arrived at 0825 hr. Morrison communicated that 7

mergansers were roosting early in the morning on the log that had been positioned under the Stockton Bridge for fish cover. The berm around the lagoon periphery was complete. The flume was functioning with the lagoon filling overnight above the screened inlet frame. Thus, steelhead smolt passage was provided overnight. The bull-dozer had been checked for fluid leaks before it was operated this day, and none were found. The beach around the bull-dozer was inspected for animals before it was moved. Kotila was grading sand from the lower beach to the flood wall to the east of the flume. The biologist left at 0925 hr.

Lagoon full and periphery between the restaurants and the flume was complete.
31 May 2019

Log secured near Stockton Avenue Bridge. 31 May 2019

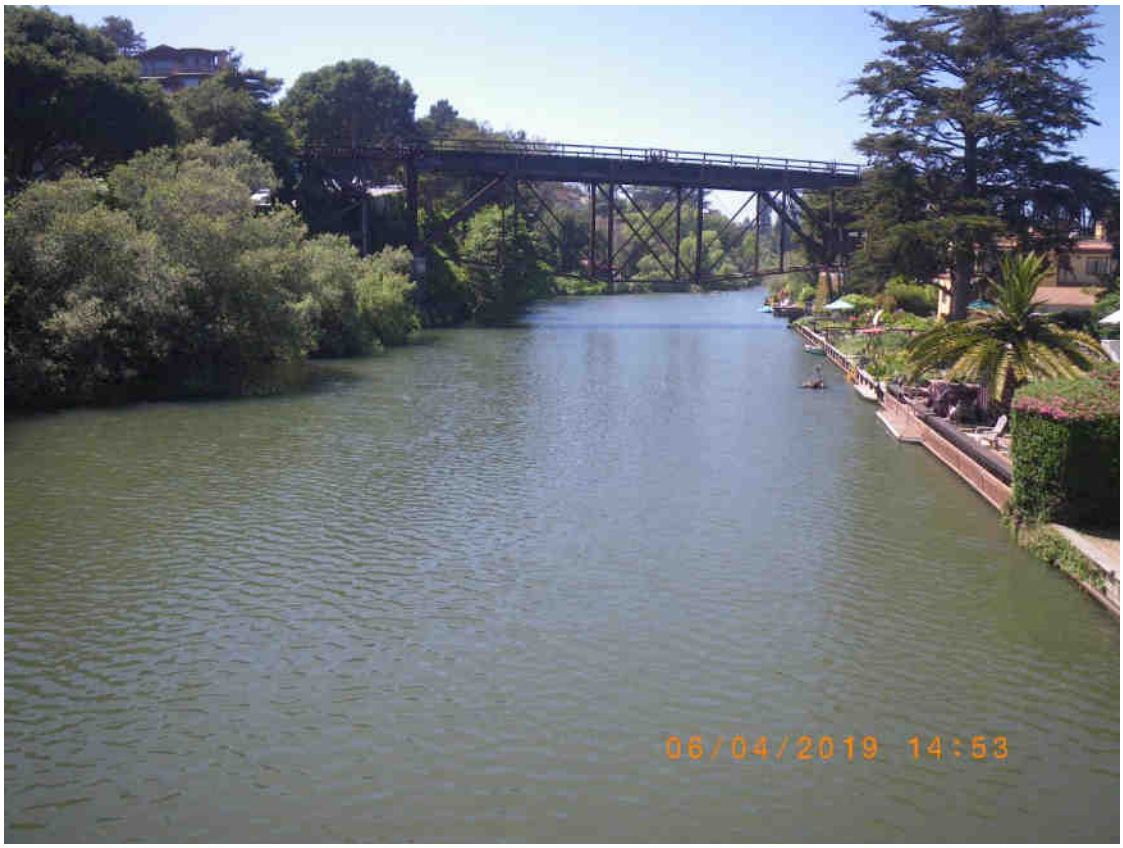
Lower lagoon downstream of Stockton Bridge after sandbar closure. 31 May 2019

Soquel Lagoon upstream of Stockton Bridge after sandbar closure. 31 May 2019

4 June 2019. The biologist visited the lagoon to detect any remaining salinity in the lagoon. The lagoon was full with a functioning flume. Gage height was an excellent 2.64. A pocket of saline water that was 6 inches thick was discovered along a 30-foot length of relatively deep lagoon next to the Venetian Court wall on the west margin below Stockton Bridge. The salinity ranged from 9.7 to 13.7 parts per thousand (ppt) in the saline layer. Seawater is 35 ppt. The biologist requested that a shroud be placed over the flume inlet to draw saltwater off the bottom and out of the lagoon. At 1421 hr, water temperature ranged from 17.3° C at the surface to 18.6° C at the bottom at 2.25 meters, adjacent to the Venetian Court wall. Oxygen ranged from 9.5 to 9.7 mg/L from the surface down through the water column to 1.75 m from the surface. Then it abruptly declined to 0.08 mg/L at 2 m to anoxic conditions below that. A domestic drinking water main pipeline broke around 1200 hr (**Ed Morrison pers. comm.**); adding water to storm drains entering Noble Gulch. The lagoon was slightly turbid from suspended sediment caused by added streamflow, with a secchi depth of 1.15 m at Stockton Bridge.

7 June 2019. A shroud (originally designed by California Department of Fish and Game) was secured over the flume inlet by Public Works staff on the restaurant (east) side to suck heavy saltwater out of the lagoon. A new screen with underwater portal for fish passage to the Bay was placed in the flume inlet.

8 June 2019. Water clarity was good during the first 2-week monitoring, with no apparent ill effects from the previous pipeline break. Oxygen levels were good (above 7.4 mg/L at all stations after dawn) with the saline layer persistent at Venetian Court wall. Temperature probes were installed in the lagoon and upstream.



Soquel Lagoon, looking upstream from Stockton Bridge. 4 June 2019

Effect of Sandbar Construction on Tidewater Gobies and Steelhead in 2019

No tidewater gobies and 7 YOY steelhead were observed and relocated during sandbar construction in 2019 after a wet winter/spring. Only two artificial breachings of the sandbar were necessary during sandbar construction. One tidewater goby had been captured in the lagoon in October 2018 after a mild winter, indicating a small population size. If tidewater gobies were present in May 2019, they were likely in small numbers and using the upper estuary to avoid tidal action and salinity during the sandbar construction. They would need to retreat to the deeper slackwater in the main channel as the estuary drew down. There was only one isolated pool found in 2019, downstream of the Golino property where old wooden pilings formed a wall out in the channel to cause isolation. Threespine sticklebacks were rescued from this pool. But no tidewater gobies were found. This lower estuary location was subject to tidal influences that would prevent tidewater goby nesting. A well defined, bathtub-like margin still existed in the estuary in 2019 after repeated winter stormflows, except for the tidally influenced mid-channel bar upstream of the railroad trestle. The gradual, bathtub-like margins allowed easy retreat of fish into deeper water in the more freshwater upper estuary. We detected no tidewater mortalities during sandbar preparation, though habitat disturbance occurred during each artificial sandbar breaching. However, we judged impacts to any tidewater gobies that were present to be minimal during sandbar construction.

The channel in lower Soquel Creek lacks sheltered backwaters for tidewater gobies to escape

high water velocities during high stormflows, except possibly under the restaurants. The tules planted in the backwater beneath the railroad trestle in June 2017 survived the winter and may serve as overwintering habitat for tidewater goby in the future if they grow and multiply. Tidewater goby populations that have re-occurred during the dry years of 2008, 2009, 2013−2016 and 2018 may be transitory.

Seven YOY steelhead were captured in the lateral channel and relocated at the Stockton Bridge near wood cover. This indicated that YOY had begun moving into the estuary from spawning areas above the lagoon. The mid-May stormflow may have encouraged YOY to drift into the estuary. With the late sandbar closure in 2019, most smolt outmigration had likely been completed. Salmonid smolts drift downstream at night. During the sandbar construction period, smolts had access to the Bay each night through the flume. Data collected on smolt outmigration and YOY downstream movements in the lower San Lorenzo River just above the estuary in the late 1980's indicated that smolt out-migration had ended by June and YOY had begun drifting into the estuary (**Alley, personal observation**). Potential predatory mergansers were observed during sandbar construction. No salmonid mortalities were observed in 2019. Deeper slackwater existed on the west margin of Reach 1, which was downstream of Stockton Bridge, upstream of the central sand deposit and adjacent Venetian Court, and extended upstream of Stockton Bridge on the west side for about 100 m under overhanging willow. These areas offered refuge for juvenile steelhead during the two artificial estuary drawdowns. Where the channel narrowed and deepened as it flowed around the central sand deposit in the lower 200 feet of Reach 1 down to the flume, water velocity was high during artificial drawdown. Small YOY steelhead could not likely hold position in this section in the middle period of the drawdown lasting about an hour each day. Because the high water velocity section was short and because considerable slackwater refuge existed during drawdown, we judged impacts to steelhead to be minimal during sandbar construction.

The seasonal effect of removing organic material and constructing the sandbar is to create good summer rearing habitat for salmonids 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 when necessary, and sandbar closure create better fish habitat for tidewater goby and salmonids 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, as would have been the case in 2018. 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 and large swells. Increased tidal overwash would further elevate water temperature, making the lagoon less hospitable for salmonids.

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 piling bolt is at elevation 9.25 ft mean low low water (mllw) and 1.77 ft above the top of the flume, which is at 7.48 ft mllw. 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 original 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 constructed in the flume inlet in 2003.

Typically, 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.

In 2019, much of the beach had been washed away by tidal action before the facilitated breach. No notch or berm near the surf could be constructed across the beach. An inner berm was in place near the lagoon periphery.

A facilitated sandbar breach was required on 26 November 2019 due to rapid increase in streamflow from storm activity and rapid rise in lagoon water surface elevation. The fish biologist assigned to monitoring was notified by Morrison, contractor working for Capitola Public Works, at approximately 1930 hr that the lagoon water surface was rising quickly and that streamflow was presently at 16 cfs at Soquel Village. Alley prepared for traveling down to the lagoon and headed that way, receiving another call from Morrison in transit in which he stated the gage reading was above 20 cfs. Alley reached the lagoon at approximately 2030 hr after driving through a continuous, torrential down pour between Brookdale and Capitola, the heaviest he had recalled ever driving through. Traffic was moving at only 25-30 mph on Highway 17 and 35-40 mph on Highway 1 due to poor visibility through the rain and wind. By 2030 the gage reading in Soquel Village had reached 51 cfs, and the lagoon water surface was rising quickly. The flume capacity was only in the range of 25-30 cfs. The joint decision between Morrison and Alley was to facilitate the breaching of the sandbar to avoid imminent flooding. Steve Jesberg, Public Works Director was also present. Then the tractor operator, Cooper Sanden, began to cut a 10-foot wide notch through the berm at the lagoon periphery. This was accomplished by 2045 hr. Water began spilling through the notch at 2052 hr. The gage reading at 2045 hr was 71.8 cfs.

The lagoon water surface had increased 6 inches in 15 minutes to above the top of the flume inlet prior to the breaching and prior to these higher flows reaching the lagoon. These observations indicated a predicted continued rapid increase in lagoon water level because stormflow was greater than the flume capacity at the time of breaching. Rainfall ceased abruptly soon after the breaching, and stormflow at Soquel Village rapidly declined to a minimum of 13.9 cfs at 2315 hr. However, rainfall resumed later that evening, with stormflow again rising to 40 cfs as early as 0115 hr on 27 November. Stormflow was sustained above 30 cfs at the gage and above the capacity of the flume to convey water from 0015 hr to 0545 hr on 27 November, which would have again caused lagoon buildup and flooding along the lagoon margin without the facilitated breach. 4 boards had been previously removed from the flume inlet to provide 12 inches of vertical opening prior to the storm. Streamflow at Soquel Village gage on the day of breaching and afterwards (later the streamflows were adjusted downward somewhat)-

28.4 cfs at 2000 hr; 26 November
51.1 cfs at 2030 hr;
71.8 cfs at 2045 hr;
36.5 cfs at 2100 hr
13.9 cfs at 2315 hr;
40.0 cfs at 0115 hr; 27 November
31.8 cfs at 0545 hr.

No fish mortality or water quality problems were observed during the facilitated breaching. Streamflows are provisional and subject to change. Streamflow at the lagoon was somewhat higher than flows measured in Soquel Village once they reached the lagoon due to added surface runoff in Capitola and contributions from Noble Gulch.

Kotila from Public Works collected a water sample in the lagoon earlier in the afternoon on 26 November, prior to breaching, and another on the morning of 27 November in the surf near the exiting stream channel from the estuary and delivered the 2 samples to Monterey Analytical. Lab analysis indicated that the pre-breach enterococcus bacterial count was 10 cfu/100 ml. The post-breach count was 1012 cfu/100 ml, necessitating additional weekly water sampling until the count declined below 104 cfu/100 ml.

27 November 2019. This was the day after the facilitated sandbar breach. The fish biologist arrived at the lagoon at 1450 hr. The sandbar was closed to the Bay at low tide due to tidal action, with the flume passing water at high capacity. See photos below. The lagoon was full, with the water surface above the flume inlet. Gage height was 2.98 ft (top of the flume is at 2.60 ft on the gage). The water was turbid with secchi depth of 18 inches. Water was fresh in the upper half meter, with gradual salinity increase to 22.5 ppt at the bottom. Refer to the table in Appendix A for this date. This indicated that tidal mixing had occurred when the sandbar was open at higher tide. Oxygen levels were good from the surface to the bottom. Water temperature was cooler than 4 days previously. No water quality problems were observed for aquatic life. No fish mortality was observed. The flume was conveying water through the lagoon and out to the Bay to prevent stagnant conditions during low tide when the sandbar was closed.

Outlet channel through sandbar after facilitated breach. 26 November 2019

Lower lagoon at low tide after breach the night before. 27 November 2019

Lagoon, looking upstream from Stockton Avenue Bridge. 27 November 2019

Outlet channel at low tide. Lagoon out-letting through the flume. 27 November 2019

Flume outlet conveying water and maintaining water transfer through lagoon during low tide.
27 November 2019

WATER QUALITY MONITORING IN 2019

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 2018, 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 2019, 6 HOBO temperature loggers were launched on 29 May 2018, just downstream of the railroad trestle in Reach 2 (as in 2008−2018) 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 13 October 2019 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.

No saltwater was detected in 2018 in the lagoon 4 days after the sandbar closure. Thus, the biologist judged that the inlet shroud was unneeded to pull saltwater off of the bottom.

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 at dawn within 0.25 m of the bottom and below 22ºC near the bottom in the afternoon, with the 7-day rolling average near the bottom equal to 21°C or less. 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 the 7-day rolling average at 20ºC or less. Maximum daily water temperature in the lagoon should not reach 26.5ºC. 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 later 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 (MWAT), should not rise above 20ºC (68ºF) and the maximum daily temperature should be less than 26 ºC (78.8 ˚F). The MWAT and maximum temperature goals are based on 1) conclusions drawn by Kubicek and Price **(1976),** 2) guidelines by SYRTAC **(2000)**, 3) laboratory findings on steelhead temperature lethality by Charlon (**1970**), Alabaster (**1962**) and McAfee (**1966**) , 4) findings Farrel et al. (2015) and 5) our data on steelhead growth rates and water temperatures in Central Coast steelhead streams. 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 Mattole 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 the lower 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 Water Level

Appendix A provides detailed water quality and lagoon height data. The lagoon level was monitored 4 days after sandbar closure (4 June) and 13 times in 2-week intervals from 8 June 2019 to 23 November 2019. **Table 3** rates habitat conditions according to a rating scale (**Table 2**). The lagoon level was rated "good" throughout the monitoring period except for "fair" on 34 June. The sandbar breach was facilitated on 26 November due to stormflow that exceeded the capacity of the flume.

Gage height in 2019 was consistently near the highest recorded through the last 4 years except for late June (**Figure 2**). Baseflow was above the seasonal median, allowing good lagoon depth even with the underwater adult portal being open much of the dry period. Lagoon depth was maintained as high as possible in 2019 through good management except in June. Typically, it is more difficult for the City to maintain the highest water surface elevation after wetter winters that bring higher baseflow during the summer. Despite the high baseflow, saltwater was detected in the lagoon on 4 June, 5 days after final sandbar closure for the season. Therefore, shroud installation was judged necessary by the biologist. With the shroud in position in June, adjustment of the inlet boards was not possible to maximize lagoon depth. The shroud remained in place until saltwater had dissipated and was noted on 24 June during monitoring. No vandalism of the flume inlet was detected in 2019.

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 2019. The flume outlet was maintained open throughout the sandbar construction period. Nocturnal smolt passage was not delayed during sandbar construction.

Once sandbar construction was complete, the Venetian side of the flume inlet was left completely boarded up. The underwater portal was provided for adults through 15 June as required by the permit. The flume outlet remained open continuously until the emergency sandbar breach on 26 November. With the absence of forecasted rain and the loss of beach in November, there was insufficient sand on the beach to create a notch through the sandbar, as is typically done in preparation of sandbar opening. An inner berm around the lagoon periphery was maintained, however. The inner berm across the beach was notched to initiate a facilitated sandbar breach on 26 November during the first stormy period of the season. The streamflow at the Soquel Village USGS gage was a measured 51 cfs at the time of the breach, with stormflow reaching an estimated 71 cfs shortly afterwards. The stormflow at the flume was somewhat higher than at the gage due to surface street runoff and contributions from Noble Gulch. The flume capacity is 25-30 cfs at best. The sandbar remained open at high tide until the next stormflow that began on 1 December and reached 441 cfs at the Soquel Village gage on 2 December. The sandbar was open at the time of this reporting.

Water Temperature Results from Two-Week Monitoring

In 2019, early morning water temperature of stream inflow at Nob Hill was cooler for the higher baseflow year of 2019 (well above the median) than in the much lower baseflow year of 2018 (slightly below the median) by 1−2°C for most of June and July, but mostly warmer than 2018 by 1−2°C in August and September (**Figure 3e**). Water temperature near the bottom at lagoon monitoring stations followed the same pattern, being cooler in 2019 in June and July and warmer than in 2018 in August and September (**Figures 3a-3d**). These annual differences in water temperature directly paralleled differences in early morning air temperatures between the years (**Figure 3f**). Morning and afternoon water temperature at lagoon monitoring stations near the bottom closely paralleled inflow water temperature and annual differences in inflow temperatures except for 18 August when inflow water temperatures were similar between years and air temperature was more than 2°C warmer in 2019 but early morning and afternoon water temperatures were more than 1.5°C cooler in 2019 (**Figures 3g-3h**). It was overcast and cloudy on 18 August 2019. The daily fluctuation in water temperature was greater in 2018 than 2019, presumably due to the lower stream inflow in 2018. During the last 29 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. With the above median baseflow to the 2019 lagoon, average lagoon site water temperature in the morning and afternoon remained much cooler than during drought years like 2015 throughout the dry season (air temperatures were also relatively high in 2015) and most of the time since 2016 (**Figures 3i and 3j**). However, 2019 morning and afternoon water temperatures in September were warmer than in 2016 and 2018 presumably due to higher September 2019 air temperatures compared to 2016 and 2018 (**Figure 3f**). 2019 water temperatures were also warmer than in 2017 in September, despite similar air temperatures in 2017, presumably because the stream inflow was much cooler in September 2017 in concert with higher baseflow in 2017 (**Table 9; Figure 3e**).

In 2019, *water temperatures near the lagoon bottom in the early morning* were rated "good" (<=20°C) at all stations during 2-week monitorings (**Tables 2 and 3**). By comparison, in the drought year 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" at all stations in the morning. In drought year 2014 there were 4 such consecutive "poor" monitorings that started later in July. So, when inflow rate is diminished during drought, lagoon water quality is poor regarding water temperature, especially when air temperatures are also relatively warmer as was the case in 2015.

Water temperatures near the bottom at dawn generally increased through the dry season from June to mid- September, except for mid-August, with an approximate 3°C increase from June to mid-September at all stations (**Figure 3g**). The same increase was observed at the sites for afternoon water temperatures, with the dip on 18 August on a cooler, overcast day. (**Figure 3h**).

Stream inflow water temperature in the morning was 1-2°C cooler than lagoon sites (**Figure 3g**), but more similar to lagoon site water temperatures in the afternoon (**Figure 3h**). In fact, afternoon inflow water temperature was warmer than all lagoon sites near the bottom in early June and warmer or similar to the lagoon site at Noble Gulch from early June to early August.

Afternoon inflow water temperature was within 1°C of lagoon site temperatures near the bottom until early September, when air temperatures became warmer and inflow temperatures became 1.5-2.5°C cooler than lagoon sites. In early October the inflow water temperature was 2.5-3.5°C cooler in the afternoon.

At the mouth of Noble Gulch in 2019, as in most years, the water temperature near the bottom in the morning and afternoon was typically cooler than other lagoon monitoring sites by 0.1−1.0°C from June through mid-October (10 of 10 monitoring dates in the morning and 9 of 10 monitoring dates in the afternoon) (**Figures 3g and 3h**). The slightly cooler conditions resulted from cooler Noble Gulch inflow that traveled along the lagoon bottom at its mouth.

In most years, morning lagoon water temperatures near the bottom are coolest at the upper Station 4 (mouth of Noble Gulch) and warm progressively downstream (**Figure 3g**). In 2019, there was a 0.5-1°C increase from Site 4 downstream to Site 1 in the morning. In the afternoon, Site 4 was always cooler than Site 1 (**Figure 3h**). But Sites 2 and 3 were sometimes cooler or warmer than the other. All 4 sites were within 0.5-1.2°C of each other in the afternoon.

Table 3. 2018 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	Salinity	Lagoon In-flow Estimated @ 0.5 cfs less than Soquel Village Gage Readings (cfs)
04June19 (Station 2 only)	open	2.64 good	good	good	good	17.7 cfs
08June19	open	2.61 good	good*	good critical good good	good	14.2 cfs
24June19	open	2.12 fair	good	good fair fair good	good	9.6 cfs
06July19	open	2.63 good	good	good	good	9.0 cfs
21July19	open	2.60 good	good	good fair good` good	good `	9.2 cfs
04Aug19	open	2.62 good	good	good	good	5.2 cfs
18Aug19	open	2.62 good	good	good	good	5.5 cfs
01Sep19	open	2.61 Good	good fair good good	good fair fair good	good	3.9 cfs
15Sep19	open	2.62 good	good	good	good	2.9 cfs
28Sep19 Nautical	open Parade	2.53 good	good	good	good	3.0 cfs
12Oct19	open	2.55 good	good	good	good	1.9 cfs
26Oct19	open	2.66 good	good	good	good	1.4 cfs
19Nov19	open	2.67 Good	good	good	good	gage artifact (leaf dam)
23Nov19	open	2.58 Good	good	good	good	gage artifact (leaf dam)

* Four ratings refer to Monitoring Sites 1-4. If one rating is given per column, it 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 29 years. All lagoon water temperature management goals were met in 2019 throughout the period of sandbar closure. 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.

Juvenile steelhead likely spend most of their time near the bottom to avoid predators 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 and oxygen concentration recorded near the lagoon bottom (0.5 feet from the bottom) have greatest relevance to assessing habitat quality.

As in past years, lagoon water temperatures near the bottom in 2019 somewhat reflected water temperature of stream inflow (**Figures 4a-f; 5a**). Daily temperature *maxima* and *minima*, as well as maximum, minimum and average 7-day rolling averages in the lagoon were consistently warmer near the bottom than the stream inflow in 1999-2019 (**Tables 4 and 5**).

In 2019, early morning water temperature of stream inflow at Nob Hill was warmer than in 2018 in early June (2 °C) and mid-September (1 °C). But they were cooler than in 2018 most of July (0.5-2.0 °C), mid-August (0.5-2.5 °C) and early October (5-6 °C) (**Figures 5a-b**). In 2019, early morning water temperature at 0.5 feet from the lagoon bottom followed a similar pattern compared to 2018 as lagoon inflow (**Figures 4a and 4g**). In 2019, early morning water temperature at 0.5 feet from the lagoon bottom was warmer than in 2018 in early June (2.5 °C) and mid-September (1.5 °C). But they were cooler than in 2018 most of July (0.5-2.0 °C), mid-August (0.5-2.7 °C) and early October (5-6 °C)

Days when lagoon water temperatures exceeded 22º C (71.6º F) near the lagoon bottom would likely be stressful for juvenile steelhead, making that a management goal to maintain a daily water temperature maximum below 22ºC near the bottom. This goal was met in 2019 at the data logger location and at all monitoring stations (**Figures 3a-3d; 4a**). In 2019 the daily maximum stayed below 21°C and was below 20.2°C most of the time at the data logger location. Another lagoon management goal is to maintain early morning maximum water temperature below 20°C near the bottom. In 2019, this management goal was met at the data logger location and at all monitoring stations except on 1 September at Station 2 where it was 20.1°C. The warmest early morning water temperature at the data logger location was 19.5°C. A third lagoon management goal is to maintain the daily 7-day rolling average at 21°C or less near the bottom. This goal was also met at the data logger location. The highest 7-day rolling average value was 19.8°C in 2019.

We see from **Tables 4 and 5** and **Figure 4h** that in wetter years (2006, 2010-2012, 2017 and 2019) the lagoon temperature management goals near the bottom for steelhead were mostly met (20°C daily minimum at dawn; 22°C daily maximum in early evening; 7-day rolling average <= 21°C). Lagoon water temperature has typically been warmer in years with reduced baseflow entering, as indicated by maximum and minimum temperatures and maximum, minimum and

average 7-day rolling averages (**Table 4; Figure 4h**). But air temperature also contributed to stream inflow temperature to determine lagoon water temperatures, as when summer air temperature was cooler in 2016 (**Figure 3f**), allowing management goals to be met, and when warmer in August and September 2017, causing management goals not to be met some of the time, despite high baseflow. The stream inflow maintains a cooler lagoon during higher baseflow years in terms of 7-day rolling averages, with the difference between inflow average 7-day rolling average temperature and lagoon average 7-day rolling average temperature near the bottom being more similar during higher baseflow years (2010-2012, 2017 and 2019) (**Table 5**).

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 2019 by the data loggers in the deep area near the railroad trestle. The mostly 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 for about 2 weeks after sandbar closure in the deep area along the Venetian Court wall where saline water at the bottom was slightly warmer at that time. In 2019, the warmest part of the water column was 4.5 feet from the bottom, and the coolest part of the water column was 1.5 ft from the bottom based on 7-daily rolling averages (**Figures 4a-4f** In most other years, water temperature was cooler nearer the bottom and warmer near the surface, based on the continuous data loggers. However, in 2017 the warmest location was 3.5 feet from the bottom, and in another relatively high baseflow year, 2006, water temperatures at 4.5 feet from the bottom were cooler than 0.5 feet from the bottom (**Alley 2018; 2006a**). Water temperatures at 0.5 and 5.5 feet from the bottom were similar in 2006.). In 2019, there were assumed non-representatively high water temperature recordings on the surface instead of at least 0.5 ft below the water surface in early June when the gage height and water surface elevation dropped 0.5 feet when the shroud was in place on the flume inlet and flashboards were not added to the flume inlet as streamflow declined (**Figure 4f**).

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 2013−2019.)

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
2019	Maximum Water Temperature °C	**20.2 (11 June)**	**24.4 Ignoring June Artifact (14 Aug)**	**21.0 (12 June)**
2019	Minimum Water Temperature °C	**14.5 (9,17,19,22,23,28 June)**	**14.5 22-23 June)**	**16.4 16-18, 21 June)**
2019	Maximum 7-Day Rolling Average*	**18.2 (Aug 29)**	**19.8 (9 Aug)**	**19.9 (Aug 29)**
2019	Minimum 7-Day Rolling Average	**15.2 (15 June)**	**16.7 (15 June)**	**17.3 (14 June)**
2019	**Average 7-Day Rolling Average**	**17.2**	**18.7**	**18.8**
2018	Maximum Water Temperature °C	**20.6 (22July, 4 Oct)**	**23.2 (25 July, 16 Aug)**	**22.1 (11 and 22 July)**
2018	Minimum Water Temperature °C	**12.9 (1 June)**	**16 (30 June, 5 July)**	**15.6 (17 June)**
2018	Maximum 7-Day Rolling Average*	**19 (19July)**	**21.9 (23 July)**	**21.3 (20 July)**
2018	Minimum 7-Day Rolling Average	**15.9 (13 June)**	**18 (28 June)**	**17.3 (15 June)**
2018	**Average 7-Day Rolling Average**	**17.7**	**19.9**	**19.3**
2017	Maximum Water Temperature °C	**21.3 (2 and 5 Sep)**	**21.7 (4 Sep)**	**22.9 (5 Sep)**
2017	Minimum Water Temperature °C	**12.9 (13 June)**	**14.5 (12 June)**	**14.5 (13 June)**
2017	Maximum 7-Day Rolling Average*	**19.6 (1 Sep)**	**20.5 (1 Sep)**	**21.3 (1 Sep)**
2017	Minimum 7-Day Rolling Average	**15.0 (8 June)**	**15.6 (7 June)**	**15.9 (7 June)**
2017	**Average 7-Day Rolling Average**	**17.7**	**18.8**	**19.3**
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**

Year	Statistic	Stream Inflow Temperature °C	Near-Surface Lagoon Temperature @ 5.5 ft from Bottom °C	Near-Bottom Lagoon Temperature @ 0.5 ft from Bottom °C
2015	Maximum Water Temperature °C	**20.6 (15 August)**	**24.8 (15-16 August)**	**24.0 (16-17 and 19 Aug)**
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; 31Aug–5 Sep)	25.2 (1 June due to saline layer)
2013	Minimum Water Temperature °C	14.1 (31 May; 4-5June)	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**

*Rolling averages were averaged for the 7 days forward from the date they were recorded on graphs and presented in this table.

Table 5. Water Temperature Comparisons between Stream Inflow and the Lagoon Near the Bottom, Diurnal Fluctuations and Differences between Years, Generated from Continuous Water Temperature Probes.
(Late May to 15 September in 2006−2019.)

Year/ Baseflow July1; Sept 1	Temp. Diff. (°C) between Stream inflow and near lagoon bottom- Max. 7-day Rolling Avg.	Temp. Diff. (°C) between Stream inflow and near lagoon bottom- Min. 7-day Rolling Avg.	Temp. Diff. (°C) between Stream inflow and near lagoon bottom- Daily 7-day Rolling Avg.	Temp. Diff. (°C) between Given Year and the Previous Year near lagoon bottom- Daily 7-day Rolling Avg.	Daily Temp. Fluctuat-ion (°C) near lagoon bottom	# of Days Temp. (°C) Min. near Lagoon Bottom above 20°C (STH goal unmet)	# of Days Temp. (°C) Max. near Lagoon Bottom above 22°C (STH goal unmet)	# of Days 7-day Rolling Avg > 21°C near Lagoon Bottom (STH goal unmet)	# of Days Temp. (°C) Max. near Lagoon Bottom above 20°C (Coho goal unmet)	# of Days Temp. (°C) above 20°C for 4 hours at Nob Hill Stream Site (STH stream goal unmet)
2019/ 10.1; 4.8	Cooler 1.6	Cooler 2.1	Cooler 1.6	0.5 warmer in June; then 0.7-1.5 cooler until late July; similar first half of August; 1.5-1.8 warmer mid-August to mid-Sept.	0.5− 1.7	0	0	0	32	0
2018/ 4.9; 2.9	Cooler 2.3	Cooler 1.4	Cooler 1.0-2.5	1.0-1.5 cooler to early July; warmer 1.0-2.0 remainder of July; similar until late Aug; cooler 0.5-2.3 late Aug to mid-Sep	0.5−1.5	10	2	6	40	5
2017/ 16.4; 6.2	cooler 0.7	cooler 0.9	cooler 1.5	cooler 1.0 to late Aug; warmer by 1.0 late Aug−mid Sep	1.0−1.5	3	4	4	55	5
2016/ 3.1; 1.4	cooler 2.5	cooler 3.5	cooler 2.0−3.0	cooler 2.0−3.0	1.5−2.5	0	0	0	50	1
2015/ 1.2; 0.4	cooler 5.4	cooler 3.5	cooler 3.5−5.0	warmer 1−2	1−2	96	64	75	111	2
2014/ 0.7; 0.35	cooler 5.2	cooler 4.8	cooler 3.0−5.5	warmer 1−3	0.5−1.5	113	81	94	119	0
2013/ 1.7; 0.4	cooler 4.7	cooler 3.2	cooler 3−4	warmer 2	0.5−1.5	63	25	40	99	1
2012/ 5.6; 1.8	cooler 1.5	cooler 0.7	cooler 2	warmer 1	1−2.5	0	0	0	7	0

2011/ 15; 5.8	cooler 0.8	cooler 0.9	cooler 1.3–1.5	Similar until cooler by 1 in late Aug – Sep	1.5–2.5	0	0	0	0	0
2010/ 7.3; 3.4	cooler 1.3	cooler 1.5	cooler 1.3–1.5	cooler 1–4	1–2.5	0	0	0	7	0
2009/ 3.3; 1.2	cooler 2	cooler 1.2	cooler 1–3.5	cooler 0–2 to mid July and cooler by 0–1 after	1.5–2.5	16	8	9	75	0
2008/ 2.0; 0.7	cooler 4.1	cooler 2.6	cooler 2	similar except cooler by 1 in early Sep	1.5–2	54	13	20	90	1
2007/ 2.3; 1.4	cooler 3.2	cooler 1.5	cooler 2	–	0.5–3	35	20	23	82	5
2006/ 17.0; 6.6	– Rolling Avg not available	– Rolling Avg not available	– Rolling Avg not available	– Rolling Avg not available	1–2.5	0	4	0	19	14

In 2019, the coho management goal of keeping maximum lagoon water temperatures below 20ºC (68ºF) near the bottom in the presence of steelhead was not met for 32 days that were monitored (**Table 5**). Generally, the pattern has been that more days exceed the management goal as baseflow is reduced. Water temperature met the coho goal for the entire dry period only in 2011, a year with higher baseflow (**Table 9**). The coho goal was mostly met in 2010 and 2012 with moderate baseflow. The high baseflow year, 2006, also met the coho goal much of the time. However, the high baseflow year of 2017 did not fit the pattern, partially due to relatively high air temperatures from mid-August to mid-September (**Figure 3f**) and generally warm inflow temperatures through the summer/fall, despite higher baseflow (**Alley 2018**).

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 2019 (**Table 5**). The goal was mostly met in all of the last 13 years, even during drought. No pattern is apparent between number of days of failure and baseflow. In fact, 2 of the 3 years when failure was more evident were wetter years, 2006 and 2017. The stream management goals for steelhead to have the maximum 7-day rolling average at 20°C or less and maximum daily temperature below 26°C were met in 2019, as it had in 2006–2018.

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 2019, the management goal was met beginning 11 June to 3 July (24 days) and after 24 September only (**Figure 5a**). For examples of cooler years, in 2012 the coho management goal was met on all but 9 days (7%) (**Alley 2013**). In 2011, the management goal was not met 23 of 93 days (25%; reaching a maximum of 17.3°C) (**Alley 2012**). 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 2011**). Coho salmon may have survived in the 2010–2012 stream habitat near the lagoon if present, based on the Matthole River findings . However, in all other past monitoring years, more stream shading and/or streamflow

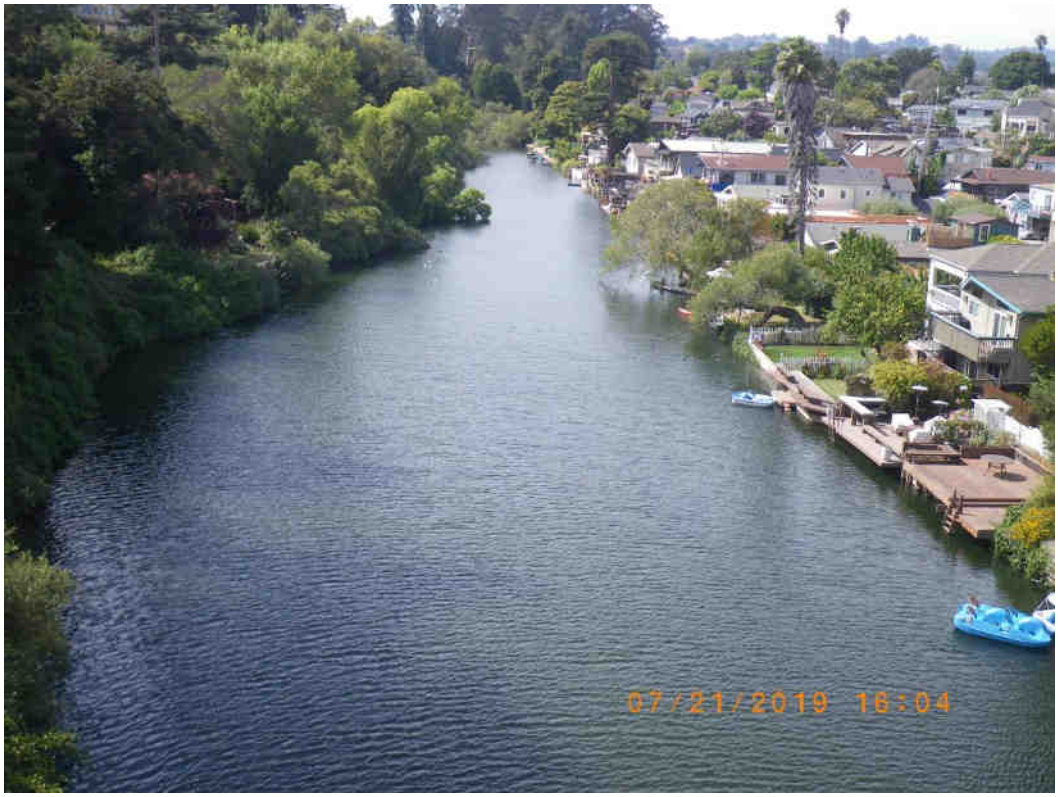
would likely be required to make lower Soquel Creek habitable for coho salmon, based on the Mattole River findings (acclimation would likely raise the acceptable temperature range). Stream temperatures were especially high in low flow years such as 2013−2015 and the higher flow years of 2006 and 2017 when shading may have been lost after high stormflows. The additional stream shading would need to come from larger trees of tall stature along the lower mainstem, such as redwood and Douglas fir.

The daily stream water temperature fluctuated more than the daily lagoon water temperature near the bottom in 2019, which was typical for previous years except 2010. The maximum daily lagoon water temperature near the bottom typically occurred between 1600 and 2100 hr each day.

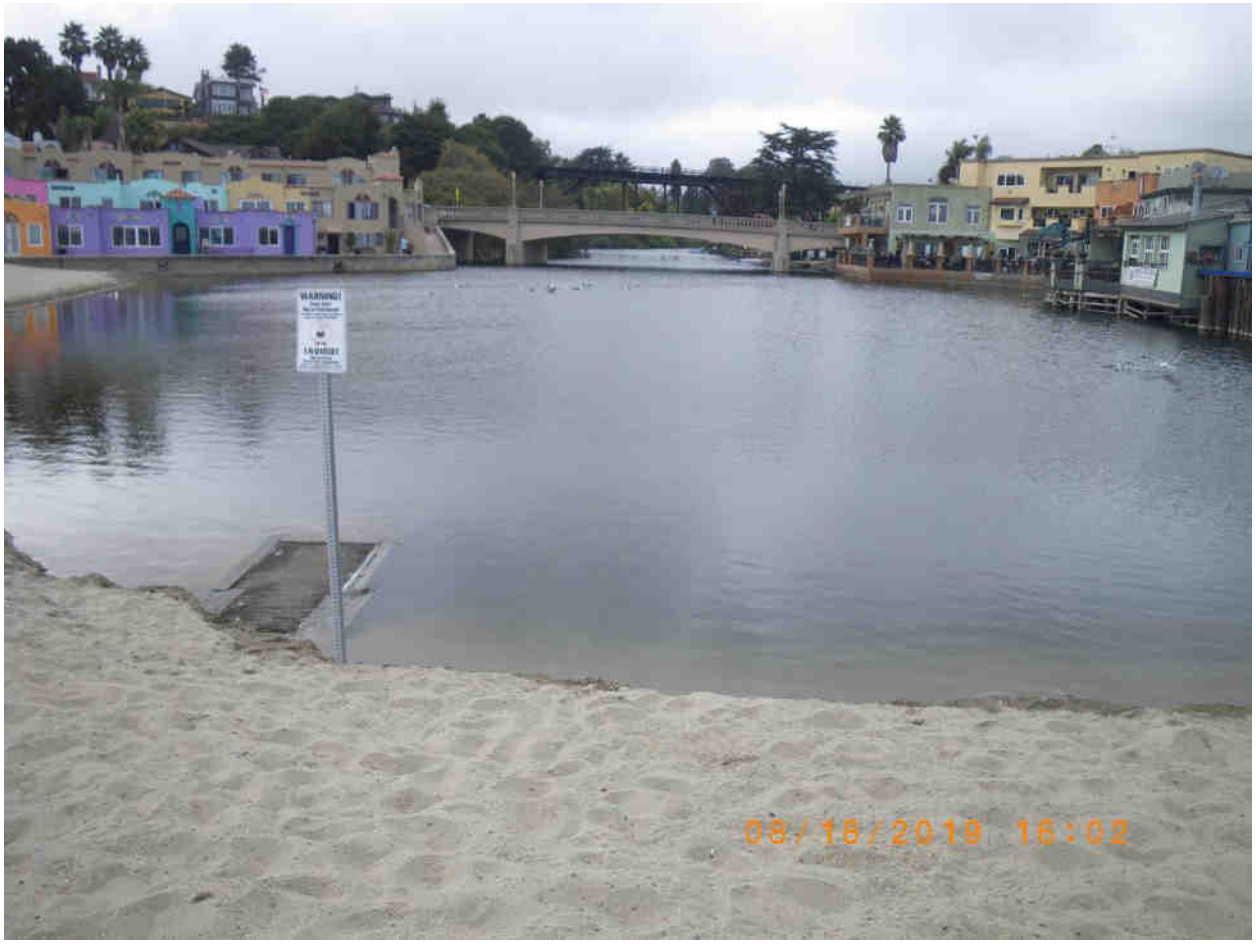
Aquatic Vegetation Monitoring.

Kelp and seagrass were abundant in the estuary prior to sandbar construction in 2019. Recent high tides and swells had brought considerable plant material inland as far as the Noble Gulch confluence. Raking out of decomposing plant material was required. Sand had been deposited midway between the flume and Stockton Bridge during the spring, creating a shallow area in the center of the estuary and a deep channel alongside the restaurants on the eastside. A backwater was created above the sand deposit on the westside adjacent to the Venetian Court wall. The streambed downstream of the sand deposit and over the sand deposit was firm. The streambed above the sand deposit was soft with considerable kelp and seagrass deposits. An estimated 70% of the decomposing plant material was raked from the lagoon in 2019 (90% in 2018, none present in 2017, 90% in 2016 and 70% in 2015). There were more nutrients available for plant growth in 2019 upstream of the shallow center area than in 2015−2018. In 2019, algae developed quickly but lost thickness in September and October when pondweed was most prevalent (**Table 6**). Pondweed was most abundant and algae the thickest in Reach 2 between Stockton Bridge and the railroad trestle. Algae coverage of the lagoon bottom became less in 2019 in Reaches 2 and 3 compared to 2017 and 2018 (**Tables 6-8**). Surface algae was scarce in 2019 with <1% coverage in Reach 1 and as much as 5% in Reaches 2 and 3 in late September. Surface algae was more abundant at the mouth of Noble Gulch than elsewhere, with a maximum of 15% coverage in mid-September. There was less surface algae in 2016−2019 compared to the warmer lagoon in 2015 during drought and much less than in 2014, which was also a drought year. Evidence of nutrient inputs from Noble Gulch in 2013−2015 and 2017-2019 was expressed by recurrent thick planktonic algae blooms and sporadically high levels of surface algae nearby, with bottom algae thicker on average than at other sites in 2019.

Reach 2, looking downstream toward Reach 1 below the Stockton Bridge and to the beach. 21 July 2019



Reach 3, looking upstream past Noble Gulch mouth. 21 July 2019



Reach 1, looking upstream from the flume inlet–Venetian Court on the left; Esplanade restaurants and Margaritaville Cove on the right; Stockton Bridge in center. 18 August 2019

Table 6. Visually Estimated Lagoon Algae/ Pondweed Coverage and Thickness in 2019.

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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
6-8	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
6-24	0.8	40	<1	0.5	40	<1	0.3	20	0	1.2	80	0
7-6	0.8	80	<1	0.5	50	0	0.4	40	0	1	70	0
7-21	1.0	80	0	1.0	60	0	0.8	80	0	1	80	0
8-4	0.5	50	<1	0.5	70	<1	0.4	60	1	0.5	60	10
8-18	Dark Cloudy	Dark Cloudy	0	Dark Cloudy	Dark Cloudy	0	Dark Cloudy	Dark Cloudy	0	Dark Cloudy	Dark Cloudy	0
9-01	Dark Glare	Dark Glare	0	1.5 (3.0 Pond-Weed)	60 (20 pond-Weed)	0	1.0 (2.5 pond-weed)	60 (1 pond-weed)	0	3.0	10	5
9-15	Dark Glare	Dark Glare	0	0.8 (3.0 pond-weed)	70 (30 pond-weed)	2	0.5 (3.0 pond-weed)	95 (5 pond-weed)	2	Soupy plankton bloom (3.0 pond-weed)	Soupy plankton bloom (15 pond-weed)	15
9-28	1.5 (4.0 pond-weed)	60 (25 pond-Weed)	0	0.5 (3.5 pond-weed)	65 (35 pond-Weed)	5	0.7 (3.5 pond-weed)	75 (5 pond-Weed)	5	0.5 (3.5 pond-weed)	85 (15 pond-Weed)	0
10-12	0.5 (4.0 pond-weed)	80 (15 pond-Weed)	0	1.0 (3.5 pond-weed)	50 (50 pond-Weed)	<1	0.5 (2.5 pond-weed)	90 (10 pond-Weed)	0	Murky Invisible	Murky plankton bloom-Bottom Invisible	0
10-26	Shaded Invisible	Shaded Invisible	0	1.0 (3.0 pond-weed)	60 (40 pond-Weed)	0	1.0 (3.0 pond-weed)	95 (5 pond-Weed)	0	1.0 (3.0 pond-weed)	75 (15 pond-Weed)	5
11-09	Shaded Invisible	Shaded Invisible	0	Shaded Invisible	Shaded Invisible	0	Shaded Invisible	Shaded Invisible	0	Shaded Invisible	Shaded Invisible	0
11-23	Shaded Invisible	Shaded Invisible	**0**	Shaded Invisible	Shaded Invisible	**0**	Shaded Invisible	Shaded Invisible	**0**	Shaded Invisible	Shaded Invisible	**0**
Avg-6-08 – 10-26	**0.7 algae (1.1 pond-Weed)**	**56 Algae (6 Pond-Weed)**	**0**	**1.3 algae (1.1 Pond-Weed)**	**46 algae (18 Pond-Weed)**	**0.5**	**0.6 algae (1.1 Pond-Weed)**	**62 algae (2.6 Pond-weed)**	**0.6**	**1.0 Algae (1.1 Pond weed)**	**58 Algae (3.5 Pond weed)**	**2.7**

Table 7. Visually Estimated Lagoon Algae/ Pondweed Coverage and Thickness in 2018.

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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
6-9	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
6-23	0.5	80	0	0.5	100	0	0.3	100	0	0.5	100	0
7-7	1.5	85	1	0.8	100	7	0.5 (3.0 pond-weed)	99 (1 pond-weed)	3	0.5	100	5
7-21	2.0 (4.0 pond-weed)	85 (5 pond-Weed)	0	2.0 (3.0 pond-weed)	99 (<1 pond-weed)	0	2.0 (3.0 pond-weed)	99 (<1 pond-weed)	0	0.3	100	0
8-4	1.5 (3.0 pond-weed)	5 (50 pond-Weed)	0	1.0 (3.0 pond-weed)	90 (10 pond-Weed)	0	0.8 (2.0 pond-weed)	95 (5 pond-Weed)	0	2.5	15	0
8-18	Dark Cloudy (3.5 pond-weed)	Dark (70 pond-Weed)	0	1.5 (3.5 pond-Weed)	90 (10 pond-Weed)	0	1.5 (3.0 pond-Weed)	95 (5 pond-Weed)	0	0.7	100	0
9-02	1.0 (4.0 pond-Weed)	40 (60 pond-Weed)	0	1.0 (2.0 Pond-Weed)	75 (25 pond-Weed)	0	2.0 (2.0 pond-weed)	95 (5 pond-weed)	0	1.0	100	0
9-16	0.2 (4.5 pond-weed)	40 (60 pond-Weed)	1	0.7 (3.0 pond-weed)	70 (25 pond-weed)	5	0.5 (2.0 pond-weed)	90 (10 pond-weed)	3	Soupy Plankton bloom	Soupy Plankton bloom	10
9-29	1.0 (4.5 pond-weed)	35 (60 pond-Weed)	<1	1.0 (2.5 pond-weed)	70 (30 pond-Weed)	<1	1.0 (1.5 pond-weed)	80 (20 pond-Weed)	2	Glare (2.5 pond-weed)	Glare (15 pond-Weed)	0
10-13	0.5 (4.0 pond-weed)	25 (60 pond-Weed)	0	Shaded	Shaded	0	Shaded	Shaded	0	1.0 (3.0 pond-weed)	90 (10 pond-Weed)	0
10-27	1.0 (3.0 pond-weed)	55 (40 pond-Weed)	0	0.5 (3.0 pond-weed)	60 (40 pond-Weed)	0	0.4 (2.0 pond-weed)	90 (10 pond-Weed)	0	1.0 (3.0 pond-weed)	90 (10 pond-Weed)	0
11-11	Shaded	Shaded	0	Shaded	Shaded	0	Shaded	Shaded	0	Shaded	Shaded	0
Avg-6-09 – 10-27	**0.9 algae (2.8 pond-Weed)**	**45 Algae (41 Pond-Weed)**	**0.2**	**0.9 algae (2.0 Pond-Weed)**	**75 algae (14 Pond-Weed)**	**1.1**	**0.9 algae (1.9 Pond-Weed)**	**84 algae (5.6 Pond-weed)**	**0.7**	**0.9 Algae (0.9 Pond weed)**	**77 Algae (3.5 Pond weed)**	**1.4**

Table 8. Visually Estimated Lagoon Algae/ Pondweed Coverage and Thickness in 2017.

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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**
6-11	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
6-25	<0.1	100	0	<0.1	100	0	<0.1	100	0	<0.1	100	0
7-9	0.8	5	0	0.3	15	0	0.3	15	0	Soupy plankton	Soupy plankton	0
7-23	1.0	100	0	0.5	100	0	0.4	100	1	0.5	80	1
8-6	1.0	60	0	0.5	100	0	0.5	100	0	0.8	80	<1
8-20	Dark Cloudy (1.5 pond-weed)	Dark	0	Dark Cloudy	Dark Cloudy	0	Dark Cloudy	Dark Cloudy	0	Dark Cloudy plankton	Dark Cloudy plankton	0
9-02	2.0 (3.0 pond-Weed)	90 (1 pond-Weed)	0	1.5 (2.0 Pond-Weed)	99 (1 pond-Weed)	5	1.0 (1.0 pond-weed)	99 (1 pond-weed)	2	3.5 Soupy plankton	80 Soupy plankton	20
9-17	2.0 (3.0 pond-weed)	85 (5 pond-Weed)	0	1.0 (2.0 pond-weed)	99 (1 pond-weed)	1	0.7 (2.0 pond-weed)	99 (1 pond-weed)	2	Murky gray	Murky gray	5
10-01	1.0 (4.0 pond-weed)	90 (5 pond-Weed)	5	Soupy Plankton bloom	Soupy Plankton bloom	5	1.0 (3.0 pond-weed)	99 (1 pond-Weed)	5	Soupy Plankton bloom	Soupy Plankton bloom	7
10-14	0.5 (4.0 pond-weed)	80 (10 pond-Weed)	<1	1.0 (3.0 pond-weed)	98 (2 pond-Weed)	0	1.0 (3.0 pond-weed)	98 (2 pond-Weed)	0	Murky Gray	Murky Gray	10
10-29	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0	Dark	Dark	0
11-11	Dark	Dark	0	Dark	Dark	2	Dark	Dark	0	Dark	Dark	0
Avg-6-11 – 10-14	**0.9 algae (1.7 pond-Weed)**	**68 Algae (2 Pond-Weed)**	**0.4**	**0.6 algae (0.9 Pond-Weed)**	**76 algae (0.5 Pond-Weed)**	**1.1**	**0.5 algae (1 Pond-Weed)**	**79 algae (0.6 Pond-weed)**	**0.8**	**1.0 Algae (0 Pond weed)**	**68 Algae (0 Pond weed)**	**3.6**

Dissolved Oxygen Results During the 2-Week Monitorings

Oxygen concentration was typically 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 because they are typically the lowest (**Figures 6b-6f**). In 2019, the average oxygen level and oxygen concentration *near the bottom* at Stations 1 and 4 near dawn and in the afternoon remained "good" (greater than 7 mg/l at dawn) for steelhead throughout the monitoring period (**Table 3; Figures 6a-1, 6a-2 6b and 6e**). Station 2, the deepest monitoring station and located just down from the Stockton Bridge had "critical" rating *near the bottom* a week after sandbar closure on 8 June because of a saltwater lens present there and "fair" ratings at dawn on 24 June, 6 July and 1 September (between 5 and 7 mg/l at dawn) (**Figure 6c**). A "good" rating was made at the other 9 monitored times. Station 3 below the trestle had "fair" ratings on 24 June and 1 September and "good" ratings at the other 11 monitoring times (**Figure 6d**). Aside from the low oxygen concentration of 1.47 mg/L at Station 2 on 8 June, oxygen concentrations at dawn at the 4 monitoring stations ranged from 6.54 mg/L (69% full saturation) on 21 July to 11.02 mg/L (120% full saturation) on 15 September. Afternoon oxygen concentrations near the bottom ranged from 7.32 mg/L (68% full saturation) on 23 November to 13.64 mg/L (134% full saturation) on 12 October.

With clear water conditions, reduced 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 stressfully low oxygen concentrations were detected in 2019 except near the bottom in the saline layer below the Stockton Bridge along the Venetian Court wall in early June. At 0.5 feet above the bottom there, oxygen was at 7.54 mg/L. Average morning lagoon oxygen concentration for the 4 lagoon stations ranged between 7.34 mg/L on 1 September and 9.95 mg/L on 15 September (**Figure 6g**) and were mostly lower than the 3 previous years until mid-September. In the afternoon, oxygen concentration for the 4 lagoon stations averaged between 8.98 on 23 November and 12.5 mg/L on 12 October (**Figure 6h**). The first stormflow of the fall season required a facilitated sandbar breach. Thus, stressful oxygen depletion was avoided in 2019 from turbid conditions that typically occur after early storms that do not breach the sandbar. When water clarity is reduced after small stormflows with a closed sandbar still intact, if light does not penetrate to photosynthesizing plant life, oxygen concentrations decline rapidly, as occurred in fall 2014 and 2015.

In comparing morning and afternoon oxygen levels in the lagoon, usually oxygen concentration was higher in the afternoon than morning *near the bottom* through the years. This was the case in 2019 except at the deepest Station 2 on 15 September and on 9 and 23 November (**Figure 6c**). These exceptions also occurred at the stream inflow (**Figure 6f**). Oxygen concentration typically increased 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 at all 4 stations in afternoon throughout the 2019 monitoring period except sometimes at Station 2 (6 of 13 monitoring days) and except at all stations on 9 and 23 November when the days shortened and shade hit the lagoon earlier in the day than previously.

Oxygen concentrations at the stream Station 5 at Nob Hill typically measured between 0830 and 0900 hr were usually similar to oxygen concentrations at lagoon stations in 2019, with less daily fluctuation than lagoon stations (**Figure 6a-1**). From 8 June to 18 August, as well as in November, stream oxygen was higher than most lagoon stations in the morning. Oxygen levels typically increased in the stream from morning to afternoon when measurements occurred between 1630 and 1730 hr (**Figures 6b-6f**), but not typically as much as at lagoon stations. Oxygen levels *near the bottom* at most lagoon stations typically exceeded those in the stream in the afternoon, except for Station 2 which often had the lowest afternoon oxygen level (**Figure 6a-2**). Morning oxygen levels in the stream in 2019 were in the 7−10 mg/L range and 70−91% full saturation. Afternoon oxygen levels were in the 8.9 – 12.9 mg/L range and 83−125% full saturation. Stream oxygen levels were much higher than in 2015, which had lower baseflow during drought.

Salinity Results

In 2019, no saline conditions were detected in the lagoon except along the Venetian Court wall in a 30-foot long pocket about 0.5 feet thick in early June after sandbar closure. The highest salinity measured in this layer was 13.7 ppt at the bottom on 4 June, 5 days after sandbar closure. The warmest water temperature measured in this layer was 18.6°C (1-2°C warmer than above), which was not stressful to steelhead. A shroud was placed on the flume inlet to suck water from the lagoon bottom through the flume. Thus, by 24 June the saline layer had dissipated, and a freshwater lagoon was maintained through the remainder of the period of sandbar closure until emergency sandbar breaching on 26 November. No tidal overwash was allowed to occur through the dry season in 2019, with an elevated berm maintained around the lagoon periphery.

Conductivity Results

Conductivity was not at stressful levels for steelhead. Monitored conductivity was lower in 2019 than 2018, ranging between 533 umhos in early June and 684 umhos *near the bottom* in mid-September, aside from 2237 umhos at Station 2 (Venetian Court wall) on 4 June (630 minimum and 775 maximum umhos *near the bottom* in 2018). As in other years, in 2019 the conductivity was usually slightly lower at Station 5 above the lagoon than in the lagoon through the summer/fall (**Appendix A**).

Stream In-Flow to the Lagoon

Lagoon water quality is generally best with relatively higher summer baseflow. Stream inflow in 2019 was relatively high (above the median baseflow for the period of record) at sandbar closure, and Soquel Creek maintained a baseflow through the dry season above the median flow until November (**Table 9; Figures 25−27**). The 2019 water year was relatively wet with four likely greater than bankfull stormflows between 1 January to 1 March 2019, with 4 more moderate stormflows between 1 and 15 March. Then little precipitation occurred until a minor, mid-May stormflow developed during the steelhead smolting period, which would have encouraged larger juveniles (=> 75 mm SL) to smolt. 2019 streamflow on 1 June at the Soquel Village gage was 21.1 cfs compared to 8.8 cfs in 2018, 26.7 cfs in 2017, 7.3 cfs in 2016 and 2.6 cfs in 2015. By October 1, the respective streamflows were 3.5 (2019), 2.1 (2018), 5.5 (2017), 0.7 (2016) and 0.25 cfs (2015).

Higher summer baseflow improves habitat conditions in the lagoon. Higher summer baseflow flushes saltwater out through the sandbar and flume more quickly than lower 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 quickly overnight when inflow is higher. Lagoon water temperature heats up more during the day with less inflow, as indicated by average lagoon water temperature at dawn and in the afternoon in 2015 (low inflow), 2016 (intermediate inflow), 2017 (high inflow), 2018 intermediate inflow just below median flow and 2019 (higher than median inflow), bearing in mind that 2016 and 2018 had cooler late summer and early fall air temperature and less stream inflow than 2017 and 2019 (**Figures 3e, 3f, 3i and 3j**). 2015 had relatively warm air temperature, warm inflow and very high lagoon water temperatures at dawn and the afternoon. The annual trend in 7-day rolling temperature averages with respect to the maximum, average and minimum for the dry season indicates the inverse relation between stream inflow rate and average lagoon temperatures (**Figure 4h**). However, the trend is less evident for the relatively high baseflow year of 2017, when the maximum temperature, the maximum 7-day rolling average and the average 7-day rolling averages are similar or higher than in 2016 and 2018, despite their lower baseflow. We judge this was because 2016 and 2018 had relatively cooler air temperature in late summer and fall and possibly more stream shading than after a wet 2016-2017 winter that would have contributed to warmer inflow in 2017 with loss of streamside vegetation and less shade.

In 2008, there were repeated problems with apparent saltwater back-flushes through the flume at high tides. This was not a problem in 2009−2019, perhaps resulting from partial boarding of the flume exit in 2014 and 2015 and the use of plywood over the flashboards in 2009−2019. 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 has been 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.

Drain Line Test for Restaurants Contiguous with Soquel Creek Lagoon

The 6 restaurants that were contiguous with Soquel Creek Lagoon were tested for leaks and deficiencies in plumbing connections. None were detected (**Appendix B**).

Evening Nautical Parade Observations

The nautical parade occurred at night on 28 September. No negative effects to fish and wildlife were observed during the evening. Seven floats took part in the procession. The lagoon water level was maintained during the event. All floats were powered by electric motor. A motorized, mobile, unlit barge was also present among the floats and appeared to be a collision threat because it was unlit and moving around unpredictably. Well lit water marshals were present in kayaks. Prior to the procession, a marshal was unable to prevent one float from traveling over a portion of the tules in the railroad trestle cove as it maneuvered around another float to avoid a collision. The tules showed no apparent damage from the incident in future days. There were no mishaps in the lagoon during or after the procession that might lead to wading in the lagoon. Water temperature was in the "good" range for steelhead. Oxygen levels were supersaturated prior to the procession (**Appendix A**). No parade debris was observed in the lagoon on 30 September.

Water Marshal positioned between a float and tules in the Railroad Trestle Cove, prior to the Nautical Parade. 28 September 2019


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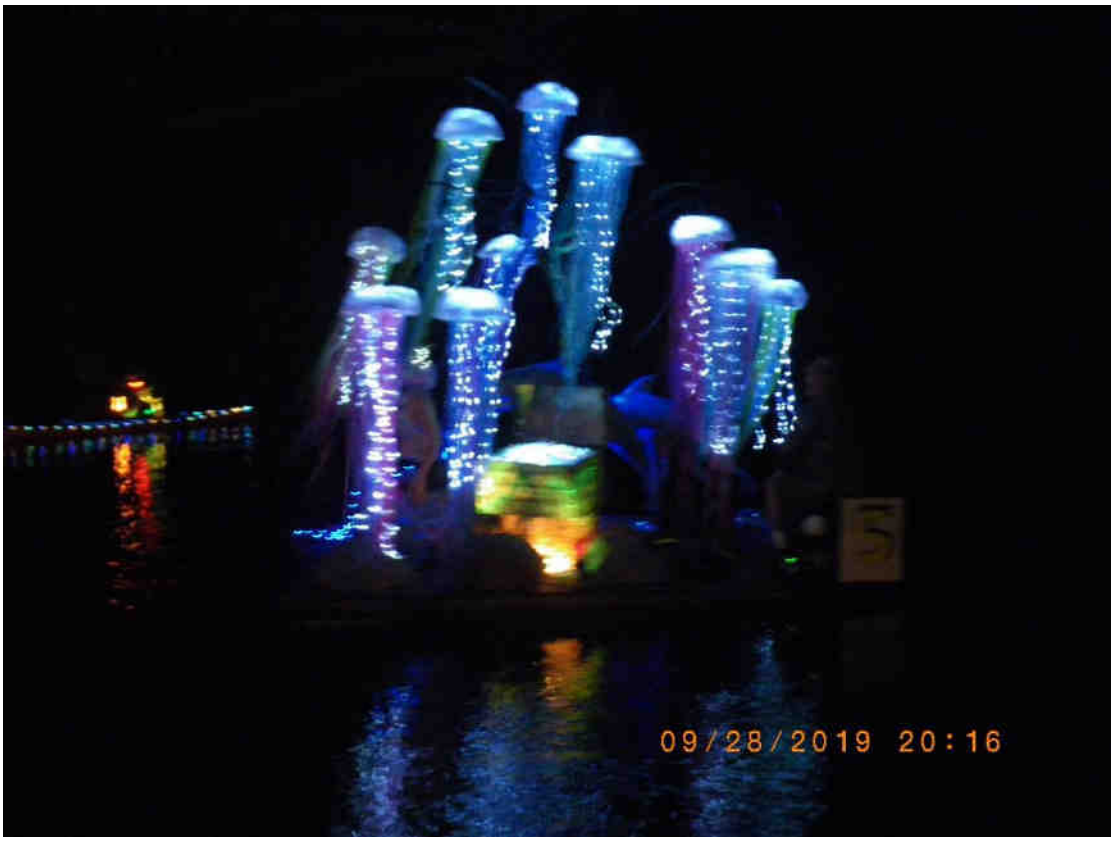
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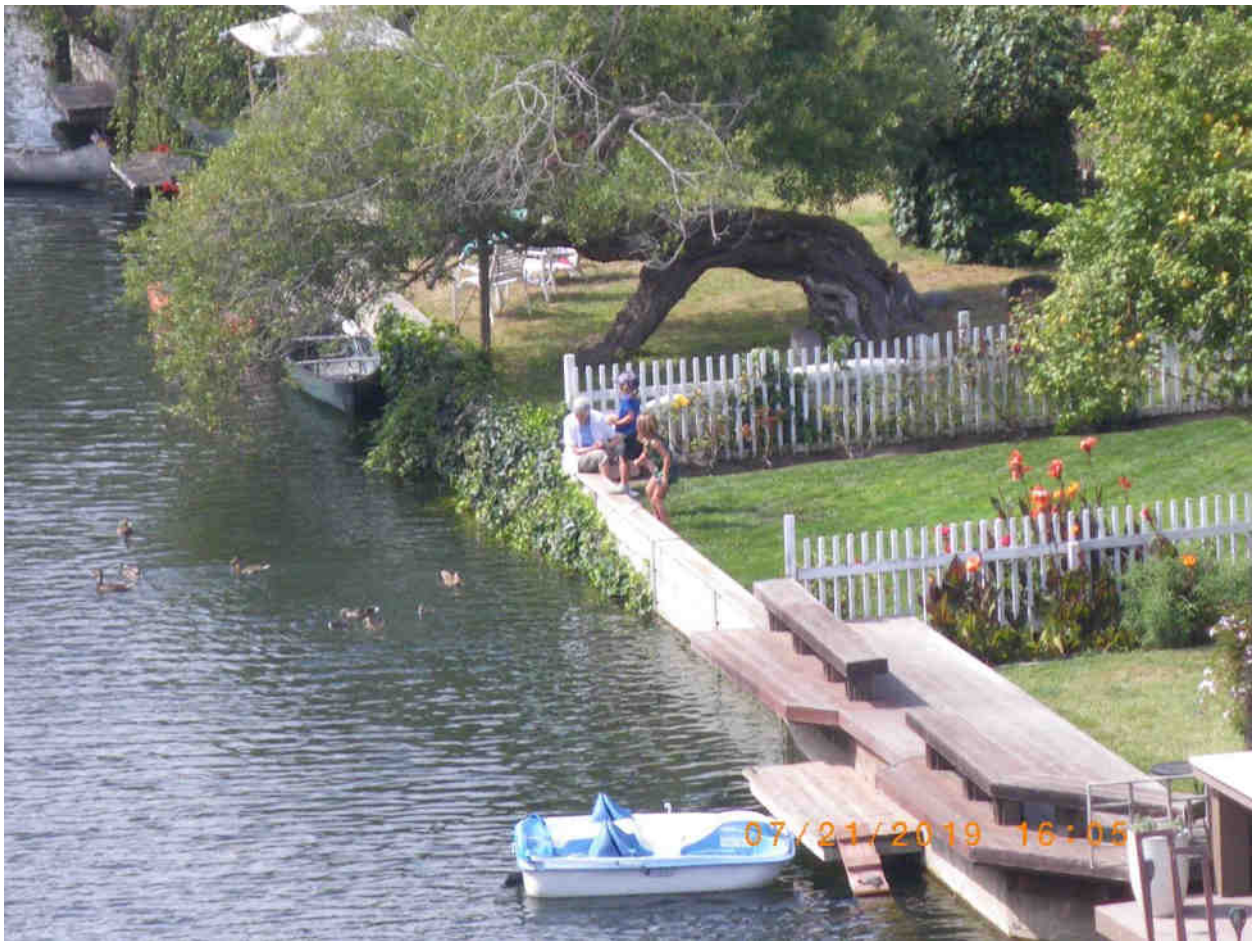
Table 9. Daily Mean Discharge Recorded at the USGS Stream Gage (11160000) in Soquel Village, At One Month Intervals from 1 June to 1 October, 1991-2019.

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
2017	27	16.4	9.7	6.2	5.5
2018	8.8	4.9	2.9	2.9	2.1
2019	21	10.1	7.0	4.8	3.5

Recreational Use, Pollution Sources and Solutions

The lagoon near the beach was posted with warning signs about potential health risks. However, increasing human use of the lagoon has been observed since 2016, when a paddle-board concession began in the village. Paddle-boarders have become commonplace (observed 5 of 13 afternoon weekend monitorings in 2019, 5 of 12 in 2018, 10 of 12 in 2017; 7 of 9 in 2016), along with more kayakers, pedal boaters, row boaters, canoers and barge users on the lagoon. The most paddle boarders counted in a reach were 6 in Reach 1, though usually they traveled in pairs. The most boat/paddleboard traffic was observed during the 3 separate monitoring days in September, especially on the day of the Nautical Parade (28 September). Waders and swimmers were commonly observed in the lagoon (usually near the beach in Reach 1; 6 of 13 afternoon monitorings in 2019, 5 of 12 in 2018, 4 of 12 in 2017; 6 of 9 in 2016). The most waders seen at one time in 2019 was 6 in Reach 1. On 21 July, two high school age boys jumped off the Stockton Bridge and swam over to Venetian Court wall. That was a first observed in 29 years. Human contact with the lagoon occurred despite warning signs being posted in close proximity. No waders or boaters/paddle boarders were observed during October and November monitorings.

Illegal fishing was observed on one occasion in 2019. Bird feeding along the lagoon and from the restaurants occurred more in 2019 than previously. High-volume bird feeding was observed on 2 occasions at the mouth of Noble Gulch where as many as 58 mallards and 5 gulls congregated. Bird feeding was observed 5 times along the lagoon and twice from restaurant decks. Ducks patrolled the lagoon next to Margaritaville in the afternoon, indicating that feeding went on regularly there. 2019 was the first year in 29 years of monitoring that rafts of gulls (as many as 24 birds) were commonly observed in Reach 3. They were using Reach 3 even during the sandbar construction and before lagoon formation. Before that, they congregated in Reach 1 only. They were also observed perching in groups on lagoon-side house roofs in Reach 3. Gulls are a threat to ducklings, and their waste is a pollution source. Previously, individual gulls were occasionally observed beyond Reach 1 when someone was feeding the ducks. The gulls may have decided to use the upper estuary more because the center of Reach 1 was very shallow at low tide before the sandbar was constructed in 2019.



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 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.**). The increased presence of paddle boarders and boaters since 2016 interfered with gull use in Reach 1. Gulls took wing when visitors appeared on their floatation devices and returned quickly to bathe and raft after they passed. Gulls avoided waders along the lagoon periphery near the flume. Human impact from disturbance on the rate of gull defecation is unknown.

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. Gray water and oily slicks have been noted emptying into the lagoon from Noble Gulch in the past. Two incidences of gray turbidity were observed at the mouth of Noble Gulch during monitoring in 2019, the most prominent occurring on 9 November with an associated oily slick on the surface. Though no gray water was detected during 2-week monitorings in 2014−2016 and 2018, gray water plumes were observed on 6 of 12 monitoring days in 2017, especially in the latter weeks of the monitoring period. Another drain into the lagoon exists under the railroad trestle, where slight oxygen depletion has been detected in recent years but not in 2018 or 2019. This drain could be capped if summer runoff was re-directed into the sewer.

Central Coast lagoons are naturally productive steelhead habitats with abundant aquatic plant populations. Juvenile steelhead grow rapidly in these lagoons where food is abundant. Plant life is the base of the food web and translates into food abundance for fast-growing juvenile steelhead in Soquel Lagoon. Also, abundant pondweed creates a forest that predators must negotiate to prey upon juvenile steelhead, offering some refuge from piscivorous birds like mergansers and pied billed grebes. Eutrophication from a biological perspective occurs when excessive nutrients induce overgrowth of plants and algae that cause oxygen depletion and fish kills if severe enough. In regard to steelhead habitat, habitat-degrading eutrophication indicated by stressfully low oxygen concentrations seldom occurs at the Noble Gulch creekmouth and has never occurred lagoon-wide in the last 29 year of Soquel Creek Lagoon monitoring.

Water quality monitoring was conducted along Noble Gulch in summer/fall 2017to pinpoint potential anthropogenic pollution sources. Noble Gulch was also monitored upstream of urban storm drains to establish a baseline. On one occasion in 2017 when a thick gray plume emanated from the Noble Gulch culvert into the lagoon, water from a residential hose entered a lateral drain approximately 60 feet from the mouth, with plant material decomposing within. If pollution sources can be 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, but reappeared in 2017. That was the only location where a planktonic bloom was observed in the lagoon in 2017. At times the bloom was so thick that the bottom was

invisible (4 of 12 monitoring days) (**Table 8**). In conclusion, there were indications of nutrient pollution and increased eutrophication at the mouth of Noble Gulch in 2017. In 2019 this algal bloom soup was observed on 2 of 13 monitoring days (**Table 6**).

Results of the 2017 water quality study in Noble Gulch are as follows. The water samples collected in Noble Gulch as it emptied into Soquel Lagoon and at upstream stations on Noble Gulch satisfied the Central Coast Ambient Monitoring Program (CCAMP) attention levels and EPA recommendations for total phosphates, as best we could tell, except for a 2.4 mg/L total nitrogen concentration detected just downstream of the Brookvale Terrace impoundment on 18 June 2017. However, plant growth, and potentially eutrophication, may be encouraged at nutrient concentrations below the CCAMP accepted attention levels. However, it appeared that nutrient levels (total nitrogen and phosphorus) in Noble Gulch were within acceptable levels for nitrogen as nitrate and phosphorus as orthophosphate on 9 of 10 monitoring days spread out over 20 weeks in summer and early fall, 2017.

On only one monitoring day of 10 in 2017 did total nitrogen increase at succeeding downstream stations in Noble Gulch, and that was the 4th monitoring, occurring in mid-July. One recurrent nutrient pattern throughout the water monitoring period was that phosphorus concentration was below detectable levels at all stations during the entire 20-week monitoring period, June through early October. The other nutrient pattern was that for the last 8 of 20 weeks monitored (and last 4 of 10 monitorings), the source of nitrogen narrowed to only nitrate, with less total nitrogen detected during those last 8 weeks compared to earlier in the season. This was positive in that no nutrient pollution from animal waste was detected during the last 8 weeks. Evidence of organic sources of nitrogen in water samples indicated that dead plant or animal wastes were entering Noble Gulch during the first 12 weeks of the study. However, nutrient concentrations often decreased between the station closest to the creekmouth (adjacent to City Hall) and the creekmouth station. The results did not indicate consistently higher nutrient levels at any one station throughout the monitoring period that might imply chronic sewage pipe leaks.

Indication of human/ animal waste pollution as organic nitrogen and ammonia was detected as kjeldahl nitrogen for at least 1 of the 5 stations during 5 of the first 6 monitorings. The most consistent location for kjeldahl nitrogen during the first 6 monitorings (12 weeks) was below the Brookvale Terrace Dam, often at the 0.5−0.6 mg/L level. But the highest kjeldahl nitrogen level was 1.0 mg/L, occurring in late July at the culvert entrance below Noble Gulch Park.

No elevation of dissolved phosphates, nitrates or organic nitrogen and ammonia was detected during the Noble Gulch study in 2017 when white or gray suspended particles from Noble Gulch entered Soquel Lagoon. On the monitoring day with the highest nitrogen concentration at the Noble Gulch creekmouth, 16 July, a green, planktonic algal bloom was observed without gray or white cloudiness. Nutrient analysis of cloudy water samples collected at the creekmouth on 10 and 24 September and 8 October detected no increased total nitrogen levels and, in fact, relatively low ones with undectable phosphorus. It was likely that plant life was absorbing nutrients at a rapid rate at the Noble Gulch mouth. On one occasion, surface runoff into the storm drain feeding Noble Gulch closest to Soquel Lagoon was observed when a thick gray plume formed at the Noble Gulch creekmouth in the lagoon. Organic debris was concentrated in this storm drain. Perhaps accumulated organic debris in multiple storm drains in the residential area between City Hall and the creekmouth experienced surface runoff to create the volume of gray

plume turbidity that was observed.

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 2019, the lagoon required emergency breaching because the flume could not accept all of the stormflow with flooding imminent. Although costly, 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.

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. In 2017, as a pilot project, tules were planted in the cove under the railroad trestle. Some of the original plantings survived the relatively mild winter of 2017-2018 and the heavier stormflows of the 2018-2019 winter. City staff will continue to monitor and augment plantings in the pilot project area.

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

Tules surviving since 2017 in "Railroad Trestle Cove." 12 October 2019

FISH CENSUSING

Steelhead Plantings. No steelhead were planted in Soquel Creek in 2019, as was the case in 2003–2018. CDFW has only allowed juvenile planting of smolts in spring 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 6 and 13 October 2019, from 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 upstream of it. Juvenile steelhead congregate in the shade

under the bridge and under the willows on the west side. The seine was pulled to the beach in front of Venetian Court. A total of 299 steelhead were captured and marked on 6 October after 3 seine hauls. There were no mortalities. A total of 300 steelhead were captured on 13 October in 3 seine hauls. There were 27 recaptures and no mortalities. The lagoon population estimate was 3,322 juvenile steelhead (5th highest in 27 years), using the Lincoln index for a closed population (**Table 10;** methods in **Ricker 1971**). Steelhead were relatively small and dominated by small YOY juveniles (**Table 11; Figure 7a**), consistent with the preponderance of small YOY captured at stream sites. But the population size was large compared to the 25-year average of 1,498 (**Figure 24**). This relatively large lagoon population was consistent with improved, higher densities of juvenile steelhead detected at most stream sampling sites in 2019 compared to recent years (**Alley 2020**). Size histograms of steelhead captured from the lagoon in 2019 and other years back to 1998 may be found in **Figures 7a−24**. No scale samples were taken in 2019 in order to minimize the holding and handling time for the large number of captured fish. Examination of the size histogram of captured fish in 2019 indicated no clear-cut demarcation between age classes. The large bell-shaped curve indicated that most juveniles were YOY, with most juveniles larger than 124 mm SL likely being yearlings. One steelhead was either a small adult at 355 mm Standard Length (400 mm Fork Length; 16 inches FL) or an older resident soon to become anadromous. With the large steelhead population in the lagoon, competition for food was undoubtedly high and likely slowed growth. Other species captured in 2019 with the large seine were 1,000+ threespine stickleback, 32 staghorn sculpins, 6 prickly sculpins (*Cottus asper*) and Sacramento suckers (6 adults and 14 YOY). Sticklebacks were abundant in the lagoon in 2019.

On 6 October 2019, 5 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. One tidewater goby was captured (**Table 11**). Numerous threespine stickleback were captured (100+). 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 for overwintering 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 migrated 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 two large stormflows in December 2012. We found them in Aptos Lagoon in 2011−2014 and 2017−2019 (**Alley 2012; 2013; 2014; 2015; 2017; 2018; 2019; 2020**).

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 (juveniles =>75 mm SL in the fall) in the 16.6 miles of steelhead habitat in the mainstem and 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 2007–2019 juvenile 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 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. Another factor that will affect the size distribution in the fall is timing of YOY entry into the lagoon. If some YOY enter the lagoon later in the summer, they will be smaller than if they entered early on. Still another factor is the proportion of yearlings versus YOY in the lagoon population. The higher the proportion of yearlings, the larger the size distribution will be. A summary table was prepared for the years, 1998−2019 (**Table 11**), corresponding to scatter plots of the data presented 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.

It is reasonable to 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 smaller, at least for YOY. 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. Usually the lagoon population is overwhelmingly dominated by young-of-the-year steelhead, based on past scale analysis. We suspect from the size distributions of juveniles captured that steelhead grew faster in 2006, 2009, 2011, 2014, 2016 and 2018 because of less competition for food with much smaller populations compared to large populations, such as those in 2007, 2008 or 2019 (**Table 10; Figure 24**). 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 with the much smaller population estimate than 2007, 2008 or 2019. 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. In 2019 the lagoon population size was large, the lagoon period was above average, and the captured juveniles were mostly relatively small. Another factor in 2019 was the mid-May stormflow after a wet spring in which YOY growth rate was likely good. This late stormflow may have encouraged larger YOY and yearlings (=>75 mm SL) to smolt and enter the Bay, leaving a smaller proportion of yearlings and smaller YOY in the juvenile population than in some years.

Table 10. Estimates of Juvenile Steelhead Numbers in Soquel Creek Lagoon for the Years 1988 and 1992-2019.

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.

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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.

2017- 259 +/- 23 (standard error). 102 fish marked from 5 effective seine hauls.

2018- 46 +/- 10 (standard error) 13 fish marked from 6 effective seine hauls.

2019- 3,322 +/- 697 (standard error) 299 fish marked from 3 effective seine hauls.

Table 11. Summary of Annual Fish Sampling Dates, Population Estimates, Steelhead Size and Lagoon Growth Period Prior to Sampling, 1998−2019.

Year	Sandbar Closure Date	Fish Sampling Dates	Weeks of Sandbar Closure Prior to Final Fish Sampling	Days of Sandbar Closure Prior to Final Fish Sampling	Steelhead Population Estimate	Median Size Grouping of Captured Fish (mm SL)- 1st and 2nd Day
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 weeks 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 unmarked fish- 2nd day)	21.3	149	None possible (No recaptures)	155-159 First Day
2015	21 May	4/11 Oct (5 unmarked fish- 2nd day)	20.4	143	None possible (No recaptures)	95-99 First day
2016	27 May	2/9 Oct	19.1	134	237	155-159 & 165-169
2017	1 June	8/15 October	19.4	136	259	160-164 & 155-159
2018	24 May	7/14 October	20.4	143	46	160-164 & 170-174
2019	31 May	6/13 October	19.6	137	3,322	95-99 & 95-99
Avg/Median				**133/ 136**	**1498/ 875**	

Table 12. 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
2017	0	6
2018	1	6
2019	1	5

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. 2012−2015 had good densities of pondweed with attached algae (15-70% of bottom coverage in various reaches) from mid-August onward**.** High pondweed production would encourage faster steelhead growth rate. Consideration must be given to potentially diminished water quality (high water temperature or low oxygen levels at the end of the night) and/or poor fish foraging efficiency if aquatic vegetation becomes too dense, making it difficult to maintain food intake. Warmer water increases fish metabolic rate and food demands.

Cooler lagoons resulting from higher summer baseflow 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 as occurred in 2019 compared to drought years, 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 lagoons in 2011−2012, 2016−2017 and 2019 were cooler. Aquatic plant production was less in 2011, 2016, 2017 and 2019 than in the warmer lagoons of 2008, 2009, 2012 and 2013−2015 and 2018 (more pondweed) (**Tables 6−7; Alley 2018a**), indicating less food available in 2011, 2016−2017 and 2019. There may have been a higher proportion of yearlings in the lagoon population in 2011 and 2016−2018 compared to other years due to overall low YOY production in the watershed. In 2016−2018, juvenile densities were extremely low in the lower mainstem Soquel Creek (**Alley 2018b**). A higher proportion of yearlings would have increased the median size of juveniles in those years.

In order to maintain good steelhead nursery habitat in Soquel Creek Lagoon, the sediment input from the watershed must be reduced. The 2019 lagoon remained deeper than recent years in Reaches 2 and 3 after deepening in 2017, with scour at the base of the exposed bulkheads visible. Station 2 was 0.25 meters (10 inches) shallower in 2019 than in 2017, however. Reach 1 was shallower than past years because wave action had pushed a plug of sand into the center of the Reach over the winter. Therefore, there was a shallow center to the lagoon, downstream of Stockton Bridge.

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). But flashboards must be added steadily through the summer as baseflow recedes. 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. 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 2013−2019. 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 2019. There were periods during the 2019 summer when threat of sink holes existed and areas were flagged on the beach nearer the flume outlet. These sinkholes were likely caused by tunneling of water that leaked from cracks in the flume. The lagoon water surface was kept at the top of the flume inlet throughout the summer/ fall in 2019 after the shroud was removed from the inlet in late June and until the sandbar breach was required before Thanksgiving in November. Usually, in drier years it is easier to maintain a high water surface elevation because streamflow recedes early and requires all flashboards in place early on.

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 2019 the sandbar remained open after the initial breach, at least at high tide from 26 November onward. More sustained storm activity in early December increased the connectivity between Bay and Creek (**Figure 27**). In 2018, good Bay connectivity occurred after the initial sandbar breach on 23 November. In 2017, the sandbar periodically closed and opened after the emergency breach on 16 November because only 1 small storm had occurred until the next significant stormflow in early January 2018. In 2015, the lagoon opened and closed repeatedly after the early breaching on 9 November because streamflow was low. 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.

BIRD AND POND TURTLE CENSUSING

Piscivorous Birds and other Waterfowl. Predation may be a factor in population size and body size distribution of juvenile steelhead. If bird predation rate is heavier, smaller steelhead would be most vulnerable because fish 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 uncommon in 2019 and much less common than in 2013–2015 (**Table 13**), although 7 were observed by Morrison on the day after sandbar construction. Other piscivorous birds observed in 2019 included pied-billed grebe, cormorant and common golden eye (23 November).

Table 13. Number of Sighting Days of Less Common Piscivorous Bird Species at Soquel Lagoon on Two-Week Interval Monitoring Days.

Year/ # Monitoring Days	Common Merganser	Pied-billed Grebe	Black-crowned Night Heron	Green Heron	Snowy Egret	Corm-orant	Great Blue Heron
2019/13	3	5	0	0	0	1	0
2018/ 12	2	7	2	1	1	1	1
2017/ 12	4	6	0	0	0	1	0
2016/ 13	3	4	1	3	0	2	0
2015/ 12	6	4	1	2	1	7	0
2014/ 13	6	7	3	2	4	1	0
2013/ 18	9	10	3	3	0	3	0
2012/ 12	3	8	0	0	1	4	0

Common merganser at Soquel Lagoon

Common merganser at Soquel Lagoon

Pied-billed grebe at Soquel Lagoon

No western pond turtles were observed in 2013−2019, although a paddle-boarder observed a turtle in the upper lagoon in 2015. Previously, they regularly basked on the instream cottonwood log across from the Noble Gulch mouth and on additional logs further downstream adjacent to the Golino Property. In 2012, as many as 3 pond turtles were observed at one time on the cottonwood log and another nearby log. 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. The cottonwood was flushed out to the beach during the wet 2016-2017 winter.

Gulls commonly bathed in Reach 1, downstream of the Stockton Bridge. However, when people were feeding the ducks in upstream reaches, a few gulls were attracted to the food source. 2019 was the first year in 29 years of monitoring that rafts of gulls consisting of as many as 24 birds were commonly observed in Reach 3. They were also observed perching in groups on lagoon-side house roofs in Reach 3. Gulls are a threat to ducklings. Previously, individual gulls were occasionally observed beyond Reach 1 when someone was feeding the ducks. 2019 gull densities fluctuated between 15 and 115 on monitoring days (**Figure 52**). On 9 November 2019, more than 100 pelicans and even more gulls congregated just beyond the creekmouth and were actively feeding, resulting in the highest gull count (115) in the lagoon for the season. Numbers in 2018 ranged between 23 and 87. Numbers in 2017 ranged between 18 and 85 (20 and 65 in 2016) during afternoon monitorings, when they are most common. The average gull count per monitoring day for 2014−2019 has been 63, 68, 42, 40, 46 and 63, respectively. The increased human waders, boats, barges and paddle boarders in 2016−2019 may have reduced gull bathing numbers on the weekends when monitoring took place. In 2019, the highest watercraft traffic

was on 28 September (day of the Nautical Parade) with 6 paddle-boarders and 1 pedal boat in Reach 1 at one time in the afternoon. The gull count went from 62 down to 15 when the paddle-boarders passed through. The gulls tended to return quickly after watercraft left an area. The highest gull count in 2018 occurred in early August when watercraft were absent.

Mallard numbers tend to be lowest in June before ducklings become common in July – September, with a decline in October at a time when coots become common (**Figure 53**). Clutches of mallards were high in early July 2018 to elevate their numbers then. However, mallard numbers trailed off afterwards and were relatively low by November. In 2019, mallard counts ranged between 5 and 62 birds on monitoring days. The average mallard count per monitoring day for 2014−2019 has been 27, 26, 31, 18, 30 and 21, respectively. Mallards no longer had the cottonwood log across from Noble Gulch to roost on or congregate around because it was washed away during the wet 2016−2017 winter. In late September 2018, American coots began to appear at the lagoon, as annually occurs. Coots were common in 2019 in fall. Although a lone coot was observed earlier in the summer, their numbers began to multiply beginning 28 September, as coots typically arrive in late September and October. The maximum number of coots counted on a monitoring day in 2015−2019 was 113, 13 (early breach), 34, 147 and 58, respectively. One brown pelican was observed in Reach 1 on 12 October. What were likely Cackling geese (*Branta hutchinsii*) were observed on the bulkhead and a lawn adjacent to the lagoon in Reach 2 on 9 and 23 November. They looked like small Canada geese. Three geese were observed the first day and 2 the next. A lagoon resident reported seeing as many as 12 on his lawn at one time.

MANAGEMENT RECOMMENDATIONS

Recommendations for Lagoon Preparation and Sandbar Construction

1. During relocation of fishes from the lateral channel (when it is present), provide limited water in-flow to the lateral channel, if necessary, to keep it wetted 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 matter is present and decomposition is occurring there.

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 through the manholes 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 to 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 when fish survival is in jeopardy, 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 salmonids are detected in the raking area during preparation for sandbar construction and 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 of 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 salmonids most likely to be present in the lagoon are out-migrating smolts. Late May is prior to down-migration of most YOY steelhead from spawning sites above the lagoon. Small steelhead fry remain in the vicinity of spawning sites before moving down

into the lagoon. Down-migrant trapping on the nearby San Lorenzo River in 1987 and 1988 by Donald Alley and Stafford Lehr (now with CDFW) indicated that a few YOY steelhead were down-migrating into the lagoon in May. But the number greatly increased in June.

6. 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.

7. 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.

8. Continue to rake as much kelp and sea grass out of the lagoon as is possible before final closure, including plant material trapped under the restaurants and in depressions around the bridge piers. Focus efforts from the Stockton Avenue Bridge downstream to the flume. Discontinue raking if juvenile salmonids are observed near the water surface. It is best to minimize time required to stockpile sand, rake out the decomposing organic matter 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 to quickly rake out decomposing kelp and to clear the sand-filled flume initially.

9. 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 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**).

10. 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.

11. 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.

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

13. 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.

14. Continue to search under the Stockton Avenue Bridge and in upstream Reaches 2 and 3 past the Rispin Mansion 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.

15. Continue to maintain an underwater portal in the flume intake for out-migration of adult steelhead until at least June 15, while maintaining a notched top plank for out-migration of smolts until at least 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 to exit the lagoon.

16. Continue to maintain the 1-foot high weir/ baffle inside the flume until at least July 1 for safe flume entrance of out-migrating salmonid smolts migrating to the Monterey Bay.

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

18. 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.

19. 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.

20. 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 or white visquine is preferable to black. Key the visquine into the lagoon margin to encourage its retention when the sandbar opens in the fall.

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

22. Continue to retrieve visquine from around the flume inlet immediately after the fall sandbar opening, if possible.

23. 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 provide freshwater outflow to prevent tidal influx. The partial closure of the flume outlet worked well in 2015.

Recommendations Regarding Sandbar Breaching

1. 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. Continue to orient the notch laterally (diagonally) across the beach to also maximize the probability of maintaining an estuary with some depth after the breach. The purpose is to maximize the residual estuary depth after the emergency breach.

2. The notch in the sandbar should be cut slightly lower than the piling bolt. Continue to orient the notch laterally (diagonally) across the beach to the southeast of the flume. Continue to make the notch at least 30 feet wide across the beach to also maximize the possibility of maintaining an estuary with some depth after the breach. The City may have to periodically re-establish the notch if it does not rain or high tides obliterate it. If a storm is predicted, the sandbar needs a notch as preparation. Continue to maintain an outer berm near the surf and an inner berm near the lagoon margin with the wide notch in between. When breaching must be facilitated, notch the inner berm first, allowing the notch across the beach to fill with water. Then notch the outer berm to the east to finish the sandbar breach.

3. 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. If turbidity still prevents light penetration to the bottom, remove enough boards to lower the water level to a point where light penetrates to the lagoon bottom. Thus, vegetation mortality and stressfully low oxygen levels for steelhead are prevented until water clarity is re-established. Re-install boards to increase lagoon depth after the lagoon clears up. Repeat this process for each succeeding small stormflow that does not require sandbar breaching.

4. 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.

5. In preparation for sandbar opening in the fall, 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.

6. 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.

7. Just as the first storm of the fall season begins, remove boards from at least one 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.

8. To delay sandbar breaching in years when algae and pondweed are especially dense in the lagoon, install a perimeter fence around the flume inlet (2"x 4" mesh and with 6-foot panels) to collect floating aquatic vegetation and prevent plugging of the flume inlet during the first small stormflows of the season. If necessary, install a perimeter fence with around the flume entrance by October to prevent plugging of the flume's screen with aquatic vegetation during the first minor storms. The goal should be to maintain the lagoon until a pattern of larger storms occurs after Thanksgiving that will maintain an open sandbar through the winter.

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

10. Take water samples for fecal bacteria analysis within 24 hours prior to the anticipated facilitated sandbar breach and within 12 hours after the breach in the surf near the creekmouth. While the sandbar remains open, collect weekly water samples for analysis until the fecal indicator bacterial count meets the standard of 104cfu/100 ml.

11. If a stagnant, kelp-filled lagoon forms in fall after an early breach followed by 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.

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

1. Since tules planted in the cove under the railroad trestle withstood winter stormflow, pursue planting more tules under the trestle and in other lagoon locations. Seek volunteers to re-establish tules 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.

2. 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.

3. 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.

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

5. Regarding the nautical parade, 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 proceeded down the lagoon and then back up before dismantling back at the bridge.

6. *Regarding the nautical parade, require that all floats, boats, kayaks, barges, paddle boards, etc., be clearly lit at night to make them clearly visible and to avoid collisions.*

7. *Regarding the nautical parade, protect tules from destruction by floats during nautical parade-related activities and from recreational boating activities, in general.*

8. Regarding the nautical parade, restrict the number/weight of float participants allowed to ride on the floats to a safe level during nautical processions.

9. Regarding the nautical parade, enforce the ban on waders during future nautical parades.

10. Regarding the nautical parade, continue to recommend to the lagoon parade organizers that floats be safely maneuvered downstream of Stockton Avenue, with a water marshal present to direct floats in a circular direction along the periphery of the lagoon after they clear the bridge.

11. Regarding the nautical parade, continue to recommend to the lagoon parade organizers to discourage alcohol consumption by float participants and rowdy behavior on their floats.

12. Regarding the nautical parade, continue to retain all flume boards to maintain maximum lagoon depth during the nautical parade.

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. Continue to maximize lagoon depth through the dry season, while maintaining passage through the flume for adult steelhead until at least June 15 and for steelhead smolts until at least July 1. If the lagoon level begins to drop below the notched upper flashboard for steelhead smolts because of the adult portal after June 15, 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 15 with the portal closed, then open it for a week to allow out-migration.

16. After July 1, leave the flume exit closed once it closes, unless flooding is eminent. Continue to install visquine or plywood on the outside of the flashboards to prevent leakage into the flume.

17. Maximize the number of boards in the flume entrance to maximize lagoon depth. Seal the boards with visquine or plywood to prevent leakage.

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

19. 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 updates.

20. "Gull Sweeps" should be installed on Esplanade roofs to test their effectiveness in deterring gulls.

21. 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.

22. 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.

23. The City should continue to fund activities to permanently remove invasive Arundo (Giant Reed) 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 to protect aquatic and streamside wildlife habitat.

24. The City should continue to 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. Consider appropriate locations along the west bank under the railroad trestle or upstream adjacent to the Golino property.

25. Continue to retain large woody material that naturally enters the lagoon.

26. 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.

Recommendations Regarding Fish Management

1. Do not plant steelhead from a hatchery into Soquel Creek unless the broodstock originate from Soquel Creek and contain sufficient genetic diversity regarding spawning timing.

2. Maintain the postings of the fishing season at the entrance to the lagoon path to Noble Gulch and the path to the park on the west side of the lagoon upstream of the Stockton Bridge.

3. Maintain the ecological interpretive signs and the no bird feeding signs in the lagoon vicinity.

4. Report any illegal fishing at the lagoon outside of the fishing season to CDFW via the Cal-Tip hotline: 1-888-334-2258.

5. Continue to allow a clear path from under the Stockton Avenue Bridge to the beach at Venetian Court to enable seining for juvenile steelhead during fall censusing.

6. If the sandbar is still in place after November 15, create an opening in the upper flashboards of the flume inlet just prior to forecasted stormflow to allow early spawning adult steelhead or coho salmon to pass through the flume from the Bay.

7. Continue to census steelhead and tidewater goby in the fall to monitor lagoon use as important nursery habitat under varying streamflow conditions, management scenarios and restoration efforts.

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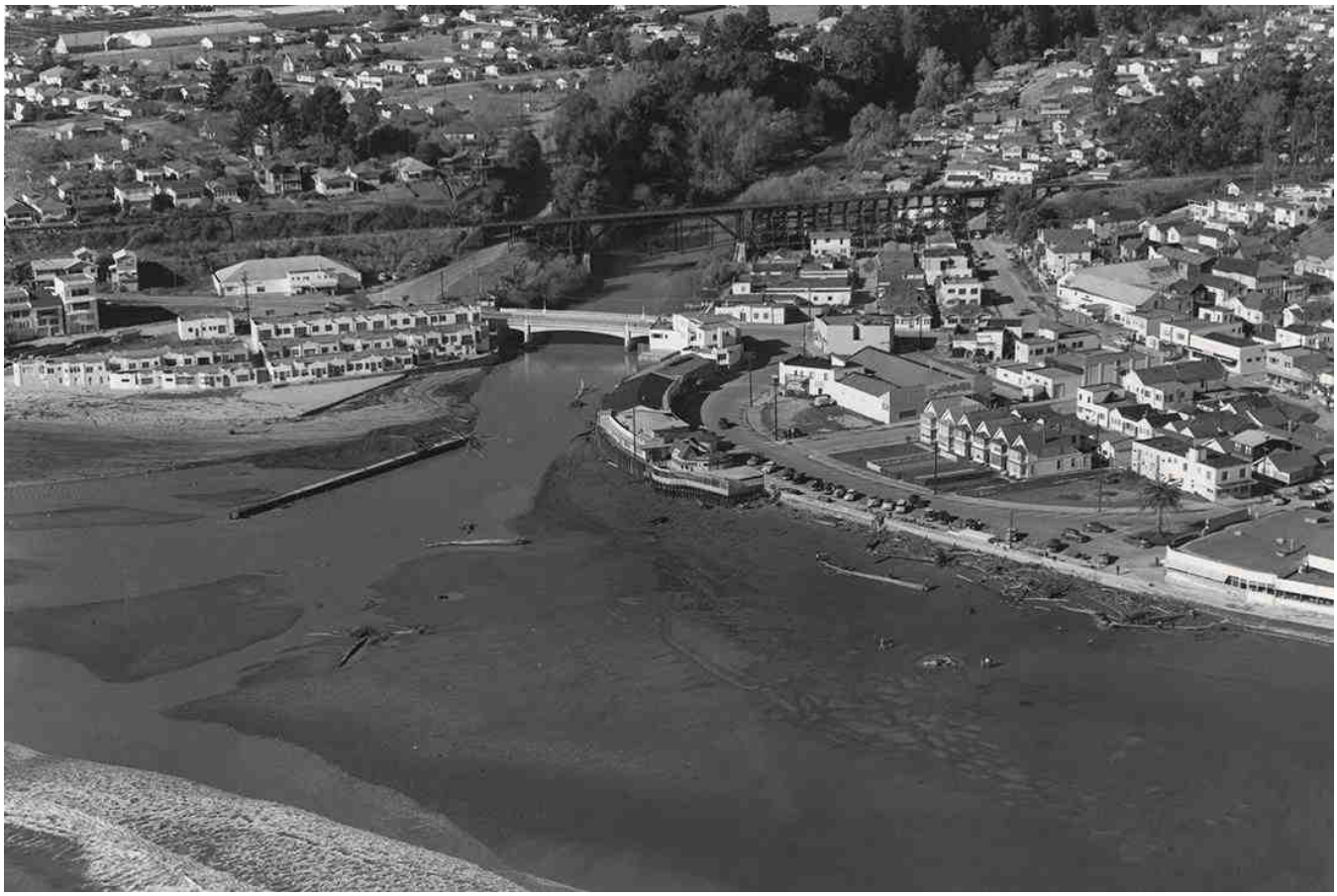
Soquel Lagoon Post-Venetian Court Construction- Older Stockton Avenue Bridge visible and prior to expanded development on eastern margin of the Lagoon, upstream and downstream of the Railroad Trestle; circa 1931.
(Courtesy of the Capitola Historical Museum)



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

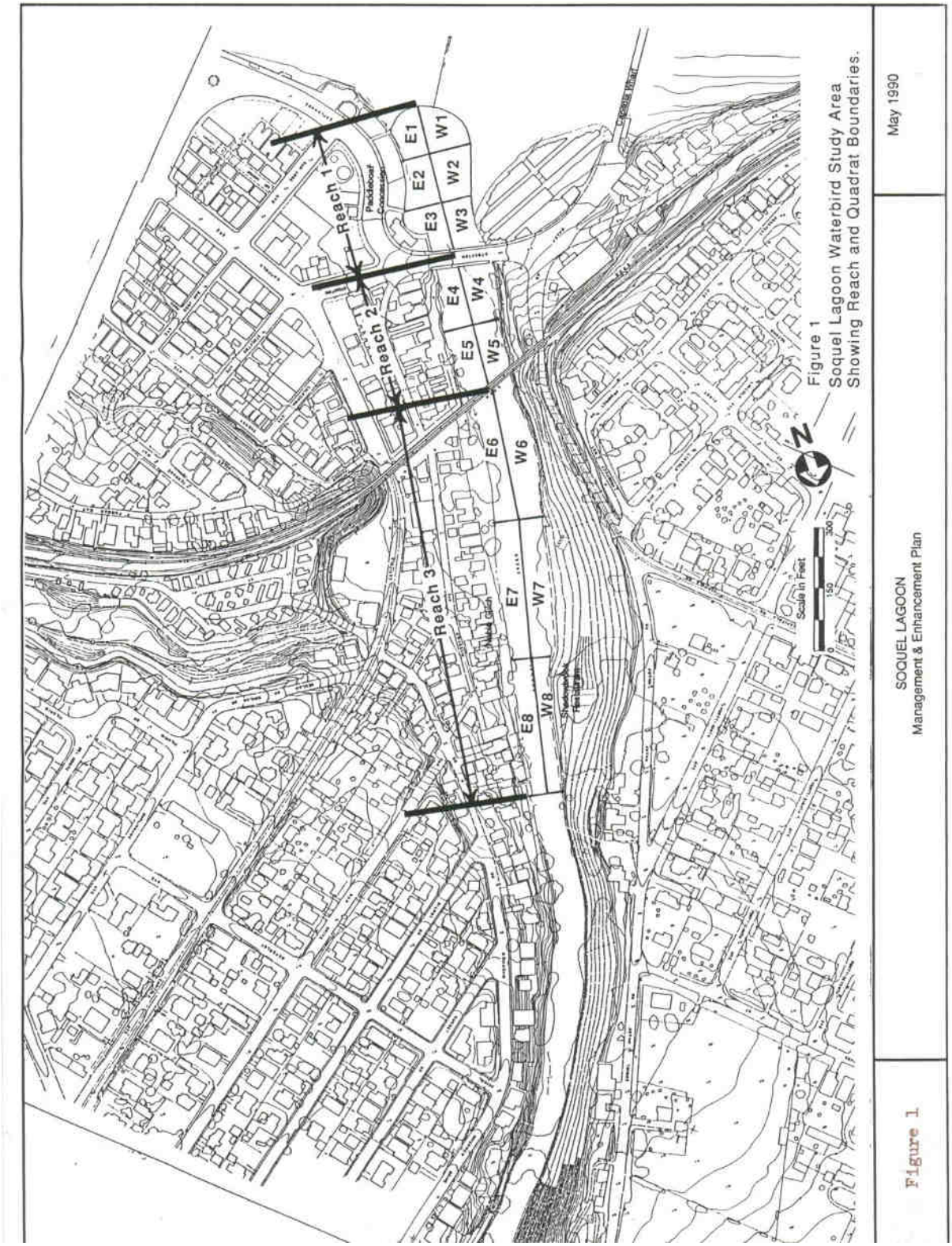


Figure 1. Map of Reaches in Soquel Creek Lagoon

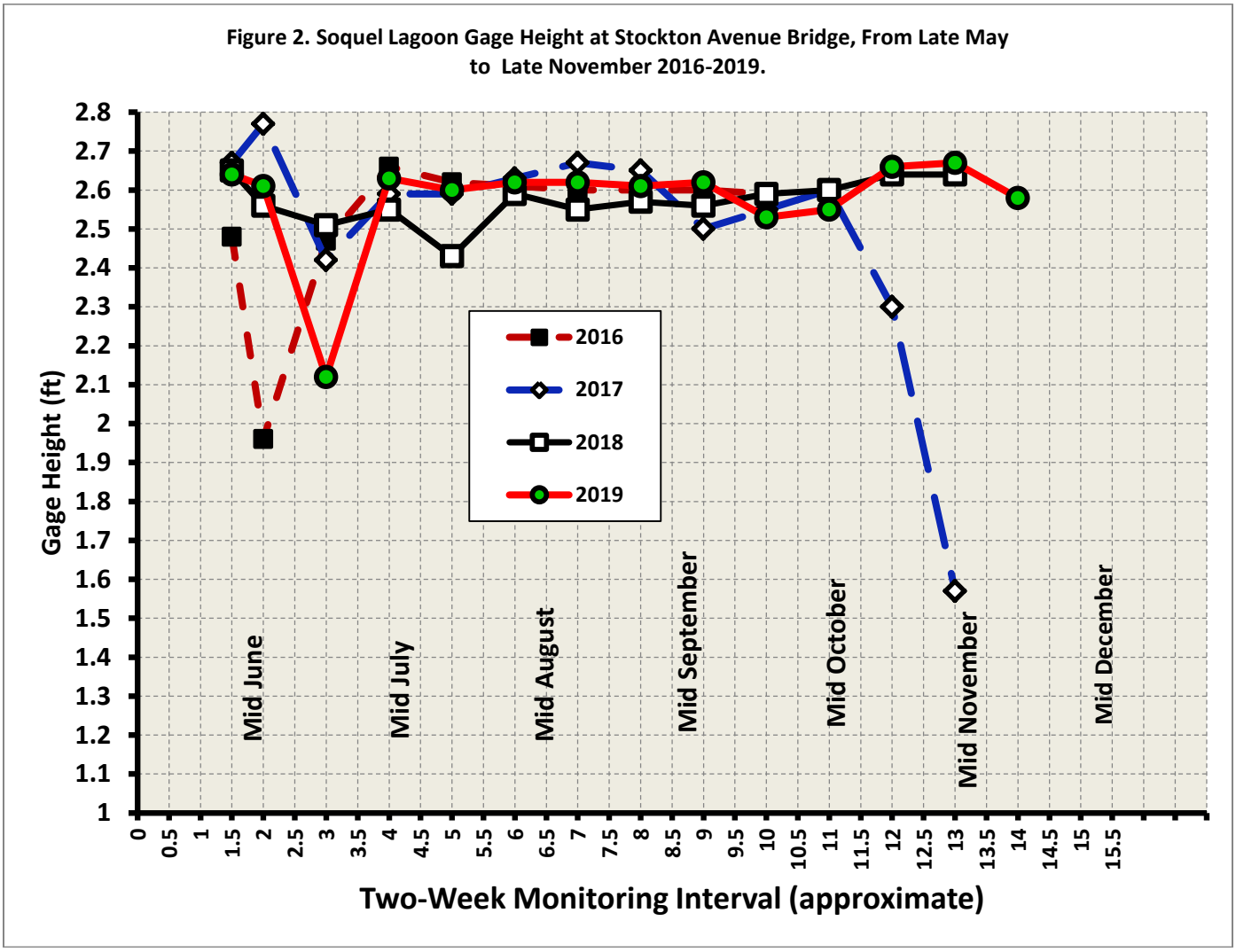


Figure 2. Soquel Lagoon Gage Height at Stockton Avenue Bridge, From Late May to Early December 2016-2019

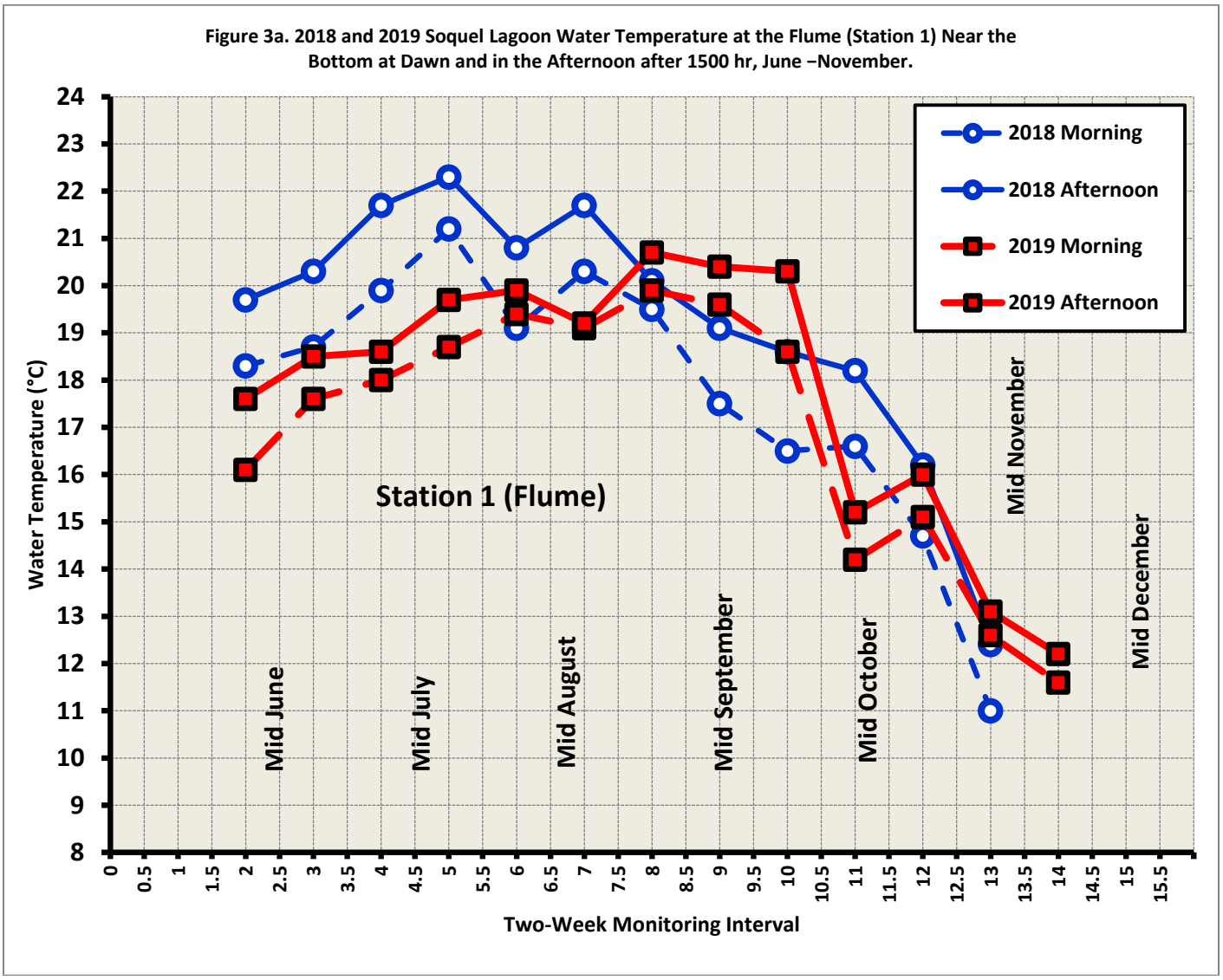


Figure 3a. 2018 and 2019 Soquel Lagoon Water Temperature at the Flume (Station 1) Near the Bottom at Dawn and in the Afternoon after 1500 hr, June – Late-November.

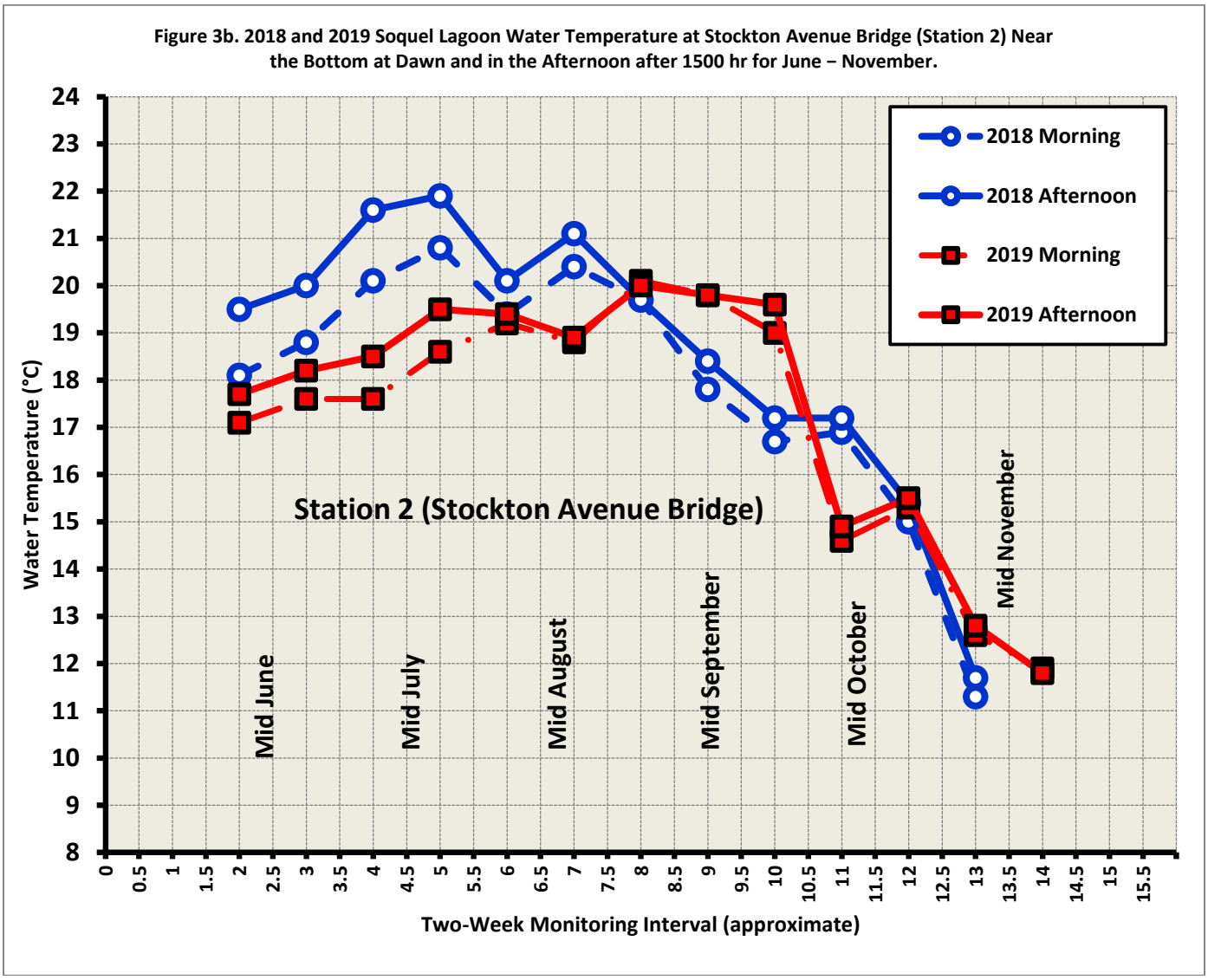


Figure 3b. 2018 and 2019 Soquel Lagoon Water Temperature at Stockton Avenue Bridge Near the Bottom at Dawn and in the Afternoon after 1500 hr for June – Late-November.

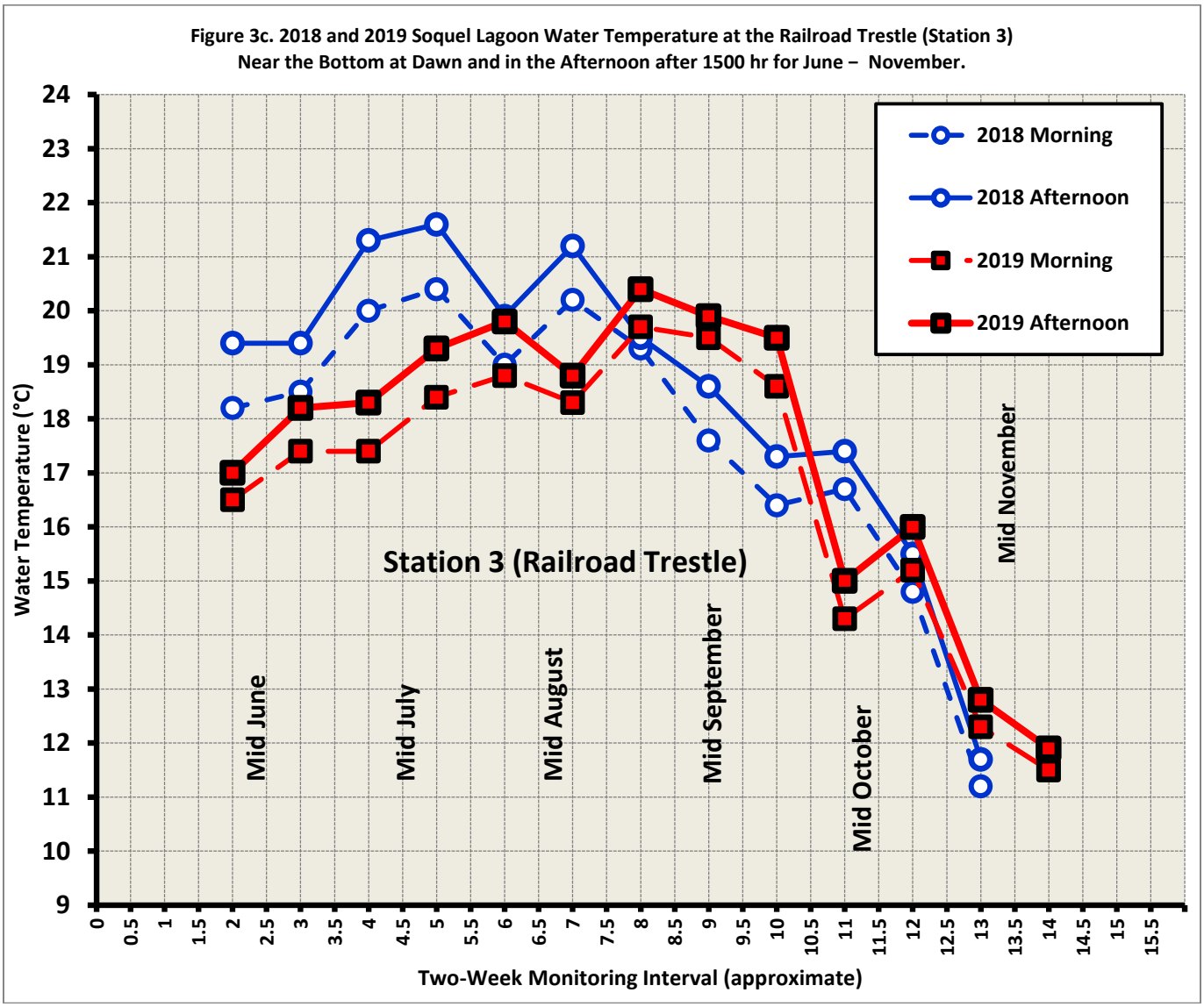


Figure 3c. 2018 and 2019 Soquel Lagoon Water Temperature at the Railroad Trestle (Station 3) Near the Bottom at Dawn and in the Afternoon after 1500 hr for June– Late-November.

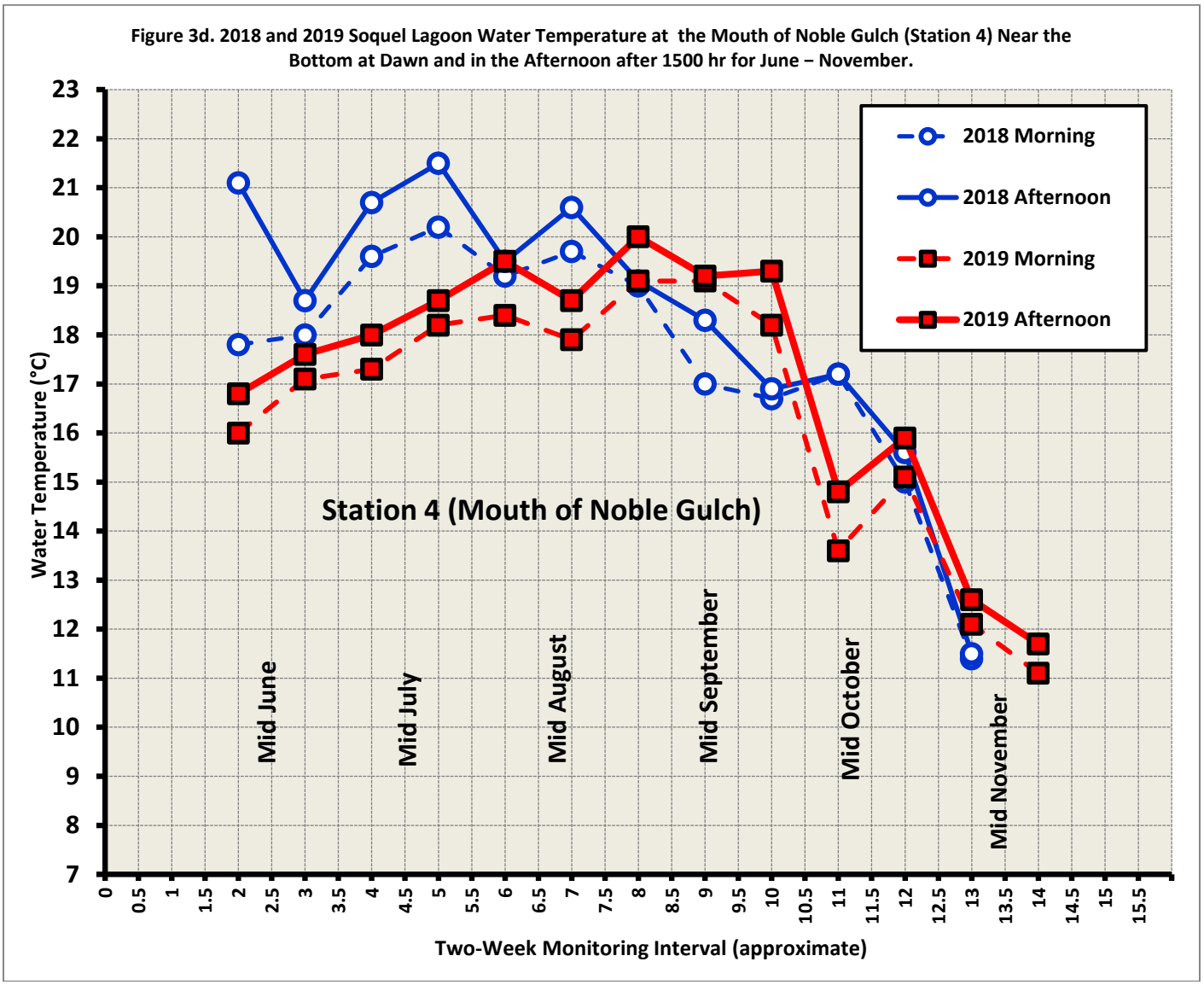


Figure 3d. 2018 and 2019 Soquel Lagoon Water Temperature at Noble Gulch Near the Bottom at Dawn (Station 4) and in the Afternoon after 1500 hr for June – Late-November.

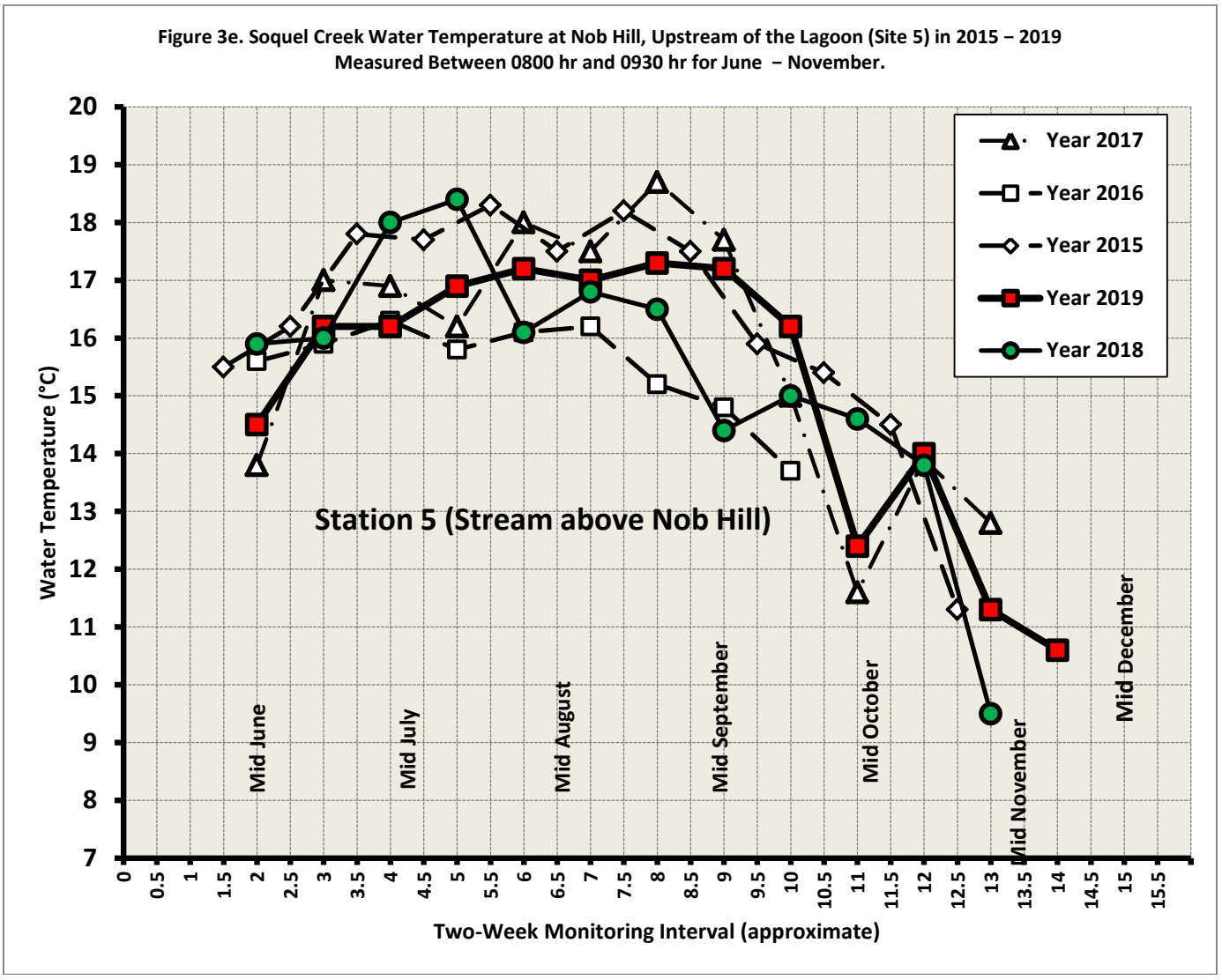


Figure 3e. Soquel Creek Water Temperature at Nob Hill Upstream of the Lagoon, 2015−2019. Measured Between 0800 hr and 0930 hr for June − Late-November.

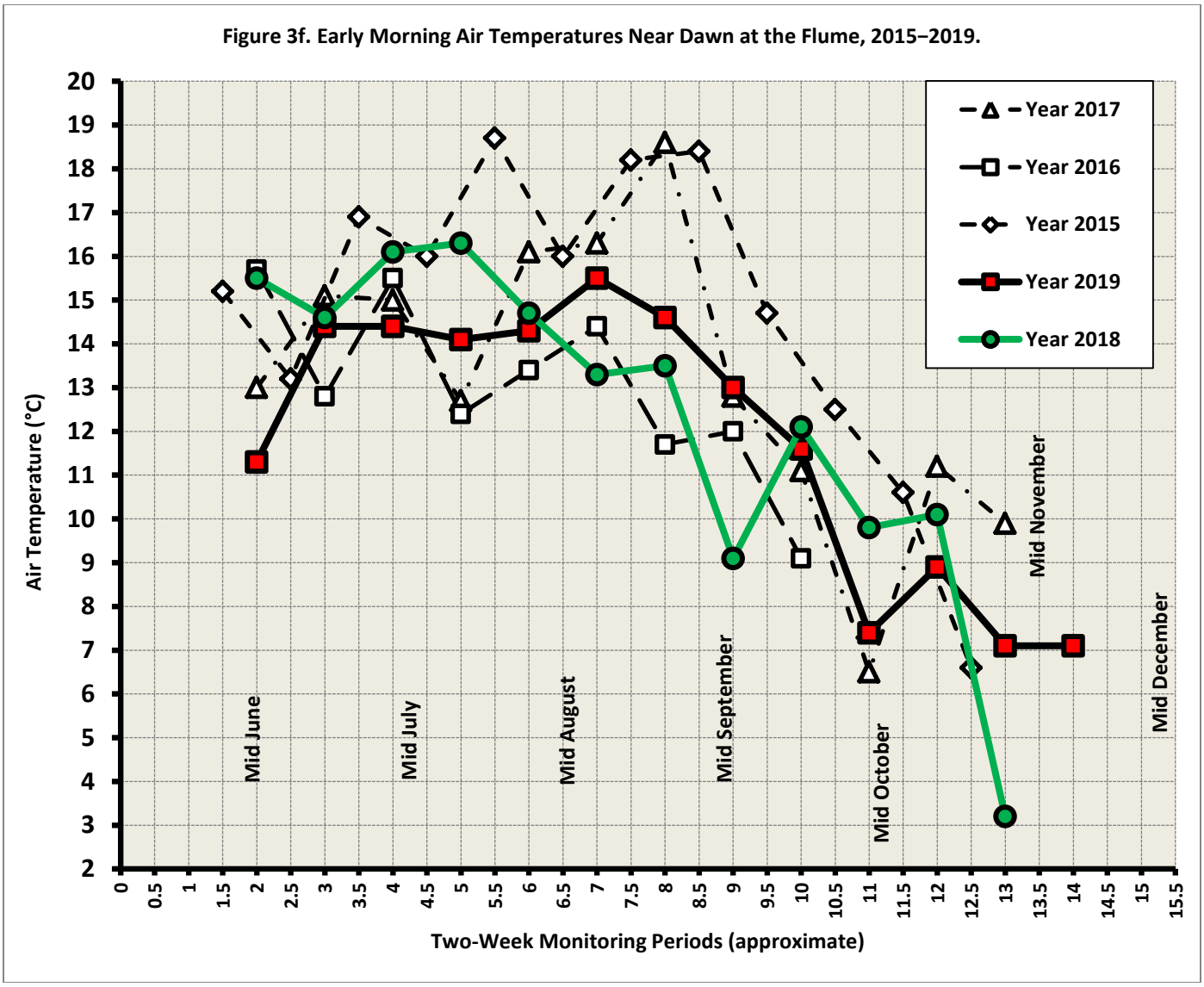


Figure 3f. Early Morning Air Temperatures Near Dawn at the Flume, 2015−2019.

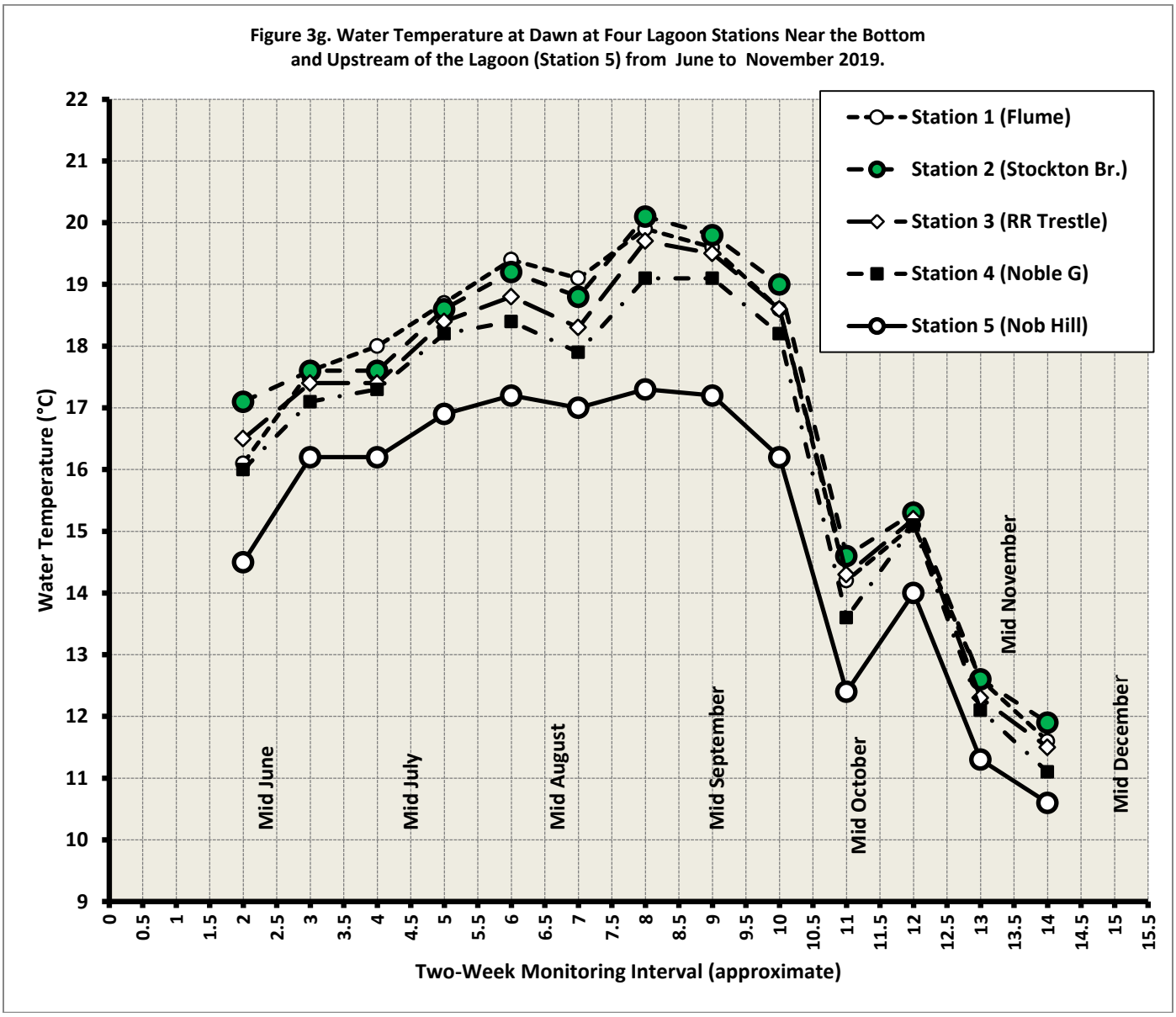


Figure 3g. Water Temperature at Dawn at Four Lagoon Stations Near the Bottom and Upstream from June to November 2019.

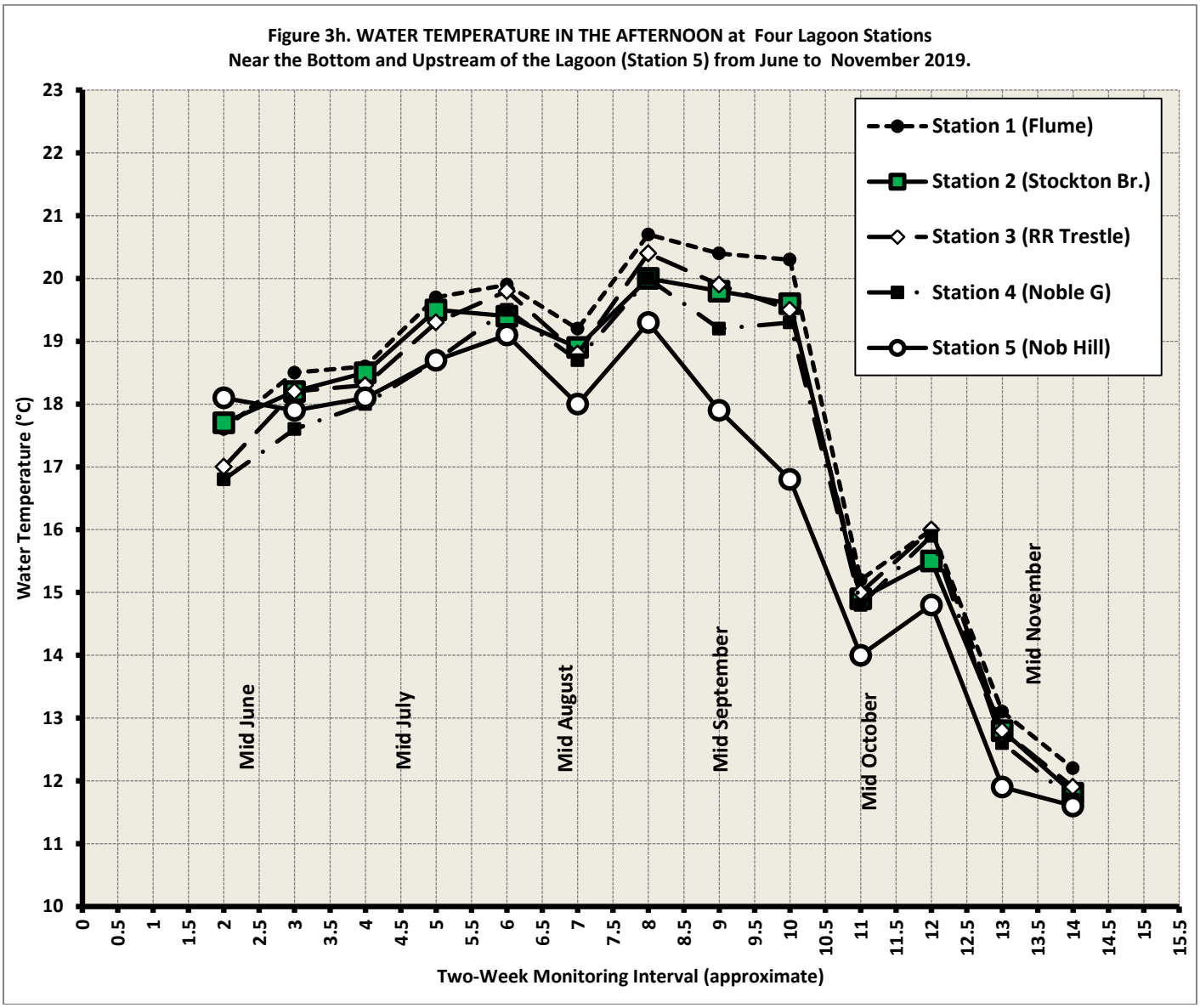


Figure 3h. Water Temperature in the Afternoon at Four Lagoon Stations Near the Bottom and Upstream from June to November 2019.

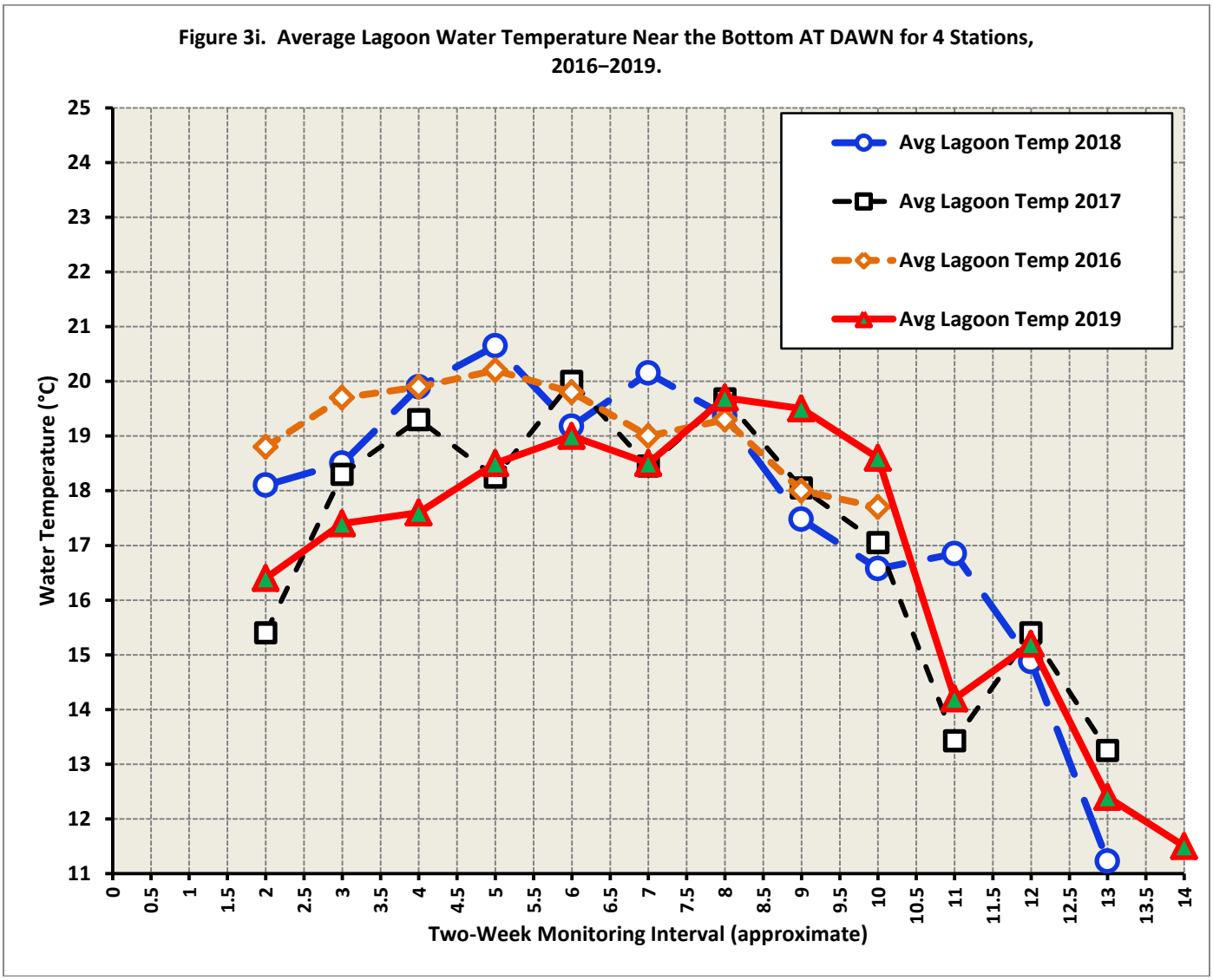


Figure 3i. Average Lagoon Water Temperature Near the Bottom at Dawn for 4 Stations, 2016–2019.

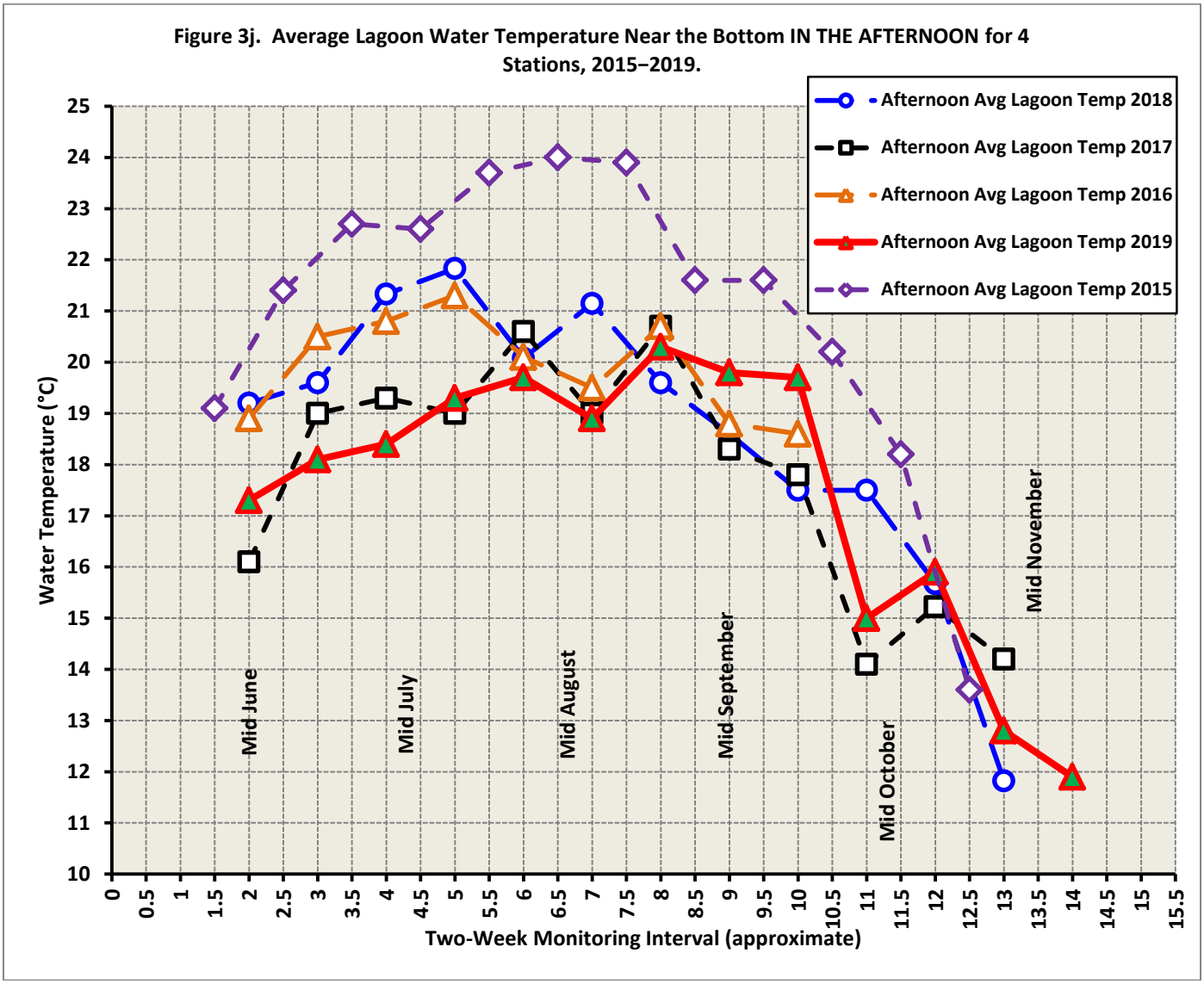


Figure 3j. Average Lagoon Water Temperature Near the Bottom in the Afternoon for 4 Stations, 2015–2019.

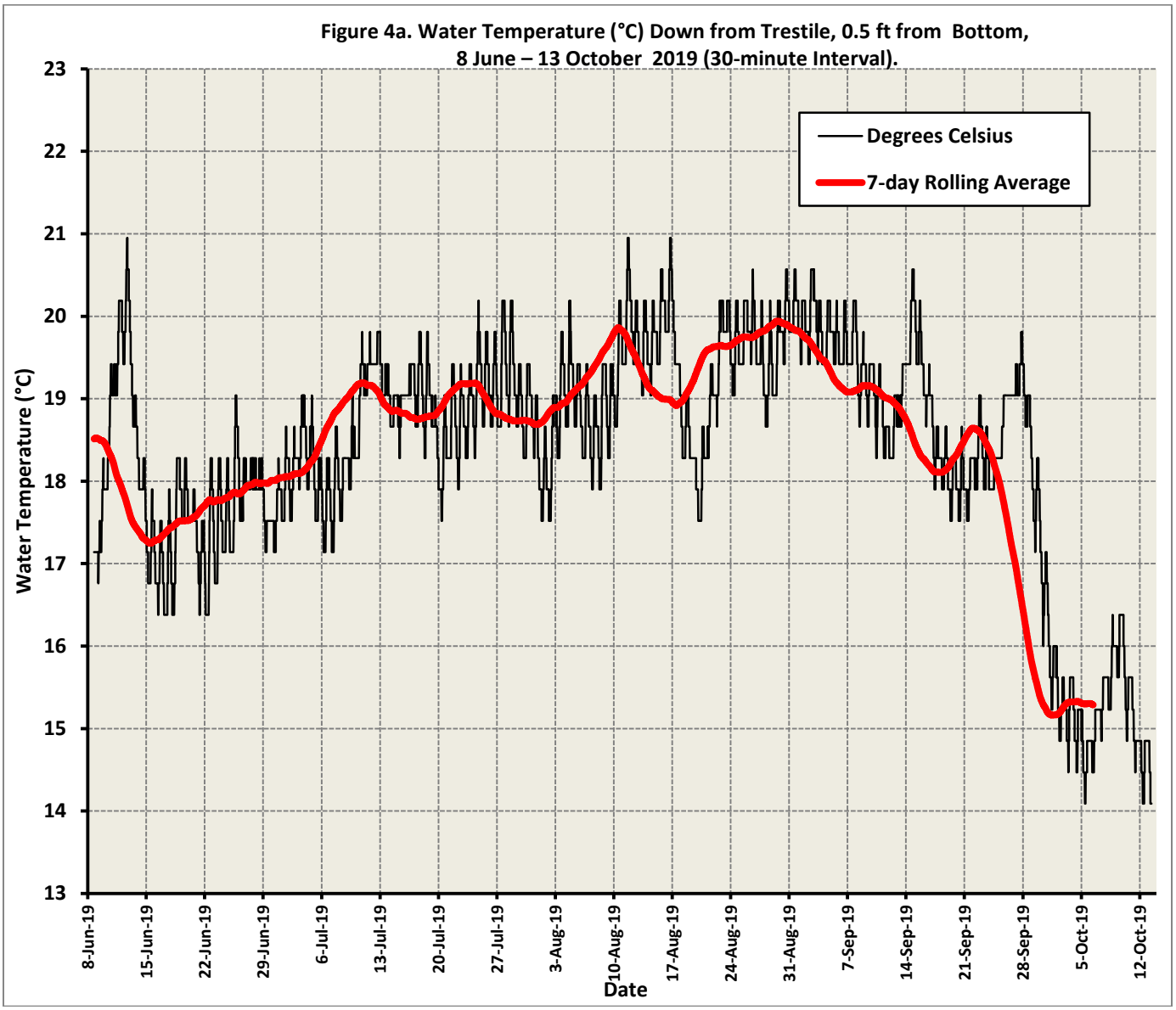


Figure 4a. Water Temperature (°C) Down from Trestile, 0.5 ft from the Bottom, 8 June – 13 October 2019 (30-minute Interval).

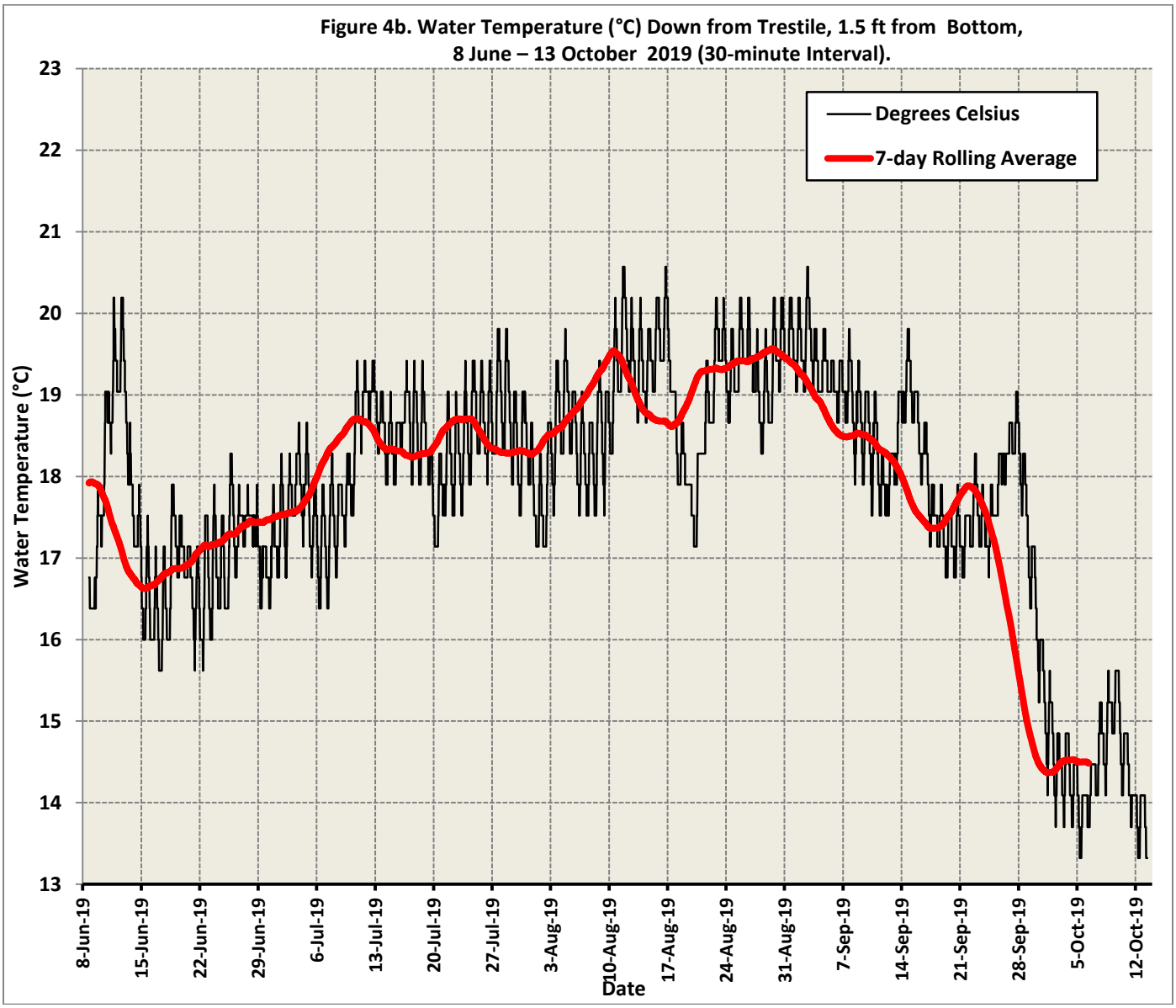


Figure 4b. Water Temperature (°C) Down from Trestle, 1.5 ft from the Bottom, 8 June – 13 October 2019 (30-minute Interval).

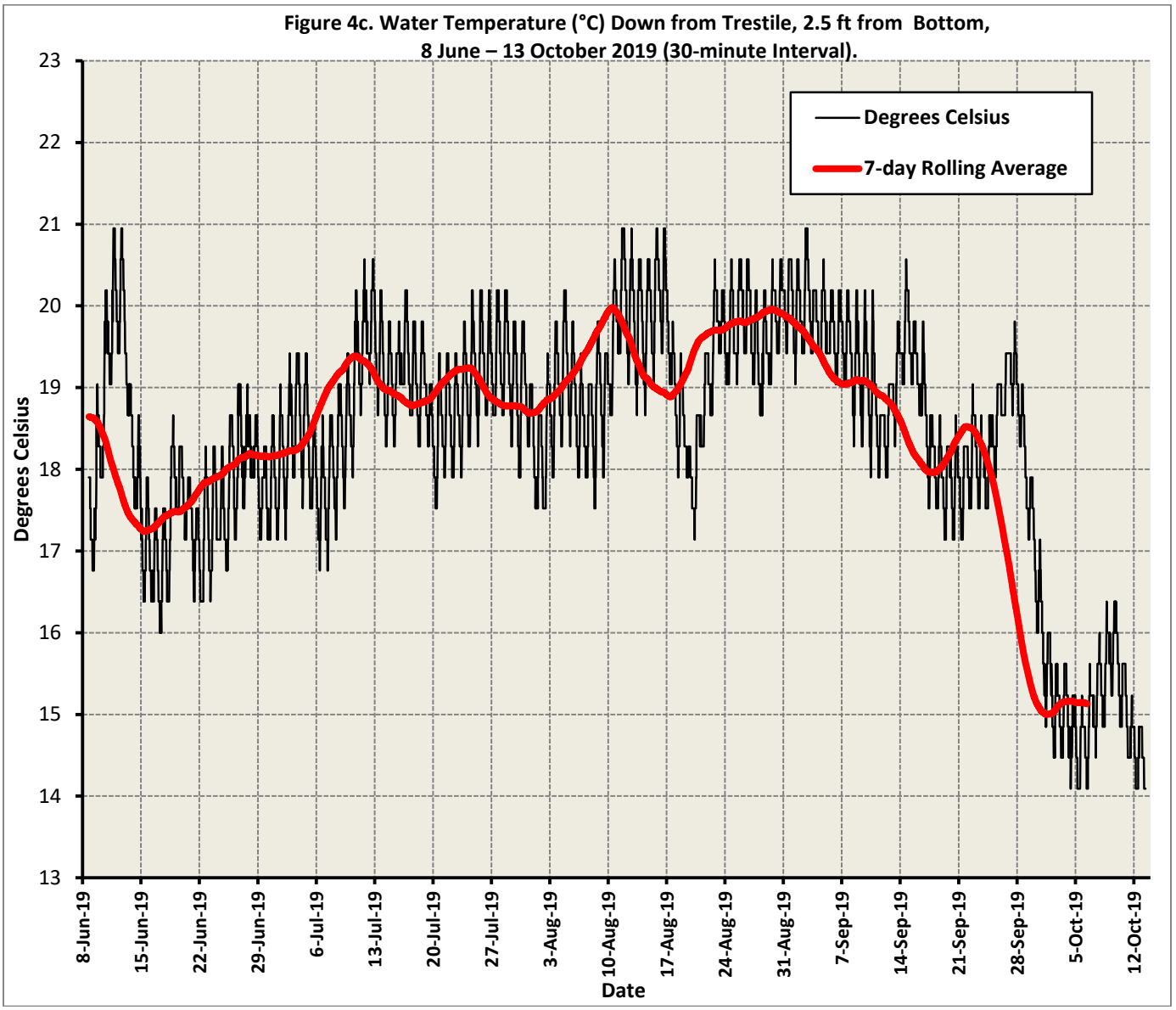


Figure 4c. Water Temperature (°C) Down from Trestle, 2.5 ft from the Bottom, 8 June – 13 October 2019 (30-minute Interval).

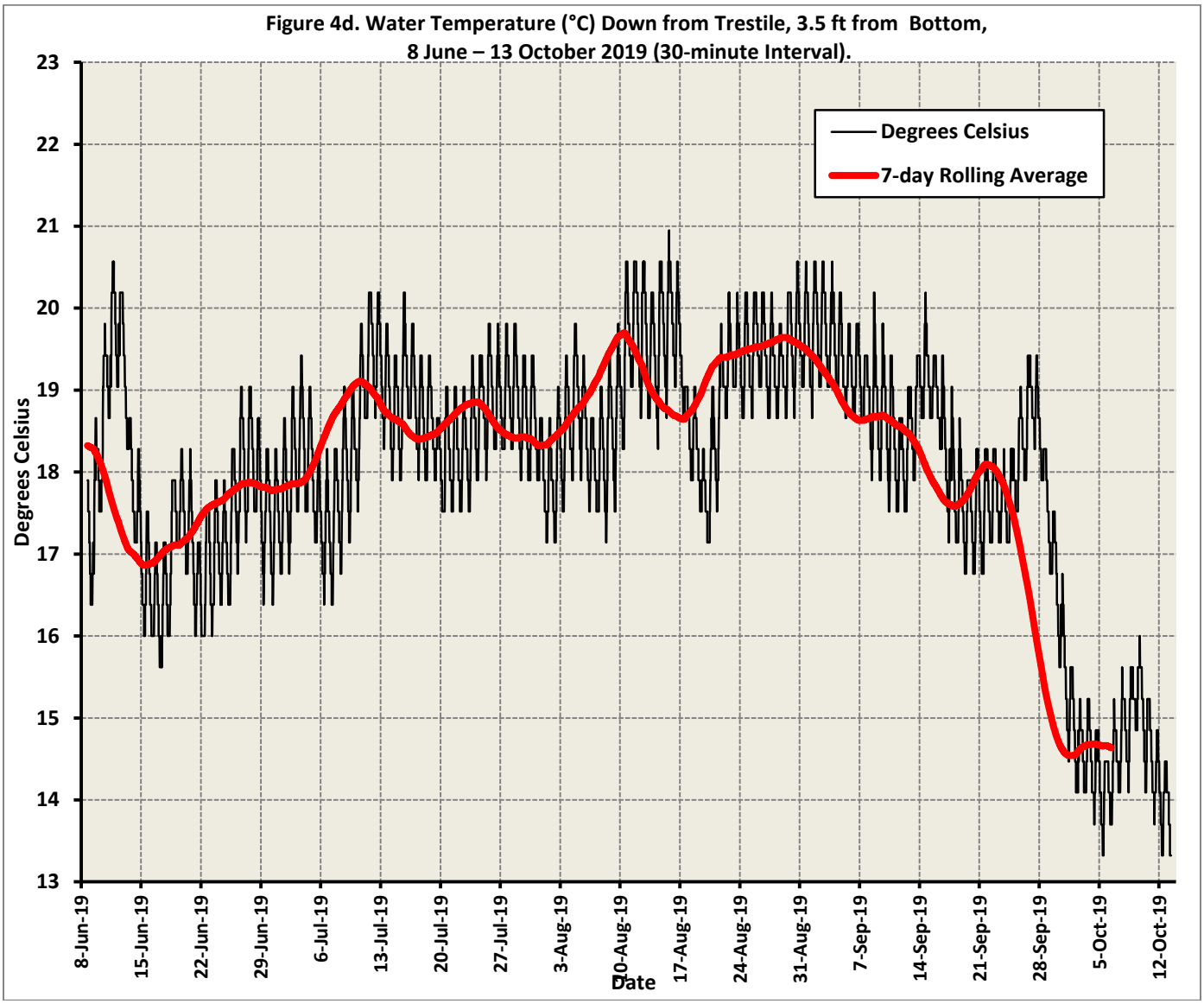


Figure 4d. Water Temperature (°C) Down from Trestle, 3.5 ft from the Bottom, 8 June – 13 October 2019 (30-minute Interval).

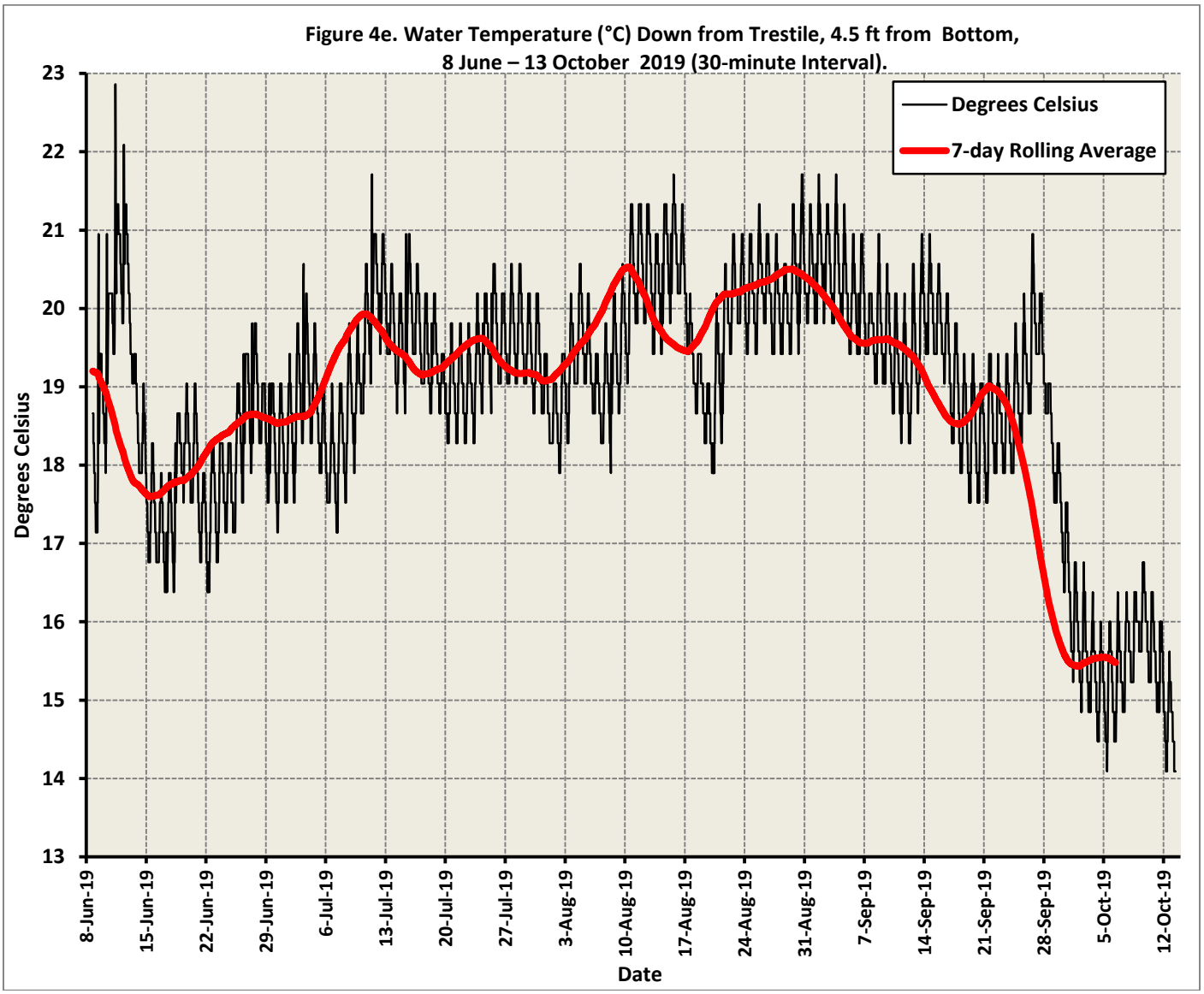


Figure 4e. Water Temperature (°C) Down from Trestle, 4.5 ft from the Bottom, 8 June – 13 October 2019 (30-minute Interval).

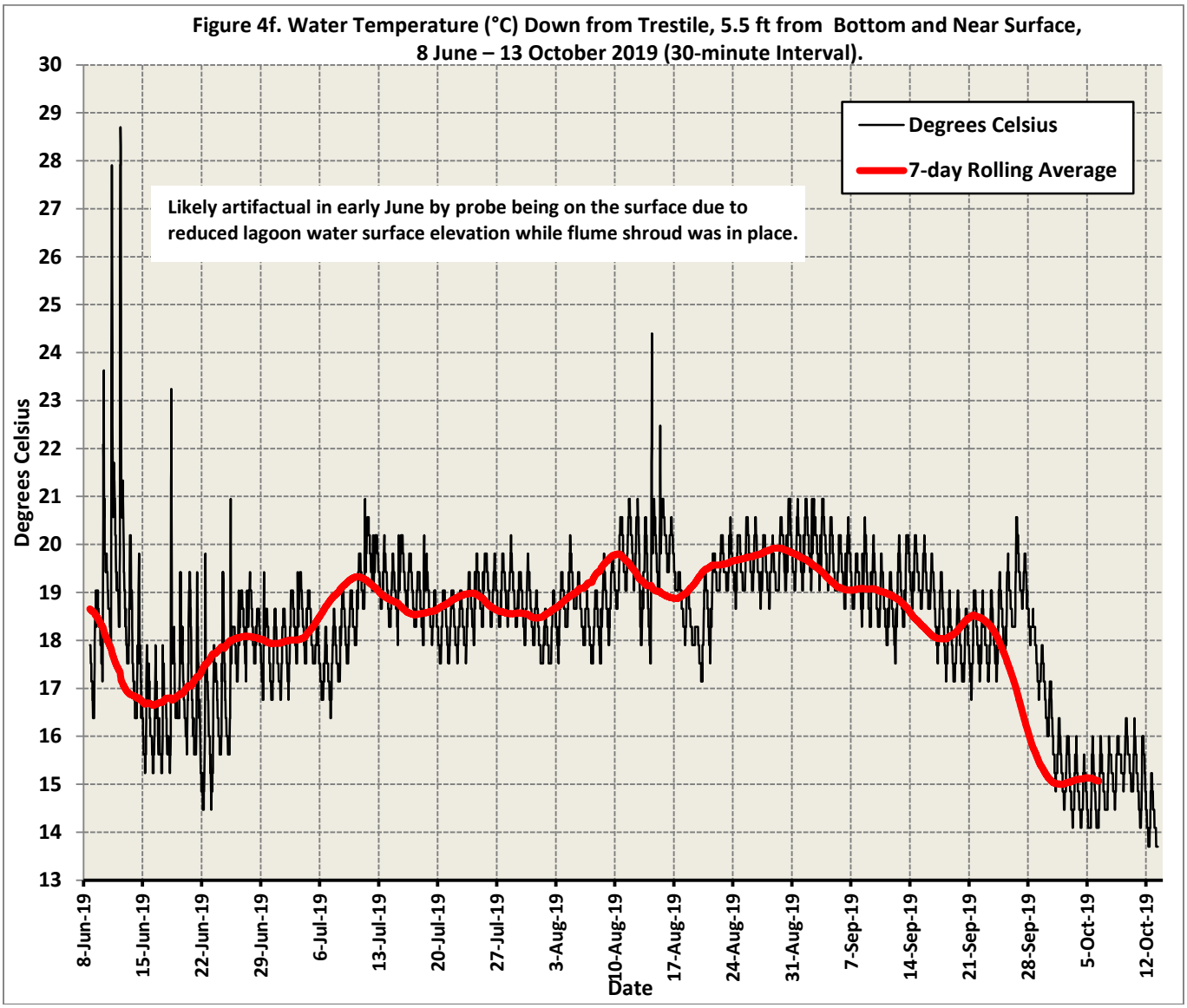


Figure 4f. Water Temperature (°C) Down from Trestle, 5.5 ft from the Bottom, 8 June – 13 October 2019 (30-minute Interval).

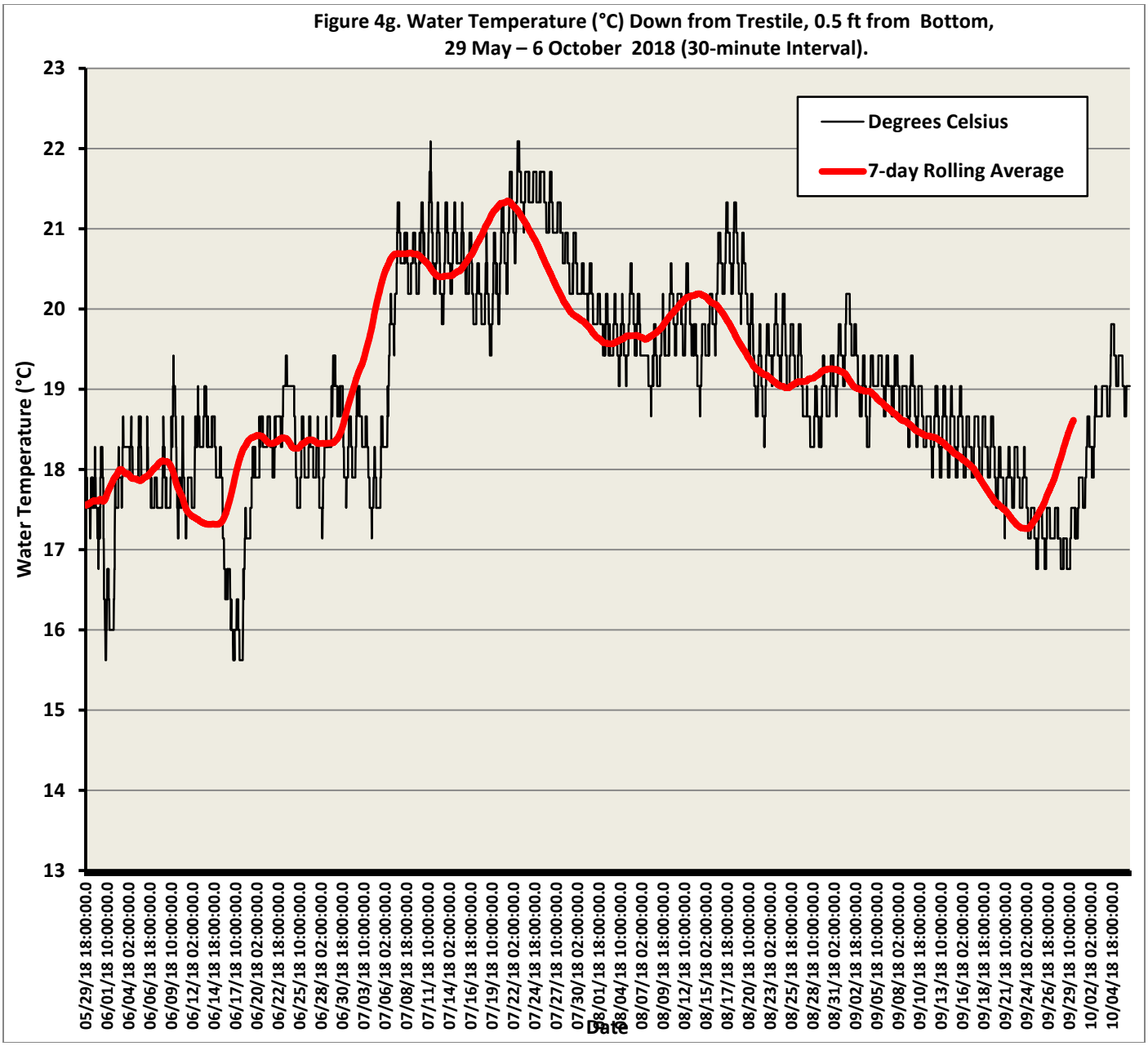


Figure 4g. Water Temperature (°C) Down from Trestle, 0.5 ft from the Bottom, 29 May – 6 October 2018 (30-minute Interval).

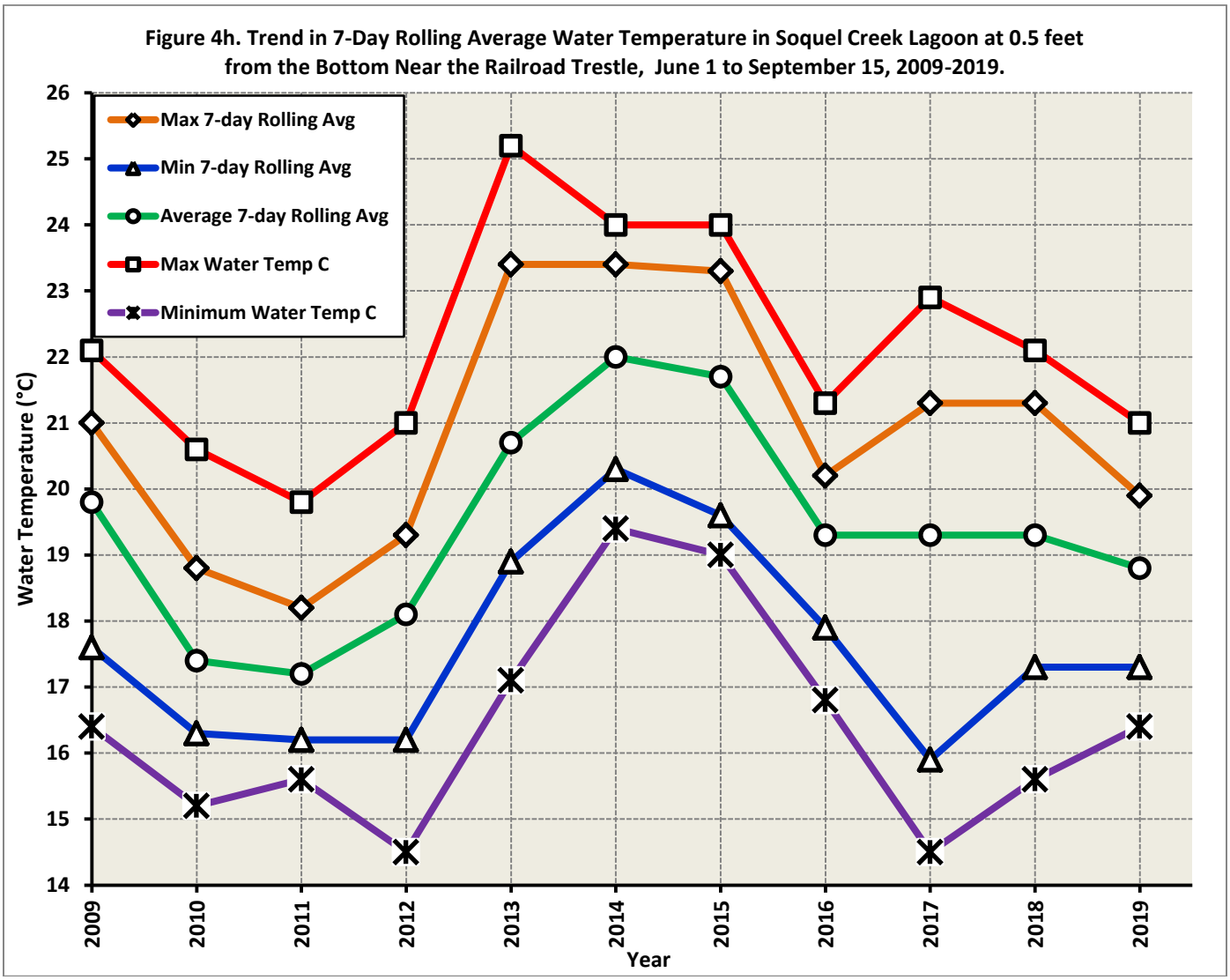


Figure 4h. Trend in 7-day Rolling Average Water Temperature in Soquel Creek Lagoon at 0.5 ft from the Bottom Near the Railroad Trestle, 2009–2019.

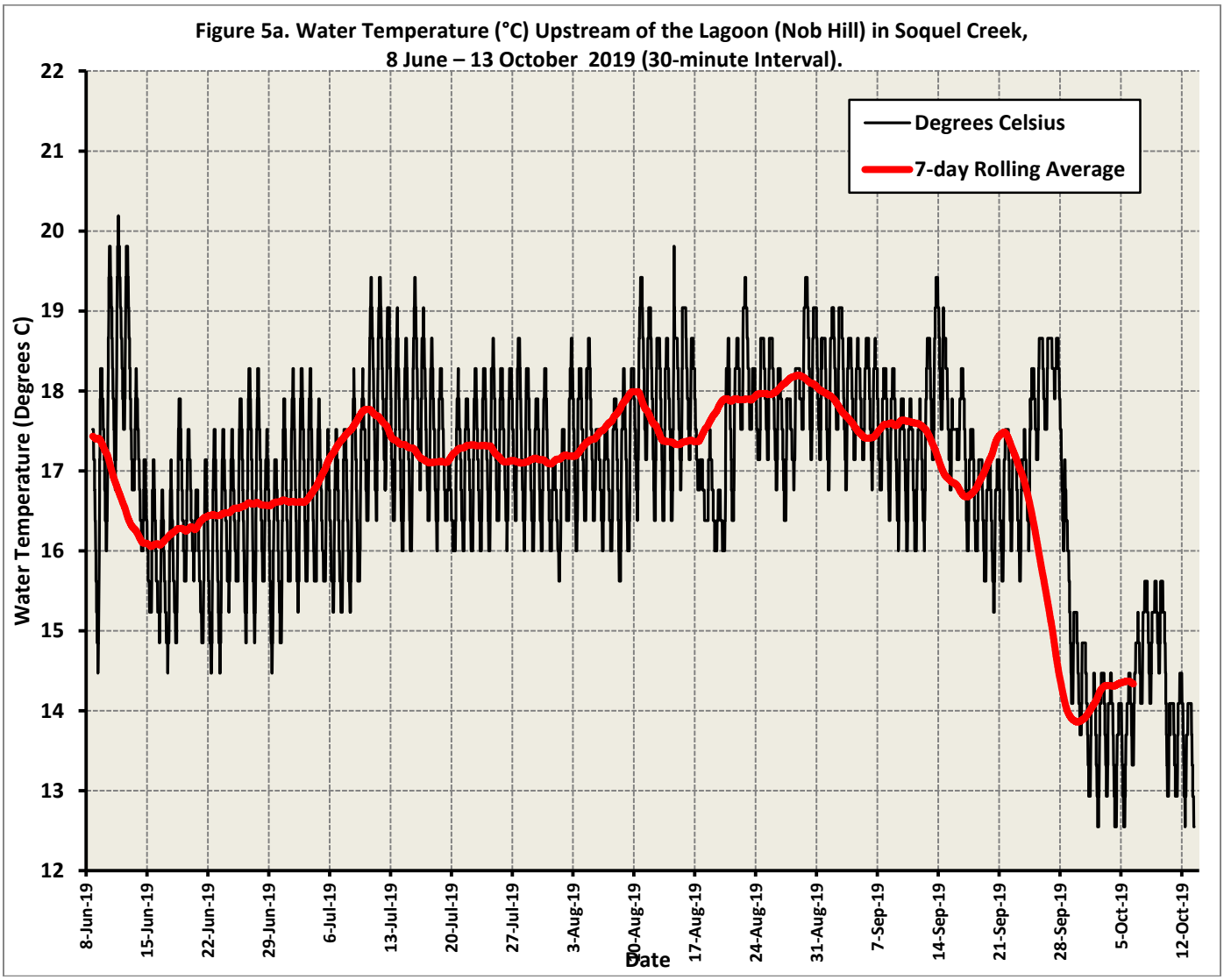


Figure 5a. Water Temperature (°C) Above the Lagoon (Nob Hill) in Soquel Creek, 8 June – 13 October 2019 (30-minute Interval).

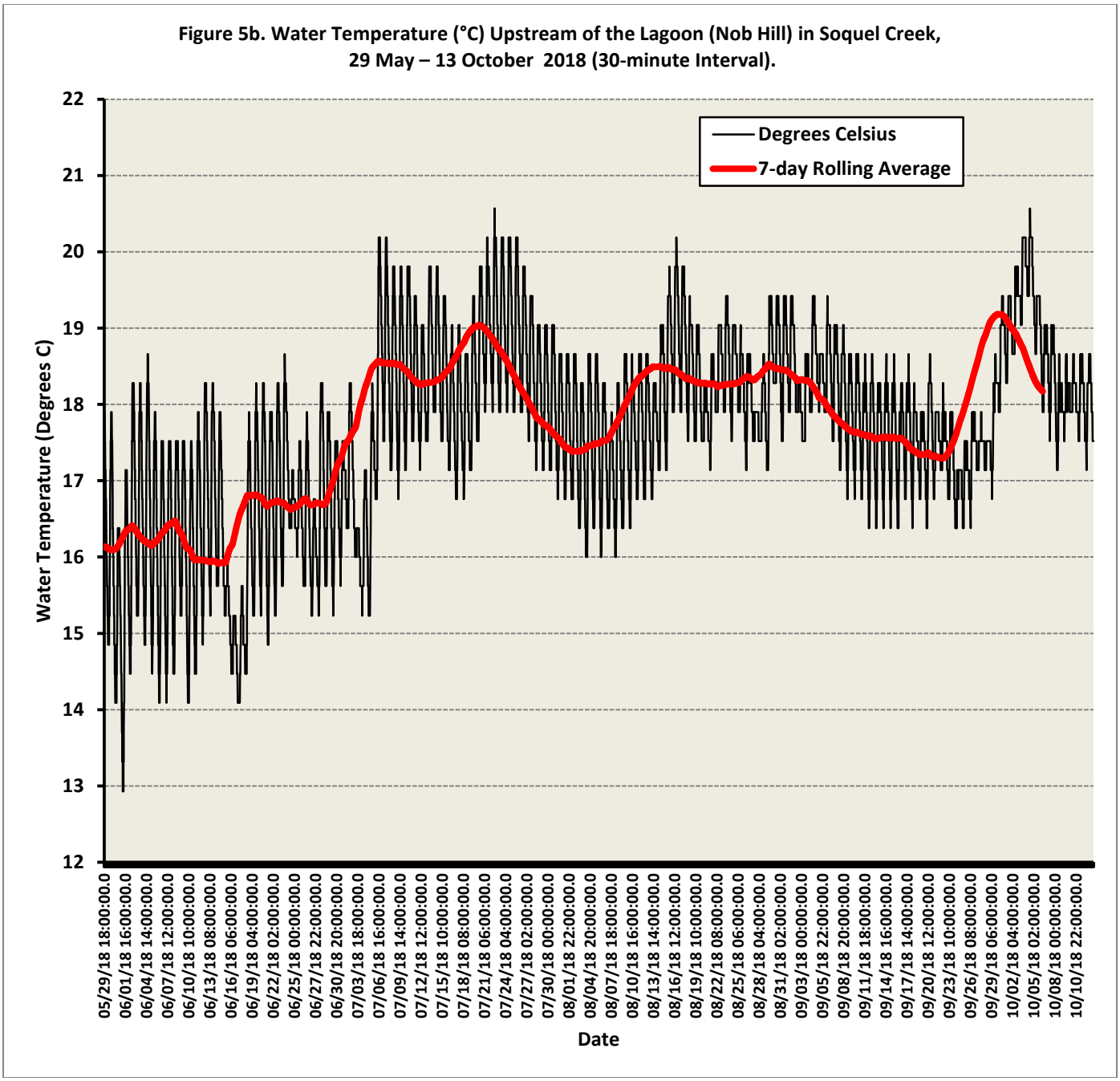


Figure 5b. Water Temperature (°C) Above the Lagoon (Nob Hill) in Soquel Creek, 29 May – 6 October 2018 (30-minute Interval).

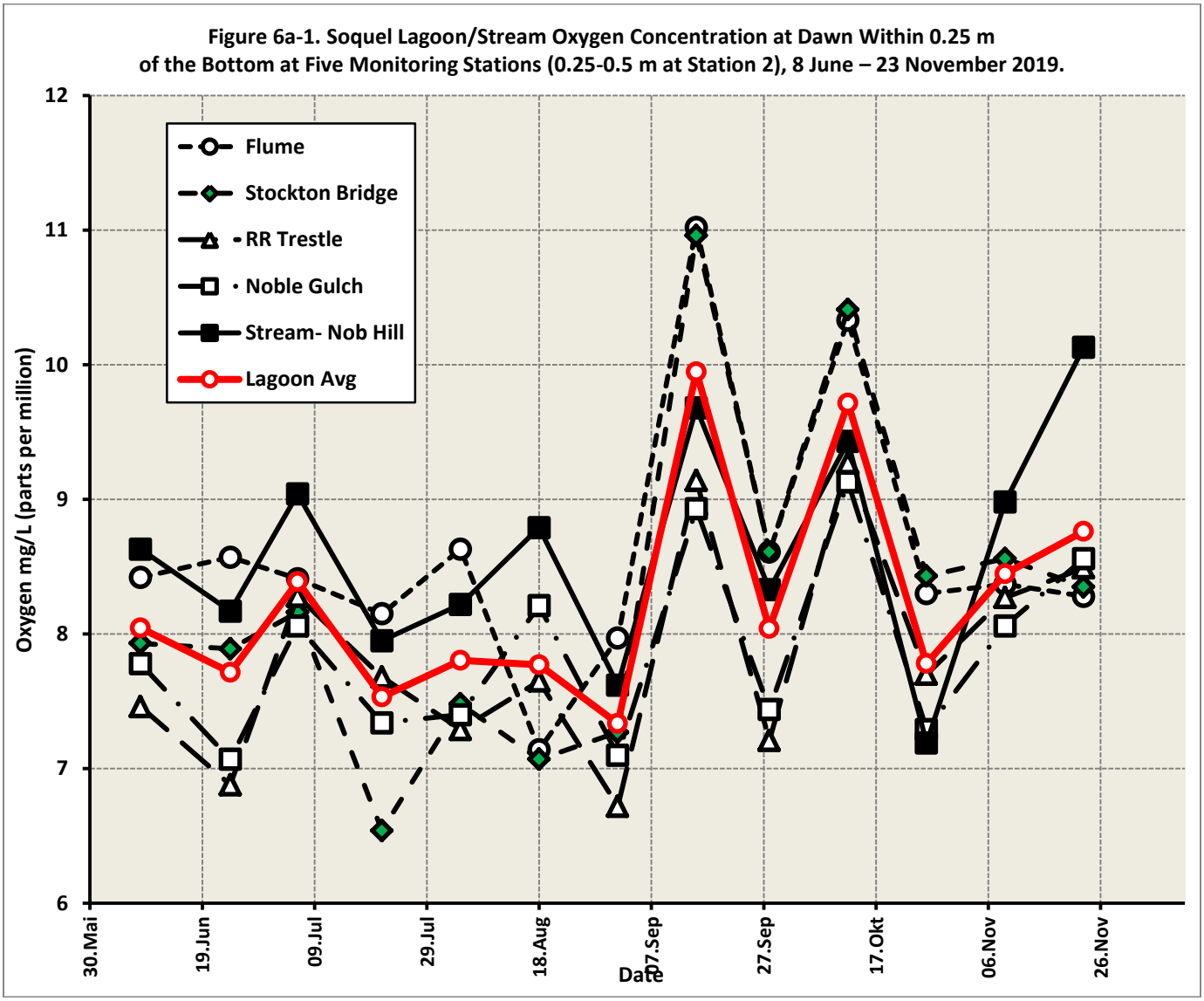


Figure 6a-1. Soquel Lagoon/Stream Oxygen Concentration at Dawn Within 0.25m of the Bottom at Five Monitoring Stations, 8 June – 23 November 2019.

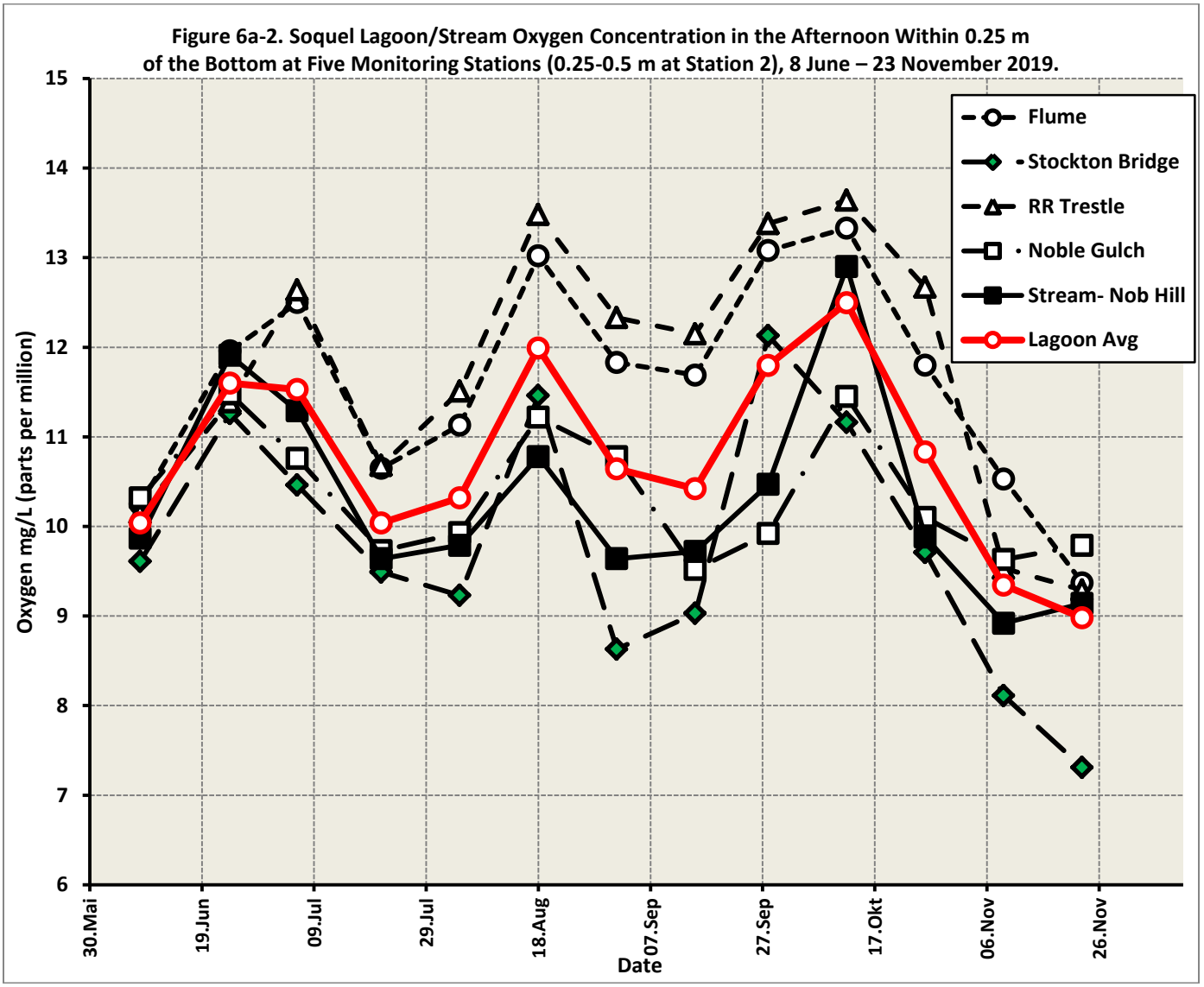


Figure 6a-2. Soquel Lagoon/Stream Oxygen Concentration in the Afternoon Within 0.25m of the Bottom at Five Monitoring Stations, 8 June – 23 November 2019.

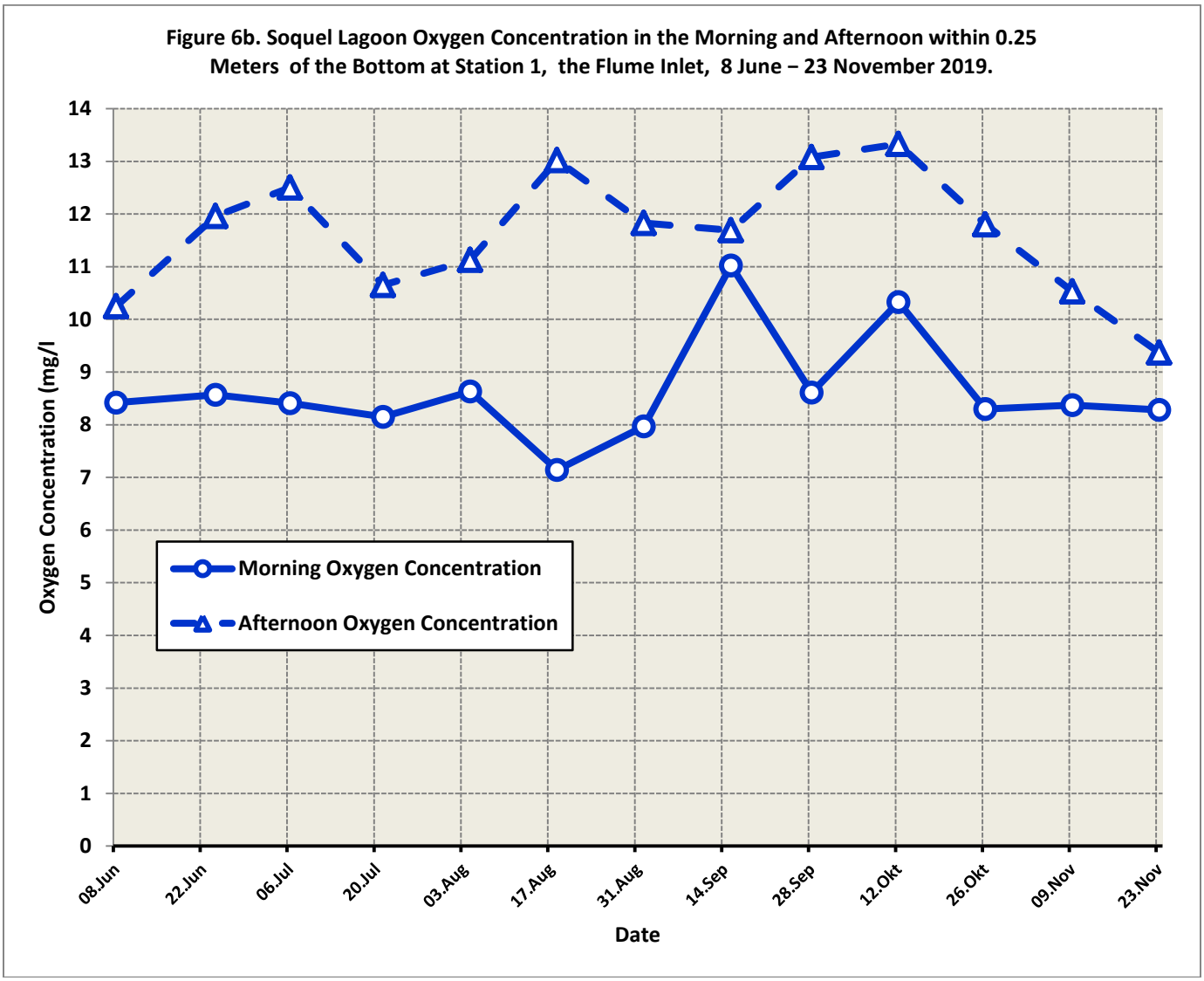


Figure 6b. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 1, the Flume Inlet, 8 June – 23 November 2019.

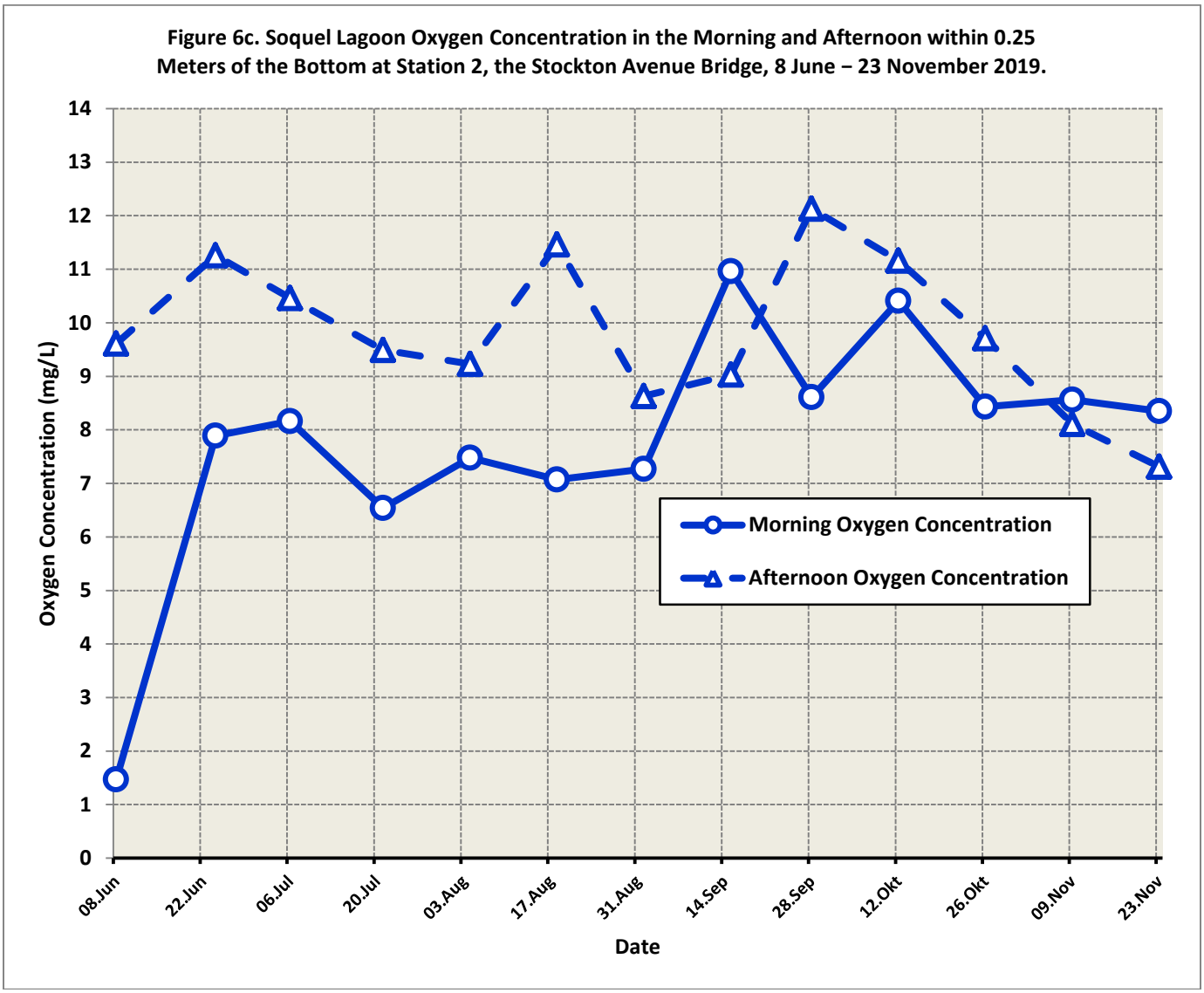


Figure 6c. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 2, the Stockton Avenue Bridge, 8 June – 23 November 2019.

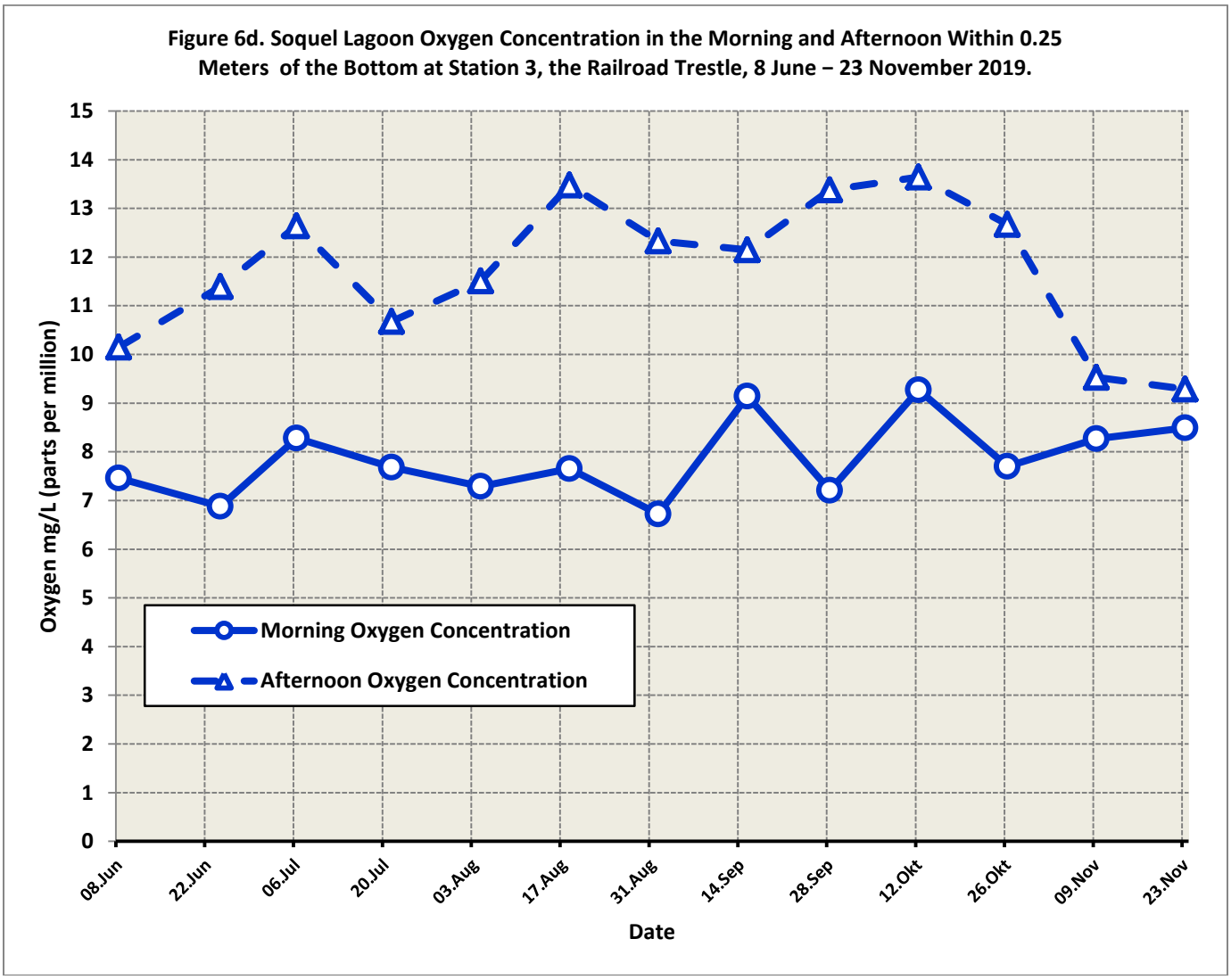


Figure 6d. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon Within 0.25 Meters of the Bottom at Station 3, the Railroad Trestle, 8 June – 23 November 2019.

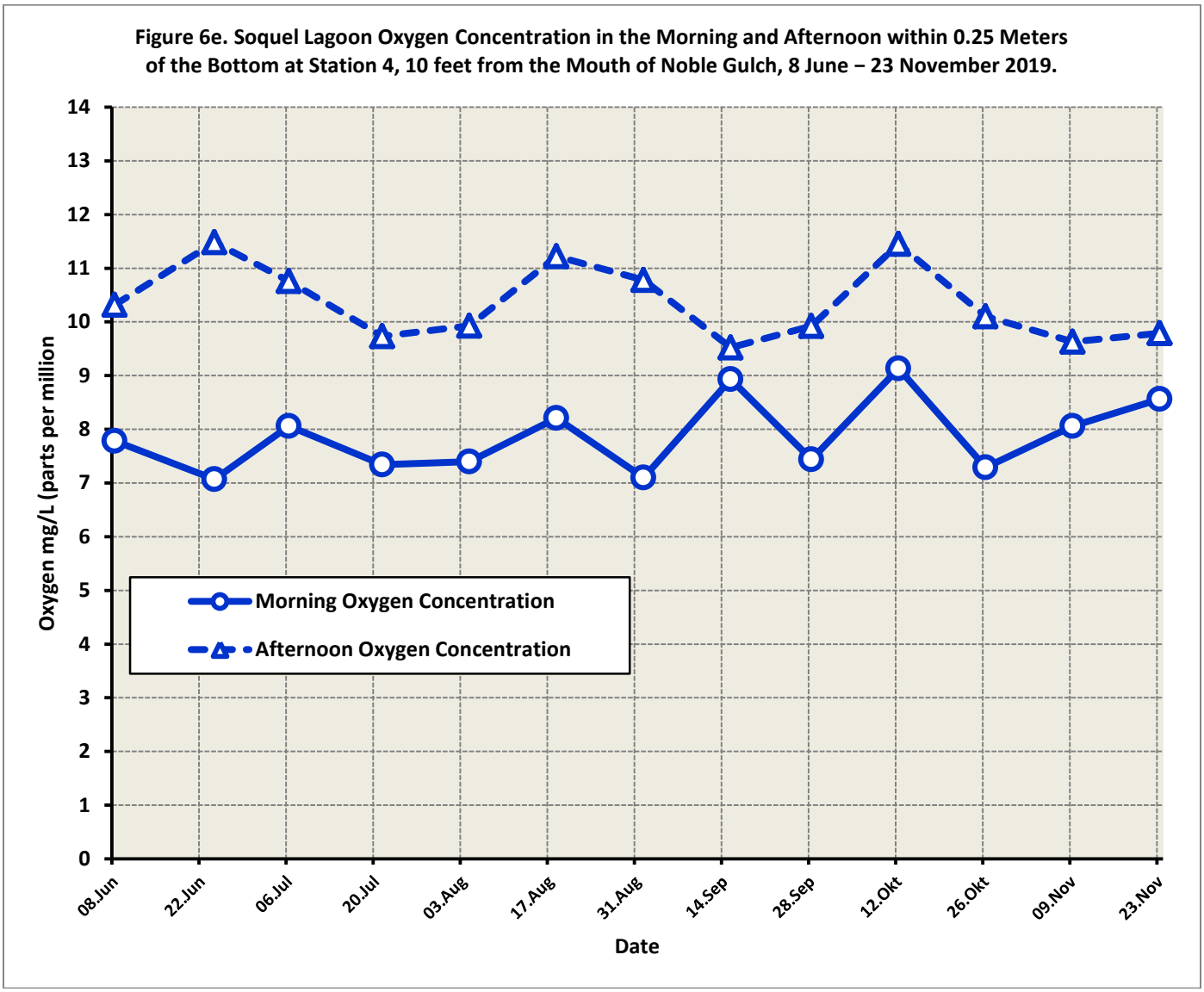


Figure 6e. Soquel Lagoon Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 4, 10 feet from the Mouth of Noble Gulch, 8 June – 23 November 2019.

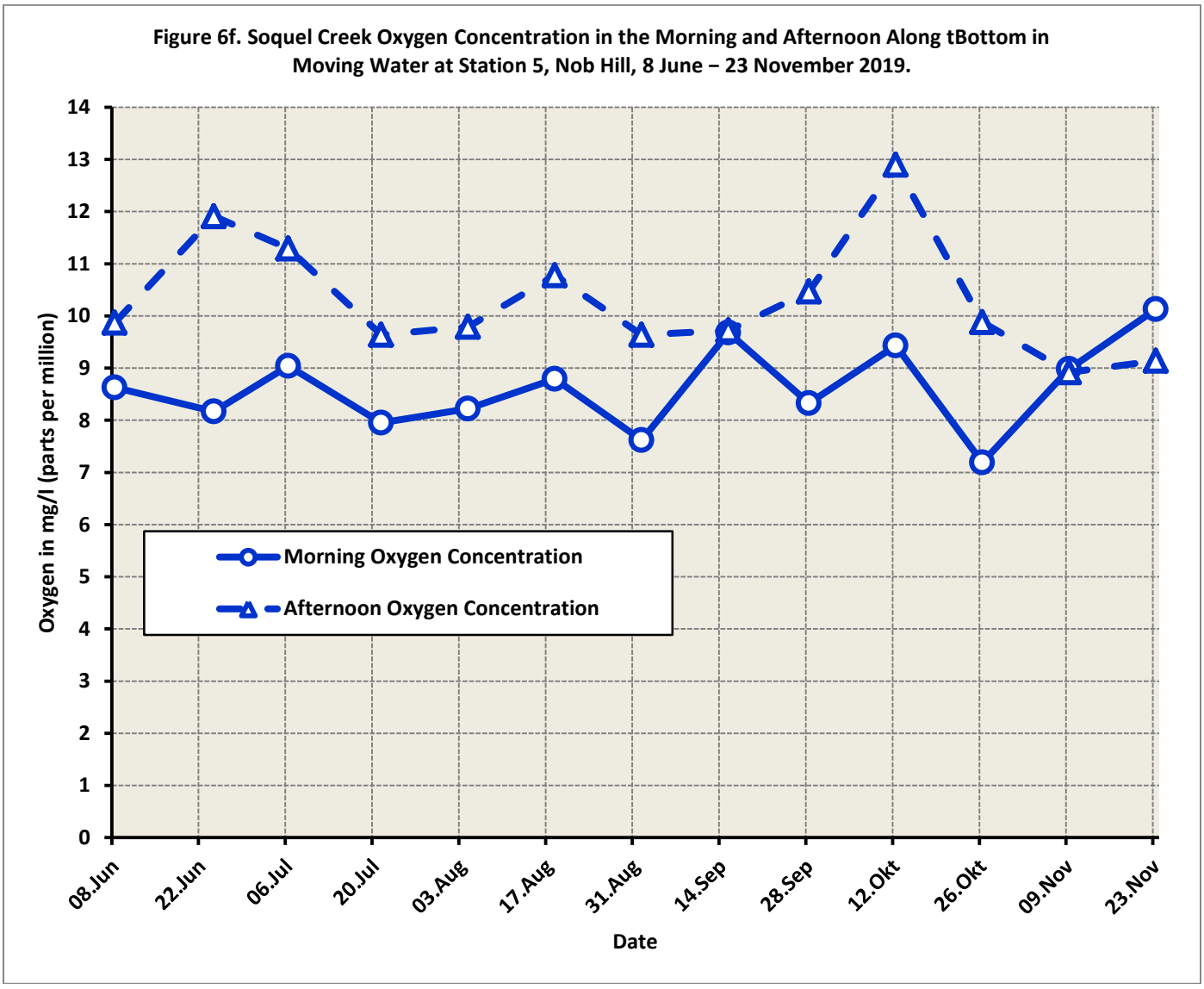


Figure 6f. Soquel Creek Oxygen Concentration in the Morning and Afternoon within 0.25 Meters of the Bottom at Station 5, Nob Hill, 8 June – 23 November 2019.

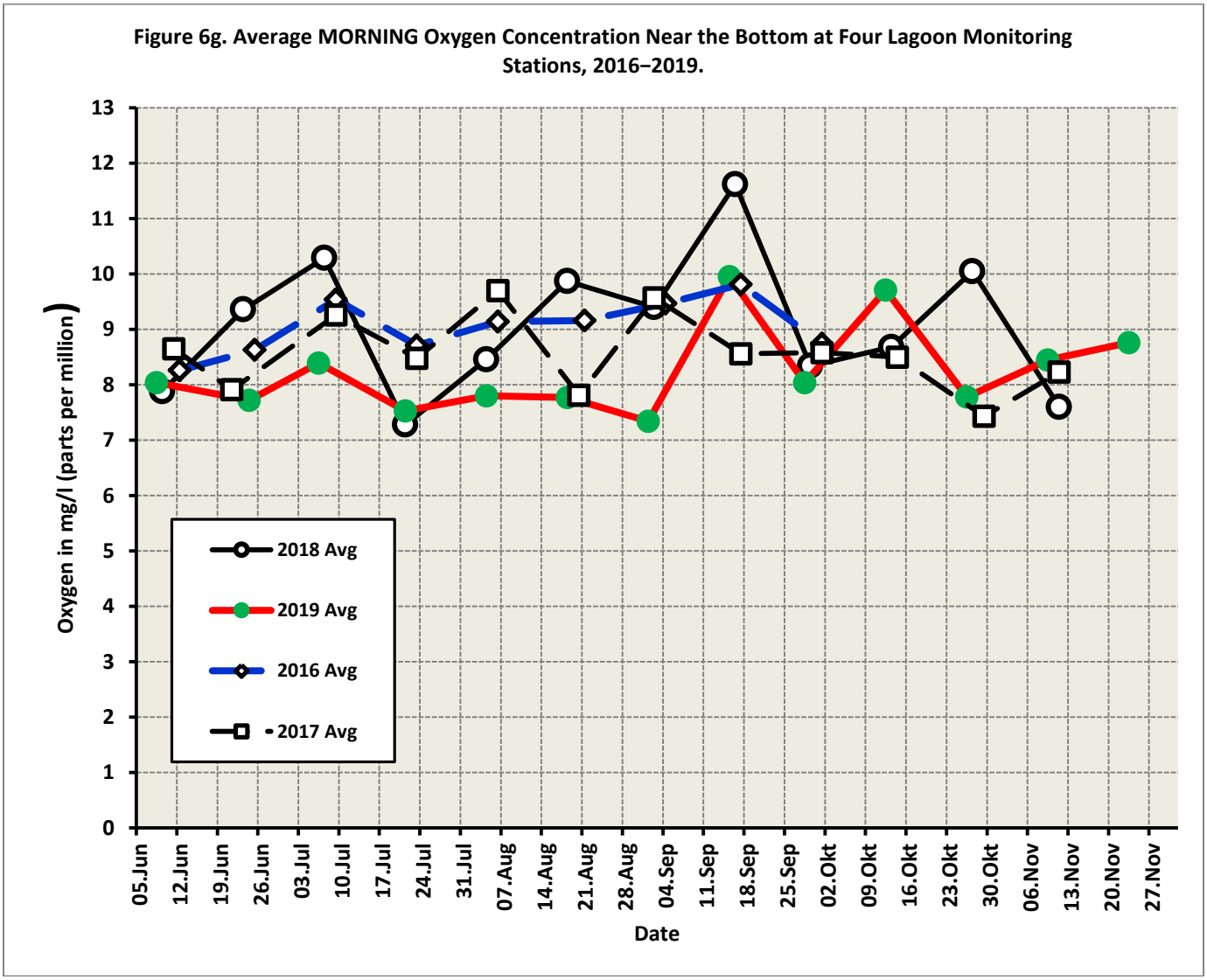


Figure 6g. Average MORNING Oxygen Concentration at Four Lagoon Monitoring Stations, 2016–2019.

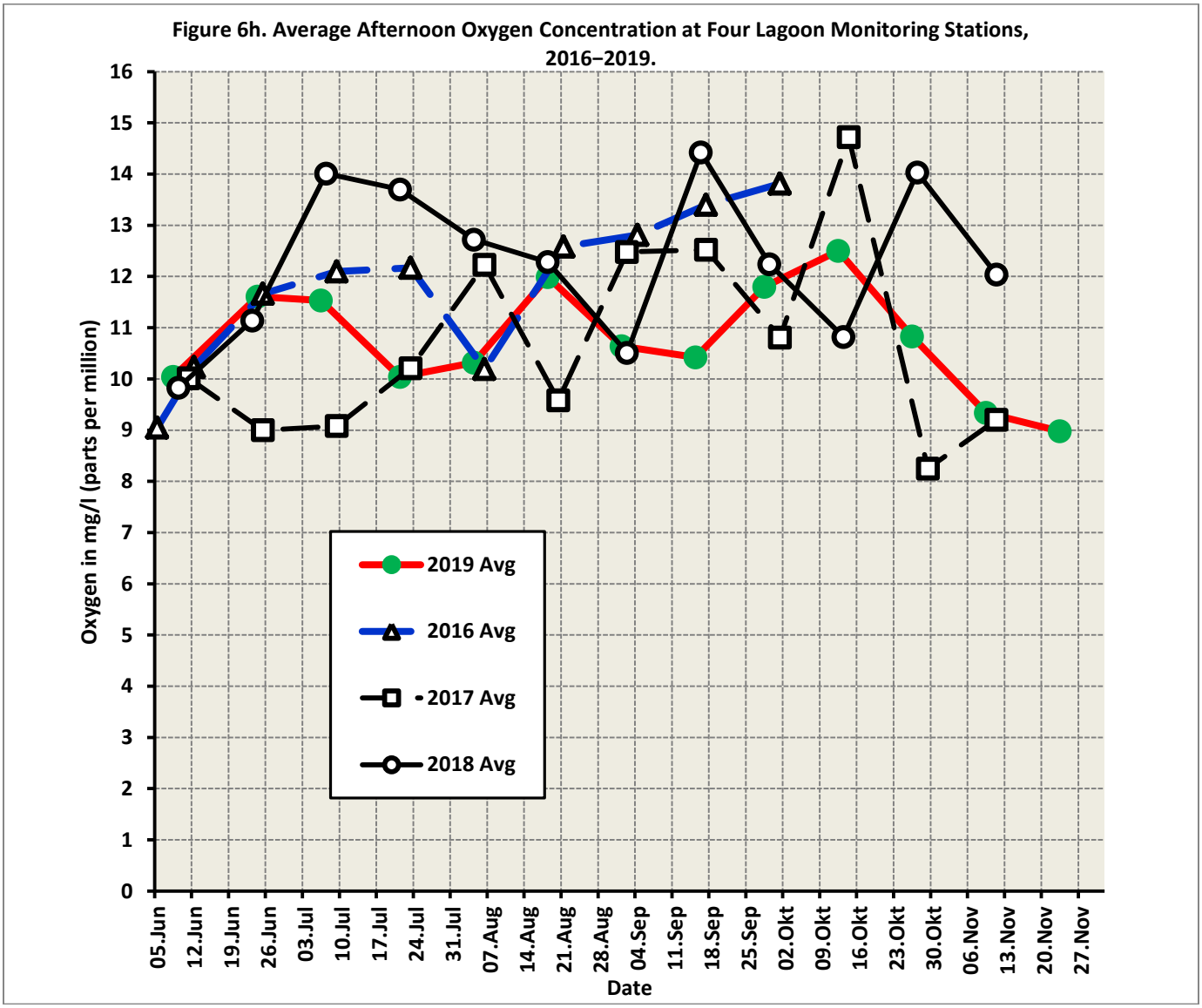


Figure 6h. Average AFTERNOON Oxygen Concentration at Four Lagoon Monitoring Stations, 2016–2019.

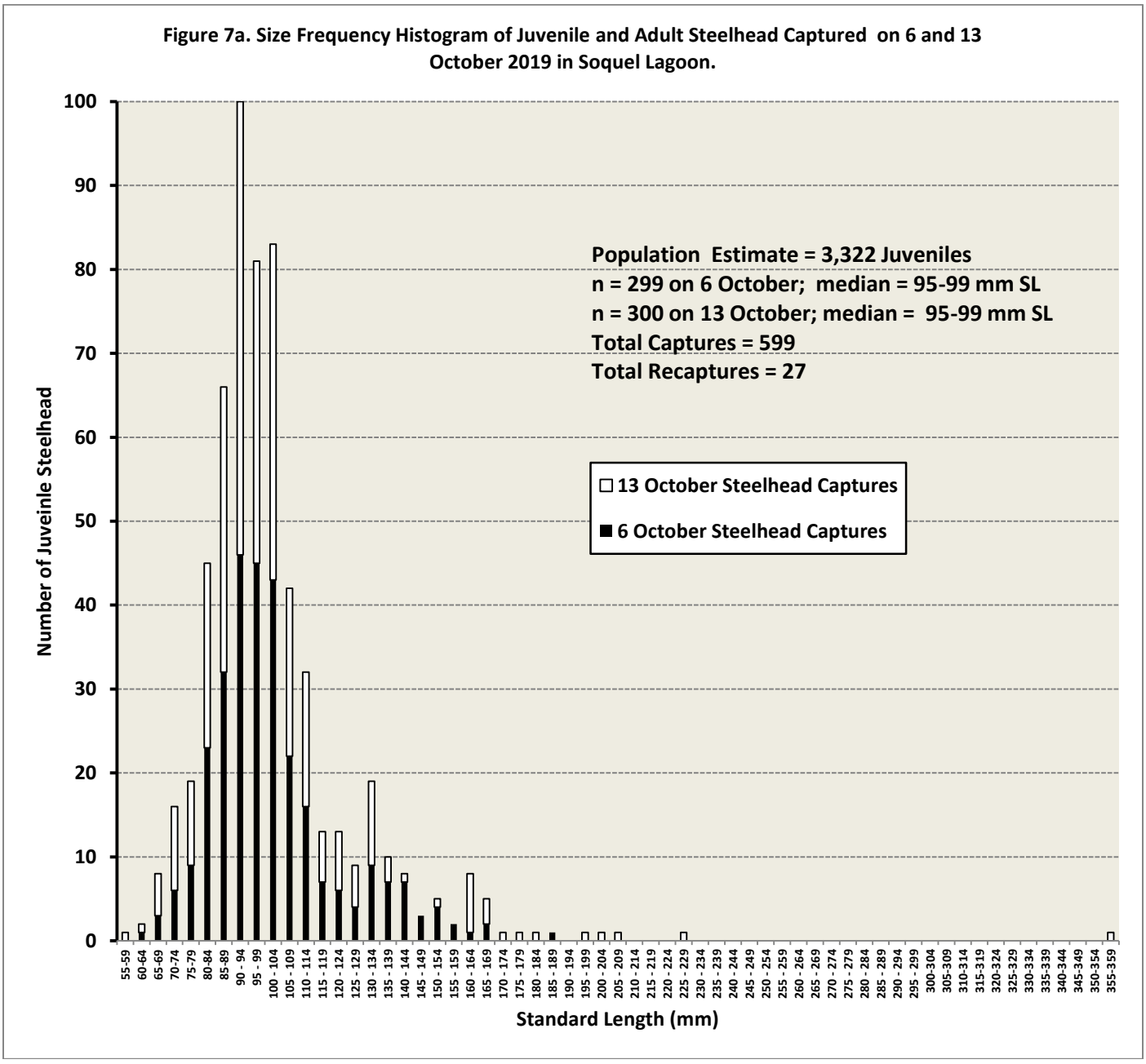


Figure 7a. Size Frequency Histogram of Steelhead Captured on 6 and 13 October 2019 in Soquel Lagoon.

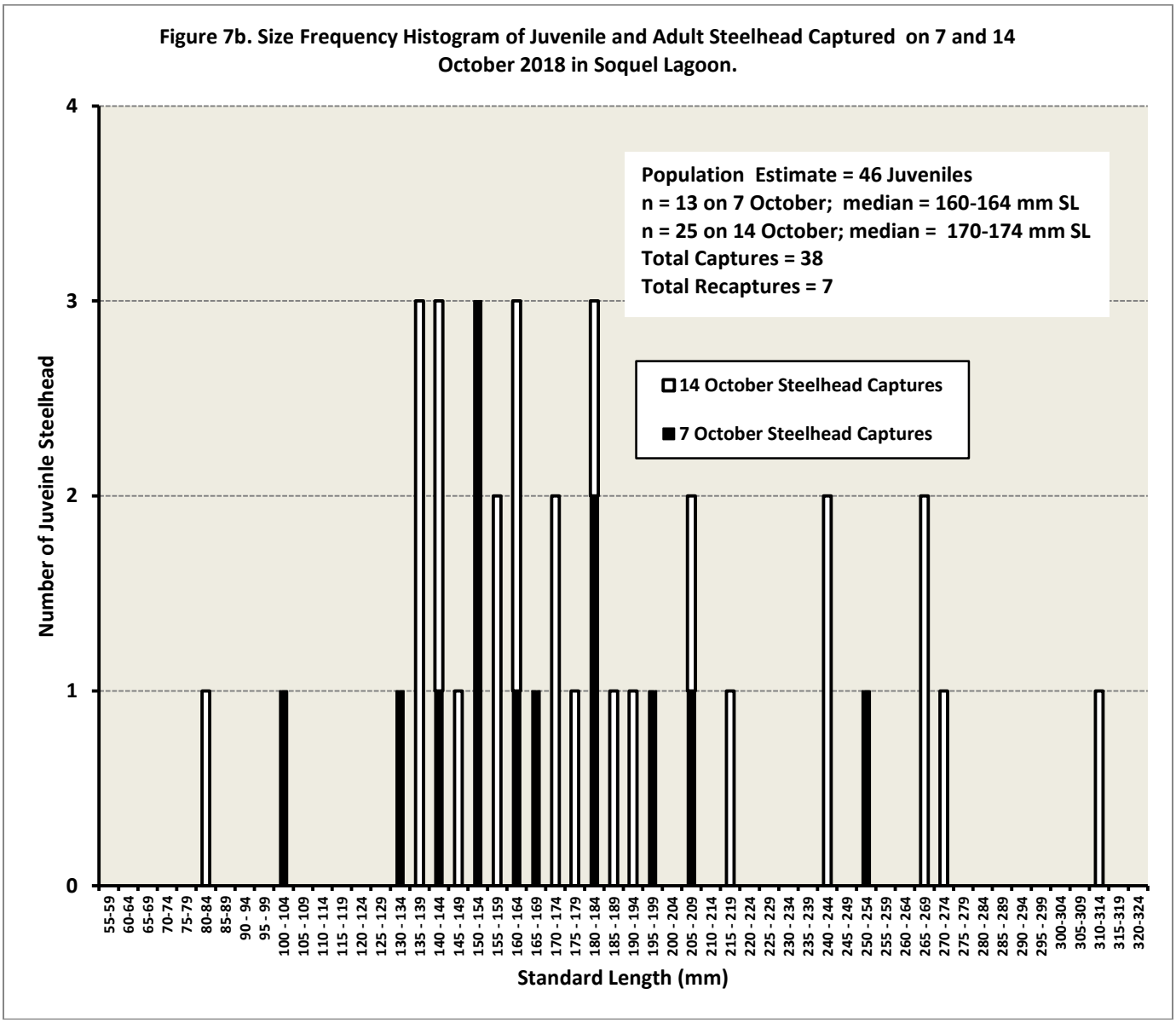


Figure 7b. Size Frequency Histogram of Steelhead Captured on 7 and 14 October 2018 in Soquel Lagoon.

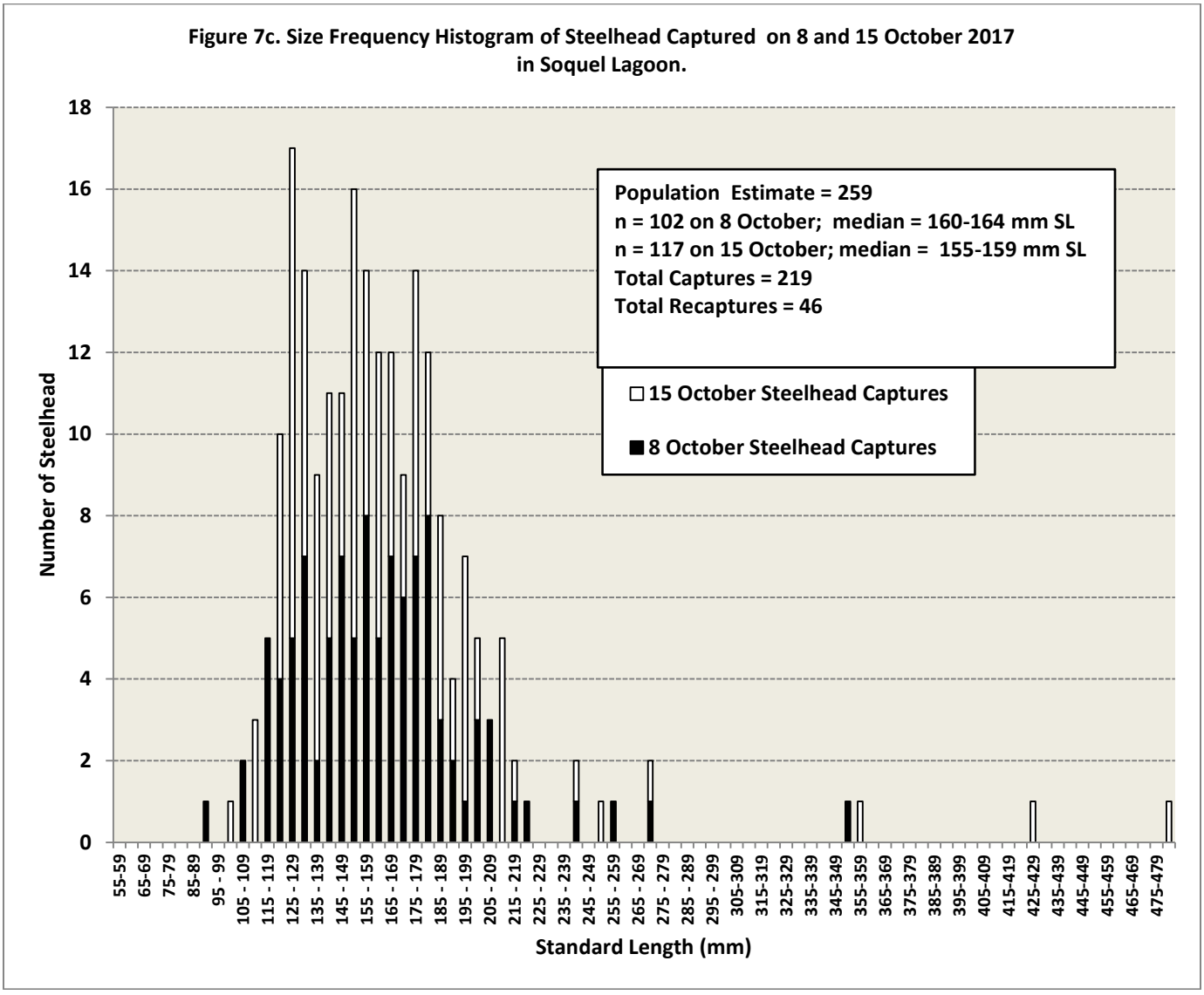


Figure 7c. Size Frequency Histogram of Steelhead Captured on 8 and 15 October 2017 in Soquel Lagoon.

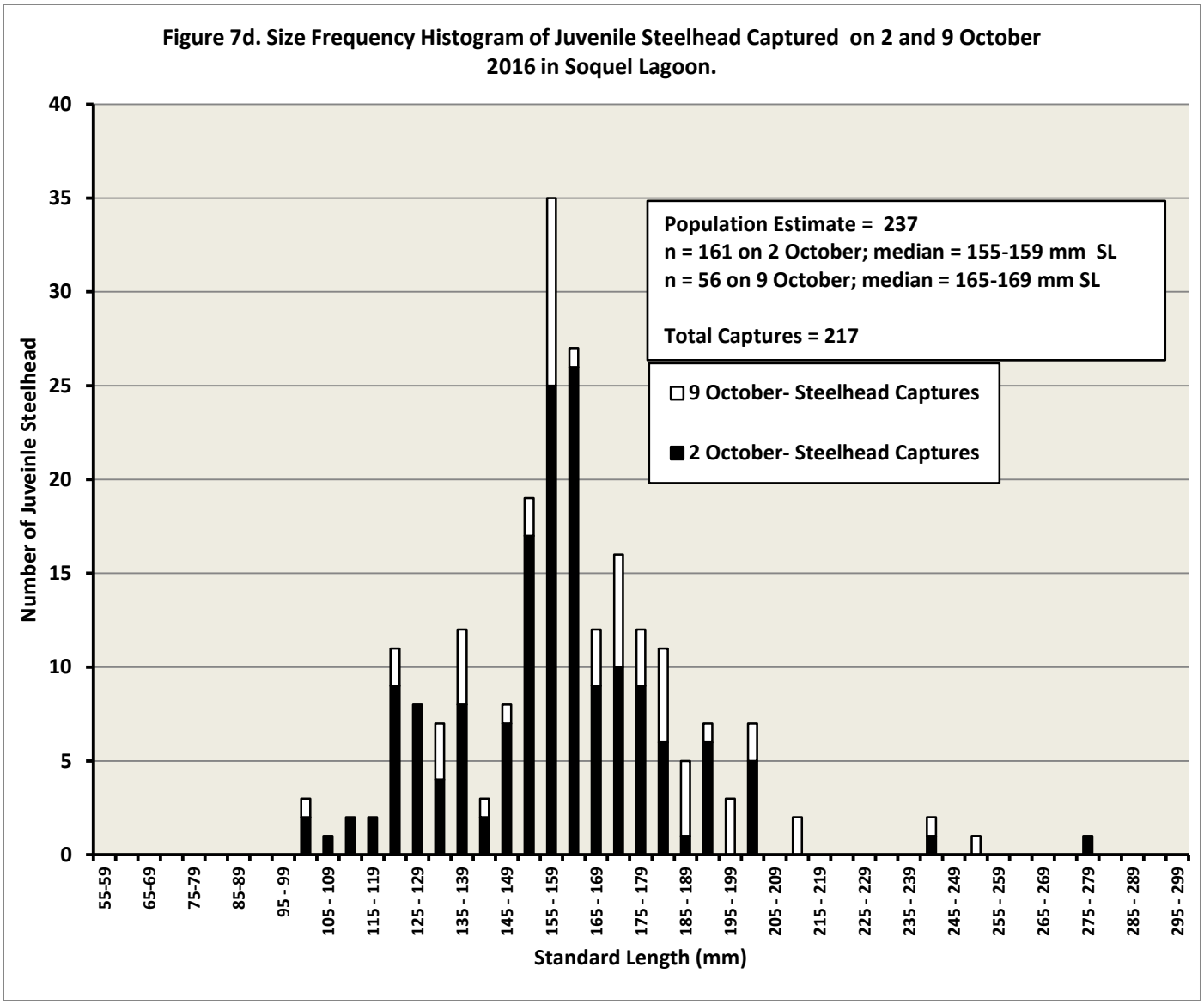


Figure 7d. Size Frequency Histogram of Juvenile Steelhead Captured on 2 and 9 October 2016 in Soquel Lagoon.

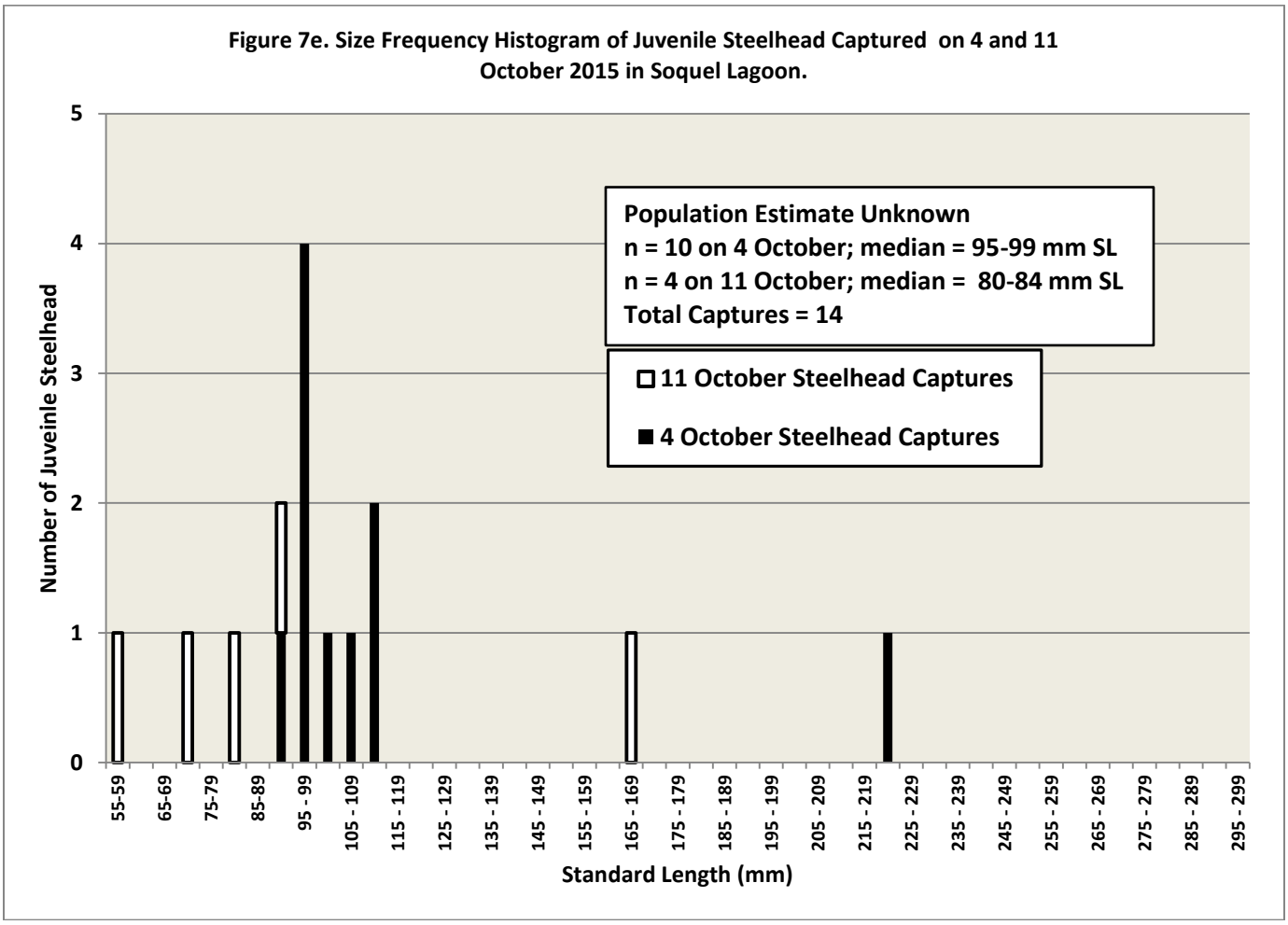


Figure 7e. Size Frequency Histogram of Juvenile Steelhead Captured on 4 and 11 October 2015 in Soquel Lagoon.

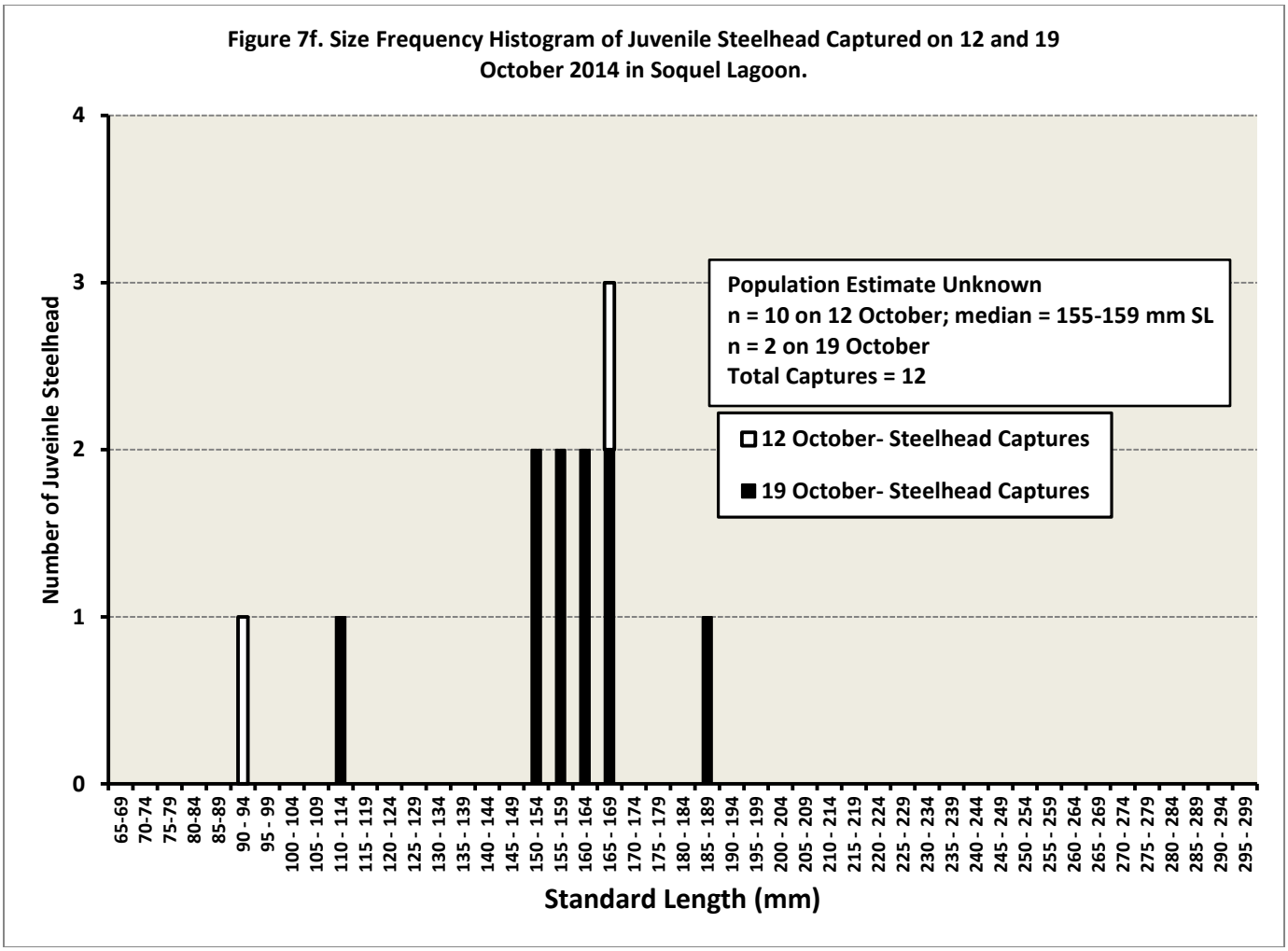


Figure 7f. Size Frequency Histogram of Juvenile Steelhead Captured on 12 and 19 October 2014 in Soquel Lagoon.

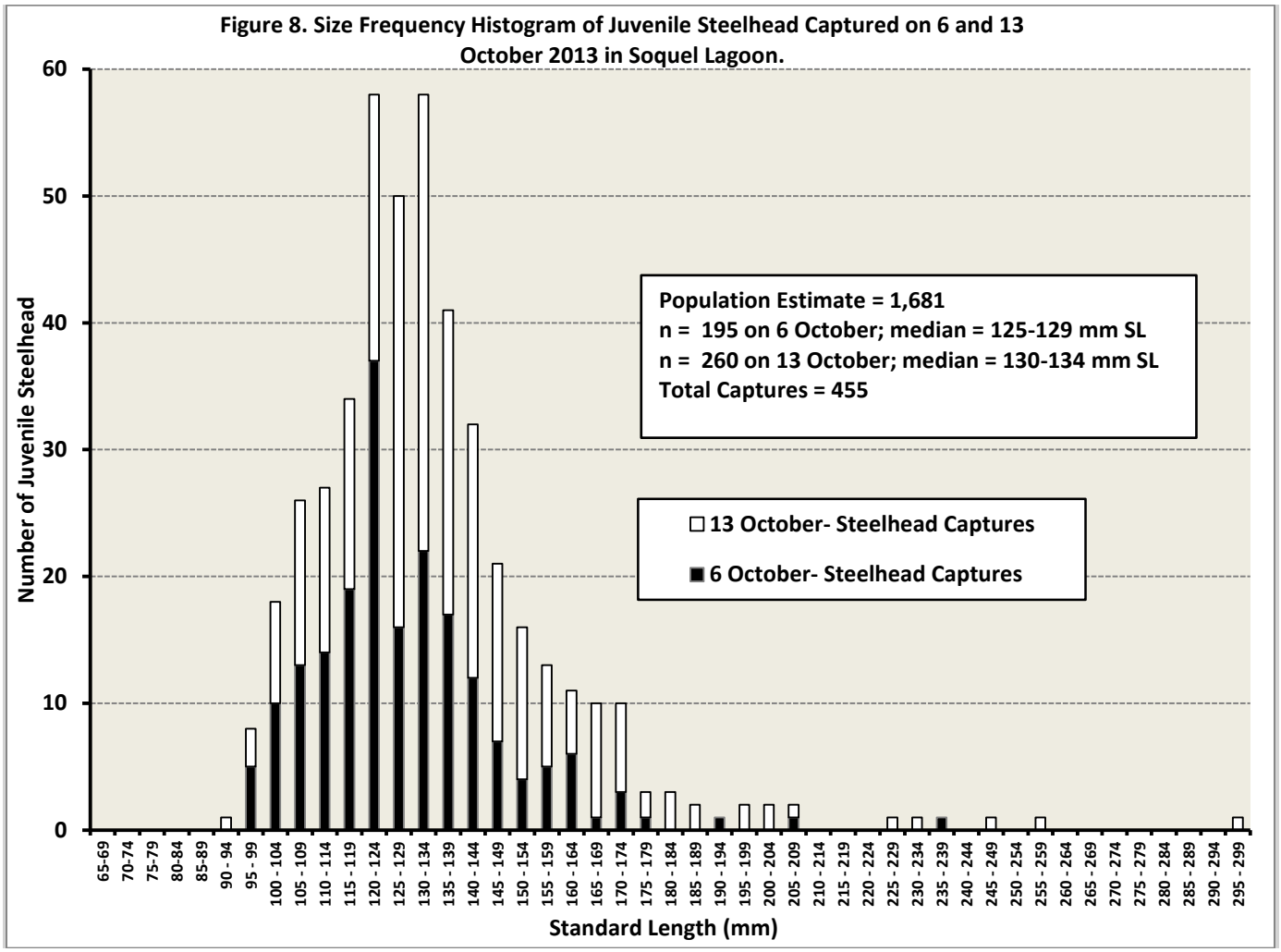


Figure 8. Size Frequency Histogram of Juvenile Steelhead Captured on 6 and 13 October 2013 in Soquel Lagoon.

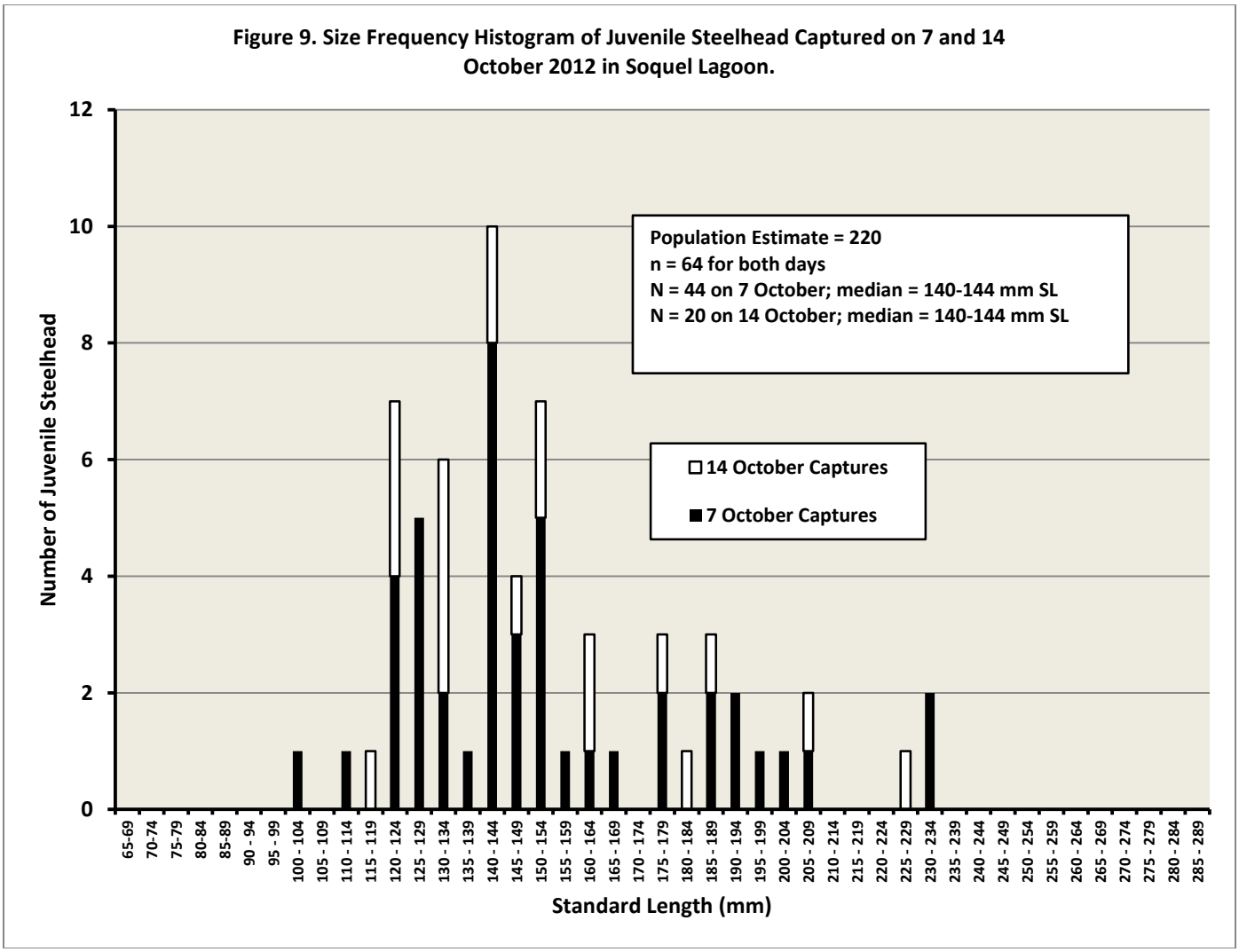


Figure 9. Size Frequency Histogram of Juvenile Steelhead Captured on 7 and 14 October 2012 in Soquel Lagoon.

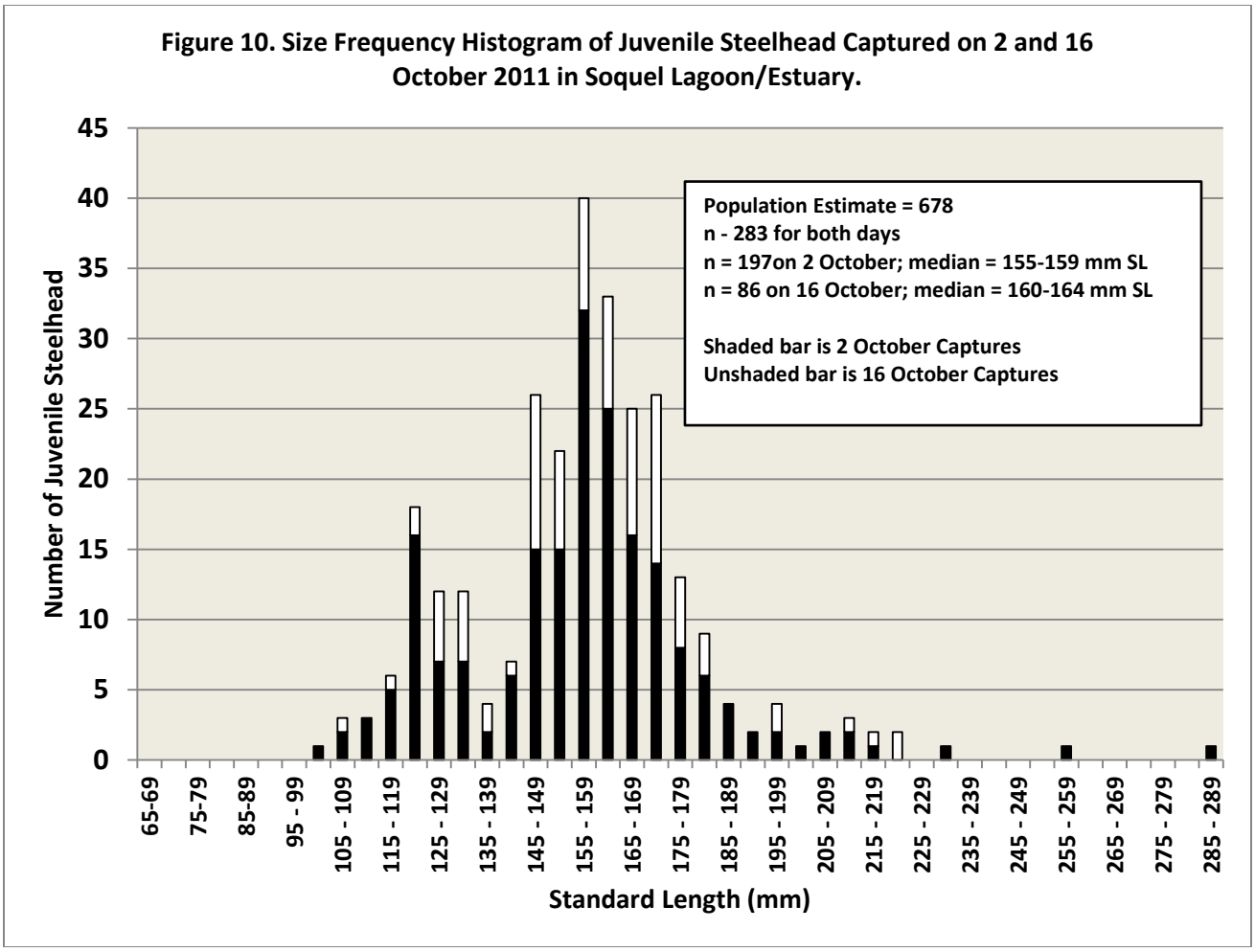


Figure 10. Size Frequency Histogram of Juvenile Steelhead Captured on 2 and 16 October 2011 in Soquel Lagoon/Estuary.

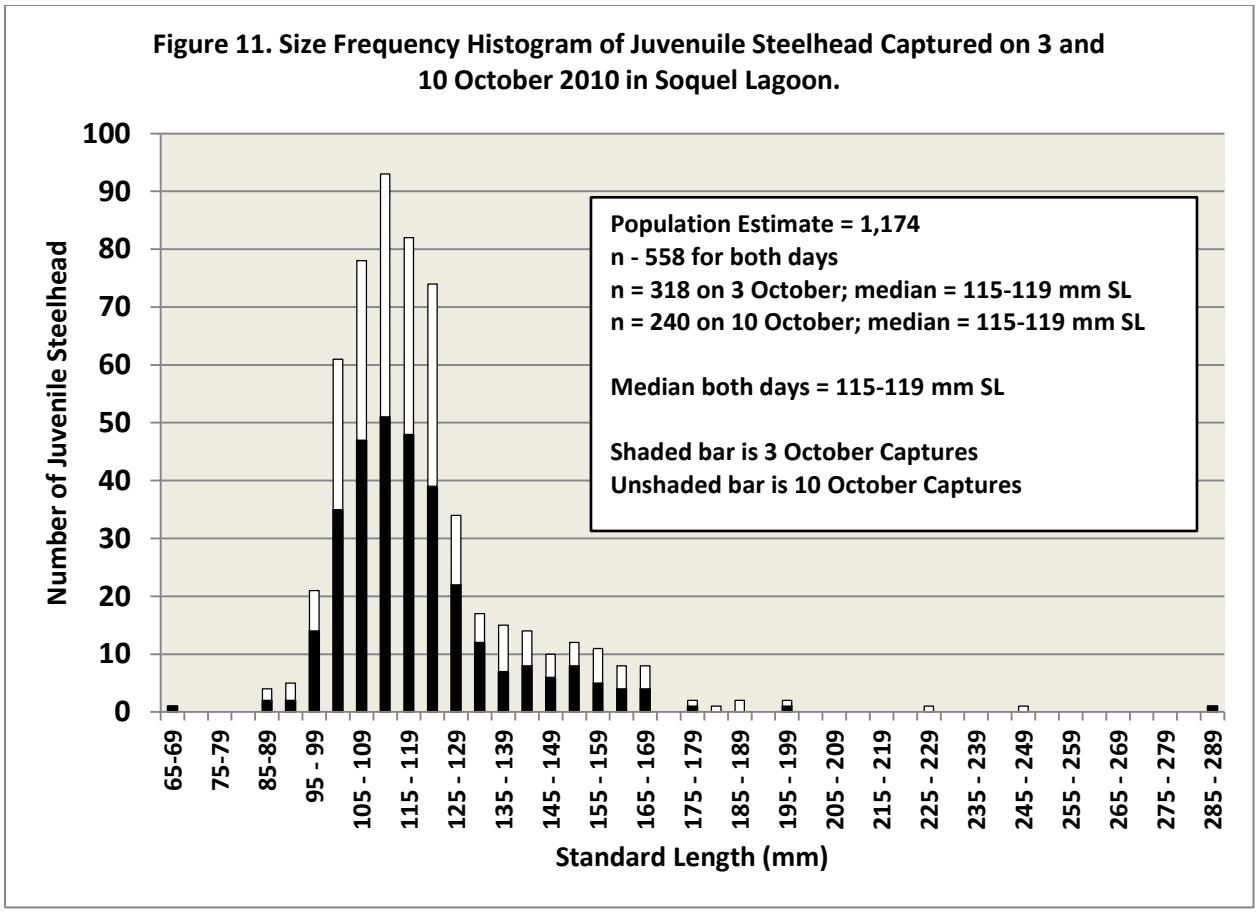


Figure 11. Size Frequency Histogram of Juvenuile Steelhead Captured on 3 and 10 October 2010 in Soquel Lagoon.

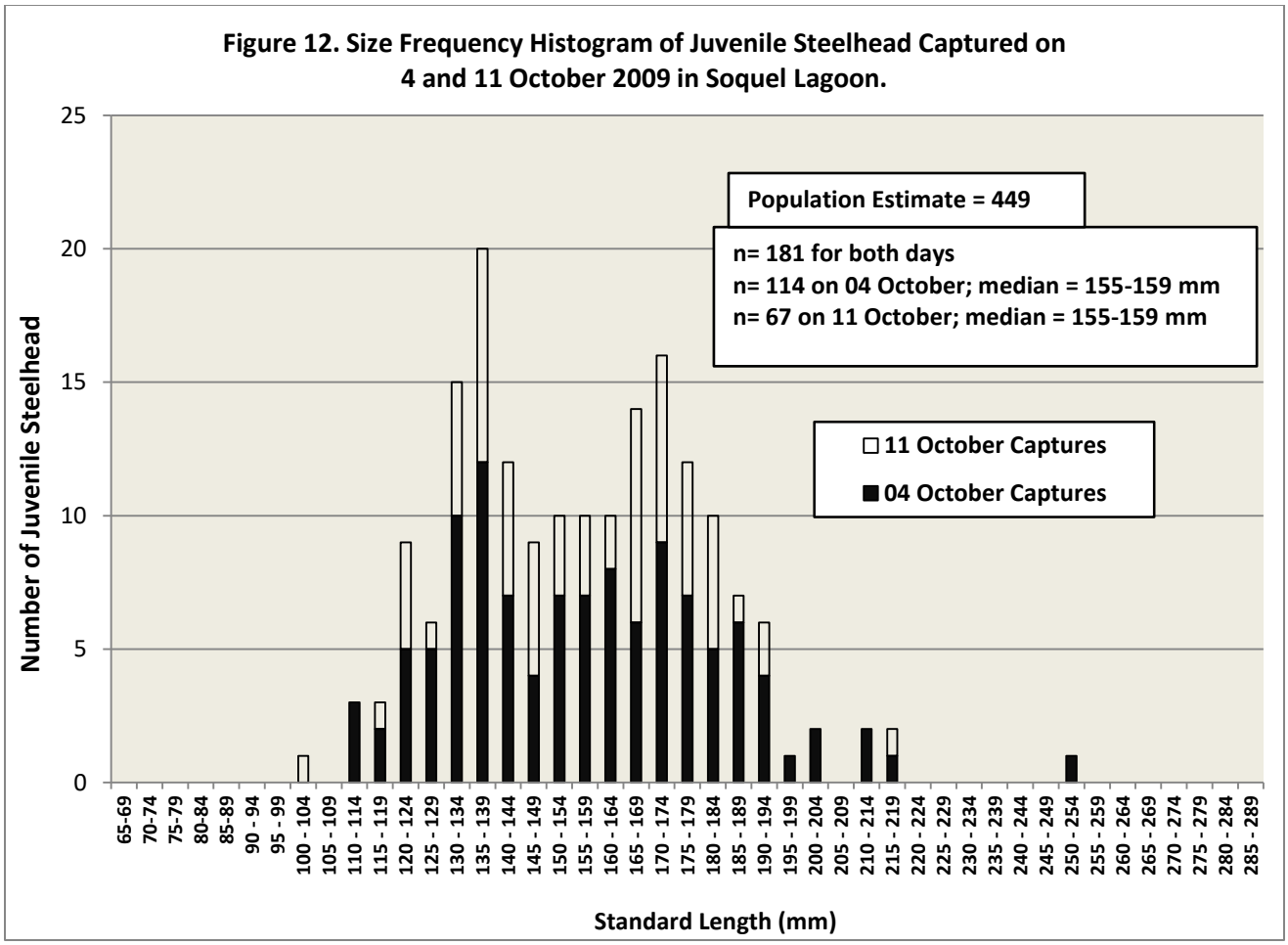


Figure 12. Size Frequency Histogram of Juvenile Steelhead Captured on 4 and 11 October 2009 in Soquel Lagoon.

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

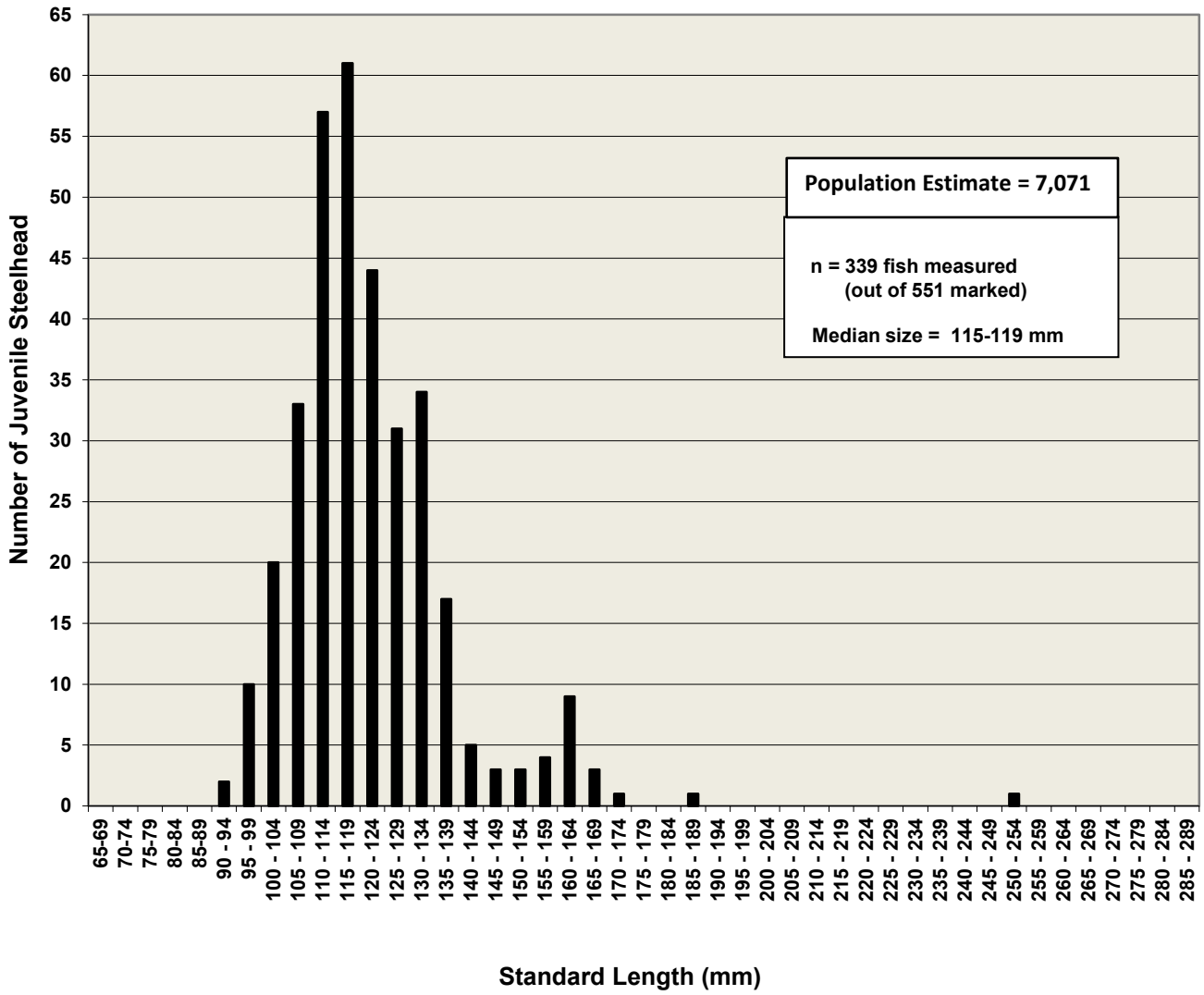


Figure 13. Size Frequency Histogram of Juvenile Steelhead Captured on 27 September 2008 in the Soquel Lagoon.

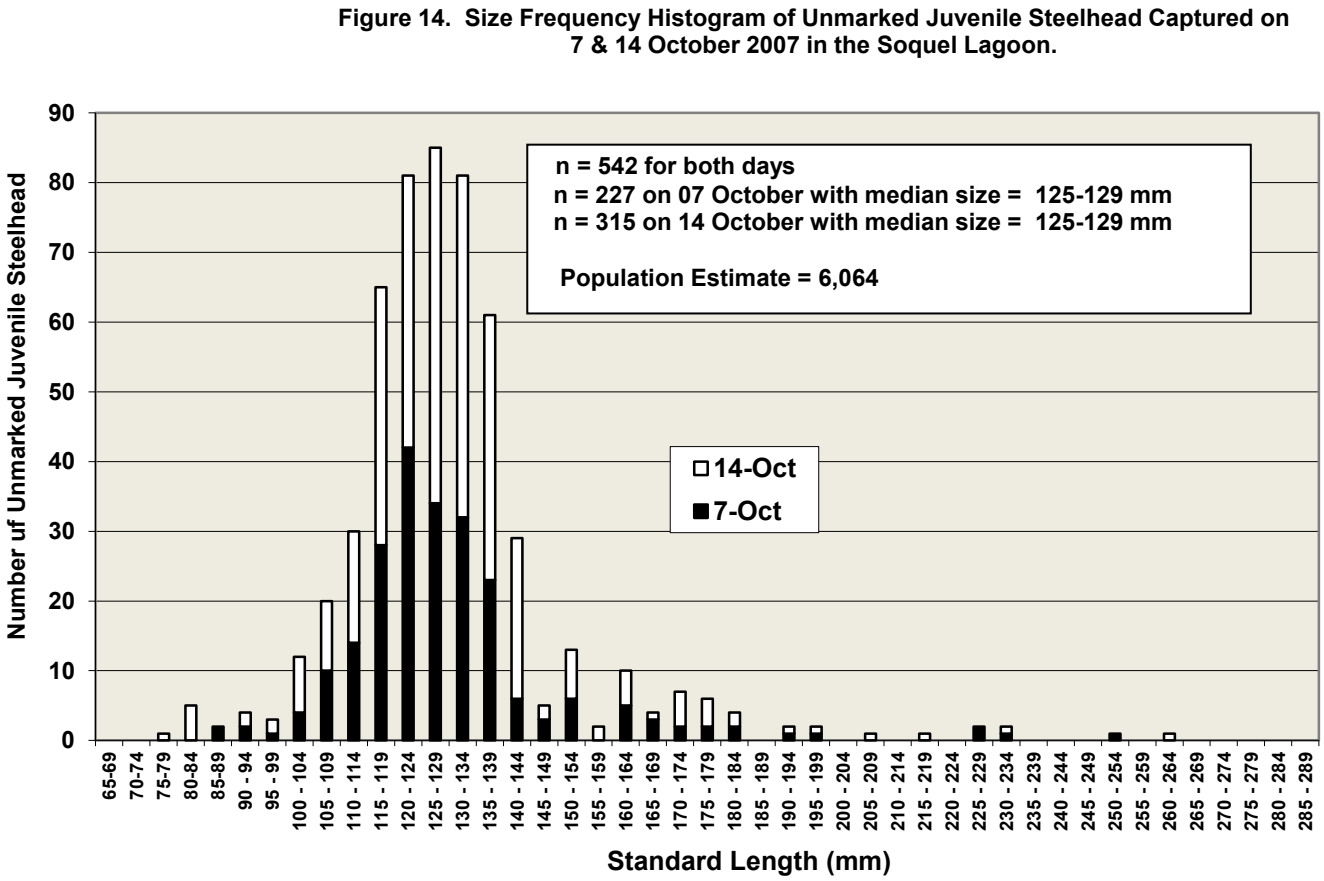


Figure 14. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 7 & 14 October 2007 in the Soquel Lagoon.

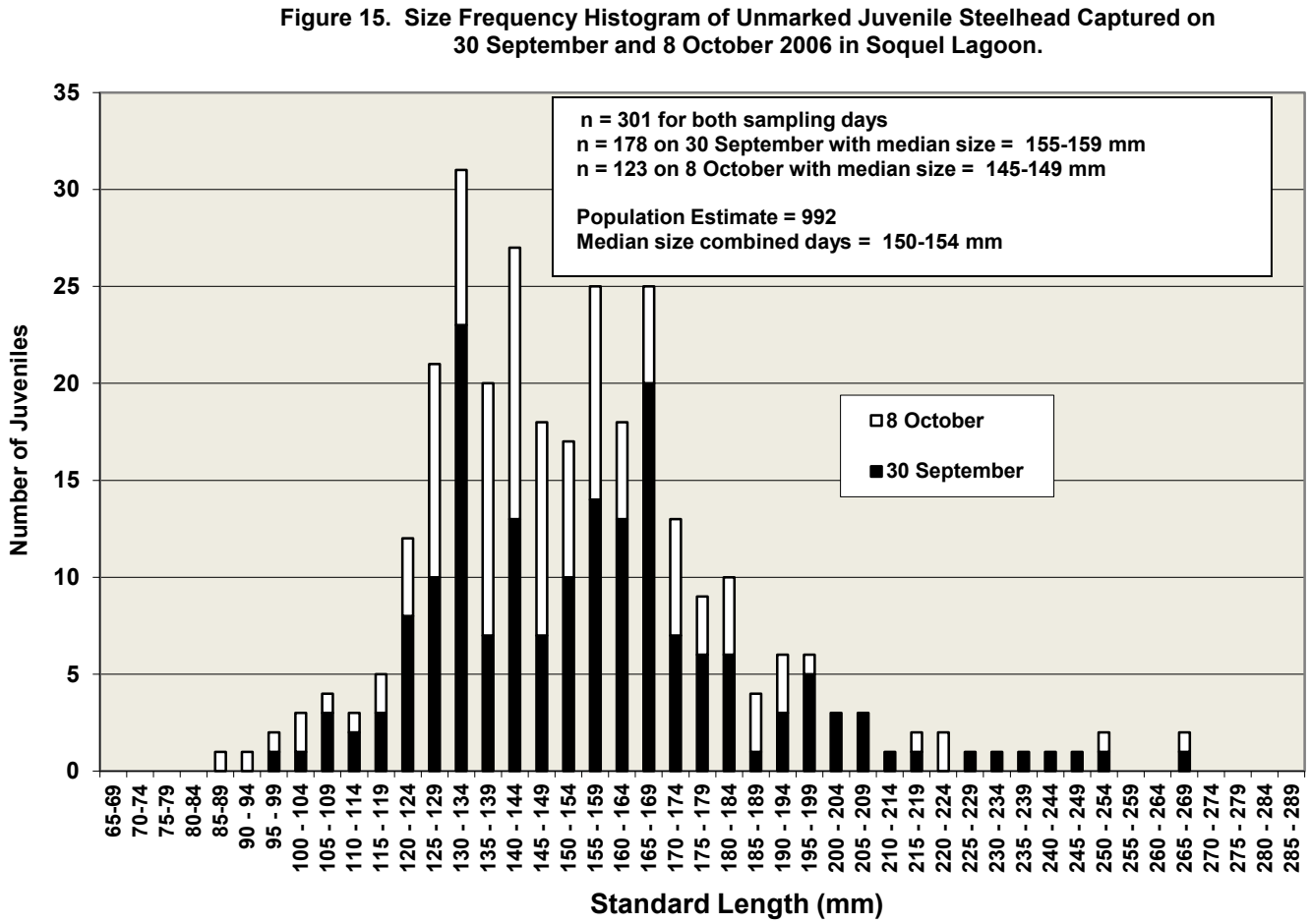


Figure 15. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 30 September and 8 October 2006 in Soquel Lagoon.

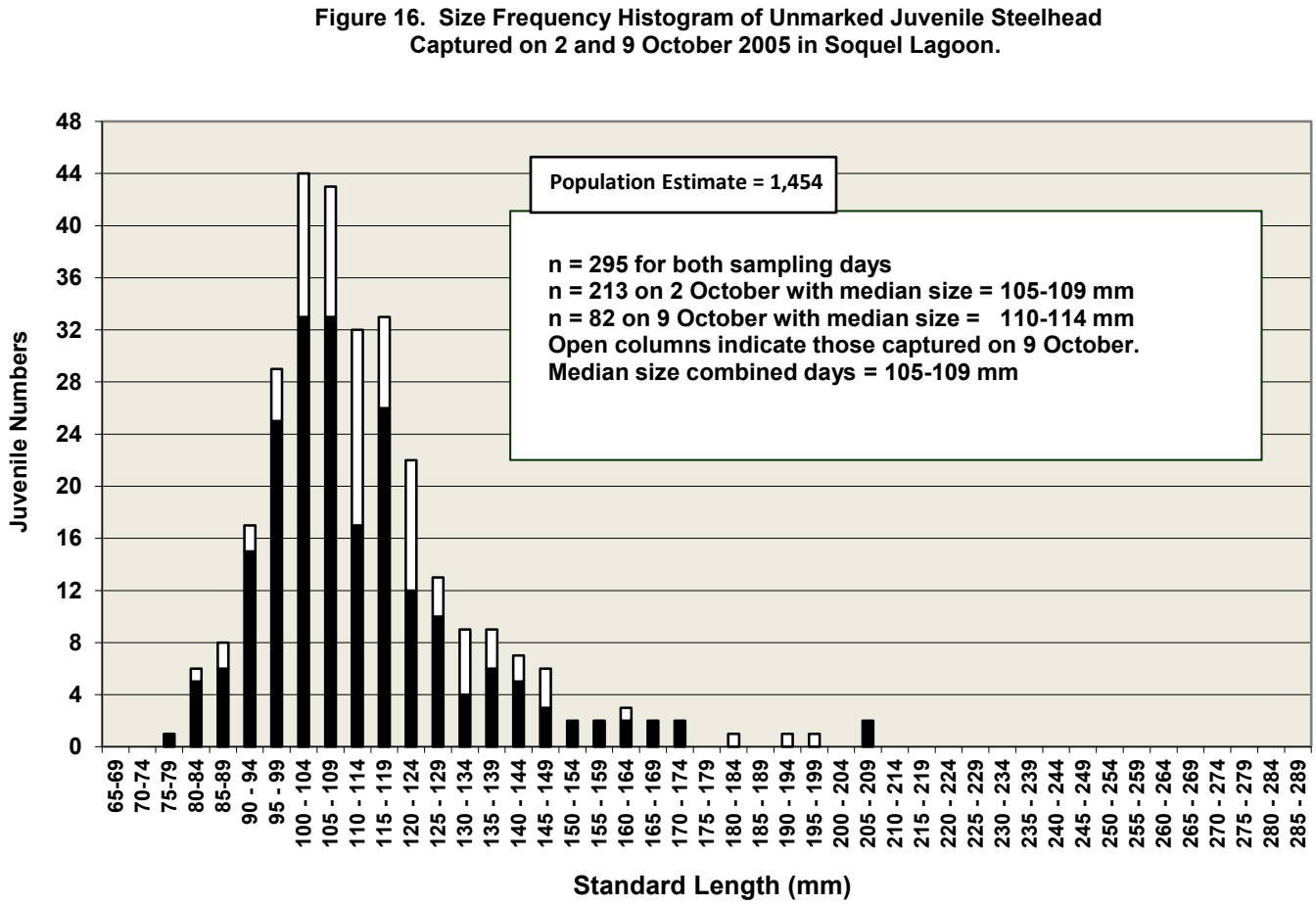


Figure 16. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 2 and 9 October 2005 in Soquel Lagoon.

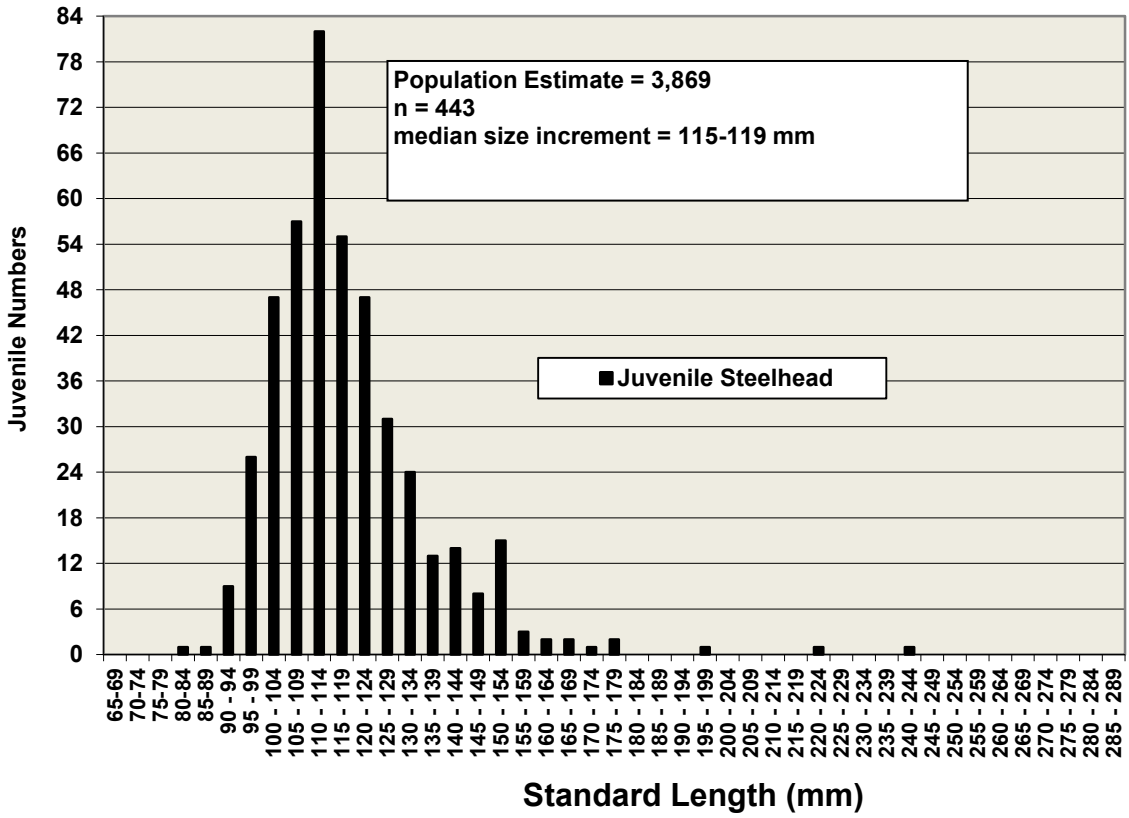


Figure 17. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 and 12 October 2004 in Soquel Lagoon.

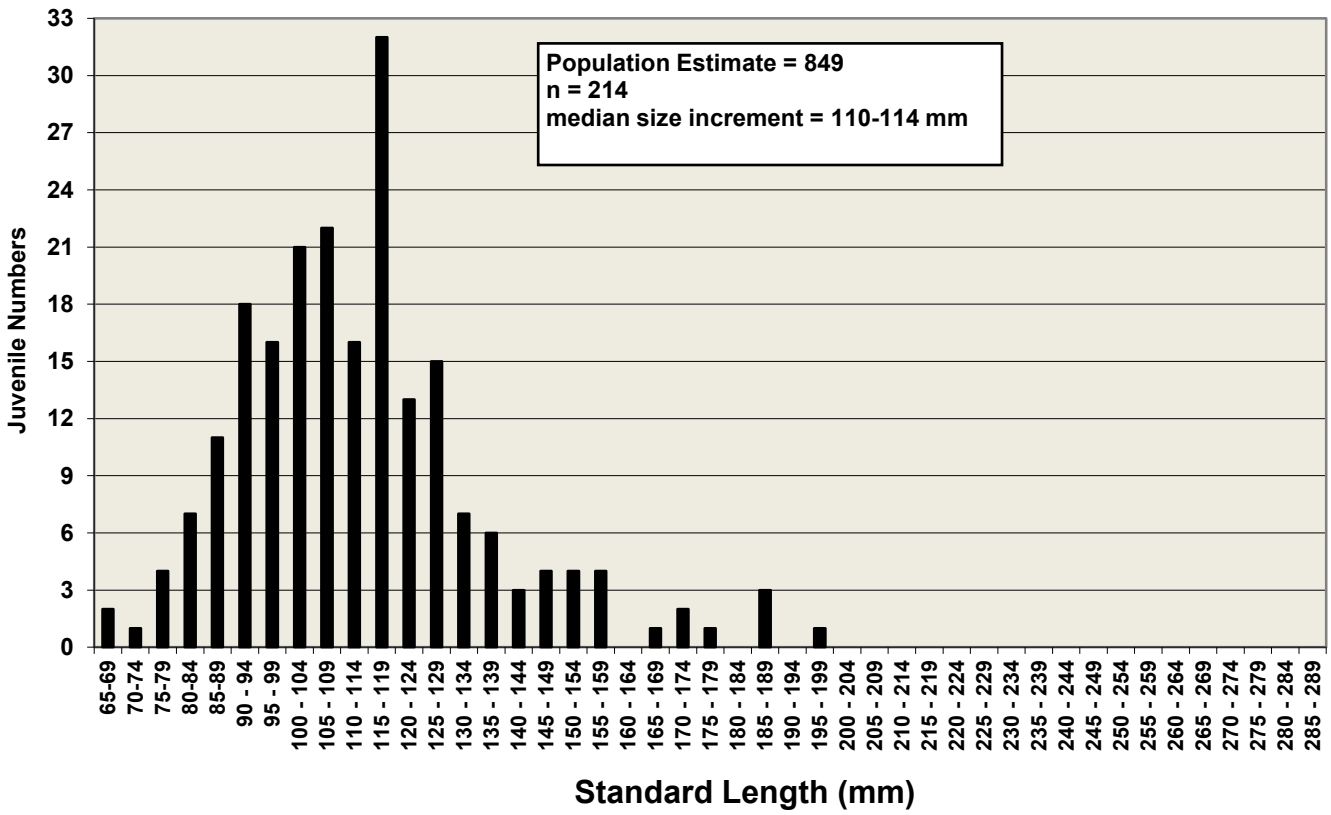


Figure 18. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 5 and 12 October 2003 in Soquel Lagoon.

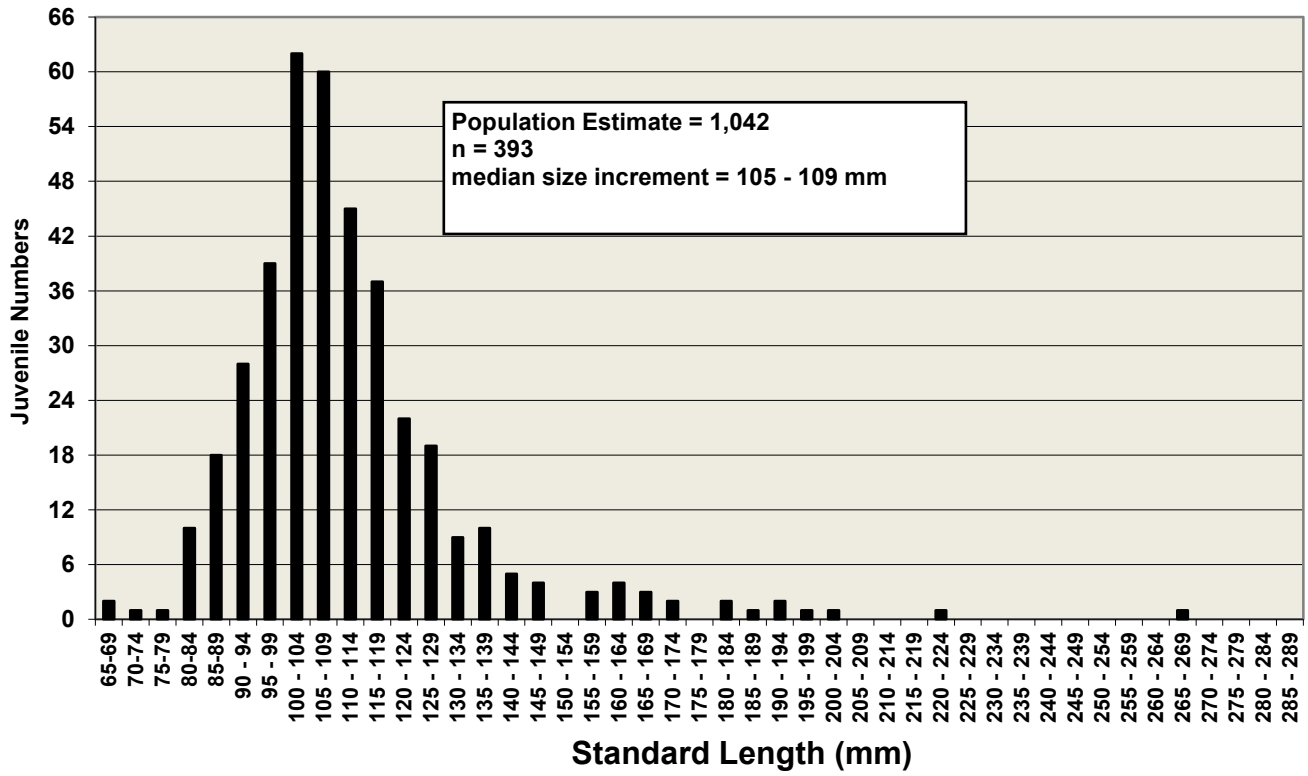


Figure 19. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 6 October 2002 in Soquel Lagoon.

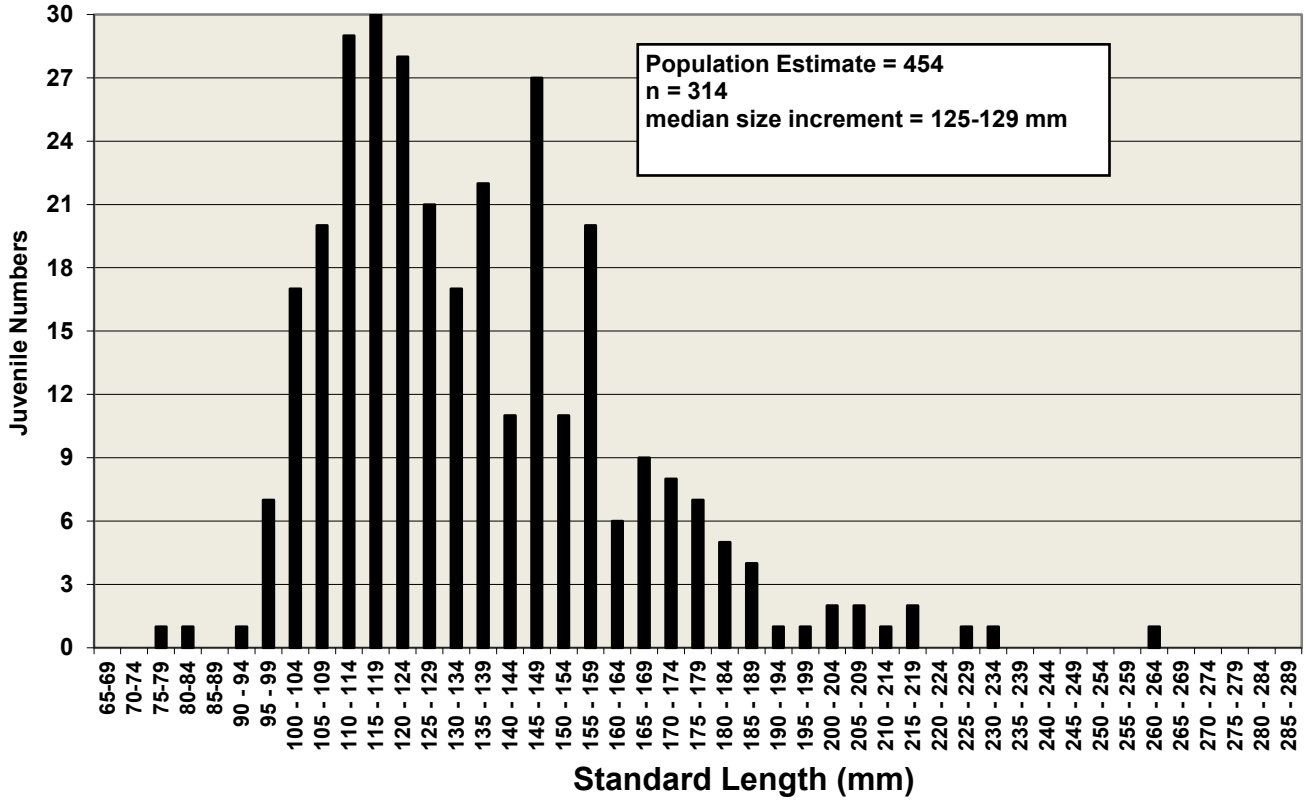


Figure 20. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 7 and 14 October 2001 in Soquel Lagoon.

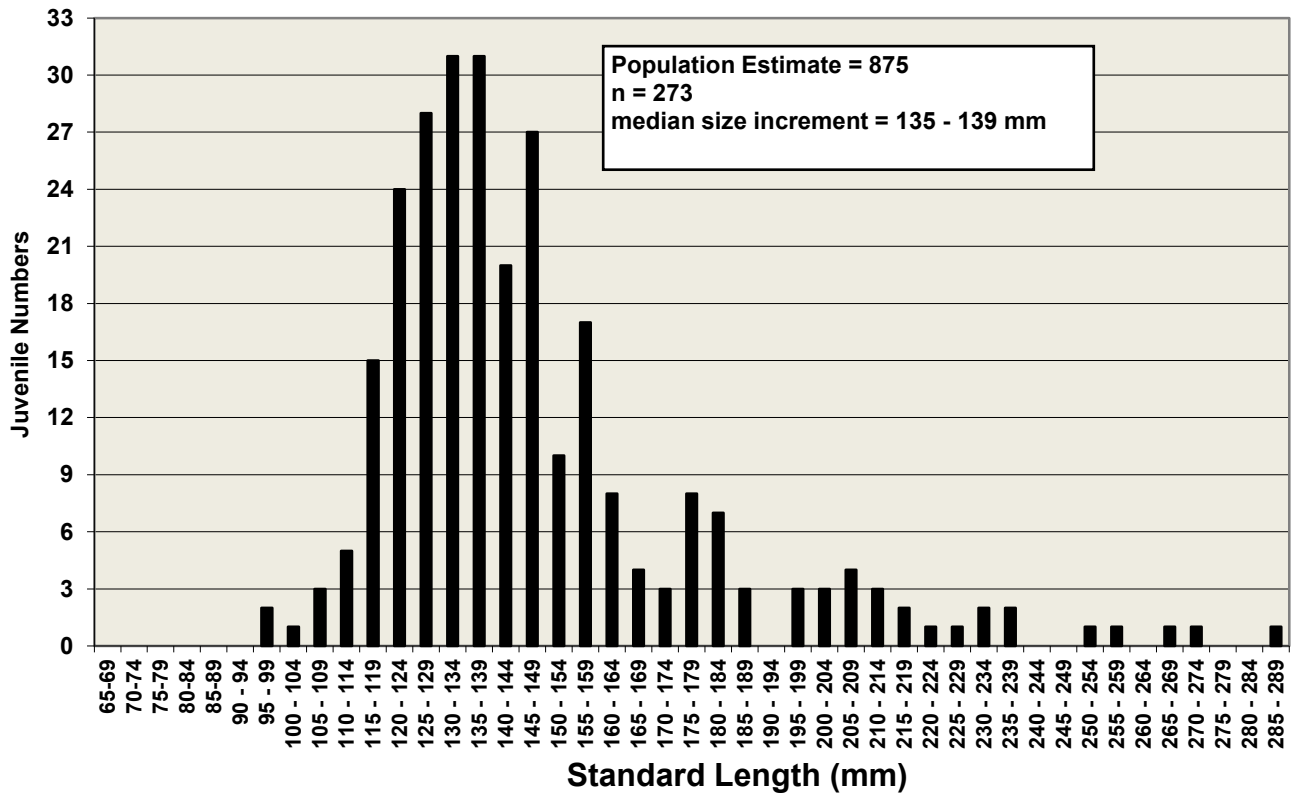


Figure 21. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 1 and 8 October 2000 in Soquel Lagoon.

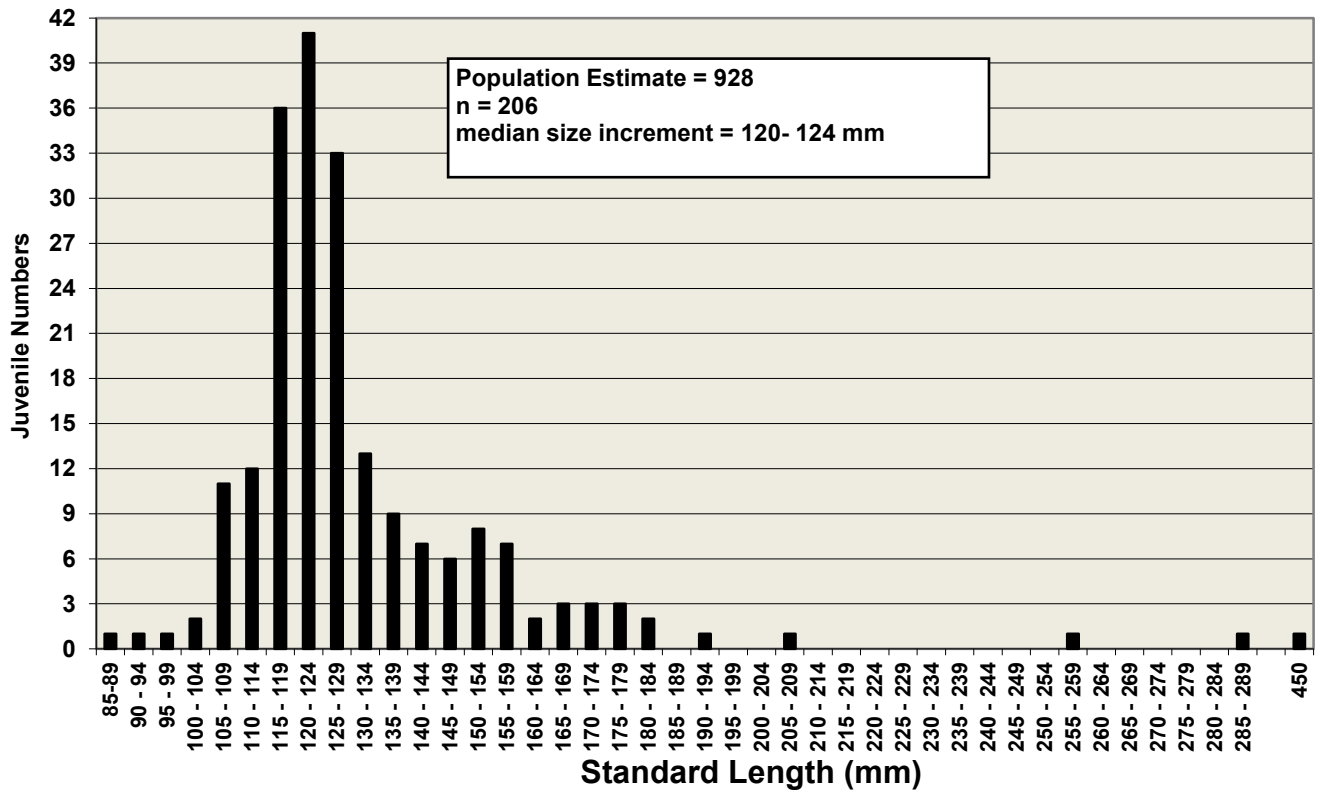


Figure 22. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 and 10 October 1999 in Soquel Lagoon.

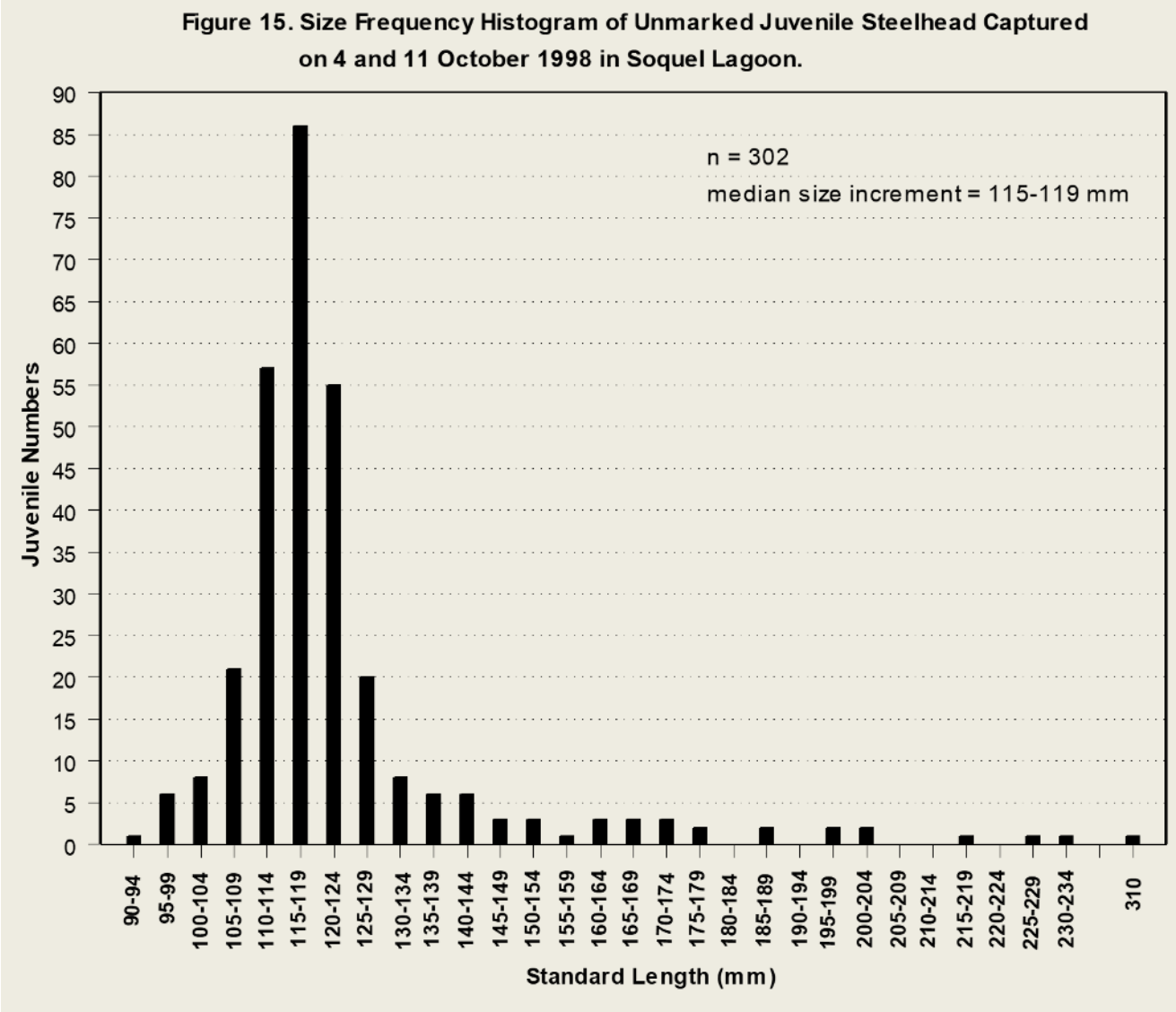


Figure 23. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 4 and 11 October 1998 in Soquel Lagoon.

Population Estimate = 671.

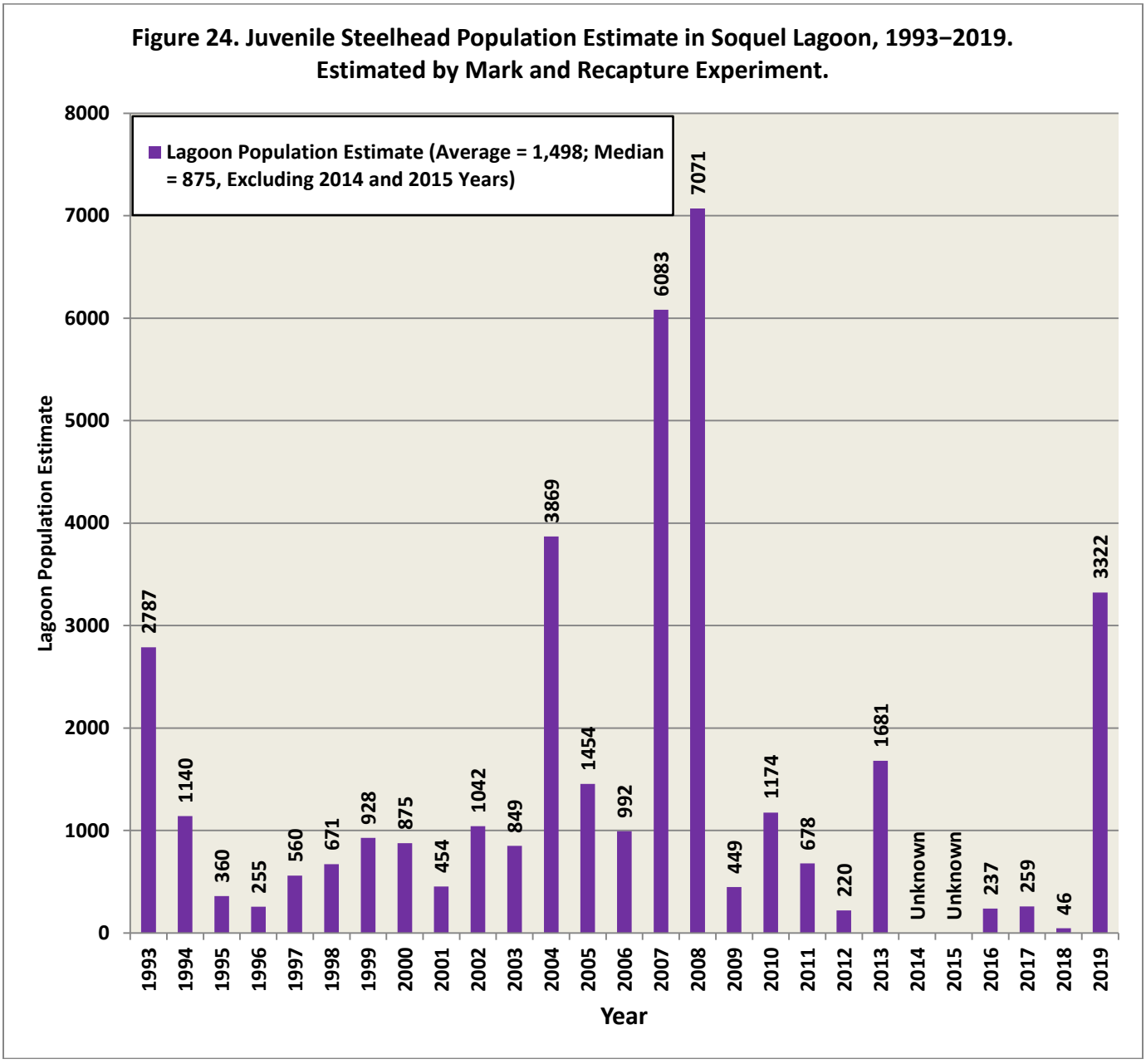


Figure 24. Steelhead Population Estimate in Soquel Lagoon, 1993−2019.

Figure 25. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2019.

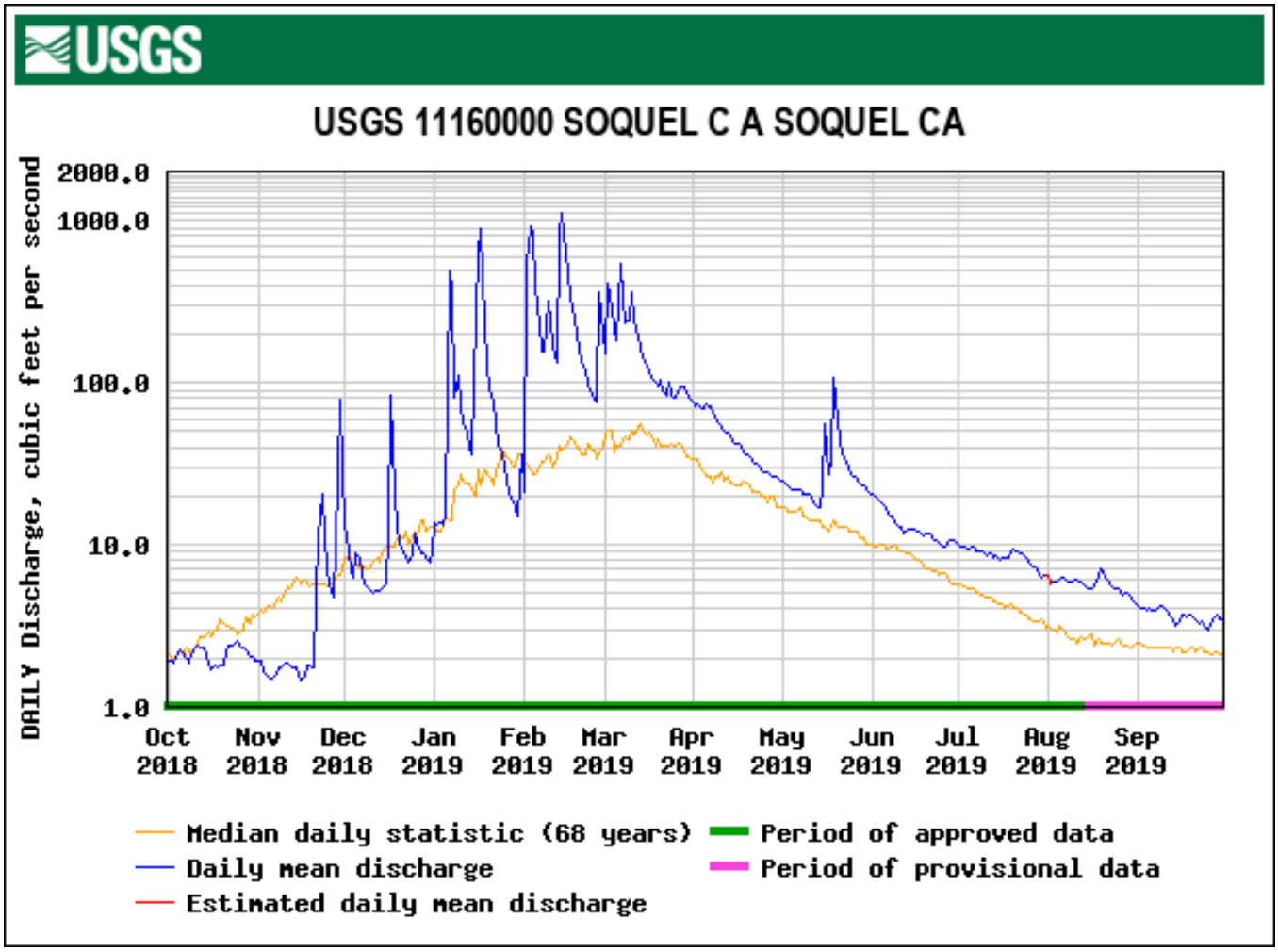


Figure 26. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2019.

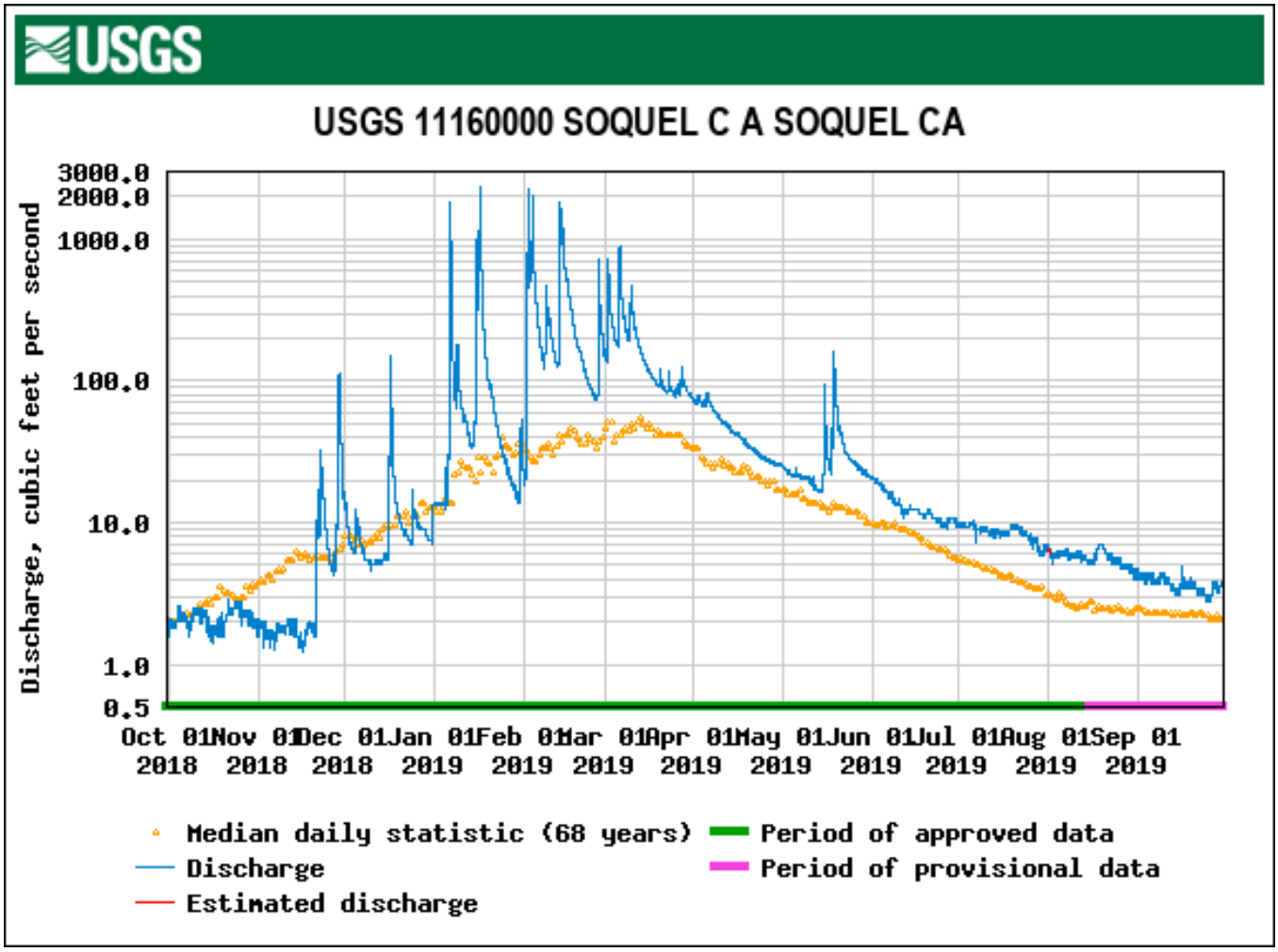


Figure 27. Soquel Creek Streamflow Hydrograph for the USGS Gage in Soquel, CA, 15 May – 9 December 2019.

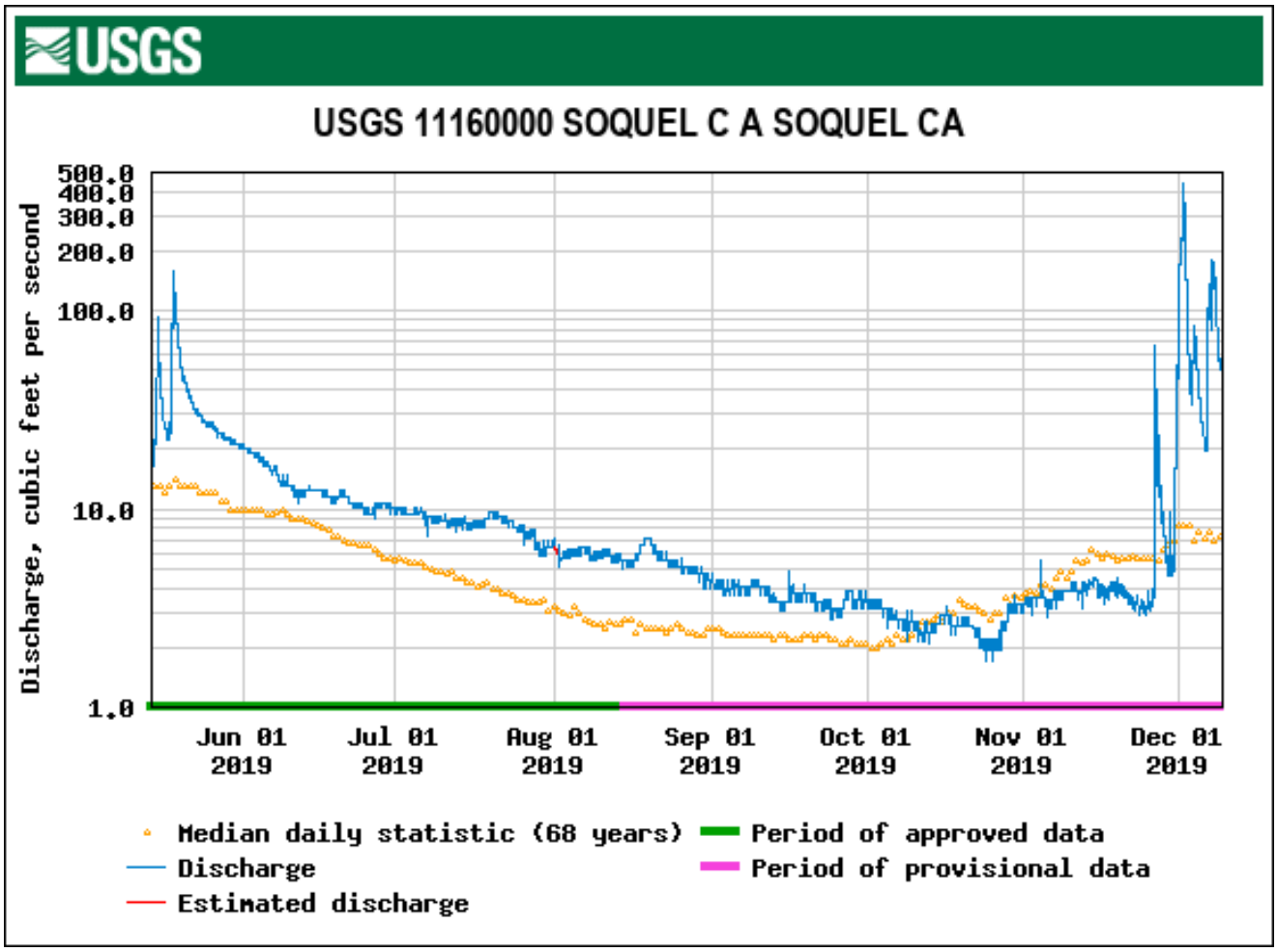


Figure 28. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2018.

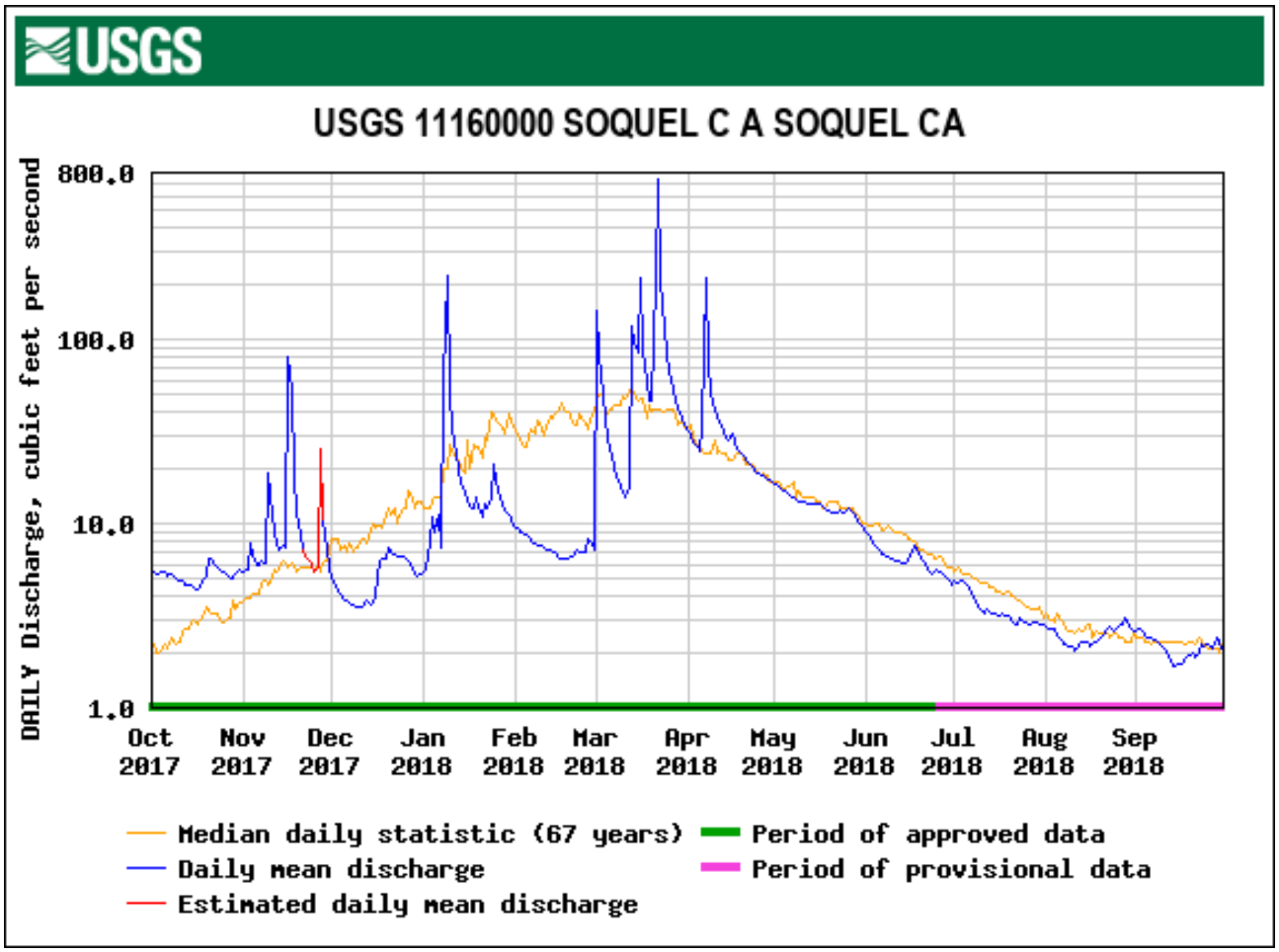


Figure 29. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2018.

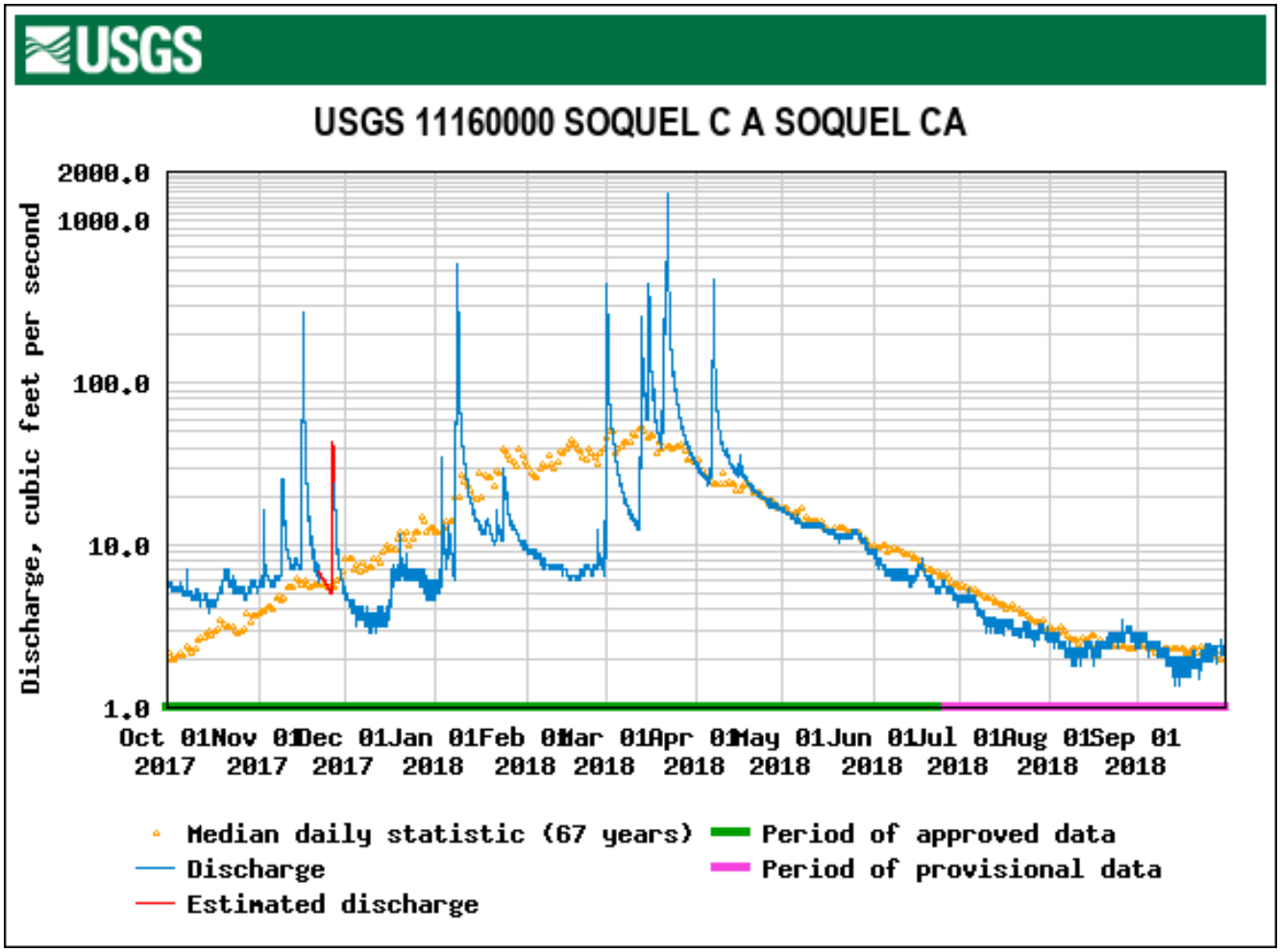


Figure 30. Soquel Creek Streamflow Hydrograph for the USGS Gage in Soquel, CA, 1 June 2017 – 1 December 2018.

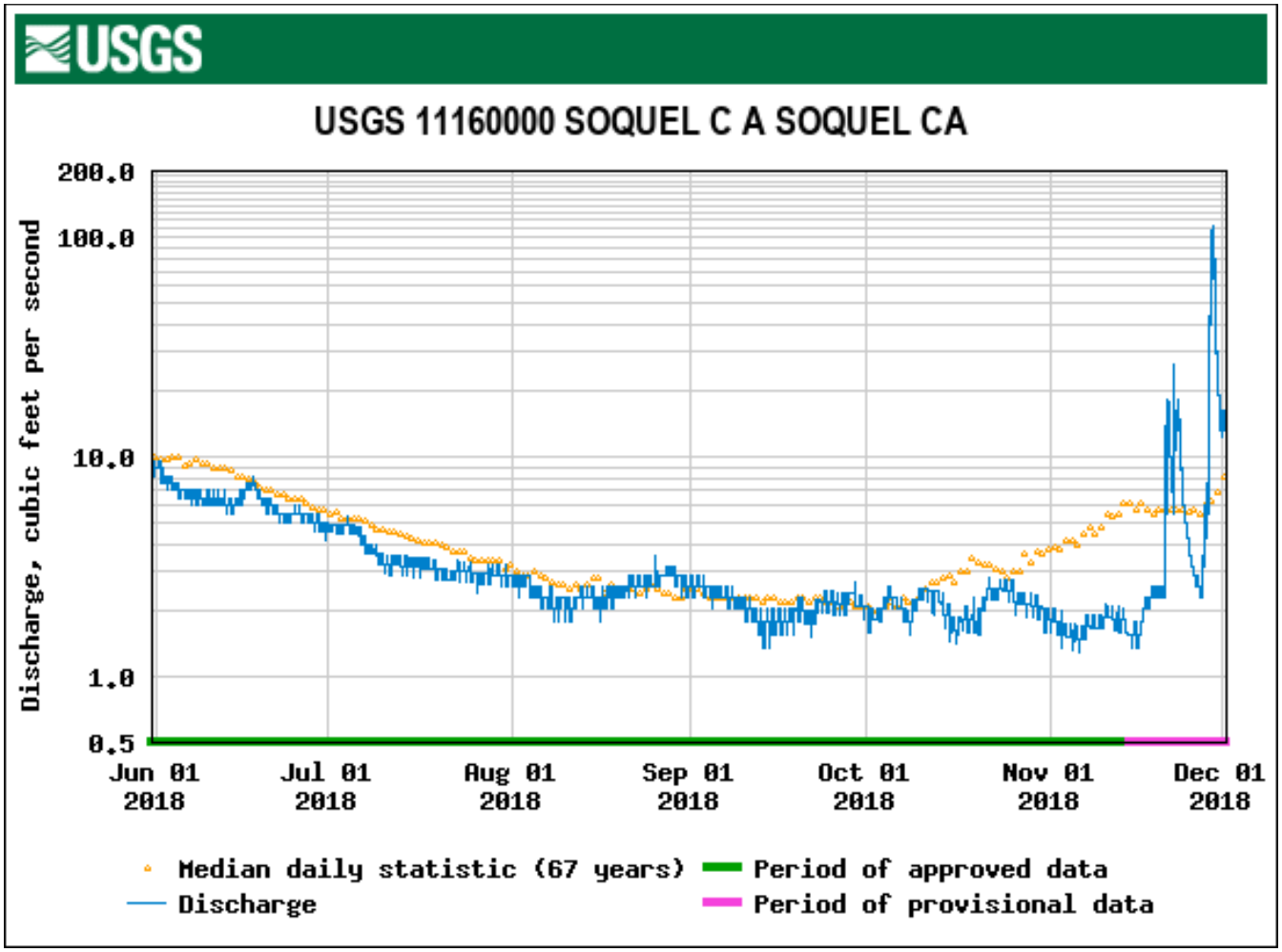


Figure 31 Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2017.

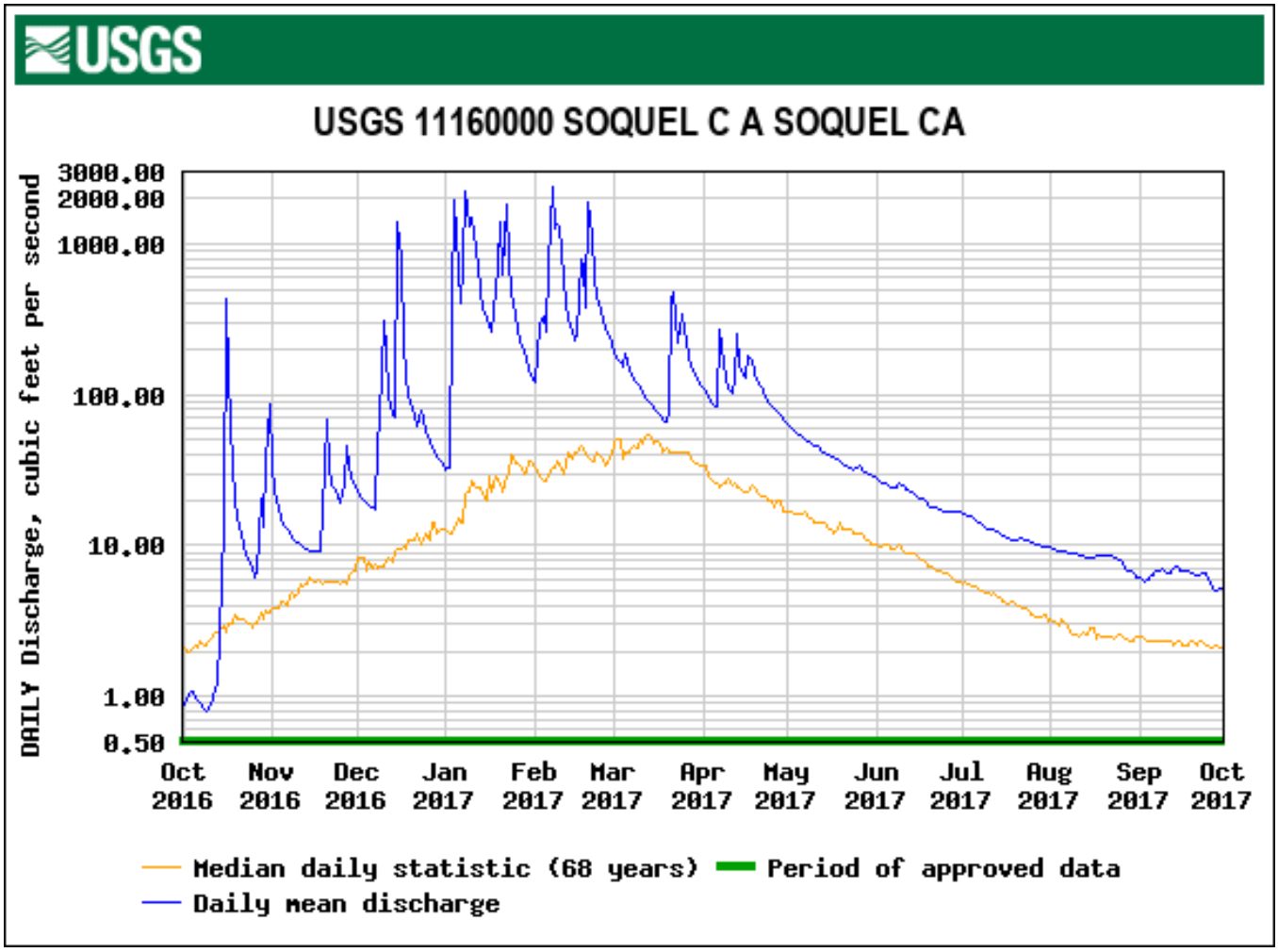


Figure 32. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2017.

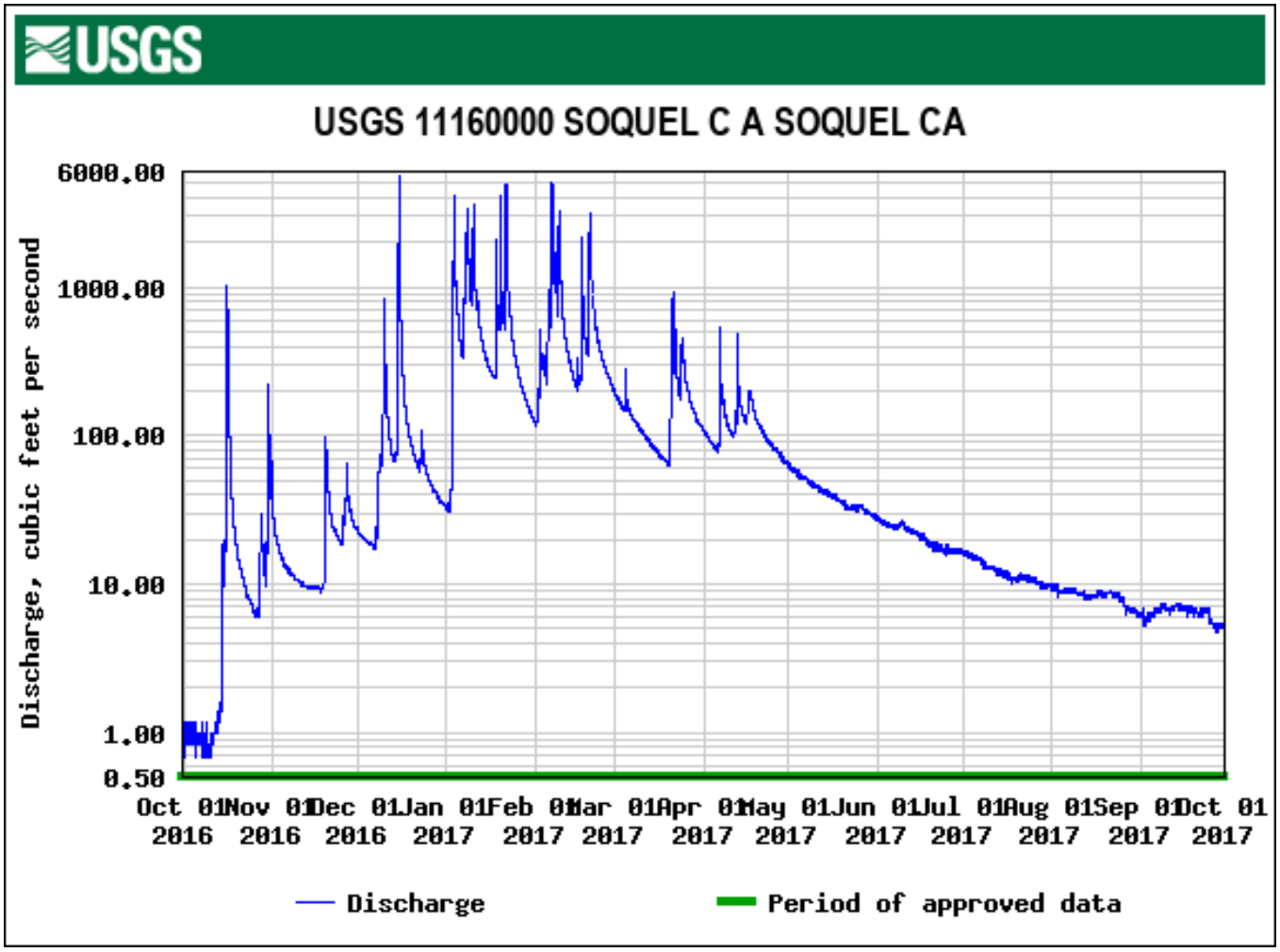


Figure 33. Soquel Creek Streamflow Hydrograph for the USGS Gage in Soquel, CA, 1 June 2017 – 20 November 2017.

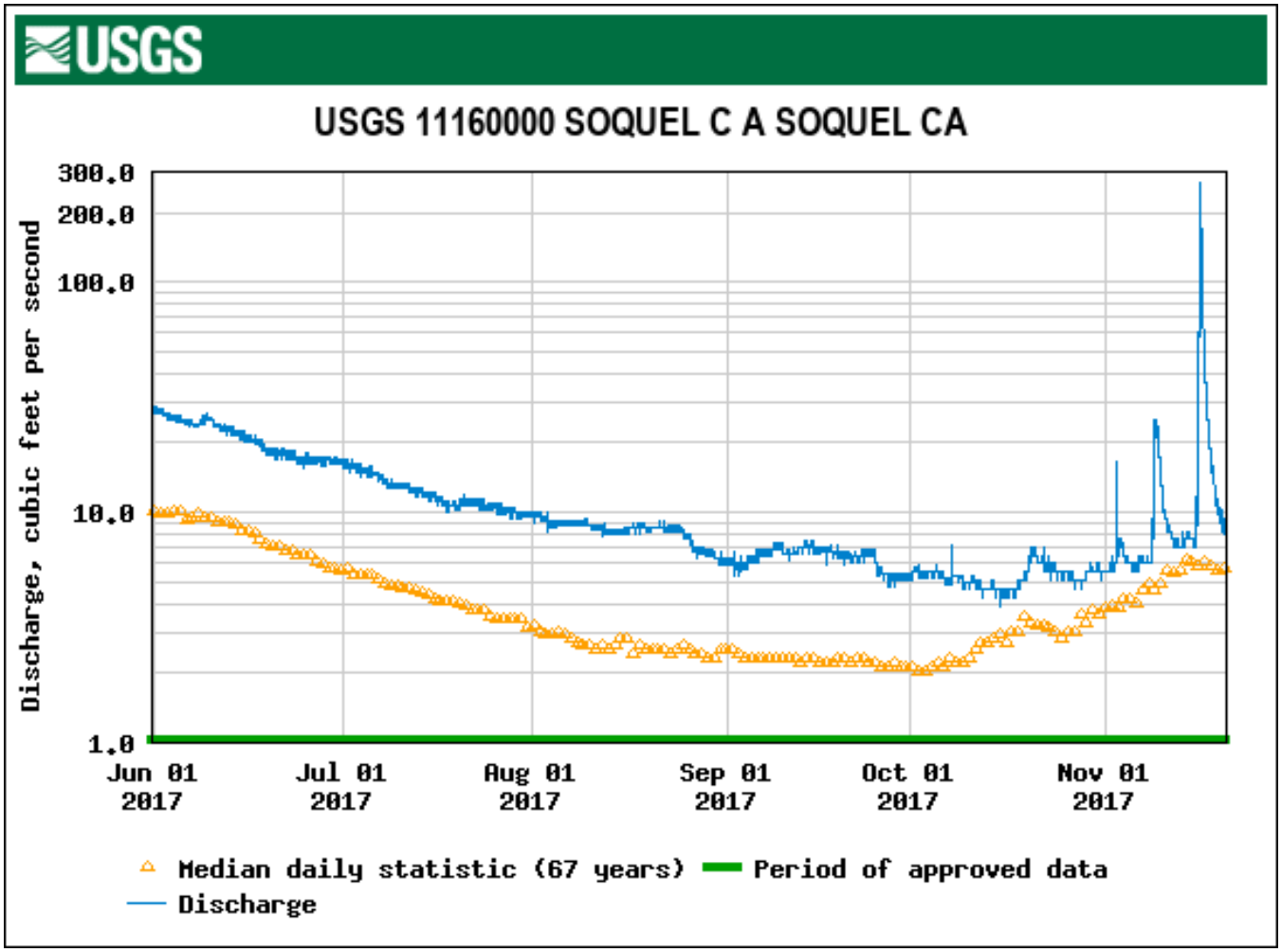


Figure 34. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2016

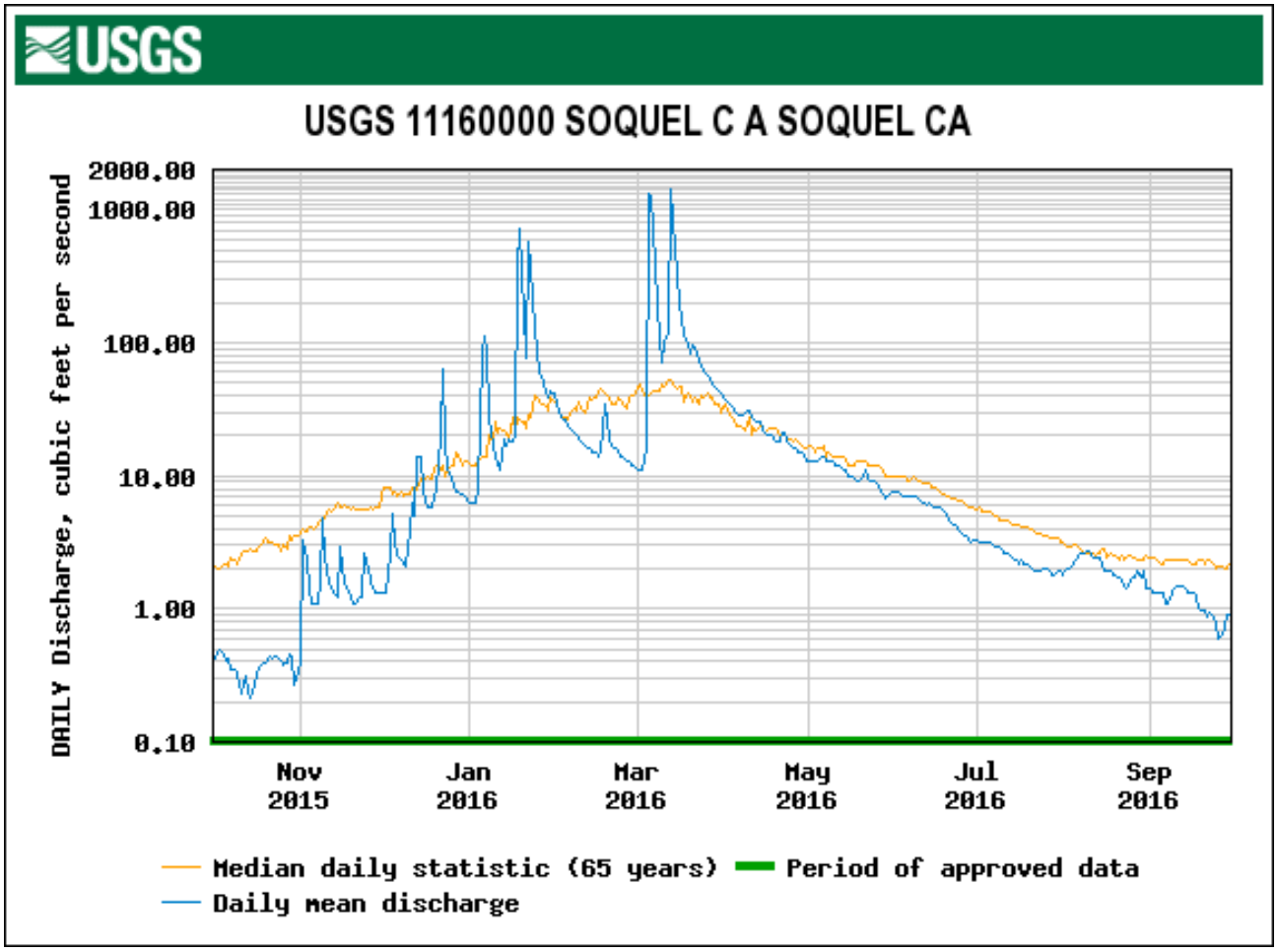


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Figure 35. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2016.

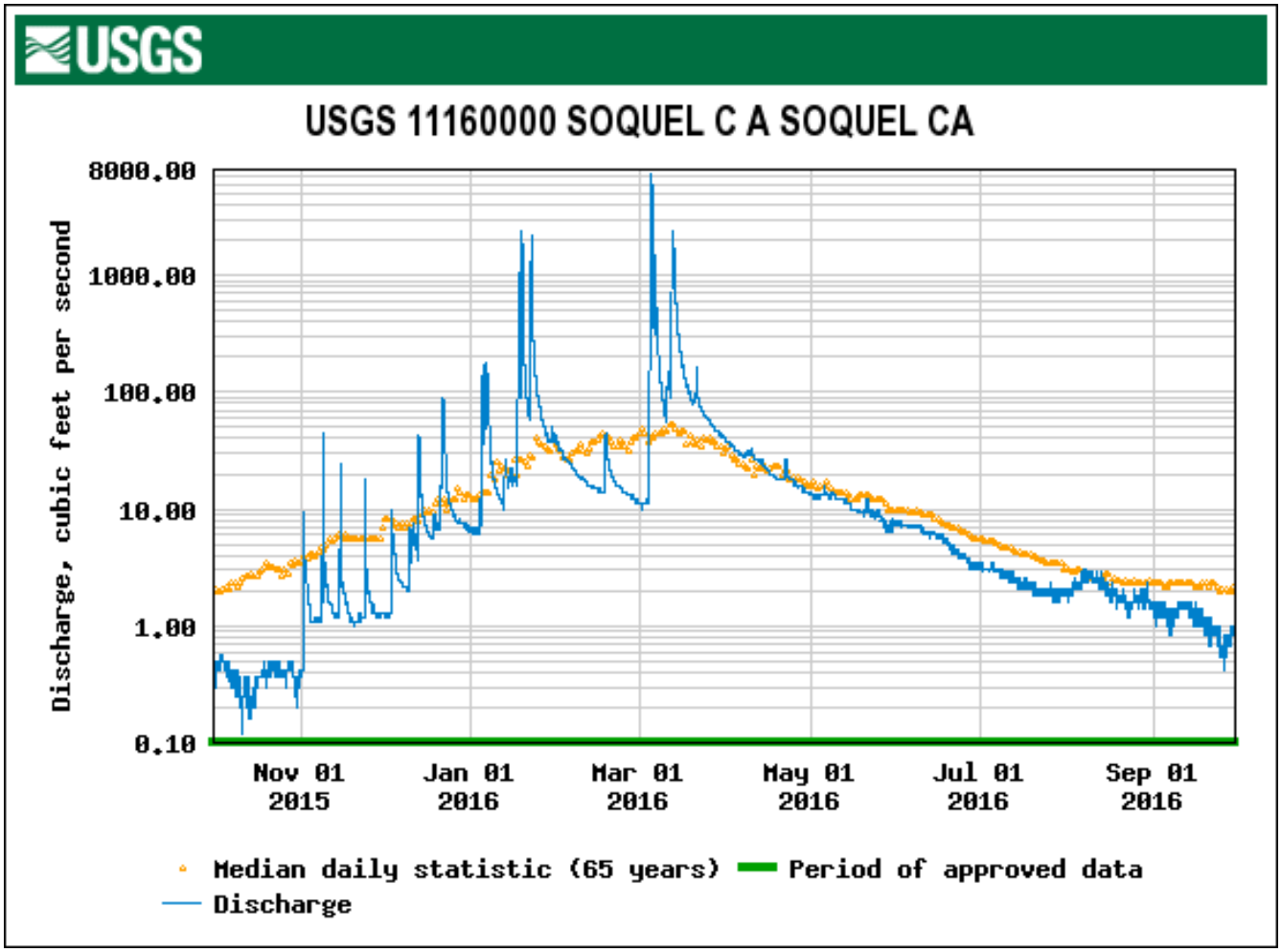


Figure 36. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 15 May 2016 – 11 October 2016.

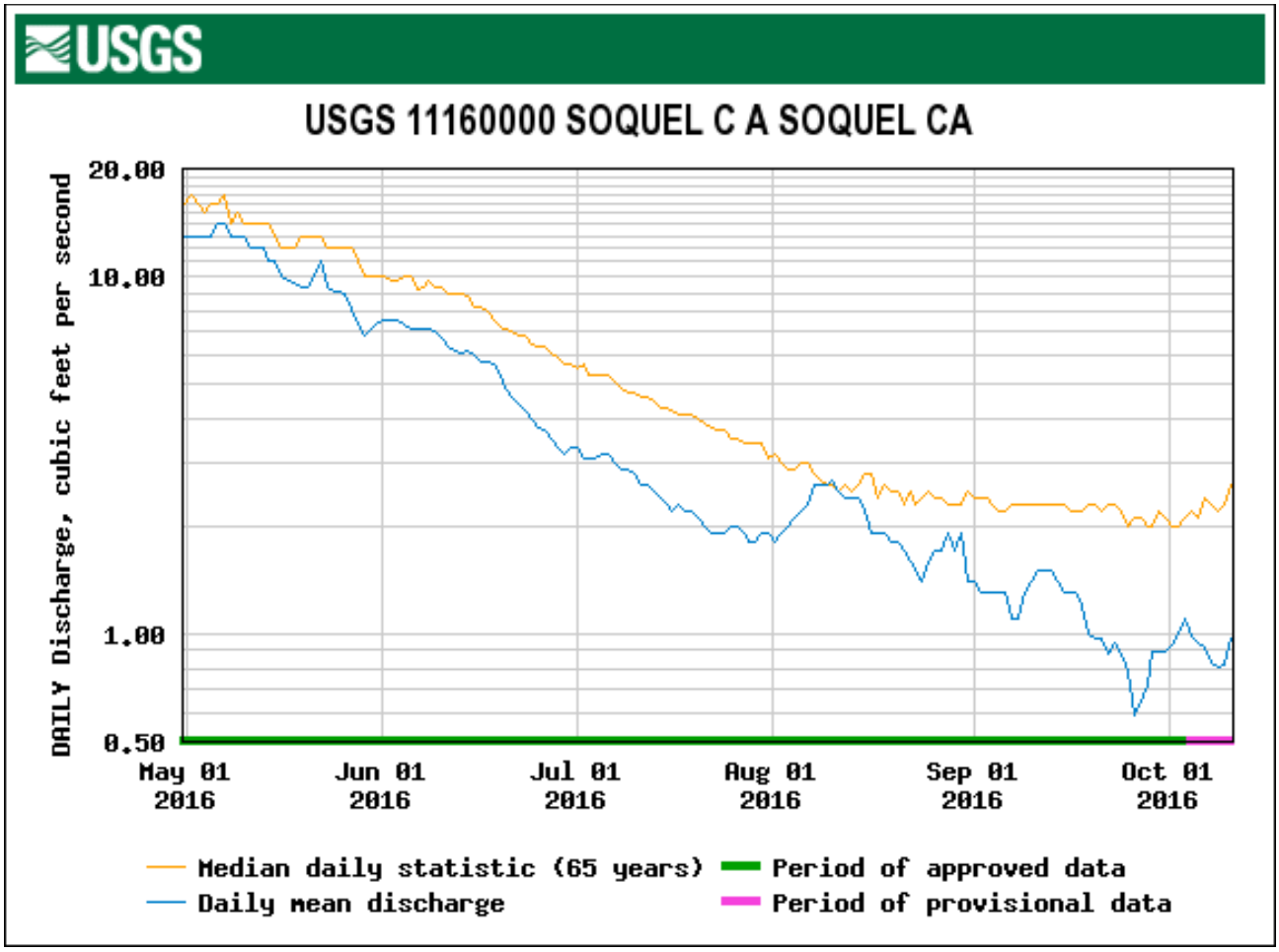


Figure 37. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2015.

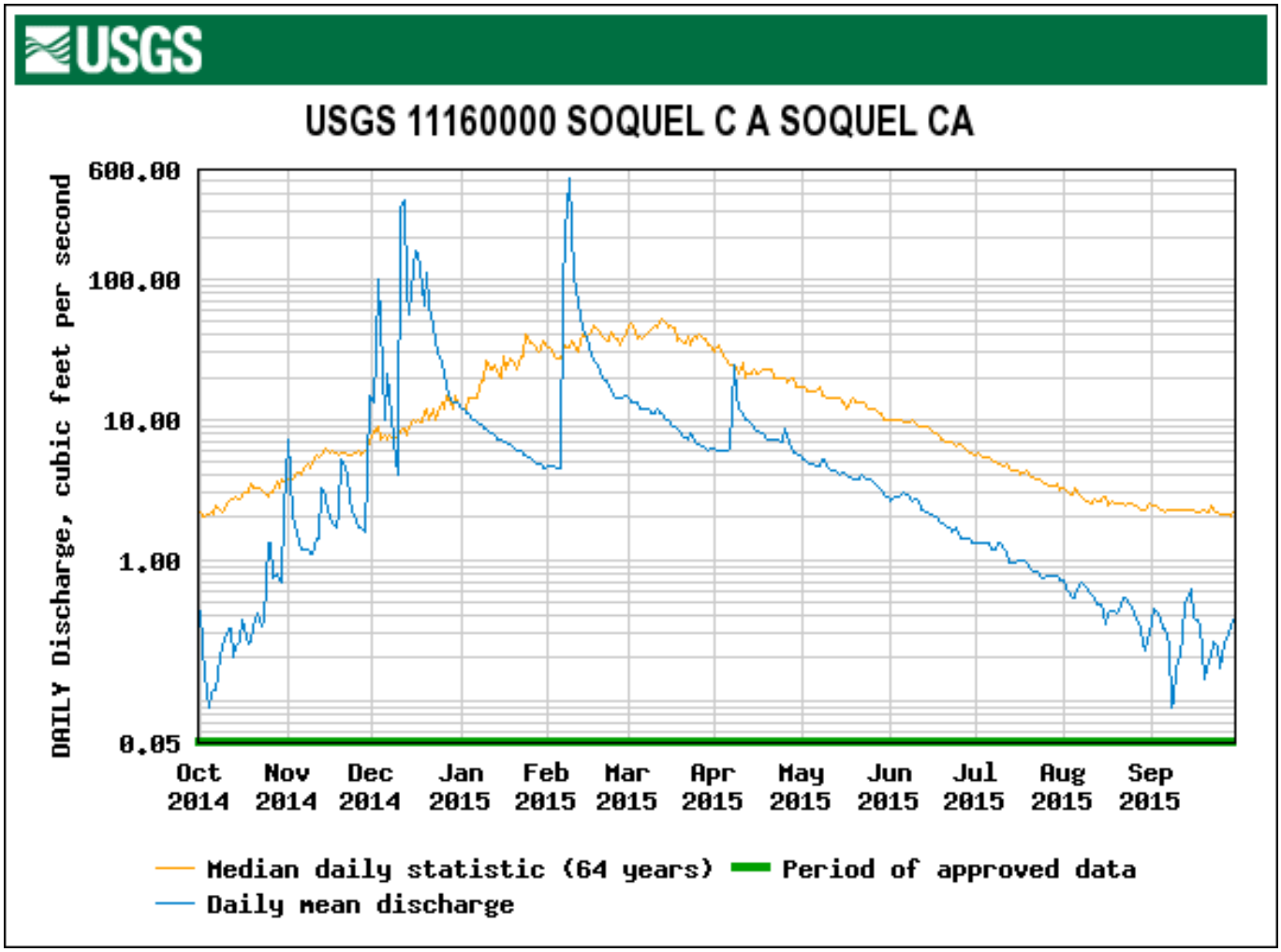


Figure 38. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2015.

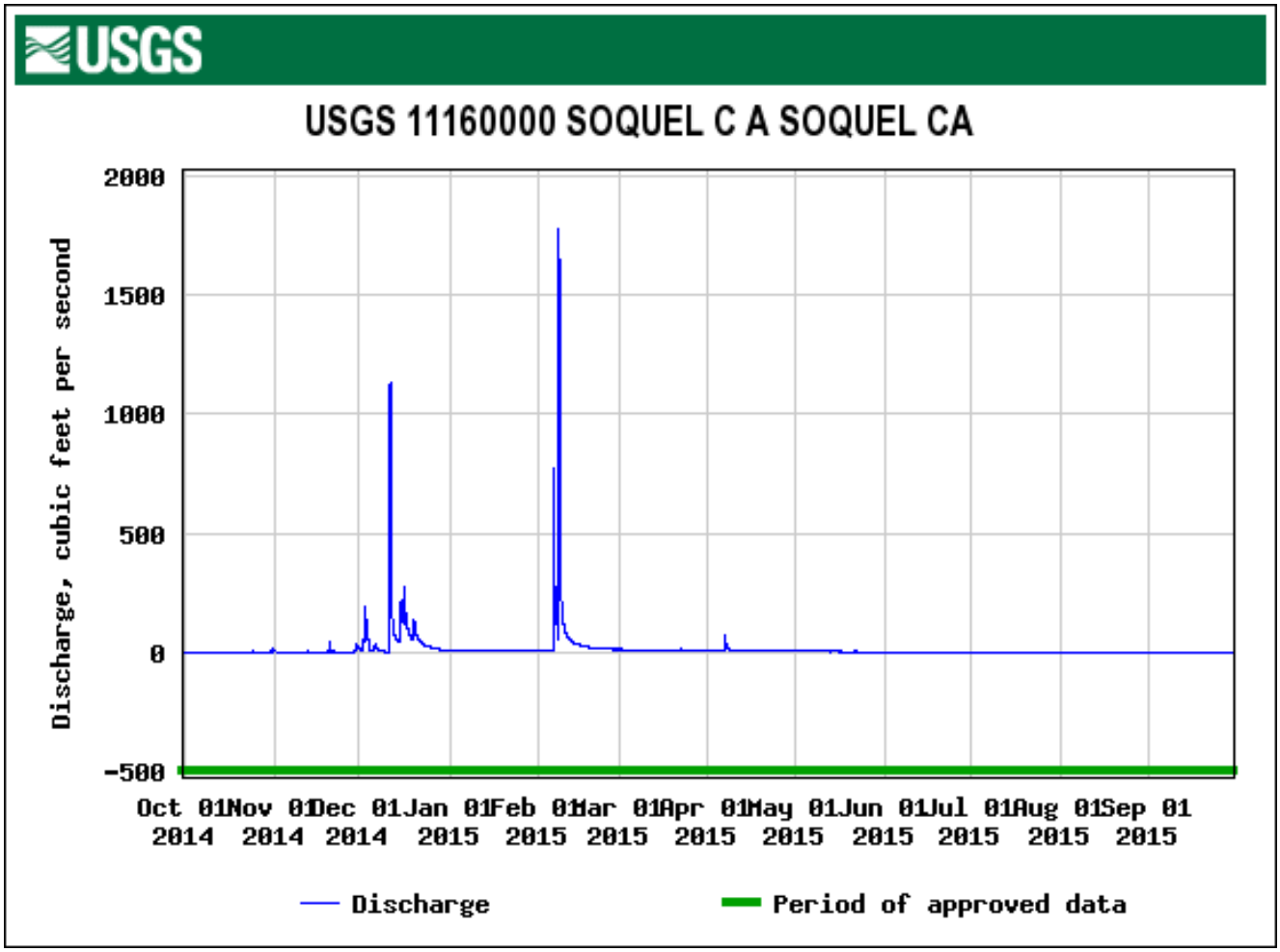


Figure 39. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 15 May 2015 – 15 November 2015.

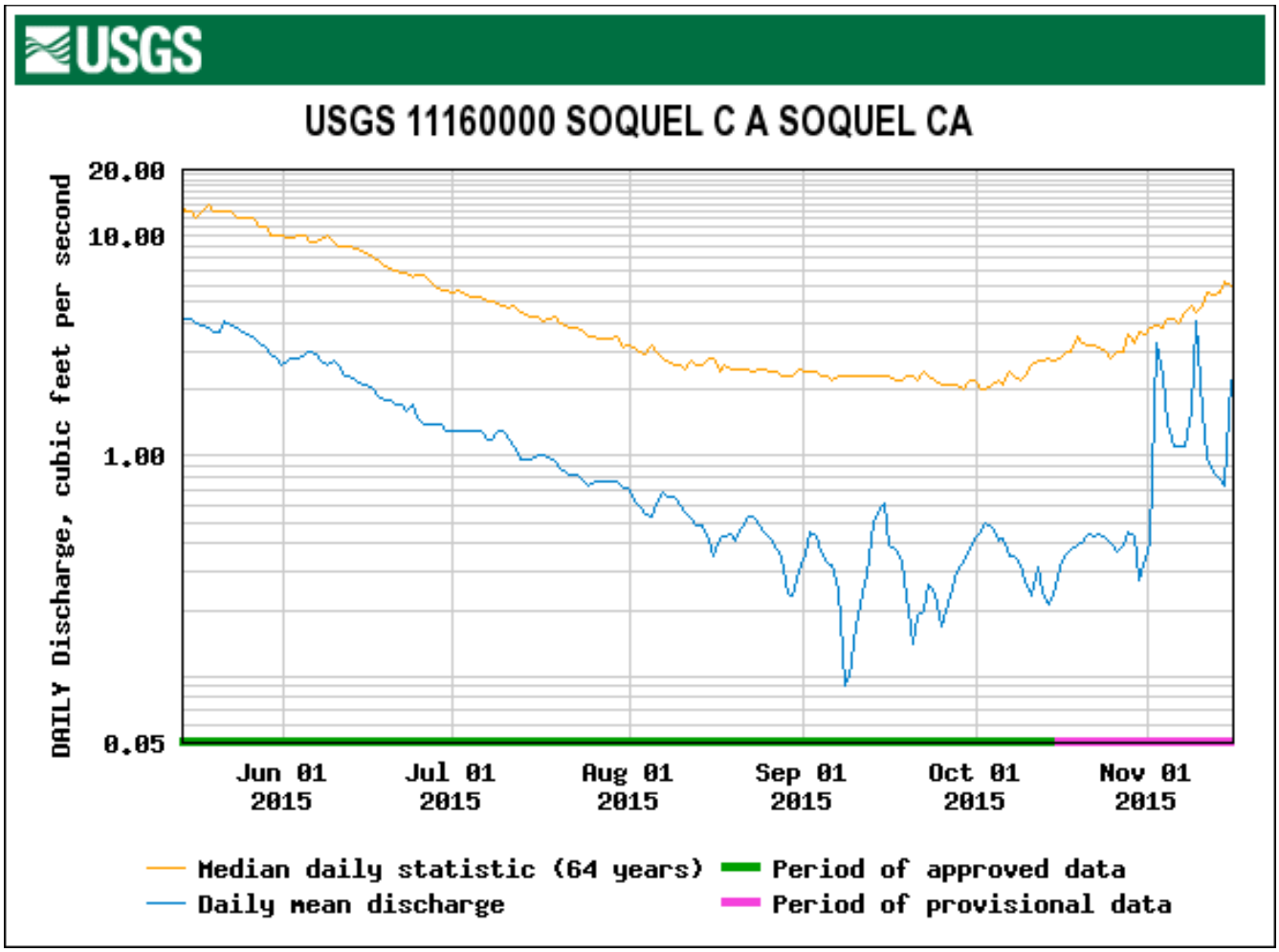


Figure 40. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2014.

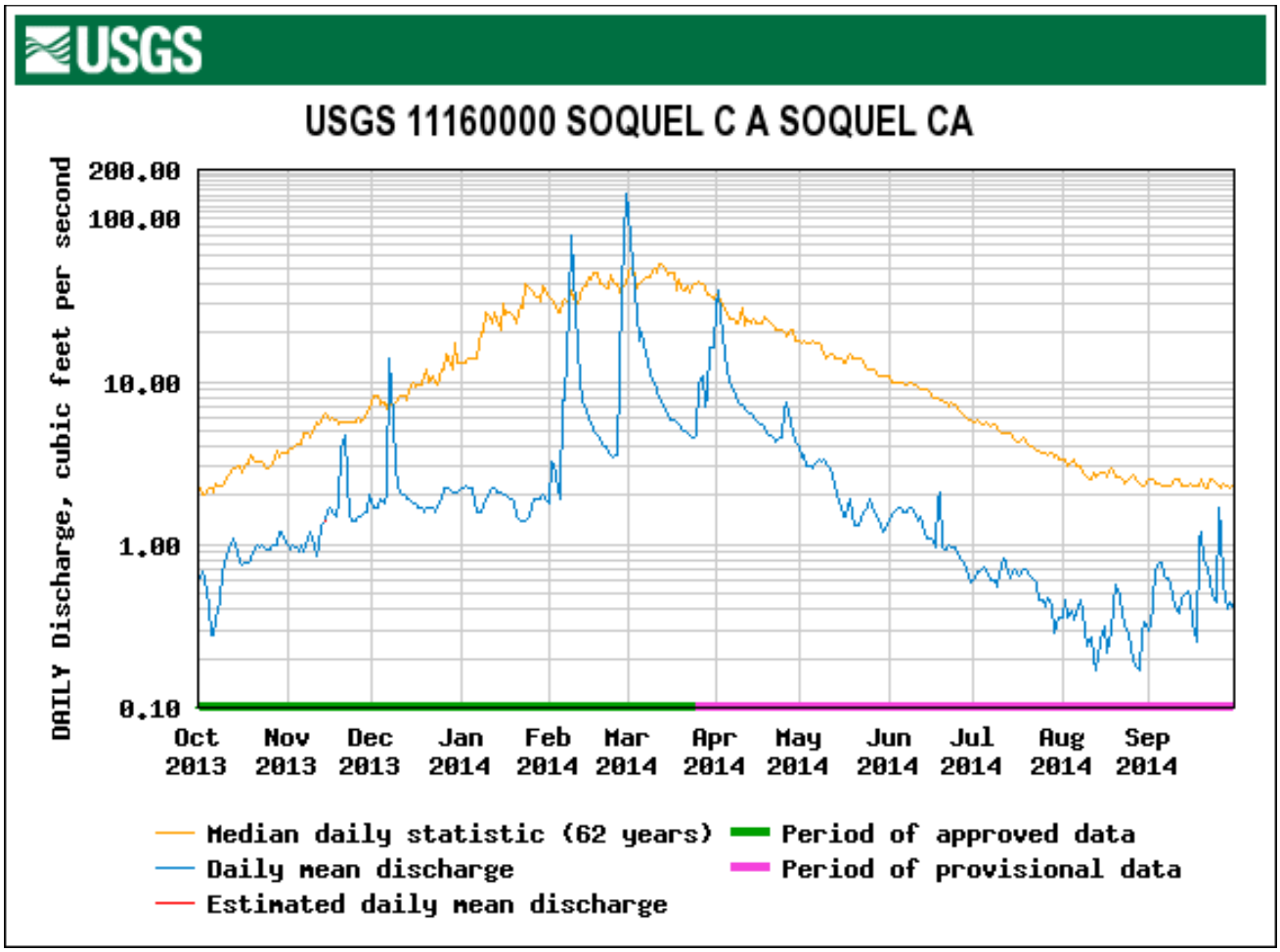


Figure 41. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2014.

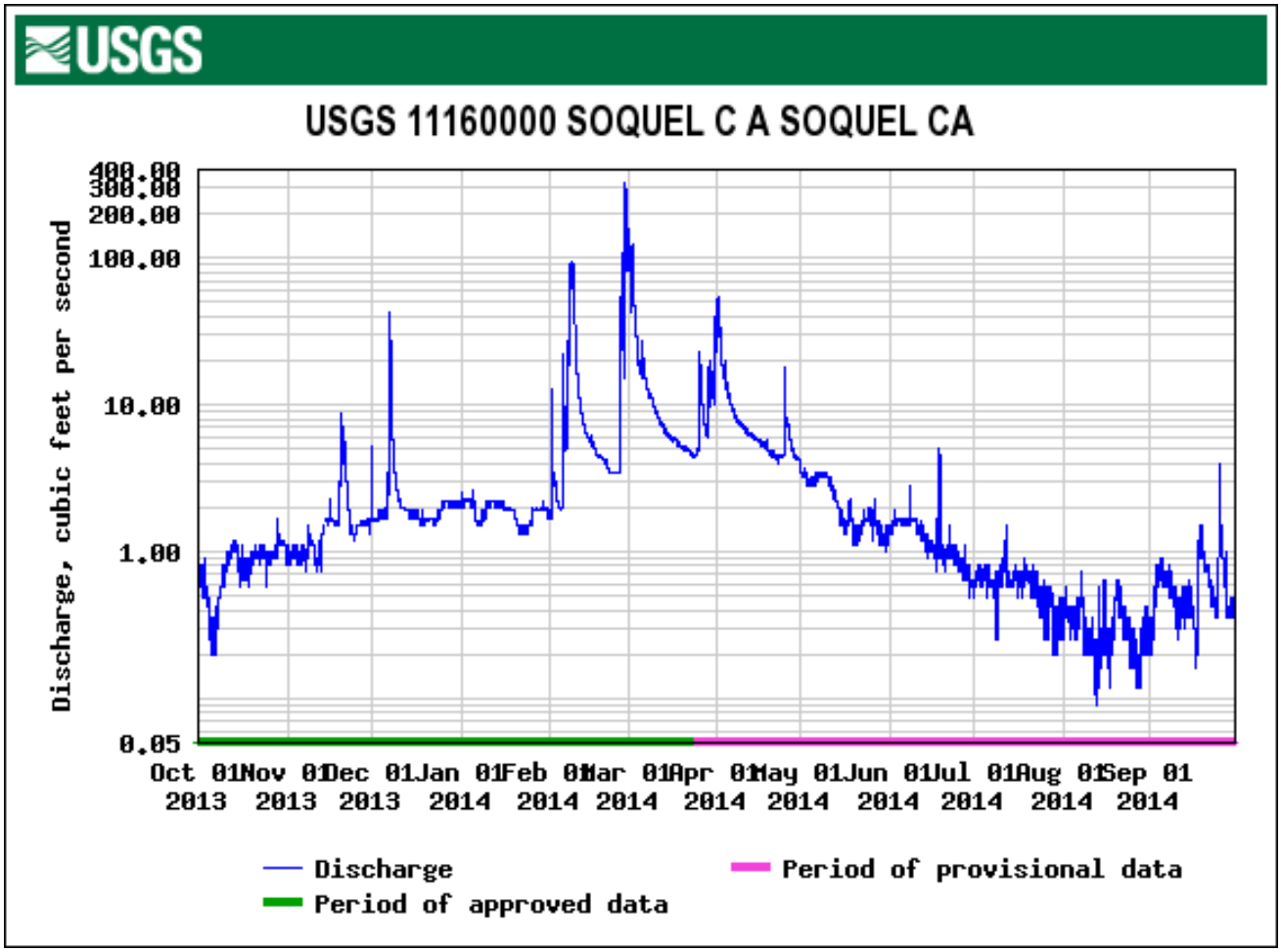


Figure 42. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2013.

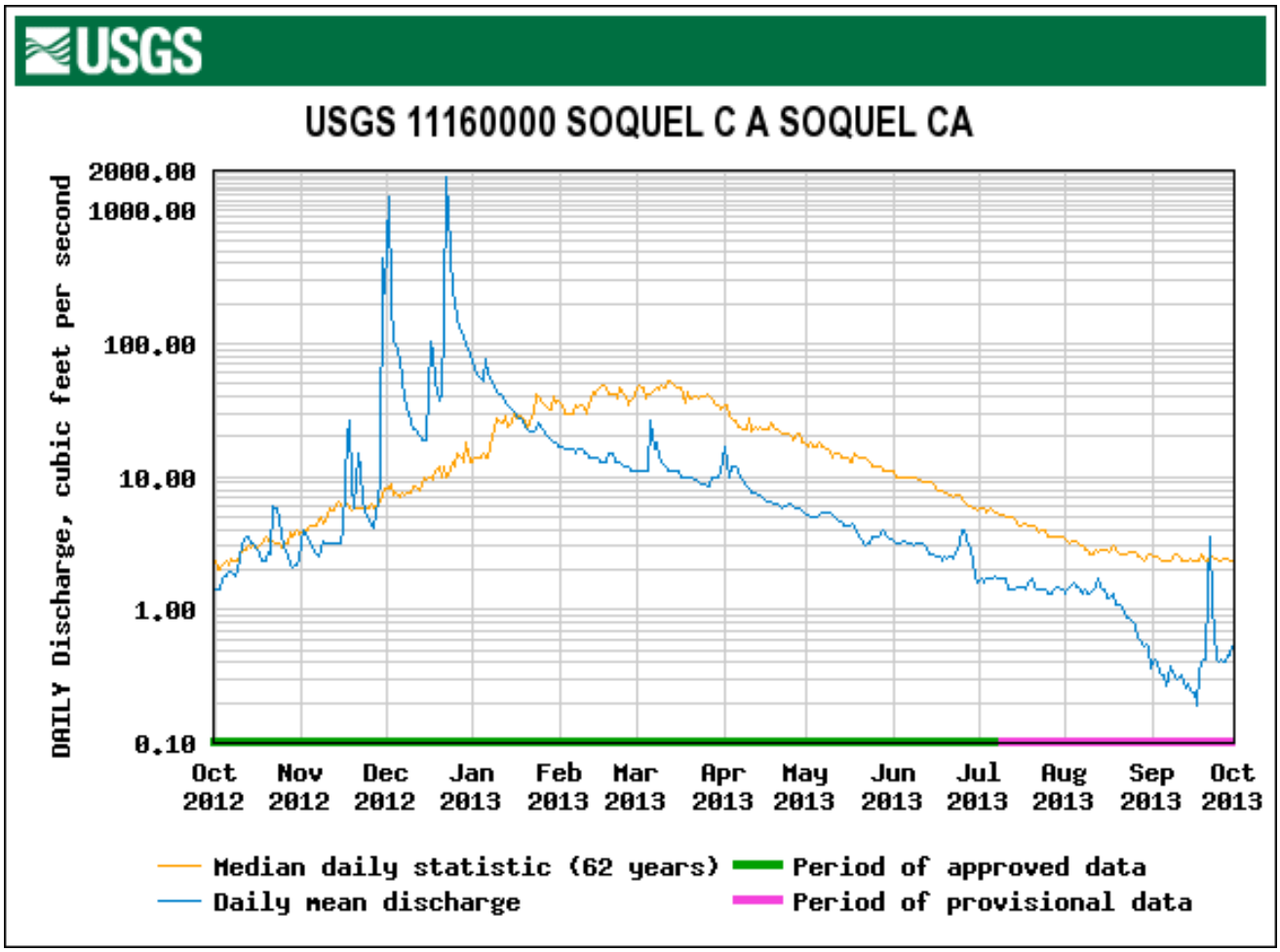


Figure 43. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, October 2012 – May 2013.

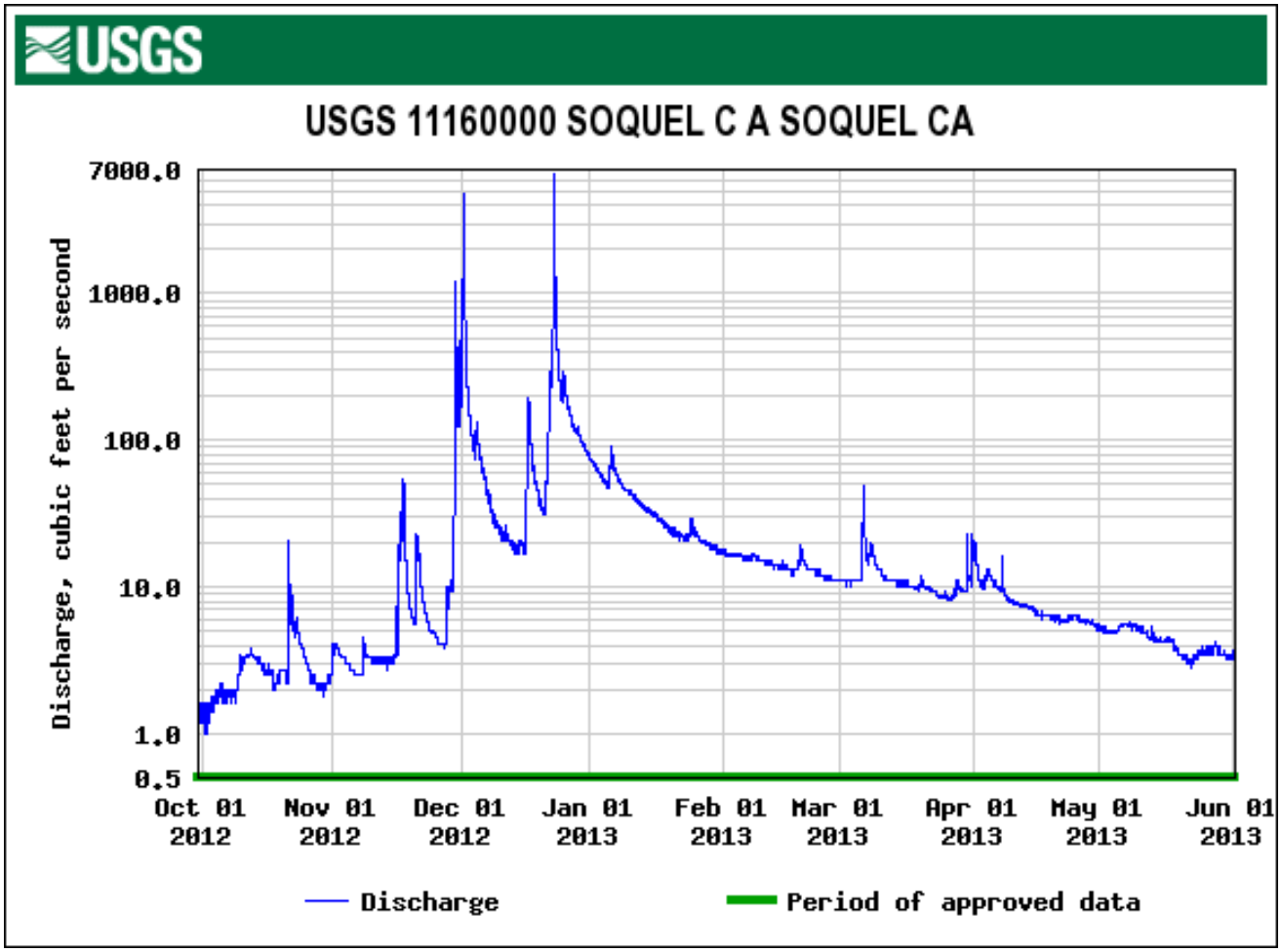


Figure 44. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2012.

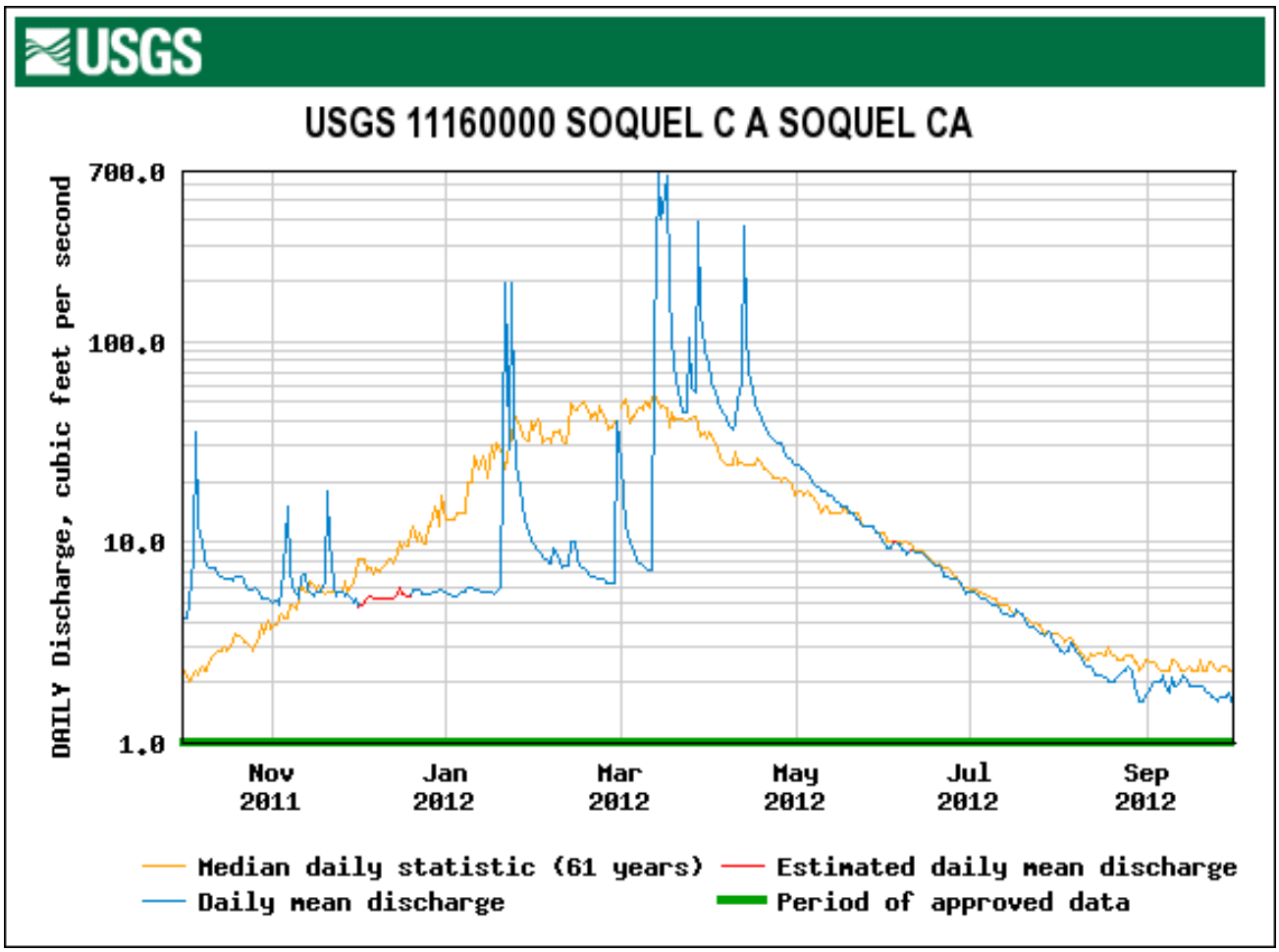


Figure 45. Soquel Creek Actual Measured Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2012.

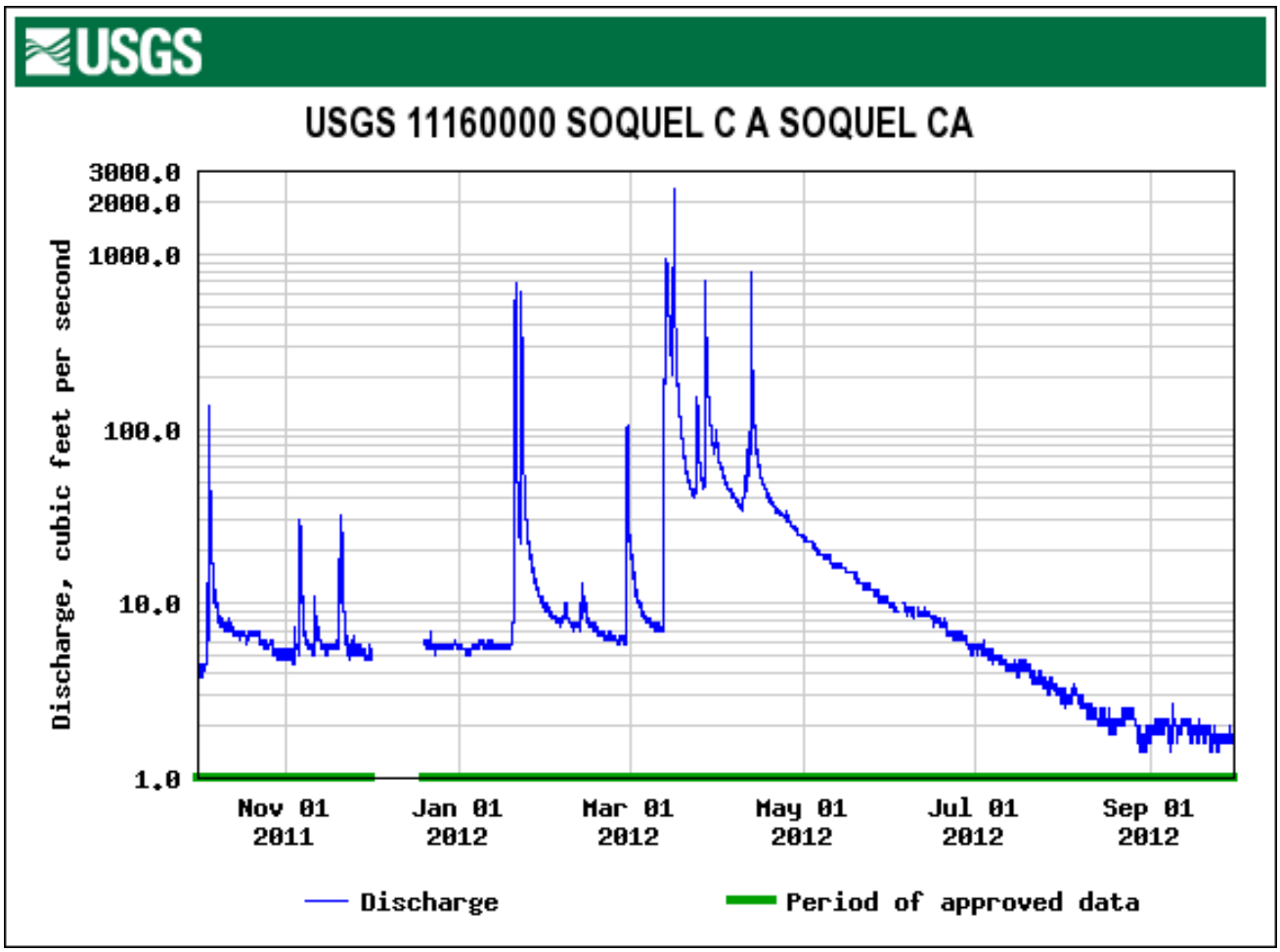


Figure 46. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2011.

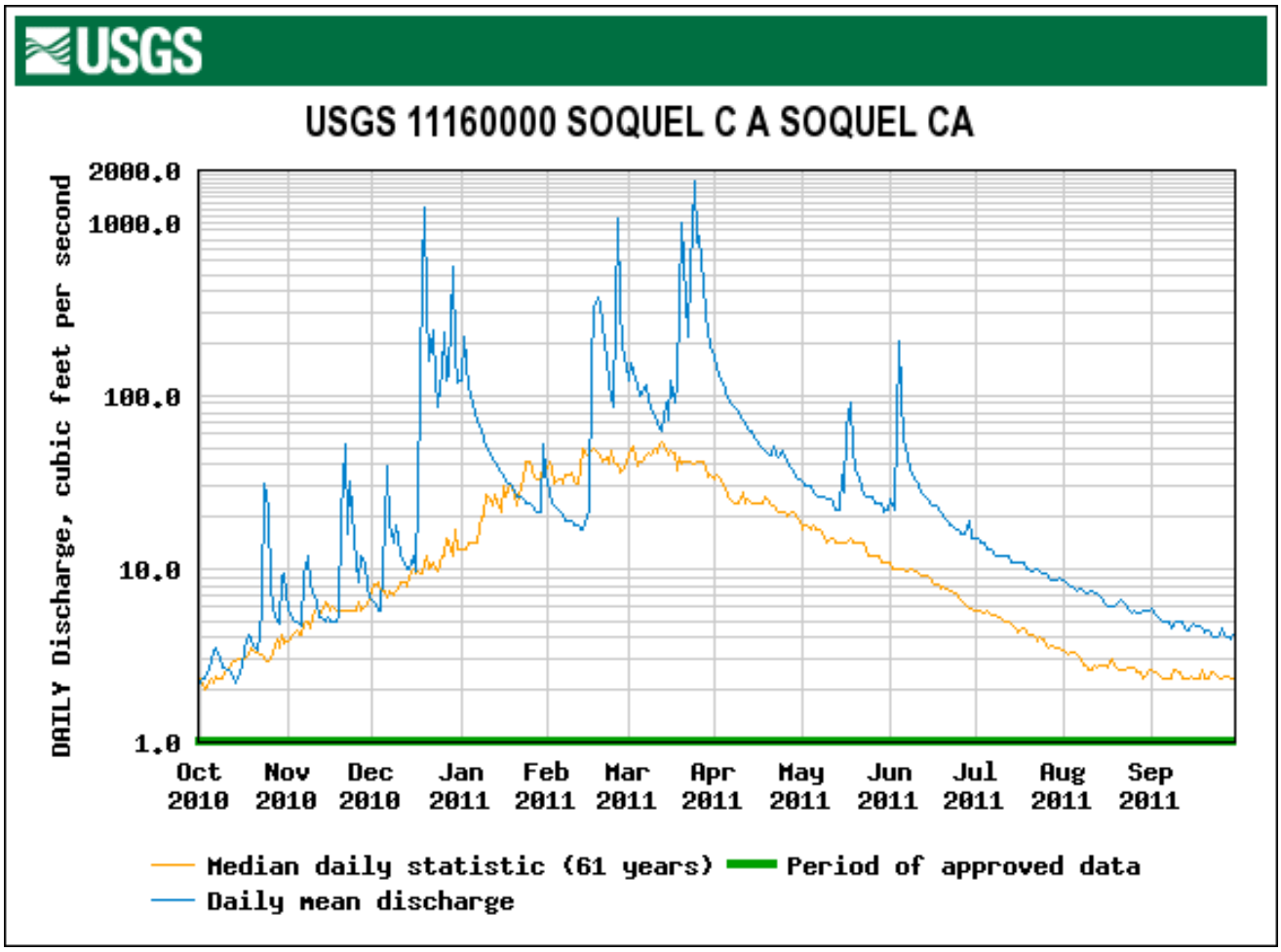


Figure 47. Soquel Creek Actual Measured Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2011.

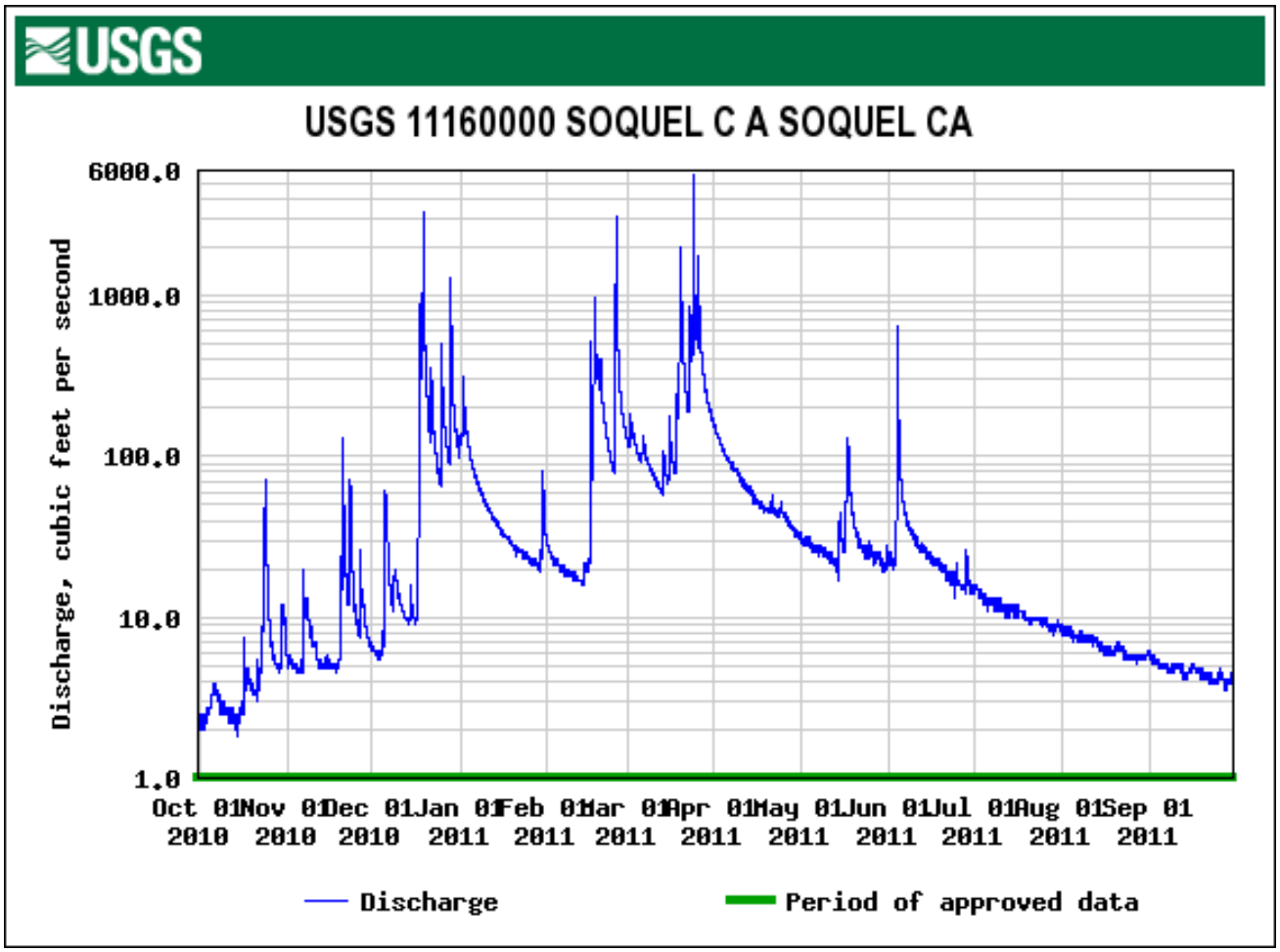


Figure 48. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2010.

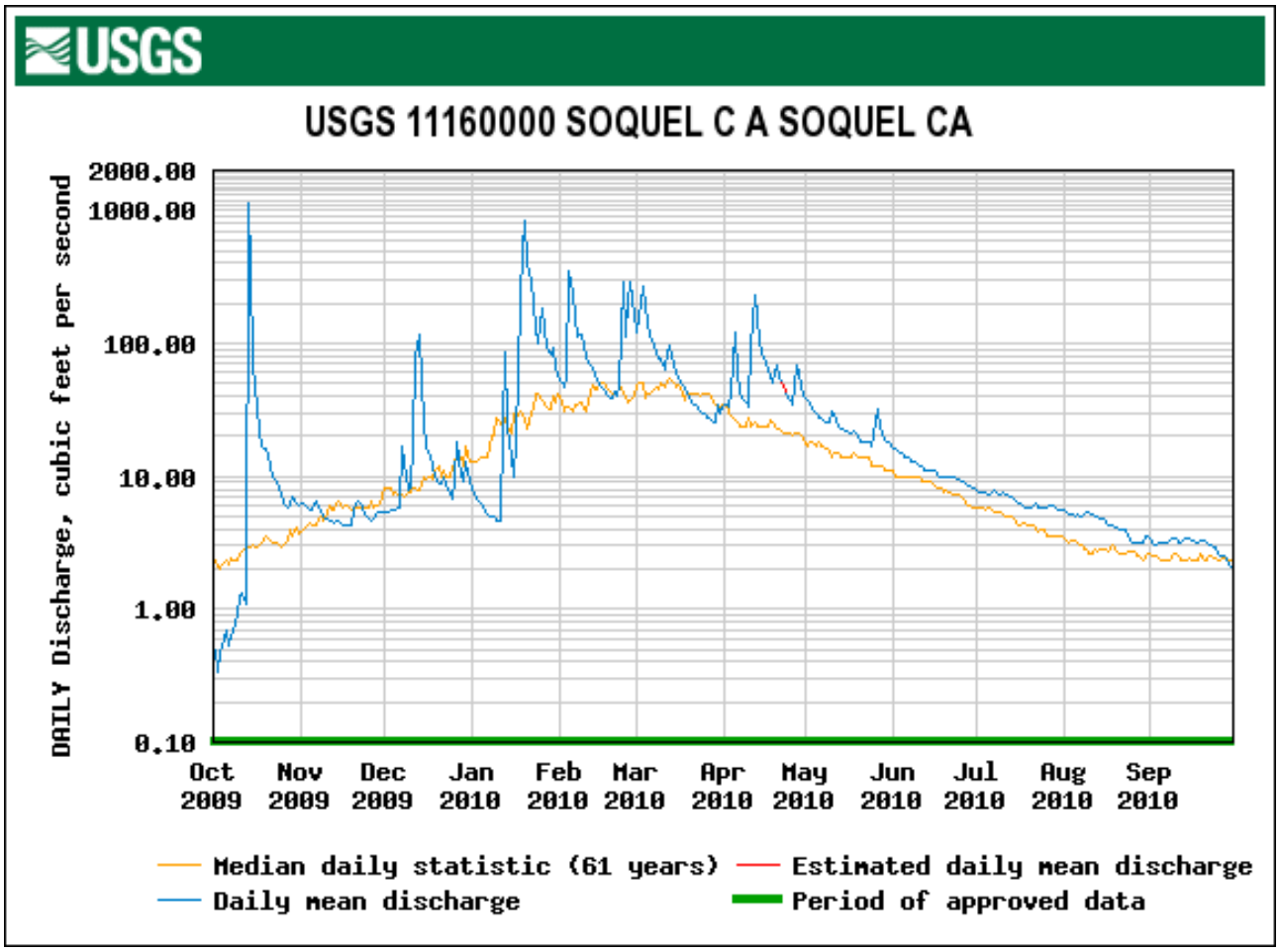


Figure 49. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2009.

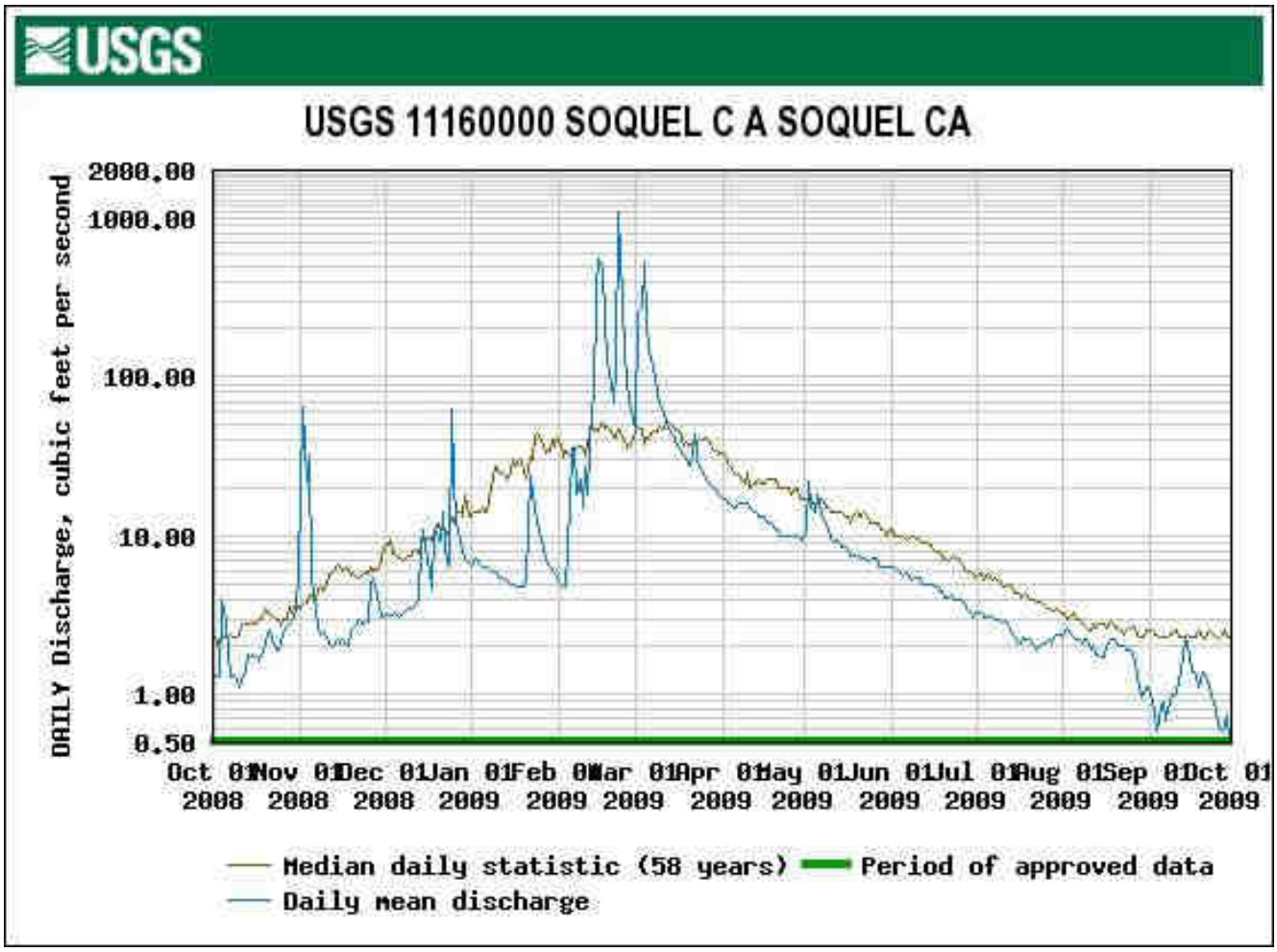


Figure 50. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2008.

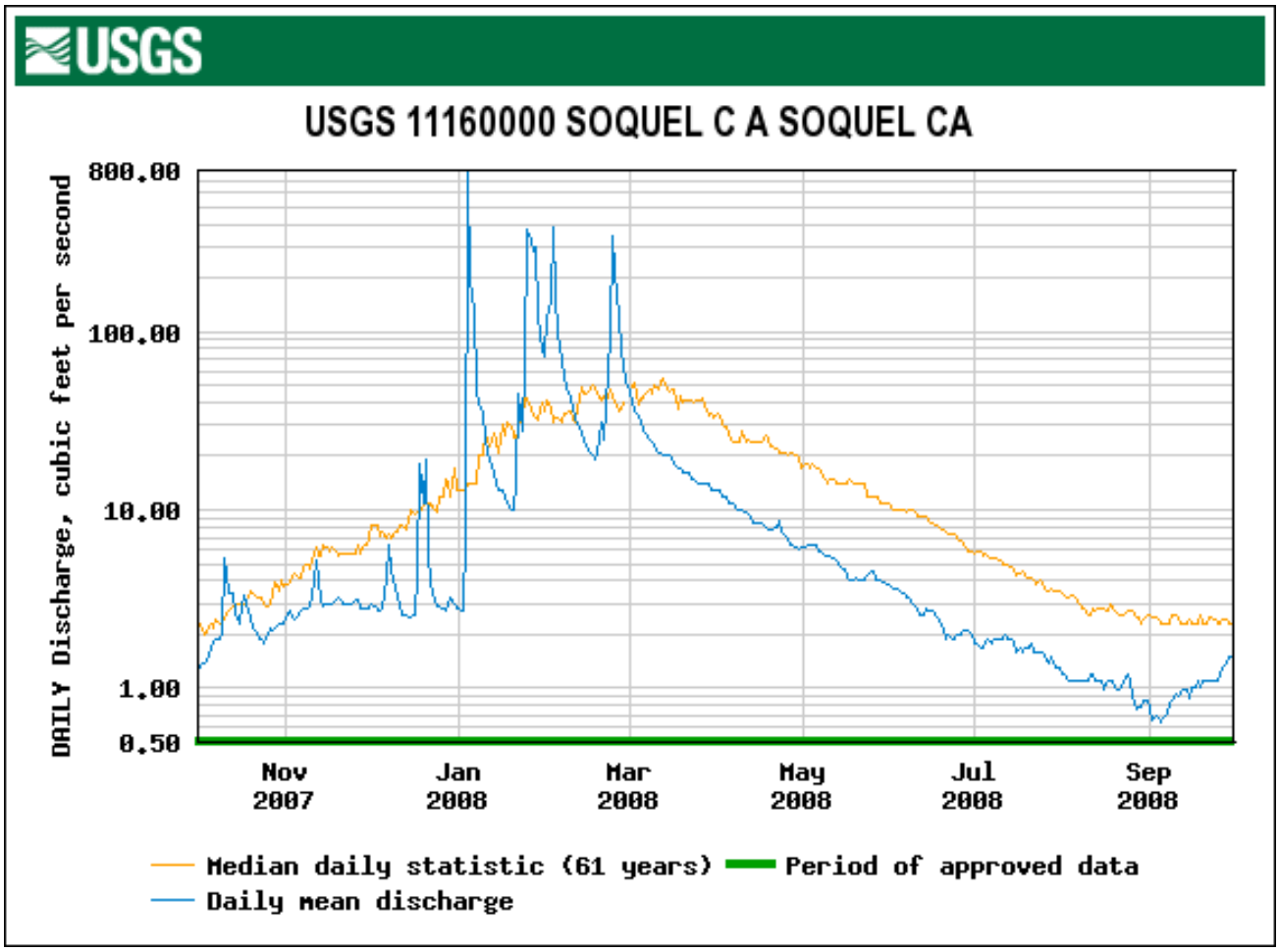


Figure 51. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2007.

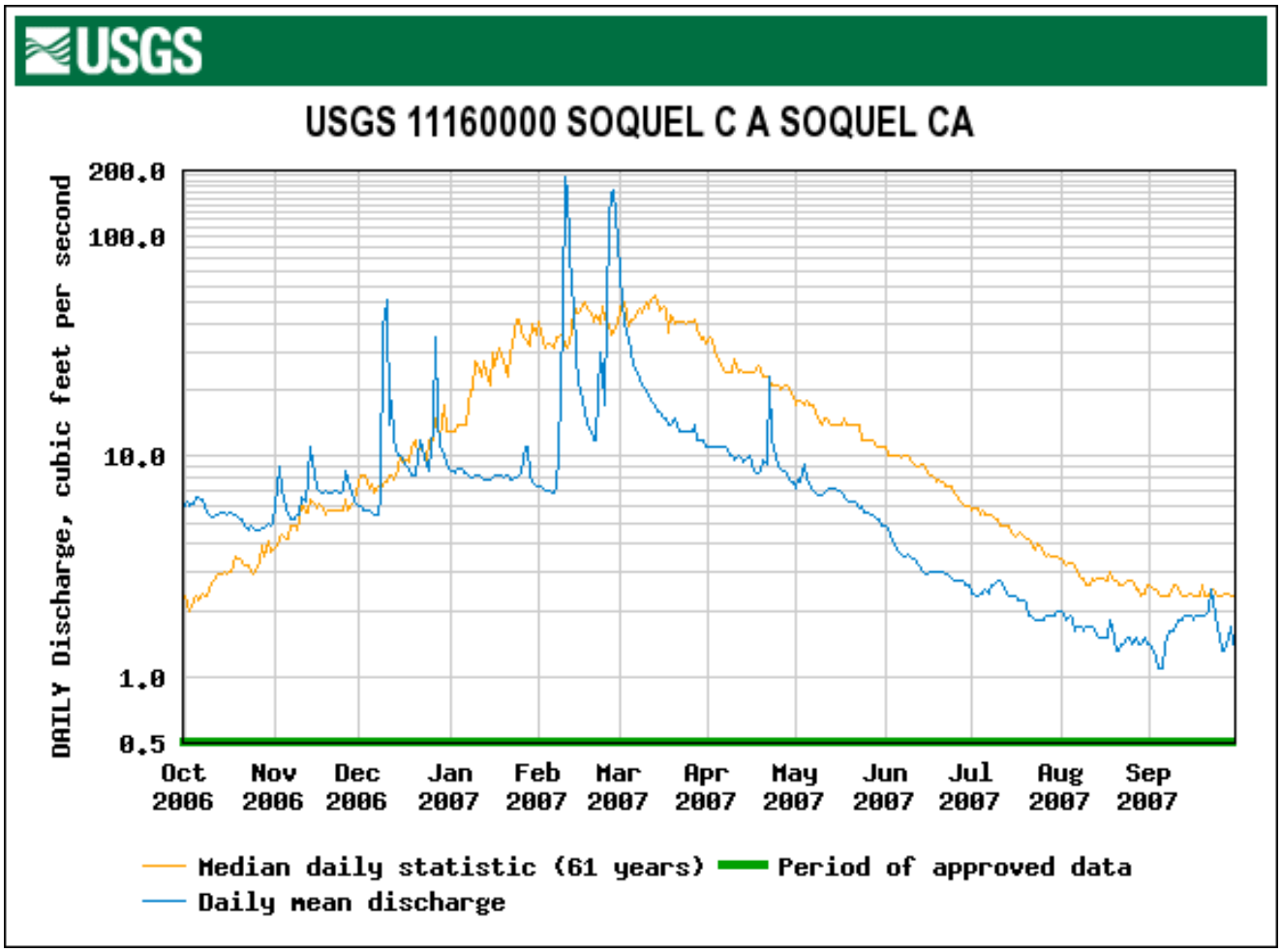


Figure 52. Maximum Visual Gull Counts on Days of Water Quality Monitoring with a Closed Sandbar at Soquel Lagoon, 2014–2019.

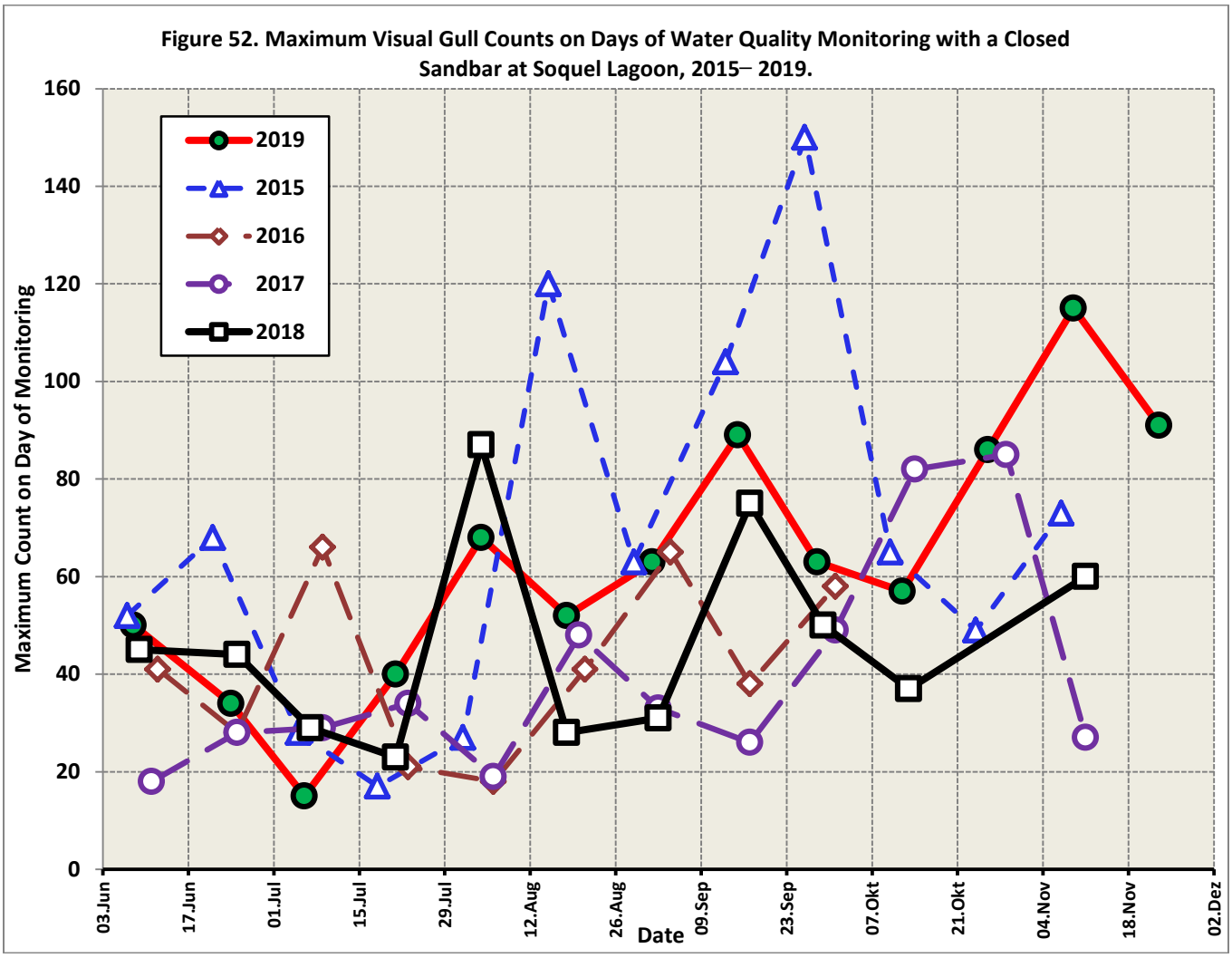
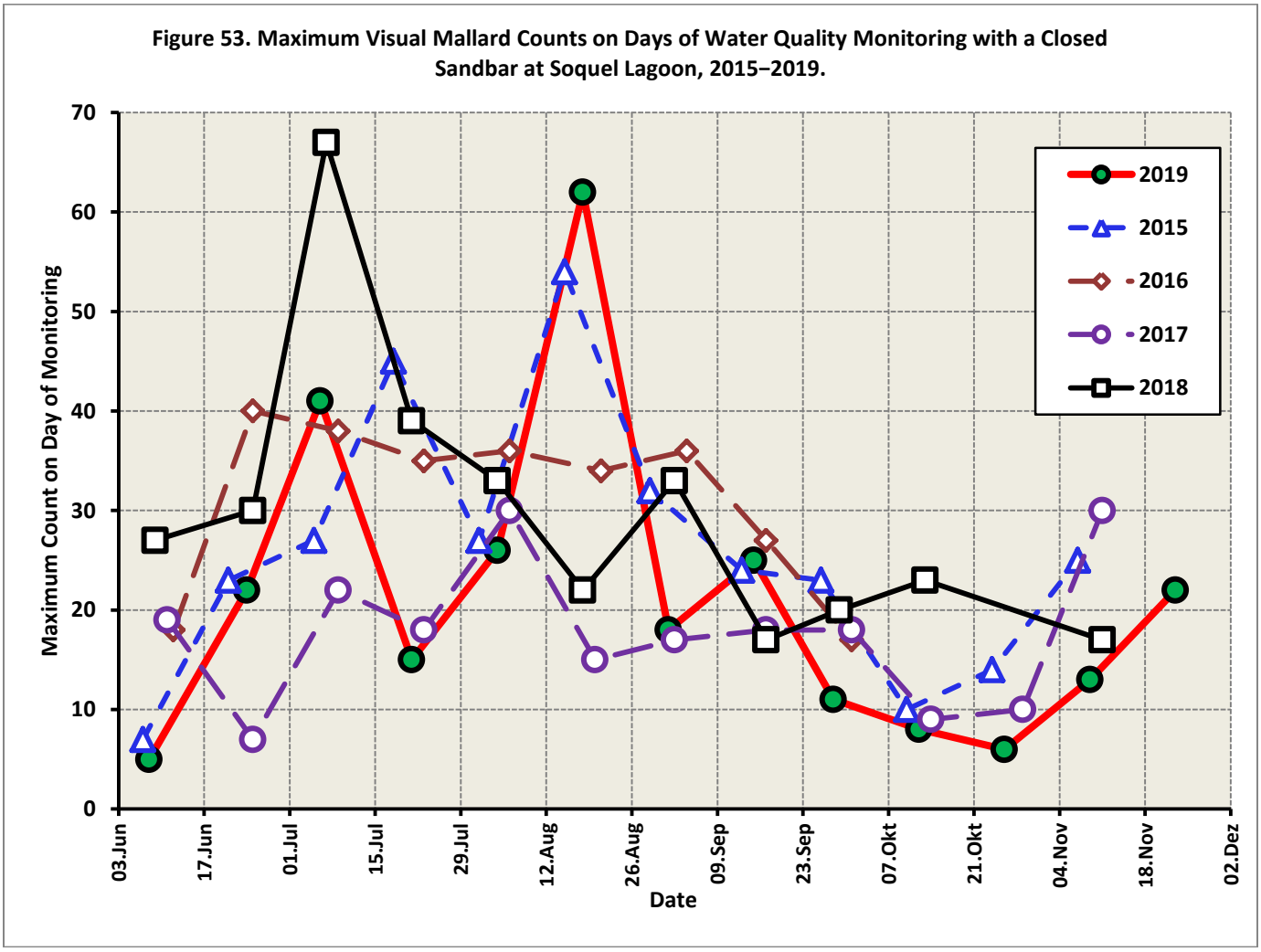


Figure 53. Maximum Visual Mallard Counts on Days of Water Quality Monitoring with a Closed Sandbar at Soquel Lagoon, 2014–2019.



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

4 June 2019– 27 November 2019.

4 June 2019. The sandbar had been closed since 30 May. A berm had been completed around the entire lagoon periphery to prevent tidal overwash on 31 May. Lagoon full with gage height of 2.64 on 4 June. Temperature probes were launched on 8 June in the lagoon and upstream. An underwater portal was present for adult out-migrants. Gage height was 2.65. Saltwater was detected at > 9 parts per thousand for 30 feet along the Venetian Court wall. The biologist recommended installing the shroud on the flume inlet, and it was installed. 18.2 cfs at Soquel Village.

			4 June 2019					
	Venetian Court Wall 1421 hr							
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.3	0.3	9.51	548				
0.25	17.4	0.3	9.42	528				
0.50	17.2	0.3	9.39	539				
0.75	17.1	0.3	9.72	531				
1.00	17.1	0.3	9.56	532				
1.25	16.9	0.3	9.68	534				
1.50	16.9	0.3	9.65	534				
1.75	16.9	0.3	9.71	532				
2.00	18.1	1.4	0.08	2231				
2.25 b	18.6	13.7	0	14162				

			8 June 2019					
	Flume		0712 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	16.6	0.3	8.96	536	16.8	0.3	8.07	539
0.25	16.5	0.3	8.56 (88)	537	16.8	0.3	8.14	538
0.50	16.7	0.3	8.56	539	16.8	0.3	8.27	537
0.75	16.7	0.3	8.42	539	16.8	0.3	9.37	537
1.00bott	16.5	0.3	8.30	538	16.8	0.3	9.06	534
1.25					16.8	0.3	8.13 (83)	538
1.50					16.8	0.3	7.92	538
1.75					16.8	0.3	7.93	537
2.0					17.1	0.3	1.47	566
2.25bott					18.1	2.6	0.27	4130
	Railroad Trestle			0746 hr	**Mouth of Noble Gulch**			0758 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	16.5	0.3	7.54	532	16.1	0.3	7.76	531
0.25	16.5	0.3	7.44	534	16.1	0.3	7.79	531
0.50	16.5	0.3	7.41	535	16.1	0.3	7.76	531
0.75	16.5	0.3	7.48	535	16.1	0.3	7.73	532
1.00	16.5	0.3	7.46	535	16.0	0.3	7.78 (79)	533
1.25b	16.5	0.3	7.46 (77)	535	16.0	0.3	7.65	538
1.37b	16.5	0.3	7.20	535				
1.50								
1.75								
	Nob Hill			0856 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**
	14.5	0.3	8.63	506				

9 June 2019. The first complete water quality monitoring of the season was accomplished after the sandbar had been closed on 29 May. Temperature probes were launched on 8 June in the lagoon and upstream. Oxygen was 77-86% full saturation in the morning near the bottom and good except along the Venetian Court wall where saltwater was present and oxygen was depleted near the bottom. From the surface to 1.75 m the oxygen was good there. Inflow oxygen in the morning was 85% full saturation at Nob Hill and good. Water temperature ranged 17.1-19.2 ° C in the afternoon in the lagoon, about 2-3°C cooler than in the low baseflow 2018. Oxygen was fully saturated in the afternoon at all stations measured near the bottom in the lagoon. Oxygen was supersaturated at the stream site near Nob Hill in the afternoon. Filamentous algae was not developing in the lagoon yet. But a phytoplankton bloom was underway.

			8-June 2019					
	Flume		1545 hr		**Stockton Avenue Bridge**			1528 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	18.3	0.3	9.40	561	18.6	0.3	9.49	564
0.25	18.4	0.3	9.29	561	18.5	0.3	9.38	565
0.50	18.4	0.3	9.45	561	18.4	0.3	9.24	563
0.75	17.6	0.3	10.25	551	18.0	0.3	9.70	559
1.00b	17.4	0.3	9.99	548	17.6	0.3	9.46	554
1.25					17.3	0.3	9.59	549
1.50					17.2	0.3	9.67 (100)	548
1.75					17.1	0.3	6.61	548
2.00					17.7	0.4	0.74	688
2.25b					18.8	12.3	0.19	18076
	Railroad Trestle			1514 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	19.2	0.3	9.23	572	19.1	0.3	9.20	574
0.25	18.9	0.3	9.12	568	19.0	0.3	9.24	568
0.50	18.7	0.3	9.07	567	18.3	0.3	9.38	562
0.75	18.6	0.3	9.22	563	17.5	0.3	9.58	556
1.00	18.1	0.3	9.32	560	16.8	0.3	10.32	542
1.25b	17.0	0.3	10.15	544	16.8	0.3	9.97	544
1.37b	17.0	0.3	9.72 (100)					
1.50								
	Nob Hill			1624 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**
	18.1	**0.3**	**9.87(105%)**	**547**				

8 June 2019. Gage height was 2.61 in the morning and 2.62 in the afternoon. Sky clear in morning and in afternoon. Inlet shroud in place.

Station 1: Flume at 0712 hr- Air temp. 11.3 C. no surface algae and yes, a planktonic algal bloom. Reach 1- no gulls bathing; no mallards. At 1500 hr- At 1545 hr- Air temp. at flume 16.9 C. no surface algae. Reach 1-26 gulls bathing. 4 mallards dabbling. No sinkholes along flume. Underwater portal in place. Flume inlet 2 ft deep. Outlet 1.2 ft deep.

Station 2: Stockton Avenue Bridge at 0725- hr- No surface algae. Light plankton bloom. Secchi depth to bottom. Reach 2- 3 mallards. At 1528 hr- no surface algae. Reach 2- 1 mallard.

Station 3: Railroad Trestle at 0746 hr- no surface algae. Reach 3- 1 mallard in water. At 1514 hr- no surface. Reach 3- 24 gulls and 4 adult mallards in water.

Station 4: Mouth of Noble Gulch at 0748 hr. No surface algae. At 1500 hr- Air Temp. at Noble Gulch 18.3. No gray water plume.

Station 5: Nob Hill at 0856 hr/ 1624 hr- Water temp. 2° C cooler than lagoon near the bottom in morning and 0.5 – 1.0° C warmer in the afternoon than lagoon near the bottom. Oxygen slightly more than in lagoon in the morning and similar in the afternoon. Streamflow – 14.7 cfs at Soquel Village gage.

24 June 2019. Morning oxygen levels were fair to good at 3 stations (70 – 85% full saturation), similar to 2 weeks previous but less than in 2018 due to delay in algae growth coincidental with cooler lagoon temperatures in 2019. Afternoon water temperatures similar to 2 weeks previous. Very slight saltwater lens remained at Venetian wall with reduced oxygen near the bottom. Lagoon depth was good. Afternoon oxygen was fully saturated at 3 stations near the bottom and supersaturated at the stream site near Nob Hill (105%). Afternoon water temperature less than 0.5°C warmer than Soquel Creek at Nob Hill and 1.5° C cooler than in the 2018 lagoon.

			24-June-2019					
	Flume			0718 hr	**Stockton Avenue Bridge**			0731 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	17.4	0.3	8.88	568	17.5	0.3	8.26	572
0.25	17.6	0.3	8.61	571	17.6	0.3	8.13	574
0.50	17.6	0.3	8.59	574	17.6	0.3	7.74	577
0.75	17.6	0.3	8.57	574	17.6	0.3	7.93	575
1.00b	17.6	0.3	8.41	574	17.6	0.3	7.98	575
1.25					17.6	0.3	8.00	574
1.50					17.6	0.3	7.93	574
1.75b					17.6	0.3	7.89 (83)	578
2.00					17.6	0.3	5.15 (55)	605
2.10b					17.8	0.3	3.39 (55)	675
	Railroad Trestle			0821 hr	**Mouth of Noble Gulch**			0837 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.4	0.3	7.21	572	17.1	0.3	7.08	570
0.25	17.4	0.3	7.02	572	17.2	0.3	7.04	570
0.50	17.4	0.3	6.97	572	17.2	0.3	7.05	570
0.75	17.4	0.3	6.93	573	17.1	0.3	7.09	568
1.00	17.4	0.3	6.88	573	17.1	0.3	7.07	571
1.13b					17.1	0.3	6.95	592
1.25b	17.4	0.3	6.80	573				
	Nob Hill			0902 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**
	16.2	0.3	8.17	547				

24 June 2019. Gage height of 2.12 in morning and 0.5 ft less than 2 weeks previous. Overcast and warm at 0718 hr. Air temperature of 14.4 C.
Station 1: Flume 0718 hr. Reach 1- no gulls bathing. No surface algae.
Station 2: Stockton Bridge 0731 hr. Reach 2-no waterfowl. No surface algae.
Station 3: Railroad trestle 0821 hr. Reach 3- 1 female adult mallard and 4 YOY near trestle and 1 female and 2 YOY at Noble Gulch exit. 14 mallards in water near Shadowbrook Restaurant. No surface algae
Station 4: Noble Gulch 0837 hr. No surface algae or gray water.
Station 5: Nob Hill at 0902 hr. 1.7° C warmer water temperature than 2 weeks previous and 1.2°c cooler than lagoon near bottom,

			24 June 2019					
	Flume			1550 hr	**Stockton Avenue Bridge**			1528 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.9	0.3	11.06	589	18.5	0.3	11.58	586
0.25	18.8	0.3	11.28	587	18.5	0.3	11.43	586
0.50	18.9	0.3	11.13	590	18.5	0.3	11.86	585
0.75	18.5	0.3	11.96	583	18.5	0.3	11.57	585
1.00b	18.5	0.3	11.80 (120)	583	18.4	0.3	11.51	584
1.25					18.3	0.3	11.43	583
1.50					18.3	0.3	11.36	583
1.75					18.2	0.3	11.26 (120)	583
2.00b					18.3	1.4	0.39	2468
	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	18.4	0.3	11.35	587	18.2	0.3	11.79	579
0.25	18.4	0.3	11.28	587	18.2	0.3	11.50	575
0.50	18.4	0.3	11.22	586	17.9	0.3	11.47	574
0.75	18.4	0.3	11.22	586	17.9	0.3	11.48	575
1.00	18.2	0.3	11.39 (122)	585	17.6	0.3	11.48 (121)	576
1.13b					17.6	0.3	11.38	577
1.25b	18.1	0.3	10.80	581				
1.50								
1.70b								
	Nob Hill			1635 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**
	17.9	0.3	11.91(126)	563				

24 June 2019. Gage height of 2.12 in afternoon. High cirrus clouds and partly cloudy with onshore breeze. Air temperature of 20.3°C at 1500 hr at Noble Gulch and 17.2° C at 1550 hr at the flume. Flume inlet = 2.0 ft. deep. Flume outlet = 1.0 ft.

Station 1: Flume 1550 hr. Reach 1- 20 gulls bathing. 1 kayak, 3 waders. <1% surface algae. 40% bottom algal film 0.3−1 ft thick averaging 0.8 ft. Remainder algae film.

Station 2: Stockton Bridge 1528 hr. Reach 2- < 1% surface algae; 40% bottom algal 0.3−1.0 ft thick, avg 0.5 ft. Remainder thin algal film. 3mallards in trestle cove.

Station 3: Railroad trestle 1515 hr. Reach 3- 10 mallards. 14 gulls. 2 kayaks heading toward Reach 1. No surface algae. 20% bottom algal film 0.2 ft−0.5 ft thick, avg 0.3 ft. No surface algae

Station 4: Noble Gulch 1500 hr. 80% bottom algal 1.0 – 2.0 ft thick, avg 1.2 ft. No surface algae. Noble Gulch outflow clear.

Station 5: Nob Hill at 1635 hr. Water temperature 1-1.6 C cooler than lagoon near the bottom. 10.1 cfs at Soquel Village.

			6 July 2019					
	Flume			0708 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	18.0	0.3	8.42	596	17.8	0.3	8.51	592
0.25	18.0	0.3	8.55	597	17.8	0.3	8.51	595
0.50	18.0	0.3	8.53	597	17.8	0.3	8.50	595
0.75	18.0	0.3	8.41 (89)	597	17.8	0.3	7.68	596
1.00b	17.9	0.3	7.92	597	17.6	0.3	8.03	596
1.25					17.6	0.3	8.08	596
1.50					17.6	0.3	8.19	594
1.75					17.6	0.3	8.20	594
2.00					17.6	0.3	8.16	596
2.15b					17.6	0.4	4.87	613
	Railroad Trestle			0744 hr	**Mouth of Noble Gulch**			0758 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.7	0.3	8.64	591	17.3	0.3	8.32	585
0.25	17.7	0.3	8.51	591	17.3	0.3	8.07	587
0.50	17.7	0.3	8.51	591	17.3	0.3	8.06	587
0.75	17.6	0.3	8.25	591	17.3	0.3	8.03	586
1.00	17.4	0.3	8.36	585	17.3	0.3	8.06 (84)	587
1.25	17.4	0.3	8.28 (86)	585	17.2	0.3	8.19	588
1.45b	17.4	0.3	7.10	588				
1.50								
	Nob Hill			0830 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**
	16.2	0.3	9.04 (92)	561				

6 July 2019. Gage height of 2.63 in morning and 0.5 feet deeper than previous week. Overcast and misty. Air temp. = 14.4° C at 0708 hr. Water temperature 2 – 2.4°C cooler in morning than previous year.
Station 1: Flume 0708 hr. Reach 1- 15 gulls bathing; 2 female mallards and 2 YOY. No surface algae. Underwater portal still present.
Station 2: Stockton Bridge 0725 hr. Reach 2- 1 female mallard and 3 YOY; one other mallard in water. No surface algae.
Station 3: Railroad trestle 0744 hr. Reach 3- 5 mallards perched on Dick Arthur's dock. No surface algae.
Station 4: Noble Gulch 0458 hr. No surface algae. No gray water.
Station 5: Nob Hill at 0830 hr. Water temperature 1 – 1.8 ° C cooler than lagoon sites.

			6 July 2019					
	Flume 1556 hr				**Stockton Avenue Bridge** 1542 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.9	0.3	11.54	609	18.8	0.3	11.19	606
0.25	19.0	0.3	11.86	609	18.8	0.3	11.10	606
0.50	18.6	0.3	12.46	603	18.8	0.3	11.08	606
0.75	18.6	0.3	12.50 (134)	601	18.7	0.3	11.10	605
1.00b	18.7	0.3	12.13	602	18.6	0.3	10.99	603
1.25					18.5	0.3	10.88	602
1.50					18.5	0.3	10.81	602
1.75					18.5	0.3	10.74	603 (114)
2.00					18.5	0.3	10.46	604
2.15b					18.3	0.4	6.38	688
	Railroad Trestle 1528 hr				**Mouth of Noble Gulch**			1503 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	18.8	0.3	11.53	607	18.5	0.3	10.23	614
0.25	18.8	0.3	11.47	608	18.5	0.3	10.09	590
0.50	18.8	0.3	11.45	608	18.4	0.3	10.11	599
0.75	18.7	0.3	11.55	606	18.3	0.3	10.46	596
1.00	18.7	0.3	11.76	605	18.0	0.3	10.76 (114)	595
1.25b	18.3	0.3	12.64 (135)	599	18.0	0.3	10.58	611
1.45b	18.3	0.3	13.04	595				
1.50								
	Nob Hill			1637 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**
	18.1	0.3	11.29 (120)	577				

6 July 2019. Gage height of 2.62 in afternoon. Clear and breezy. Air temperature of 21.2 C at Noble Gulch at 1503 hr and 17.7 °C at flume at 1556 hr. Afternoon water temperature 1°C warmer than 2 weeks earlier and 2-3°C cooler than previous year.

Station 1: Flume at 1556 hr. Reach 1- 8 and later 15 gulls bathing; 5 adult mallard adjacent Margaritaville. 6 waders. <1% surface algae. 80% bottom algae 0.5-1 ft thick, avg 0.8 ft. Remainder algal film.

Station 2: Stockton Avenue Bridge at 1542 hr. Secchi depth to bottom. Reach 2- No surface algae. 2 gulls. 50% bottom algae 0.2-1.0 ft thick, avg 0.5 ft. Remainder algal film.

Station 3: Railroad Trestle at 1528 hr. Reach 3- No surface algae. 40% bottom algae 0.2-1.0 ft thick, avg 0.4 ft thick. 18 adult mallards in water; 6 mallards on dock downstream of Arthur dock; 1 female mallard and 1 YOY on Arthur's dock. 4 gulls.

Station 4: Mouth of Noble Gulch at 1503 hr. No surface algae. 70% bottom algae 1 ft thick, avg 1.0 ft thick; remainder algal film. No gray water.

Station 5: Nob Hill at 1637 hr. Water temperature 0.5 C cooler or less than the lagoon near bottom. 9.6 cfs at Soquel Village.

			21-July-2019					
	Flume 0710 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 (% sat.)**	**umhos**	**(C)**	**(ppt)**	**mg/l (% sat.)**	**Umhos**
0.00	18.7	0.3	8.08	614	18.6	0.3	8.24	615
0.25	18.7	0.3	8.20	621	18.6	0.3	8.19	621
0.50	18.7	0.3	8.19	621	18.6	0.3	7.90	621
0.75	18.7	0.3	8.15	621	18.7	0.3	7.63	623
1.00b	18.7	0.3	8.08	621	18.7	0.3	7.31	623
1.25					18.7	0.3	7.28	623
1.50					18.7	0.3	6.62	626
1.75					18.7	0.3	6.43	627
2.00					18.6	0.3	6.54 (69)	624
2.20b					18.6	0.3	5.22	623
	Railroad Trestle 0743 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 (% sat.)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	18.4	0.3	7.77	616	18.2	0.3	7.61	617
0.25	18.4	0.3	7.66	617	18.2	0.3	7.43	616
0.50	18.5	0.3	7.59	617	18.2	0.3	7.39	616
0.75	18.4	0.3	7.74	617	18.2	0.3	7.33	615
1.00	18.4	0.3	7.74	617	18.2	0.3	7.34 (78)	614
1.25b	18.4	0.3	7.68 (82)	617	18.0	0.4	7.56	630
1.45b	18.5	0.3	5.48	618				
1.50								
	Nob Hill			0826 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**
	16.9	0.3	7.95	586				

21 July 2019. Gage height of 2.60 in morning. Overcast, misty. Air temperature of 14.1 ^{o}C at 0710 hr. Water temperature 0.7 - 1 C warmer than morning 2 weeks previous. Water temperature 2 – 2.5 C cooler near the bottom than previous year.

Station 1: Flume at 0710 hr. Reach 1- 12 gulls bathing. No surface algae.

Station 2: Stockton Avenue Bridge at 0725 hr. Reach 2- 4 mallards. Family feeding ducks at Stockton Bridge at 0800 hr. No surface algae.

Station 3: Railroad Trestle at 0743 hr. Reach 3- 11 mallards; 1 coot in water. No surface algae.

Station 4: Mouth of Noble Gulch at 0756 hr. no gray water.

Station 5: Nob Hill at 0826 hr. Water temperature 1.3 – 1.8 C cooler than lagoon.

			21-July-2019					
	Flume 1542 hr				**Stockton Ave Bridge** 1526 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	20.0	0.3	9.74	639	19.8	0.3	9.85	634
0.25	20.0	0.3	9.99	639	19.8	0.3	9.92	635
0.50	19.7	0.3	10.53	635	19.8	0.3	9.92	635
0.75	19.7	0.3	10.65 (117)	634	19.7	0.3	9.93	636
1.00b	19.7	0.3	10.22	634	19.7	0.3	9.84	634
1.25					19.6	0.3	9.77	633
1.50					19.5	0.3	9.66	632
1.75					19.5	0.3	9.56	632
2.00					19.5	0.3	9.49 (105)	632
2.20b					19.5	0.3	6.56	633
	Railroad Trestle 1514 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	19.6	0.3	9.83	636	19.9	0.3	8.99	642
0.25	19.7	0.3	9.97	637	19.9	0.3	8.73	636
0.50	19.7	0.3	9.97	637	19.6	0.3	8.80	634
0.75	19.6	0.3	10.05	636	19.2	0.3	9.25	628
1.00	19.5	0.3	10.02	636	18.7	0.3	9.73	627 (104)
1.25b	19.3	0.3	10.68 (116)	629	18.7	0.3	9.84	629
1.45b	19.7	0.3	14.33	629				
	Nob Hill			1630 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**
	18.7	0.3	9.64 (103)	531				

21 July 2019. Gage height of 2.62 in afternoon. Partly cloudy with cirrus clouds, breezy. Air temp. = 18.7 C at Noble Gulch at 1500 hr and 16.0 °C at flume at 1542 hr. 2°C cooler near the bottom than previous year.

Station 1: Flume at 1542 hr. Reach 1- 22 gulls; 3 paddle boarders and 2 waders. 2 other boys jumped from Stockton Bridge into Reach 1. No surface algae. 80% bottom algae 0.2 - 2 ft thick, avg 1 ft. Remainder algal film.

Station 2: Stockton Avenue Bridge at 1526 hr. Secchi depth to bottom. Reach 2- No surface algae. 60% bottom algae 0.2 - 3 ft thick, avg 1 ft. 11 mallards (some from Reach 3).

Station 3: Railroad Trestle at 1514 hr. Reach 3- No surface algae. 80% bottom algae 0.2 - 3 ft thick, avg 0.8 ft. Children feeding ducks at Noble Gulch- 32 ducks congregated (22 subadults), 1 female mallard and 1 duckling on Arthur's dock. 18 gulls. 1 pedal boat.

Station 4: Mouth of Noble Gulch at 1500 hr. No surface algae. 80% bottom algae 0.3 0 1.5 ft thick, averaging 1 ft. thick.

Station 5: Nob Hill at 1630hr. Water temperature 0.3 - 1° C cooler than lagoon. 0.3°C warmer than previous year. 9 cfs at Soquel Village.

			4-Aug-2019					
	Flume 0715 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)(% sat.)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)(%sat.)**	**umhos**
0.00	19.4	0.4	8.68	643	19.3	0.4	8.12	641
0.25	19.4	0.4	8.68	643	19.3	0.4	8.06	643
0.50	19.4	0.4	8.73	643	19.3	0.4	7.80	643
0.75	19.4	0.4	8.68 (94)	643	19.3	0.4	7.50	645
1.00b	19.4	0.4	8.39	643	19.3	0.4	7.37	644
1.25					19.3	0.4	7.41	644
1.50					19.3	0.4	7.51	644
1.75					19.3	0.4	7.48	644
2.00					19.3	0.4	7.48 (81)	643
2.15b					19.3	0.4	7.03	643
	Railroad Trestle 0745 hr				**Mouth of Noble Gulch** 0800 hr			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)(%sat.)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)(%sat.)**	**Cond 4 umhos**
0.00	18.9	0.4	7.51	634	18.4	0.4	7.85	625
0.25	18.9	0.4	7.40	637	18.4	0.4	7.63	628
0.50	18.9	0.4	7.28	637	18.4	0.4	7.57	625
0.75	18.9	0.4	7.17	637	18.4	0.4	7.39	630
1.00	18.8	0.4	7.31	632	18.4	0.4	7.40 (80)	628
1.25b	18.8	0.4	7.29 (78)	632	18.2	0.4	6.41	637
1.50b	18.8	0.4	5.04	632				
	Nob Hill			0837 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**
	17.2	0.4	8.22 (85)	597				

4 August 2019. Gage height of 2.62 (morning) and 2.58 (afternoon). Foggy at 0715 hr with air temperature of 14.3 ° C at flume. Air temperature 17.3 ° C at 1545 hr at flume and 20.3 C at 1500 hr at Noble Gulch; clear and breezy. Flume inlet 1.2 ft deep. Flume outlet 1.0 ft deep in afternoon. Morning water temperature 0.5 C warmer than previous week. Water temperatures generally 1.5-2.2 °C warmer in afternoon than in the morning.

Station 1: Flume at 0715 hr. Reach 1- 17 gulls. No surface algae.
Station 2: Stockton Avenue Bridge at 0730 hr. Secchi depth to the bottom. Reach 2- 5 mallards. No surface algae.
Station 3: Railroad trestle at 0745 hr. Reach 3- 14 mallards in water. 5% surface algae.
Station 4: Mouth of Noble Gulch at 0800 hr. No surface algae. No gray water.
Station 5: Nob Hill at 0837 hr. Water temperature 0.3°C warmer than 2 weeks earlier.

			4-Aug-2019					
	Flume 1545 hr				**Stockton Avenue Bridge** 1529 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)(% sat.)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)(%sat.)**	**Umhos**
0.00	20.8	0.4	9.39	662	20.6	0.4	9.41	660
0.25	20.7	0.4	9.63	661	20.7	0.4	9.44	661
0.50	20.0	0.4	10.59	659	20.4	0.4	9.33	659
0.75	19.9	0.4	11.13 (122)	645	20.4	0.4	9.25	657
1.00b	20.0	0.4	10.72	648	20.3	0.4	9.19	656
1.25					20.0	0.4	9.15	655
1.50					19.9	0.4	9.19	652
1.75					19.8	0.4	9.23	650
2.00					19.4	0.4	8.62 (92)	648
2.20b					19.2	0.4	5.91	647
	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)(% sat.)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)(%sat.)**	**umhos**
0.00	21.3	0.4	9.26	670	21.1	0.4	9.06	675
0.25	21.0	0.4	9.33	666	20.7	0.4	9.19	666
0.50	20.8	0.4	9.34	664	20.6	0.4	9.16	660
0.75	20.6	0.4	9.35	660	19.9	0.4	9.98	653
1.00	20.1	0.4	10.57	656	19.5	0.4	9.93 (108)	642
1.25b	19.8	0.4	11.51 (126)	647	19.0	0.4	10.37	632
1.50b	19.4	0.4	11.76	638				
	Nob Hill			1632 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**
	19.1	0.3	9.79	620				

4 August 2019.

Station 1: Flume at 1545 hr. Reach 1- 63 gulls bathing; 1 adult mallard in water. 2 waders. <1% surface algae. 50% bottom algae 0.2 - 2 ft thick, averaging 0.5 ft.; remaining margins with algal film.

Station 2: Stockton Avenue Bridge at 1529 hr. Reach 2- 2 mallards. <1% surface algae. 70% bottom algae 0.2 - 3 ft thick; avg 0.5 ft. remainder algal film.

Station 3: Railroad trestle at 1515 hr. Reach 3- 1% surface algae. 60% bottom algae 0.2-34 ft thick; avg 0.4 ft. 23 adult mallards; 5 gulls; 1 coot

Station 4: Mouth of Noble Gulch at 1500 hr. 10% surface algae. 60% of bottom covered by algae 0.2–3ft thick, averaging 0.5 ft. No gray water.

Station 5: Nob Hill at 1632 hr. Water temperature 0.3 – 0.7 C cooler than lagoon and 0.4 C warmer than 2 weeks earlier. 6.2 cfs at Soquel Village and nearly 3 cfs less than 2 weeks before.

			18-Aug-2019					
	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	19.3	0.4	8.46	658	19.0	0.4	8.97	650
0.25	19.3	0.4	8.36	655	19.1	0.4	8.81	651
0.50	19.3	0.4	8.30	655	19.1	0.4	8.63	651
0.75	19.1	0.4	7.14 (78)	654	19.1	0.4	8.47	652
1.00b	19.1	0.4	6.81	653	19.1	0.4	8.24	652
1.25					18.9	0.4	7.01	654
1.50					18.8	0.4	7.00	652
1.75					18.8	0.4	6.99	651
2.00					18.8	0.4	7.07 (75)	651
2.15					18.6	0.4	6.02	650
	Railroad Trestle 0733 hr				**Mouth of Noble Gulch** 0751 hr			
Depth (m)	**Temp 3 (C)**	**Salin 3 (ppt)**	**O2 3 (mg/l)(% sat.)**	**Cond 3 umhos**	**Temp 4 (C)**	**Salin 4 (ppt)**	**O2 4 (mg/l)(% sat.)**	**Cond 4 umhos**
0.00	19.0	0.4	8.59	648	18.3	0.4	9.01	620
0.25	19.0	0.4	8.51	650	18.4	0.4	8.62	621
0.50	18.9	0.4	8.57	649	18.4	0.4	8.61	621
0.75	18.9	0.4	8.60	649	18.0	0.4	8.28	615
1.00	18.7	0.4	7.51	648	17.9	0.4	8.21 (87)	639
1.25b	18.3	0.4	7.65 (82)	638	17.9	0.4	6.75	654
1.50b	18.3	0.4	5.85	638				
	Nob Hill			0825 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**
	17.0	0.3	8.79	603				

18 August 2019. Gage height of 2.62 (morning) and 2.62 (afternoon). Overcast/windy at 0700 hr with air temperature of 15.5 ° C at flume. Air temperature 17.6 ° C at 1554 hr at flume and the same at Noble Gulch at 1500 hr under partly cloudy windy conditions. Flume inlet 1.3 ft deep. Flume outlet 1.0 ft deep. Lagoon water temperatures 1 – 2 C cooler than previous year. Water temperatures generally 0.5-1 °C warmer in afternoon lagoon than in the morning near the bottom. Afternoon lagoon water temperatures 1.5 – 2.5 C cooler than previous year.

Station 1: Flume at 0700 hr. Reach 1- In water 39 gulls bathing. No surface algae.
Station 2: Stockton Avenue Bridge at 0715hr. Secchi depth to the bottom. Reach 2- 4 mallards in water; 2 mallards on trestle abutment. No surface algae.
Station 3: Railroad trestle at 0733 hr. Reach 3- 4 mallards; 1 pied-billed grebe. 22 steelhead surface hits per minute. No surface algae.
Station 4: Mouth of Noble Gulch at 0751 hr. 3% surface algae. Murky water.
Station 5: Nob Hill at 0825 hr. Water temperature 0.2°C warmer than 2 weeks earlier. 7.1 cfs at Soquel Village.

			18-Aug-2019					
	Flume 1554 hr				**Stockton Avenue Bridge** 1536 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**		**(ppt)**	**(mg/l)**	**Umhos**
0.00	19.9	0.4	10.21	652	19.7	0.4	11.03	659
0.25	20.0	0.4	10.15	663	19.7	0.4	11.04	657
0.50	19.2	0.4	12.60	648	19.7	0.4	11.15	657
0.75	19.2	0.4	13.02 (142)	646	19.6	0.4	11.07	655
1.00b	19.2	0.4	12.52	645	19.5	0.4	11.09	654
1.25					19.2	0.4	11.44	651
1.50					19.2	0.4	11.62	649
1.75					19.1	0.4	11.84	648
2.00					18.9	0.4	11.46	647
2.25b					18.9	0.4	8.54	650
	Railroad Trestle 1521 hr				**Mouth of Noble Gulch** 1500 hr			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.5	0.4	10.65	655	19.0	0.4	11.27	
0.25	19.5	0.4	10.56	655	19.1	0.4	10.95	
0.50	19.5	0.4	10.54	655	19.2	0.4	10.93	
0.75	19.5	0.4	10.85	655	19.0	0.4	11.00	
1.00	19.4	0.4	11.03 (120)	654	18.7	0.4	11.22 (120)	
1.25b	18.8	0.4	13.48 (144)	639	18.6	0.4	11.54	
1.50b	18.9	0.4	8.54	637				
	Nob Hill			1631 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**
	18.0	0.3	10.78 (114)	614				

18 August 2019.

Station 1: Flume at 1554 hr. Reach 1- 47 gulls bathing; 2 waders. Cannot see bottom to estimate aquatic vegetation because of cloudiness.

Station 2: Stockton Avenue Bridge at 1536 hr. Reach 2- No surface algae. 4 mallards in water from Reach 3.

Station 3: Railroad trestle at 1521 hr. Reach 3- No surface algae. Waterfowl being feed at Noble Gulch exit. 58 mallards (mostly subadults); 1 merganser; 11 gulls. 1 paddle board.

Station 4: Mouth of Noble Gulch at 1500 hr. No surface algae.

Station 5: Nob Hill at 1631 hr. Water temperature 0.7 – 1.2 °C cooler than the lagoon near bottom and same temperature as 2 weeks earlier. 0.4° C cooler than previous year.

			1-Sep-2019					
	Flume 0701 hr				**Stockton Avenue Bridge** 0714 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.9	0.4	8.10	668	20.1	0.4	7.35	666
0.25	20.0	0.4	8.14	670	20.1	0.4	7.28	673
0.50	20.0	0.4	8.03	671	20.1	0.4	7.32	674
0.75	19.9	0.4	7.97 (88)	670	20.1	0.4	7.17	672
1.00b	20.0	0.4	7.76	670	20.2	0.4	6.64	675
1.25					20.1	0.4	7.26	674
1.50					20.1	0.4	7.17	674
1.75					20.1	0.4	7.27	674
2.00					20.1	0.4	6.86 (76)	674
2.15b					20.1	0.4	5.66	674
	Railroad Trestle 0737 hr				**Mouth of Noble Gulch** 0753 hr			674
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	19.7	0.4	6.53	664	19.1	0.4	7.29	645
0.25	19.7	0.4	6.72	666	19.1	0.4	7.07	651
0.50	19.7	0.4	6.66	666	19.1	0.4	7.02	651
0.75	19.7	0.4	6.65	666	19.1	0.4	7.10	650
1.00	19.7	0.4	6.69	666	19.1	0.4	7.10(76)	650
1.25b	19.7	0.4	6.72 (73)	665	19.0	0.4	6.67	649
1.50b	19.7	0.4	5.17	666				
	Nob Hill			0820 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**
	17.3	0.4	7.62 (79)	618				

1 September 2019. Gage height of 2.61 (morning) and 2.54 (afternoon). Clear at 0700 hr- air temperature of 14.6 ° C. Lagoon water temperature 0.1 – 0.5 C warmer than previous year in the morning. Air temperature at flume at 1556 hr and 22.1 C at Noble Gulch at 1500 hr. Clear and breezy. Afternoon lagoon water temperature 0.1 – 0.8 C warmer near the bottom than in morning. Lagoon water temperature 0.3 – 0.9 C warmer than previous year in the afternoon. Flume inlet 1.3 ft; flume exit 0.8 ft.
Station 1: Flume at 0701 hr. Reach 1- 29 gulls; 1 mallard in water; 2 mergansers roosting on wood under Stockton Bridge. No surface algae.
Station 2: Stockton Avenue Bridge at 0714 hr. Reach 2-6 mallards in water. 2 steelhead surface hits per minute. No surface algae.
Station 3: Railroad trestle at 0737 hr. Reach 3-11 mallards and 2 mergansers (from bridge) in water . No surface algae.
Station 4: Mouth of Noble Gulch at 0753 hr. No surface algae or gray water.
Station 5: Nob Hill at 0820 hr. Water temperature 0.7° C cooler than 2 weeks earlier, 1.8 – 2.8° C cooler than the lagoon near the bottom. 0.8° C warmer than previous year. Estimated streamflow = 4.4 cfs at Soquel Village and 2.7 cfs less than 2 weeks ago.

			1-Sep-2019					
	Flume 1556 hr				**Stockton Avenue Bridge** 1536 hr			
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	21.3	0.4	10.36	686	21.7	0.4	9.12	696
0.25	21.2	0.4	11.33	686	21.7	0.4	9.18	696
0.50	20.8	0.4	11.55	678	21.7	0.4	9.23	695
0.75	20.7	0.4	11.83 (132)	675	21.5	0.4	8.89	695
1.00b	20.7	0.4	11.74	675	20.8	0.4	9.99	688
1.25					20.7	0.4	10.07	682
1.50					20.5	0.4	10.25	678
1.75					20.4	0.4	10.48	675
2.00					20.0	0.4	8.63 (94)	673
2.10b					20.0	0.4	7.94	673
	Railroad Trestle 1518 hr				**Mouth of Noble Gulch** 1500 hr			
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	22.4	0.4	9.35	705	22.1	0.4	9.10	
0.25	22.3	0.4	9.43	705	21.8	0.4	9.04	
0.50	21.9	0.4	9.43	701	21.6	0.4	9.03	
0.75	21.1	0.4	10.51	691	20.1	0.4	9.57	
1.00	20.5	0.4	12.04	673	20.0	0.4	10.78 (118)	
1.25b	20.4	0.4	12.33 (137)	673	19.9	0.4	12.93	
1.50b	20.5	0.4	10.38	671				
1.75								
	Nob Hill			1640 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**
	19.3	0.4	9.64 (105)	637				

1 September 2019.

Station 1: Flume at 1556 hr. Reach 1- 45 gulls; 4 mallards from Reach 2 begging at Margaritaville. 5 waders, 1 kayak, 1 pedal boat, 1 electric boat. Could not see bottom. No surface algae.

Station 2: Stockton Avenue Bridge at 1536 hr. Reach 2- 4 mallards in water. Surveyed aquatic vegetation before water quality measurements. 20% pondweed with algae 2-4 ft, averaging 3 ft. 60% bottom algae 0.5 – 3 ft thick; avg 1.5 ft. Remainder algal film. No surface algae.

Station 3: Railroad trestle at 1518 hr. Reach 3- 14 mallards and 18 gulls in water. 1% pondweed with algae 1-3 ft thick, averaging 2.5 ft. 60% bottom algae 0.5 - 3 ft thick, avg 1 ft. Remainder algal film. No surface algae. 5 paddle boards, 3 kayaks, 2 pedal boats.

Station 4: Mouth of Noble Gulch at 1500 hr. 5 % surface algae slight gray water. Bottom invisible at Noble Gulch mouth. Could see 10% bottom algae 3-4 ft thick, avg 3 feet at periphery.

Station 5: Nob Hill at 1631 hr. Water temperature 0.7 – 1.4 C cooler than lagoon near the bottom in the afternoon. 1.3 C warmer than 2 weeks previous in the afternoon and . 4.4 cfs at Soquel Village.

			15-Sep-2019					
	Flume			0716 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	19.5	0.4	11.02	671	19.8	0.4	11.16	674
0.25	19.6	0.4	11.08	671	19.8	0.4	11.08	678
0.50	19.6	0.4	11.08	673	19.8	0.4	11.01	679
0.75	19.6	0.4	11.02 (120)	673	19.8	0.4	10.85	679
1.00b	19.6	0.4	10.32	673	19.8	0.4	10.86	679
1.25					19.8	0.4	10.87	679
1.50					19.8	0.4	10.96	679
1.75					19.8	0.4	10.98 (121)	679
2.00					19.8	0.4	10.96 (120)	679
2.15b					19.8	0.4	9.93	679
	Railroad Trestle			0749 hr	**Mouth of Noble Gulch**			0806 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	19.5	0.4	9.49	672	19.1	0.4	9.03	655
0.25	19.5	0.4	9.30	676	19.1	0.4	8.78	662
0.50	19.5	0.4	9.26	676	19.1	0.4	8.76	663
0.75	19.5	0.4	9.27	676	19.1	0.4	8.91	662
1.00	19.5	0.4	9.21	676	19.1	0.4	8.93 (96)	660
1.25b	19.5	0.4	9.14 (100)	676	18.8	0.4	8.13	651
1.50b	19.6	0.4	7.91	677				
	Nob Hill			0831 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**
	17.2	0.4	9.68 (100)	619				

15 September 2019. Art and Wine Festival Day. Gage height of 2.62 (morning) and 2.62 (afternoon). Overcast, foggy. warm in morning and clear in afternoon with onshore breeze. Air temperature of 13.0˚ C at 0716 hr (4 degrees warmer than previous year) and 17.6 ° C at 1555 hr. Lagoon water temperature 2 C warmer than previous year in the morning; 1 C warmer in afternoon. 3 C warmer than previous year at lagoon inlet Nob Hill in the morning and 0.7 C warmer in the afternoon. Flume inlet 1.2 ft and exit 0.5 ft in afternoon at low tide.

Station 1: Flume at 0708 hr- Reach 1- 27 gulls bathing, 2 mallards in water, 1 coot. No surface algae. Flume at 1555 hr- Reach 1- 89 gulls bathing, 5 mallards (2 from Reach 2), and 1 merganser on log under Stockton Bridge. No surface algae. Could not see bottom

Station 2: Stockton Avenue Bridge at 0730 hr- Reach 2 – 2 mallards in water. No surface algae. Reach 2 at 1541 hr-. Secchi depth to bottom. Humans feeding 13 mallards and 1 gull in water; 1 pied-billed grebe, 2 paddle boarders. Surveyed vegetation before water quality measurements. 2% surface algae. 30% pondweed with algae 2-4 ft, averaging 3 ft. 70% of bottom covered with algae 0.3-1.0 ft thick, averaging 0.8 ft thick.

Station 3: Railroad trestle at 0749 hr- Reach 3- 5 mallards. No surface algae. Reach 2 at 1521 hr- 7 mallards. 2% surface algae. 95% bottom algae 0.2-4.0 ft thick, avg 0.5 ft. 5% pondweed with algae 2 - 4 ft thick, averaging 3.0 ft.

Station 4: Mouth of Noble Gulch at 0806 hr- No surface algae. No gray plume at mouth. At 1502 hr-

15% surface algae. 15% pondweed + algae 3 ft thick. Remainder soupy from plankton.
Station 5: Nob Hill at 0831 hr. Water temperature 0.1°C cooler than 2 weeks earlier in the morning and 1.4 C warmer in the afternoon than 2 weeks pervious. 1.9 - 2.6° C cooler than lagoon near the bottom in the morning and 1.2 – 2.5 C cooler than the lagoon in the afternoon. 3.4 cfs at Soquel Village and 1 cfs less than 2 weeks previous.

			15-Sep-2019					
	Flume			1555 hr	**Stockton Avenue Bridge**			1541 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	20.9	0.4	10.62	693	21.0	0.4	10.32	691
0.25	20.6	0.4	11.20	693	20.9	0.4	10.33	694
0.50	20.5	0.4	11.45	686	20.8	0.4	10.12	693
0.75	20.4	0.4	11.69	683	20.6	0.4	10.03	688
1.00b	20.4	0.4	11.37	684	20.5	0.4	9.79	689
1.25					20.3	0.4	9.64	686
1.50					20.1	0.4	9.44	684
1.75					20.0	0.4	9.03	683
2.00					19.8	0.4	6.61 (73)	682
2.15b					19.7	0.4	4.65	683
	Railroad Trestle			1521 hr	**Mouth of Noble Gulch**			1502 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	21.3	0.4	10.33	699	21.0	0.4	8.64	703
0.25	21.1	0.4	9.91	698	21.0	0.4	8.54	696
0.50	20.9	0.4	9.48	694	20.6	0.4	8.62	689
0.75	19.9	0.4	11.82	678	19.6	0.4	9.04	649
1.00	19.9	0.4	11.89	676	19.2	0.4	9.52 (103)	652
1.25b	19.9	0.4	12.15 (134)	676	19.1	0.4	10.89	650
1.50b	19.9	0.4	11.59	676				
	Nob Hill			1627 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**
	17.9	0.4	9.72 (96)	627				

			28-Sep-2019					
	Flume			0722 hr	**Stockton Avenue Bridge**			0736 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.6	0.4	8.84	660	18.9	0.4	8.50	667
0.25	18.6	0.4	8.85	664	18.9	0.4	8.51	668
0.50	18.7	0.4	8.87	664	19.0	0.4	8.39	668
0.75	18.6	0.4	8.61	663	19.1	0.4	8.26	670
1.00b	18.6	0.4	7.96	663	19.0	0.4	8.56	669
1.25					19.0	0.4	8.51	669
1.50					19.0	0.4	8.62	669
1.75					19.0	0.4	8.64	669
2.00					19.0	0.4	8.61 (93)	669
2.15b					19.0	0.4	6.92	671
	Railroad Trestle			0755 hr	**Mouth of Noble Gulch**			0810 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.6	0.4	7.45	664	18.1	0.4	7.65	646
0.25	18.6	0.4	7.39	664	18.1	0.4	7.59	650
0.50	18.6	0.4	4.34	664	18.1	0.4	7.57	651
0.75	18.6	0.4	7.39	664	18.1	0.4	7.50	651
1.00	18.6	0.4	7.38	664	18.2	0.4	7.44 (79)	651
1.25b	18.6	0.4	7.21	664	18.2	0.4	5.12	678
1.45b	18.6	0.4	6.54	664				
	Nob Hill			0839 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**
	16.2	0.4	8.33 (85)	600				

28 September 2019. Wharf to Wharf Race this day. Nautical procession this night. Gage height of 2.53 (morning), cool and clear and 2.55 (afternoon) clear and windy in afternoon. Cloudy the day before. Air temperature of 11.6˚ C at 0722 hr at flume and 15.1° C at 1614 hr. Flume inlet/exit 1.0 ft/ 0.5 ft.
Station 1: Flume at 0722 hr- Reach 1- 6 gulls bathing, mallard in water. No surface algae. Flume at 1614 hr- Reach 1- 62 gulls before paddleboards, 15 gulls after paddleboards entered. 5 mallards adjacent Margaritaville. 6 paddle-boarders; 1 pedal boat from Reach 2. No surface algae. 25% bottom algae 3 - 5 ft thick, avg 4.0 ft. 60% bottom algae 1 - 3 ft thick, avg 1.5 ft. Thin algae film on remainder.
Station 2: Stockton Avenue Bridge at 0736 hr- Reach 2- No surface algae. 1 mallard in water; 5 mallards perched on railroad trestle abutments; 2 coots in water. Surveyed vegetation before water quality measurements. At 1559 hr- Reach 2 – 5% green surface algae; 35% pondweed + algae 3 – 4 ft thick, avg 3.5 ft; 65% bottom algae 0.2 – 1.0 ft thick, avg. 0.5 ft, 1 gull, 1 mallard, 1 coot in water. 1 pedal boat, 1 row boat, 1 barge**.**
Station 3: Railroad trestle at 0755 hr- Reach 3- 8 mallards dabbling, 7 coots. No surface algae. At 1540 hr- Reach 3- 5 mallards, 2 coots in water. 1 paddleboard, 3 kayaks, 2 canoes. 5% green surface algae; 75% bottom algae 0.5 – 1 ft thick; avg 0.7 ft; 5% pondweed with algae 3-4 ft thick, averaging 3 ft.
Station 4: Mouth of Noble Gulch at 0839 hr- No surf. algae. No gray water plume at mouth. At 1520 hr- 18.2 C air temperature. No surface algae; 15% pondweed with averaging 3.5 ft thick. 85% bottom algae

0.1 – 1 ft thick; avg 0.5 ft.
Station 5: Nob Hill at 0839 hr- Water temperature 1 C cooler in the morning and afternoon than 2 weeks earlier. – 3.5 cfs in Soquel Village in the afternoon and 0.1 cfs more than 2 weeks previous.

			28-Sep-2019					
	Flume			1614 hr	**Stockton Avenue Bridge**			1559 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	20.3	0.4	12.97	682	19.5	0.4	12.38	673
0.25	20.3	0.4	13.07	684	19.5	0.4	12.35	673
0.50	20.3	0.4	13.12	684	19.6	0.4	12.24	674
0.75	20.3	0.4	13.08 (145)	684	19.6	0.4	12.05	674
1.00b	20.3	0.4	10.51	683	19.6	0.4	12.20	674
1.25					19.6	0.4	12.26	674
1.50					19.6	0.4	12.31	674
1.75					19.6	0.4	12.38	674
2.00					19.6	0.4	12.13 (133)	674
2.15b					19.4	0.4	5.21	674
	Railroad Trestle			1540 hr	**Mouth of Noble Gulch**			1520 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.5	0.4	13.17	672	19.7	0.4	11.25	677
0.25	19.5	0.4	13.14	672	19.7	0.4	11.45	680
0.50	19.5	0.4	13.16	673	19.6	0.4	11.72	680
0.75	19.5	0.4	13.23	673	19.5	0.4	11.32	682
1.00	19.5	0.4	13.23	673	19.3	0.4	9.92 (108)	675
1.25b	19.5	0.4	13.38 (146)	673	19.1	0.4	19.61 (213)	756
1.45b	19.5	0.4	11.72	672				
	Nob Hill			1645 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**
	16.8	0.4	10.47 (108)	604				

28 September 2019. Nautical Procession. No negative effects to fish and wildlife were observed during the evening. Seven floats took part in a nighttime procession in Soquel Lagoon (4 previous year). The lagoon water level was maintained during the event. All floats were powered by electric motor. The floats were very colorful and impressively designed. A motorized, mobile, unlit barge was also present among the floats and appeared to be a collision threat because it was unlit and moving around. Well lit water marshals were present in kayaks. Prior to the procession, a marshal was unable to prevent one float from traveling over a portion of the tules in the railroad trestle cove as it maneuvered around another float. The tules showed no damage from the incident in future days. There were no mishaps in the lagoon during or after the procession that might lead to wading in the lagoon.

			6-Oct-19 immediately prior to fish sampling					
	Flume				**Above Stockton Avenue Bridge**			0821 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)(% sat.)**	**umhos**
0.00					14.7	0.4	10.83	637
0.25					14.7	0.4	10.95	606
0.50					14.7	0.4	10.94	606
0.75					14.7	0.4	10.96	606
1.00					14.7	0.4	10.83	606
1.25b					14.7	0.4	9.53	606
1.50								
1.75								
2.00								
	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								

6 October 2019. Monitoring prior to fish sampling.

			12-Oct-2019					
	Flume			0738 hr	**Stockton Avenue Bridge**			0750 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	14.2	0.4	10.27	597	14.6	0.4	10.44	601
0.25	14.2	0.4	10.42	597	14.6	0.4	10.45	603
0.50	14.2	0.4	10.36	598	14.6	0.4	10.55	604
0.75	14.2	0.4	10.33 (101)	598	14.6	0.4	10.21	604
1.00b	14.2	0.4	9.72	598	14.6	0.4	10.23	605
1.25					14.6	0.4	10.44	604
1.50					14.6	0.4	10.46	604
1.75					14.6	0.4	10.41 (103)	604
2.00b					14.6	0.4	9.19	604
	Railroad Trestle			0808 hr	**Mouth of Noble Gulch**			0824 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	04.3	0.4	9.44	596	13.6	0.4	9.01	581
0.25	14.3	0.4	9.40	599	13.7	0.4	9.15	591
0.50	14.3	0.4	9.47	598	13.7	0.4	9.20	590
0.75	14.3	0.4	9.46	598	13.7	0.4	9.16	590
1.00	14.3	0.4	9.42	599	13.6	0.4	9.13 (88)	589
1.25b	14.3	0.4	9.27 (91)	599	13.6	0.4	8.94	589
1.38b	14.4	0.4	6.68	599				
	Nob Hill			0900 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**
	12.4	0.4	9.43	554				

12 October 2019. Gage height of 2.55 (morning) with cool, clear, cool (morning) and 2.53 (afternoon) clear and breezy in afternoon by 1548. Air temperature of 7.4˚ C at 0738 hr and 14.7 ° C at 1608 hr. Flume inlet 1 ft; flume exit 0.7 ft.

Station 1: Flume at 0738 hr- Reach 1- No gulls bathing and few on beach. No surface algae. Flume at 1608 hr- Reach 1- 56 gulls bathing and 1brown pelican in water. No surface algae. 80% bottom algae about 0.2 – 1.0 ft thick, avg 0.5 ft. 15% pondweed + algae 3-5 ft thick, avg 4 ft. Algae film on remainder.

Station 2: Stockton Avenue Bridge at 0750 hr- Reach 2- 14 coots in water, 2 mallards and 2 gulls in water. No surface algae. Reach 2 at 1548 hr- Secchi depth to bottom. 1 gull and 9 coots in water. <1% algae near surface. Surveyed vegetation before water quality measurements. 50% pondweed and algae 2 – 4 ft thick, avg 3.5 ft. 50% bottom algae 0.5 – 2 ft, avg 1 ft.

Station 3: Railroad trestle at 0808 hr- Reach 3- 6 mallards dabbling, 19 coots. Man fishing. No surface algae. At 1529 hr- Reach 3- 5 coots and 4 mallards in water. 2% algae near surface. 10% pondweed + algae 2 – 4 ft thick; avg 2.5 ft. 90% bottom algae 0.2 – 1.5 ft; avg 0.5 ft.

Station 4: Mouth of Noble Gulch at 0824 hr- No surf. algae. No gray water plume at NG mouth. At 1512 hr- still no gray water. Bottom invisible because too shaded.

Station 5: Nob Hill at 0900 hr- Water temperature at 12.4 C and 3.8°C cooler in morning than 2 weeks earlier and 2.8 C cooler in the afternoon than 2 weeks before. 2.4 cfs at Soquel Village and 1 cfs less than 2 weeks ago.

			12-Oct-2019					
	Flume			1608 hr	**Stockton Avenue Bridge**			1548 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	15.5	0.4	12.70	616	16.0	0.4	12.26	622
0.25	15.4	0.4	12.97	614	16.0	0.4	12.26	622
0.50	15.3	0.4	13.22	609	15.9	0.4	12.62	621
0.75	15.2	0.4	13.33 (133)	609	15.2	0.4	11.21	613
1.00b	15.4	0.4	13.48	610	15.0	0.4	11.27	609
1.25					14.9	0.4	11.20	608
1.50					14.9	0.4	11.10	608
1.75					14.9	0.4	11.16 (111)	608
2.00b					14.7	0.4	9.39	607
	Railroad Trestle			1529 hr	**Mouth of Noble Gulch**			1512 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	17.0	0.4	13.02	635	16.7	0.4	10.81	640
0.25	16.6	0.4	12.17	632	16.2	0.4	10.41	622
0.50	15.7	0.4	11.94	620	15.5	0.4	10.89	586
0.75	15.1	0.4	12.97	611	14.8	0.4	11.38	605
1.00	15.0	0.4	13.23	608	14.8	0.4	11.45 (112)	608
1.25b	15.0	0.4	13.64 (136)	606	14.7	0.4	10.95	618
1.40b	15.1	0.4	13.04	606				
	Nob Hill			1643 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**
	14.0	0.4	12.90	576				

			13-Oct-19 immediately prior to fish sampling					
	Flume				**Above Stockton Avenue Bridge**			0815 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)(% sat.)**	**umhos**
0.00					14.5	0.4	11.73	600
0.25					14.5	0.4	11.80	602
0.50					14.5	0.4	11.41	602
0.75					14.4	0.4	11.03	602
1.00					14.4	0.4	11.13 (109)	602
1.18b					14.4	0.4	10.41	602

13 October 2019. Monitoring prior to fish sampling.

			26-Oct-2019					
	Flume			0743 hr	**Stockton Avenue Bridge**			0809 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	15.0	0.4	8.40	616	15.2	0.4	8.52	6.15
0.25	15.1	0.4	8.47	614	15.3	0.4	8.55	618
0.50	15.0	0.4	8.41	614	15.3	0.4	8.52	618
0.75	15.1	0.4	8.30	614	15.3	0.4	8.44	618
1.00b	15.1	0.4	6.19	615	15.3	0.4	8.44	618
1.25					15.3	0.4	8.42	618
1.50					15.3	0.4	8.44	618
1.75					15.3	0.4	8.45	618
2.00					15.3	0.4	8.43 (84)	618
2.15b					15.3	0.4	8.18	619
	Railroad Trestle			0828 hr	**Mouth of Noble Gulch**			0841 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	15.2	0.4	7.75	618	15.1	0.4	8.13	619
0.25	15.2	0.4	7.71	619	15.1	0.4	7.32	616
0.50	15.2	0.4	7.71	619	15.1	0.4	7.30	616
0.75	15.2	0.4	7.73	620	15.1	0.4	7.29	616
1.00	15.2	0.4	7.72	620	15.1	0.4	7.29 (73)	616
1.25b	15.2	0.4	7.70 (77)	620	15.2	0.4	5.92	620
1.50b	15.3	0.4	6.49	620				
	Nob Hill			0906 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**
	14.0	0.4	7.19	586				

26 October 2019. Still daylight saving time and dark in morning. Gage height of 2.66 and clear in morning and 2.63, clear and breezy then windy in afternoon. Air temperature of 8.9˚ C at 0743 hr and 15.2 ° C at 1541 hr. Flume inlet 1 ft; Flume exit 0.7 ft.

Station 1: Flume at 0743 hr- Reach 1- 23 gulls bathing, 17 coots in water. No surface algae. Flume at 1541 hr- Reach 1- 86 gulls bathing, 3 coots. Bottom invisible- shaded.

Station 2: Stockton Avenue Bridge at 0809 hr- Reach 2- 20 coots in water, 4 mallards in water- 2 mallards roosting on trestle abutment. No surface algae. Reach 2 at 1527 hr- Secchi depth to bottom. 34 coots. 40% pondweed with algae 3 – 4.5 ft thick; avg 3.0 ft. 60% bottom algae 0.5 - 3.0 ft thick, averaging 1 ft.

Station 3: Railroad trestle at 0828 hr- Reach 3- 2 mallards dabbling, 2 coots, and 1 pied billed grebe. No surface algae. At 1511 hr- Reach 3- 15 coots, 1 pied billed grebe in water. No surf. algae. 5% pondweed with algae 2-4 ft thick, avg 3 ft. 95% bottom algae 0.5 - 3.0 ft thick, avg 1 ft.

Station 4: Mouth of Noble Gulch at 0841 hr- No surf. algae. No gray water plume at mouth. At 1453 hr- No gray water. 5% bright green algae at surface. 75% bottom algae 0.5 – 1.5 ft thick; avg 1 ft. 15% pondweed with algae 3 ft thick.

Station 5: Nob Hill at 0841 hr- Water temperature 14.0 C and 1.6 °C warmer than 2 weeks earlier in the morning. Stream 1 - 2 C cooler than lagoon in the morning. Nob Hill at 1453 hr- Water temperature 0.8 ˚ C warmer than 2 weeks earlier and increasing 0.8 C during day. 2.2 cfs at Soquel Village.

			26-Oct-2019					
	Flume			1541 hr	**Stockton Avenue Bridge**			1527 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	16.2	0.4	11.88	631	16.3	0.4	11.90	631
0.25	16.1	0.4	11.85	629	16.3	0.4	11.67	631
0.50	16.0	0.4	11.93	628	16.2	0.4	11.54	631
0.75	16.0	0.4	11.80 (120)	628	16.2	0.4	11.11	630
1.00b	16.1	0.4	12.25	627	16.1	0.4	10.82	630
1.25					16.1	0.4	10.54	630
1.50					15.9	0.4	9.96	628
1.75					15.7	0.4	9.71	626
2.00					15.5	0.4	8.57	624
2.15b					15.4	0.4	5.82	623
	Railroad Trestle			1511 hr	**Mouth of Noble Gulch**			1453 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	17.0	0.4	11.70	646	17.0	0.4	10.05	650
0.25	16.8	0.4	11.29	643	16.9	0.4	9.97	642
0.50	16.3	0.4	10.85	636	16.6	0.4	9.98	630
0.75	16.1	0.4	10.92	632	15.9	0.4	10.06	623
1.00	16.0	0.4	11.21	631	15.9	0.4	10.10 (102)	629
1.25b	16.0	0.4	12.67 (128)	630	15.9	0.4	12.54 (127)	643
1.45b	16.0	0.4	11.72	625				
	Nob Hill			1636 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**
	14.8	0.4	9.88	581				

			9-Nov-2019					
	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	125.6	0.4	8.15	581	12.6	0.4	8.63	580
0.25	12.6	0.4	8.53	583	12.6	0.4	8.57	584
0.50	12.6	0.4	8.40	584	12.6	0.4	8.60	584
0.75	12.6	0.4	8.37 (79)	584	12.6	0.4	8.57	584
1.00b	12.5	0.4	7.57	584	12.7	0.4	8.52	585
1.25					12.7	0.4	8.51	585
1.50					12.7	0.4	8.53	585
1.75					12.6	0.4	8.56	585
2.00					12.6	0.4	8.55 (81)	585
2.15b					12.6	0.4	7.15	585
	Railroad Trestle			0743 hr	**Mouth of Noble Gulch**			0800 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	12.3	0.4	8.32	579	12.3	0.4	8.19	556
0.25	12.3	0.4	8.32	581	12.2	0.4	7.56	573
0.50	12.3	0.4	8.33	581	12.1	0.4	8.03	579
0.75	12.3	0.4	8.29	581	12.1	0.4	8.07	578
1.00	12.3	0.4	8.31	581	12.1	0.4	8.06 (75)	578
1.25b	12.3	0.4	8.27 (78)	581	12.2	0.4	6.74	588
1.50b	12.4	0.4	5.93	582				
	Nob Hill			0831 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**
	11.3	0.4	8.98	549				

9 November 2019. Gage height of 2.67 (morning) lightly overcast. Gage height 2.69 (afternoon) clear. Air temperature 7.1˚C at 0713 hr and 13.8 °C at 1557 hr. Flume inlet 1.2 ft; flume exit 0.7 ft in afternoon.
Station 1: Flume at 0713 hr- Reach 1- No gulls or cormorants initially and 107 gulls bathing and 1 cormorant by 0813 hr, 17coots and 1 mallard initially. Back pressure in flume at high tide. No surface algae. Flume at 1557 hr- Reach 1- 115 gulls bathing, 25 coots, 1 cormorant and 2 mallards in water. No surface algae. Bottom invisible in shade.
Station 2: Stockton Avenue Bridge at 0713 hr- Reach 2- 43 coots, 1 pied billed grebe and 2 mallards in water. No surface algae. Reach 2 at 1539 hr- Secchi depth to bottom. 2 mallards, 17 coots in water. No surface algae. Bottom invisible because in shade.
Station 3: Railroad trestle at 0743 hr- Reach 3- 10 mallards dabbling, 18 coots, 8 gulls, 3 Cackling Canada geese (likely because smaller than Canada geese). No surface algae. At 1525 hr- Reach 3- 16 coots and 1 pied billed grebe. No surface algae. Bottom invisible in shade.
Station 4: Mouth of Noble Gulch at 0800 hr- No surface algae. 6 gulls on house roof just upstream of Noble Gulch. At 1511 hr- No surface algae. Bottom invisible in shade. Gray water plume at mouth with oily slick.
Station 5: Nob Hill at 0800 hr- Water temperature 11.3 C and 2.7 ° cooler than 2 weeks earlier on a

relatively cold morning and 0.8-1.3 C cooler than lagoon. Nob Hill at 1639 hr- Water temperature 2.9 ˚C cooler than 2 weeks earlier in the afternoon and 0.7-1.2 C cooler than the lagoon. 3.9 cfs in afternoon at Soquel Village gage. 1.7 cfs increase from 2 weeks previous. Stream margin more inundated than 2 weeks previous.

			9-Nov-2019					
	Flume			1557 hr	**Stockton Avenue Bridge**			1539 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	13.3	0.4	10.03	592	13.4	0.4	10.24	596
0.25	13.2	0.4	10.05	593	13.4	0.4	10.22	595
0.50	13.2	0.4	10.29	591	13.3	0.4	9.90	594
0.75	13.1	0.4	10.53 (101)	591	13.3	0.4	9.59	593
1.00b	13.2	0.4	9.86	591	13.2	0.4	9.37	592
1.25					13.0	0.4	8.39	591
1.50					12.8	0.4	8.25	588
1.75					12.8	0.4	8.11	588
2.00					12.8	0.4	7.79 (74)	587
2.15b					12.8	0.4	0.79	588
	Railroad Trestle			1525 hr	**Mouth of Noble Gulch**			1511 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	13.6	0.4	9.87	600	13.5	0.4	9.83	590
0.25	13.5	0.4	9.66	597	13.3	0.4	9.30	589
0.50	13.4	0.4	9.61	596	13.1	0.4	9.72	589
0.75	13.1	0.4	9.42	592	12.7	0.4	9.37	591
1.00	12.9	0.4	9.55	589	12.6	0.4	9.63 (91)	589
1.25b	12.8	0.4	9.53 (90)	587	12.9	0.4	19.82	619
1.50b	12.8	0.4	8.27	588				
	Nob Hill			1639 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**
	11.9	0.4	8.92 (83)	560				

			23-Nov-2019					
	Flume			0726 hr	**Stockton Avenue Bridge**			0740 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	11.6	0.4	8.39	579	11.9	0.4	8.50	582
0.25	11.6	0.4	8.39	579	11.9	0.4	8.37	582
0.50	11.6	0.4	8.32	579	11.9	0.4	8.36	582
0.75	11.6	0.4	8.28 (76)	576	11.9	0.4	8.35	582
1.00b	11.6	0.4	7.90	576	11.9	0.4	8.37	582
1.25					11.9	0.4	8.32	582
1.50					11.9	0.4	8.35	582
1.75					11.9	0.4	8.34	582
2.00					11.9	0.4	8.35 (77)	582
2.15b					11.9	0.4	7.37	582
	Railroad Trestle			0805 hr	**Mouth of Noble Gulch**			0820 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	11.3	0.4	8.62	572	11.1	0.4	8.78	569
0.25	11.3	0.4	8.50	573	11.1	0.4	8.52	569
0.50	11.3	0.4	8.50	573	11.1	0.4	8.58	568
0.75	11.5	0.4	8.51	573	11.1	0.4	8.59	568
1.00	11.5	0.4	8.50	573	11.1	0.4	8.56 (78)	569
1.25b	11.5	0.4	8.49 (78)	573	11.2	0.4	8.28	604
1.45b	11.5	0.4	7.63	574				
	Nob Hill			0853 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**
	10.6	0.4	10.13(91)	549				

23 November 2019. Gage height of 2.58 (morning) clear. Gage height 2.58 (afternoon) clear. Air temperature 7.1˚ C at 0726 hr and 13.7 °C at 1556 hr. Flume inlet 1.2 ft; flume exit 0.7 ft in afternoon.
Station 1: Flume at 0726 hr- Reach 1- 24 gulls, 17coots. Considerable tidal back pressure in flume at high tide with no saltwater entering the lagoon. No surface algae. Flume at 1556 hr- Reach 1- 89 gulls bathing, 20 coots, 1 common golden eye duck, 6 mallards being fed by restaurant and 2 mallards under bridge in water. No surface algae. Aquatic vegetation invisible in shade.
Station 2: Stockton Avenue Bridge at 0740 hr- Reach 2- 16 coots, 2 pied billed grebes, 3 golden eye, 6 mallards in water being fed by father and son, 2 mallards roosting on log under bridge. No surface algae. Reach 2 at 1542 hr- Secchi depth to bottom. 12 mallards and 1 gull being fed by people, 12 coots and 1 golden eye in water. 2 Cackling geese (look like small Canada geese) on lawn adjacent lagoon. No surface algae. Aquatic vegetation invisible because in shade.
Station 3: Railroad trestle at 0805 hr- Reach 3- 2 mallards in water, 15 coots, 2 Canada geese on bulkhead, 1 golden eye adjacent Shadowbrook Restaurant and 2 golden eye near trestle. No surface algae. At 1525 hr- Reach 3- 16 coots and 1 pied billed grebe from Reach 2. No surface algae. Aquatic vegetation invisible in shade.
Station 4: Mouth of Noble Gulch at 0820 hr- No surface algae. No gray water. 1 gull on house roof just upstream of Noble Gulch. At 1500 hr- No surface algae. No gray water. Aquatic vegetation invisible in

shade.

Station 5: Nob Hill at 0853 hr- Water temperature at 10.6 C and 0.7 ° cooler than 2 weeks earlier on a relatively cold morning and 1 C cooler than lagoon. Nob Hill at 1625 hr- Water temperature at 11/6 C and 0.3 ˚C warmer than 2 weeks earlier in the afternoon and 1.2- 1.5 C cooler than the lagoon. 7.0 cfs in afternoon at Soquel Village gage (may be inaccurate due to damming by leaves). 3 cfs increase from 2 weeks previous, which seems unlikely. Stream margin less inundated than 2 weeks previous.

			23-Nov-2019					
	Flume			1556 hr	**Stockton Avenue Bridge**			1542 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	13.3	0.4	10.03	592	13.4	0.4	10.24	596
0.25	13.2	0.4	10.05	593	13.4	0.4	10.22	595
0.50	13.2	0.4	10.29	591	13.3	0.4	9.90	594
0.75	13.1	0.4	10.53 (101)	591	13.3	0.4	9.59	593
1.00b	13.2	0.4	9.86	591	13.2	0.4	9.37	592
1.25					13.0	0.4	8.39	591
1.50					12.8	0.4	8.25	588
1.75					12.8	0.4	8.11	588
2.00					12.8	0.4	7.79 (74)	587
2.15b					12.8	0.4	0.79	588
	Railroad Trestle			1521 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	13.6	0.4	9.87	600	13.5	0.4	9.83	590
0.25	13.5	0.4	9.66	597	13.3	0.4	9.30	589
0.50	13.4	0.4	9.61	596	13.1	0.4	9.72	589
0.75	13.1	0.4	9.42	592	12.7	0.4	9.37	591
1.00	12.9	0.4	9.55	589	12.6	0.4	9.63 (91)	589
1.25b	12.8	0.4	9.53 (90)	587	12.9	0.4	19.82	619
1.50b	12.8	0.4	8.27	588				
	Nob Hill			1625 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**
	11.6	0.4	9.14	554				

26 November 2019. Facilitated Sandbar Breach. Fish biologist was notified by Morrison, contractor working for Capitola Public Works at approximately 1930 hr that the lagoon water surface was rising quickly and was presently at 16 cfs at Soquel Village. Alley prepared for traveling down to the lagoon and headed that way, receiving another call from Morrison in transit in which he stated the gage reading was above 20 cfs. Alley reached the lagoon at approximately 2230 hr after driving through a continuous torrential down pour from Brookdale to Capitola, the heaviest he had ever driven through. Traffic was moving at only 25-30 mph on Highway 17 and 40 mph on Highway 1 due to poor visibility through the rain and wind. By 2030 the gage reading in Soquel Village had reached 51 cfs and the lagoon water surface was rising quickly. The flume capacity was only in the range of 25-30 cfs. The joint decision made between Morrison and Alley was to facilitate the breaching of the sandbar to avoid imminent flooding. Then the equipment operator, Cooper, began to cut a 10-foot wide notch through the berm at the lagoon periphery. This was accomplished by 2045 hr. Water began spilling through the notch at 2052 hr. The gage reading at 2045 hr was 71.8 cfs. The lagoon water surface had increased 6 inches in 15 minutes to above the top of the flume inlet prior to the breaching and prior to these higher flows reaching the lagoon. Stormflow was obviously greater than the flume capacity at the time of breaching to cause water surface elevation to rise quickly. Rainfall ceased abruptly soon after the breaching, and stormflow at Soquel Village rapidly declined to a minimum of 13.9 cfs at 2315 hr. However, rainfall resumed later, with stormflow again rising to 40 cfs as early as 0115 hr on 27 November. Stormflow was sustained above 30 cfs at the gage and above the capacity of the flume to convey water from 0015 hr to 0545 hr on 27 November, which would have again caused flooding along the lagoon margin without the facilitated breach. 4 boards had been previously removed from the flume inlet to provide 12 inches of vertical opening prior to the storm. Kotila from Public Works collected a water sample in the lagoon earlier in the afternoon on 26 November, prior to breaching, and another on the morning of 27 November in the surf near the exiting stream channel from the estuary and delivered the 2 samples to Monterey Analytical. Streamflow at Soquel Village gage-

28.4 cfs at 2000 hr;
51.1 cfs at 2030 hr;
71.8 cfs at 2045 hr;
36.5 cfs at 2100 hr
13.9 cfs at 2315 hr;
40.0 cfs at 0115 hr;
31.8 cfs at 0545 hr.

No fish mortality or water quality problems were observed during the facilitated breaching. Streamflows are provisional and subject to change. Streamflow at the lagoon was somewhat higher than in Soquel Village due to surface runoff in Capitola and contributions from Noble Gulch.

Lab analysis indicated that the pre-breach enterococcus bacterial count was 10 cfu/100 ml. The post-breach count was 1010 cfu/100 ml, requiring additional weekly water sampling.

27 November 2019. The day after the facilitated sandbar breach. Biologist arrived at the lagoon at 1450 hr. The sandbar was closed to the Bay at low tide, with the flume passing water at high capacity. See photos. The lagoon was full, with the water surface above the flume inlet. Gage height 2.98 (Top of the flume is at 2.60). The water was turbid with secchi depth of 18 inches. Water was fresh in the upper half meter, with gradual salinity increase to 22.5 ppt at the bottom. Refer to the table. This indicated tidal mixing had occurred when the sandbar was open at higher tide. Oxygen levels were good from the surface to the bottom. Water temperature was cooler than 4 days previously. No water quality problems were observed for aquatic life. No fish mortality was observed. The flume was conveying water through the lagoon and out to the Bay during low tide when the sandbar was closed.

			27-Nov-2019					
	Flume				**Stockton Avenue Bridge**			1510 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					9.9	0.7	11.06	922
0.25					9.8	0.7	10.92	953
0.50					10.4	3.8	10.40	4985
0.75					10.7	13.2	9.03	15869
1.00					11.0	16.9	8.85	20186
1.25					11.1	18.4	8.27	21858
1.50					11.2	20.0	8.68	23645
1.75					11.3	21.3	8.47	25130
2.00					11.4	22.1	7.99	26014
2.25b					11.5	22.5	6.90	26534
	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								
1.25b								
1.50b								
	Nob Hill							
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**

Outlet channel through sandbar after facilitated breach. 26 November 2019

Lower lagoon at low tide after breach the night before. 27 November 2019

Lagoon, looking upstream from Stockton Avenue Bridge. 27 November 2019

Outlet channel at low tide. 27 November 2019

Flume outlet conveying lagoon water and maintaining water transfer through lagoon during low tide.
27 November 2019

APPENDIX B. 2019 Drain Line Test for Restaurants Contiguous with Soquel Creek Lagoon.

done NM

2019 DRAIN LINE TEST FOR RESTAURANTS CONTIGUOUS WITH SOQUEL CREEK				
RESTAURANT	**INITIAL CONTACT**	**TEST DATE**	**COMMENTS**	**SIGN OFF**
MY THAI BEACH 207 Esplanade	LW 4/11/19	4-29-19	Test approved.	NM
BAY BAR 209-B Esplanade	[signature] 4-11-19	5-3-19	Test approved	NM
PIZZA MY HEART 209-A Esplanade	[signature] 4-11-19	5-3-19	Test approved	NM
SAND BAR 211 Esplanade	Jake Chapnick 4-11-19	5-7-19	Test approved	NM
PARADISE BAR & GRILL 215 Esplanade	nicole allen 4/11/19	5-22-19	Test approved. Lagoon closing date extended due to rain	NM.
ZELDA'S 203 Esplanade	[signature] 4/11/19	5-9-19	Test approved	NM