D.W. ALLEY & Associates aquatic biology

Soquel Lagoon Monitoring Report- 2021

(Sampling for Tidewater Goby under USFWS Endangered Species Recovery Permit TE-793645-4)

Steelhead Reared in Soquel Lagoon, October 2021

Flume Interior during Final Inspection after Rehabilitation, April 2021

Prepared for the
CITY OF CAPITOLA, 420 Capitola Avenue, Capitola, California 95010
D.W. ALLEY & Associates, Aquatic Biology

January 2022 **Project # 106-31**

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

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SOQUEL CREEK LAGOON MONITORING REPORT, 2021

ACKNOWLEDGMENTS

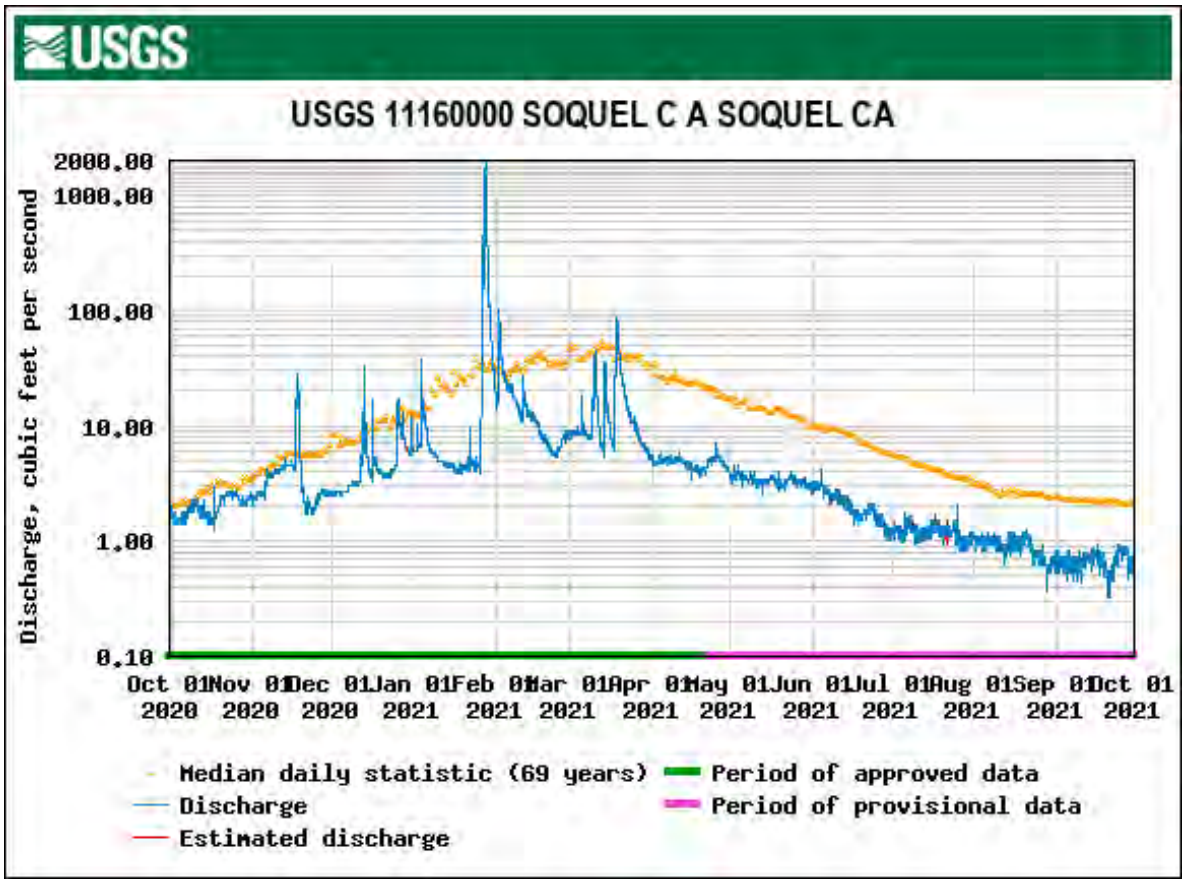
Ed Morrison and the Capitola Public Works Department did well in constructing the sandbar preparing the flume and maintaining the lagoon in 2021. We appreciate that Matt Kotila, as heavy equipment operator and field supervisor, and Ed Morrison, as consultant contractor and former Public Works supervisor, teamed to daily monitor the lagoon. They adjusted the flume inlet as needed to maximize lagoon depth, light penetration to the bottom, to maintain oxygen levels and provide steelhead passage through the flume as baseflow declined. 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 in relocating fish from the lateral channel prior to sandbar construction in May. We thank Steve Needens for weekend beach and sand berm maintenance and for keeping the flume inlet and outlet clear through the dry season. 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, despite the COVID-19 virus threat. They were local residents and other volunteers interested in preserving the steelhead population in Soquel Creek. Robin Aston, math teacher at Soquel High School, 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. College students, Nigel Circhir, and his friend, Zoe, returned to assist in capturing fish and recording data. Biologists Josie Moss, 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 their measure. 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.

Pulling in the Beach Seine to Census the Steelhead Population in Soquel Lagoon. October 2021

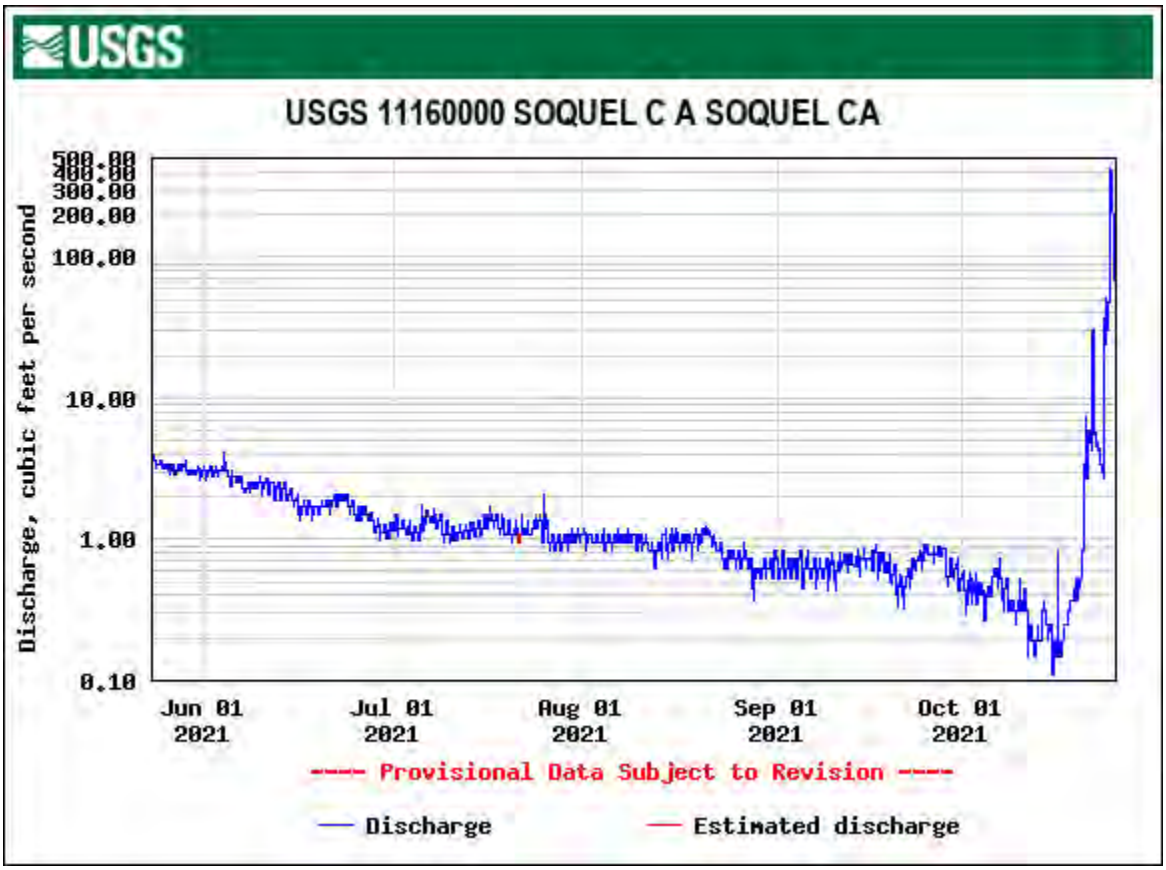
REPORT SUMMARY

As per the 2021 permit conditions, sandbar construction began on 24 May 2021 and was completed on 1 June 2021. Over the past winter, there had been only one significant stormflow, occurring in late January, during a relatively very mild winter. From November 2020 until late January 2021, only 4 small stormflows of less than 40 cfs occurred. The late January stormflow reached near 2,000 cfs and was above bankfull (a stormflow with 1.5−2-year frequency). Then 4 more small stormflows between 30 and 100 cfs occurred from February to mid-March, with 3 coming in the first 3 weeks of March. No stormflows occurred after that which could have provided upstream steelhead spawning passage later in the season. Streamflow had declined to 3.7 cfs (0600 hr) on 24 May 2021 at the Soquel Village USGS gage when sandbar construction began. The sandbar was naturally closed to the Bay at low tide at the beginning of that day.



As required in permits, a fishery biologist was present during all activities that could affect the fish habitat in the lagoon/estuary during sandbar construction. This was our thirty-first year of monitoring and assisting in activities associated with sandbar construction at Soquel Creek Lagoon. Annual monitoring reports for the first 30 years are available at the City (**Alley 1991-2021**). As stated in the Soquel Lagoon Management and Enhancement Plan (**1990**) and 2004 Soquel Creek Lagoon Management and Enhancement Plan Update (**2004**), all instream removal of kelp, sea grass and other organic debris was to be done without heavy equipment in the stream channel.

Kelp and seagrass were present in the estuary prior to sandbar construction. The estuary bottom was soft with considerable decomposing plant material downstream of Stockton Bridge and along the margins upstream. Raking out of decomposing plant material was of limited value because most material had decomposed into soft ooze which could not be easily dislodged or transported out with the limited streamflow. With the very low baseflow and high amount of decomposing material, it was decided that raking was inappropriate in 2021. The concern was that water quality problems for fish may develop from raking that would yield little success in removing sources of biological oxygen demand after sandbar closure. The lagoon depth in Reach1 had increased from the previous year, with apparent scour occurring during the bankfull event in January. The typical lateral channel had developed across the beach in the spring prior to sandbar construction, with a slow-moving stream channel to the surf zone that went diagonally across the beach to the upper end of the rock jetty, which had been rehabilitated the previous winter. Wood had collected at the creekmouth, which was closed at low tide. Only two artificial sandbar breachings with only partial drawdown were necessary during sandbar construction.



As the dewatering occurred the first day of sandbar construction, fish relocated from the lateral channel included 15 tidewater gobies (*Eucyclogobius newberryi*) captured at the upper end of the lateral channel with no young-of-the-year individuals detected, 52 small juvenile staghorn sculpins (*Leptocottus armatus*) and 21 threespine sticklebacks (*Gasterosteus aculeatus*). No fish mortalities were observed. 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.

Prior to sandbar construction, the plumbing of Esplanade businesses was inspected for leaks by

City staff, and repairs were made as necessary. Steelhead passage was maintained at night through the flume during sandbar construction that was completed on 1 June. On 1 June, 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, and the sandbar was closed for the season by Kotila at 1235 hr. The tules planted 4 years previously in the cove beneath the railroad trestle had survived the relatively mild winter and were growing well to provide improved backwater habitat for tidewater goby.

No stream underflow beneath the flume was evident near the flume outlet through the monitoring period, indicating that repair of the flume and placement of cut-off walls beneath the flume the previous spring were apparently successful in sealing cracks and preventing leaks. The flume's interior was now lined with fiberglass and a protective resin (note photo on the cover page). This was a very positive improvement that insured that the City could continue to operate the flume and create good steelhead nursery habitat in the future.

Cut-off wall to be secured under the flume. 8 February 2021

Cut-off wall being secured to pilings under the flume. 8 February 2021

Sandbar Opening. On 18-19 October 2021, Kotila cut a 30-foot wide notch across the beach with an inner berm constructed near the lagoon periphery and an outer berm constructed near the surf to prevent wave action with high swells to open the sandbar without stormflow. In preparation for the first major storm forecasted in the winter season to occur on 24 October 2021, the shroud was removed from the flume inlet on 19 October. On 21 October after a small stormflow of 7 cfs, the underwater portal was opened on the flume inlet. On 23 October after a brief stormflow of 30 cfs and prior to the 24 October stormflow that required opening the sandbar, two 4x4 flashboards were removed from either side of the flume inlet in preparation for the next predicted stormflow. At 0500 hr on 24 October, Kotila reduced the height of the outer berm to minimize hydraulic head on the lagoon at the time of sandbar opening so as to minimize estuary evacuation and to minimize water velocity. After rain overnight, the lagoon water surface had risen to the piling bolt on 24 October to signal the need to breach the sandbar. Streamflow estimated at the Soquel Village gage was 30 cfs and rising. The flume capacity is in the 25-30 cfs range. Kotila opened the sandbar with the tractor at 0610 hr to prevent flooding. Streamflow increased to about 50 cfs midday and declined back down to 30 cfs before it increased abruptly to approximately 500 cfs at the gage in the early morning of 25 October. By midday, Soquel Creek flow had declined to approximately 200 cfs at the gage, with the estuary extending from bank to bank with ample deep water habitat. No fish mortality or water quality problems were observed during the sandbar opening.

Lagoon Depth. The lagoon level was rated "good" throughout the monitoring period. The sandbar was breached to prevent flooding on 24 October due to stormflow that exceeded the capacity of the flume. Gage height in 2021 was consistently near the highest recorded through the last 4 years at above a gage height of 2.50 until mid-October, after which the sandbar was breached (**Figure 2**). 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. During the summer of 2021, baseflow was consistently low, allowing good management of the flume inlet to maximize lagoon depth through the dry period.

Water Temperature. Lagoon water temperature was within the tolerance range of steelhead in 2021 but was likely stressful from June through August. A water temperature management goal is to maintain dawn water temperature near the bottom below 20° C. This goal was met only 2 days in the first 10 weeks at the data logger location and only a third of the days for the following 4 weeks to 15 September (**Figure 4a**). Water temperatures near the bottom went from poor to fair through the summer and did not cool to the "good" range below 20°C at most sites until late August (**Tables 2 and 3**). Water temperature was critically high near the bottom in June at Station 2 below Stockton Bridge, where a stagnant saltwater lens existed. It had dissipated by 22 June at the data logger location downstream of the railroad trestle and by 25 July at the Venetian Court wall. The early morning goal was exceeded at Station 2 on 7 of 10 monitorings, at Station 1on 5 of 10 monitorings, at Station 3 on 5 of 10 monitorings and at Station 4 on 2 of 10 monitorings. Average morning water temperature for the 4 lagoon monitoring sites was in the 20-21.5°C range on 4 of 10 monitorings (**Figure 3i**).

Another management goal is to have afternoon water temperature near the bottom not exceed 22°C. This goal was not met in 2021 at the data logger location for 8 of the first 10 weeks after sandbar closure until mid-August and then was met afterwards until sandbar breaching (**Figure 4a**). This goal was exceeded at Station 2 on 4 of 10 monitorings, at Station 1 on 3 of 10 monitorings, at Station 3 on 2 of 10 monitorings and was met at Station 4 at the mouth of Noble Gulch. The warmest water temperatures were from mid-June to mid-August when average afternoon water temperatures were in the 22-23°C range on 4 of 10 monitorings (**Figure 3j**).

A third lagoon management goal is to maintain the daily 7-day rolling average temperature at 21°C or less near the bottom. In 2021, this goal was met at the data logger location for a week in mid-July out of the first 10 weeks to mid-August and then afterwards (**Figure 4a**). In 2020 with higher baseflow from Soquel Creek, this goal was met at the data logger location except for a week in August (**Figure 4g**). The annual trend in 7-day rolling temperature averages with respect to the maximum, average and minimum for the dry season indicates that they increase substantially in dry/drought years when stream inflow rate is much reduced (**Figure 4i**).

Stream Inflow and Influence on Lagoon Water Temperature. Lagoon water quality is generally best with higher summer baseflow from the cooler Soquel Creek. The 2021 Soquel Creek baseflow through the dry season was much below the median flow (**Table 9; Figures 25–26**). With less inflow, especially in June – August, lagoon water temperature heated up more during the day and cooled off less at night, as indicated by higher average lagoon water temperature at dawn and in the afternoon in 2021 and 2015 (another drought inflow year)

(**Figures 3i and 3j**). We observed cooler lagoon water temperature in 2019 (much higher inflow) than in 2021 (low inflow) for the months of June through August (**Figures 3a-3d**). 2015 had relatively warm air temperature, warm inflow and very high lagoon water temperatures at dawn and the afternoon. To maximize summer baseflow, water percolation into the aquifer during the rainy season must be maximized, and surface runoff must be minimized. Summer surface 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. Lower Soquel Creek maintained its continuity in 2021.

Aquatic Vegetation. Kelp and seagrass were present in the estuary prior to sandbar construction. The estuary bottom was soft with considerable decomposing plant material downstream of Stockton Bridge and along the margins upstream. Raking out of decomposing plant material was of limited value because most material had decomposed into soft ooze which could not be easily dislodged or transported out with the limited streamflow. It was decided that raking was inappropriate in 2021.

In 2021, bottom algae developed quickly and was thickest in August but lost some thickness and percent bottom coverage in September and October when pondweed became thicker and occupied a higher percentage of the lagoon bottom (**Table 5**). Pondweed was more abundant and algae was thicker in Reach 3 (above the railroad trestle) than Reach 2 (between Stockton Bridge and the railroad trestle). At the mouth of Noble Gulch and in the lagoon downstream, bottom algae was thickest in July but declined as pondweed covered more of the bottom and thickened through the summer and fall. The lagoon bottom in Reach 1 was largely invisible in 2021.

In 2021, unlike in 2017−2019, pondweed proliferated and dominated lagoon coverage in August through mid-October much more than in 2017−2019. Surface algae was more prominent in 2021 than in the previous 2017−2019 monitoring years (**Tables 6-8**). Surface algae was also relatively high in previous drought years of 2014 and 2015. As was typical of past years, surface algae was more abundant at the mouth of Noble Gulch than elsewhere, with a maximum of 25% coverage in mid-October of 2021.

Oxygen Concentration. No stressfully low oxygen concentrations for steelhead were detected in 2021 except near the bottom at Station 2 (near Stockton Bridge) in mid-June, when a stagnant saltwater lens was present (**Table 3; Figure 6a-1**). Oxygen concentrations near the bottom at dawn were in the "good" range (>7 mg/L) at the other 3 monitoring stations throughout the monitoring period except 6.99 mg/L at Station 1 on 22 August. At Station 2 near the bottom, oxygen was "critically" low on 13 June, "fair" on 27 June and "good" at the next 8 monitorings. Oxygen levels were in the good range in the upper water column above the saltwater lens in the first 1.25 m from the surface at dawn at Station 2. The 4-station lagoon average near the bottom at dawn was above 7 mg/L (good range) at 8 of 10 monitorings, the exceptions being the first 2 monitorings in June in the fair range (5-7 mg/L) when the low readings at Station 2 brought the average down (**Figure 6b**). The dip in the average oxygen concentration at dawn on 22 August came after 2 days of overcast skies that diminished plant photosynthesis and oxygen production in the lagoon. Afternoon oxygen levels near the bottom were above 7 mg/L (good range) at all sites during all monitorings except for the first monitoring (13 June) at Station 2 (poor range) (**Figure 6a-2**).

Salinity. In 2021, a saline layer was detected along the deep area adjacent to the Venetian Court wall on 5 June. Initially it was between 1.5 and 2 feet thick (0.5 to 0.75 m), and created very warm, low oxygen conditions within. Steelhead inhabiting this area would avoid the poor water quality conditions within the saltwater lens by living higher in the water column. On 7 June, a shroud was installed on the flume inlet on the restaurant side to draw saltwater from the bottom out of the lagoon. By 27 June, the saltwater lens was thinner and less than 1 foot (0.25 m) thick. By our monitoring on 10 July, the saltwater lens was less than 1 foot thick. At depth 1.75 m, salinity was 0.7 ppt (21.7 C morning water temperature). At the bottom at 2 m, salinity was 9.7 (24.9 C morning water temperature). By our monitoring on 25 July, the saltwater lens had dissipated with salinity 0.6 ppt through the water column and no morning temperature stratification (20.5 C at the bottom). Tidal overwash occurred the evening of 19 August, which increased the salinity to only 1.8 ppt (21.6 C morning water temperature) at dawn on 22 August. By afternoon, the saltwater had dissipated. A freshwater lagoon was maintained until the sandbar breach on 24 October.

Fish Sampling Results. A total of 335 steelhead were captured and 299 retained, measured and marked on 3 October after 5 seine hauls. This indicated that juvenile steelhead were abundant in the lagoon in 2021. There were 4 mortalities. A total of only 19 steelhead were captured on 10 October in 7 seine hauls. There was one recapture and no mortalities. A reliable estimate of population size was not possible by using the Lincoln Index because it appeared that juvenile steelhead captured on 3 October did not randomly redistribute throughout the lagoon after release. It appeared instead that most steelhead moved upstream beyond our sampling zone during the week between samplings. A Soquel Creek Water District waterline broke and emptied considerable treated drinking water into Noble Gulch and then into lower Soquel Lagoon in between fish sampling weekends. Considerable floating duckweed also entered the lagoon from Noble Gulch. No fish mortalities were observed after the water spill, and threespine stickleback were common in our 3 and 10 October seine hauls, indicating a lack of mortality of this species after the spill. According to Capitola staff reports, the lower lagoon remained turbid for 2 days after the water input. This turbidity hampered visual feeding by steelhead and apparently caused most of the juvenile population to redistribute further upstream and out of reach of our 10 October seining effort. We expected the juvenile steelhead to spread out and eventually repopulate the lower lagoon after our 10 October sampling was completed. Our permit did not allow further sampling.

A rough 2021 steelhead population estimate was based on catch per unit effort comparisons in 2021with 2019 and 2020 catch per unit effort rates when we had population estimates for those years. Thus, we obtained a population estimate of 2,500 for 2021. This population estimate was above average and above the median compared to the 27-year average of 1,529 (median= 928), including the 2021 estimate (**Table 10; Figure 24**). Steelhead young-of-the-year were relatively large in 2021 despite warm water conditions that increased food demands, and the juvenile steelhead population estimate was relatively high (**Table 11; Figure 7a**). Spawning had likely been successful in the lower mainstem near the lagoon to seed the lagoon with YOY, and many 2020 YOY likely resided in the 2021 lagoon as yearlings.

Bird Counts. Mergansers were commonly observed in 2021 as they had been in other drought

years, 2013−2015 (**Table 13)**. Other piscivorous birds observed in 2021 included pied-billed grebe, great blue heron, cormorant, snowy egret, and common egret. Pied-billed grebes were especially abundant in late summer/fall, with as many as 5 observed on 16 October. One was observed capturing a sculpin earlier in summer. Egrets were observed in October. A very active red-necked phalarope *(Phalaropus lobatus)* was feeding on surface food items near the flume inlet during sandbar construction on 24 May. A white-faced Ibis (*Plegadis chihi*) probed the sand for food along the Reach 1 margin near Venetian Court on 2 October.

Recreational Use. Due to changes in COVID-19 protocol, a nautical parade was held during the Capitola Beach Festival. City staff did not receive notice of the event. Therefore, the biologist was not present for monitoring. In 2021 as in past years, the lagoon near the beach was posted with warning signs about potential health risks. However, greater 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 9 of 10 afternoon monitoring in 2021), along with kayakers, pedal boaters, row boaters, canoers and barge users. In 2021, the most paddle boarders counted in a reach were 6 in Reach 3 on 27 June. Waders and swimmers were commonly observed in the lagoon during weekend afternoon monitoring in past years but less so in 2021 (usually near the beach in Reach 1; 2 of 10 afternoon monitorings in 2021). The most waders seen at one time in 2021 was 12 on 13 June in Reach 1. Vegetation was trimmed to expose the no fishing sign along the lagoon path to discourage illegal fishing. None was observed in 2021.

LAGOON AND ESTUARY FORMATION

Results of Fish Relocation During Construction Activities

24 May 2021. The usual lateral channel developed across the beach prior to sandbar construction, and went diagonally across the beach to the outer end of the jetty. On 24 May, 13 seine hauls were made up the lateral channel that was uniformly sandy without rocks or cobbles to afford pockets of shelter from moving water. The wetted channel was beyond the rip-rap boulders adjacent to Zelda's Restaurant at the upstream end of the lateral channel. Therefore, they offered no fish cover. The last 50 feet of the lateral channel before reaching the jetty was too deep to effectively search for fish. We had the City's operator, Kotila, slowly grade a dam across the lateral channel at the upstream end of this section to allow it to partially drain and shallow. The abundance of kelp in this section prevented effective seining for fish. Thorough probing with dipnets through the kelp offered no evidence of fish life. The remainder of the lateral channel upstream of the dam was seined in an upstream direction, with fish relocated above the Stockton Avenue Bridge. A 30-foot long, 4-feet high, 1/8-inch meshed beach seine was used by Alley and Cooper Sanden from Capitola Public Works. The first 8 seine hauls yielded no fish. A low dam was pushed across the upstream end of the lateral channel when seining was completed. Kotila slowly covered over the lateral channel with sand from downstream to upstream after seining was completed. Alley observed this process to capture any additional fish that would appear beyond the sand spreading into the channel. Fish relocated included 15 tidewater gobies (*Eucyclogobius newberryi*) captured at the upper end of the lateral channel with no young-of-the-year individuals detected, 52 small, juvenile staghorn sculpins (*Leptocottus armatus*) and 21 threespine sticklebacks (*Gasterosteus aculeatus*) (**Table 1**). There were not fish mortalities observed.

On 27 May and 1 June when an outlet channel was created beside the flume to reduce lagoon depth, no stranding was observed along the lagoon margin below Stockton Bridge. Survey for stranded fish upstream of Stockton Bridge was unnecessary because the lagoon width was maintained during lagoon drawdowns.

Table 1. Observation and relocation of fish during sandbar construction, 2021.

Date	Location	Tidewater goby (Observed/ Relocated)	Juvenile Steelhead (Observed/ Relocated)	Threespine stickleback (Observed/ Relocated)	Staghorn sculpin (Observed/ Relocated)	Prickly sculpin (Observed/ Relocated)
5-24-2021	Lateral Channel	15/15	0/0	21/21	52/52	0/0
5-27-2021	Downstream of Stockton Ave Bridge	0/0	0/0	0/0	0/0	0/0
6-01-2021	Downstream of Stockton Ave Bridge	0/0	0/0	0/0	0/0	0/0

Monitoring of Flume Maintenance and Sandbar Construction

24 May 2021. The fishery biologist, Alley, arrived at 0545 hr, prior to heavy equipment operation. The gauged discharge at Soquel Village was 3.9 cfs at 0600 hr. The estuary was partially full to within 2 feet of the top of the flume, with the flume inlet naturally isolated from the estuary with sand. There was significant sand deposited on the beach after a dry winter/spring. The typical lateral channel developed across the beach prior to sandbar construction, and went across the beach to the upper end of the jetty. With the especially low baseflow in spring 2021, the sandbar often closed at low tide and opened at high tide for several weeks prior to 24 May. The sandbar was closed at low tide on 24 May, and the lateral channel was wide (25−30 feet wide) and pond-like. The bottom was uniformly sandy. The bull-dozer was checked for fluid leaks before it was operated this day, and none were found. The flagged beach around the bull-dozer was inspected for animals before it was moved. The lagoon periphery was surveyed for salmonids up to Noble Gulch, 0635 hr – 0700 hr, with none observed. The lateral channel was partially blocked off 50 feet upstream of the jetty at 0910 hr. A small outlet channel was created along the jetty with the bulldozer, and this lower section was allowed to shallow. Then it was thoroughly probed with dipnets for fish through clumps of kelp. Above the dam, the lateral channel was seined for fish in an upstream direction to near the flume inlet until 1235 hr. A low-lying dam was constructed across the upstream end of the lateral channel to prevent fish from entering the channel after seining and to allow water to spill over into the lagoon as the lateral channel was covered over with sand from downstream to upstream after seining was completed. The bull-dozer operator, Matt Kotila, did not cut an outlet channel along the flume this day, but instead connected the flume inlet to the estuary. The lagoon outflow was directed through the flume that flushed out remaining sand from inside. No extra flushing of sand with pumped water through the flume man-holes was necessary in 2021. An unusual bird for the lagoon was observed near the flume inlet- a red-necked phalarope (*Phalaropus lobatus*). They swim around rapidly and stir up plankton in deeper water or bottom-dwelling invertebrates in shallows with their feet, picking them off the water surface or near the water surface for food. Kotila covered the lateral channel with sand and 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 1536 hr with overnight steelhead smolt access provided to the Bay through the flume with the lagoon water surface within approximately 1 foot of the top of the flume.

Sandbar closed along the jetty at low tide. 24 May 2021

Lateral channel ponded diagonally across the beach, looking upstream toward the flume. 24 May 2021

Kotila covering the lateral channel after fish relocation. 24 May 2021

Steelhead passage provided through the flume by the end of the day. 24 May 2021

Very active red-headed phalarope in lower lagoon. 24 May 2021

25 May 2021. The biologist arrived at 0600 hr prior to equipment operation. The flume was functioning as it outletted water from the lagoon. The lagoon water level was at the top of the flume. 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 again 3.9 cfs at 0600 hr. The sand berm around the lagoon margin remained overnight, and the lagoon surface had remained within 1 foot of the top of the flume. The water depth of the highest flashboard was 4 inches this morning. Smolt steelhead passage through the flume had been maintained overnight. The lagoon periphery was walked by the fishery biologist, 0615 hr – 0745 hr, and no fish or mergansers were observed. No outlet channel was cut alongside the flume this day. Sand was stockpiled along the lagoon periphery, especially just east of the flume. Streamflow continued to flow through the flume and provide steelhead smolt passage over the oncoming night. The biologist left the lagoon at 0830 hr after work around the lagoon margin was ended.

Lateral channel conversion to beach completed the previous day. 25 May 2021

Lagoon spilling over flashboards with smolt passage previous night. 25 May 2021

Streamflow passing through the flume the previous night for smolt passage. 25 May 2021

Lower lagoon viewed downstream from Stockton Bridge to flume inlet. 25 May 2021

Upper lagoon viewed from Stockton Bridge upstream. 25 May 2021

26 May 2021. No grading work was scheduled or occurred near the lagoon periphery this day. No monitoring was required. Kotila checked for leaks in the bulldozer and inspected around it prior to operation this day. The sandbar was left intact. Sand grading occurred from the lower beach to the upper beach. Flashboards were added to the flume inlet, with a screened frame at the top (constructed by Morrison) with an unscreened adult and smolt passage portal in the middle. Streamflow continued through the flume unimpeded this day and through the night to provide steelhead smolt passage to the Bay. Morrison observed a group of 5 mergansers (2 males and 3 females) in the lower lagoon in the morning.

27 May 2021. The fishery biologist arrived at 0530 hr. The lagoon periphery was walked by the fishery biologist, 0535 hr – 0600 hr, and no fish or mergansers were observed. The gauged discharge at Soquel Village was 3.6 cfs at 0600 hr. The lagoon water surface had increased to within approximately 8 inches from the top of the flume with 4 inches depth over the uppermost flashboard overnight, allowing adult and smolt passage through the unscreened portal. Kotila checked for bulldozer leaks and animals before operating the bulldozer. He opened an outlet channel cut adjacent to the flume at 0615 hr and closed off the flume inlet with sand. Streamflow slowly drained through the outlet channel that varied in width between 10 and 15 feet by 0642 hr with a visually estimated outflow of 8 cfs. No fish were observed to pass through the outlet channel. The lagoon drained approximately 0.7 foot per hour down 2 feet so that Kotila could create a flat pad around the flume inlet. The approximate 2 feet of drawdown was similar to a typical tidal fluctuation from high to low tide. The smooth, bathtub-like lagoon periphery receded approximately 2−4 feet in width along the beach, downstream of the Stockton Bridge during the drawdown. The shoreline in shallow Margaritaville Cove receded approximately 15 feet, as it typically did during low tide when the sandbar was naturally open to the Bay in April,

as observed by Alley during flume rehabilitation. No stranded fish were observed during the lagoon drawdown. Upstream of Stockton Bridge with the vertical bulkheads present, the lagoon did not narrow. This made surveying for stranded fish unnecessary upstream. The sand pad was completed by 0845 hr, and the flume inlet was now reconnected to the lagoon to allow water passage through. The last of the Esplanade restaurants passed inspection for plumbing leaks (**Appendix A**). The outlet channel was dammed by 0915 hr. Kotila filled in the outlet channel and compacted the sand berm around the lagoon periphery. The biologist left at 1400 hr.

Lagoon filled overnight with added flashboards and screened frame having an unscreened steelhead passage portal in the center. 27 May 2021

Outlet channel. 27 May 2021

Receded lagoon margin immediately after sandbar closure. 27 May 2021

Receded lagoon margin immediately after sandbar closure. 27 May 2021

Lagoon width maintained upstream of Stockton Bridge during flume preparation. 27 May 2021

28 May 2021. The biologist arrived at 0846 hr to assess smolt passage conditions. Kotila observed that water was flowing out of the flume when he started work at approximately 0600 hr, indicating that smolt passage was available for at least a portion of the night. He checked for bulldozer leaks and animals around it prior to moving it. By 0900 hr, water was spilling over the uppermost flashboard through the passage portal with 4 inches of depth. This 4-inch depth was maintained to the flume exit. Streamflow at the Soquel Village gage was recorded as 3.6 cfs at 0600 hr. Sand was being graded to the level of the wooden deck beside Zelda's Restaurant and compacted around the lagoon periphery with the bulldozer. No stream underflow beneath the flume was evident near the flume outlet, indicating that repair of the flume and placement of cut-off walls beneath the flume the previous spring were apparently successful in sealing cracks and preventing leaks. The flume's interior was now lined with fiberglass and a protective resin. The biologist left at 0945 hr with steelhead smolt passage through the flume assured through the Memorial Day weekend. The sidewalk grates were covered previously to prevent cigarette butts from accumulating in the sidewalk drains.

Water flowing over screened flashboards and through unscreened passage portal to provide steelhead passage to the Monterey Bay. 28 May 2021

Flume outfall. 28 May 2021

1 June 2021. The biologist arrived at 0600 hr prior to operation of the bulldozer. The bulldozer was checked for leaks and the area around it was checked for animals prior to moving it. Alley walked the lagoon periphery, 0635 hr – 0655 hr, and no fish or mergansers were observed. Streamflow was spilling through the adult/smolt passage portal at a depth of 4 inches, indicating successful passage access to the Bay over the past weekend. Streamflow was estimated at the Soquel Village gage to be 3.3 cfs at 0600 hr. No evidence of stream underflow beneath the flume was observed near the flume outlet. Kotila opened an outlet channel adjacent to the flume at 0700 hr. No fish were observed to pass through the outlet channel. One merganser was observed fishing downstream of the Stockton Bridge near the restaurants in early morning. No fish capture by it was observed. The flume inlet was closed off with sand after 0850 hr to evacuate water inside. A new weir (constructed by Morrison) was then installed inside the flume by Sanden near the flume inlet and before the fiberglassed section. The weir would insure a 1-foot deep splash pool for steelhead headed toward the Bay as they entered the flume inlet over the flashboards. The lagoon was reconnected with the flume inlet with water flowing into the flume by 1200 hr. The outlet channel next to the flume was dammed for the dry season at 1235 hr. The approximately 2 feet of drawdown over a 5-hour period was similar to a typical tidal fluctuation from high to low tide. Then Kotila flattened the pad around the flume inlet above the water surface to stop the flow of water through the flume. The pad was then covered with clear visquine by Public Works staff, secured with sandbags and covered with sand by hand shoveling. This was done to prevent water seepage under the flume and through the sandberm later in the summer. The outlet channel was then filled in and packed with the bulldozer. The biologist left at 1600 hr.

Steelhead passage provided via the flume over previous Memorial Day weekend. 6-01-2021

Outlet channel cut adjacent to the flume inlet. 6-01-2021

Interior weir installed in flume, upstream of fiberglassed section. 1 June 2021

Visquine sheeting spread out and secured around the flume inlet. 1 June 2021

Lower lagoon and Margaritaville Cove after sandbar closure. 1 June 2021

Upper lagoon after sandbar closure and flume preparation. 1 June 2021

2 June 2021. The biologist arrived at 1330 hr to evaluate the flume inlet and lagoon depth. Three logs had been secured under the Stockton Bridge with 2 submerged to provide fish escape cover. Two 2"x 4" wood spacers had been screwed on either side of the passage portal in the screened flume inlet to raise the lagoon water surface. The lagoon gage height was 2.00 and in the "fair" range. Alley contacted Morrison and requested 4 more inches of wood spacers be screwed on either side of the passage portal.

Water flowing over screened opening and through unscreened passage portal to provide adult and smolt steelhead passage to the Monterey Bay. 2 June 2021

5 June 2021 The biologist visited the lagoon to detect any remaining salinity in the lagoon. The lagoon had filled well into the "good" range (2.2 feet and greater) near the top of the flume with a gage reading of 2.48 feet. Salinity was monitored through the lagoon water column. Along the deep crevice beside the Venetian Court wall at depths of 1.5 meters down to 2 meters at the bottom, a stagnant saltwater lens (14.6 ppt to 25.5 ppt salinity at the bottom) with very warm (27.5 C to 26.8 C at the bottom), poorly oxygenated (0.86 mg/L to 0 mg/L at the bottom) water was found. Much of the lagoon upstream of Stockton Bridge was less than 1.5 meters deep, creating cooler (19.4 to 19.9 C at 1.25 meters), wind-mixed, well oxygenated (11.38 mg/L to 7.63 mg/L at 1.25 meters) , nearly freshwater conditions 0.8 ppt to 0.9 ppt at 1.25 meters) through most of the water column above a thin saltwater lens. With saltwater present, a shroud was recommended to be installed on the flume inlet to draw saltwater off the bottom and out to the Bay through the flume.

7 June 2021. A shroud was installed on the restaurant side of the flume inlet. An additional 2"x 4" flashboard was added to the Venetian Court side of the flume inlet to further raise the lagoon water surface.

Effects of Sandbar Construction on Tidewater Goby and Steelhead in 2021

Fifteen tidewater gobies and no steelhead were observed and relocated from the lateral channel across the beach during sandbar construction in 2021. This was after a very dry winter/spring with one bankfull event in late January and little rain afterwards. Only two artificial breachings of the sandbar with only partial drawdown were necessary during sandbar construction. Tidewater gobies present in the lower lagoon below Stockton Bridge would need to retreat to the deeper slackwater in the main channel as the estuary drew down, which was similar to daily tidal fluctuations when the sandbar was open prior to construction. The smooth bathtub ring at the lagoon margin prevented isolated pools from developing during drawdown that may strand tidewater gobies, steelhead and or other fishes. No stranding was observed. Tidewater gobies prefer to nest upstream of lagoon areas subject to tidal fluctuations, especially when very high tides occur. Areas beyond Stockton Avenue Bridge had much reduced tidal fluctuation in 2021, with no loss of lagoon width during low tide. Lower estuary locations as far upstream as at least Noble Gulch confluence are subjected to tidal fluctuations in wetter springs when the sandbar opening to the Bay is more pronounced. Because of the 2 slow, partial drawdowns during sandbar construction in 2021, lagoon width and water velocity were stable upstream of Stockton Bridge and would not hinder tidewater nesting or strand tidewater gobies, steelhead or other fishes. We detected no tidewater mortalities during drawdowns and flume preparations, with minimal recession of the lagoon margin downstream of Stockton Avenue Bridge. We judged impacts to tidewater gobies to be minor during sandbar construction in 2021, and no fish mortalities were observed.

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. Tules planted in the backwater beneath the railroad trestle in June 2017 survived the mild winter and grew well and expanded in 2021 from their 2020 condition, serving as rearing and overwintering habitat for tidewater goby in the future if they continue to grow and multiply. Because of the lack of winter escape cover, tidewater goby populations that have re-occurred at Soquel Lagoon during the dry years of 2008, 2009, 2013−2016 and annually since 2018 may be transitory.

Tule plantings beneath the railroad trestle prior to lagoon formation. 22 May 2017

Tules beneath the railroad trestle prior to lagoon formation 22 May 2018

Tules beneath the railroad trestle prior to lagoon formation. 29 May 2019

Tules beneath the railroad trestle after lagoon formation 11 June 2020

Tules flourishing beneath the railroad trestle after lagoon formation. 22 August 2021

No YOY steelhead were captured in the lateral channel in 2021. This indicated that YOY had not yet begun moving into the estuary from spawning areas above the lagoon. There had been no late spring storms to encourage YOY to drift into the estuary. With the late May sandbar closure in 2021, most steelhead smolt outmigration had likely been completed. Salmonid smolts passively drift downstream at night and are facilitated by late spring stormflows. However, in 2021 the last notable stormflow of only 90 cfs occurred in mid-March. So, there could still have been late smolts passing through to the Bay during sandbar construction. During the sandbar construction period, adults and smolts had access to the Bay through the flume during at least a portion of the nighttime hours every night. Smolt passage access may have been less continuous under natural conditions prior to construction due to the low baseflow throughout the spring of 2021. Frequent natural sandbar closures occurred under non-high tide conditions, as was observed by Alley during monitoring of the flume rehabilitation in April and on 24 May when the sandbar construction period began in 2021.

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**). A predatory merganser was observed on the last day of sandbar construction (1 June) by Alley. Morrison observed 5 mergansers in the lagoon on the morning of 26 May when no work was

being done along the lagoon margin. Deeper slackwater existed upstream of Stockton Bridge on the west side for about 100 m under overhanging willows providing shade and cover. These areas offered ample refuge for juvenile steelhead during the two artificial estuary drawdowns. The lower lagoon bottom was uniformly wide and flat to minimize water velocity during the slow drawdowns. No high water velocity conditions developed at the entrance of the outlet channel in 2021, and considerable slackwater refuge existed during drawdown when smolts would seek refuge during daylight hours. With all factors considered, we judged impacts to steelhead to be minor during sandbar construction, and no salmonid mortalities were in 2021.

The seasonal effect of typically 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 typically created with cooler, deeper, freshwater conditions, with reduced potential for eutrophication and associated increased biological oxygen demand from plant decomposition and nighttime plant respiration. Kelp and seagrass removal, when necessary, and sandbar closure create better fish habitat for tidewater goby and salmonids than if the sandbar was allowed to close naturally and kelp and seagrass was left to decompose.

In the drought year of 2021, the sandbar likely would have naturally closed permanently for the summer soon after the timing of the manual closure. And because no raking out of decomposing vegetation occurred, the amount of kelp and seagrass trapped in the lagoon to decompose would be similar to natural conditions. However, less saltwater was likely trapped in the lagoon in 2021 compared to natural conditions because no tidal overwash or tidal inflow of saltwater occurred after 24 May, and the shroud installed on the flume inlet will suck saltwater from the lagoon bottom, to some extent. Under natural sandbar conditions, a lagoon would have formed with more saltwater trapped to create a thicker, unmixed, anoxic lagoon bottom, which would collect more heat and raise lagoon water temperature higher than will occur with the flume/shroud and high sandbar berm now functioning during the dry season of 2021. 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 by perpetuating the stagnant saltwater lens on the bottom, making the lagoon less hospitable for salmonids and tidewater gobies. Under constructed conditions, the lagoon will likely convert to freshwater to maintain better conditions for fish (deeper, cooler, better oxygenated) than would have occurred under natural conditions.

Emergency Sandbar Breaching and Post-Breaching Bacterial Monitoring

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.

On 18-19 October 2021, Kotila cut a 30-foot wide notch across the beach with an inner berm constructed near the lagoon periphery and an outer berm constructed near the surf to prevent wave action with high swells to open the sandbar without stormflow. In preparation for the first major storm forecasted in the winter season to occur on 24 October 2021, the shroud was removed from the flume inlet on 19 October. On 21 October after a small stormflow of 7 cfs, the underwater portal was opened on the flume inlet. On 23 October after a brief stormflow of 30 cfs and prior to the 24 October stormflow that required opening the sandbar, two 4x4 flashboards were removed from either side of the flume inlet in preparation for the next predicted stormflow. At 0500 hr on 24 October, Kotila reduced the height of the outer berm to minimize the hydraulic head on the lagoon at the time of sandbar opening so as to minimize estuary evacuation and to minimize water velocity. After rain overnight, the lagoon water surface had risen to the piling bolt on 24 October to signal the need to breach the sandbar. Streamflow estimated at the Soquel Village gage was 30 cfs and rising. The flume capacity is in the 25-30 cfs range. Kotila opened the sandbar with the tractor at 0610 hr to prevent flooding. Streamflow increased to about 50 cfs midday and declined back down to 30 cfs before it increased abruptly to approximately 500 cfs at the gage in the early morning of 25 October. By midday, Soquel Creek flow had declined to approximately 200 cfs at the gage, with the estuary extending from bank to bank with ample deep water habitat and an estimated gage height of 1.6 ft. No fish mortality or water quality problems were observed during the sandbar opening.

The outlet through the beach was approximately 50 feet wide midday on 25 October. A secondary channel through the beach existed adjacent to the Venetian Court wall. Streamflows are provisional and subject to change. Streamflow at the lagoon was somewhat higher than flows measured in Soquel Village once it reached the lagoon due to added surface runoff in Capitola and contributions from Noble Gulch. Kotila delivered the before and after sandbar opening samples taken at the mouth of Soquel Creek to Monterey Analytical. Lab analysis indicated that the pre-opening enterococcus bacterial count was 1,500 cfu/100 ml. The post-opening count was also less than 4,600 cfu/100 ml, requiring additional weekly water sampling until the count was less than 104 cfu/100 ml. Water quality sampling ended on 18 November 2021 with an Enterococcus bacterial count of 60 cfu/ 100 ml.

City of Capitola
Danielle Uharriet
420 Capitola Ave
Capitola, CA 95010

Monterey Bay Analytical Services
4 Justin Court Suite D, Monterey, CA 93940
831.375.MBAS (6227)
www.MBASinc.com
ELAP Certification Number: 2385

Monday, October 25, 2021

Sample Results

Lab Number: 211024_04-01

Collection Date/Time: 10/24/2021 4:40 Sample Collector: Kotila M Client Sample #:
Received Date/Time: 10/24/2021 13:15 System ID: Coliform Designation:

Sample Description: Ocean

Analyte	Method	Unit	Result	Qualifier	Dilution	PQL	Analysis Date/Time	Analyst
Enterococci	Enterolert	MPN/100mL	1500		100	100	10/24/2021 14:35	JP

Comments:

Lab Number: 211024_04-02

Collection Date/Time: 10/24/2021 12:00 Sample Collector: Kotila M Client Sample #:
Received Date/Time: 10/24/2021 13:15 System ID: Coliform Designation:

Sample Description: Capitola Beach

Analyte	Method	Unit	Result	Qualifier	Dilution	PQL	Analysis Date/Time	Analyst
Enterococci	Enterolert	MPN/100mL	4600		100	100	10/24/2021 14:35	JP

Comments:

Report Approved by: David Holland, Laboratory Director

The results in this report are related only to the samples analyzed.
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Abbreviations/Definitions: mg/L: Milligrams per liter (=ppm) µg/L: Micrograms per liter (=ppb) MPN: Most Probable Number
MDL: Method Detection Limit PQL: Practical Quantitation Limit MCL: Maximum Contamination Level ND: Not Detected at the PQL (or MDL, if shown)
E: Analysis performed by External Laboratory; see Report attachments H: Analyzed outside of method hold time QC: Quality Control
J: Result is < PQL but ≥ MDL; the concentration is an approximate value.

10/25/21 MJ

City of Capitola
Danielle Uharriet
420 Capitola Ave
Capitola, CA 95010

Monterey Bay Analytical Services
4 Justin Court Suite D, Monterey, CA 93940
831.375.MBAS (6227)
www.MBASinc.com
ELAP Certification Number: 2385

Monday, November 22, 2021

Sample Results

Lab Number: 211118_07-01

Collection Date/Time: 11/18/2021 7:30 Sample Collector: Nerdens, S Client Sample #:
Received Date/Time: 11/18/2021 9:22 System ID: Coliform Designation:

Sample Description: Post-Breach Lagoon Water @Ocean

Analyte	Method	Unit	Result	Qualifier	Dilution	PQL	Analysis Date/Time	Analyst
Enterococci	Enterolert	MPN/100mL	60		10	10	11/18/2021 15:15	BM

Comments:

Report Approved by: David Holland, Laboratory Director

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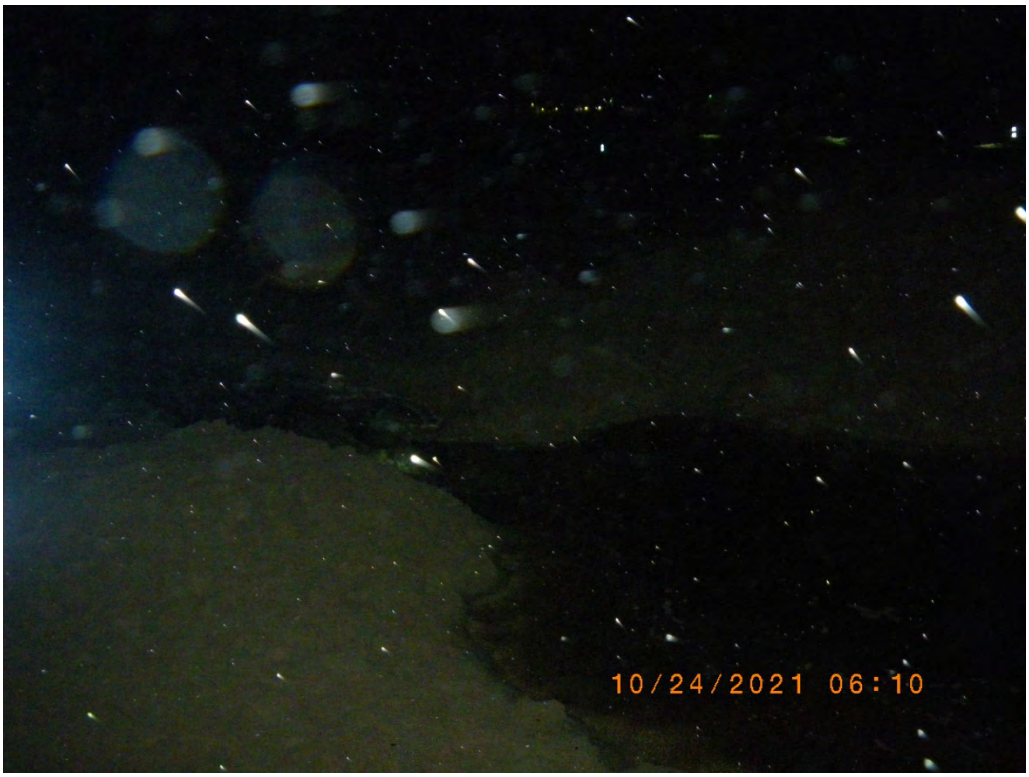
MDL: Method Detection Limit PQL: Practical Quantitation Limit MCL: Maximum Contamination Level ND: Not Detected at the PQL (or MDL, if shown)
E: Analysis performed by External Laboratory; see Report attachments H: Analyzed outside of method hold time QC: Quality Control
J: Result is < PQL but ≥ MDL; the concentration is an approximate value.

11/29/21 SS



Outlet channel through sandbar at initial opening, with Wharf lights in distance (Alley photo). 0610 hr, 24 October 2021

Soquel Estuary opening to the Monterey Bay at near 200 cfs. 25 October 2021.

Soquel Estuary outlet adjacent to the flume at near 200 cfs. 25 October 2021

Soquel Estuary, looking upstream for Stockton Bridge into Reach 2 at near 200 cfs. 25 October 2021.

Mergansers swimming out into Soquel Estuary from the Noble Gulch culvert opening at approximately 200 cubic feet/ second streamflow. 25 October 2021

WATER QUALITY MONITORING IN 2021

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 21.6 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 1.86 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, 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, 6 HOBO temperature loggers were launched on 9 June 2021, just downstream of the railroad trestle in Reach 2 (as in 2008−2020) 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 10 October 2021 prior to any rain.

Water quality in terms of oxygen concentration, temperature, conductivity and salinity was measured at each lagoon station at two-week intervals after the sandbar was constructed until the sandbar breached in the fall. Prior to the first full monitoring, salinity was measured in deeper portions of the lagoon to determine if saltwater had been trapped during sandbar construction. Saltwater was detected in 2021 in the lagoon 4 days after the sandbar closure. Thus, the biologist judged that the inlet shroud was needed 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	21.6-23	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 in temperature than the enhancement goal we established for Soquel Creek upstream during the development of a watershed plan, 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 previous 20 years, with relatively high baseflow and deeper lagoon. Water temperature near the bottom exceeded 20° C for a 3-day period in early June and a 4-day period in mid-July. However, it is unlikely that Soquel Creek Lagoon may cool 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 by 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 after a mild winter 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 during drought.

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 on 5 June and 10 times at 2-week intervals from 13 June 2021 to 16 October 2021. **Table 3** rates habitat conditions according to a rating scale (**Table 2**). The lagoon level was rated "good" throughout the monitoring period. The sandbar was breached to prevent flooding on 24 October due to stormflow that exceeded the capacity of the flume.

Gage height in 2021 was consistently near the highest recorded through the last 4 years at above a gage height of 2.50 until mid-October, after which the sandbar was breached on 24 October (**Figure 2**). 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. During the summer of 2021, baseflow was consistently low, allowing good management of the flume inlet to maximize lagoon depth through the dry period. 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. Saltwater was detected on the lagoon bottom in the deep pocket adjacent the Venetian Court wall on 5 June, 4 days after final sandbar closure for the season. Therefore, the shroud was not installed on the flume inlet. No vandalism of the flume inlet was detected in 2021.

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 2021. 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, and was covered on 15 July after smolt passage requirements were met. Boards were added to the top of the flume inlet to create a flat surface after that. The shroud was left in place until the week of the sandbar opening. The flume outlet remained open continuously until the sandbar opening on 24 October. On 18 October, the shroud was removed. On 21 October, the underwater portal was opened again. On 22 October, two 4x4 boards were removed on either side of the flume inlet. When the emergency breached occurred at 0610 hr on 24 October, the streamflow at the Soquel Village USGS gage was an estimated 30 cfs, and streamflow was likely above 30 cfs at the lagoon at the time of the opening, with stormflow reaching an estimated 500 cfs on early 25 October. 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. After 25 October, the sandbar was periodically closing at low tide and closed completely by 8 November, when near midnight a stormflow of nearly 60 cfs at the gage reopened it.

Water Temperature Results from Two-Week Monitorings

Air temperature is an important factor in determining lagoon water temperature. It partially determines the overnight cooling of the lagoon as overnight breezes circulate the entire freshwater column with the surface air. The warmer the air temperature at night, the less the lagoon will cool overnight. Despite warmer air temperatures in August and September in 2020 than 2021, water temperatures at dawn were similar or warmer in 2021, presumably due to the reduced baseflow in 2021. Water temperature near the bottom at lagoon monitoring stations in the morning and afternoon in 2021 were warmer compared to a higher baseflow year, such as 2019, from mid-June through mid-August (**Figures 3a-3d**). 2021 afternoon water temperatures were also higher than in 2019 at 3 of 4 sites through mid-September (excepting at the mouth of Noble Gulch). Morning air temperatures at the flume in 2021 were mostly warmer than other years in June and early July but mostly cooler than other years from mid-July to early September (**Figure 3f**).

Another important factor affecting lagoon water temperature and cooling is the inflow rate. Soquel Creek is cooler than the lagoon. So, the more inflow from the creek, the cooler the lagoon water temperature will be. Lagoon water temperatures paralleled Soquel Creek water temperature in 2021, as in past years (**Figures 3g and 3h**). Lagoon water temperatures were mostly 2−4°C warmer than the inflow temperatures in the morning and 1−3.5°C warmer in the afternoon (**Figure 3g−3h**). In 2021, early morning water temperature of stream inflow at Nob Hill was warmer than most of the other past 4 years in June through July, but cooler than the other past 4 years until late September, despite lower baseflow. The exception was 2018, which had cooler lagoon water temperature in August and September that corresponded to cooler air temperatures that year (**Figures 3f and 3i**). Lagoon water temperatures remained relatively high

through September 2021 despite cooler air temperatures and cooler inflow water temperatures after early July (**Figure 3e**). The influence of very low inflow volume overshadowed its cooler temperature and cooler air temperatures.

Saltwater trapped in the lagoon also determines water temperature where saltwater lenses form in deeper pockets. Heavy, stagnant saltwater lenses on the lagoon bottom become warm and anoxic because they cannot circulate to the water surface overnight. Water temperatures were very high near the bottom at the deep Station 2 near Stockton Bridge through mid-July because of the warm saltwater lens there (**Figure 3b**). Lagoon Station 2 was the warmest near the bottom at dawn while Station 4 was the coolest. Lagoon Station 1 was the warmest near the bottom in the afternoon even after the saltwater lens dissipated at Station 2, while Station 4 remained the coolest near the bottom in the afternoon due to cool Noble Gulch inflow. In 2021, water temperatures near the bottom at dawn went from poor to fair through the summer and did not cool to the "good" range below 20°C for most sites until late August. Water temperature was critically high near the bottom in June at Station 2, when a stagnant saltwater lens existed there.

In 2021, *water temperatures near the lagoon bottom in the early morning* were rated mostly "poor" (>21.5°C) to fair (20-21.5°C) through early August during 2-week monitorings (**Tables 2 and 3**). They were mostly "fair" to "good" after that. The early morning water temperature goal of not reaching 20°C near the lagoon bottom was exceeded at Station 2 on 7 of 10 monitorings, on 5 of 10 monitorings at Station 1, on 5 of 10 monitorings at Station 3 and on 2 of 10 monitorings at Station 4.

Station 1 at the flume had the warmest water temperatures near the bottom in the afternoon even after the saltwater lens at Station 2 dissipated. At Station 1, water temperature near the bottom ranged from 21.3 to 23.1°C between mid-June and mid-September. At the coolest Station 4 at the mouth of Noble Gulch, they ranged from 19.1 to 21.9°C. Thus, the 22°C maximum daily afternoon water temperature goal was exceeded at Station 2 on 4 of 10 monitorings, at Station 1 on 3 of 10 monitorings, at Station 3 on 2 of 10 monitorings and was met at Station 4. The warmest water temperatures were from mid-June to mid-August.

In most years, morning lagoon water temperatures near the bottom are coolest at the upper Station 4 (mouth of Noble Gulch) and are warmer progressively downstream (**Figure 3g**). However, in 2021, water temperature near the bottom at dawn was warmer at Station 2 in the deep area below Stockton Bridge on the first 9 of 10 monitorings. In the afternoon, Station 4 at the mouth of Noble Gulch was warmest on 8 of 10 monitorings.

This 22°C maximum temperature goal was not met in 2021 on 2 of the 6 monitoring days (2-week intervals) to mid-August at Station 3 near the railroad trestle and then afterwards in 2021 (**Figure 3c**). The goal was met on all 10 monitoring days at Station 4 at the mouth of Noble Gulch in 2021 (**Figure 3d**). The average lagoon water temperature at monitoring sites was warmer at dawn and in the afternoon near the bottom on 4 of the 6 monitoring days in 2021 for 2018-2021 at dawn and 2017-2019 and 2021 in afternoon (**Figures 3i and 3j**).

Another lagoon management goal is to maintain early morning maximum water temperature below 20°C near the bottom. This goal was met at Station 3c at the railroad trestle on 5 of the 8

monitoring days to mid-September 2021 (**Figure 3c**). In 2020, this goal was met except on 9 August at Station 1 (Flume) and 22 August at the lower 3 stations, excepting Station 4 (Noble Gulch).

Table 3. 2021 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)
5June21 (Station 2 only)	open	2.48 good	critical	critical	poor	2.3 cfs
13June21	open	2.59 good	good* critical good good	good critical good good	good poor good good	1.8 cfs
27June21	open	2.59 good	fair poor fair fair	good fair good good	good good good good	1.2 cfs
10July21	open	2.55 good	fair poor poor fair	good	good	0.7 cfs
25July21	open	2.62 good	fair fair fair good	good	good	0.9 cfs
08Aug21	open	2.60 good	fair fair fair good	good	good	0.6 cfs
22Aug21	open	2.62 good	fair fair good good	good	good	0.5 cfs
05Sep21	open	2.63 good	good fair fair good	good	good	0.2 cfs
19Sep21	open	2.63 good	good	good good good fair	good	0.2 cfs
02Oct21	open	2.63 good	good	good	good	<0.1 cfs
16Oct21	open	2.65 good	good	good	good	<0.05 cfs

* 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 31 years. Lagoon water temperature management goals were not met for steelhead in 2021. The 7-day rolling average near the bottom exceeded 20°C for 13 continuous weeks from early June to early September and went as high as 25.9°C near the bottom in early June with a saltwater lens present (**Figure 4a**). After the saltwater lens dissipated, the 7-day rolling average went as high as 22.1°C near the bottom in early August. After the saltwater lens dissipated, water temperatures as indicated by the 7-day rolling average were slightly cooler near the bottom than higher in the water column (**Figures 4a-4f**). Water temperatures near the bottom were warmer than in 2020, which had higher baseflow, and warmer than in 2019, which had relatively high baseflow, when all management goals were met in those years (**Figures 4a, 4g and 4h**). 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.

In 2021, early morning water temperature of stream inflow at Nob Hill was warmer than in 2020 from mid-June to early October except for 2 warmer 2020 spikes in mid-August and early September (**Figures 5a-b**). 2021 early morning water temperatures of stream inflow were also cooler than in the higher baseflow year of 2019, except in September it was warmer in 2019 (**Figure 5c**). Daily temperature *maxima* and *minima*, as well as the overall maximum, minimum and average 7-day rolling averages in the lagoon for the period of sandbar closure were consistently warmer near the bottom than the stream inflow in 1999-2021 (**Table 4**). These metrics also increased in 2021 compared to those in 2019 and 2020, when baseflow was higher, except the maximum lagoon temperature was the same in 2020 and 2021 (**Figure 4i**). As stated before, 2020 had a warm spike in mid-August that greatly raised maximum daily temperature. From mid-June to early August the 7-day rolling average range for the lagoon in 2021 was 20−22°C and for 2020 was 18.5−20°C, indicating a warmer lagoon in the first half of the lagoon season in 2021 (**Figures 4a and 4g**). Then from mid-August to mid-September, the 7-day rolling average in the lagoon for 2021 was 19.5−22°C and for 2020 was 17.4−21.8°C, indicating a warmer lagoon in 2021 than 2020, though the maxima were similar due to the warm spike in mid-August 2020.

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. For fish, as water temperature increases, then metabolic rate and food demand increase while scope for activity may decline. This 22°C maximum temperature goal was not met in 2021 at the data logger location for 8 of

the first 10 weeks of the lagoon period until mid-August and then was met afterwards (**Figure 4a**). By comparison, this goal was met in 2019 and 2020 at all monitoring stations except for 5 days in mid-August 2020 (**Figures 4g and 4h; Alley 2021**).

Another lagoon management goal is to maintain early morning maximum water temperature below 20°C near the bottom. In 2021, this goal was met only 2 days in the first 10 weeks at the data logger location and only a third of the days for the following 4 weeks to 15 September. In 2020, this management goal was met at the data logger location near the bottom
A third lagoon management goal is to maintain the daily 7-day rolling average at 21°C or less near the bottom. In 2021, this goal was met at the data logger location for a week in mid-July out of the first 10 weeks to mid-August and then afterwards (**Figure 4a**). In 2020, this goal was met at the data logger location except for a week in August (**Figure 4g**).

We see from **Table 4** and **Figure 4i** 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 by early evening; 7-day rolling average <= 21°C). Lagoon water temperature has typically been warmer in years with reduced baseflow entering, such as drought years of 2009, 20213-2015 and 2021, as indicated by maximum and minimum temperatures and maximum, minimum and average 7-day rolling averages (**Table 4; Figure 4i**). But air temperature also contributes to stream inflow temperature to determine lagoon water temperatures, as when summer air temperature was cooler in 2016 (**Alley 2021**), allowing management goals to be met, and when air temperature was warmer in August and September 2017 (**Figure 3f**), causing management goals not to be met some of the time, despite high baseflow . Fortunately, in 2021 the early morning air temperature was cooler than several other years until September, cooling the lagoon's elevated afternoon temperatures somewhat by morning, especially in the latter half of July and latter half of August (**Figures 3i and 4a**). However, water temperatures were still likely stressful to steelhead at those times, causing higher metabolic rate, reduced scope for activity and increased food demands. The maximum lagoon water temperature and maximum 7-day rolling average in 2021 at the logger location after freshwater conversion of the lagoon remained below those registered in the drought years of 2013-2015 (**Figure 3j**). Average maximum water temperature at monitoring sites on monitoring days in 2021 was decidedly cooler than in 2015 (**Figure 4j**).

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) (**Alley 2020**).

As in past years, in 2021 no lagoon thermocline (a thermocline has a warm, well-mixed, oxygen-rich epilimnion above it and a cool, non-circulated, oxygen-poor hypolimnion below) developed. However, for the first 2-3 weeks after sandbar closure (until 22 June), temperature stratification and oxygen loss were detected by the data loggers in the deep area near the railroad trestle and during water quality monitoring at Stations 2 (**Figures 3b and 4a**). This resulted from a stagnant saline layer along the lagoon bottom that dissipated by mid-June. After the saline layer had

passed through the sandbar and out through the flume, 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 after 22 June (**Figures 4a-4f**). In most years, water temperature was cooler nearer the bottom and warmer near the surface, based on the continuous data loggers. In 2021, water temperature at 0.5 and 1.5 feet from the bottom was slightly cooler than at 2.5 to 5.5 feet above the bottom, where water temperature appeared the same.

Table 4. Water Temperature Statistics from Continuous Water Temperature Probes at 30-Minute Intervals in Soquel Lagoon after Freshwater Conversion and Immediately Upstream. (Late May to 15 September in 2013−2021.)

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
2021	Maximum Water Temperature °C	**19.8 (12 Aug)**	**23.4 (10 July)**	**23.2 (10 July)**
2021	Minimum Water Temperature °C	**15.6; 15.8 (14 Sep; 26 Aug)**	**19.7 (26 Aug)**	**19.4 (26 Aug)**
2021	Maximum 7-Day Rolling Average*	**18.3; 18.1 (26 June; 5 July)**	**22.2 (5 July)**	**22.1 6 July)**
2021	Minimum 7-Day Rolling Average	**16.2 (11 Sep)**	**19.7 (14 Sep)**	**19.6 (13 Sep)**
2021	**Average 7-Day Rolling Average**	**17.4**	**21.4**	**21.2**
2020	Maximum Water Temperature °C	**21.3 (16 Aug)**	**23.6 (16 Aug)**	**23.2 (16 Aug)**
2020	Minimum Water Temperature °C	**14.1 (3July, 12 Sep)**	**16.0 (15 Sep)**	**16.4 (3 July)**
2020	Maximum 7-Day Rolling Average*	**9.0 (13 Aug)**	**21.2 (13 Aug)**	**21.8 (14 Aug)**
2020	Minimum 7-Day Rolling Average	**15.4 (9 Sep)**	**17.2 (9 Sep)**	**17.4 (10 Sep)**
2020	**Average 7-Day Rolling Average**	**16.7**	**18.8**	**19.2**
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	**20.6**	**23.2**	**22.1**

	Temperature °C	**(22July, 4 Oct)**	**(25 July, 16 Aug)**	**(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**
Year	**Statistic**	**Stream Inflow Temperature °C**	**Near-Surface Lagoon Temperature @ 5.5 ft from Bottom °C**	**Near-Bottom Lagoon Temperature @ 0.5 ft from Bottom °C**
2016	Maximum Water Temperature °C	**21.0 (19 June)**	**21.7 (20-23 June, 25 June, 9-13 July, 20-24 July, 31 Aug)**	**21.3 (24 and 29 July, 2 Aug)**
2016	Minimum Water Temperature °C	**13.7 (15-16 June)**	**17.1 (14 Sep)**	**16.8 (16 June)**
2016	Maximum 7-Day Rolling Average*	**17.7 (18 June)**	**20.8 (19 July)**	**20.2 (18-20 July)**
2016	Minimum 7-Day Rolling Average	**15.4 (11 Sep)**	**18.4 (10 Sep)**	**17.9 (11 Sep)**
2016	**Average 7-Day Rolling Average**	**16.7**	**19.9**	**19.3**
2015	Maximum Water Temperature °C	**20.6 (15 August)**	**24.8 (15-16 August)**	**24.0 (16-17 and 19 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.

In 2021, the coho management goal of keeping maximum lagoon water temperatures below 20ºC (68ºF) near the bottom in the presence of steelhead was met for 12 days that were monitored during the period 9 June to 15 September (**Figure 4a**). 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 and generally warm inflow temperatures through the summer/fall, despite higher baseflow (**Alley 2018**).

The daily stream water temperature fluctuated more than the daily lagoon water temperature near the bottom in 2021, which was typical for previous years except 2010. The maximum daily lagoon water temperature near the bottom typically occurred between 1600 and 2100 hr.

Aquatic Vegetation Monitoring.

Decomposed kelp and seagrass were abundant in the estuary prior to sandbar construction in 2021 after a very mild winter. A thick layer of decaying plant material lined much of the lower estuary downstream of Stockton Bridge when the sandbar was closed. With the low baseflow at the time of sandbar construction, raking of plant material from the lagoon was deemed unadvisable for water quality considerations. Only an estimated 10% of the decomposing plant material was raked from the lagoon in 2020 (30% in 2019, 90% in 2018, none present in 2017, 90% in 2016 and 70% in 2015). Thus, there were more nutrients available for plant growth in 2021 than in most years.

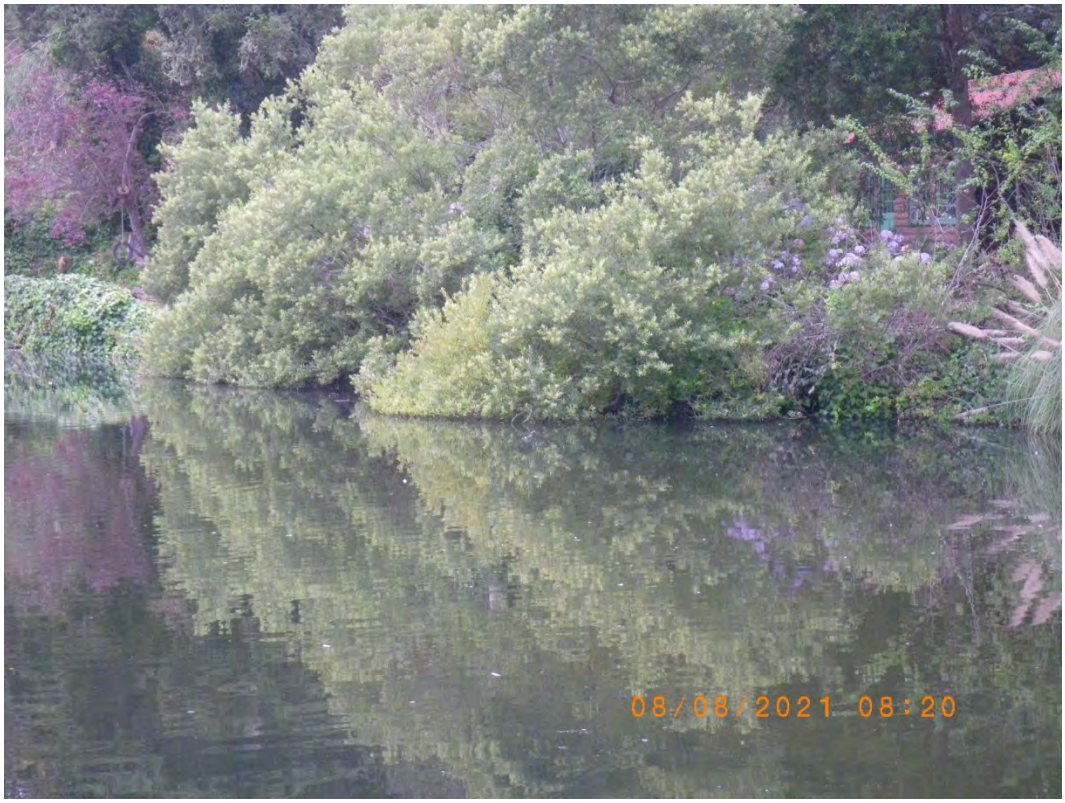
Flume outlet to the Capitola Beach and Monterey Bay. 8 August 2021

Reach 1- Looking upstream with flume inlet in foreground and Venetian Court on left. 8 August 2021

Reach1- Looking downstream from Stockton Bridge with Venetian Court wall on right. 8 August 2021

Reach 2- Looking downstream at valuable fish cover under overhanging willows. 8 August 2021

Reach 3- Looking upstream with Golino cabin on left. 8 August 2021



Reach 3- Valuable fish cover under overhanging willows near the Golino cabin. 8 August 2021

Soquel Creek at Nob Hill, looking downstream. 8 August 2021

Aquatic Vegetation Monitoring.

Kelp and seagrass were present in the estuary prior to sandbar construction. The estuary bottom was soft with considerable decomposing plant material downstream of Stockton Bridge and along the margins upstream. Raking out of decomposing plant material was of limited value because most material had decomposed into soft ooze which could not be easily dislodged or transported out with the limited streamflow. With the very low baseflow and high amount of decomposing material, it was decided that raking was inappropriate in 2021. The concern was that water quality problems for fish may develop from raking that would yield little success in removing sources of biological oxygen demand after sandbar closure. An estimated 10% of the decomposing plant material was raked from the lagoon in 2020 (90% in 2019, 90% in 2018, none present in 2017, 90% in 2016 and 70% in 2015).

In 2021, bottom algae developed quickly and increased in thickness into September. Its bottom coverage was greatest in early summer but declined as pondweed became prominent in August and September (**Table 5**). Surface algae increased in late summer and fall in Reach 3 and at the mouth of Noble Gulch, as is typical for years when stream inflow is low and water temperature is relatively high. Compared to a higher inflow year such as 2019, algae and pondweed coverage and thickness were greater in 2021, along with surface algae coverage (**Table 6**). The lagoon bottom in Reach 1 was largely invisible in 2021. Algae coverage of the lagoon bottom in 2021 became more than in 2019 and similar to 2017 and 2018 early on (**Tables 6-8**). Aquatic vegetation was not monitored in 2020 when only morning monitoring was done before the

lagoon bottom became visible later in the day. In 2021, unlike in 2017−2019, pondweed proliferated and dominated in lagoon coverage in August through mid-October much more than in 2017−2019. Surface algae was more prominent in 2021 than in the previous 2017−2019 monitoring years (**Tables 6-8**). Surface algae was also relatively high in previous drought years of 2014 and 2015. As was typical of past years, surface algae was more abundant at the mouth of Noble Gulch than elsewhere, with a maximum of 25% coverage in mid-October. Evidence of nutrient inputs from Noble Gulch in 2013−2015, 2017-2019 and 2021 was expressed by recurrent thick planktonic algae blooms and sporadically high levels of surface algae nearby.

Lower Soquel Lagoon, Reach 1, with surface algae. 19 September 2021

Table 5. Visually Estimated Lagoon Algae/ Pondweed Coverage and Thickness in 2021.

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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
6-13	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
6-27	0.3	85	0	0.2	100	0	0.2	100	0	1.0	80	0
7-10	Invisible Breezy		<1	Invisible Breezy		2	0.7	100	2	2.0	60	5
7-25	Invisible Breezy		0	Invisible Breezy		0	0.8 (2.0 pond-weed)	99 (1 pond-weed)	0	2.0	60	0
8-8	95% Invisible Dark	Pondweed visible adjacent Restaurants	<1	1.0	100	0	1.5 (2.0 pond-weed)	99 (1 pond-weed)	<1	1.0	60	0
8-22	95% Invisible Dark (3.5 pond-weed	Pondweed visible adjacent Restaurants	<1	1.0 (1.5 pond-weed)	80 (20 pond-weed)	0	2.0 (3.0 pond-weed)	80 (20 pond-weed)	1	1.0 (3.0 pond-weed)	30 (30 pond-weed)	5
9-05	95% Invisible breezy (3.5 pond-weed	Pondweed visible adjacent Restaurants	10	Invisible breezy		2	1.5 (2.0 pond-weed)	60 (40 pond-weed)	2	1.0 (3.0 pond-weed)	40 (60 pond-weed)	10
9-19	95% Invisible breezy (4.0 pond-weed	Pondweed visible adjacent Restaurants	3	1.5 (3.0 pond-weed)	60 (40 pond-weed)	<1	1.5 (3.0 pond-weed)	40 (60 pond-weed)	7	1.0 (4.0 pond-weed)	40 (60 pond-weed)	15
10-2	95% Invisible Dark (4.0 pond-weed	Pondweed visible adjacent Restaurants	0	Invisible Shaded		<1	Invisible Shaded		3	1.0 (4.0 pond-weed)	30 (70 pond-Weed)	20
10-16	Invisible Dark breezy		2	Invisible Shaded		2	Invisible Shaded		10	1.0 (4.0 pond-weed)	30 (50 pond-Weed; 20 bare sand)	25
Avg-6-13 – 10-16			**1.5**	**0.7 algae (0.9 Pond-Weed)**	**68 algae (12 Pond-Weed)**	**0.6**	**1.0 Algae (1.5 Pond-Weed)**	**72 Algae (15.3 Pond-weed)**	**2.5**	**1.1 Algae (1.8 Pond weed)**	**43 Algae (27 Pond weed)**	**8**

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

.

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 used by cell respiration overnight before plant photosynthesis could begin producing oxygen with the light. Near dawn is the time when oxygen levels are most importantly measured and rated because they are typically the lowest (**Alley 2021**). No stressfully low oxygen concentrations for

steelhead were detected in 2021 except near the bottom at Station 2 (near Stockton Bridge) in mid-June, when a stagnant saltwater lens was present at that time (**Table 3; Figure 6a-1**). Oxygen concentrations near the bottom at dawn were in the "good" range (>7 mg/L) at the other 3 monitoring stations throughout the monitoring period except 6.99 mg/L at Station 1 on 22 August. At Station 2 near the bottom, oxygen was "critically" low on 13 June, "fair" on 27 June and "good" at the next 8 monitorings. Oxygen levels were in the good range in the upper water column above the saltwater lens in the first 1.25 m from the surface at dawn at Station 2 (**Appendix A**). The 4-station lagoon average near the bottom at dawn was above 7 mg/L (good range) at 8 of 10 monitorings, the exceptions being the first 2 monitorings in June in the fair range (5-7 mg/L) when the low readings at Station 2 brought the average down (**Figure 6b**). The dip in the average oxygen concentration at dawn on 22 August came after 2 days of overcast skies that diminished photosynthesis and oxygen production in the lagoon. Afternoon oxygen levels near the bottom were above 7 mg/L (good range) at all sites during all monitorings except for the first monitoring (13 June) at Station 2 (poor range) (**Figure 6a-2**). The 4-station lagoon average near the bottom in the afternoon was above 7 mg/L (good range) throughout the monitoring period and within the same general high range of previous years (**Figure 6c**).

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. The salinity lens at Station 2 reduced oxygen concentrations in June. The decline in oxygen concentrations detected on 22 August came after 2 days of overcast skies. When water clarity is reduced after small stormflows with a closed sandbar still intact, light does not penetrate to photosynthesizing plant life, and oxygen concentrations decline rapidly, as occurred in fall 2014 and 2015. This did not occur in fall, 2021. On 21 October after a small stormflow of 7 cfs, the underwater portal was opened. On 22 October prior to the stormflow that required opening the sandbar on 24 October and after a small stormflow of 12 cfs, two 4x4 flashboards were removed from either side of the flume inlet in preparation for the next predicted stormflow. These actions shallowed the lagoon to allow sunlight to penetrate to the lagoon bottom until the sandbar was opened in the early morning of 24 October. Thus, oxygen levels likely remained high until the sandbar was breached.

Salinity Results

In 2021, a saline layer was detected along the deep area (2 m deep) adjacent to the Venetian Court wall on 5 June. Initially it was initially slightly more than 1.5 ft (0.5 m) thick, and created very warm, low oxygen conditions within. At depth 1.75 m, salinity was 20.2 ppt (28.6 C morning water temperature). At the bottom at 2 m, salinity was 25.5 (28.6 C morning water temperature). The upper 1.25 meters of the 2 meter water column had good oxygen conditions throughout the time of the saltwater lens. Steelhead inhabiting this area would avoid the poor water quality conditions within the saltwater lens by remaining higher in the water column. On 7 June, a shroud was installed on the flume inlet on the restaurant side to draw saltwater from the bottom out of the lagoon. By 13 June, at depth 1.75 m, salinity was 17.2 ppt (27.1 C morning water temperature). At the bottom at 2 m, salinity was 24.3 (28.3 C morning water temperature). By 27 June, the saltwater lens was thinner and less than 1 foot (0.25 m) thick. At depth 1.75 m, salinity was 0.8 ppt (22.5 C morning water temperature). At the bottom at 2 m, salinity was 17.8 (26.6 C morning water temperature). By our monitoring on 10 July, at depth 1.75 m, salinity was

0.7 ppt (21.7 C morning water temperature). At the bottom at 2 m, salinity was 9.7 (24.9 C morning water temperature). By our monitoring on 25 July, the saltwater lens had dissipated with salinity 0.6 ppt through the water column and no morning temperature stratification (20.5 C at the bottom). Tidal overwash occurred the evening of 19 August, which increased the salinity to only 1.8 ppt (21.6 C morning water temperature) at dawn on 22 August. By afternoon, the saltwater had dissipated. A freshwater lagoon was maintained until the sandbar breach on 24 October.

Conductivity Results

As stated earlier, 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**). Although conductivity went above this range in the saltwater lens at the bottom at Station 2 in June, steelhead had been exposed to daily tidal influences before sandbar closure and did not become acclimatized to freshwater until later. And, steelhead could avoid the high conductivity by swimming above the saltwater lens. Therefore, it is unlikely that the saltwater lens caused stress to steelhead inhabiting the lagoon in early summer. By late July, the saltwater lens had disappeared. Conductivity was not at stressful levels for steelhead in the vicinity of the other 3 monitoring stations during the 10 monitorings in 2021 (**Appendix A**).

Stream In-Flow to the Lagoon

Lagoon water quality is generally best with relatively higher summer baseflow. Soquel Creek in 2021 maintained a baseflow through the dry season that was much below the median flow (**Table 9; Figures 25−26**). There had been only one significant stormflow occurring in late January during a relatively very mild winter. In November until late January, only 3 small stormflows of less than 40 cfs occurred. The late January stormflow reached near 2,000 cfs and was above bankfull. Then 4 more small stormflows between 30 and 100 cfs occurred from February to mid-March, with 3 coming in the first 3 weeks of March. No stormflows occurred after that which would provide any upstream steelhead spawning passage (a 7.2 cfs occurrence in early May). Streamflow had declined to 3.7 cfs (0600 hr) on 24 May 2021 at Soquel Village gage when sandbar construction began. The sandbar was closed to the Bay at low tide. Hydrographs for previous water years, 2007−2020, are in **Appendix C**.

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. With less inflow in June−August, lagoon water temperature heats up more during the day and cools off less at night, as indicated by higher average lagoon water temperature at dawn in 2015 (low drought inflow) (**Alley 2020**). We observed cooler lagoon water temperature in 2019 (high inflow) than in 2018, 2020 (intermediate inflows) or 2021(low inflow) for the months of June through August (**Figures 3a-d; 3i**). 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 that they increase substantially in dry/drought years (2009, 2013-2015 and 2021) when stream inflow rate is much reduced (**Figure 4i**). However, the trend toward reduced water temperature during

higher baseflow years was less evident in 2017 and 2019, when the maximum temperature and the maximum and average 7-day rolling averages were similar or higher than in intermediate baseflow years of 2016, 2018 and 2020. For 20016 and 2018, we suspect this was partially because they had cooler air temperature in late summer and fall with more stream shading than after wet 2016-2017 and 2018-2019 winters that would have contributed to warmer inflow in 2017 and 2019 due to loss of streamside vegetation and less shade. Maximum 7-day rolling average increased only 0.3°C from 2020 to 2021. However, minimum 7-day rolling average and the average 7-day rolling average after freshwater conversion of the lagoon increased 2°C in WY2021 (low baseflow) compared to WY2020 (intermediate 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 5 restaurants that were contiguous with Soquel Creek Lagoon were tested for leaks and deficiencies in plumbing connections. All deficiencies were repaired prior to sandbar construction (**Appendix B**).

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, 1991-2021.

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
2020	9.7	5.1	3.3	2.3	1.8
2021	3.1	1.2	1.2	0.7	0.5

* Red denotes drier water years. ** White denotes intermediate water years. *** Blue denotes wetter water years.

Recreational Use, Pollution Sources and Solutions

Due to changes in COVID-19 protocol, a nautical parade was held during the Capitola Beach Festival. City staff did not receive notice of the event. Therefore, the biologist was not present for monitoring. The lagoon near the beach was posted with warning signs about potential health risks. However, greater human use of the lagoon has been observed since 2016, when a paddle-board concession began in the village. Paddle-boarders have become commonplace during weekend monitorings (observed 9 of 10 afternoon monitoring in 2021; 5 of 13 in 2019; 5 of 12 in 2018, 10 of 12 in 2017; 7 of 9 in 2016), along with kayakers, pedal boaters, row boaters, canoers and barge users. In 2021, the most paddle boarders counted in a reach were 6 in Reach 3 on 27 June. Waders and swimmers were commonly observed in the lagoon during weekend afternoon monitoring in past years but less so in 2021 (usually near the beach in Reach 1; 2 of 10 afternoon monitorings in 2021; 6 of 13 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 2021 was 12 on 13 June in Reach 1 (6 in 2019). Vegetation was trimmed to expose the no fishing sign along the lagoon path to discourage illegal summer/fall fishing. None was observed during monitoring in 2021.

Illegal fishing was not observed in 2020. Legal fishing was observed on 23 January 2021 by 2 fishermen before any adult steelhead had entered the lagoon. No bird feeding was observed in 2020. The common high congregation of mallards in Margaritaville Cove in 2020 may have resulted from feeding from the adjacent restaurants, though none was observed in early morning. In previous years, mallard ducks patrolled the lagoon next to Margaritaville in the afternoon, indicating that feeding went on regularly there.

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. They may increase the biological oxygen demand somewhat under the trestle (Station 3). 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. None was observed in 2020. 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 and 2 monitoring days in 2019, especially in the latter weeks of the monitoring period. Another drain into the lagoon exists under the railroad trestle, where slightly below average oxygen concentrations (indicating some oxygen depletion) have been detected in recent years in mid-summer, including 2020 and 2021 (**Figures 6a-1 and 6a-3**), 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.

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. They persisted in 2020 after a moderate winter and then expanded and grew to their greatest height in 2021 after a very mild 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.)

FISH CENSUSING

Steelhead Plantings. No steelhead were planted in Soquel Creek in 2021, as was the case in 2003–2020. 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 and tidewater goby occurred on 3 and 10 October 2021, from upstream of the Stockton Avenue Bridge to the beach. A bag-seine with dimensions 106 feet long by 6 feet high by 3/8-inch mesh was used. The seine was set perpendicular to shore, parallel to the Stockton Avenue Bridge and 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 335 steelhead were captured and 299 retained, measured and marked on 3 October after 5 seine hauls. This indicated that juvenile steelhead were abundant in the lagoon in 2021. There were 4 mortalities. A total of only 19 steelhead were captured on 10 October in 7 seine hauls. There was one recapture and no mortalities. A reliable estimate of population size was not possible by using the Lincoln Index because it appeared that juveniles captured on 3 October did not randomly redistribute

throughout the lagoon after release. It appeared that most captured steelhead moved upstream beyond our sampling zone during the week between samplings. As Ed Morrison was informed, on 7 October, between the times of our 2 weekend sampling efforts, a Soquel Creek Water District waterline broke and emptied considerable treated drinking water into Noble Gulch and then into lower Soquel Lagoon. Considerable floating duckweed also entered the lagoon from Noble Gulch. No fish mortalities were observed after the water spill, and threespine stickleback were common in our 3 and 10 October seine hauls, indicating a lack of mortality of this species after the spill. According to Capitola staff reports, the lower lagoon remained turbid for 2 days after the water input. This turbidity hampered visual feeding by steelhead and apparently caused most of the juvenile population to redistribute further upstream and out of reach of our 10 October seining effort. We expected the juvenile steelhead to spread out and eventually repopulate the lower lagoon after our 10 October sampling was completed. Our permit did not allow further sampling.

A rough 2021 population estimate could be made based on catch per unit effort in 2021 compared with catch per unit effort rates in 2019 and 2020 on the first day of sampling when we had population estimates for those years. From these comparisons we assumed that the 2021 population estimate to be less than the 2019 estimate of 3,322 and more than the 2020 estimate of 1,344. When comparing the catch-per-unit-efforts of 2019 and 2021 and applying them to the 2019 population estimate, we obtained a 2021 population estimate of 2,200. When comparing the catch-per-unit-effort rates of 2020 and 2021 and applying them to the 2020 population estimate, we obtain a 2021 population estimate of 2,800. Averaging the two estimates, we obtained an estimate of 2,500 for 2021. The population estimate was above average and above the median compared to the 27-year average of 1,529 (median= 928), including the 2021 estimate (**Table 10; Figure 24**). Steelhead young-lf-the-year were relatively large in 2021 despite warm water conditions that increased food demands, and the juvenile steelhead population estimate was relatively high (**Table 11; Figure 7a**). Spawning was likely prevalent in the lower mainstem, and many 2020 YOY likely resided in the 2021 lagoon as yearlings.

Threespine Stickleback. October 2017. (Photo by T. Suttle.)

Starry Flounder. October 2021. (Photo by T. Suttle.)

Young-of-the-Year Juvenile Steelhead. October 2021. (Photo by T. Suttle.)

Tidewater Gobies. October 2017. (Photo by T. Suttle.)

Sacramento Sucker. October 2017. (Photo by T. Suttle.)

Staghorn Sculpin. October 2021. (Photo by T. Suttle.)

Size histograms of steelhead captured from the lagoon in 2021 and other years back to 1998 may be found in **Figures 7a−23**. No scale samples were taken in 2021 in order to minimize the holding and handling time for the large number of captured fish on the first sampling day. Examination of the size histogram of captured fish in 2021 indicated a demarcation between age classes somewhere in the range of 150-160 mm SL. The large bell-shaped curve indicated that most juveniles were YOY with a good number of yearlings and with most juveniles larger than 160 mm SL likely being yearlings (at least 18%). Other fish species captured in 2021 with the large seine were 2,000+ threespine stickleback (uncounted) and 50+ tidewater gobies (uncounted).

In 2021, 5 seine hauls were made for tidewater gobies with the 30-foot x 4-foot x 1/8-inch mesh beach seine on 3 October along the lagoon periphery where the 106-ft seine was not used. 210 tidewater gobies were captured with 144 threespine stickleback and 1 starry flounder. A record of tidewater goby captures may be found in **Table 12**. 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 in 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, after mild winters in 2007 and 2008. They likely re-colonized Soquel Lagoon again in 2013 after large stormflows in December 2012. They were present in Aptos Lagoon in 2011−2014 and 2017−2021 (**Alley 2012; 2013; 2014; 2015; 2018; 2019; 2020; 2021;2022**).

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 2007–2021 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, 1998−2021 (**Table 10**), 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, 2018 and 2020 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.

Famously large Prickly Sculpins from Soquel Creek (also inhabit the Lagoon). August 2012

Table 10. Estimates of Juvenile Steelhead Numbers in Soquel Creek Lagoon for the Years 1988 and 1992-2021.

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.
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.
2020-	1,344 +/- 256 (standard error), 192 fish marked from 6 effective seine hauls
2021-	2,500 estimated based on catch-per-unit-effort. 335 captured; 299 marked from 5 seine hauls

Table 11. Summary of Annual Fish Sampling Dates, Population Estimates, Steelhead Size and Lagoon Growth Period Prior to Sampling, 1998−2021.

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 First Day
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	21.3	149	None possible (No recap.)	155-159 First Day
2015	21 May	4/11 Oct	20.4	143	None possible (No recap.)	95-99 First day
2016	27 May	2/9 October	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	19.1	134	3,322	95-99 Both days
2020	11 June	4/11 October	17.3	121	1,344	130-134 Both days
2021	1 June	3/10 October	18.6	130	2,500 C per Unit E	140-144 & 150-154
Avg/Median				**132/ 137**	**1,529/ 928**	

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 fine-mesh seine)
1988 drought	102	2
1992 drought	2	?
1993	0	4
1994 mild	35	4
1995 wet	0	8
1996 wet	0	6
1997 below avg	1	8
1998 wet	0	4
1999 wet	0	5
2000	0	5
2001	0	5
2002	0	5
2003	0	5
2004	0	5
2005	0	4
2006 wet	0	5
2007 drought	0	5
2008 drought	33	4
2009 drought	8	4
2010 above avg	0	6
2011 wet	0	6
2012 below avg	0	5
2013 drought	10	7
2014 drought	481	6
2015 drought	309	5
2016 mild	98	4
2017 wet	0	6
2018 mild	1	6
2019 wet	1	5
2020 mild	117	6 (106-ft coarse-mesh seine)
2021 drought	210	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 and 2021 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 will 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 and 2021 lagoons were 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, 2013−2015, 2018 and 2021 (more pondweed), indicating less food available in 2011, 2016−2017 and 2019 (**Alley 2018a; 2020**). 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 drought years, more adults may spawn in the lower creek near the lagoon due to restricted passage flows to the upper watershed. This has lead to high lagoon densities during the drought years of 2007 and 2008, presumably of mostly YOY fish. We suspect the same large population in 2021 but cannot confirm this due to the apparent interference of the water spill in modifying steelhead distribution in the lagoon. Based on the size histogram of captured steelhead on 3 October, most juveniles were YOY, however.

In order to maintain good steelhead nursery habitat in Soquel Creek Lagoon, the sediment input from the watershed must be reduced. The 2021 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. Reach 1 also deepened in the 2020-2021 winter. In 2021, more juvenile steelhead were captured than in past years from lower Reach 1, prior to the water spill into Noble Gulch and ensuing turbidity.

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 2013−2020. 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 2020. The lagoon water surface was kept at the top of the flume inlet throughout the summer/ fall in 2020 until the series of small storms began in November, which required periodic lowering of the lagoon level to insure that light penetrated to the bottom for plant photosynthesis after stormflows that created turbidity. Lagoon height was increased after water clarity returned after these small stormflows. 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 2021 the sandbar had to be opened early with 3 stormflows that occurred in rapid succession in a 3-day period. Therefore, lagoon turbidity, high B.O.D. and oxygen depletion after early storms was not an issue. 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 commonly observed in 2021 as they had been in other drought years, 2013−2015 (**Table 13)**. Other piscivorous birds observed in 2021 included pied-billed grebe, great blue heron, cormorant, snowy egret, and common egret. Pied-billed grebes were especially abundant in late summer/fall, with as many as 5 observed on 16 October. One was observed capturing a sculpin earlier in summer. Egrets were observed in October. A very active red-necked phalarope *(Phalaropus lobatus)* was feeding on surface food items near the flume inlet during sandbar construction on 24 May. A white-faced Ibis (*Plegadis chihi*) probed the sand for food along the Reach 1 margin near Venetian Court on 2 October.

Very active red-neck phalarope in lower lagoon during sandbar contruction. 24 May 2021

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 Goldeneye	Common Merganser	Pied-billed Grebe	Black-crowned Night Heron	Green Heron	Snowy Egret	Corm-orant	Great Blue Heron
2021/10	0	8	6	0	2	2 (2 common egrets)	2	1
2020/16 (morning only)	6	3	9	1	0	1	1	0
2019/13	1	3	5	0	0	0	1	0
2018/ 12	0	2	7	2	1	1	1	1
2017/ 12	0	4	6	0	0	0	1	0
2016/ 13	0	3	4	1	3	0	2	0
2015/ 12	0	6	4	1	2	1	7	0
2014/ 13	0	6	7	3	2	4	1	0
2013/ 18	3	9	10	3	3	0	3	0
2012/ 12	0	3	8	0	0	1	4	0

White-faced Ibis at Soquel Lagoon in Fall. 2 October 2021

No western pond turtles were observed in 2013−2021, although a paddle-boarder observed a turtle in the upper lagoon in 2015. Previously, they 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 log had sagged and was mostly underwater in 2013−2015, offering limited basking area. In 2016, it had moved upstream a few feet and was still partially submerged. Then it was flushed out to the beach during the wet 2016-2017 winter.

Gulls commonly bathed in Reach 1, downstream of the Stockton Bridge and did so in 2021. However, in past years when people were observed feeding the ducks in upstream reaches, a few gulls were attracted to the food source. 2019 was the first year in 31 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 in 2019. Gulls were not observed in Reach 3 during the morning-only monitorings of 2020. As many as 22 gulls were observed in the afternoon in Reach 3 in 2021. The rafts were most common until early August, and only a few were observed after that in Reach 3. Gulls are a threat to ducklings. Previously, individual gulls were occasionally observed beyond Reach 1 when someone was feeding the

ducks. 2021 gull numbers fluctuated between 0 on some mornings (2 and 16 October) and 61 in the afternoon (2 October) on monitoring days (**Figure 27**). The average gull count per monitoring day until 1 December for 2014−2021 has been 63, 68, 42, 40, 46, 63, 36 and 44, respectively. Gulls counts until mid-October were relatively low in 2021 after mid-July compared to other recent years.

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 28**). In 2021, mallard numbers increased in July and generally declined through the summer until early October. But then there was an upswing in mid-October. Mallard densities were lower than several previous years, with seemingly less successful recruitment of ducklings. The average mallard count per monitoring day to 1 December for 2014−2021 has been 27, 26, 31, 18, 30, 21, 44 and 23, respectively, giving 2020 the highest average in the last 8 years. 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 2021 in fall, as is typical. One coot inhabited the lagoon most of the summer. But more were first detected on 19 September (3 October in 2020; 28 September in 2019), as coots typically arrive in late September and early October. The maximum number of coots counted on a monitoring day in 2015−2021 was 113, 13 (early breach), 34, 147, 58 and 38 (early breach), respectively. The large, gray-brown domestic duck that came to the lagoon in 2020 was present throughout the 2021 monitoring period. It had paired up with a male mallard.

NEW AND CONTINUING 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. Until concrete wings are constructed, 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. Upstream 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. NEW−If a significant saltwater layer (0.25−0.5 m thick) is trapped in deeper pockets along the lagoon bottom adjacent Venetian Courts and upstream after sandbar construction under drought conditions (low stream inflow), then pump water from the very warm, oxygen-depressed saltwater lens through a hose to the flume until the saltwater lens is substantially removed and water quality is restored. The pump intake shall be screened to prevent fish mortality.

2. 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.

3. A previous recommendation in the original Management Plan (**1990**) should be emphasized to prevent fish mortality; parking lots and streets draining into the lagoon should be cleaned thoroughly before the first fall rains.

4. 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.

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

6. 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.

7. 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.

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

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

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

11. 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.

12. 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.

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

14. 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.

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

16. 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.

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

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

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

20. 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.

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

22. 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.

23. 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.

24. 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.

25. 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.

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

27. 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.

Community Support during Steelhead Censusing. October 2021

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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

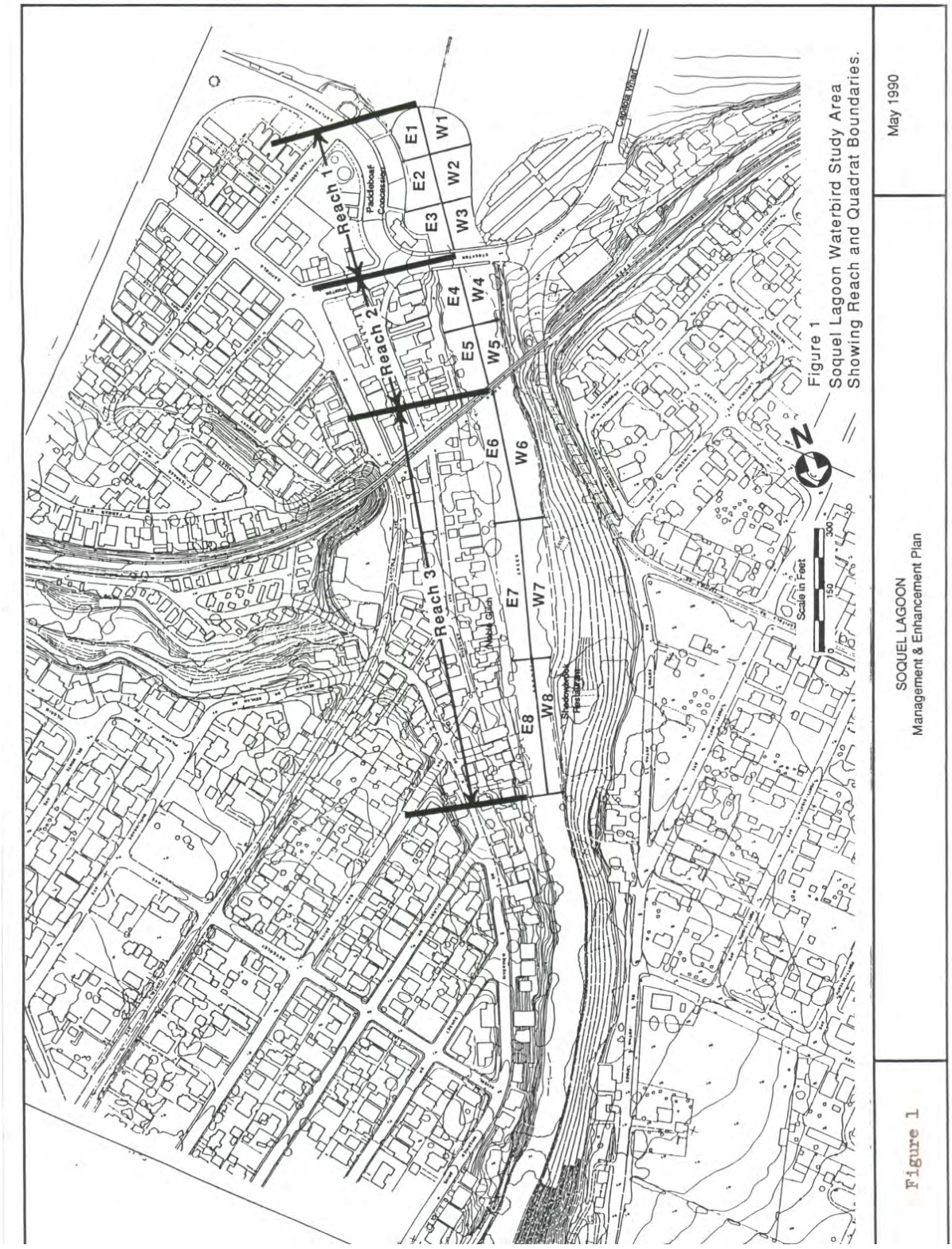


Figure 1. Map of Reaches in Soquel Creek Lagoon

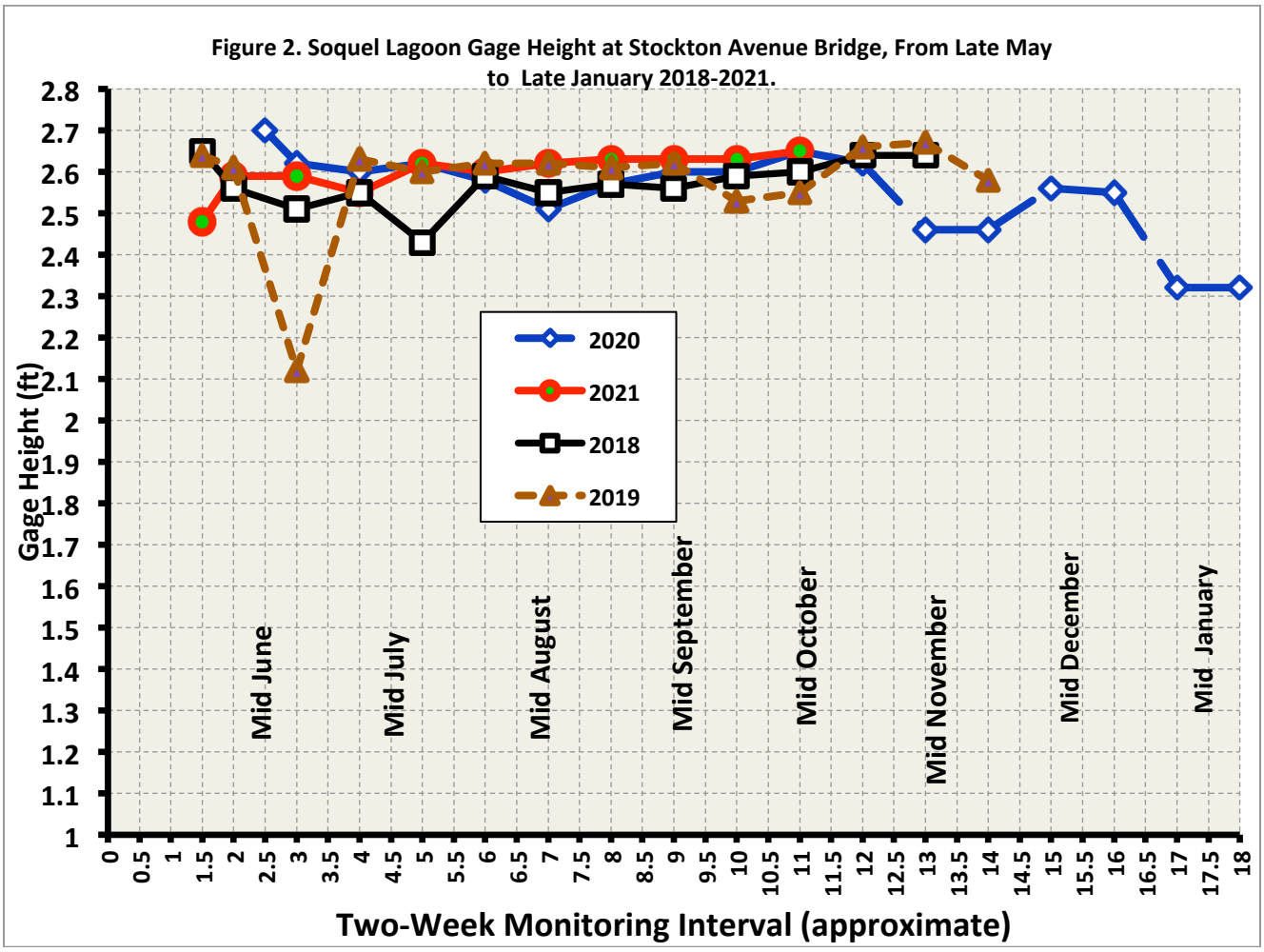


Figure 2. Soquel Lagoon Gage Height at Stockton Avenue Bridge, From Late May to Early December 2018-2021

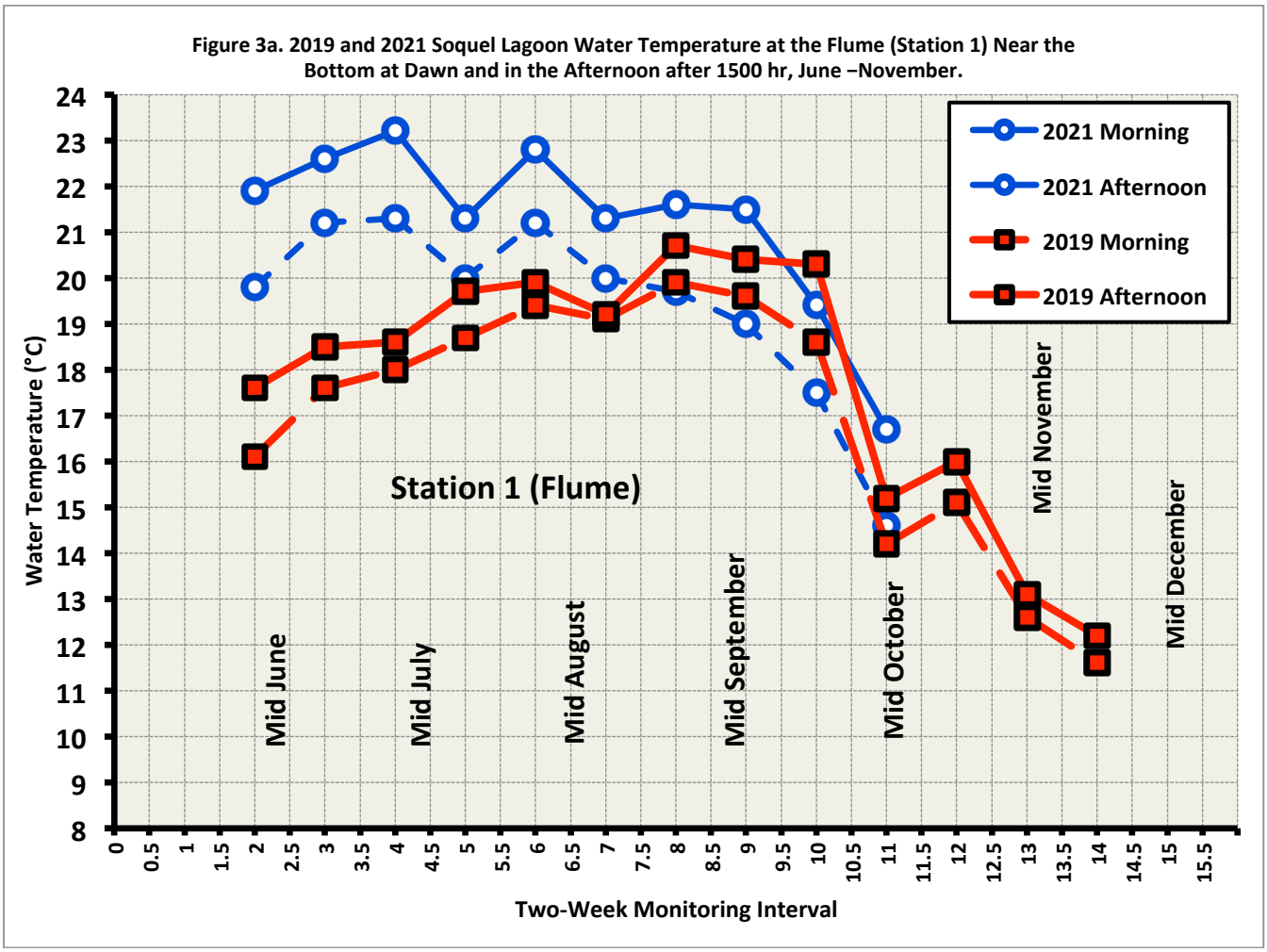


Figure 3a. Soquel Lagoon Water Temperature at the Flume (Station 1) Near the Bottom at Dawn and in the Afternoon, Comparing 2021 to the higher flow year, 2019, June – October.

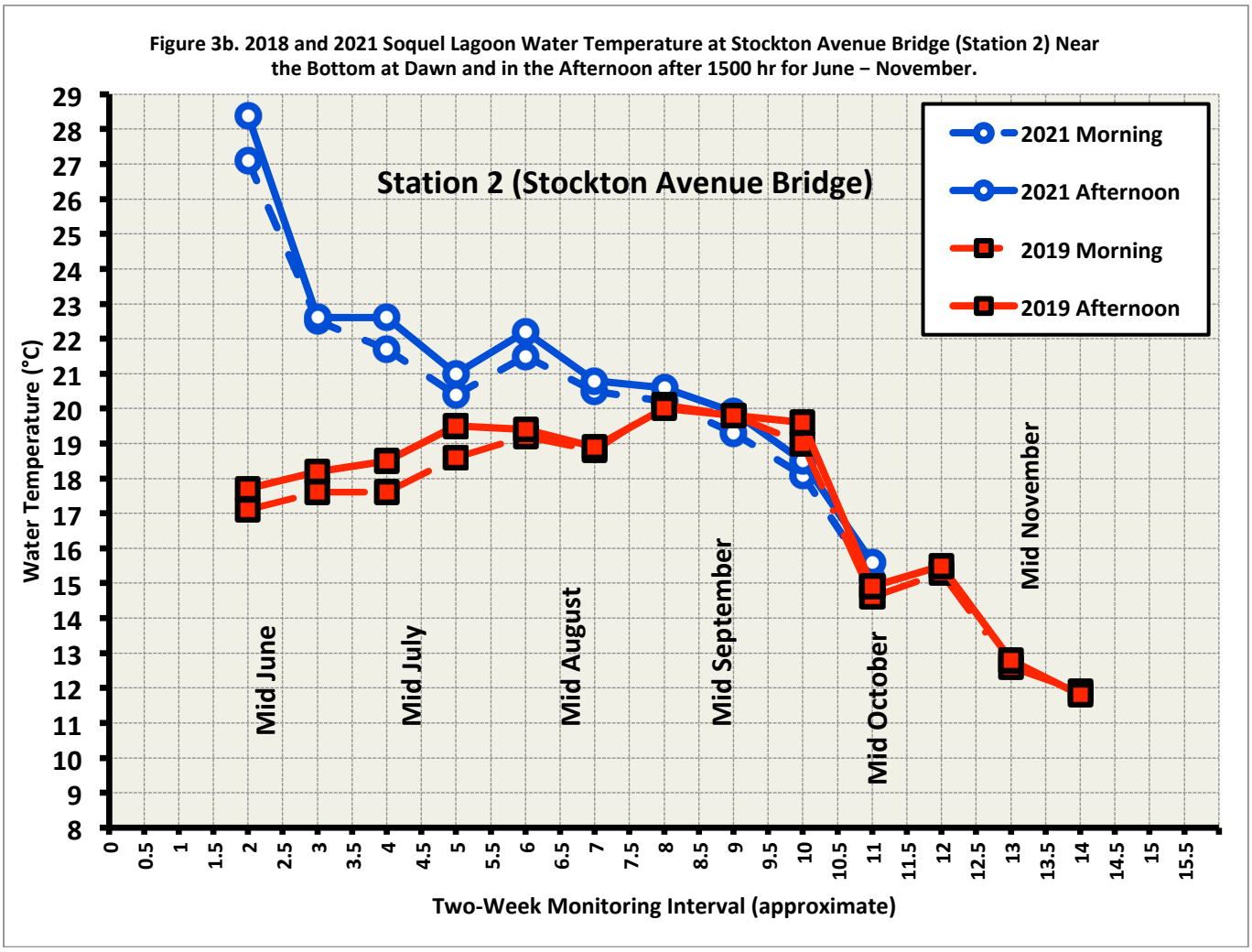


Figure 3b. Soquel Lagoon Water Temperature at Stockton Avenue Bridge (Station 2) Near the Bottom at Dawn and in the Afternoon, Comparing 2021 to the higher flow year, 2019, June – October.

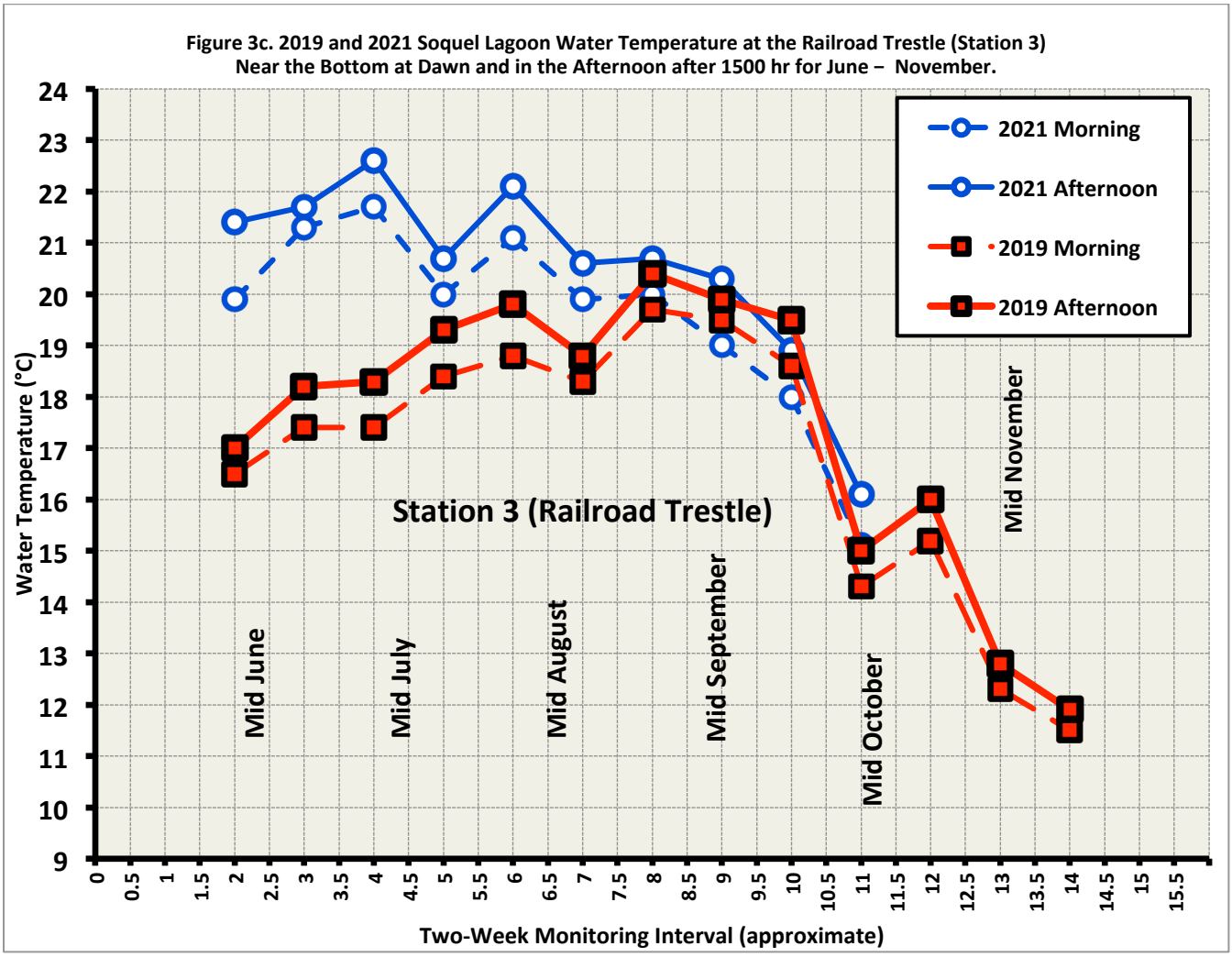


Figure 3c. Soquel Lagoon Water Temperature at the Railroad Trestle (Station 3) Near the Bottom at Dawn and in the Afternoon, Comparing 2021 to a Higher Flow Year, 2019, June − October.

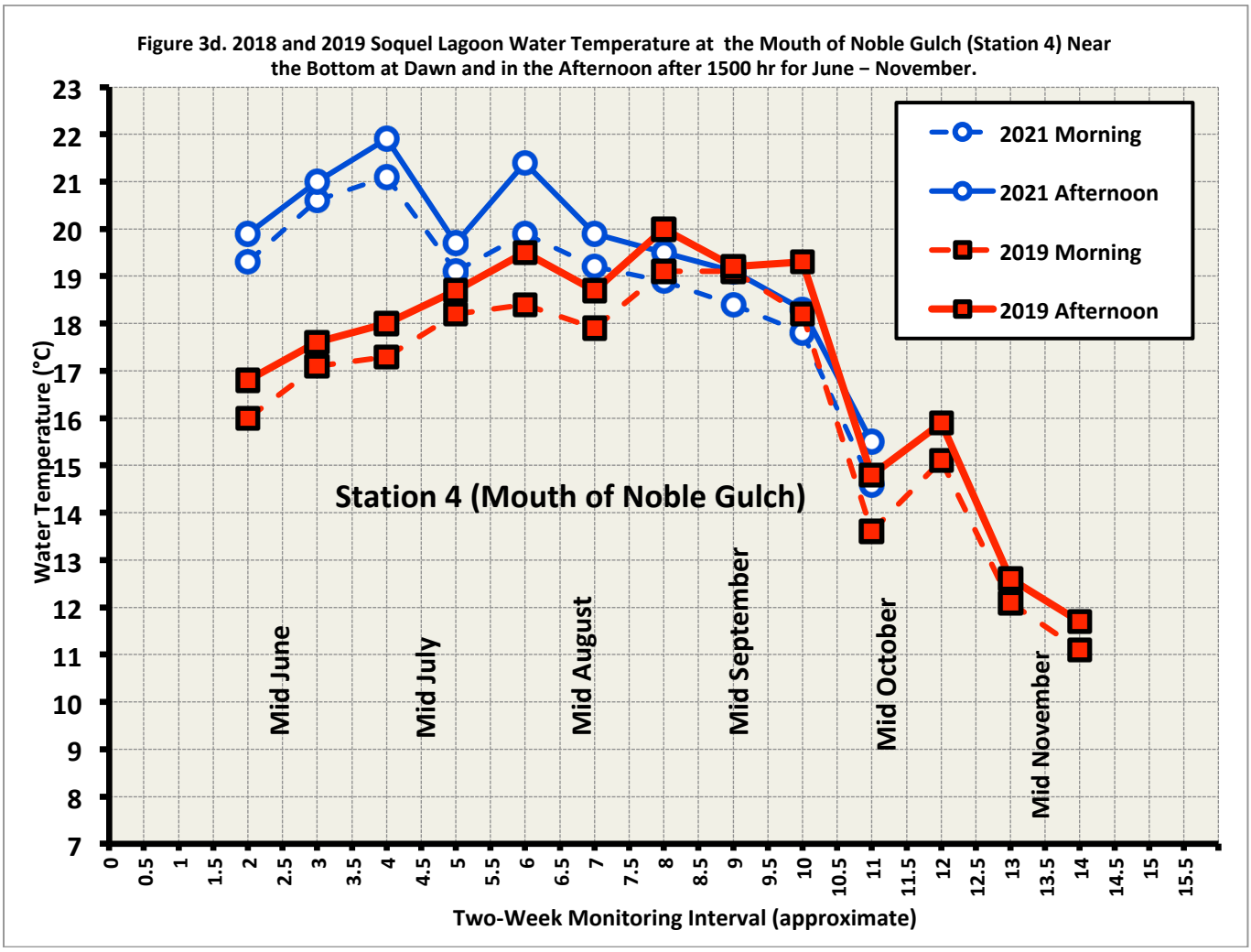


Figure 3d. Soquel Lagoon Water Temperature at the Mouth of Noble Gulch (Station 4) Near the Bottom at Dawn and in the Afternoon, Comparing 2021 to a Higher Flow Year, 2019, June – October.

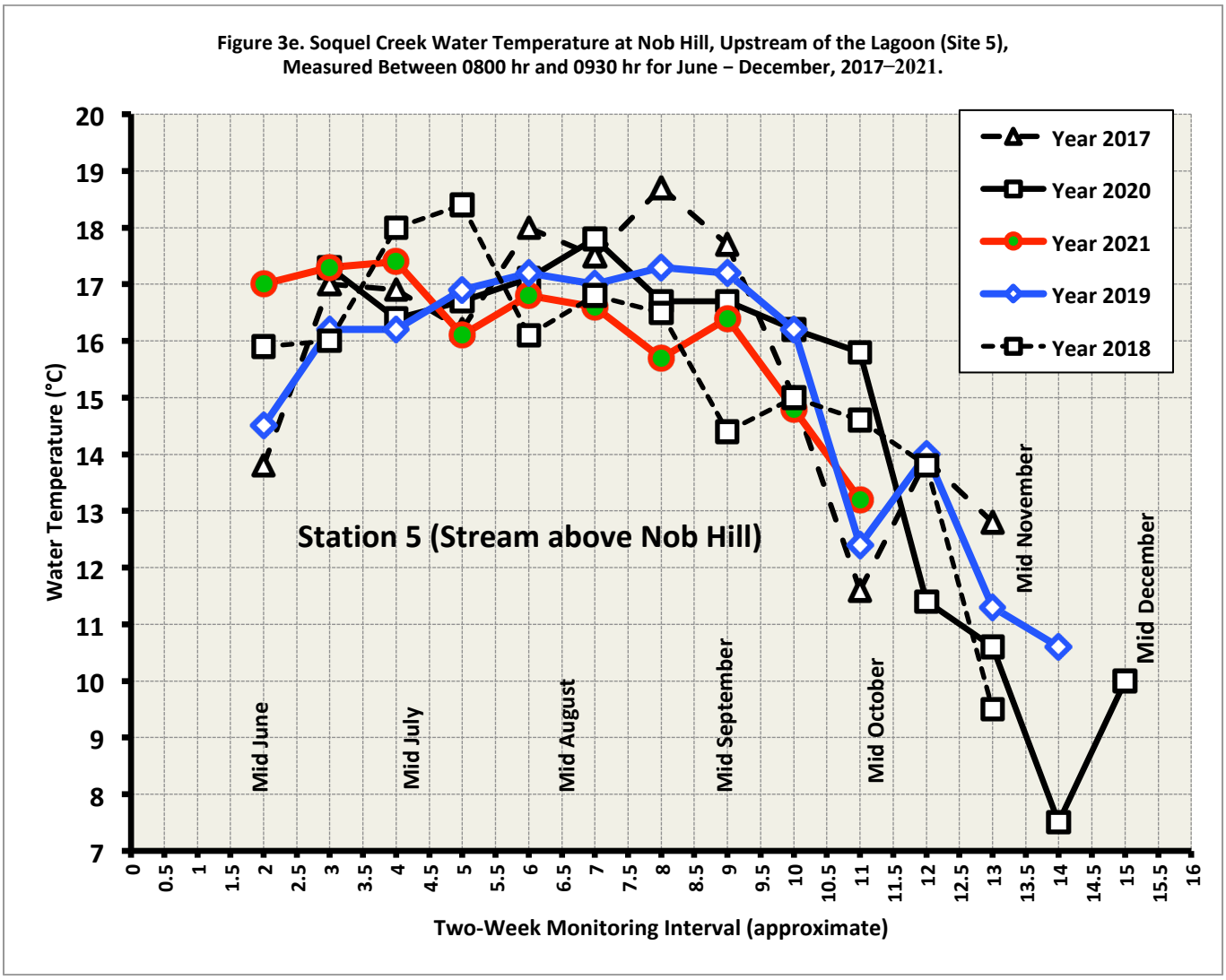


Figure 3e. Soquel Creek Water Temperature at Nob Hill Upstream of the Lagoon, 2017–2021. Measured Between 0800 hr and 0930 hr for June – Mid-December.

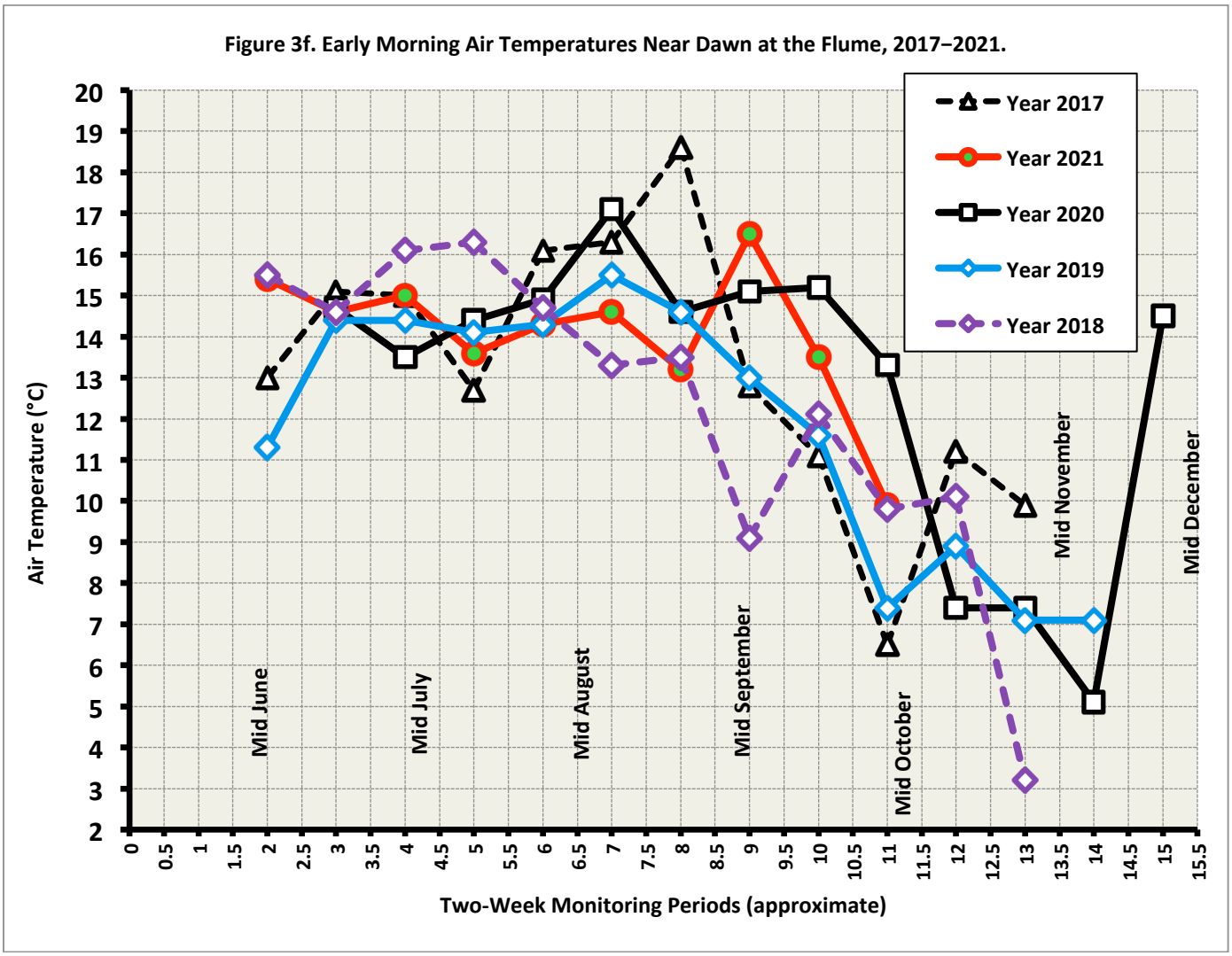


Figure 3f. Early Morning Air Temperatures Near Dawn at the Flume, 2017−2021.

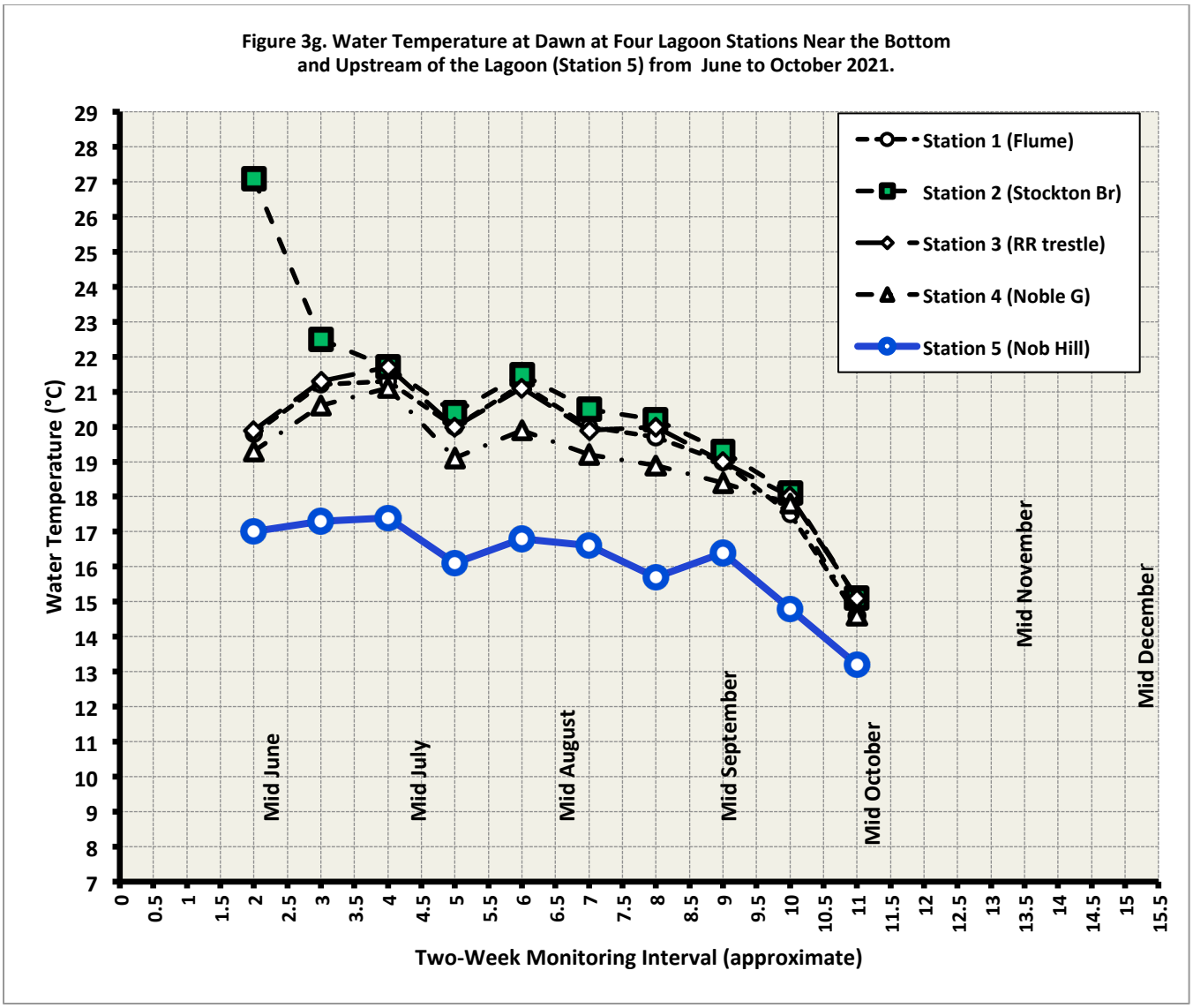


Figure 3g. Water Temperature at Dawn at Four Lagoon Stations Near the Bottom and Upstream from June to Mid-October 2021.

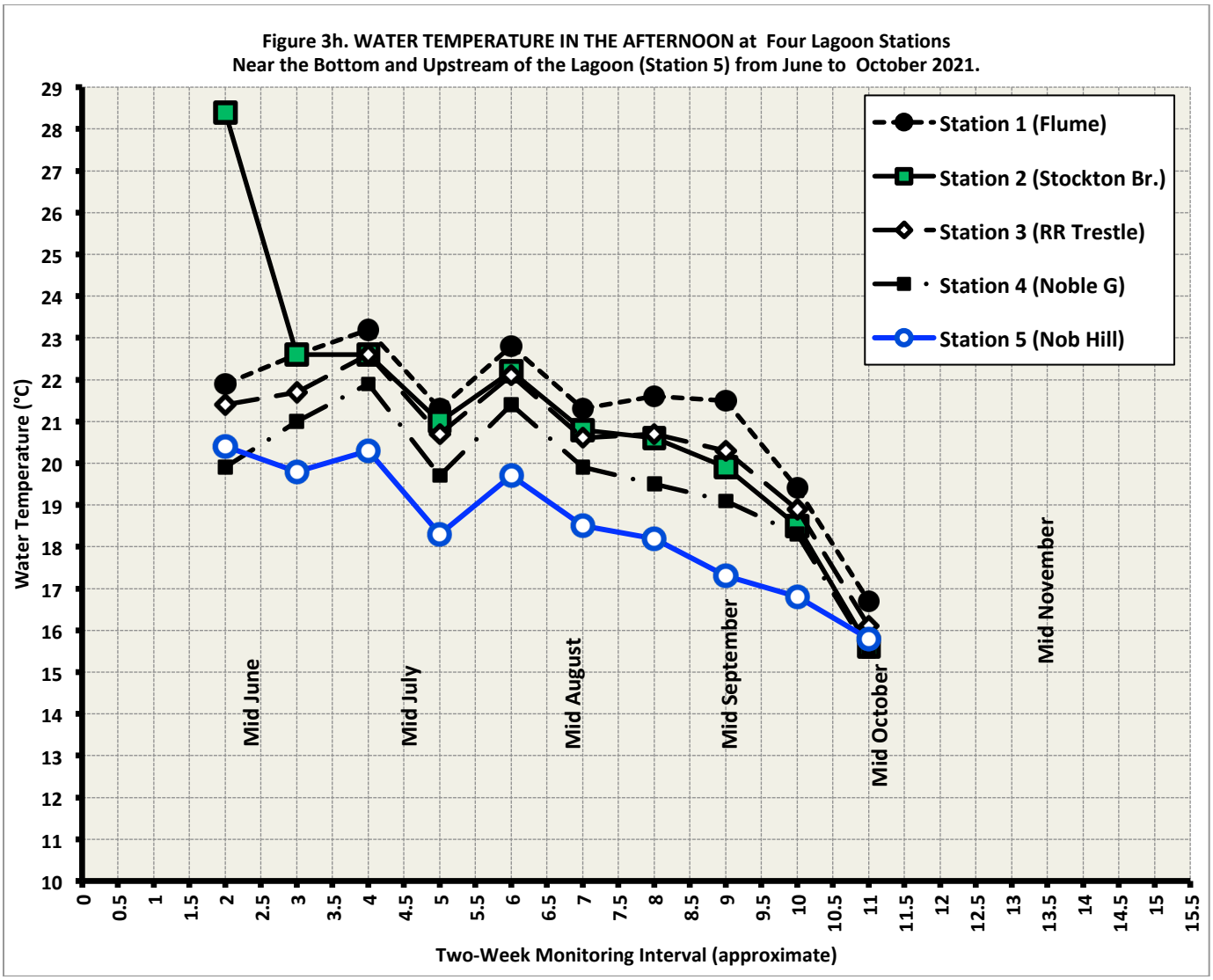


Figure 3h. Water Temperature in the Afternoon at Four Lagoon Stations Near the Bottom and Upstream from June to Mid-October 2021.

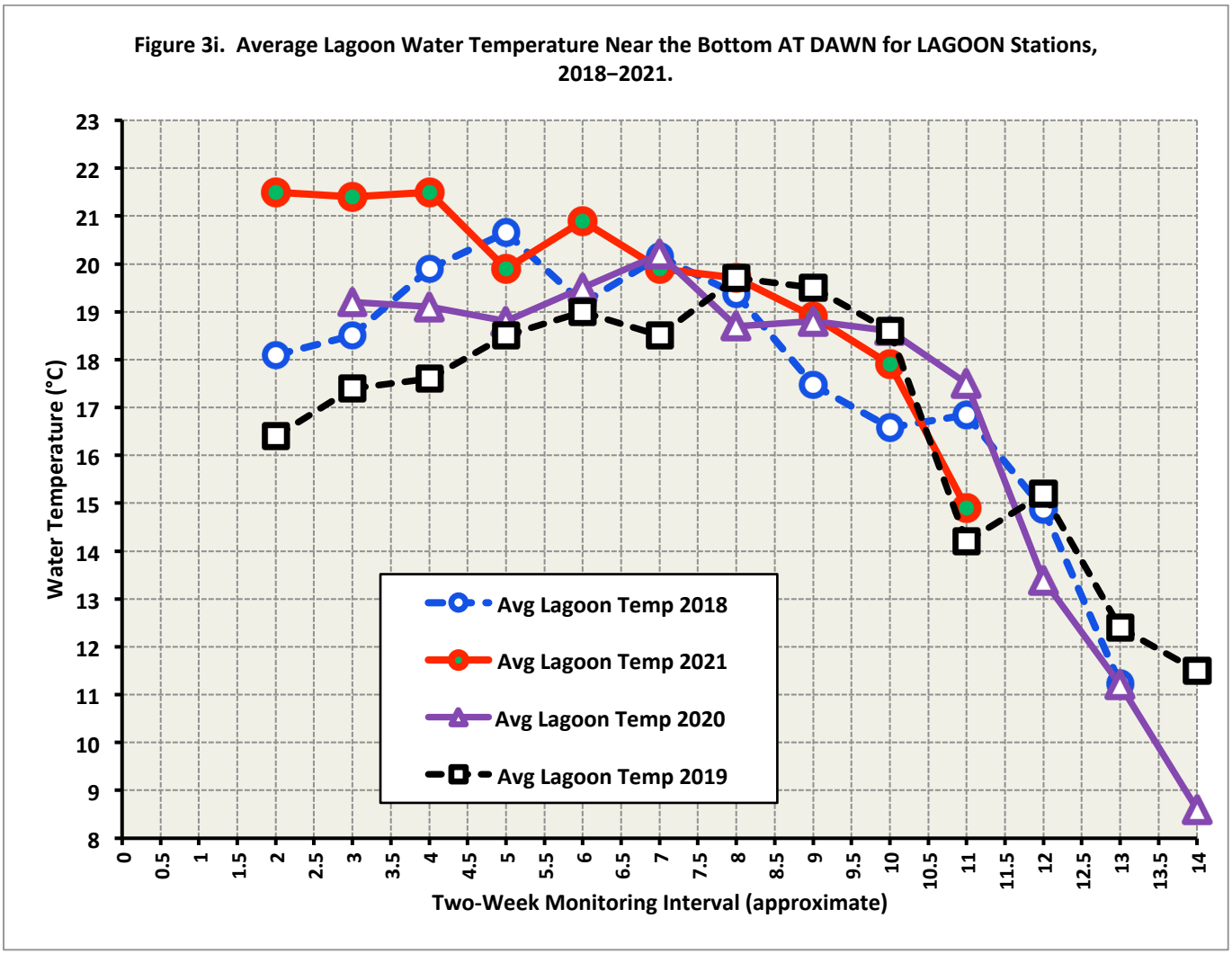


Figure 3i. Average Lagoon Water Temperature Near the Bottom at Dawn for 4 Stations, 2018–2021.

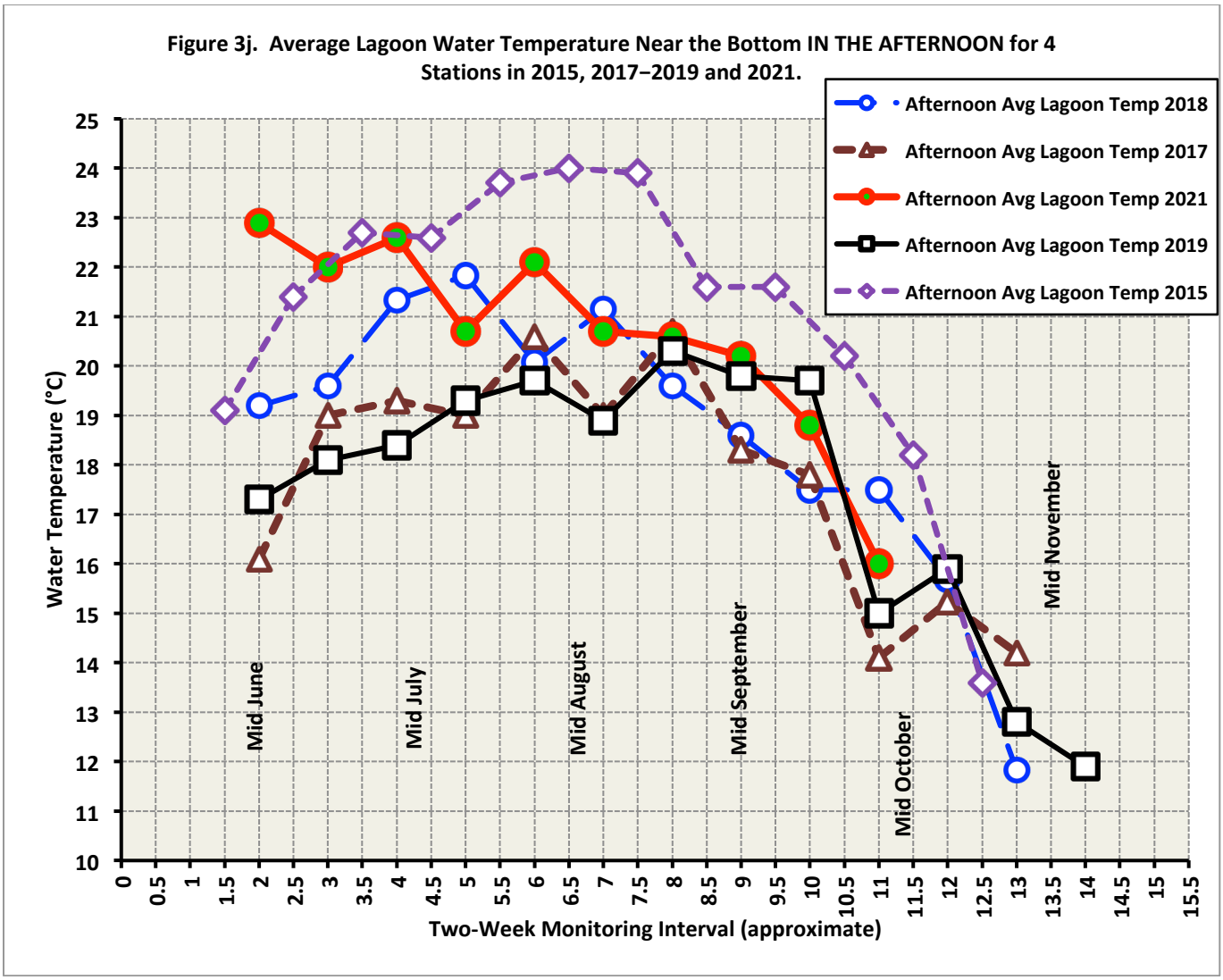


Figure 3j. Average Lagoon Water Temperature Near the Bottom in the Afternoon for 4 Stations, 2015, 2017-2019 and 2021.

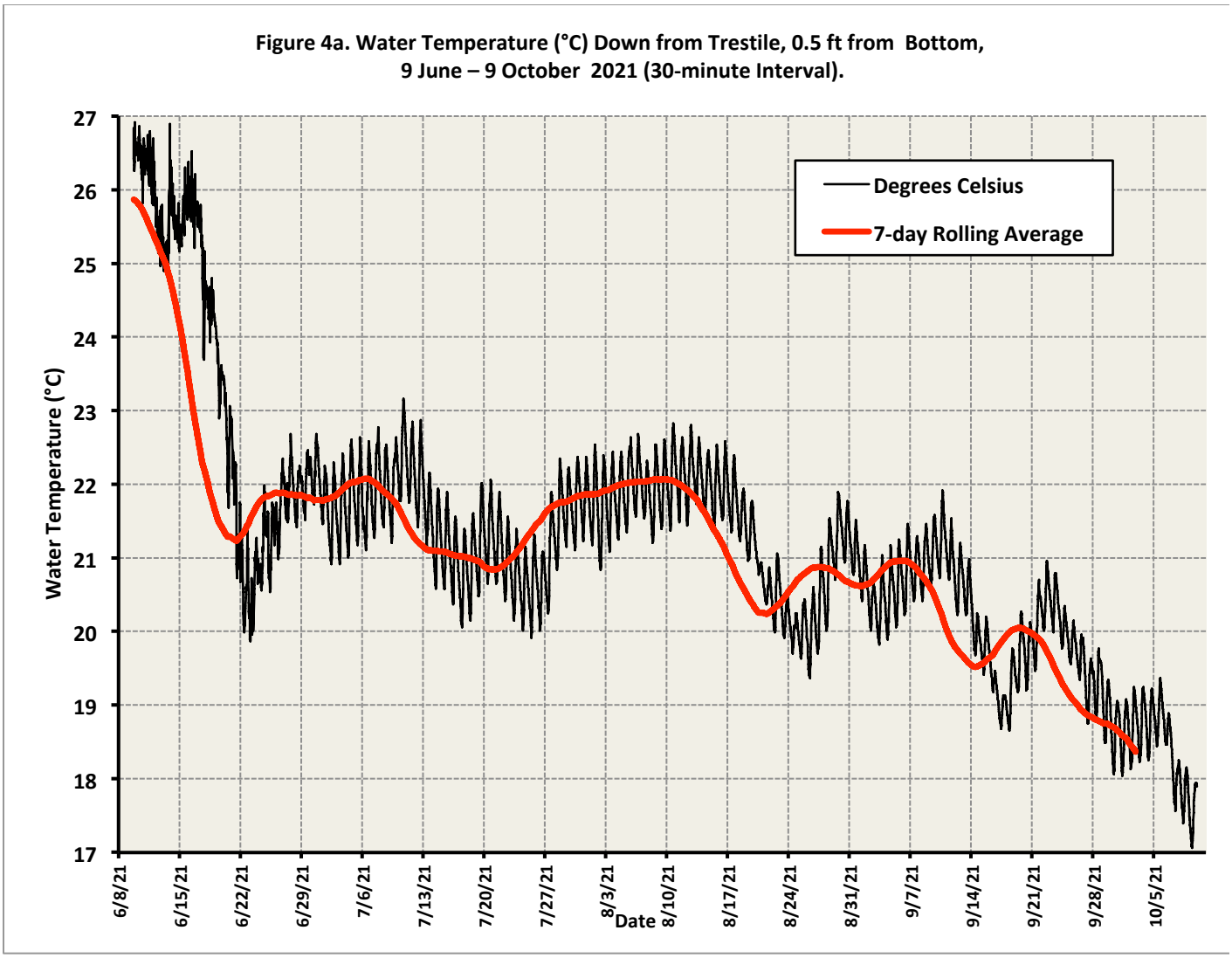


Figure 4a. Water Temperature (°C) Down from Trestile, 0.5 ft from the Bottom, 9 June – 9 October 2021 (30-minute Interval).

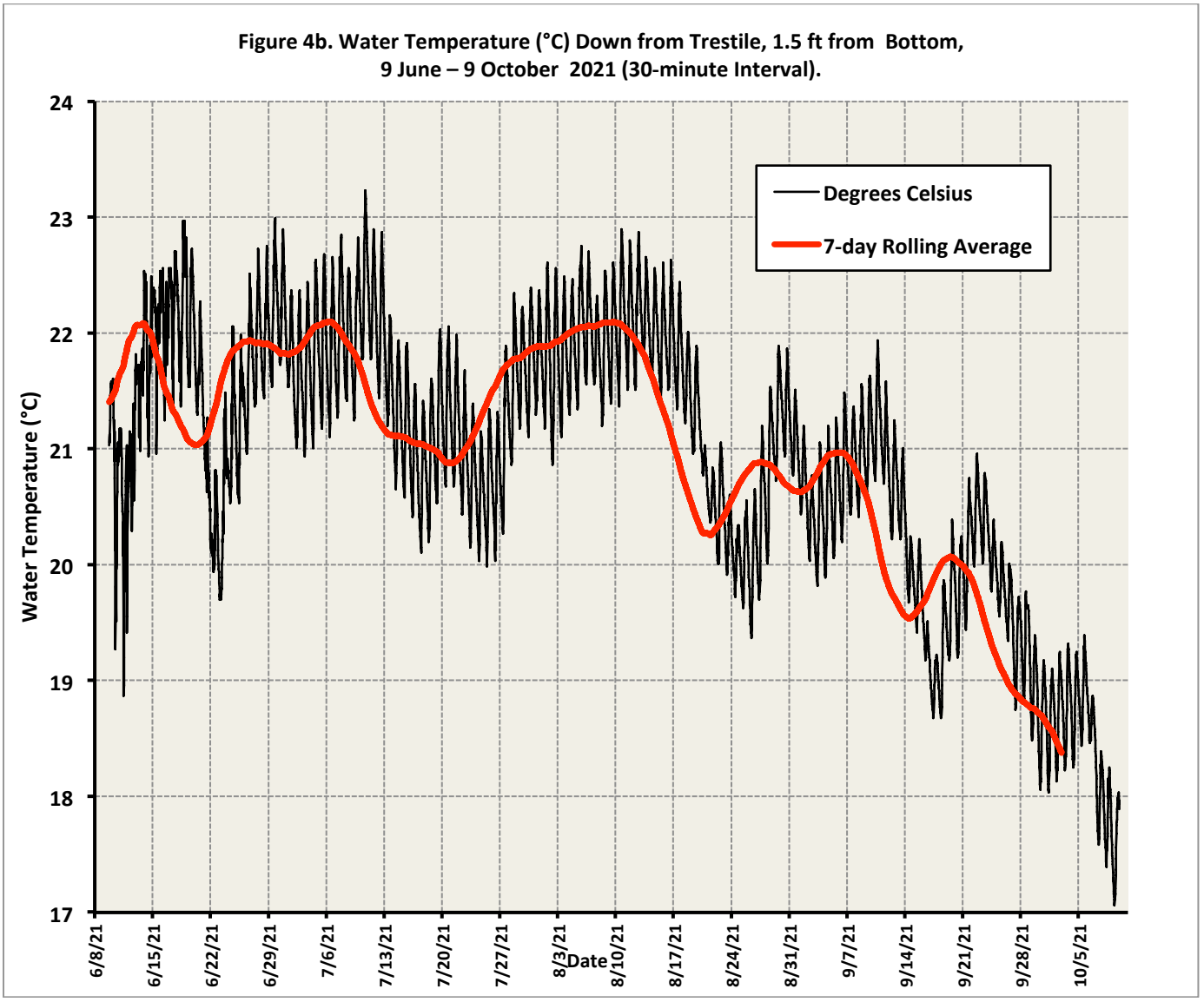


Figure 4b. Water Temperature (°C) Down from Trestle, 1.5 ft from the Bottom, 9 June – 9 October 2021 (30-minute Interval).

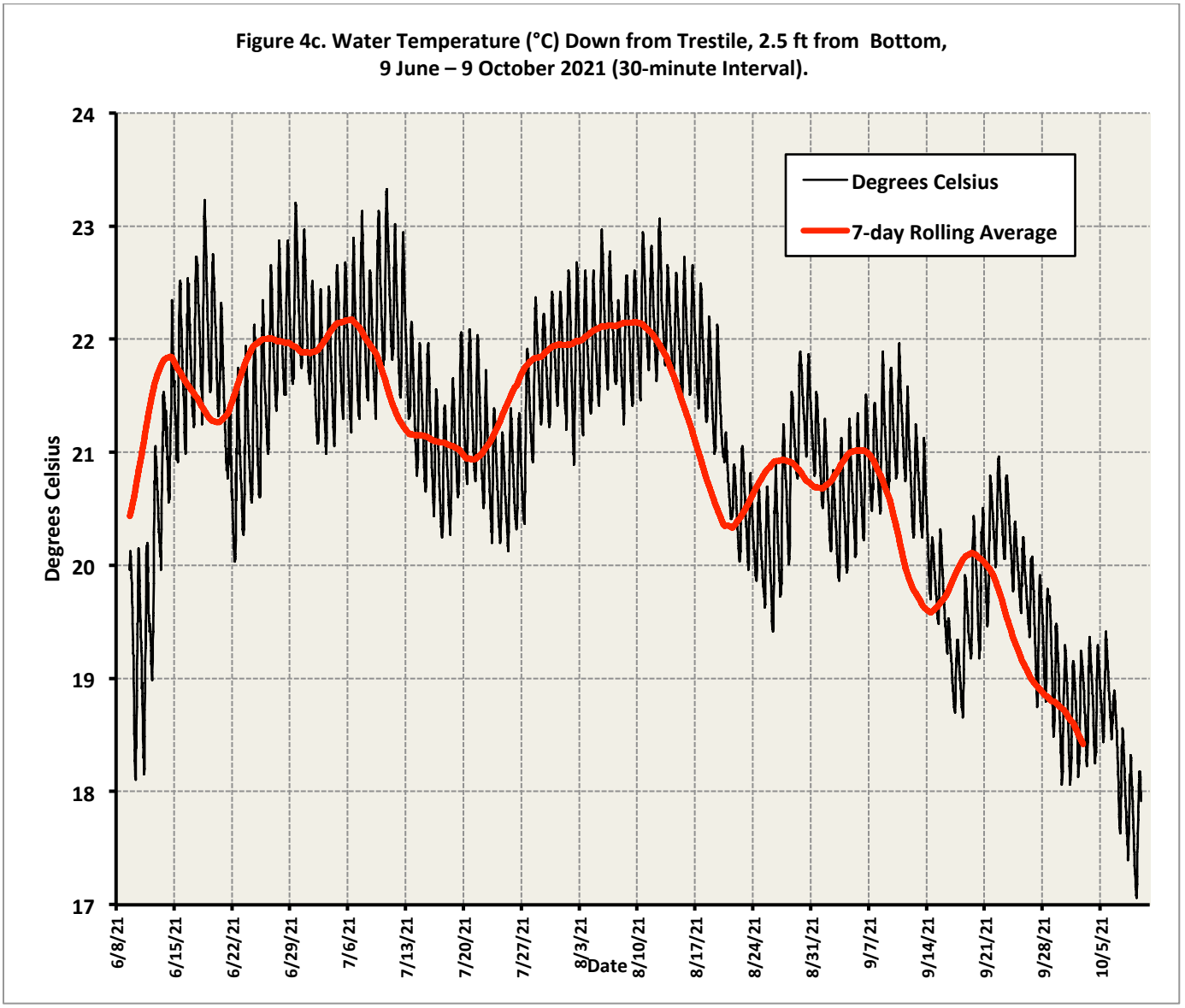


Figure 4c. Water Temperature (°C) Down from Trestle, 2.5 ft from the Bottom, 9 June – 9 October 2021 (30-minute Interval).

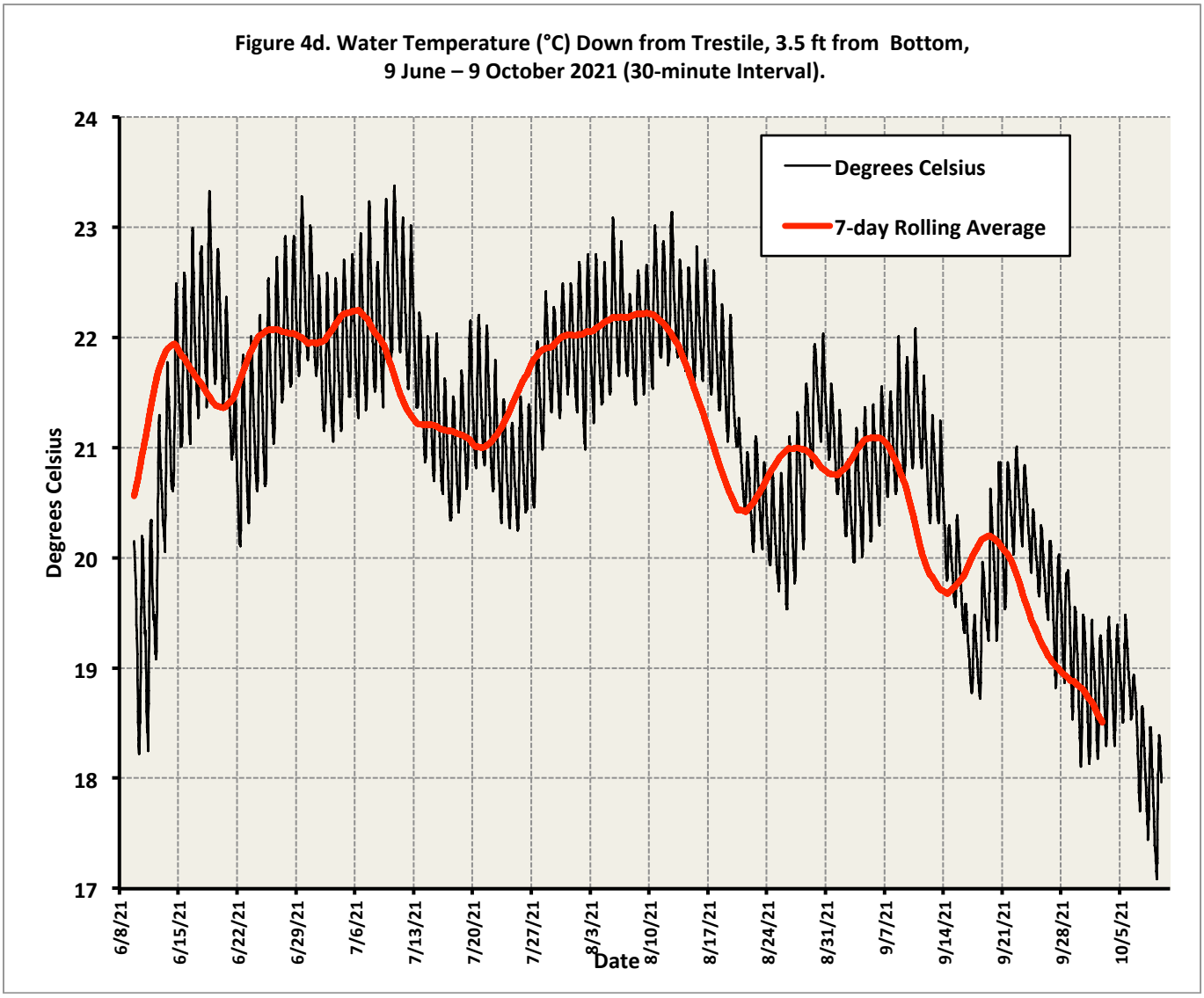


Figure 4d. Water Temperature (°C) Down from Trestle, 3.5 ft from the Bottom, 9 June – 9 October 2021 (30-minute Interval).

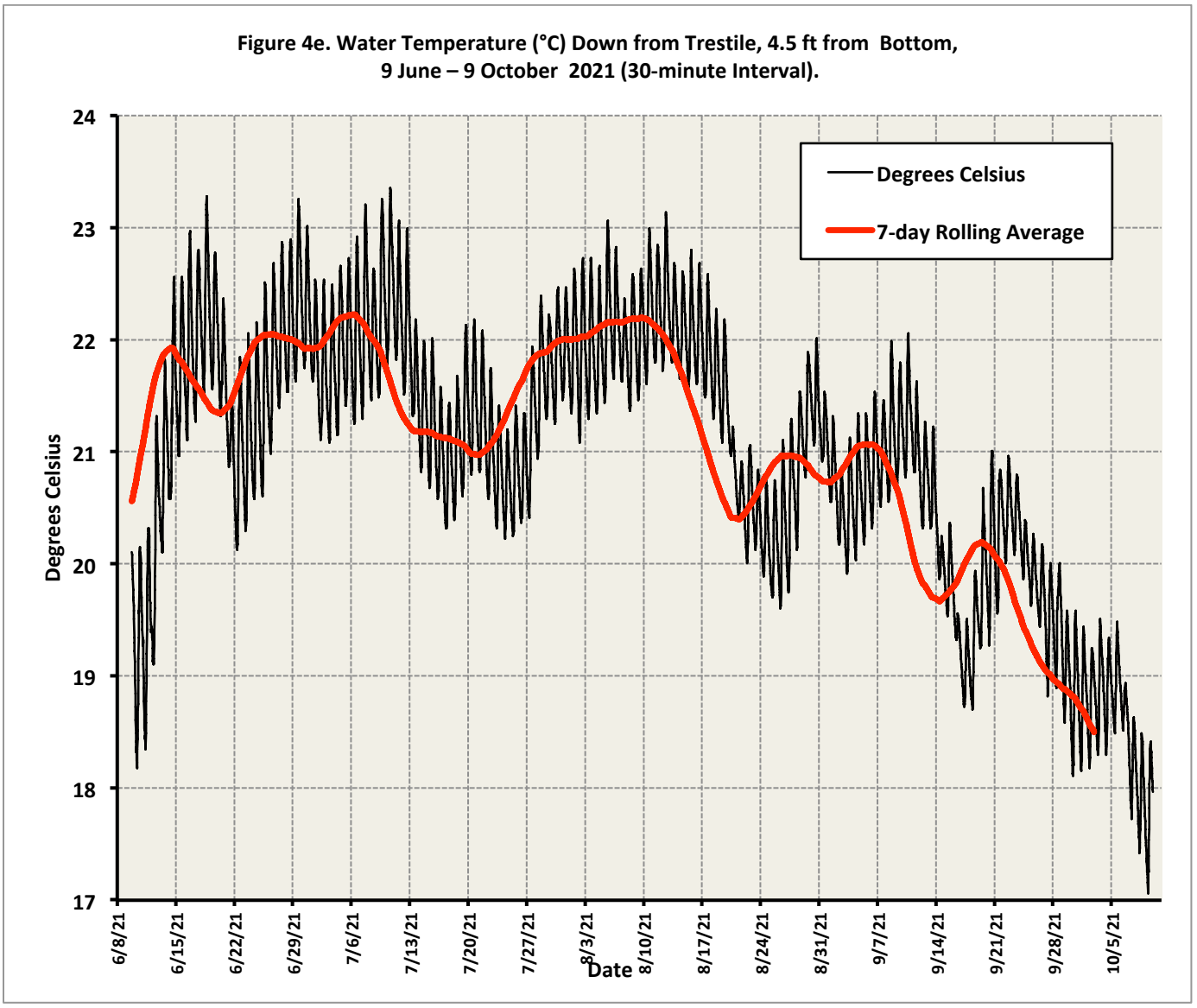


Figure 4e. Water Temperature (°C) Down from Trestle, 4.5 ft from the Bottom, 9 June – 9 October 2021 (30-minute Interval).

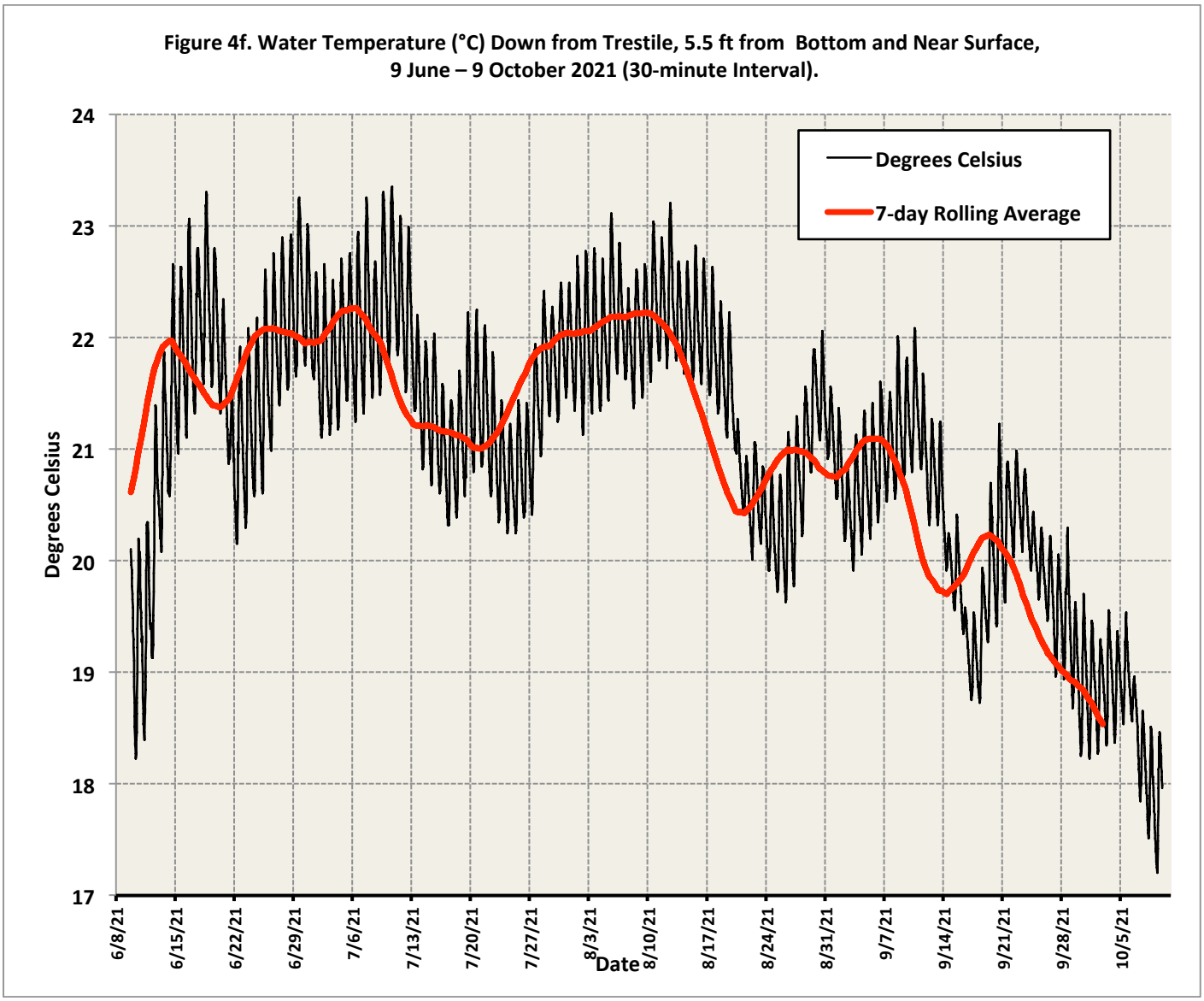


Figure 4f. Water Temperature (°C) Down from Trestle, 5.5 ft from the Bottom, 9 June – 9 October 2021 (30-minute Interval).

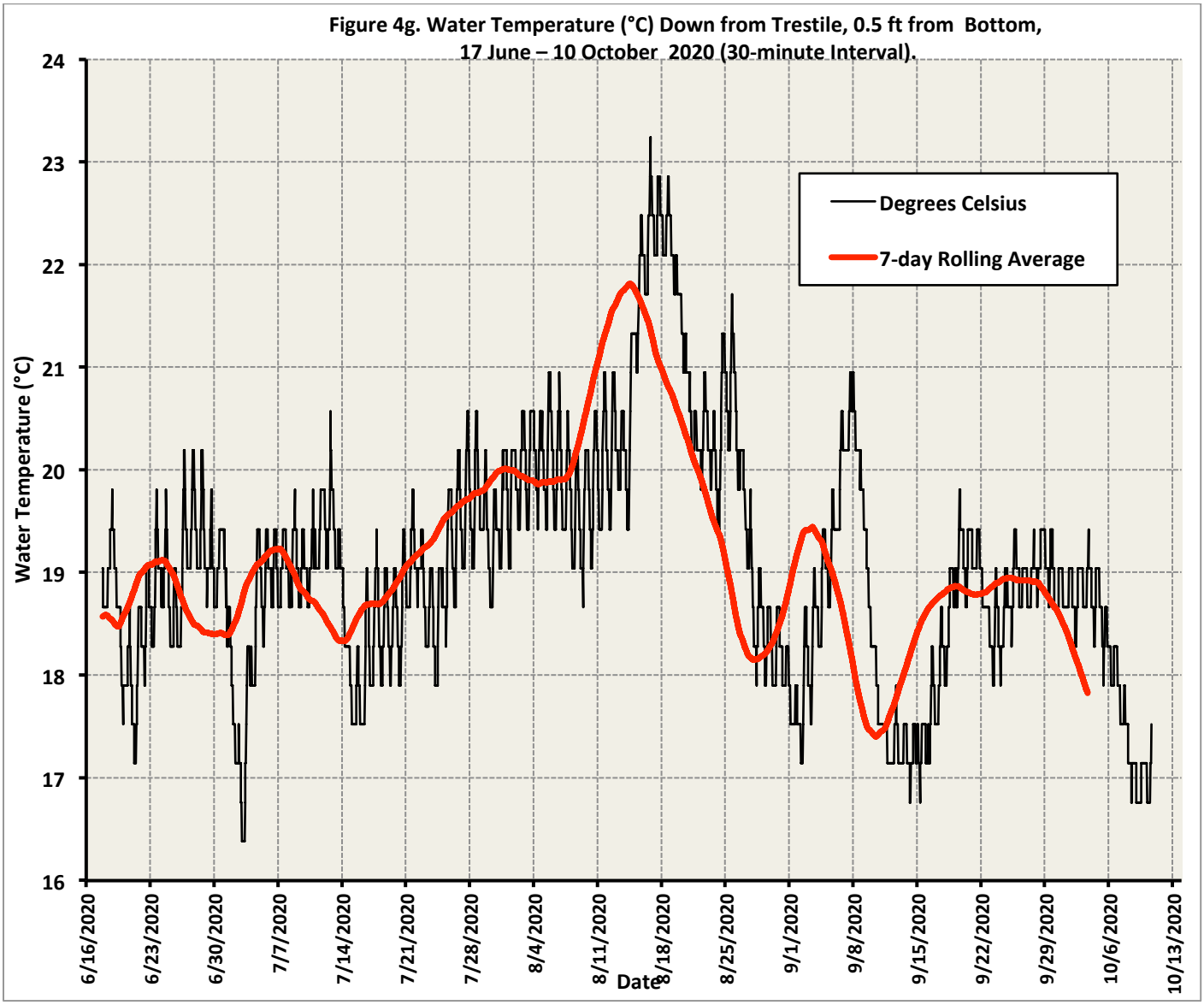


Figure 4g. Water Temperature (°C) Down from Trestle, 0.5 ft from the Bottom, 17 June – 10 October 2020 (30-minute Interval).

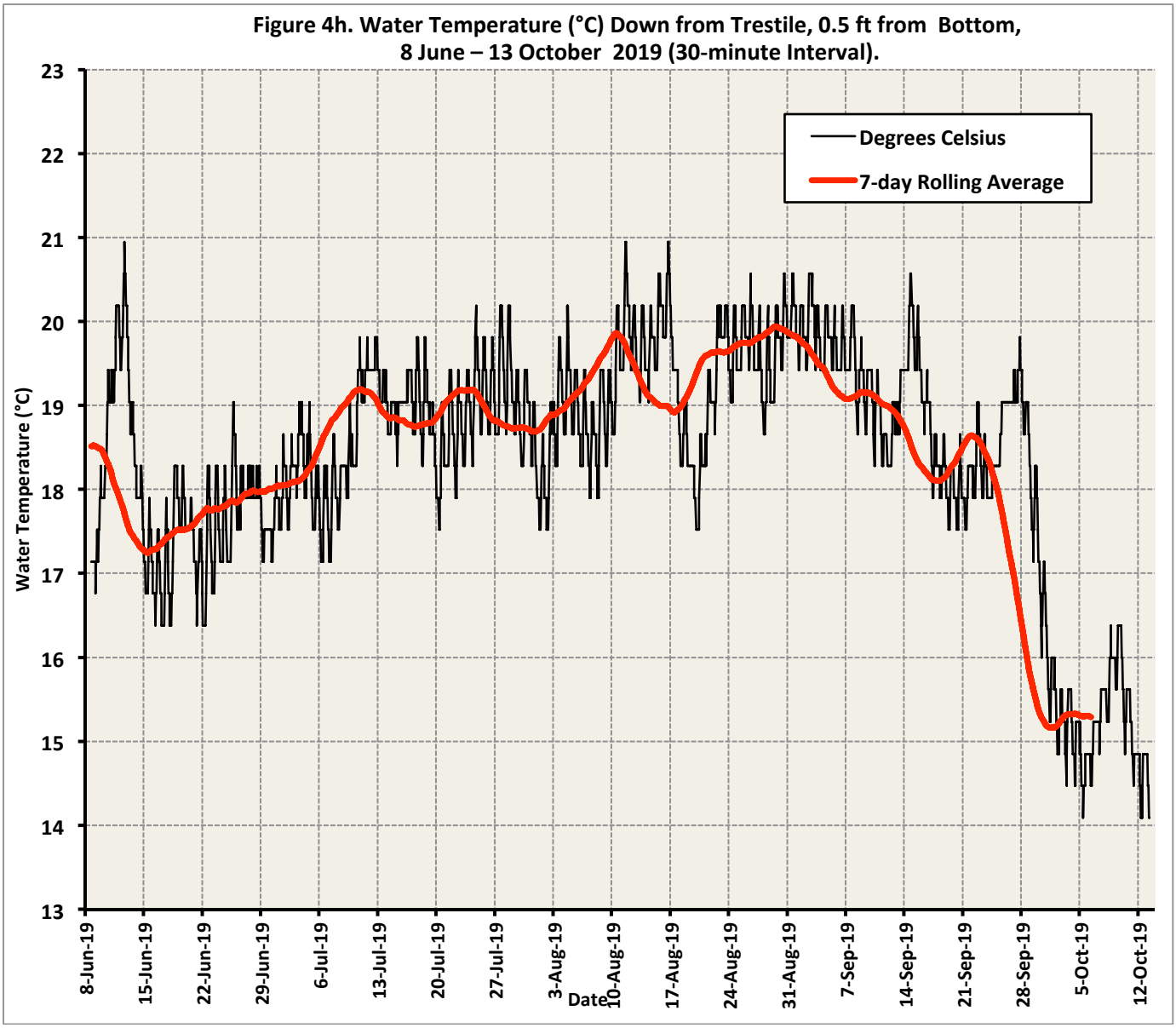


Figure 4h. Water Temperature (°C) Down from Trestle, 0.5 ft from the Bottom, 8 June – 13 October 2019 (30-minute Interval).

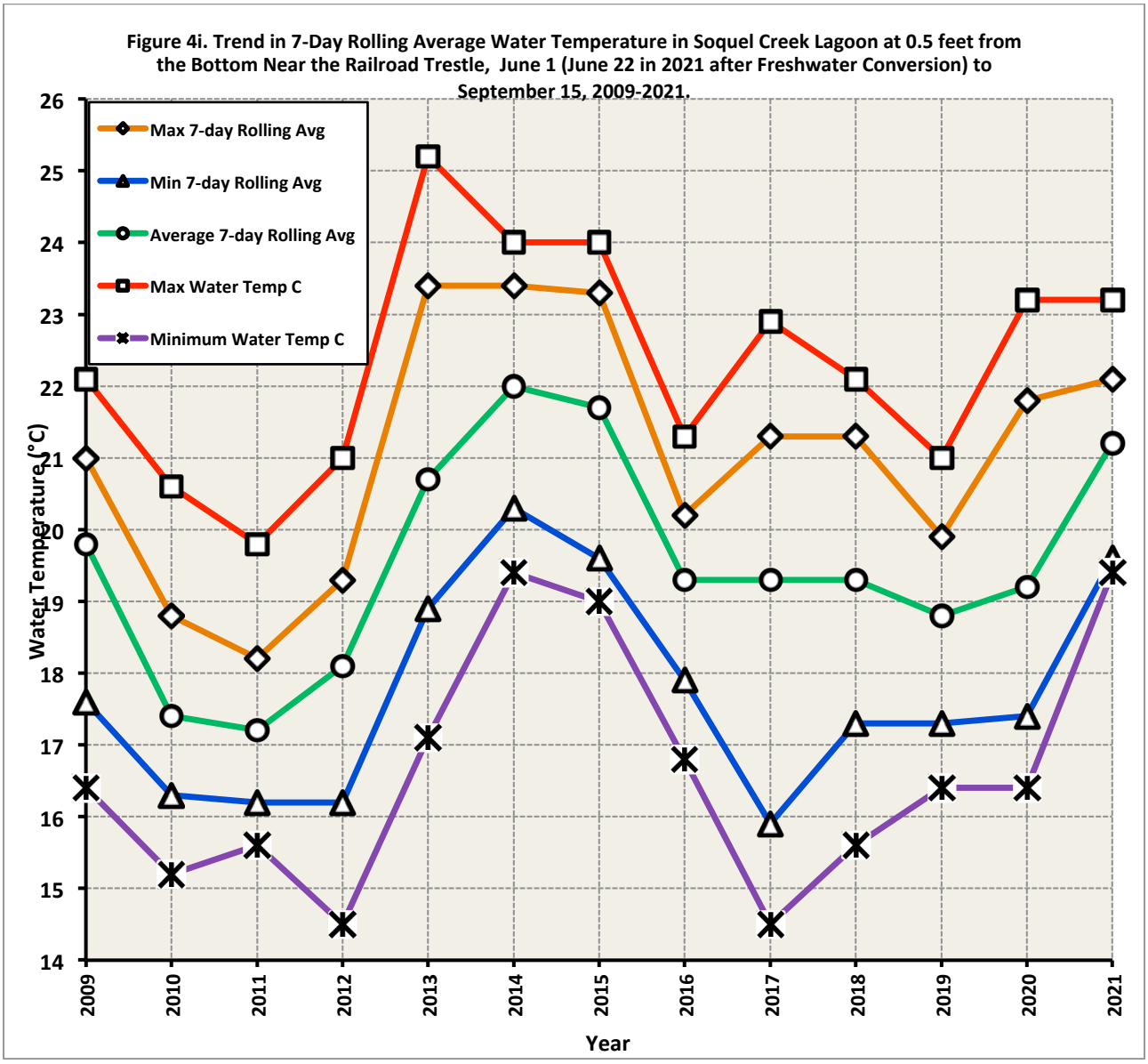


Figure 4i. Trend in 7-day Rolling Average Water Temperature in Soquel Creek Lagoon at 0.5 ft from the Bottom Near the Railroad Trestle, 2009–2021.

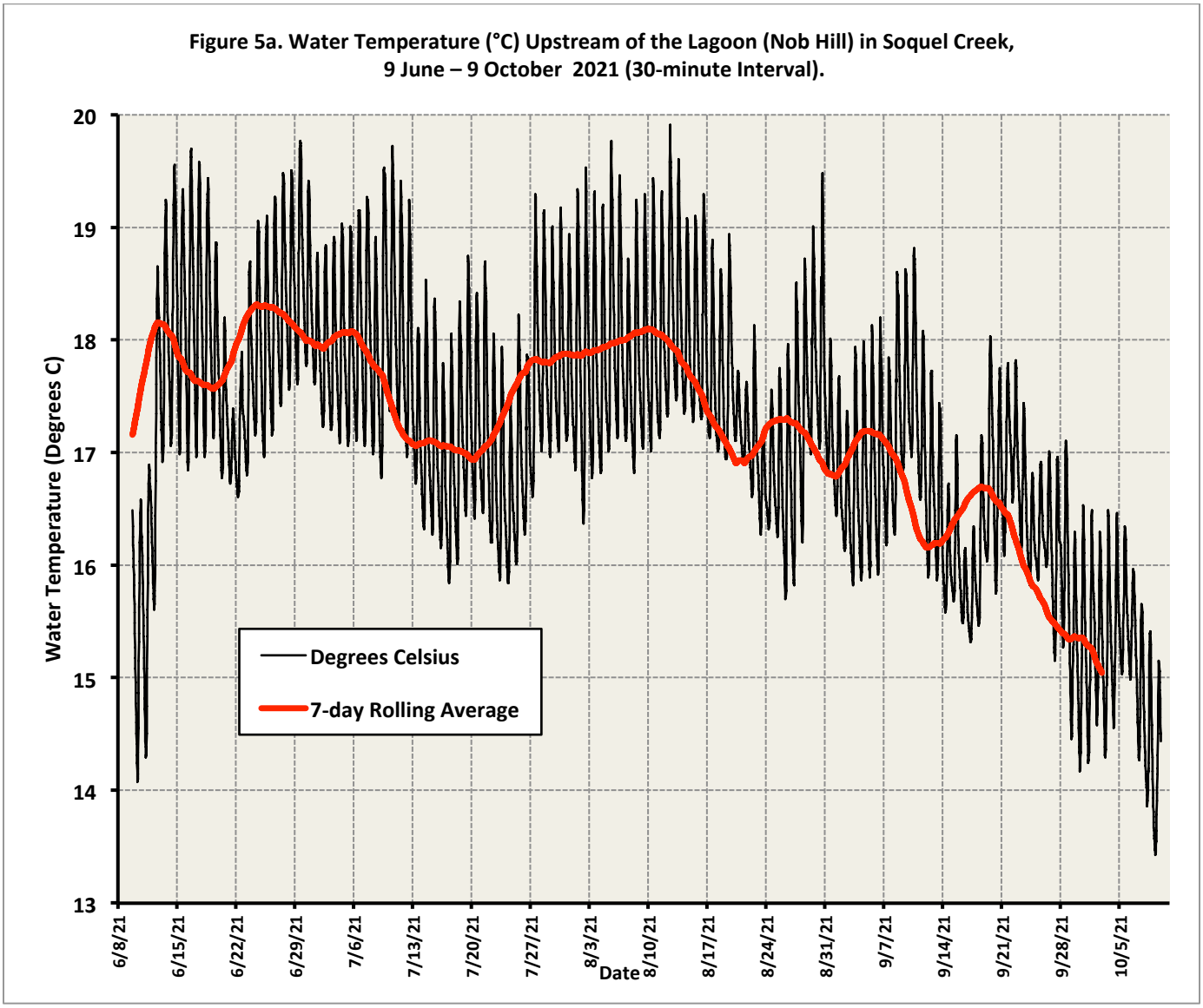


Figure 5a. Water Temperature (°C) Above the Lagoon (Nob Hill) in Soquel Creek, 9 June – 9 October 2021 (30-minute Interval).

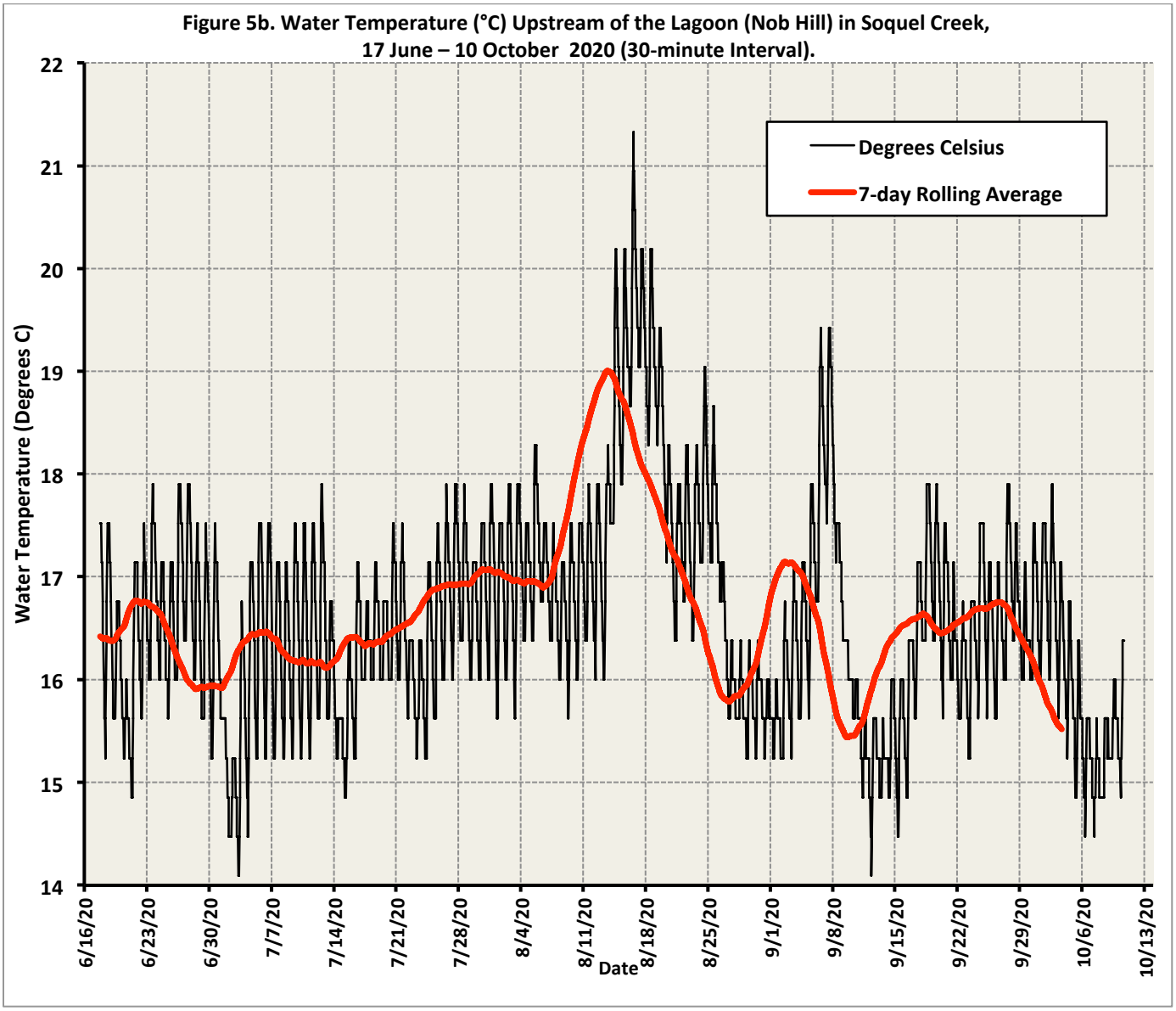


Figure 5b. Water Temperature (°C) Above the Lagoon (Nob Hill) in Soquel Creek, 17 June – 10 October 2020 (30-minute Interval).

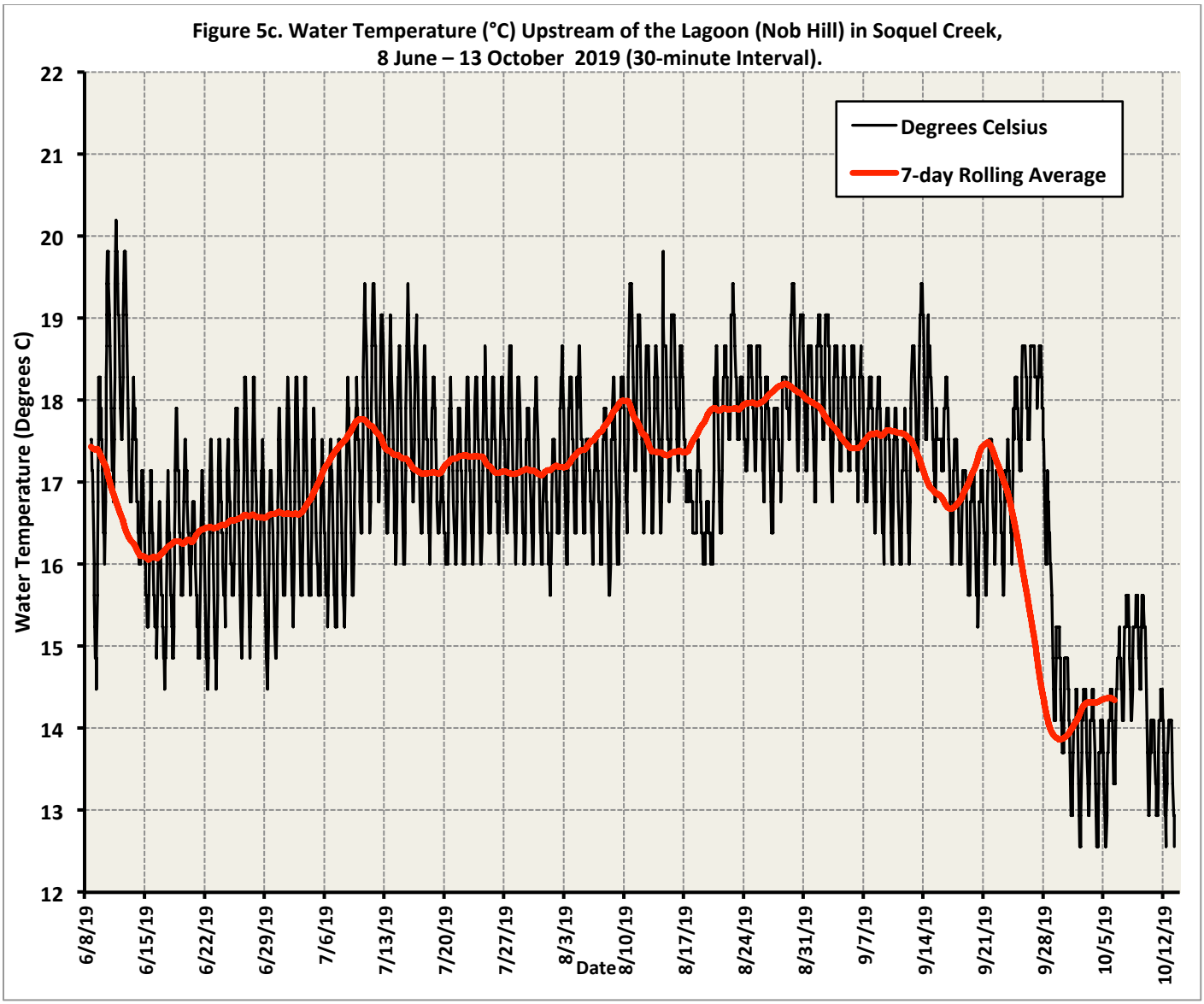


Figure 5c. Water Temperature (°C) Above the Lagoon (Nob Hill) in Soquel Creek, 8 June – 13 October 2019 (30-minute Interval).

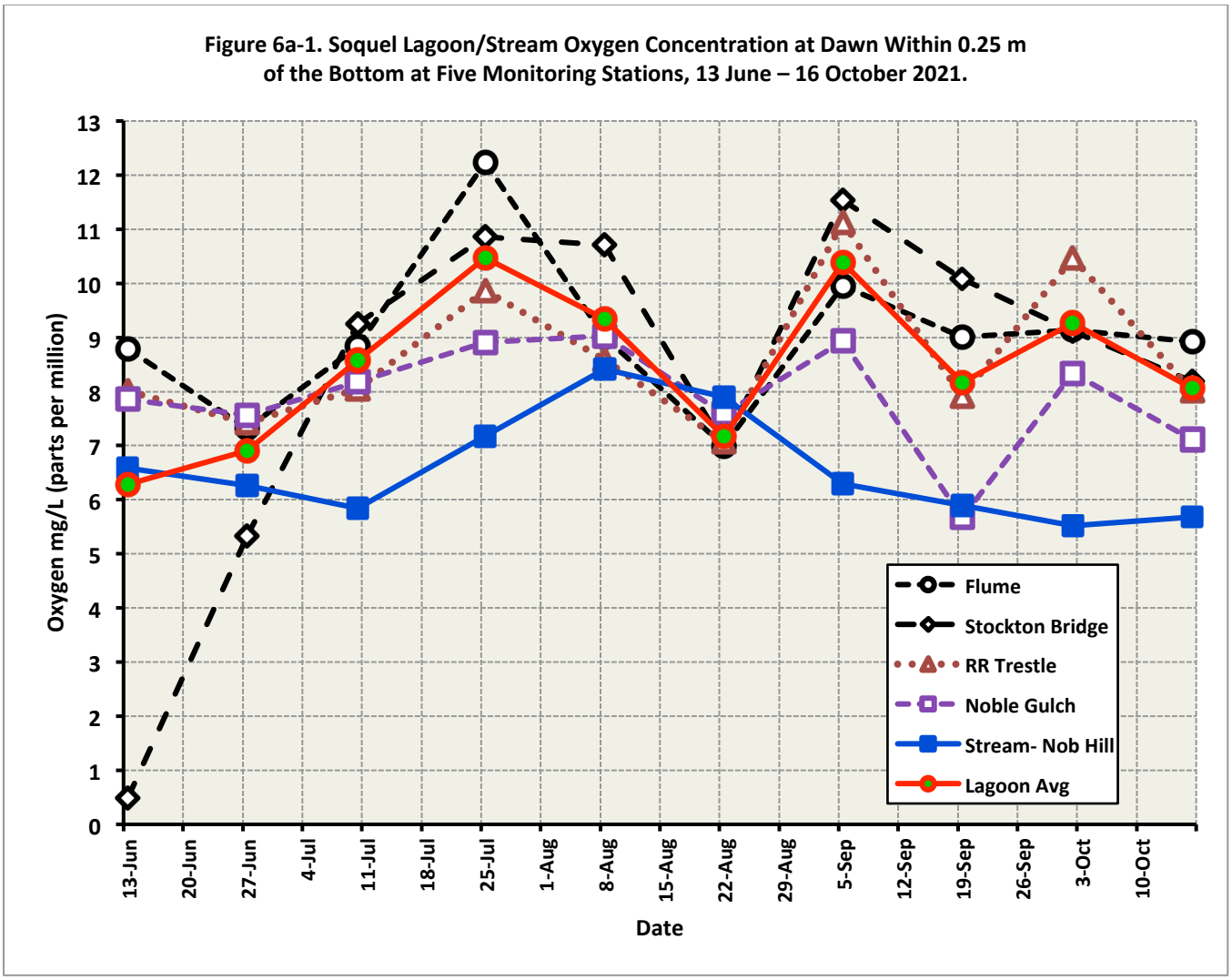


Figure 6a-1. Soquel Lagoon/Stream Oxygen Concentration at Dawn Within 0.25m of the Bottom at Five Monitoring Stations, 13 June – 16 October 2021.

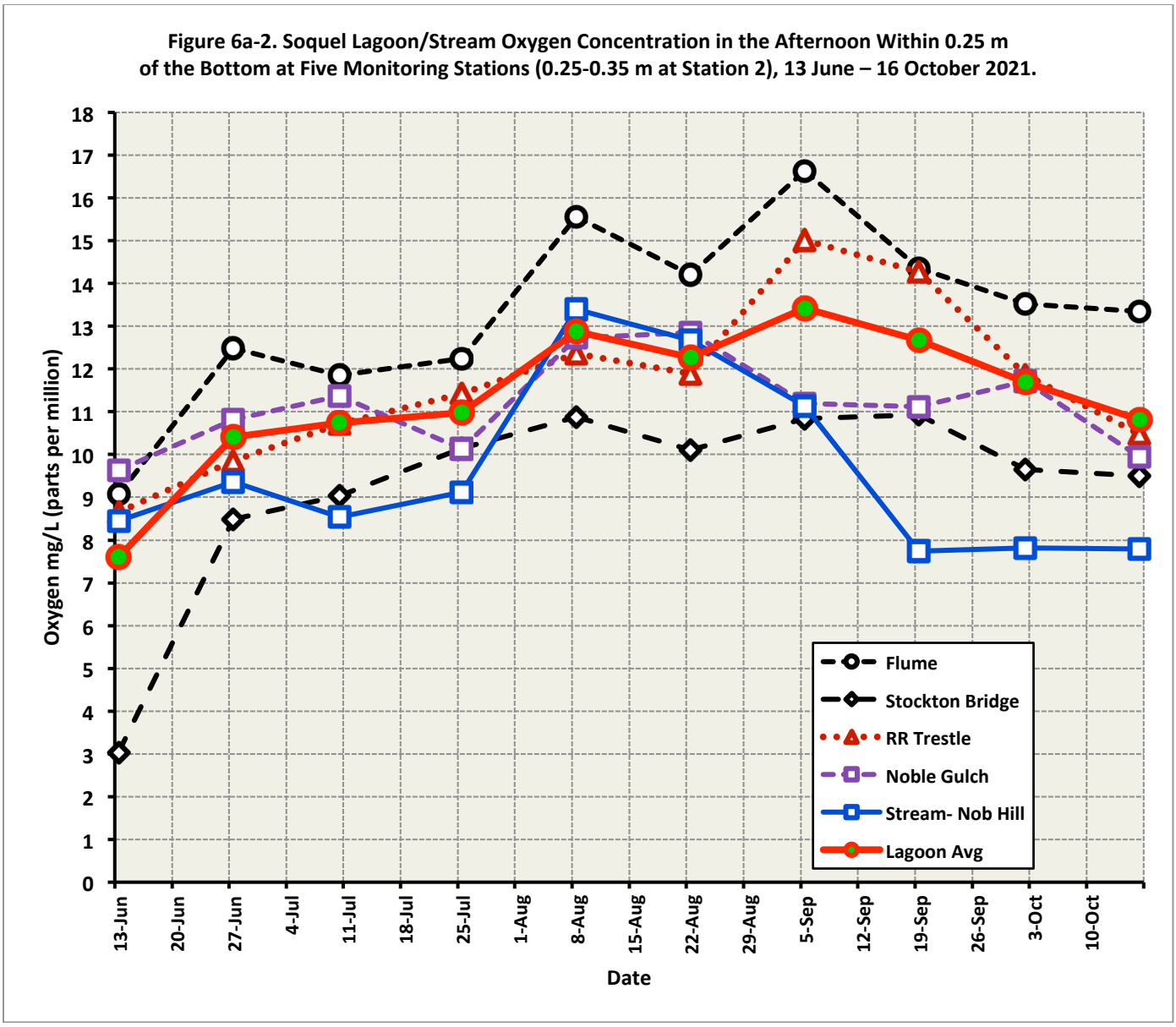


Figure 6a-2. Soquel Lagoon/Stream Oxygen Concentration in the Afternoon Within 0.25m of the Bottom at Five Monitoring Stations, 13 June – 16 October 2021.

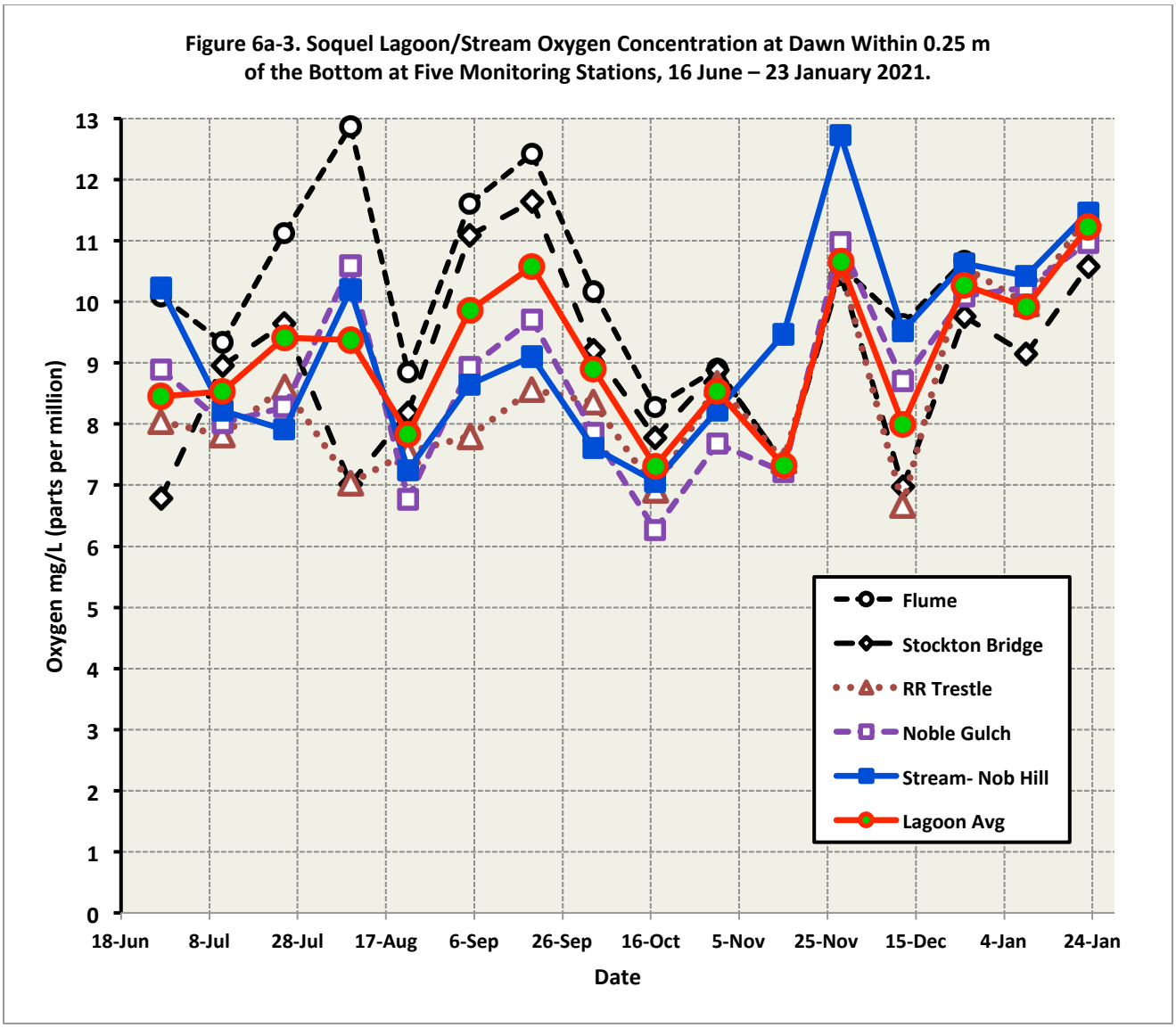


Figure 6a-3. Soquel Lagoon/Stream Oxygen Concentration at Dawn Within 0.25m of the Bottom at Five Monitoring Stations, 16 June – 23 January 2021.

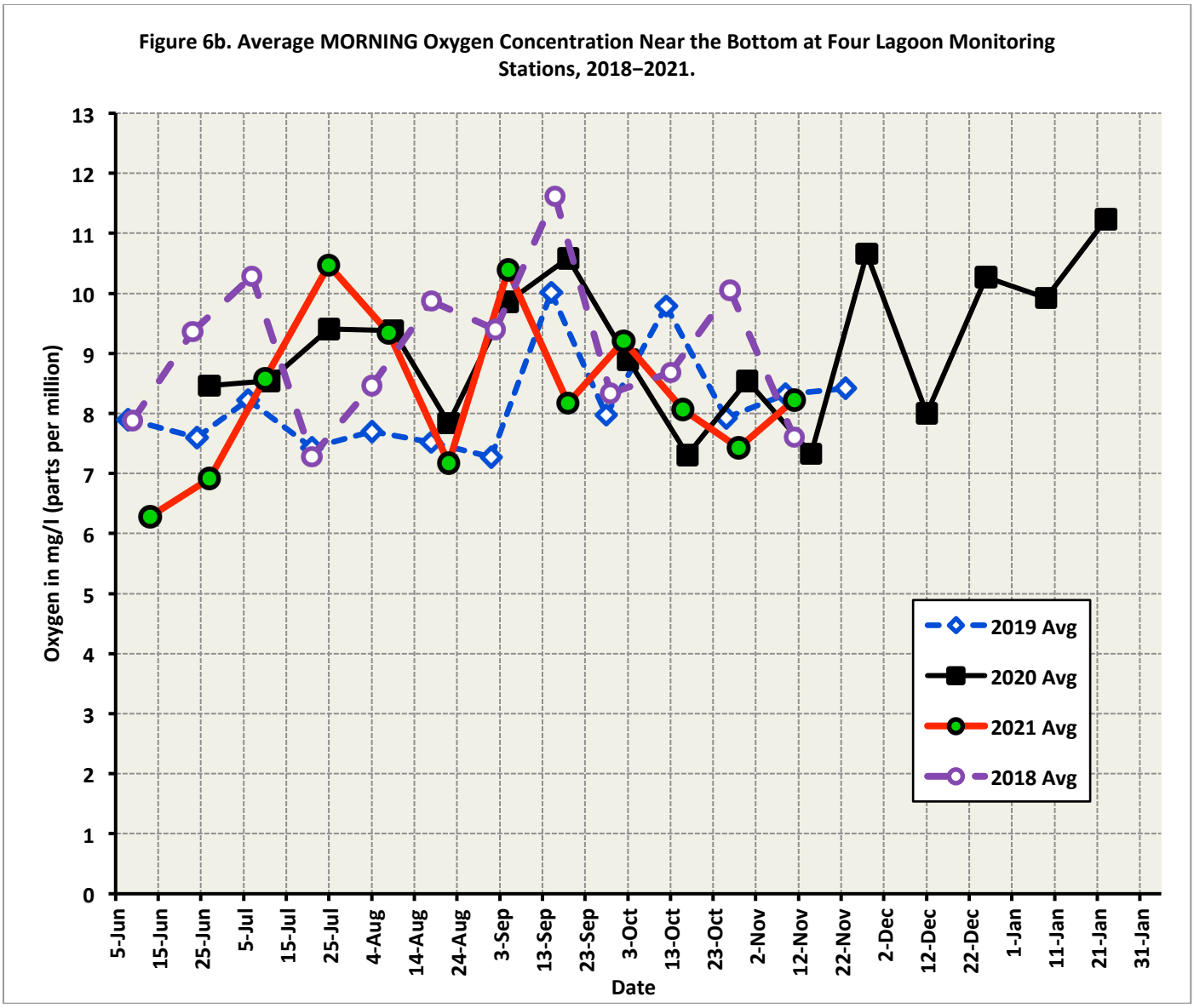


Figure 6b. Average MORNING Oxygen Concentration at Four Lagoon Monitoring Stations, 2018−2021.

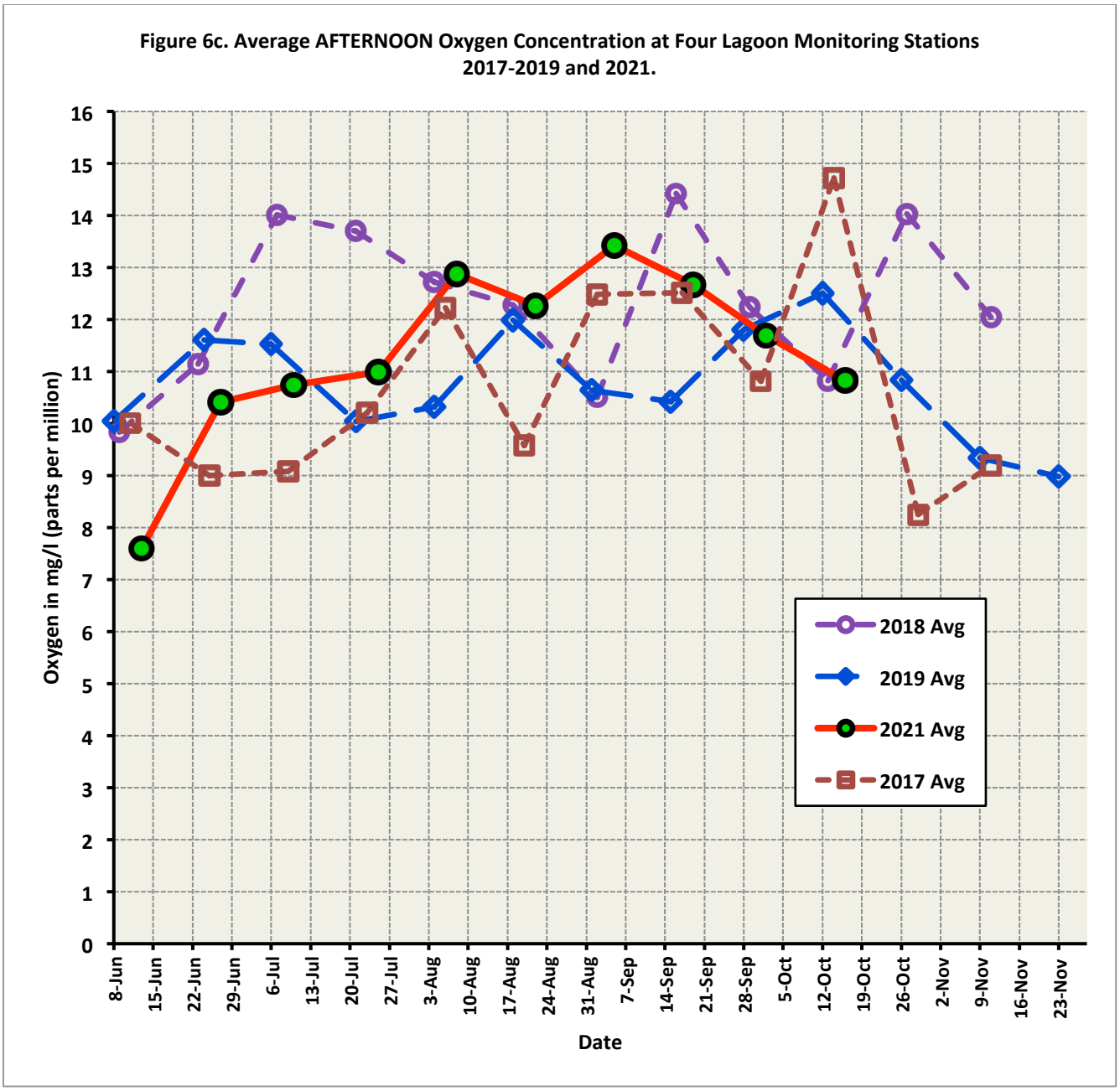


Figure 6c. Average MORNING Oxygen Concentration at Four Lagoon Monitoring Stations, 2017−2019 and 2021.

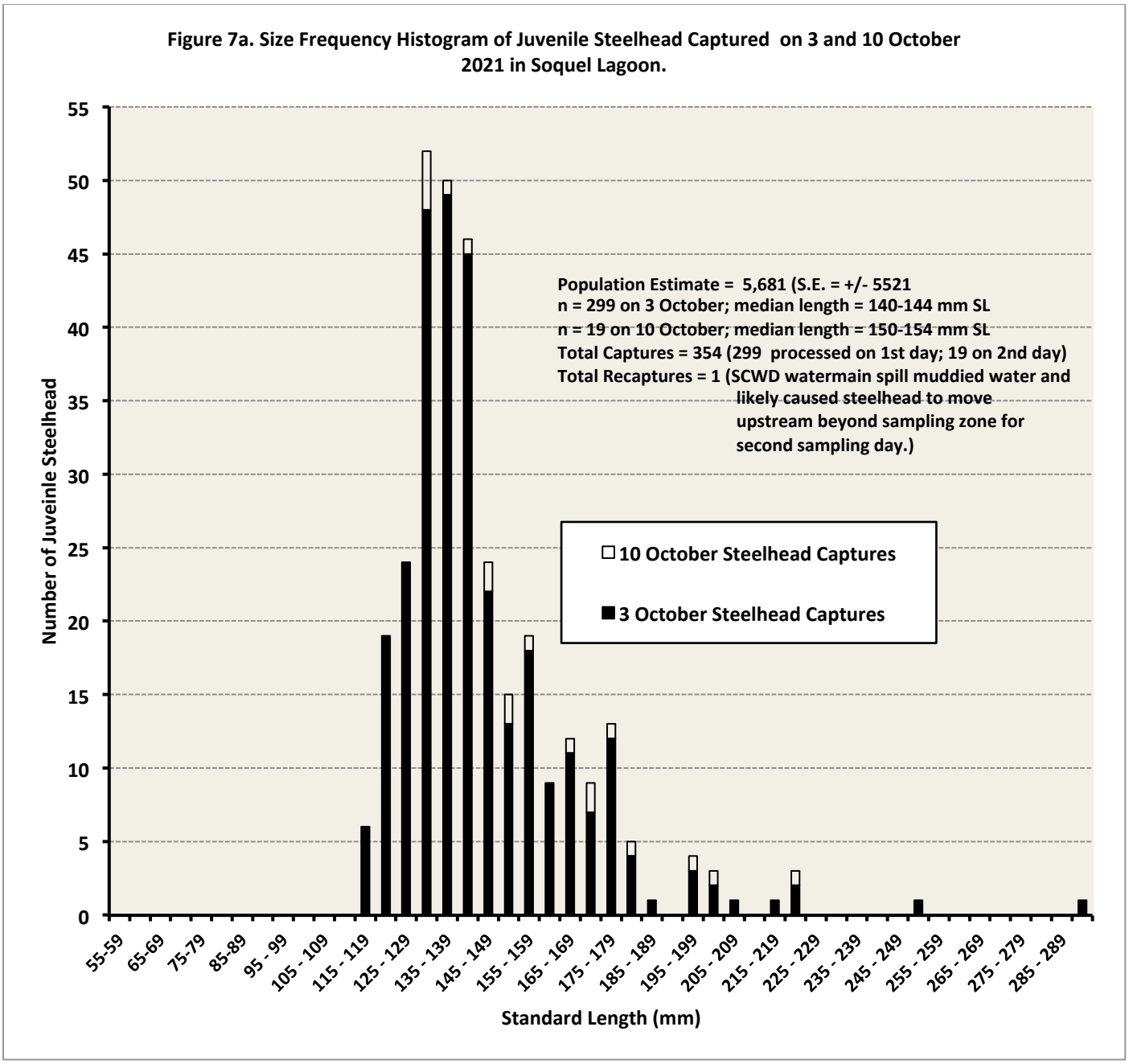


Figure 7a. Size Frequency Histogram of Steelhead Captured on 3 and 10 October 2021 in Soquel Lagoon

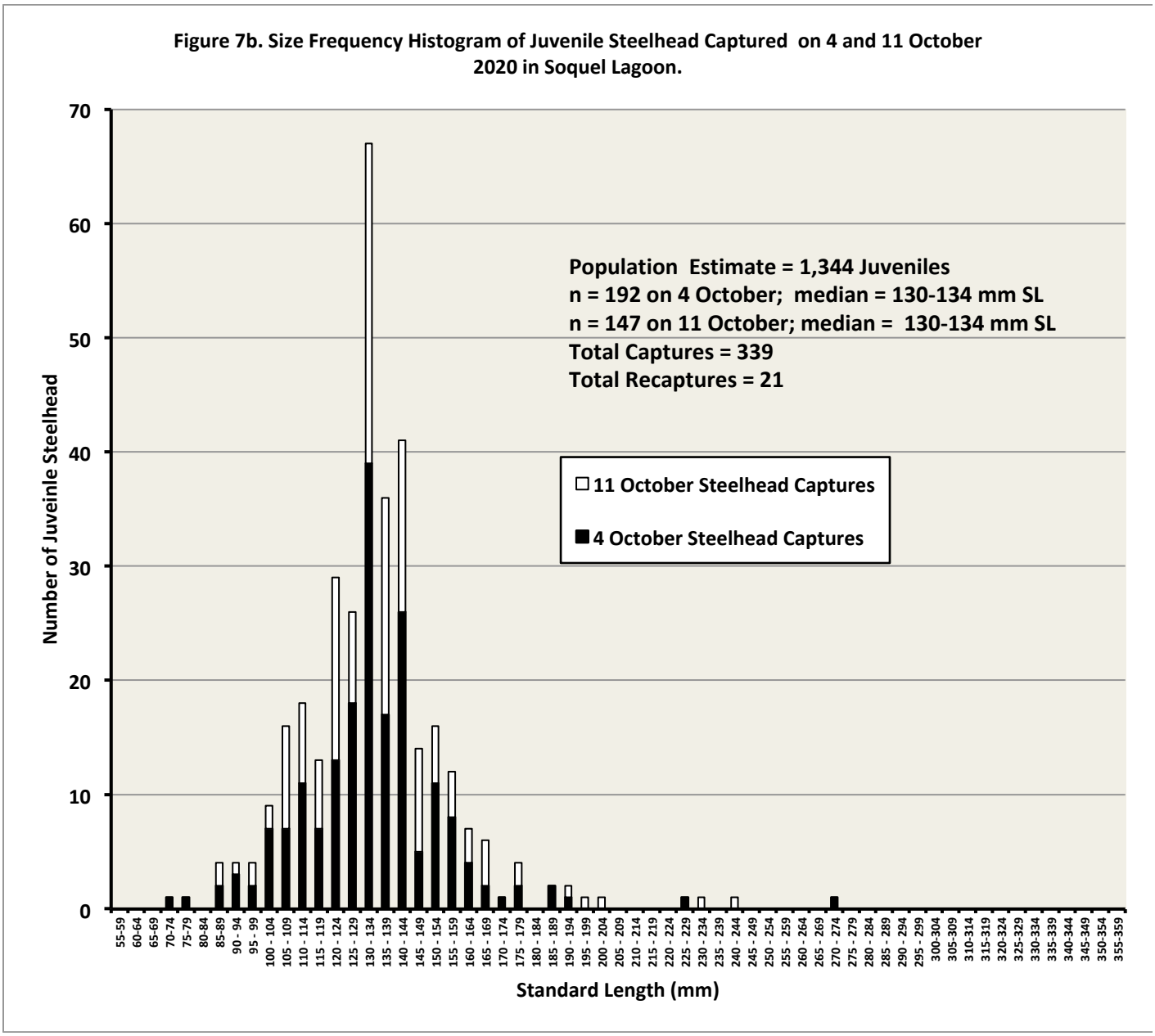


Figure 7b. Size Frequency Histogram of Steelhead Captured on 4 and 11 October 2020 in Soquel Lagoon

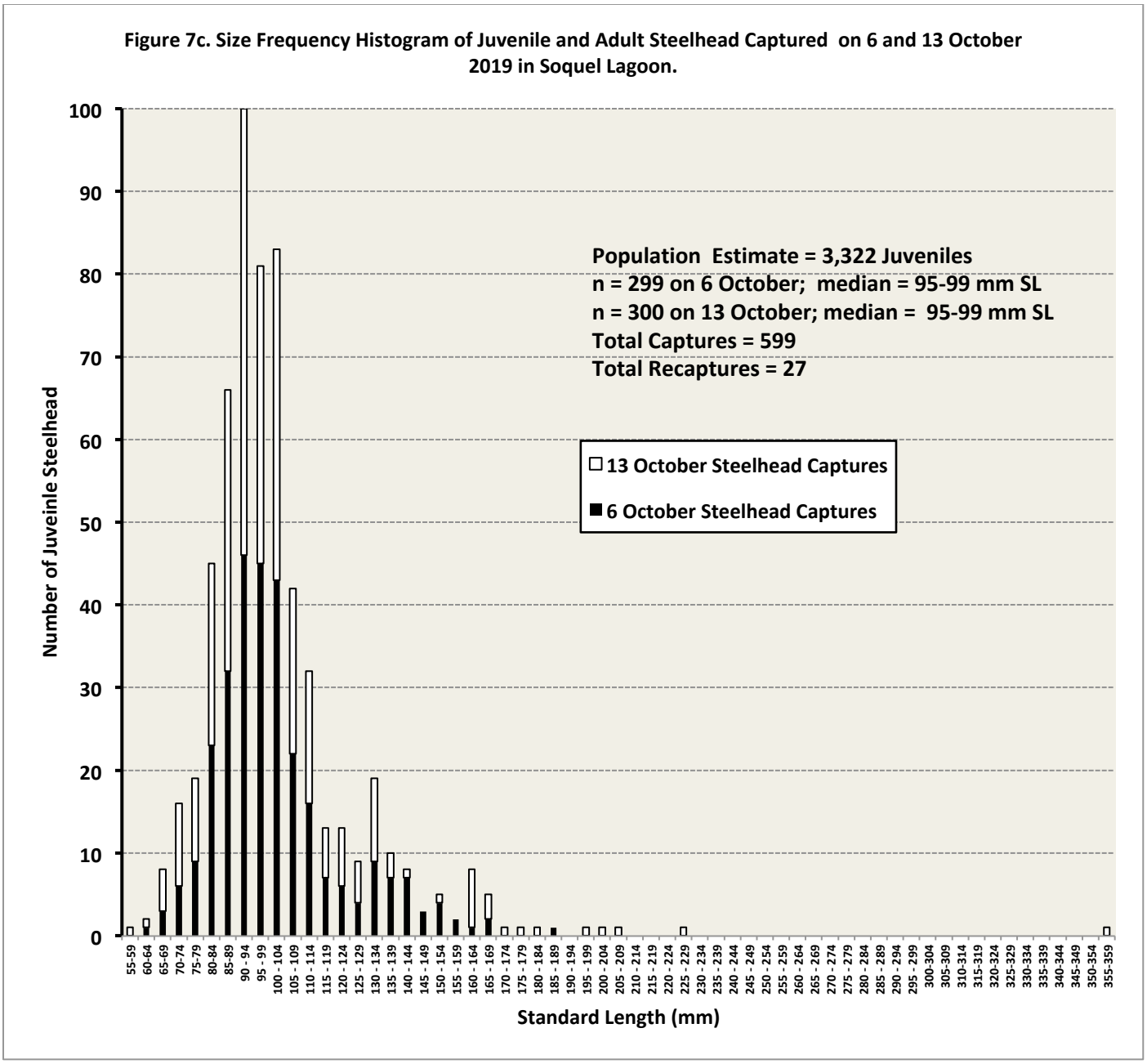


Figure 7c. Size Frequency Histogram of Steelhead Captured on 6 and 13 October 2019 in Soquel Lagoon.

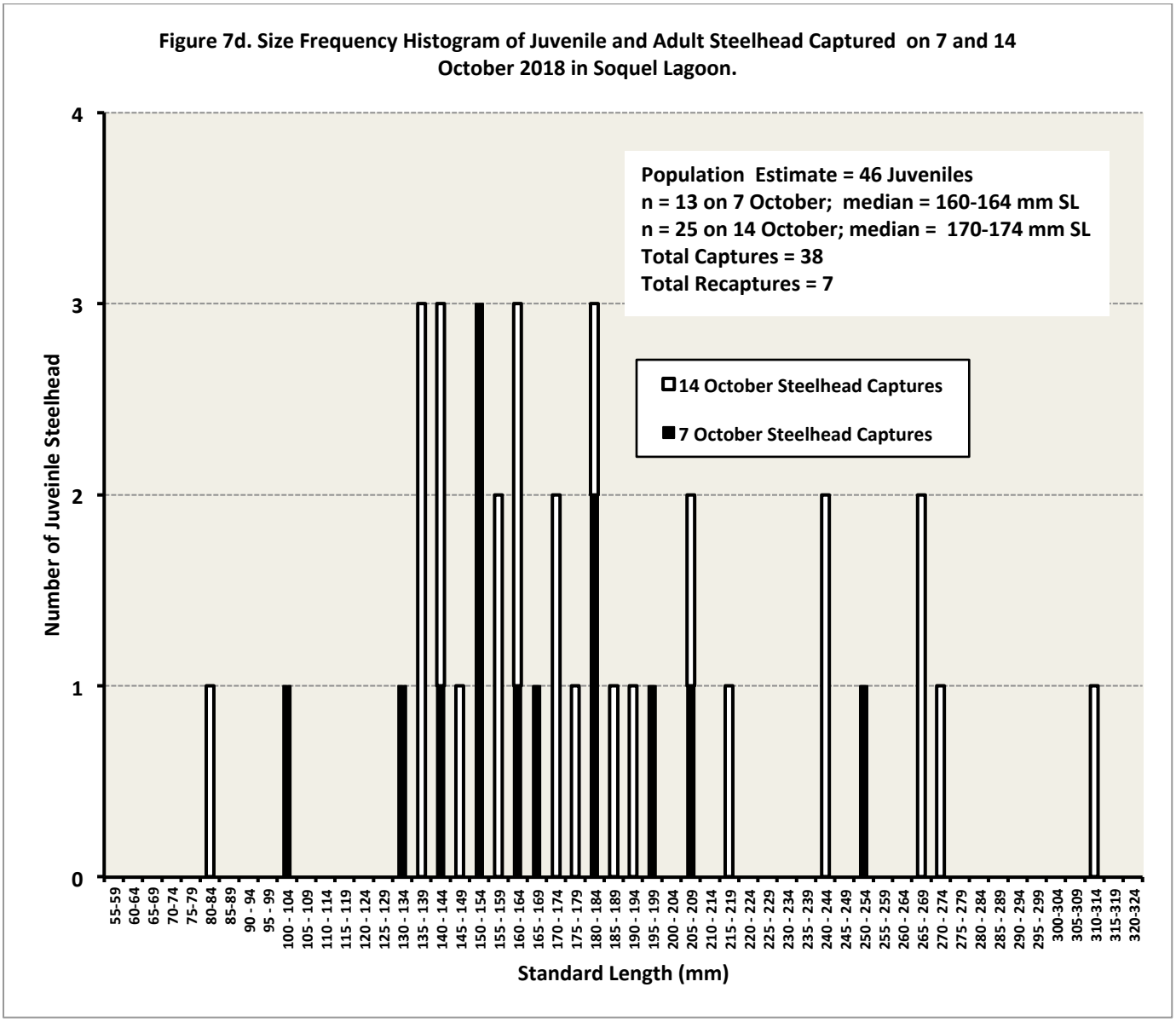


Figure 7d. Size Frequency Histogram of Steelhead Captured on 7 and 14 October 2018 in Soquel Lagoon.

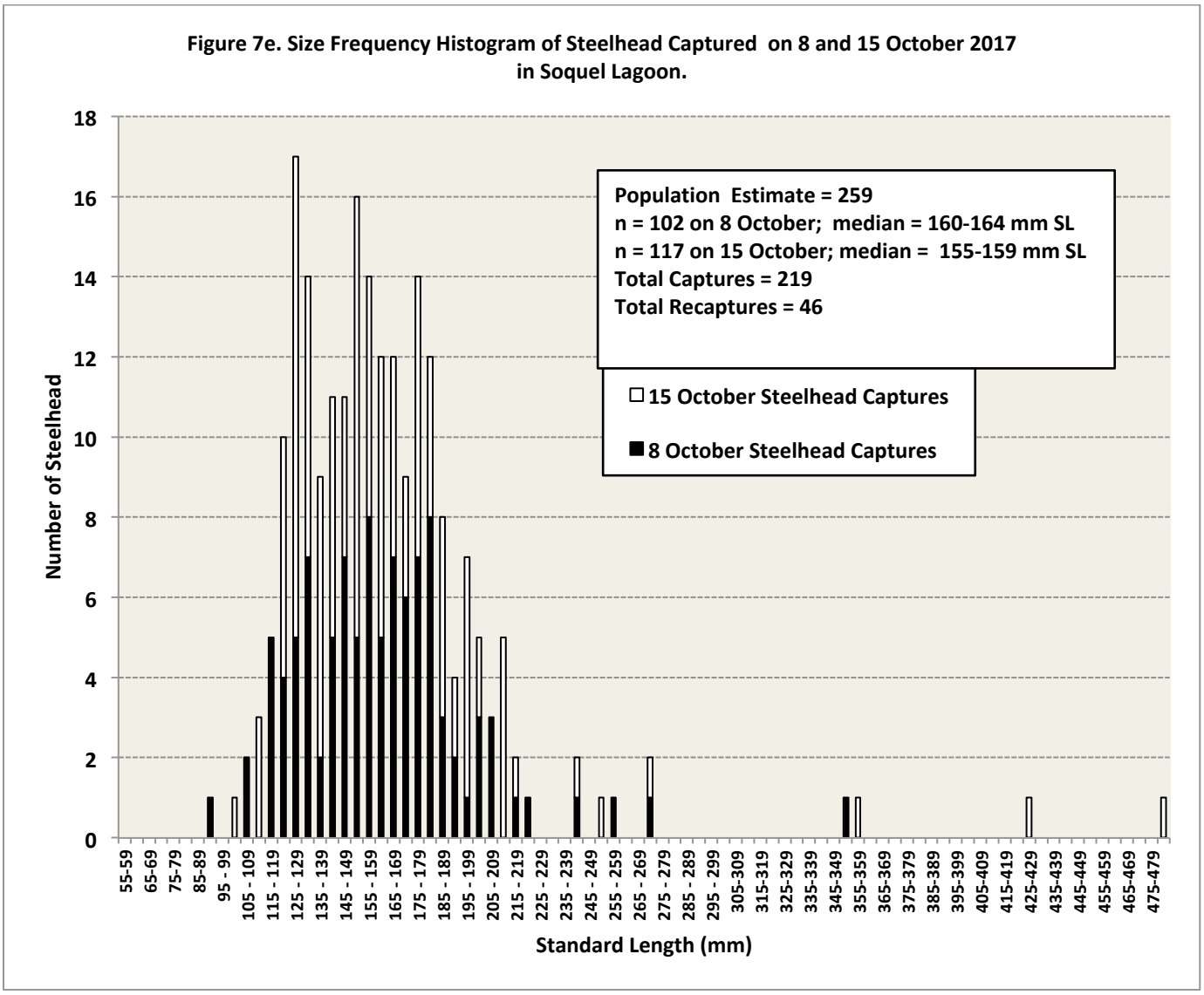


Figure 7e. Size Frequency Histogram of Steelhead Captured on 8 and 15 October 2017 in Soquel Lagoon.

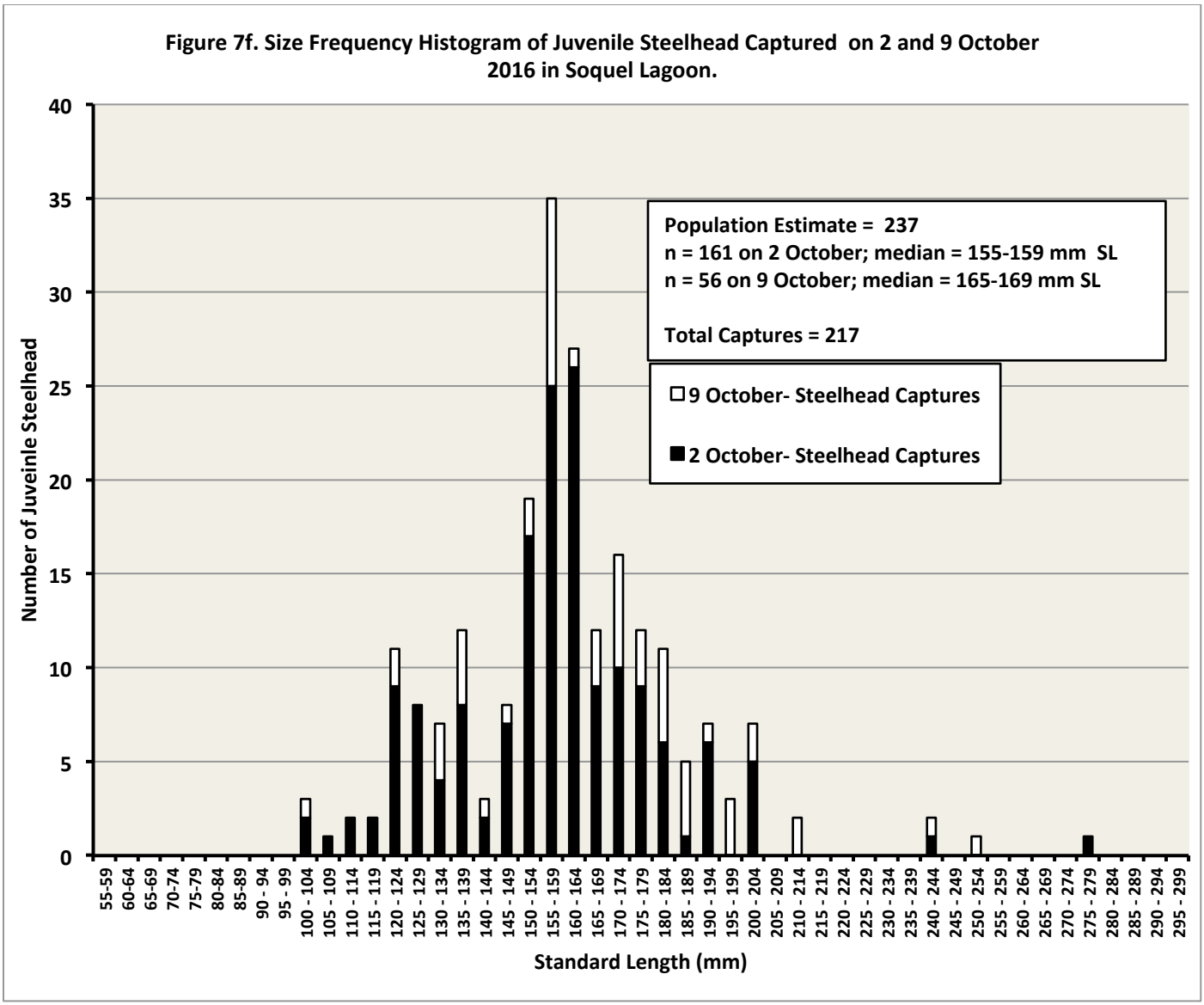


Figure 7f. Size Frequency Histogram of Juvenile Steelhead Captured on 2 and 9 October 2016 in Soquel Lagoon.

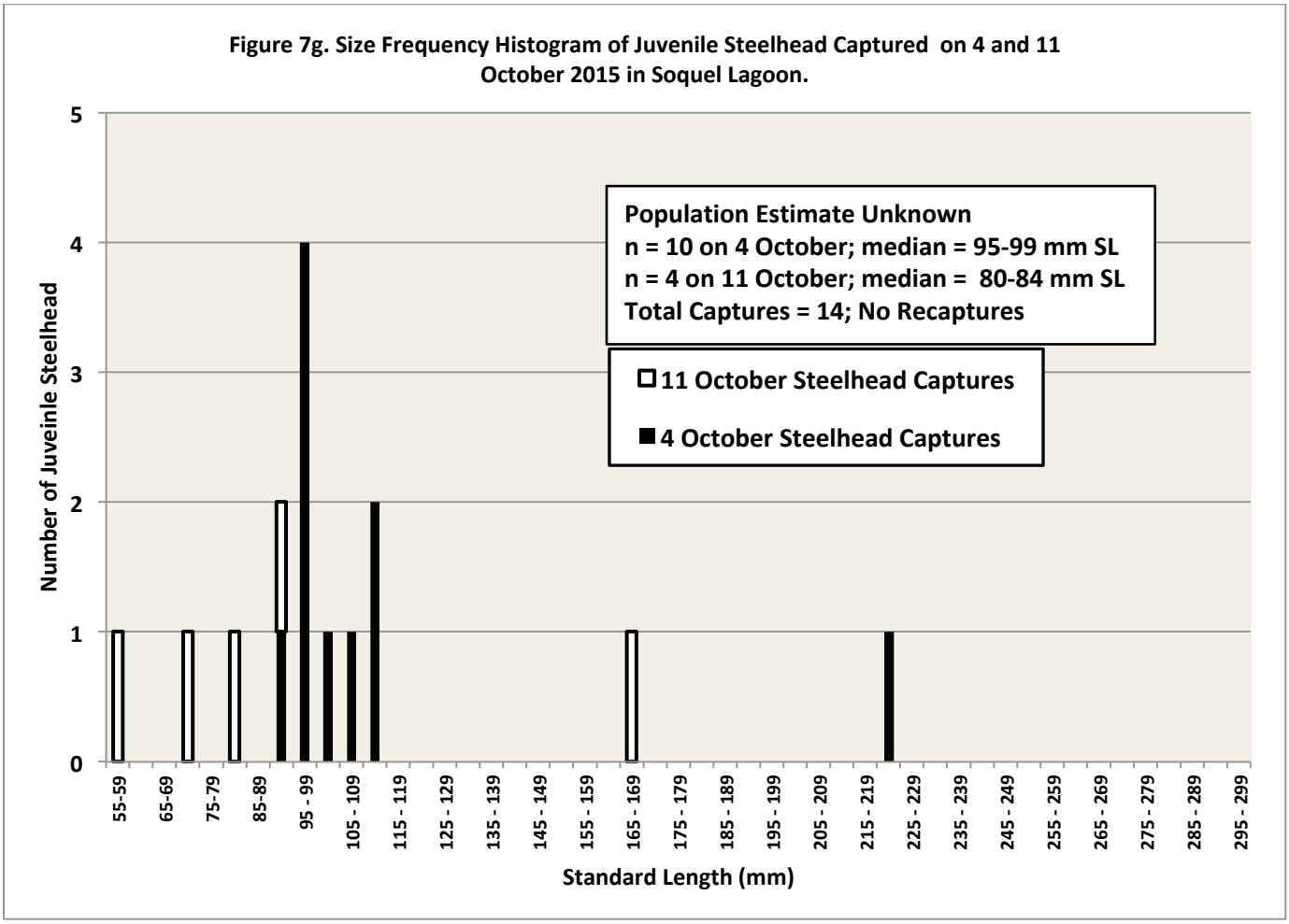


Figure 7g. Size Frequency Histogram of Juvenile Steelhead Captured on 4 and 11 October 2015 in Soquel Lagoon.

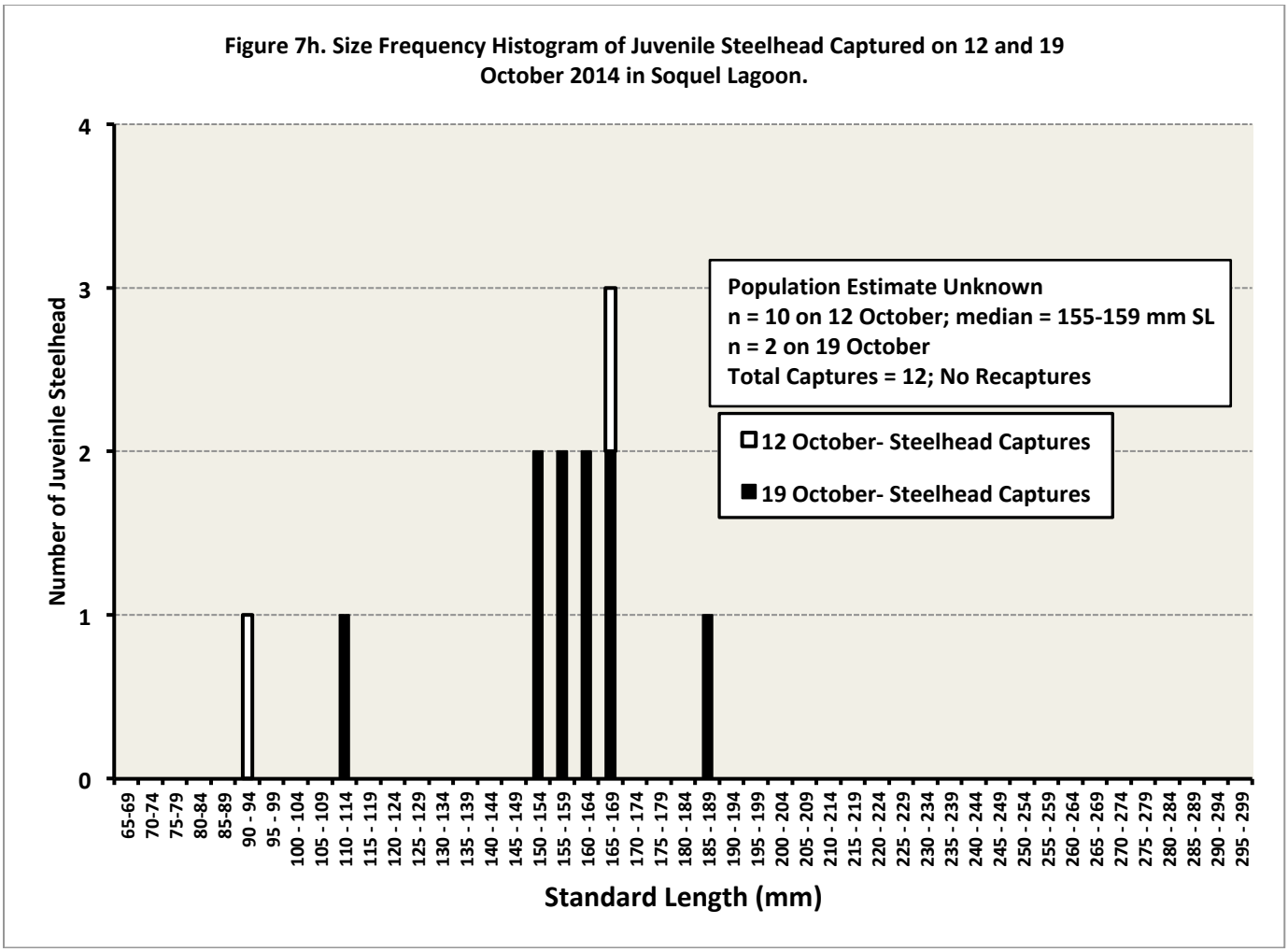


Figure 7h. Size Frequency Histogram of Juvenile Steelhead Captured on 12 and 19 October 2014 in Soquel Lagoon.

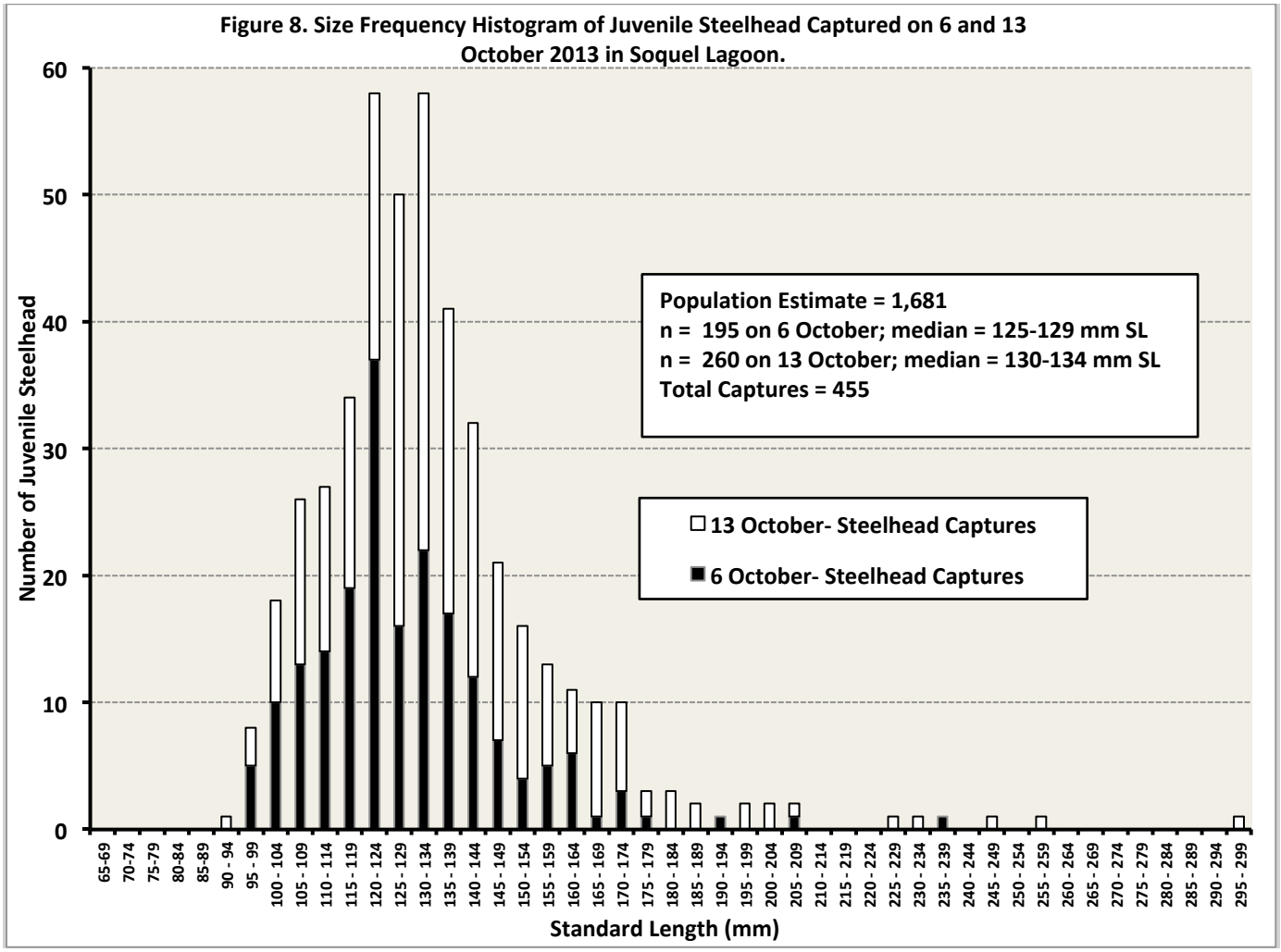


Figure 8. Size Frequency Histogram of Juvenile Steelhead Captured on 6 and 13 October 2013 in Soquel Lagoon.

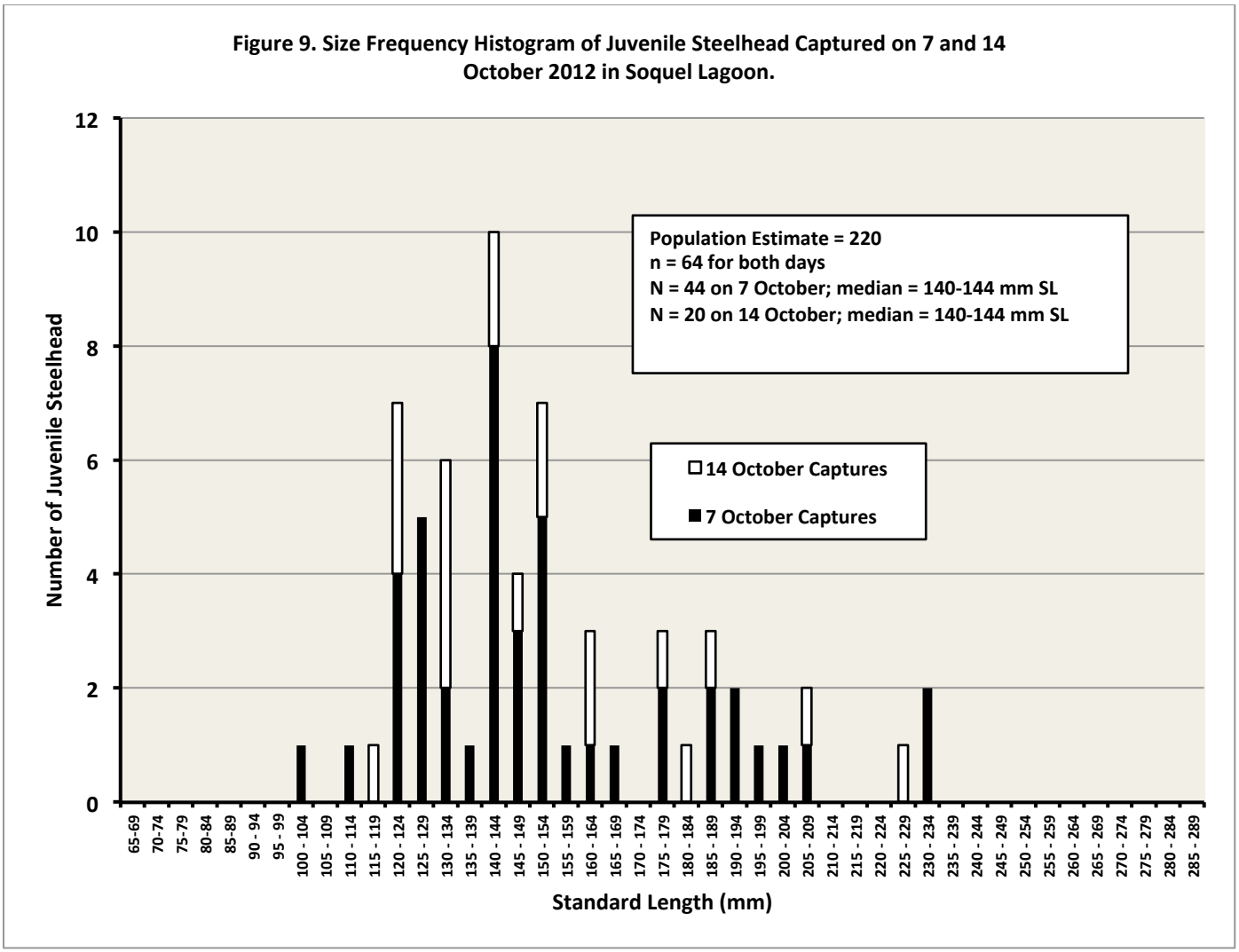


Figure 9. Size Frequency Histogram of Juvenile Steelhead Captured on 7 and 14 October 2012 in Soquel Lagoon.

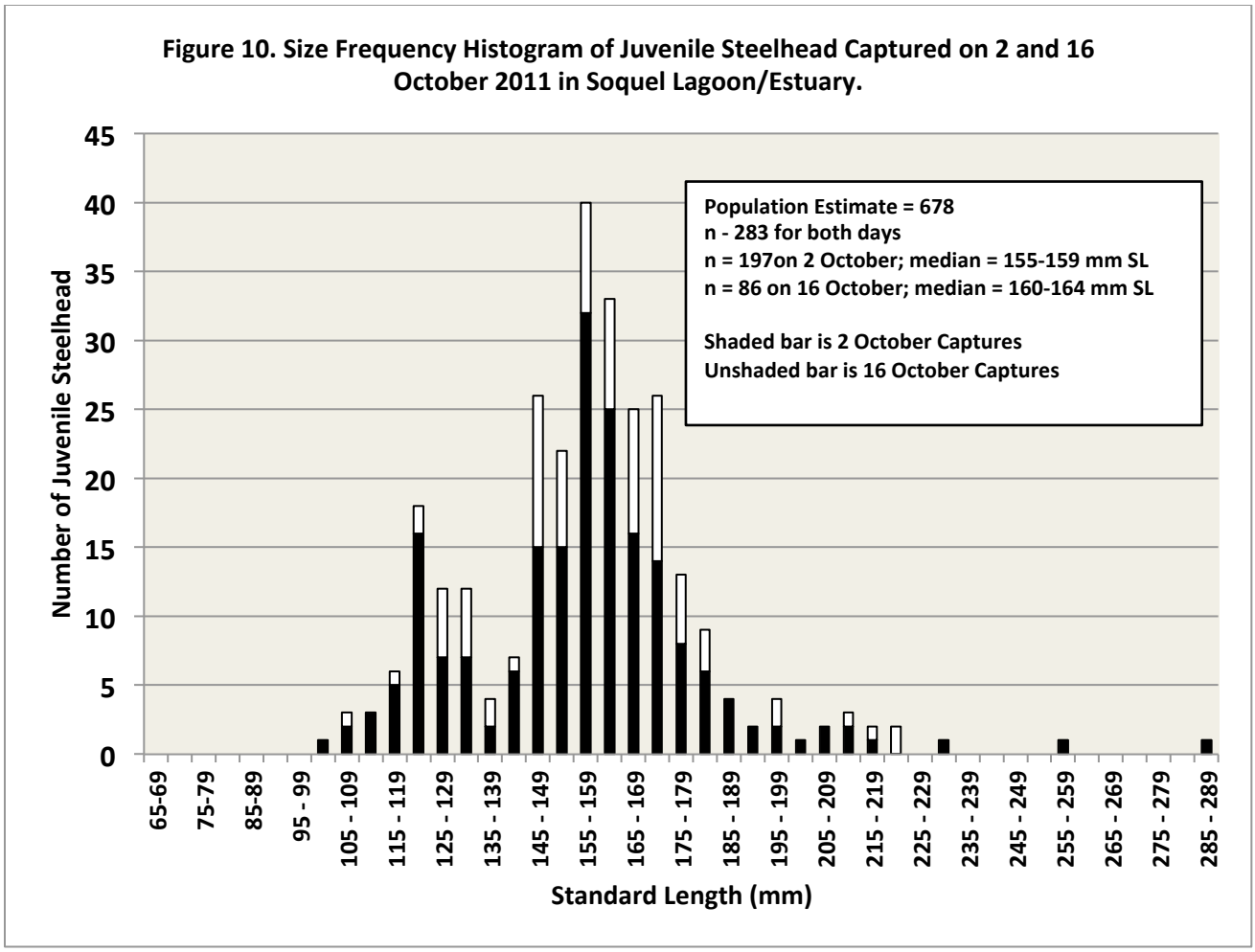


Figure 10. Size Frequency Histogram of Juvenile Steelhead Captured on 2 and 16 October 2011 in Soquel Lagoon/Estuary.

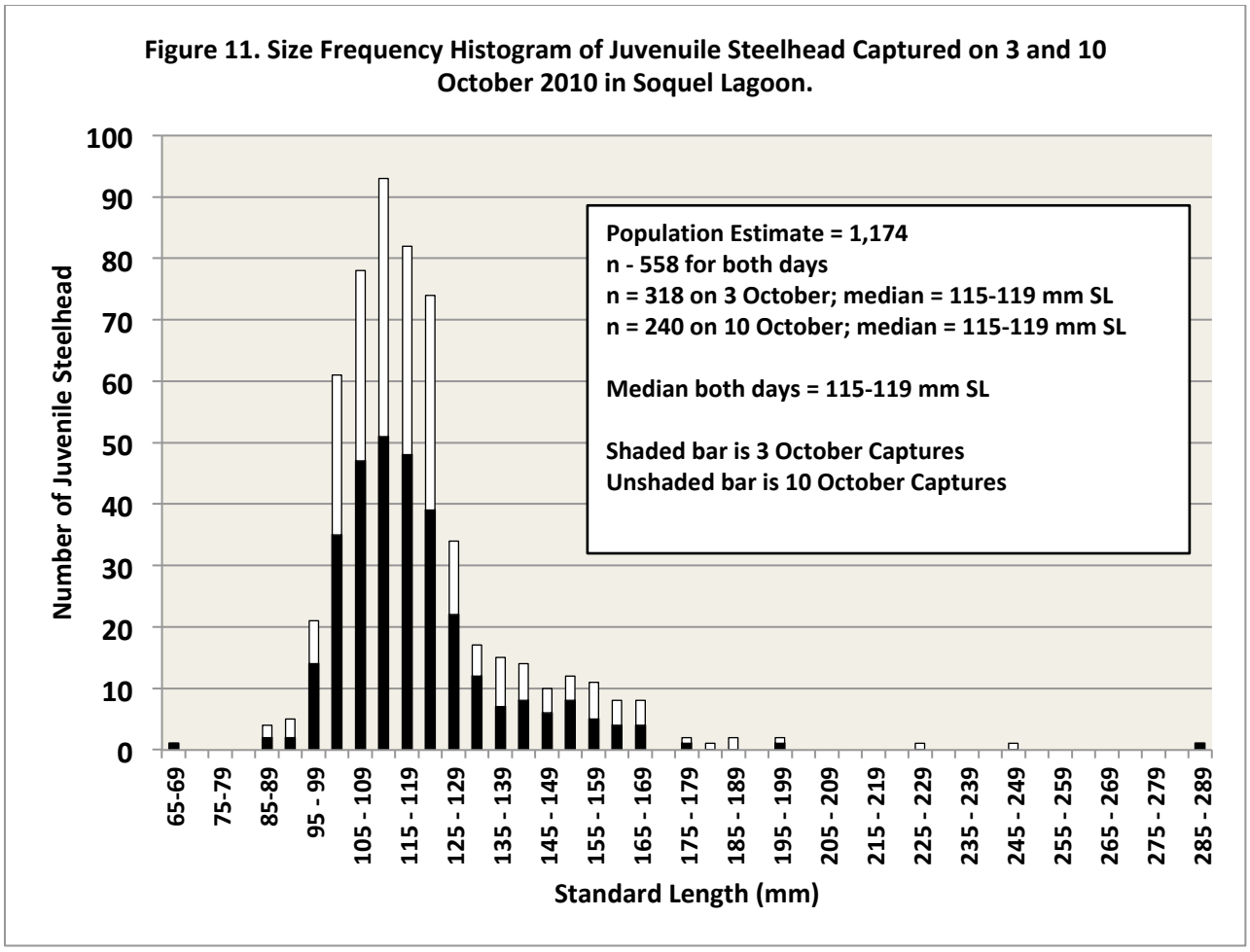


Figure 11. Size Frequency Histogram of Juvenuile Steelhead Captured on 3 and 10 October 2010 in Soquel Lagoon.

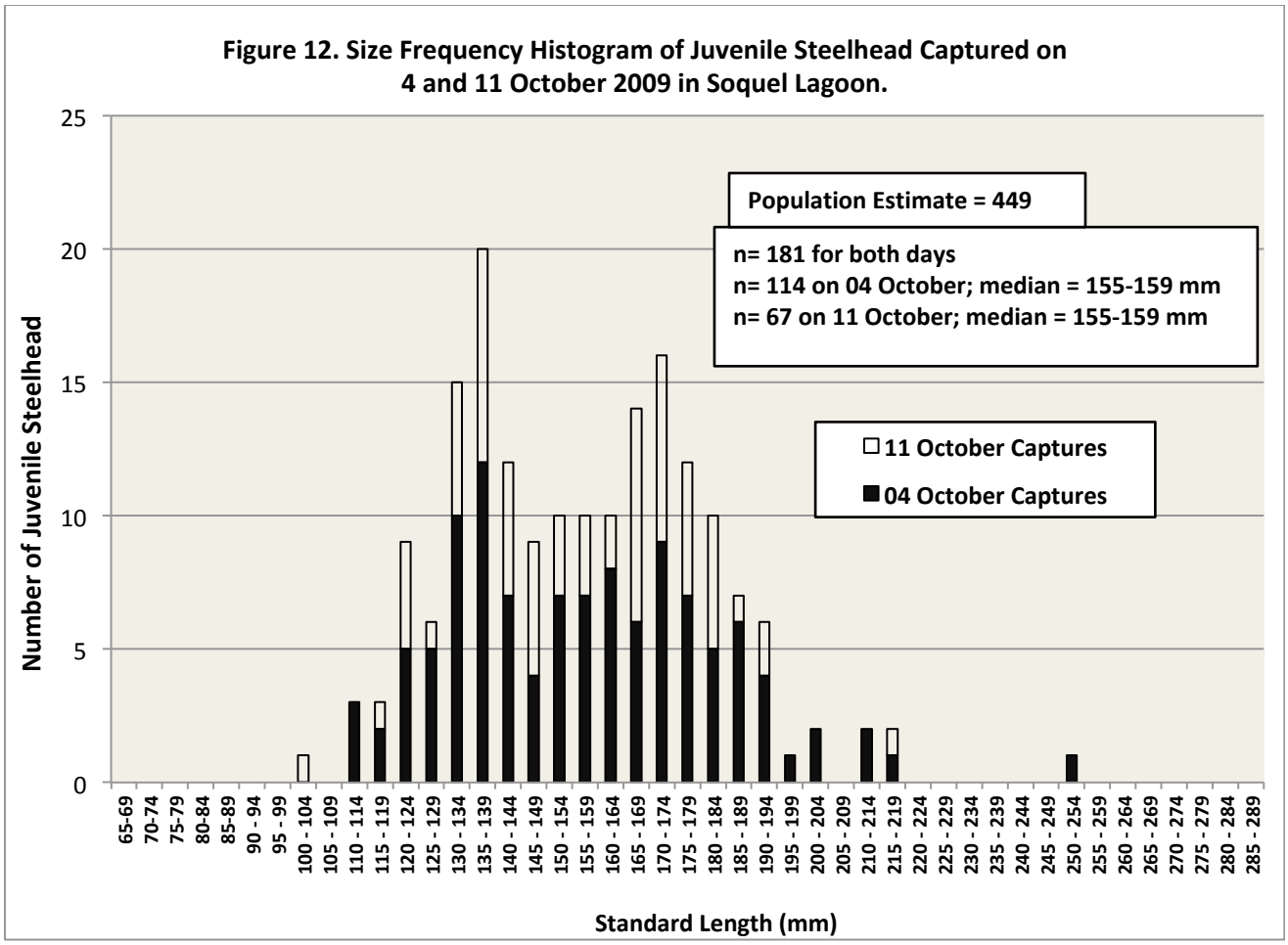


Figure 12. Size Frequency Histogram of Juvenile Steelhead Captured on 4 and 11 October 2009 in Soquel Lagoon.

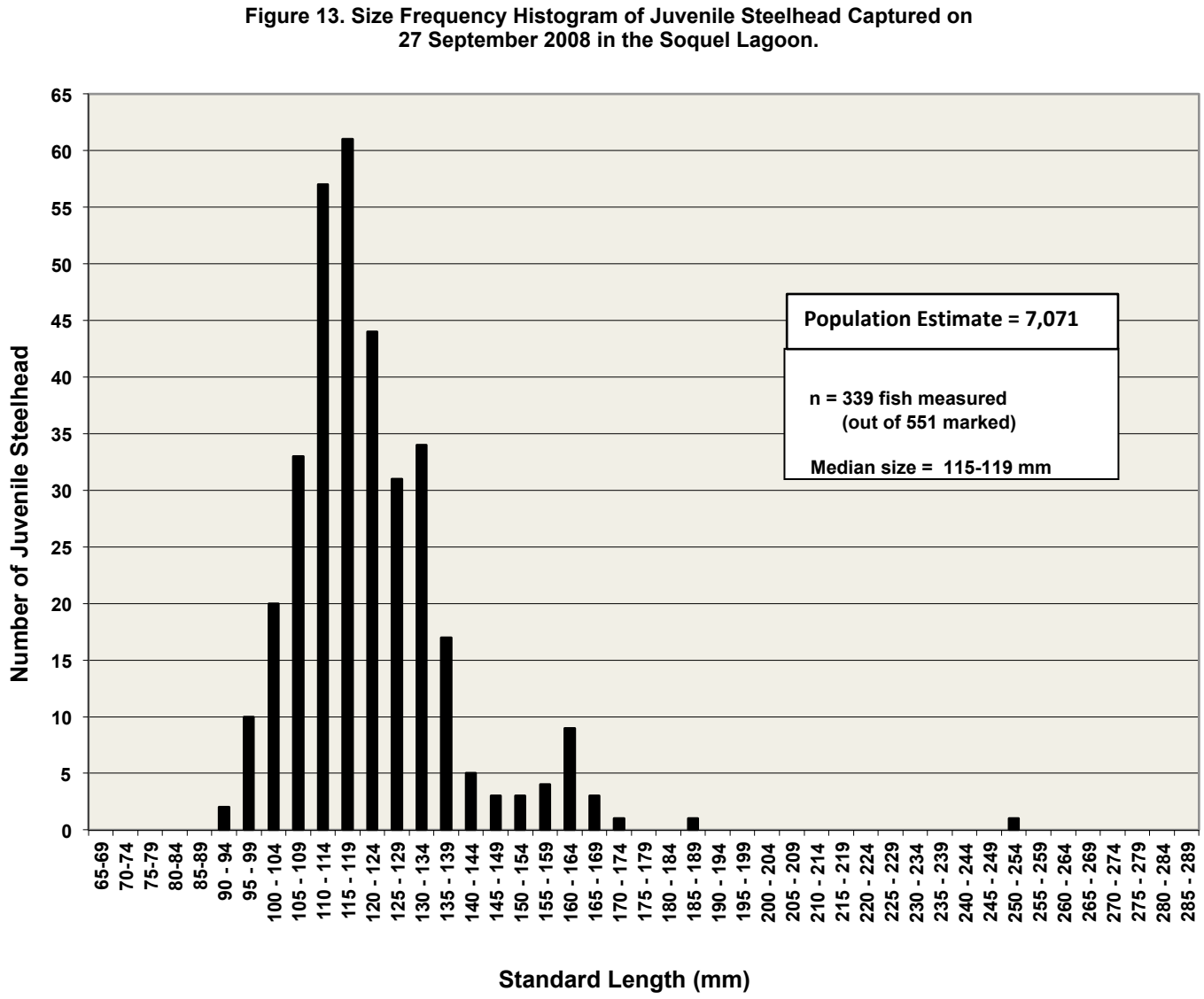


Figure 13. Size Frequency Histogram of Juvenile Steelhead Captured on 27 September 2008 in the Soquel Lagoon.

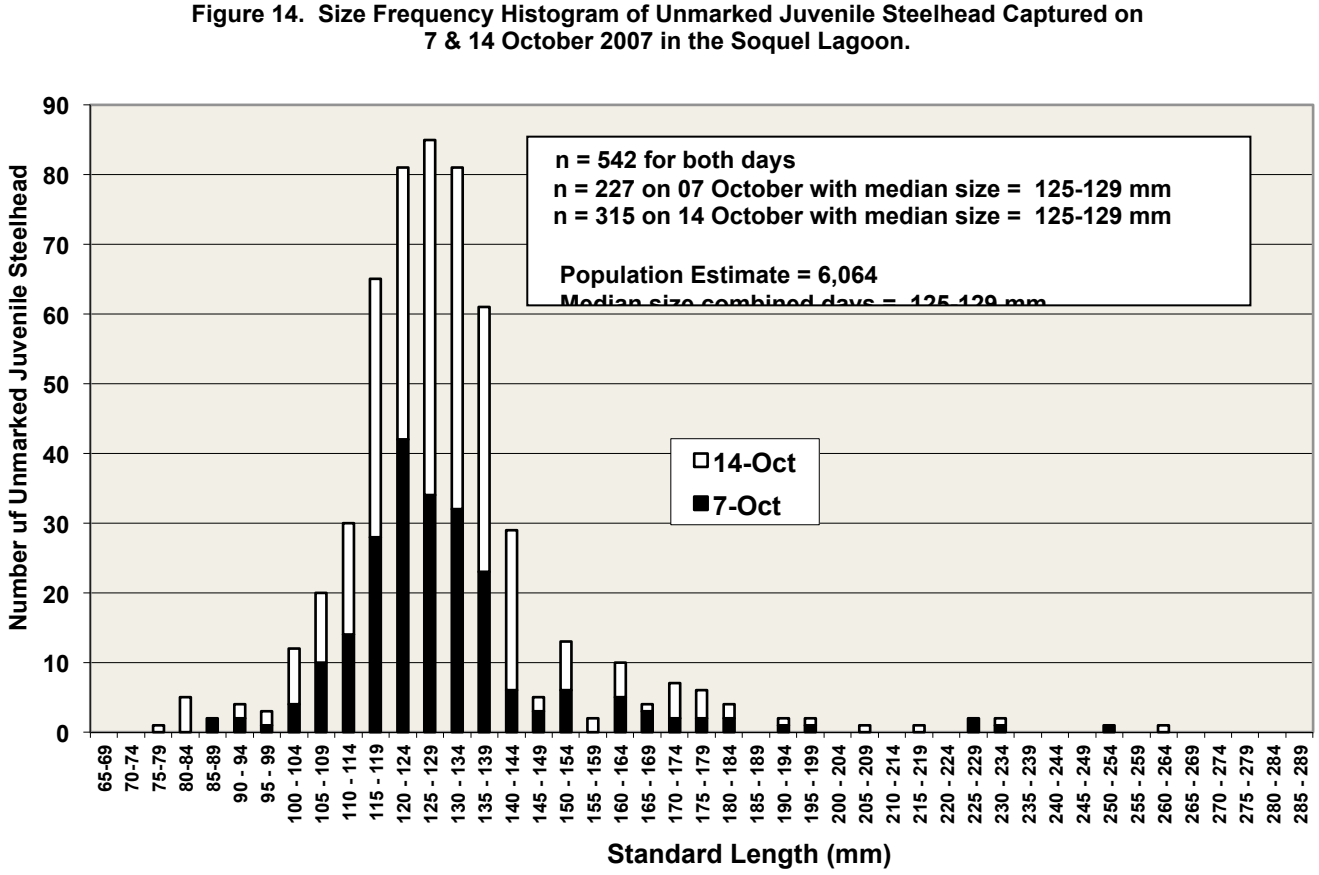


Figure 14. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 7 & 14 October 2007 in the Soquel Lagoon.

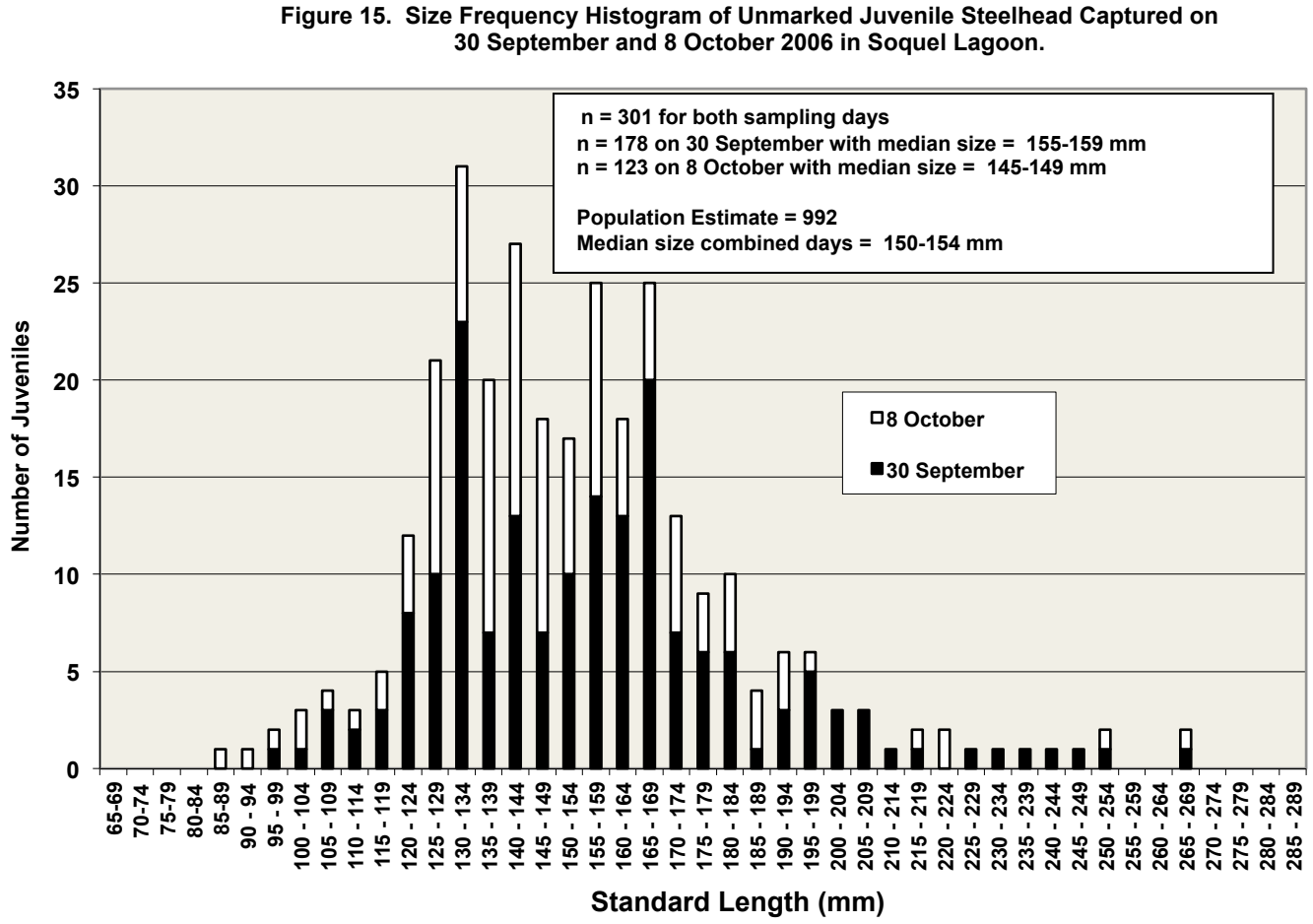


Figure 15. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 30 September and 8 October 2006 in Soquel Lagoon.

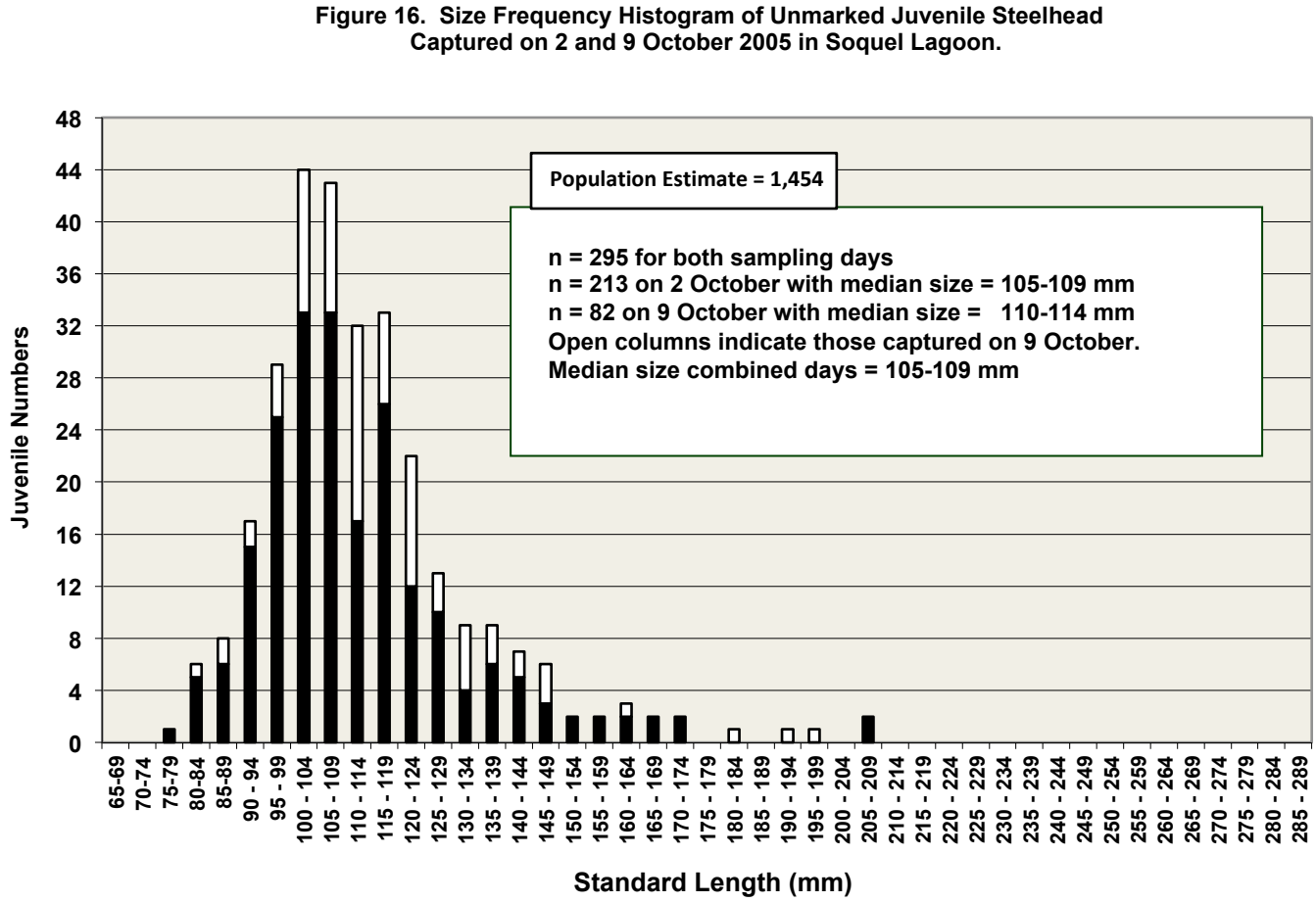


Figure 16. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 2 and 9 October 2005 in Soquel Lagoon.

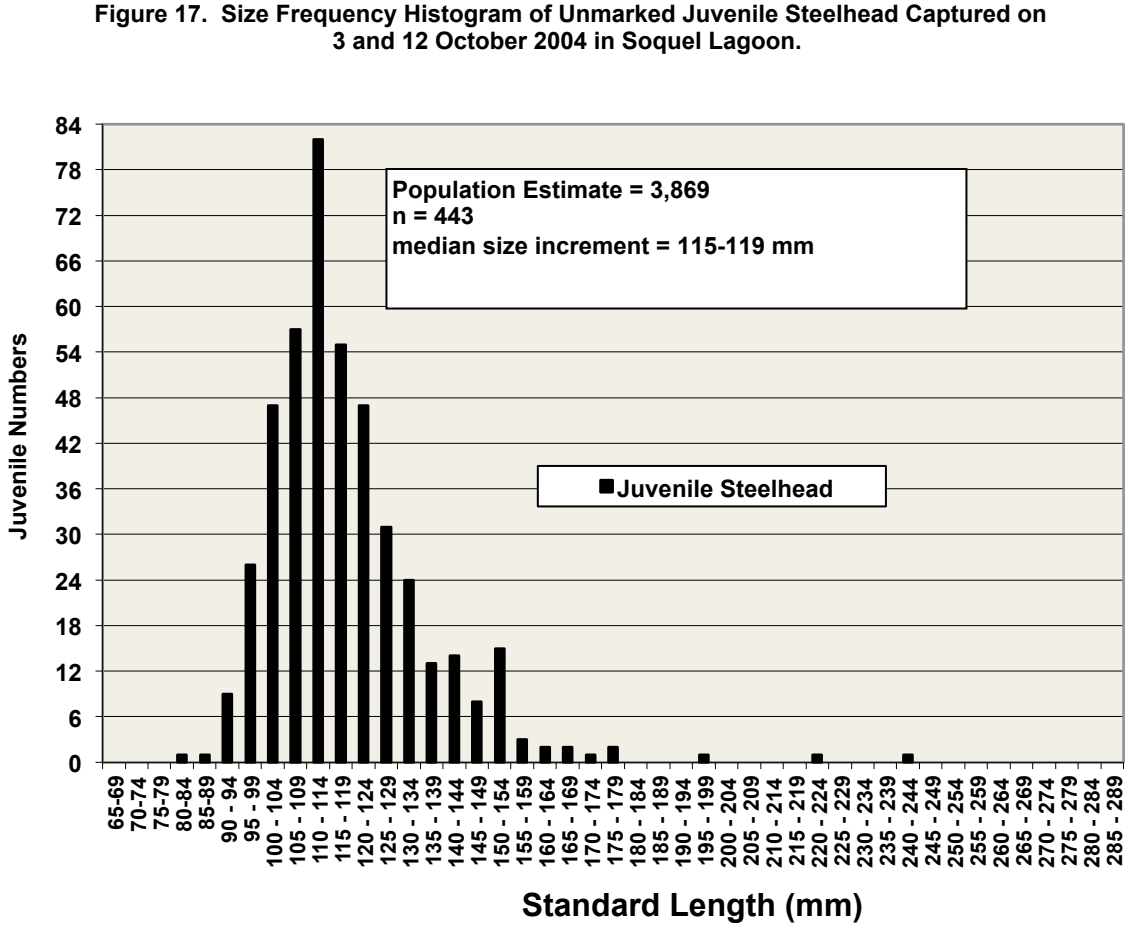


Figure 17. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 and 12 October 2004 in Soquel Lagoon.

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

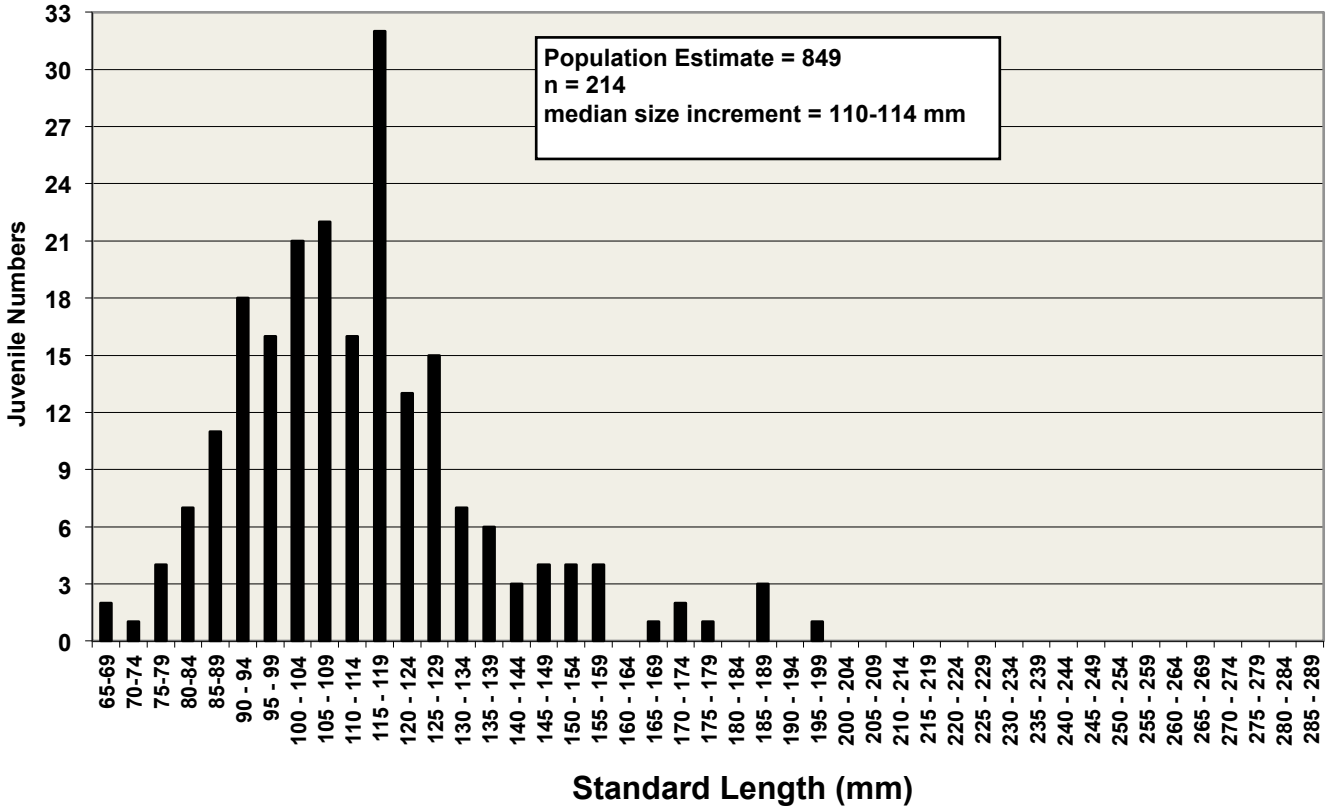


Figure 18. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 5 and 12 October 2003 in Soquel Lagoon.

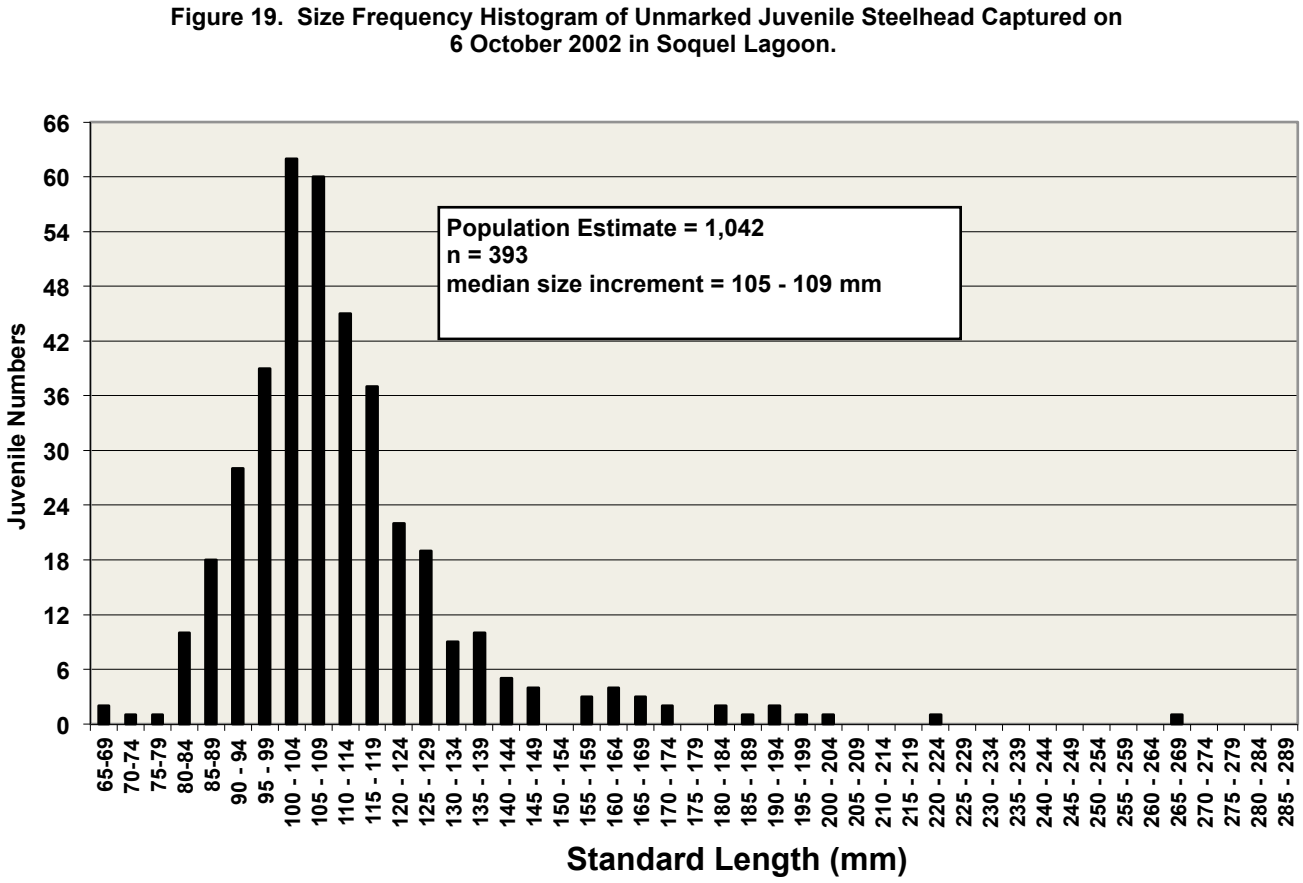


Figure 19. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 6 October 2002 in Soquel Lagoon.

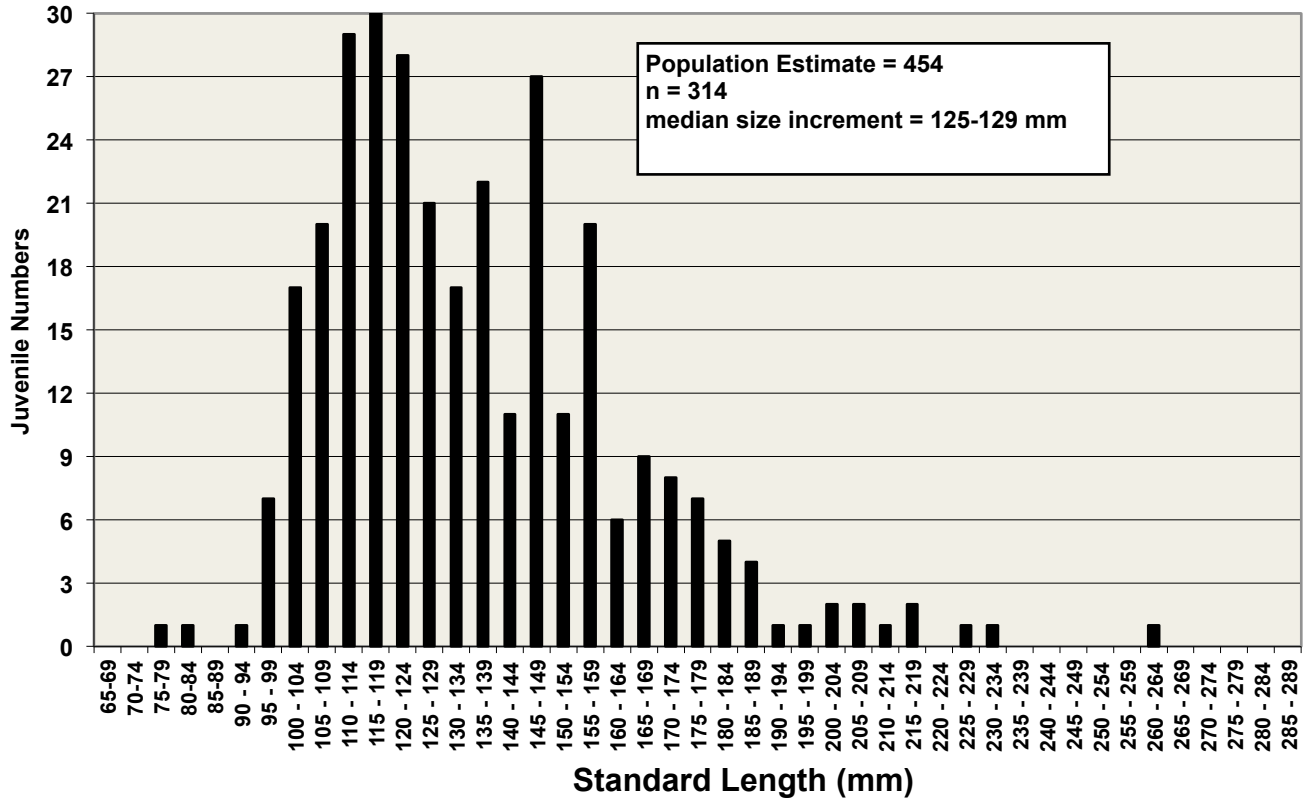


Figure 20. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 7 and 14 October 2001 in Soquel Lagoon.

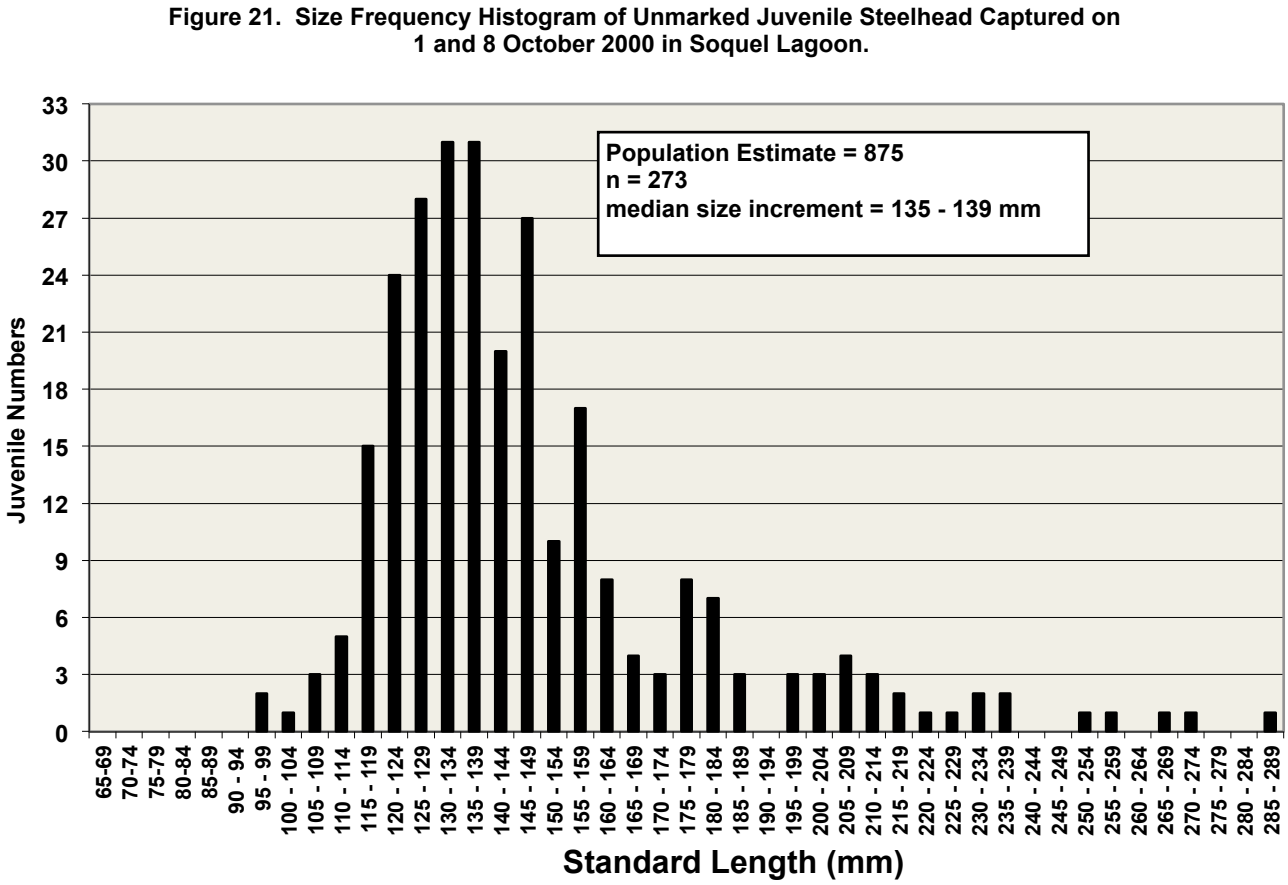


Figure 21. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 1 and 8 October 2000 in Soquel Lagoon.

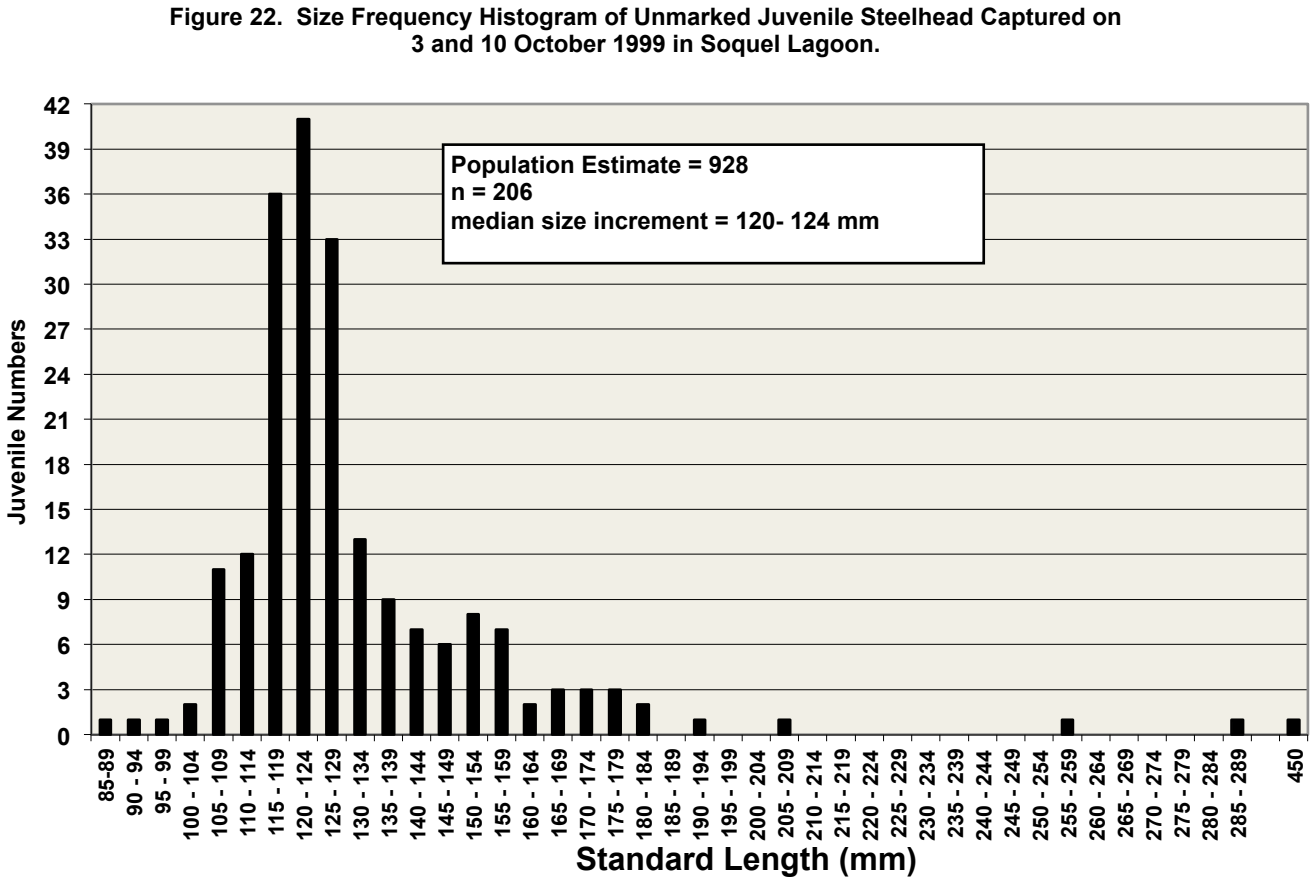


Figure 22. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 3 and 10 October 1999 in Soquel Lagoon.

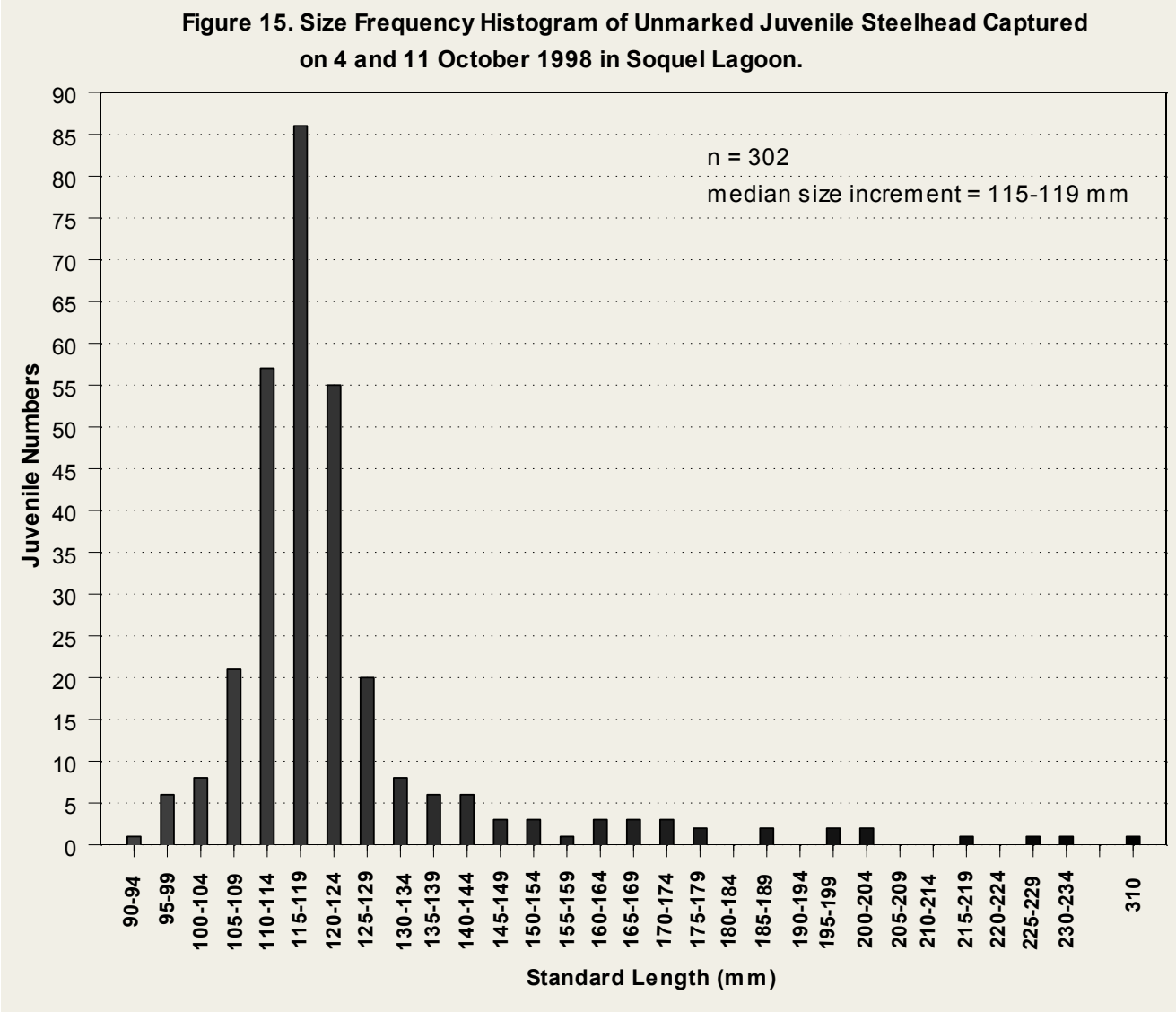


Figure 23. Size Frequency Histogram of Unmarked Juvenile Steelhead Captured on 4 and 11 October 1998 in Soquel Lagoon.

Population Estimate = 671.

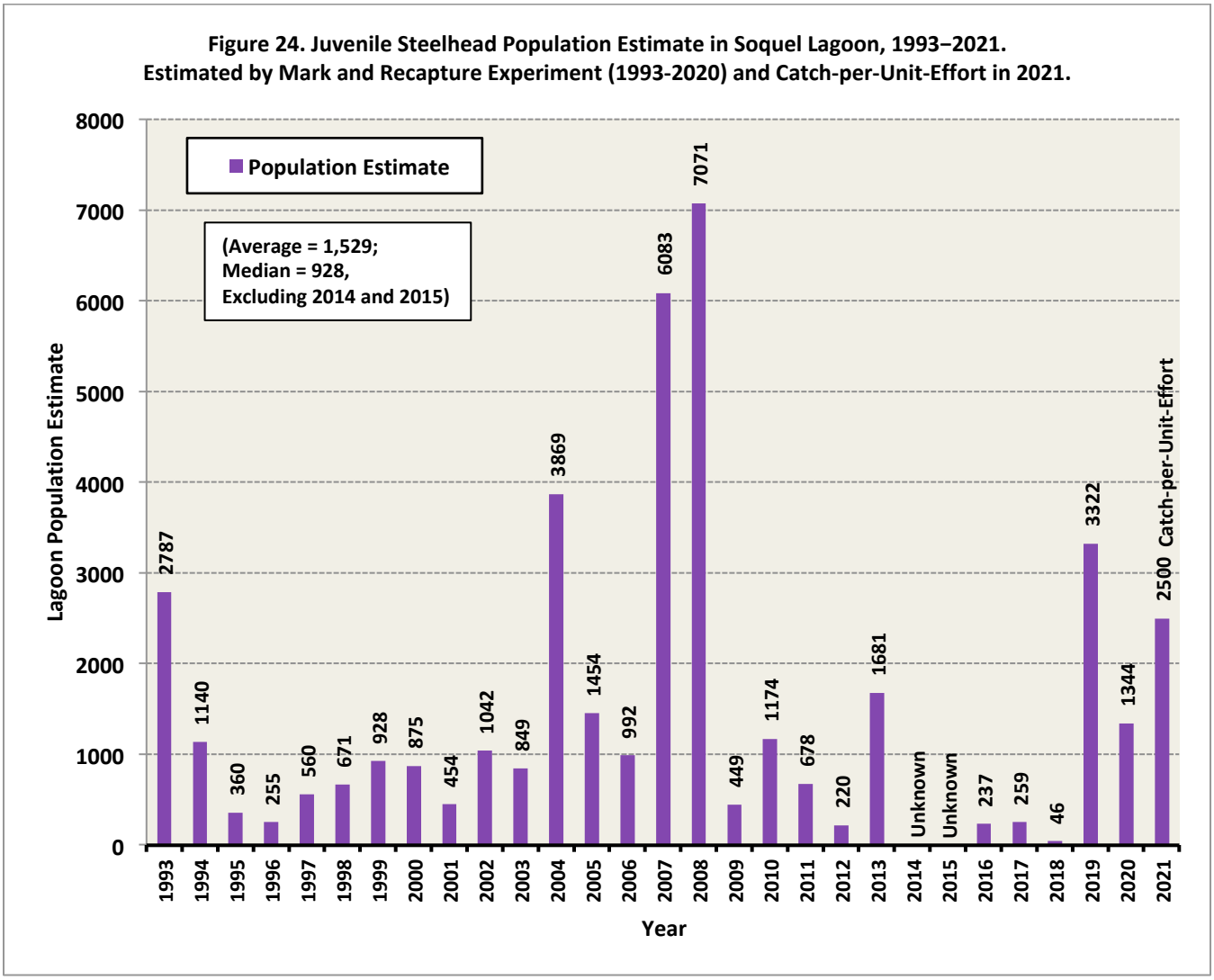


Figure 24. Steelhead Population Estimate in Soquel Lagoon, 1993−2021.

Figure 25. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2021.

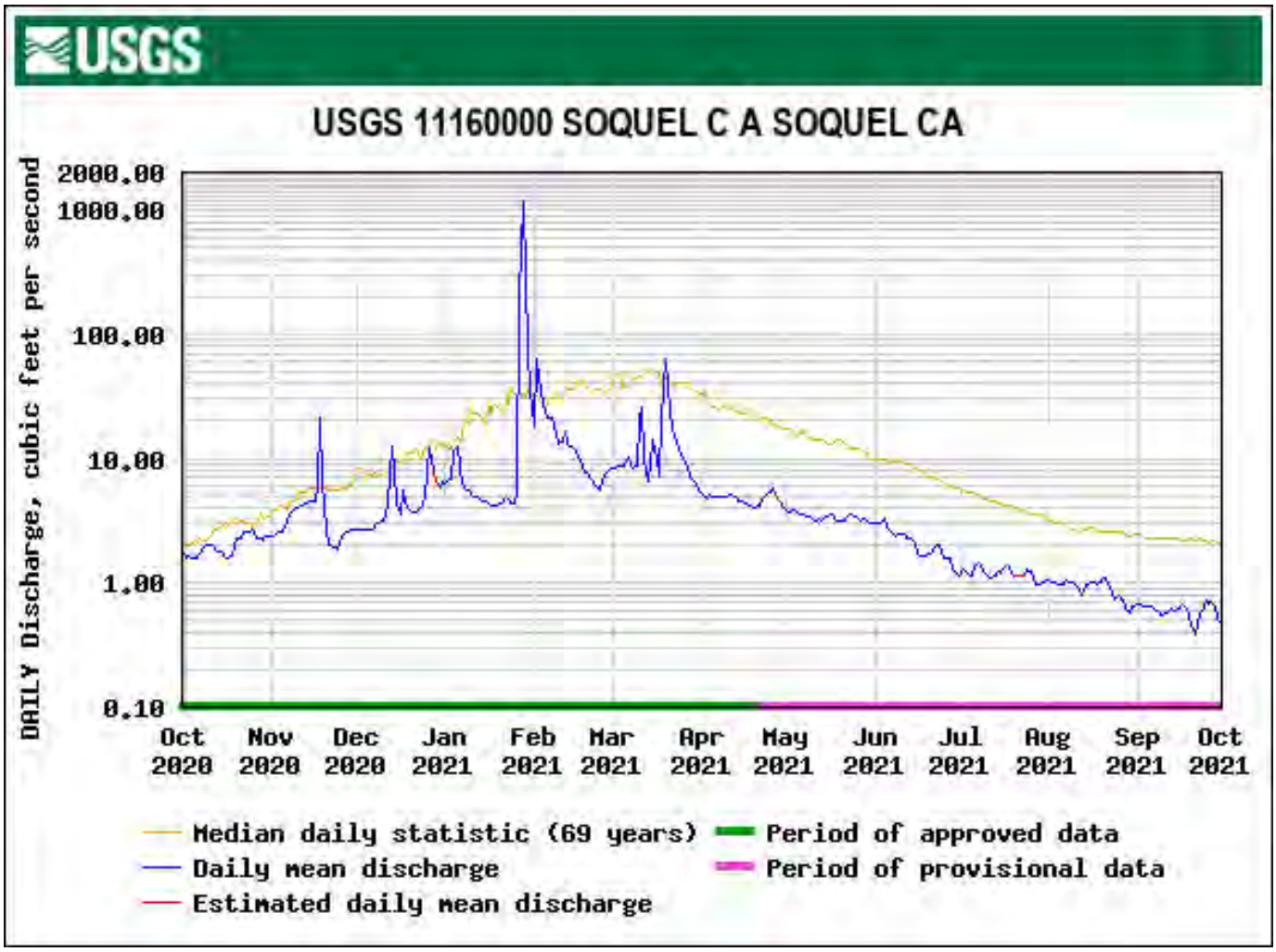


Figure 26. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 20 May 2021− 9 November 2021.

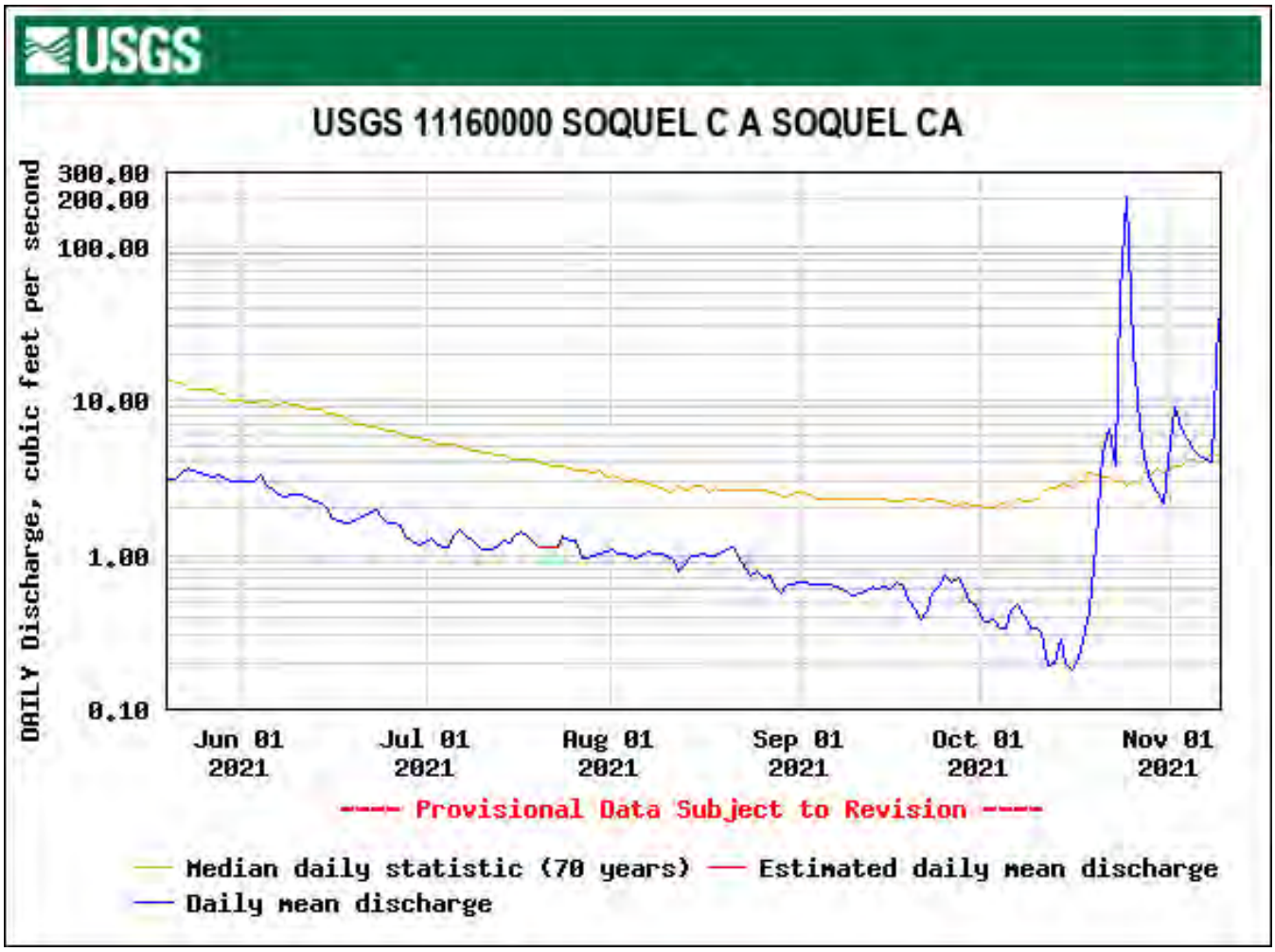


Figure 27. Maximum Visual Gull Counts on Days of Water Quality Monitoring with a Closed Sandbar at Soquel Lagoon, 2017−2021.

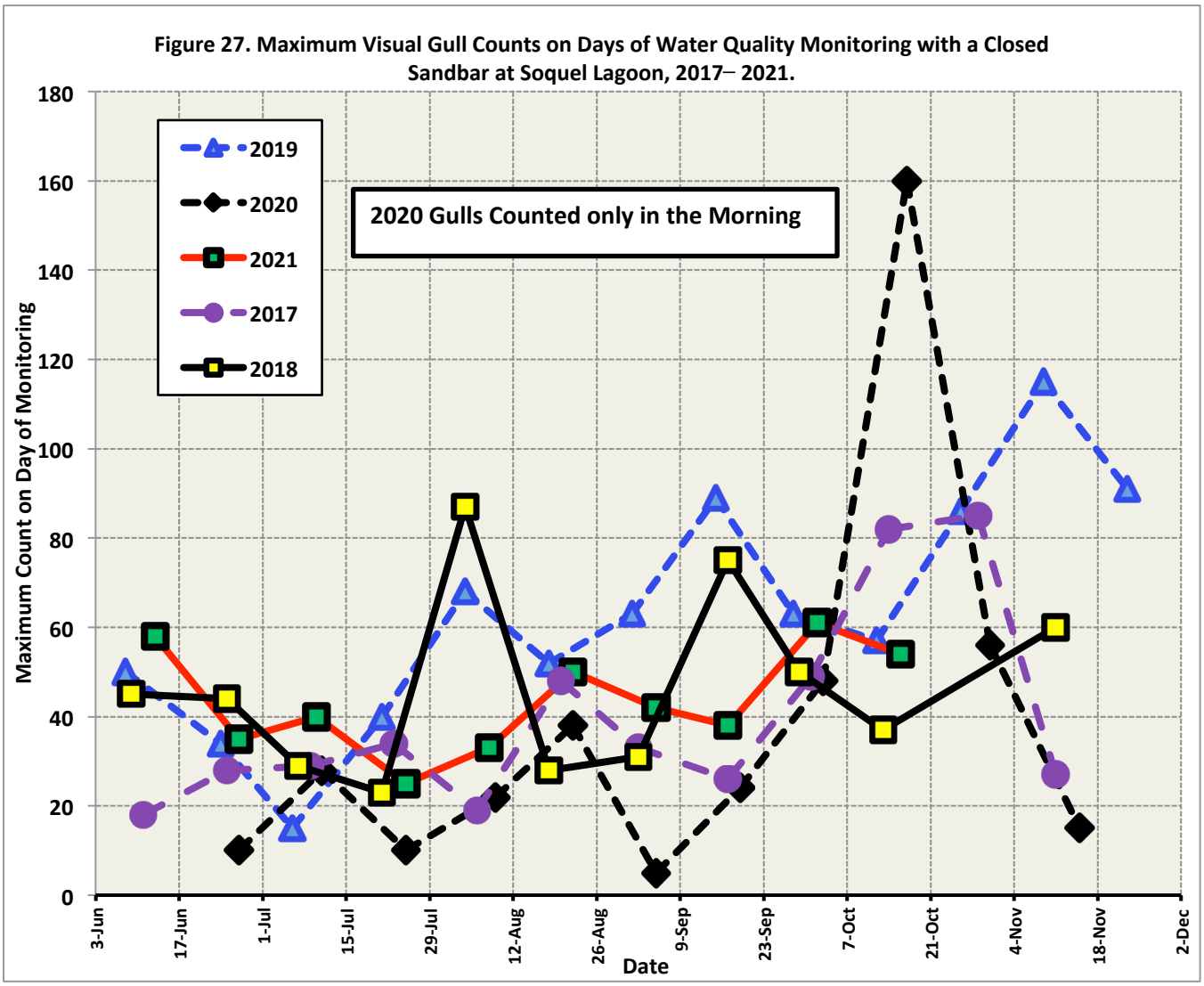
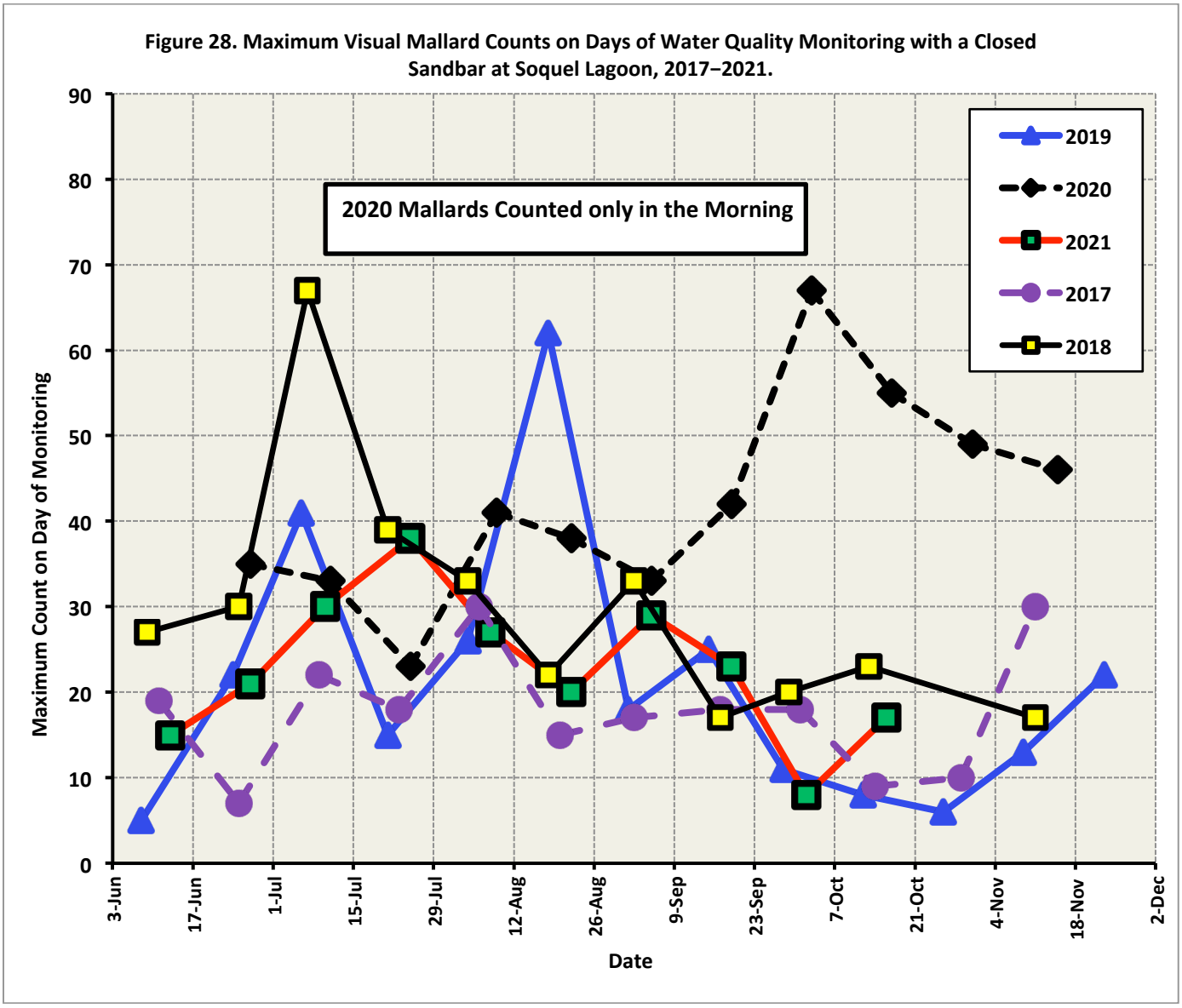


Figure 28. Maximum Visual Mallard Counts on Days of Water Quality Monitoring with a Closed Sandbar at Soquel Lagoon, 2017–2021.



APPENDIX A. Water Quality and Stormflow Data and Observations of Birds and Sandbar Opening.

24 May 2021–25 October 2021.

5 June 2021. The sandbar had been closed since 1 June. The lagoon was full with a functioning flume on 5 June, with a gage height of 2.48. Air temperature 16.6 C at 1122 hr. An 8 inch high x 8 inch wide opening at top of flashboards for adult steelhead passage present since 2 June. Saltwater detected at the Venetian Court wall. The biologist recommended that the shroud be installed on the flume inlet. **cfs at Soquel Village**.

			5 June 2021					
	Below Stockton Ave Bridge			1122 hr	**Above Stockton Ave Bridge**			1142 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.4	0.8	11.38	1378	19.4	0.8	10.92	1491
0.25	19.4	0.8	11.27	1372	19.3	0.8	10.91	1494
0.50	19.1	0.8	11.92	1350	19.4	0.9	10.90	1497
0.75	19.0	0.8	12.77	1343	19.4	0.9	10.90	1497
1.00	19.1	0.8	12.49 (135%)	1403	19.4	0.9	10.83 (118%)	1510
1.25	21.2	1.1	5.64 (65%)	1880	19.9	0.9	7.63 (85%)	1662
1.45 bot					24.3	5.5	8.09	9760
1.50	27.5	14.6	0.86	25480				
1.75	28.6	20.2	0.60	34637				
2.00 bot	28.6	25.5	0	41408				
	Railroad Trestle				**Mouth of Noble Gulch**			
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**
	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**

7 June 2021. Morrison added a 2 inch x 4 inch board on Venetian side of flume inlet to raise lagoon water level. Shroud was installed on restaurant side of flume inlet. Lagoon water level increased to the top of the flume.

9 June 2021. Temperature probes were launched in the lagoon and upstream.

13 June 2021. The first complete water quality monitoring of the season was accomplished after the sandbar had been closed on 1 June. A berm had been completed around the entire lagoon periphery to prevent tidal overwash. Temperature probes were launched on 9 June in the lagoon and upstream. Gage height was 2.59. Flume inlet 1.1 ft; flume outlet 0.35 ft at low tide in morning. Flume inlet 1.3 ft; flume outlet 0.7 ft at high tide in afternoon. Sky clear in morning and afternoon. Air temperature 15.4°C at 0712 hr; 21.3 C at 1613 hr.. Oxygen in the morning was 81-98% full saturation near the bottom and rated good at 3 shallower sites but 7% saturation at deep site 2 beside Venetian wall. Inflow oxygen in the morning was good (92% full saturation) at Nob Hill. Oxygen in the afternoon was 95-104% full saturation near the bottom at the 3 shallower sites and 36% full saturation at the deep site 2 beside Venetian wall. Water temperature ranged 19.3-19.9 ° C in the morning at the 3 shallow sites and good, but was 27.1 C (critically high) in the saltwater lens near the bottom at Site 2. In the afternoon, water temperature near the bottom ranged 19.9-21.9 C (good to poor) at the 3 shallow sites and 28.4 C (critically high) near the bottom at Site 2. No surface algae. Secchi depth to the bottom.

			13 June 2021					
	Flume		0712 hr	Air temp 15.4 C	**Stockton Avenue Bridge**			0727 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	19.7	0.8	8.80	1355	20.1	0.8	9.19	1372
0.25	19.8	0.8	8.77	1356	20.2	0.8	9.22	1371
0.50	19.8	0.8	8.78	1357	20.1	0.8	9.18	1371
0.70bott	19.8	0.8	8.71	1356				
0.75					20.1	0.8	9.68	1373
1.00					20.2	0.8	10.06	1392
1.25					20.3	0.9	8.79	1570
1.50					23.2	2.0	1.51	5196
1.75					27.1	17.2	0.48	29600
2.00bott					28.3	24.3	0.08	40841
	Railroad Trestle			0747 hr	**Mouth of Noble Gulch**			0801 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	19.8	0.7	8.33	1215	19.4	0.6	8.13	1039
0.25	19.9	0.7	8.36	1214	19.5	0.6	8.03	1041
0.50	19.8	0.7	8.53	1211	19.5	0.6	8.04	1041
0.75	19.8	0.7	8.54 (94%)	1211	19.5	0.6	8.02	1091
1.00	19.9	0.7	8.42	1220	19.5	0.6	8.03	1040
1.25	19.9	0.7	8.01(89%)	1263	19.3	0.6	7.85(81%)	1024
1.30b					20.1	0.8	3.60(39%	1468

							)	
1.45b	22.5	3.7	3.96(48%)	9740				
	Nob Hill			0855 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	0.4	6.58 (68%)	652				

Station 1: Flume at 0712 hr- Air temp. 15.4°C. no surface algae and yes, a planktonic algal bloom. Reach 1- 10 gulls bathing. Lagoon water level just above top of the flume. Shroud in place on restaurant side.
Station 2: Stockton Avenue Bridge at 0727- hr- No surface algae. Light plankton bloom. Secchi depth to bottom. Reach 2 mallards.
Station 3: Railroad Trestle at 0747 hr- no surface algae. Reach 3- 8 gulls, 4 mallards, 1 coot. Swallows active.
Station 4: Mouth of Noble Gulch at 0801 hr. No surface algae. No gray water plume.
Station 5: Nob Hill at 0855 hr- Water temp. 2.3-2.9° C cooler than lagoon near the bottom in morning at 3 shallow sites above the saltwater lens. Oxygen 1.2-2.2 mg/l less than in lagoon in the morning at those sites. Streamflow – 2.5 cfs at Soquel Village gage.

			13 June 2021					
	Flume		1613 hr	Air temp 21.3 C	**Stockton Avenue Bridge**			1532 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	21.9	0.8	9.19	1471	21.9	0.8	9.07	1463
0.25	22.0	0.8	9.19	1443	21.8	0.8	9.09	1419
0.50	21.9	0.8	9.07(104%)	1436	21.7	0.8	9.12	1404
0.70bott	21.8	0.8	8.96	1406				
0.75					21.7	0.8	9.03	1407
1.00					21.6	0.8	8.72	1397
1.25					21.3	0.7	7.59	1361
1.50					23.3	2.5	3.79	4507
1.75					28.4	18.9	3.04	32487
2.00bott					28.8	22.1	..012	37890
	Railroad Trestle			1515 hr	**Mouth of Noble Gulch** 1500 hr			Air temp. 23.3 C
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	22.6	0.8	9.04	1443	22.8	0.7	9.11	
0.25	22.4	0.8	9.04	1441	22.5	0.7	9.16	
0.50	22.1	0.8	8.62	1422	22.2	0.7	9.17	
0.75	21.9	0.7	9.00	1399	21.9	0.7	9.16	
1.00	21.6	0.7	8.89	1367	20.0	0.6	10.10	
1.25	21.4	0.8	8.65	1409	19.9	0.5	9.63(106%)	
1.30b					19.9	0.6	7.28	
1.45b	23.9	3.2	11.57	5857				
	Nob Hill			0855 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**
	20.4	0.3	8.45(92%)	609				

Station 1: Flume at 1613 hr- Air temp. 21.3°C. No surface algae and yes, a planktonic algal bloom. Reach 1- 36 gulls bathing, 4 mallards adj. Margaritaville, 12 waders, 1 barge from R-2. Gage height 2.59.
Station 2: Stockton Avenue Bridge at 1532 hr- No surface algae. Plankton bloom. Secchi depth to bottom. Reach 5 mallards, 1 inflatable boat, 2 paddle boarders, 1 barge from Reach 3.
Station 3: Railroad Trestle at 1515 hr- no surface algae. Reach 3- 22 gulls, 4 mallards and 2 ducklings, 1 coot. 2 paddle boarders, 1 canoe. 4
Station 4: Mouth of Noble Gulch at 1500 hr. No surface algae. No gray water plume.
Station 5: Nob Hill at 1648 hr- Water temp. -0.5-1.5° C cooler than lagoon near the bottom in afternoon at 3 shallow sites above the saltwater lens. Oxygen 0.2-0.7 mg/l less than in lagoon in the afternoon at those sites.

27 June 2021. Gage height was 2.59 morning and afternoon. Flume inlet 1.2 ft. Flume outlet 1.7 ft (high tide in afternoon). No sinkholes on beach. Sky overcast in morning and clear and breezy in afternoon. Air temp. 14.6°C (morning); 18.3 C (afternoon at flume); 21.2 C afternoon at Noble Gulch). Shroud in place. Oxygen was 62-85% full saturation in the morning near the bottom and fair to good; 99-122% full saturation in the afternoon near the bottom and good. Oxygen at Nob Hill inflow was 85% full saturation and fair in the morning and 103% full saturation and good in the afternoon. Water temperature ranged 20.6-22.5° C in the morning in the lagoon near the bottom and fair to poor, it being 3-4°C warmer than the stream inflow water temperature. No surface algae. Secchi depth to the bottom.

			27 June 2021					
	Flume		0700 hr		**Stockton Avenue Bridge**			0712 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	21.2	0.7	7.28	1242	21.5	0.7	7.97	1250
0.25	21.2	0.7	7.35	1245	21.5	0.7	8.00	1252
0.50	21.2	0.7	7.32	1247	21.4	0.7	7.99	1254
0.75b	21.2	0.7	7.02	1250	21.5	0.7	7.82	1260
1.00					21.5	0.7	7.69	1272
1.25					21.5	0.7	7.93 (90)	1282
1.50					21.4	0.7	7.98 (91)	1306
1.75					22.5	0.8	5.33 (62)	1882
2.00b					26.6	17.8	0.08	30067
	Railroad Trestle			0734 hr	**Mouth of Noble Gulch**			0748 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	21.2	0.6	7.51	1120	20.6	0.6	7.45	1069
0.25	21.2	0.6	7.47	1129	20.6	0.6	7.41	1073
0.50	21.3	0.6	7.52	1129	20.6	0.6	7.41	1073
0.75	21.3	0.6	7.50	1129	20.6	0.6	7.45	1072
1.00	21.3	0.6	7.49	1129	20.6	0.6	7.56 (85)	1072
1.25b	21.3	0.6	7.42 (84)	1129	21.0	0.8	6.18	1431
1.45b	21.3	0.6	6.81	1130				
	Nob Hill			0819 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**	**6.26 (85)**	**638**				

Station 1: Flume at 0700 hr- Air temp. 14.6 C. no surface algae. Reach 1- 6 gulls bathing ; 4 adult mallards and 3 ducklings..
Station 2: Stockton Avenue Bridge at 0717- hr- No surface algae. Secchi depth to bottom. Reach 2- 10 mallards in water (3 from Reach 1), 2 mergansers, 1 domestic duck (gray).
Station 3: Railroad Trestle at 0734 hr- no surface algae. Reach 3- 4 mallards in water.
Station 4: Mouth of Noble Gulch at 0748 hr. No surface algae. No gray water plume.
Station 5: Nob Hill at 0819 hr- Water temp. 3-4° C cooler than lagoon near the bottom in morning. Oxygen similar to or less than in lagoon near the bottom in the morning. Streamflow –1.7 cfs at

Soquel Village gage.

			27 June 2021					
	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	22.6	0.6	10.44	1240	22.7	0.7	10.17	1288
0.25	22.6	0.7	10.45	1241	22.7	0.7	10.16	1286
0.50	22.6	0.7	12.49 (122)	1242	22.6	0.7	10.06	1279
0.75b	22.7	0.7	10.37	1249	22.6	0.7	10.10	1274
1.00					22.5	0.7	9.73	1272
1.25					22.4	0.7	9.79	1267
1.50					22.2	0.7	9.45 (108)	1273
1.75					22.6	1.4	8.49 (99)	2647
2.00					27.3	15.1	0.11	26409
2.10b					24.0	20.6	0	34221
	Railroad Trestle			1512 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	23.1	0.7	9.43	1267	23.3	0.6	9.84	1185
0.25	23.0	0.7	9.92	1255	23.2	0.6	9.76	1185
0.50	22.9	0.7	9.65	1253	22.4	0.6	9.55	1164
0.75	22.8	0.6	9.44	1238	22.1	0.6	9.61	1122
1.00	22.4	0.6	9.18	1207	21.0	0.5	10.82 (121)	1015
1.25b	21.7	0.6	9.85 (113)	1115	20.9	0.6	8.49	1033
1.45b	21.7	0.6	8.78	1094				
	Nob Hill			0819 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**
	19.8	**0.4**	**9.36 (103)**	**672**				

Station 1: Flume at 1545 hr- Air temp. 18.3 C. no surface algae. Reach 1- 22 gulls bathing ; 1 adult mallard. 85% bottom algae to 1 ft thick, avg 0.3 ft, remainder film. Soupy plankton bloom. 9 waders, 2 paddle boarders.
Station 2: Stockton Avenue Bridge at 1528- hr- No surface algae. Secchi depth to bottom. R-2 100% bottom algae 0.1-1.0 ft thick: avg 0.2. Plankton bloom Reach 2- 3 mallards.
Station 3: Railroad Trestle at 1512 hr- no surface algae. Reach 3- 16 adult mallards and 4 ducklings, 13 gulls, 1 coot. 6 paddle boarders. R-3 100% bottom algae 0.2-0.8 ft thick: avg 0.2 ft.
Station 4: Mouth of Noble Gulch at 0748 hr. No surface algae. No gray water plume. 80% bottom algae 0.5-1.5 ft thick; avg 1.0 ft.
Station 5: Nob Hill at 1635 hr- Water temp. 2-3° C cooler than lagoon near the bottom in afternoon. Oxygen less than in lagoon near the bottom in the afternoon but supersaturated.

10 July 2021. Gage height of 2.55 in morning. Flume inlet 1.1 ft. Flume outlet 0.4 ft at low tide. No flume underflow or sink holes on beach. Overcast at 0705 hr. Air temperature of 15 C. Morning oxygen levels were good (92% – 106% super saturation), oxygen higher than 2 weeks previous in morning with warmer water temperatures in the fair to poor range near the bottom (21.1-21.7 C). Secchi depth to bottom. Gage height of 2.54 in the afternoon. Flume inlet 1.1 ft. Flume outlet 0.5-0.7 ft on incoming tide. Oxygen levels supersaturated in afternoon (104-139%) with warmer water temperatures than 2 weeks previous near the bottom (21.9-23.2 C) in the afternoon.

			10-July-2021					
	Flume			0705 hr	**Stockton Avenue Bridge**			0718 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	21.2	0.6	8.82	1147	21.6	0.6	9.74	1159
0.25	21.3	0.6	8.80	1147	21.6	0.6	9.73	1166
0.50	21.3	0.6	8.83	1148	21.7	0.6	9.66	1168
0.75b	21.3	0.6	8.64	1182	21.7	0.6	8.74	1169
1.00					21.7	0.6	8.53	1183
1.25					21.7	0.6	9.18	1185
1.50					21.7	0.6	9.40	1212
1.75					21.7	0.6	9.25 (106)	1223
2.00b					24.9	0.6	2.06	16507
	Railroad Trestle			0738 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	21.7	0.6	7.83	1139	21.2	0.6	8.23	
0.25	21.7	0.6	8.10	1141	21.1	0.6	8.19	
0.50	21.7	0.6	8.13	1140	21.1	0.6	8.17	
0.75	21.7	0.6	8.31	1138	21.1	0.6	8.27	
1.00	21.7	0.6	8.05 (92)	1143	21.1	0.6	8.18 (92)	
1.25b	21.7	0.6	7.52	1143	21.8	1.1	1.26	
	Nob Hill			0822 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**
	17.4	0.4	5.84 (61%)	612				

Station 1: Flume 0705 hr. Reach 1- 11 gulls bathing. 3 mergansers, 3 adult mallards and 1 duckling, 1 domestic gray duck. No surface algae.
Station 2: Stockton Bridge 0718 hr. Reach 2- 6 mallards in water, 3 mallards on dock near trestle, 1 mallard on trestle abutment, 1 isolated mallard duckling near trestle dock. No surface algae.
Station 3: Railroad trestle 0738 hr. Reach 3- 9 mallard (4 from R-2), 9 gulls, 1 pied billed grebe and 1 unattended duckling. No surface algae.
Station 4: Noble Gulch 0752 hr. No surface algae or gray water.
Station 5: Nob Hill at 0822 hr. 0.1° C warmer water temperature than 2 weeks previous and 4°C cooler than lagoon near bottom. Streamflow– 1.2 cfs at Soquel Village gage.

				10-July-2021				
	Flume			1547 hr	**Stockton Avenue Bridge**			1530 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	23.2	0.6	11.67	1204	23.3	0.6	11.23	1206
0.25	23.2	0.6	11.92	1205	23.2	0.6	10.90	1208
0.50	23.2	0.6	11.85 (139)	1202	23.1	0.6	10.71	1201
0.72b	23.2	0.6	11.64	1201				
0.75					23.1	0.6	10.83	1199
1.00					22.9	0.6	10.41	1193
1.25					22.7	0.6	10.21	1191
1.50					22.7	0.6	10.19	1190
1.75					22.6	0.6	9.03 (104)	1193
2.00b					25.8	8.9	1.17	15476
	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)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	23.6	0.6	10.29	1202	23.7	0.6	10.46	1194
0.25	23.4	0.6	10.34	1201	23.6	0.6	10.40	1185
0.50	23.4	0.6	10.29	1197	23.2	0.6	10.08	1166
0.75	23.2	0.6	10.52	1190	22.5	0.6	10.25	1145
1.00	23.1	0.6	10.48	1182	21.9	0.6	11.39 (130)	1060
1.25b	22.6	0.6	10.72 (124)	1151	21.8	0.6	11.23	1048
1.45b	22.3	0.6	6.71	1156				
	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**
	20.3	0.3	8.54 (95%)	630				

Station 1: Flume 1547 hr. Reach 1- 33 gulls bathing. 8 adult mallards adjacent Margaritaville, <1% surface algae. Breezy and planktonic soup making bottom invisible.
Station 2: Stockton Bridge 1530 hr. Reach 2- 7 adult mallards and 2 ducklings. 2% surface algae. Bottom invisible due to planktonic soup.
Station 3: Railroad trestle 1514 hr. Reach 3- 13 mallard, 8 gulls, 3 paddle boarders, 2 kayakers. 2% surface algae. 99% bottom algae 0.2-1.5 ft thick; avg 0.7 ft. <1% pondweed under trestle.
Station 4: Noble Gulch 1500 hr. air temperature 22.3 C. 5% surface algae, no gray water. 60% bottom algae 1-3.5 ft thick; average 2 ft.
Station 5: Nob Hill at 1637 hr. 0.5° C warmer water temperature than 2 weeks previous and 1.6-2.9 °C cooler than lagoon near bottom.

25 July 2021. Gage height of 2.62 in morning. Flume inlet 0.95 ft. Flume outlet 0.4 ft at very low tide. Small flume underflow but no sink holes on beach. Overcast at 0700 hr. Air temperature of 13.6 C. Morning oxygen levels were good (96% – 135% super saturation near the bottom), oxygen higher than 2 weeks previous in morning with cooler water temperatures in the fair to good range near the bottom (19.1-20.4 C). Secchi depth to bottom. Gage height of 2.62 in the afternoon. Flume inlet 1.0 ft. Flume outlet 0.9-1.2 ft on incoming tide. Oxygen levels supersaturated in afternoon at 3 of 4 sites (98-139%) with cooler water temperatures than 2 weeks previous near the bottom (19.7-21.3 C) in the afternoon.

			25-July-2021					
	Flume			0700 hr	**Stockton Avenue Bridge**			0724 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	20.0	0.6	12.34	1063	20.3	0.6	11.32	1068
0.25	20.0	0.6	12.25	1068	20.4	0.6	11.49	1074
0.50	20.0	0.6	12.24	1068	20.4	0.6	11.50	1075
0.70b	19.9	0.6	11.35	1253	20.4	0.6	10.45	1075
1.00					20.4	0.6	11.07	1077
1.25					20.4	0.6	11.40	1077
1.50					20.4	0.6	11.45	1077
1.75					20.4	0.6	11.48 (128)	1077
2.00					20.4	0.6	10.86	1083
2.10b					20.5	0.6	0.31	1104
	Railroad Trestle			0743 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	20.0	0.6	9.75	1052	19.1	0.5	8.84	959
0.25	20.1	0.6	9.57	1058	19.2	0.5	8.93	962
0.50	20.1	0.6	9.46	1060	19.2	0.5	8.98	961
0.75	20.1	0.6	9.93	1059	19.2	0.5	8.93	961
1.00	20.0	0.6	9.95	1057	19.1	0.5	8.82	960
1.25	20.0	0.6	9.87 (109)	1059	19.1	0.5	8.91 (96)	947
135b					18.6	0.5	3.60	900
1.50b	20.0	0.6	9.27	1070				
	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**
	16.1	0.4	7.18	593				

Station 1: Flume 0700 hr. Reach 1- 6 gulls bathing. 3 mergansers, 9 adult mallards in water and 2 mallards on wood under bridge, 1 merganser. No surface algae.
Station 2: Stockton Bridge 0724 hr. Reach 2- 7 mallards feeding ground, east side above bridge, 2 mallards in water. No surface algae.
Station 3: Railroad trestle 0743 hr. Reach 3- 12 mallards, 9 gulls, 2 pied billed grebe (1 swallowed a sculpin). 33 steelhead hits/min on the surface. No surface algae.
Station 4: Noble Gulch 0758 hr. No surface algae or gray water.

Station 5: Nob Hill at 0830 hr. 1.3° C cooler water temperature than 2 weeks previous and 4°C cooler than lagoon near bottom. Streamflow– 1.4 cfs at Soquel Village gage.

			25-July-2021					
	Flume			1546 hr	**Stockton Avenue Bridge**			1531 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	0.6	12.16	1080	21.3	0.6	11.16	1089
0.25	21.3	0.6	12.28	1082	21.3	0.6	11.07	1091
0.50	21.3	0.6	12.25 (139)	1082	21.3	0.6	10.85	1091
0.70b	21.4	0.6	11.67	1084				
0.75					21.2	0.6	11.19	1089
1.00					21.1	0.6	10.48	1088
1.25					21.1	0.6	10.34	1087
1.50					21.0	0.6	10.37	1087
1.75					21.0	0.6	10.14 (114)	1087
2.00					20.9	0.6	8.71	1088
2.10b					20.8	0.6	6.37	1091
	Railroad Trestle			1516 hr	**Mouth of Noble Gulch**			1500 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	21.2	0.6	11.48	1066	21.7	0.6	10.29	1069
0.25	21.2	0.6	11.53	1067	21.4	0.6	10.25	1064
0.50	21.2	0.6	11.38	1066	21.2	0.6	10.15	1051
0.75	21.2	0.6	11.48	1067	20.5	0.5	1036	1008
1.00	21.1	0.6	11.27	1066	20.1	0.5	11.81	970
1.25	20.7	0.6	11.42 (128)	1058	19.7	0.5	10.13 (110)	966
1.35b					19.8	0.5	11.65	977
1.50b	20.5	0.6	9.08	1048				
	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**
	18.3	0.4	9.12 (97)	649				

Station 1: Flume 1546 hr. Reach 1- 17 gulls bathing. 4 adult mallards roosting adjacent Margaritaville, 1 padddle boarder, 3 swimmers, 1 wader. No surface algae. Wind turbulence and planktonic soup made bottom invisible.
Station 2: Stockton Bridge 1531 hr. Reach 2- 18 adult mallards, 1 domestic duck and 1 gull being fed. 1 canoer. No surface algae. Bottom invisible due to planktonic soup and wind turbulence.
Station 3: Railroad trestle 1516 hr. Reach 3- 12 adult mallards and 1 duckling, 8 gulls, 1 coot, 4 paddle boarders. No surface algae. 99% bottom algae 0.5-3.0 ft thick; avg 0.8 ft. <1% pondweed under trestle 2 ft. thick.
Station 4: Noble Gulch 1500 hr. No surface algae or gray water. 40% bottom algae 1-3 ft thick; avg

2 ft.
Station 5: Nob Hill at 1632 hr. 2° C cooler water temperature than 2 weeks previous and 1.4- 3 °C cooler than lagoon near bottom.

8 August 2021. Gage height of 2.60 in morning. Flume inlet 1 ft. Flume outlet 0.3 ft at low tide. Air temperature of 14.3 C. Morning oxygen levels were good (97% – 122% super saturation near the bottom), oxygen similar to 2 weeks previous in morning with warmer water temperatures in the poor to good range near the bottom (19.9-21.5 C). Secchi depth to bottom. Gage height of 2.61 in the afternoon. Flume inlet 1.0 ft. Flume outlet 0.8 ft on incoming tide. Fog was rolling in but sky still sunny. Oxygen levels supersaturated in afternoon at all 4 sites (125-192%) with warmer water temperatures than 2 weeks previous near the bottom (21.4-22.8 C) in the afternoon.

			8-August-2021					
	Flume			0720 hr	**Stockton Avenue Bridge**			0733 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	21.0	0.5	9.05	972	21.4	0.5	10.70	980
0.25	21.1	0.5	8.98	979	21.4	0.5	10.90	985
0.50	22.2	0.5	9.10 (103%)	980	21.4	0.5	10.85	985
0.65b	21.1	0.5	8.60	980				
0.75					21.5	0.5	9.58	980
1.00					21.5	0.5	10.66	986
1.25					21.5	0.5	10.87	986
1.50					21.5	0.5	10.97	986
1.75					21.5	0.5	10.71 (122)	986
2.00b					21.5	0.5	10.66	986
	Railroad Trestle			0752 hr	**Mouth of Noble Gulch**			0808 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	0.5	9.53	977	20.4	0.5	9.20	932
0.25	21.3	0.5	9.72	979	20.4	0.5	9.31	933
0.50	21.3	0.5	9.58	978	20.5	0.5	9.45	935
0.75	21.3	0.5	9.15	980	20.4	0.5	9.49	934
1.00	21.2	0.5	8.43	980	20.4	0.5	9.49	934
1.25	21.1	0.5	8.59 (97)	981	19.9	0.5	9.03 (100)	915
1.30b					20.2	0.5	1.12	841
145b	21.1	0.5	7.42	981		0.5		
1.50								
	Nob Hill			0842 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	8.41 (87%)	602				

Station 1: Flume 0720 hr. Reach 1- 28 gulls bathing. 6 adult mallards and 1 gray domestic duck in water and 5 mallards and 1 merganser on wood under Stockton Bridge. No surface algae.

Station 2: Stockton Bridge 0733 hr. Reach 2- 5 mallards in water. No surface algae.
Station 3: Railroad trestle 0752 hr. Reach 3- 15 adult mallards and 1 duckling, 1 coot. No surface algae.
Station 4: Noble Gulch 0808 hr. No surface algae or gray water.
Station 5: Nob Hill at 0842 hr. 0.7° C warmer water temperature than 2 weeks previous and 4-5 °C cooler than lagoon near bottom. Streamflow– 1.1 cfs at Soquel Village gage.

			8-August-2021					
	Flume			1605 hr	**Stockton Avenue Bridge**			1550 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	22.7	0.5	15.96	1003	22.7	0.5	12.94	1006
0.25	22.8	0.5	16.17	1005	22.7	0.5	12.74	1008
0.50	22.8	0.5	15.56 (192)	1004	22.6	0.5	12.46	1008
0.68b	22.8	0.5	15.75	1005				
0.75					22.5	0.5	11.82	1006
1.00					22.4	0.5	11.09	1004
1.25					22.3	0.5	11.55	1004
1.50					22.3	0.5	11.29	1002
1.75					22.2	0.5	10.88 (125)	1002
2.00					21.9	0.5	8.66	992
	Railroad Trestle			1519 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	0.5	13.53	989	22.4	0.5	10.96	996
0.25	22.4	0.5	13.56	993	22.3	0.5	11.22	983
0.50	22.4	0.5	13.38	993	22.2	0.5	11.38	982
0.75	22.4	0.5	13.34	994	22.0	0.5	12.38	977
1.00	22.3	0.5	13.39	993	21.5	0.5	14.88	975
1.25	22.1	0.5	12.36 (144)	993	21.4	0.5	12.72 (144)	968
1.35b					21.8	0.6	18.46	1114
1.45b	22.0	0.5	14.07	991				
	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**
	19.7	0.3	13.40 (145%)	635				

Station 1: Flume 1605 hr. Air temp. = 18.4 C. Reach 1- 24 gulls bathing (some Hermann's). 4 adult mallards adjacent Margaritaville with 1 gray domestic duck, 3 swimmers. <1% surface algae. Pondweed visible adjacent Margaritaville with remainder invisible under very breezy conditions.
Station 2: Stockton Bridge 1550 hr. Reach 2- 5 adult mallards on deck and 4 in water, 1 greenback heron and 1 kingfisher. 1 paddle boarder. No surface algae. 100% bottom algae 0.5-3 ft thick; avg 1

ft.
Station 3: Railroad trestle 1519 hr. Reach 3- 12 adult mallards and 1 duckling, 9 gulls, 2 boats, 2 kayakers. No surface algae. 99% bottom algae 0.5-3.0 ft thick; avg 1.5 ft. <1% pondweed under trestle 2 ft. thick.
Station 4: Noble Gulch 1500 hr. Air temp. = 19.5 C. No surface algae or gray water. 40% bottom algae 0.5-3 ft thick; avg 1 ft.
Station 5: Nob Hill at 1653 hr. 1.4 °C warmer water temperature than 2 weeks previous and 2.5- 3 °C cooler than lagoon near bottom.

22 August 2021. Gage height of 2.62 in morning. Flume inlet 1 ft. Flume outlet 0.9 ft at low tide. Air temperature of 14.6 C at 714 hr. Tidal overwash on 19 August. Overcast the past 2 days and drizzling this morning, depressing oxygen levels. Morning oxygen levels fair to good (77% – 80% saturation near the bottom), oxygen lower than 2 weeks previous in morning with cooler water temperatures in the fair to good range near the bottom (19.2-20.5 C). Secchi depth to bottom. Gage height of 2.62 in the afternoon. Flume inlet 1.0 ft. Flume outlet 1.1 ft on incoming tide. Sunny. Oxygen levels supersaturated in afternoon at all 4 sites (113-161%) with cooler water temperatures than 2 weeks previous near the bottom (19.9-21.3 C) in the afternoon.

			22-August-2021					
	Flume			0714 hr	**Stockton Avenue Bridge**			0735 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	20.0	0.6	7.04	1057	20.1	0.6	8.37	1031
0.25	20.0	0.6	7.02	1067	20.1	0.6	8.26	1037
0.50	20.0	0.6	6.99 (77%)	1069	20.1	0.6	8.29	1039
0.60b	20.0	0.6	6.65	1069				
0.75					20.2	0.6	7.84	10.9
1.00					20.2	0.6	7.62	1038
1.25					20.2	0.6	7.78	1047
1.50					20.3	0.6	7.89	1067
1.75					20.5	0.6	7.01 (78)	1214
2.00b					21.6	1.8	2.98	3175
	Railroad Trestle			0753 hr	**Mouth of Noble Gulch**			0808 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	19.9	0.5	8.40	955	19.2	0.5	7.85	867
0.25	19.9	0.5	7.98	957	19.2	0.5	7.46	874
0.50	20.0	0.5	7.73	957	19.2	0.5	7.62	885
0.75	19.9	0.5	7.35	955	19.2	0.5	7.51	884
1.00	19.9	0.5	7.28	953	19.2	0.5	7.59 (82)	881
1.25b	19.9	0.5	7.07 (78)	952	19.6	0.6	1.32	1000
145b	20.0	0.5	4.28	950				
1.50								
	Nob Hill			0850 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**

	16.6	0.3	7.90 (80%)	583				

Station 1: Flume 0714 hr. Reach 1- 16 gulls bathing. 7 adult mallards and 1 gray domestic duck in water. No surface algae.
Station 2: Stockton Bridge 0735 hr. Reach 2- 3 mallards from dock near trestle in water, 1 coot. No surface algae.
Station 3: Railroad trestle 0753 hr. Reach 3- 7 adult mallards. 1% surface algae.
Station 4: Noble Gulch 0808 hr. 5% surface algae and no gray water.
Station 5: Nob Hill at 0850 hr. 0.2° C cooler water temperature than 2 weeks previous and 2.4-3.9 °C cooler than lagoon near bottom. Streamflow– 1.0 cfs at Soquel Village gage.

				22-August-2021				
	Flume			1551 hr	**Stockton Avenue Bridge**			1534 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	0.6	13.98	1085	21.1	0.6	11.77	1063
0.25	21.3	0.6	14.09	1084	21.1	0.6	12.08	1065
0.50	21.3	0.6	14.21 (161%)	1082	21.1	0.6	11.00	1064
0.60b	21.3	0.6	13.71	1083				
0.75					21.0	0.6	10.63	1068
1.00					20.9	0.6	9.81	1057
1.25					20.9	0.6	10.29	1055
1.50					20.8	0.6	10.20	1055
1.75					20.8	0.6	10.11	1056 (113)
2.00					21.1	0.8	3.34	1478
	Railroad Trestle			1516 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	20.8	0.5	13.09	967	21.3	0.5	11.20	936
0.25	20.8	0.5	12.97	968	20.9	0.5	11.16	931
0.50	20.8	0.5	12.72	969	20.6	0.5	11.2	936
0.75	20.8	0.5	12.82	969	20.3	0.5	11.96	914
1.00	20.8	0.5	12.75	968	19.9	0.5	12.85 (141)	887
1.25	20.6	0.5	11.84 (133)	967	19.8	0.5	12.62	874
1.45b	20.6	0.5	10.88	967				
	Nob Hill			1642 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**
	18.5	0.3	12.67 (135%)	614				

Station 1: Flume 1551 hr. Air temp. = 16.9 C. Reach 1- 50 gulls bathing (some Hermann's). 2 adult

mallards adjacent Margaritaville with 1 gray domestic duck. <1% surface algae. Pondweed with attached algae visible adjacent Margaritaville 3.5 ft thick with remainder invisible.
Station 2: Stockton Bridge 1534 hr. Reach 2- 3 adult mallards in water. 1 paddle boarder. 1% surface algae. 80% bottom algae 0.2-1.5 ft thick; avg 1 ft. 20% pondweed with algae 1-2 ft thick; avg 1.5 ft.
Station 3: Railroad trestle 1516 hr. Reach 3- 15 adult mallards, 4 gulls, 1 coot, 1 canoe, 3 paddle boarders, 1 barge. 1% surface algae. 80% bottom algae 0.5-3 ft thick; avg 2 ft. 20% pondweed with algae 2-4 ft thick; avg 2 ft.
Station 4: Noble Gulch 1500 hr. Air temp. = 19.5 C. No surface algae or gray water. 40% bottom algae 0.5-3 ft thick; avg 1 ft.
Station 5: Nob Hill at 1642 hr. 1.2 °C cooler water temperature than 2 weeks previous and 1.4- 2.8 °C cooler than lagoon near bottom.

5 September 2021. Gage height of 2.63 in morning. Flume inlet 1 ft. Flume outlet 0.35-0.5 ft across outlet sill at low tide. Air temperature of 13.2 C at 0710 hr, with fog. Morning oxygen levels very good (96% – 128% saturation near the bottom), oxygen higher than 2 weeks previous in morning with similar water temperatures in the fair to good range near the bottom (18.9-20.2 C). Secchi depth to bottom. Gage height of 2.63 in the afternoon. Flume inlet 1.0 ft. Flume outlet 0.3-0.6 ft across outlet sill on incoming tide. Sunny. Oxygen levels supersaturated in afternoon at all 4 sites (121-189%) with similar water temperatures to 2 weeks previous near the bottom (19.5-21.6 C) in the afternoon.

			5-September-2021					
	Flume			0710 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	0.5	9.92	887	20.1	0.5	12.32	893
0.25	19.7	0.5	9.84	890	10.1	0.5	12.28	896
0.50	19.7	0.5	9.95 (109)	891	20.2	0.5	11.20	896
0.60b	19.6	0.5	10.16	888	20.2	0.5		
0.75					20.2	0.5	11.92	897
1.00					20.2	0.5	11.72	898
1.25					20.2	0.5	12.05	897
1.50					20.2	0.5	12.11	897
1.75					20.2	0.5	11.54	897
2.00b					20.2	0.5	11.20	897
	Railroad Trestle			0747 hr	**Mouth of Noble Gulch**			0807 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	19.9	0.5	11.48	880	79.3	0.5	10.69	835
0.25	19.9	0.5	11.34	888	19.2	0.5	10.65	846
0.50	19.9	0.5	11.53	889	19.2	0.5	10.61	847
0.75	19.9	0.5	11.59	889	19.2	0.5	10.58	845
1.00	19.9	0.5	11.57	889	19.2	0.5	10.59	849
1.25	20.0	0.5	11.13	889	18.9	0.5	8.93 (96)	810
135b		0.5			18.9	0.5	6.69	843
1.45b	20.0	0.5	9.67	891				
	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**
	15.7	0.3	6.29 (64)	563				

Station 1: Flume 0710 hr. Reach 1- 27 gulls bathing. 24 mallards and 1 gray domestic duck in water, 2 coots, 1 pied billed grebe. 10% surface algae.
Station 2: Stockton Bridge 0730 hr. Reach 2- 5 mallards from Reach 1. 2% surface algae. 1 pedal boat.
Station 3: Railroad trestle 0747 hr. Reach 3- 9 adult mallards (4 followed pedal boat from Reach 2). 2% surface algae.
Station 4: Noble Gulch 0802 hr. 10% surface algae and no gray water.

Station 5: Nob Hill at 0831 hr. 0.9° C cooler water temperature than 2 weeks previous and 3.5-4.8 °C cooler than lagoon near bottom. Streamflow– 0.8 cfs at Soquel Village gage.

				5 September-2021				
	Flume			1600 hr	**Stockton Avenue Bridge**			1544 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	21.7	0.5	15.92	913	21.4	0.5	13.91	909
0.25	21.7	0.5	16.74	914	21.4	0.5	13.71	913
0.50	21.6	0.5	16.64 (189%)	912	21.3	0.5	13.65	913
0.60b	21.5	0.5	15.83	910				
0.75					21.3	0.5	13.17	914
1.00					21.2	0.5	12.40	913
1.25					21.0	0.5	11.82	911
1.50					20.8	0.5	11.16	910
1.75					20.7	0.5	10.84	907
2.00					20.6	0.5	9.25 (103)	907
2.10b					20.5	0.5	6.78	908
	Railroad Trestle			1527 hr	**Mouth of Noble Gulch**			1500 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	21.6	0.5	12.86	`920	22.2	0.5	13.21	947
0.25	21.5	0.5	12.94	919	21.7	0.5	13.54	923
0.50	21.5	0.5	13.56	917	20.9	0.5	15.53	898
0.75	21.4	0.5	14.03	915	20.4	0.5	15.16	881
1.00	21.3	0.5	13.74	913	20.3	0.5	14.25	870
1.25	20.7	0.5	15.01	902	19.5	0.4	11.19 (122)	795
1.30b					20.8	0.6	15.10	1044
1.45b	20.7	0.5	15.67	898				
	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**
	18.2	0.3	11.13 (119%)	597				

Station 1: Flume 1551 hr. Air temp. = 16.9 C. Reach 1- 50 gulls bathing (some Hermann's). 2 adult mallards adjacent Margaritaville with 1 brown domestic duck. <1% surface algae. Pondweed with attached algae visible adjacent Margaritaville 3.5 ft thick with remainder invisible.
Station 2: Stockton Bridge 1534 hr. Reach 2- 3 adult mallards in water. 1 paddle boarder. 1% surface algae. 80% bottom algae 0.2-1.5 ft thick; avg 1 ft. 20% pondweed with algae 1-2 ft thick; avg 1.5 ft.
Station 3: Railroad trestle 1516 hr. Reach 3- 15 adult mallards, 4 gulls, 1 coot, 1 canoe, 3 paddle boarders, 1 barge. 1% surface algae. 80% bottom algae 0.5-3 ft thick; avg 2 ft. 20% pondweed with algae 2-4 ft thick; avg 2 ft.

Station 4: Noble Gulch 1500 hr. Air temp. = 19.5 C. No surface algae or gray water. 40% bottom algae 0.5-3 ft thick; avg 1 ft.
Station 5: Nob Hill at 1642 hr. 1.2 °C cooler water temperature than 2 weeks previous and 1.4- 2.8 °C cooler than lagoon near bottom.

19 September 2021. Gage height of 2.63 in morning. Flume inlet 1 ft. Flume outlet 0.4 ft across outlet sill with tidal influence. Air temperature of 16.5 C at 0750 hr with sky mostly clear. Morning oxygen levels fair to good (66% – 109% saturation near the bottom), oxygen lower than 2 weeks previous in morning with cooler water temperatures in the good range near the bottom (18.4-19.3.2 C). Secchi depth to bottom. Gage height of 2.63 in the afternoon. Flume inlet 1.0 ft. Flume outlet 0.4 ft across outlet sill. Sunny and breezy. Oxygen levels supersaturated in afternoon at all 4 sites (119-164%) with cooler water temperatures compared to 2 weeks previous near the bottom (19.1-21.5 C) in the afternoon.

			19 September-2021					
	Flume			0750 hr	**Stockton Avenue Bridge**			0806 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.0	0.5	8.45	855	19.3	0.5	10.29	857
0.25	19.0	0.5	8.41	854	19.3	0.5	10.31	857
0.50	19.0	0.5	9.01 (97%)	853	19.3	0.5	10.22	858
0.60b	18.9	0.5	8.87	852				
0.75					19.3	0.5	10.23	858
1.00					19.3	0.5	10.03	858
1.25					19.3	0.5	10.15	858
1.50					19.3	0.5	10.00	858
1.75					19.3	0.5	10.08 (109%)	857
2.00b					19.3	0.5	8.27	858
	Railroad Trestle			0827 hr	**Mouth of Noble Gulch**			0842 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	19.1	0.5	9.49	851	18.3	0.4	8.82	780
0.25	19.1	0.5	9.29	852	18.3	0.4	8.61	783
0.50	19.1	0.5	9.01	851	18.4	0.4	8.78	794
0.75	19.1	0.5	8.62	852	18.4	0.4	8.79	791
1.00	19.1	0.5	8.43 (85%)	852	18.4	0.5	8.22 (87%)	818
1.25	19.0	0.5	7.91	852	18.4	0.5	5.67 (66%)	879
130b					19.0	0.9	2.70	1530
1.45b	19.0	0.5	5.75	852				
	Nob Hill			0920 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**
	16.4	0.3	5.90 (60%)	569				

Station 1: Flume 0750 hr. Reach 1- 23 gulls bathing, 2 mallards and 3 mergansers. 3% surface algae.
Station 2: Stockton Bridge 0806 hr. Reach 2- 5 coots, 2 pied billed grebes. <1% surface algae.
Station 3: Railroad trestle 0827 hr. Reach 3- 3 adult mallards, 3 gulls, 2 pied billed grebes. 2%

surface algae.
Station 4: Noble Gulch 0842 hr. 15% surface algae and no gray water.
Station 5: Nob Hill at 0920 hr. 0.7° C warmer water temperature than 2 weeks previous and 2-2.9 °C cooler than lagoon near bottom. Streamflow– 0.7 cfs at Soquel Village gage.

			19 September-2021					
	Flume			1558 hr	**Stockton Avenue Bridge**			1547 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	21.5	0.5	14.52	890	20.6	0.5	11.39	876
0.25	21.6	0.5	15.01	889	20.6	0.5	11.73	878
0.50	21.5	0.5	14.36 (164)	890	20.6	0.5	11.83	879
0.60b	21.4	0.5	13.93	888				
0.75					20.6	0.5	11.75	878
1.00					20.6	0.5	11.50	879
1.25					20.6	0.5	11.87	879
1.50					20.1	0.5	12.47	869
1.75					19.9	0.5	10.93 (128)	866
2.00b					19.6	0.5	5.25	866
	Railroad Trestle			1528 hr	**Mouth of Noble Gulch**			1505 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	21.3	0.5	12.14	908		0.5	12.87	899
0.25	21.3	0.5	12.04	890		0.5	12.23	881
0.50	20.5	0.5	12.80	876		0.5	11.41	855
0.75	20.4	0.5	12.59	871		0.4	13.24	799
1.00	20.4	0.5	13.22	870		0.4	13.07 (142)	800
1.25	20.3	0.5	14.27	869		0.4	11.12 (119)	794
1.30b						0.5	16.55	921
1.45b	20.1	0.5	15.20	858				
	Nob Hill			1642 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	7.74 (82%)	617				

Station 1: Flume 1558 hr. Air temp. = 17.7 C. Reach 1- 43 gulls bathing (some Hermann's). 9 adult mallards adjacent Margaritaville with 1 brown/gray domestic duck, 3 mergansers. 3% surface algae. Pondweed with attached algae visible adjacent Margaritaville 4 ft thick with remainder invisible.
Station 2: Stockton Bridge 1547 hr. Reach 2- 8 adult mallards in water, 1 cormorant, 2 mergansers. 1 kayaker. <1% surface algae. 60% bottom algae 1-4 ft thick; avg 1.5 ft. 40% pondweed with algae 2-4 ft thick; avg 3 ft.
Station 3: Railroad trestle 1528 hr. Reach 3- 6 adult mallards, 5 coot, 4 pied billed grebes, 1

kingfisher. 7% surface algae. 40% bottom algae 1-5 ft thick; avg 2 ft. 60% pondweed with algae 2-4 ft thick; avg 3 ft.
Station 4: Noble Gulch 1505 hr. Air temp. = 22.2 C. 15% surface algae and no gray water. 40% bottom algae 1 ft thick; 60% pondweed and algae 4 ft thick.
Station 5: Nob Hill at 1642 hr. 0.9 °C cooler water temperature than 2 weeks previous and 1.8- 3.1 °C cooler than lagoon near bottom.

2 October 2021. Gage height of 2.63 in morning. Flume inlet 1.2 ft. Flume outlet 0.4-1.0 ft across outlet sill with incoming tide. Air temperature of 13.5 C at 0800 hr with clear sky. Morning oxygen levels good (109% – 137% saturation near the bottom), oxygen higher than 2 weeks previous in morning with cooler water temperatures in the good range near the bottom (17.5-18.1 C). Secchi depth to bottom. Gage height of 2.63 in the afternoon. Flume inlet 1.1 ft. Flume outlet 0.3-0.4 ft across outlet sill. Sunny and breezy by 1545 hr. Oxygen levels supersaturated in afternoon at all 4 sites (103-147%) near the bottom, with cooler water temperatures compared to 2 weeks previous near the bottom (18.3-19.4 C) in the afternoon.

			2 October-2021					
	Flume			0800 hr	**Stockton Avenue Bridge**			0810 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	17.5	0.5	9.05	792	18.1	0.5	8.96	799
0.25	17.5	0.5	9.06	790	18.1	0.5	9.15	799
0.50	17.5	0.5	9.14	789	18.1	0.5	10.09	800
0.60b	17.5	0.5	8.88	789				
0.75					18.1	0.5	9.96	800
1.00					18.1	0.5	9.86	801
1.25					18.1	0.5	9.87	800
1.50					18.1	0.5	9.35	800
1.75					18.1	0.5	9.10	800
2.00					18.1	0.5	9.11	800
2.10b					18.1	0.5	8.59	800
	Railroad Trestle			0831 hr	**Mouth of Noble Gulch**			0845 hr
Depth	**Temp 3**	**Salin 3**	**O2 3**	**Cond 3**	**Temp 4**	**Salin 4**	**O2 4**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	18.0	0.5	9.35	797	17.5	0.4	10.38	791
0.25	18.0	0.5	9.76	800	17.5	0.4	10.34	794
0.50	18.0	0.5	9.21	800	17.6	0.4	10.63	795
0.75	18.0	0.5	9.57	800	17.6	0.4	10.48	794
1.00	18.0	0.5	10.19	800	17.6	0.5	10.24	796
1.25	18.0	0.5	10.47	800	17.8	0.5	8.34	709
135b					18.5	0.8	3.81	1413
1.45b	18.1	0.5	8.76	800				
	Nob Hill			0920 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	0.3	5.52 (64%)	533				

Station 1: Flume 0800 hr. Reach 1- No gulls in lagoon or on beach, 1 mallard in water, 2 mallards and 1 domestic duck on log under bridge, 1 snowy egret on Venetian Court margin. no surface algae.
Station 2: Stockton Bridge 0810 hr. Reach 2- 1 coots, 1 pied billed grebe, 1 merganser, 4 mallards in water, 3 mallards on trestle abutment. 1% surface algae.
Station 3: Railroad trestle 0831 hr. Reach 3- 2 pied billed grebes, 9 coots, 2 mergansers. 5% surf.

algae.
Station 4: Noble Gulch 0845 hr. 10% surface algae and no gray water.
Station 5: Nob Hill at 0920 hr. 1.6° C cooler water temperature than 2 weeks previous and 2.7-3.3 °C cooler than lagoon near bottom. Streamflow– 0.5 cfs at Soquel Village gage.

				2 October-2021				
	Flume			1552 hr	**Stockton Avenue Bridge**			1530 hr
Depth	**Temp 1**	**Salin 1**	**O2 1**	**Cond 1**	**Temp 2**	**Salin 2**	**O2 2**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	19.4	0.5	13.77	815	19.3	0.5	11.59	818
0.25	19.4	0.5	13.65	814	19.2	0.5	11.45	817
0.50	19.4	0.5	13.52 (147%)	814	19.1	0.5	11.26	815
0.60b	19.3	0.5	13.41	813				
0.75					19.1	0.5	10.96	812
1.00					19.0	0.5	10.32	814
1.25					18.9	0.5	9.91	813
1.50					18.9	0.5	10.15	811
1.75					18.8	0.5	9.65	810
2.00					18.5	0.5	7.01	810
2.10b					18.5	0.5	6.04	809
	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	20.0	0.5	10.87	831	20.2	0.5	11.90	846
0.25	19.8	0.5	10.63	830	19.4	0.5	11.49	825
0.50	19.4	0.5	10.35	824	19.1	0.4	10.74	805
0.75	19.3	0.5	10.39	820	18.7	0.4	12.35	797
1.00	19.1	0.5	10.32	817	18.6	0.4	11.71 (125)	774
1.25	18.9	0.5	11.87	812	18.3	0.5	9.85	795
1.30b					18.6	0.5	8.89	807
1.45b	18.8	0.5	10.86	811				
	Nob Hill			1642 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	0.3	7.82 (81%)	581				

Station 1: Flume 1552 hr. Air temp. = 15.9 C. Reach 1- 61 gulls bathing (some Hermann's). 6 mallards adjacent Margaritaville with 1 brown/gray domestic duck from Reach 2, 1 cormorant, 2 pied billed grebe, 1 white-faced ibis. No surface algae. Pondweed with attached algae visible adjacent Margaritaville with remainder invisible.
Station 2: Stockton Bridge 1530 hr. Reach 2- 6 mallards adjacent Margaritaville with 1 brown/gray domestic duck, 1 common egret on willow, 2 mergansers, 1 pied billed grebe. 1 kayaker, 1canoer. <1% surface algae. Bottom shaded and invisible.
Station 3: Railroad trestle 1515 hr. Reach 3- 2 mallards, 14 coots, 1 pied billed grebe. 1 paddle boarder. 3% surface algae. Bottom shaded and invisible.

Station 4: Noble Gulch 1500 hr. Air temp. = 21.6 C. 20% surface algae and no gray water. 30% bottom algae 1 ft thick; 70% pondweed and algae 3-4 ft thick; 3.5 ft avg.
Station 5: Nob Hill at 1636 hr. 0.5 °C cooler water temperature than 2 weeks previous and 1.5- 2.5 °C cooler than lagoon near bottom.

7 October 2021. A Soquel Creek Water District water line broke and leaked into Noble Gulch. The lower lagoon was cloudy for a reported 2 days. No fish mortalities were observed.
10 October 2021. Temperature probes retrieved.

16 October 2021. Gage height of 2.65 in morning. Flume inlet 1.2 ft. Flume outlet 0.4-2.0 ft across outlet sill with incoming tide. Air temperature of 9.9 C at 0803 hr with clear sky. Morning oxygen levels good (70% – 88% saturation near the bottom), oxygen lower than 2 weeks previous in morning with cooler water temperatures in the good range near the bottom (14.6-15.1 C). Secchi depth to bottom. Gage height of 2.65 in the afternoon. Flume inlet 1.0 ft. Flume outlet 0.3-0.7 ft with tidal influence. Sunny and slightly breezy. Oxygen levels supersaturated in afternoon at 3 of 4 sites (96-138%) near the bottom. Cooler water temperatures compared to 2 weeks previous near bottom (15.5-16.7 C) in the afternoon.

			16 October-2021					
	Flume			0803 hr	**Stockton Avenue Bridge**			0819 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	14.6	0.5	9.19	743	15.1	0.5	8.64	756
0.25	14.5	0.5	9.10	741	15.1	0.5	8.60	755
0.50	14.6	0.5	8.92 (88)	742	15.1	0.5	8.56	755
0.60b	14.6	0.5	8.76	743				
0.75					15.1	0.5	8.73	755
1.00					15.1	0.5	8.36	755
1.25					15.1	0.5	8.35	755
1.50					15.1	0.5	8.37	755
1.75					15.1	0.5	8.19 (82%)	755
2.00					15.1	0.5	6.88	755
	Railroad Trestle			0838 hr	**Mouth of Noble Gulch**			0854 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	15.1	0.5	8.02	757	14.7	0.5	7.25	740
0.25	15.1	0.5	8.05	754	14.7	0.5	7.23	745
0.50	15.1	0.5	8.10	754	14.7	0.5	7.23	744
0.75	15.1	0.5	8.11	754	14.7	0.5	7.23	744
1.00	15.1	0.5	8.05	755	14.6	0.5	7.33	740
1.25	15.1	0.5	8.02 (80%)	755	14.6	0.5	7.11 (780%)	751
130b					14.8	0.5	6.31	783
1.45b	15.1	0.5	7.27	755				
	Nob Hill			0923 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**

	13.2	0.3	5.68 (54%)	532				

Station 1: Flume 0803 hr. Reach 1- No gulls in lagoon or on beach, 1 snowy egret Venetian Court margin.
Station 2: Stockton Bridge 0819 hr. Reach 2- 1 coots, 2 pied billed grebes, 1 mallard, 1 domestic duck.
Station 3: Railroad trestle 0838 hr. Reach 3- 1 pied billed grebe, 23 coots, 8 mallards being human-fed at windmill house rental.
Station 4: Noble Gulch 0854 hr. No gray water.
Station 5: Nob Hill at 0923 hr. 1.6°C cooler water temperature than 2 weeks previous and 1.4-1.9 °C cooler than lagoon near bottom. Streamflow– 0.2 cfs at Soquel Village gage.

			16 October-2021					
	Flume			1559 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	16.8	0.5	13.37	779	16.2	0.5	10.93	773
0.25	16.7	0.5	13.53	777	16.2	0.5	10.92	772
0.50	16.7	0.5	13.35 (138%)	777	16.2	0.5	10.97	772
0.60b	16.7	0.5	13.06	776				
0.75					16.2	0.5	10.93	771
1.00					16.1	0.5	10.44	770
1.25					15.8	0.5	10.02	766
1.50					15.8	0.5	10.04	765
1.75					15.6	0.5	9.50 (96%)	763
2.00					15.5	0.5	9.22	763
	Railroad Trestle			1528 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	16.9	0.5	10.46	795	18.1	0.5	11.30	821
0.25	16.9	0.5	10.59	784	17.4	0.5	10.64	790
0.50	16.7	0.5	10.30	780	16.4	0.4	10.14	740
0.75	16.7	0.5	10.41	779	15.8	0.4	12.20	723
1.00	16.2	0.5	10.23	773	15.6	0.5	11.73	754
1.25	16.1	0.5	10.47 (107)	769	15.5	0.5	9.94 (100%)	754
1.33b					15.4	0.5	6.82	752
1.45b	15.9	0.5	10.17	767				
	Nob Hill			1648 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**
	15.8	0.3	7.79 (78%)	573				

Station 1: Flume 1559 hr. Air temp. = 16.6 C. Reach 1- 54 gulls bathing (some Hermann's). 2% surface algae. Pondweed with attached algae visible adjacent Margaritaville with remainder

invisible.
Station 2: Stockton Bridge 1548 hr. Reach 2- 5 mallards, 1 common egret on willow, 1 merganser. 2 paddle boarders. 2% surface algae. Bottom shaded and invisible.
Station 3: Railroad trestle 1528 hr. Reach 3- 12 mallards, 24 coots, 5 pied billed grebes, 1 gull, 1 greenback heron. 10% surface algae. Bottom shaded and invisible.
Station 4: Noble Gulch 1502 hr. 25% surface algae and no gray water. 30% bottom algae 1 ft thick; 50% pondweed and algae; all 4 ft thick. 20% bare sand from Noble Gulch flushing through on 7 October.
Station 5: Nob Hill at 1648 hr. 1.0 °C cooler water temperature than 2 weeks previous and warmer than 2 sites near the bottom in the lagoon and 0.3-0.9 C cooler than 2 sites.

18-19 October 2021. Public Works staff cut a 30-foot wide notch across the beach in preparation for any emergency sandbar breach that may be necessary. They put a berm across the notch near the surf and another inner one approximately 20 feet from the lagoon's water's edge to prevent swells from opening the sandbar without stormflow. The shroud was removed from the flume inlet on 19 October.

23 October 2021. Public Works staff and Ed Morrison removed 2 boards from each side of the flume inlet along with removing algae and pondweed that had collected on the grate at the flume inlet. The lagoon surface level had raised about a foot due to the inlet plugging with plant material the previous night after a brief stormflow of 30 cfs measured at the gage passed through the flume.

24 October 2021. The fish biologist arrived at the lagoon at 0600 hr, as previously scheduled. After rain overnight, the lagoon water surface had risen to the piling bolt to signal the need to breach the sandbar. Streamflow estimated at the Soquel Village gage was 30 cfs and rising. City Public Works operator, Matt Kotila, opened the sandbar with the tractor at 0610 hr. Streamflow increased to about 50 cfs midday and declined back down to 30 cfs before it increased abruptly to approximately 500 cfs in the early morning of 25 October.

25 October 2021. At midday, Soquel Creek was flowing at approximately 200 cfs, with the estuary extending from bank to bank with ample deep water habitat and an estimated gage height of 1.6 ft. The outlet through the beach was approximately 50 feet wide. A secondary channel through the beach existed adjacent to the Venetian Court wall.

APPENDIX B. 2021 Drain Line Test for Restaurants Contiguous with Soquel Creek Lagoon.

2021 DRAIN LINE STATIC PRESSURE TESTS
FOR RESTAURANTS CONTIGUOUS WITH SOQUEL CREEK

RESTAURANT	INITIAL CONTACT	TEST DATE	COMMENTS	BUILDING DEPT. SIGN OFF
MY THAI BEACH 207 Esplanade	4/20/21 1st letter sent email & 1st Class mail 5/11/20 2nd letter sent email	5/27/21	pass Fail (no access)	ct
BAY BAR 209-B Esplanade	4/20/21 1st letter sent email & 1st Class mail 5/11/20 2nd letter sent email	5/20/21		ct
PIZZA MY HEART 209-A Esplanade	4/20/21 1st letter sent email & 1st Class mail 5/11/20 2nd letter sent email	5/20/21		ct
SAND BAR 211 Esplanade	4/20/21 1st letter sent email & 1st Class mail 5/11/20 2nd letter sent email	5/20/21	~~Fail~~ pass correction s made	ct
PARADISE BAR & GRILL 215 Esplanade	4/20/21 1st letter sent email & 1st Class mail 5/11/20 2nd letter sent email	5/18/21	replacing Te Kitchen sink	ct
ZELDA'S 203 Esplanade	4/20/21 1st letter sent email & 1st Class mail 5/11/20 2nd letter sent email	5/18/21		ct

APPENDIX C. Hydrographs for USGS 11160000 Soquel Creek Stream Gage at Soquel, CA; Water Years 2007−2021.

Figure 1. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2020.

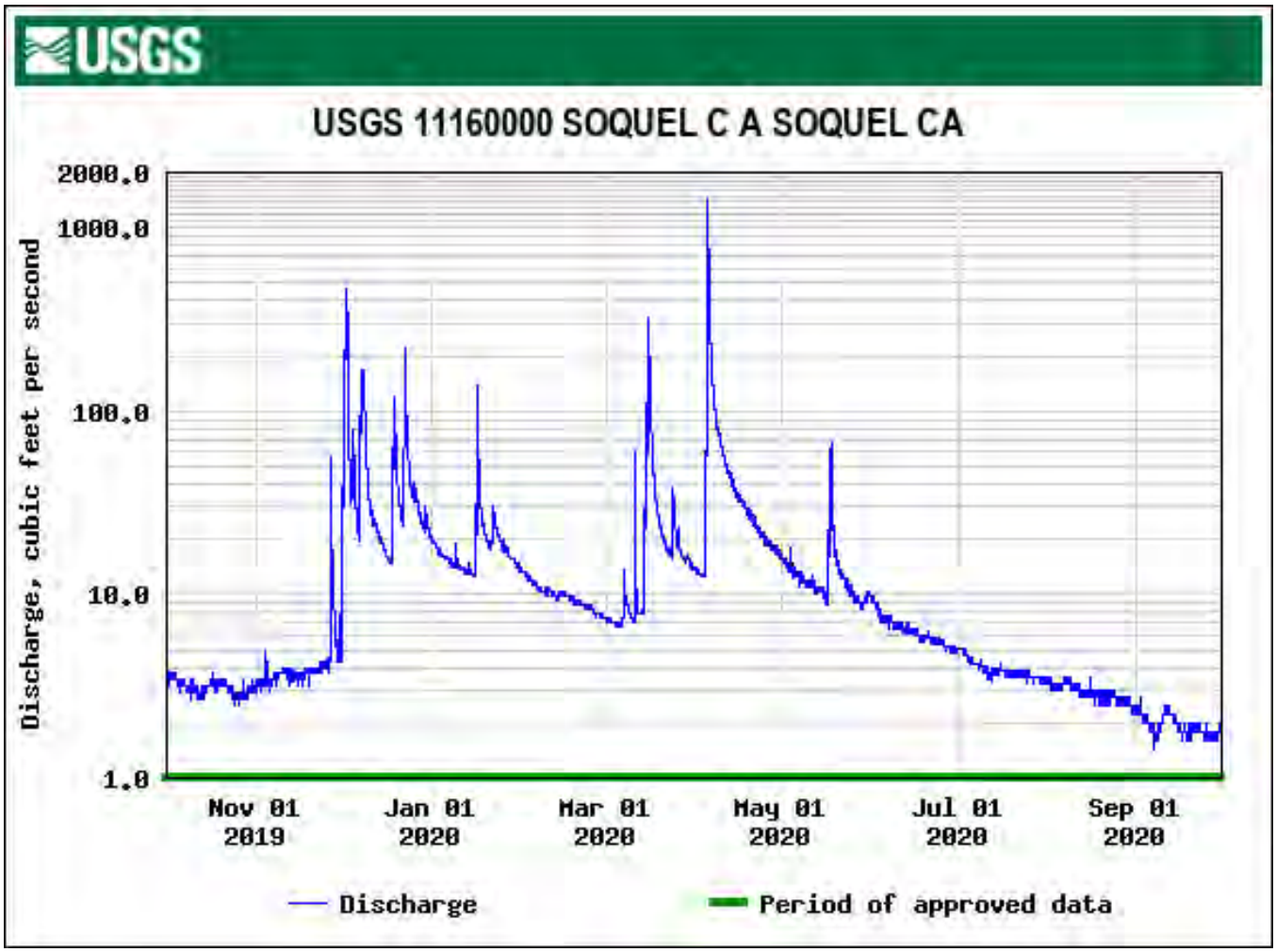


Figure 2. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2020.

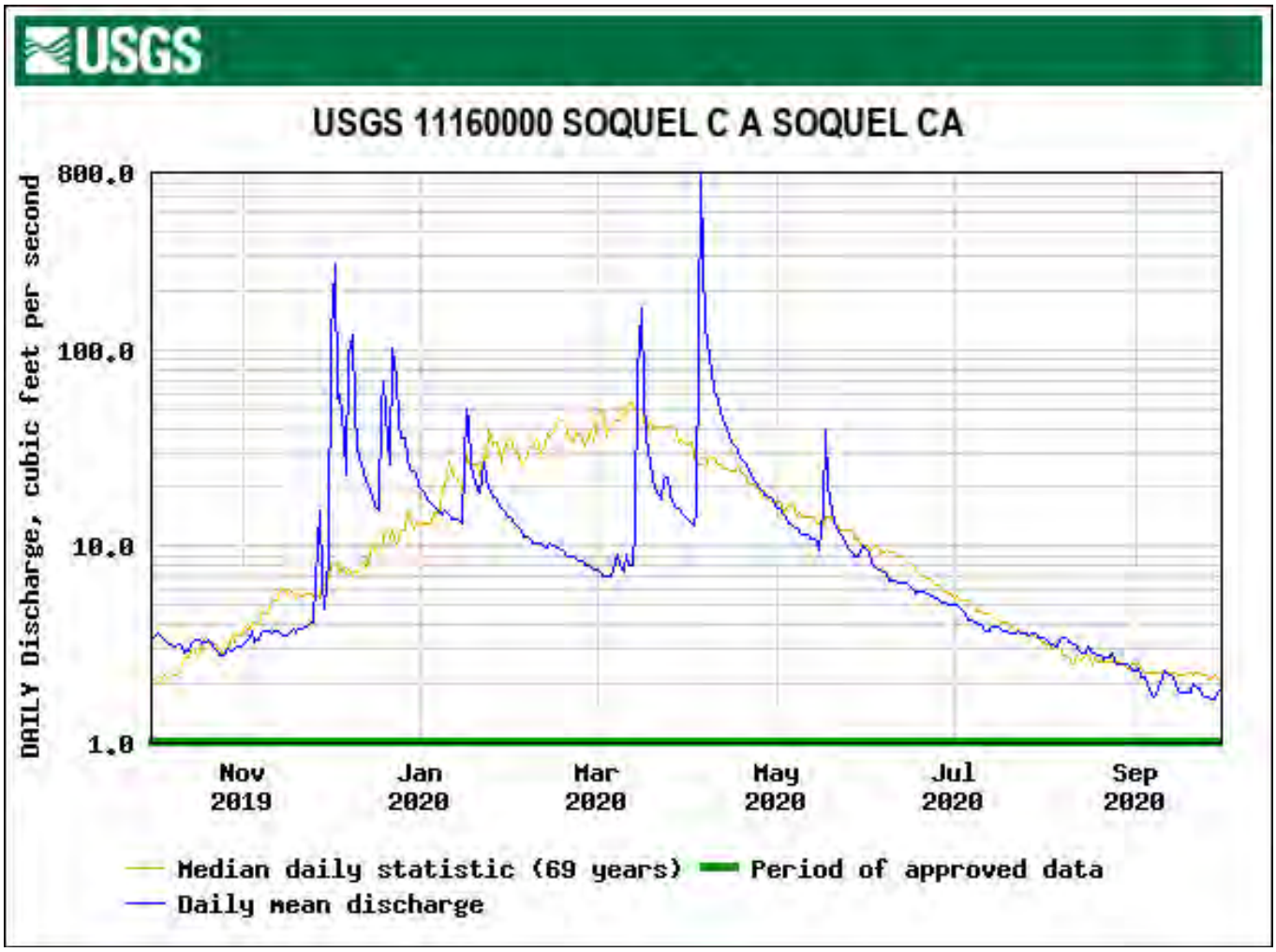


Figure 3. Soquel Creek Streamflow Hydrograph for the USGS Gage in Soquel, CA, 1 June 2020– 1 February 2021.

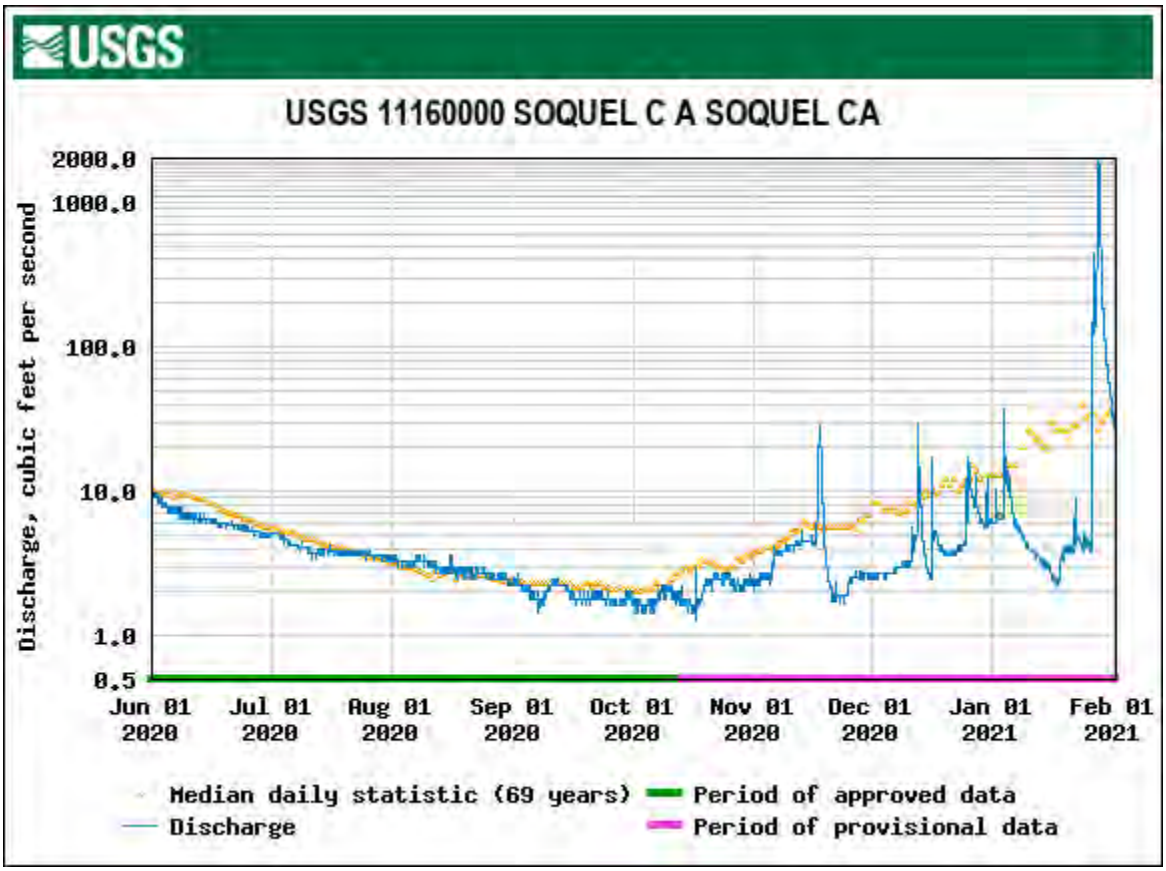


Figure 4. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2019.

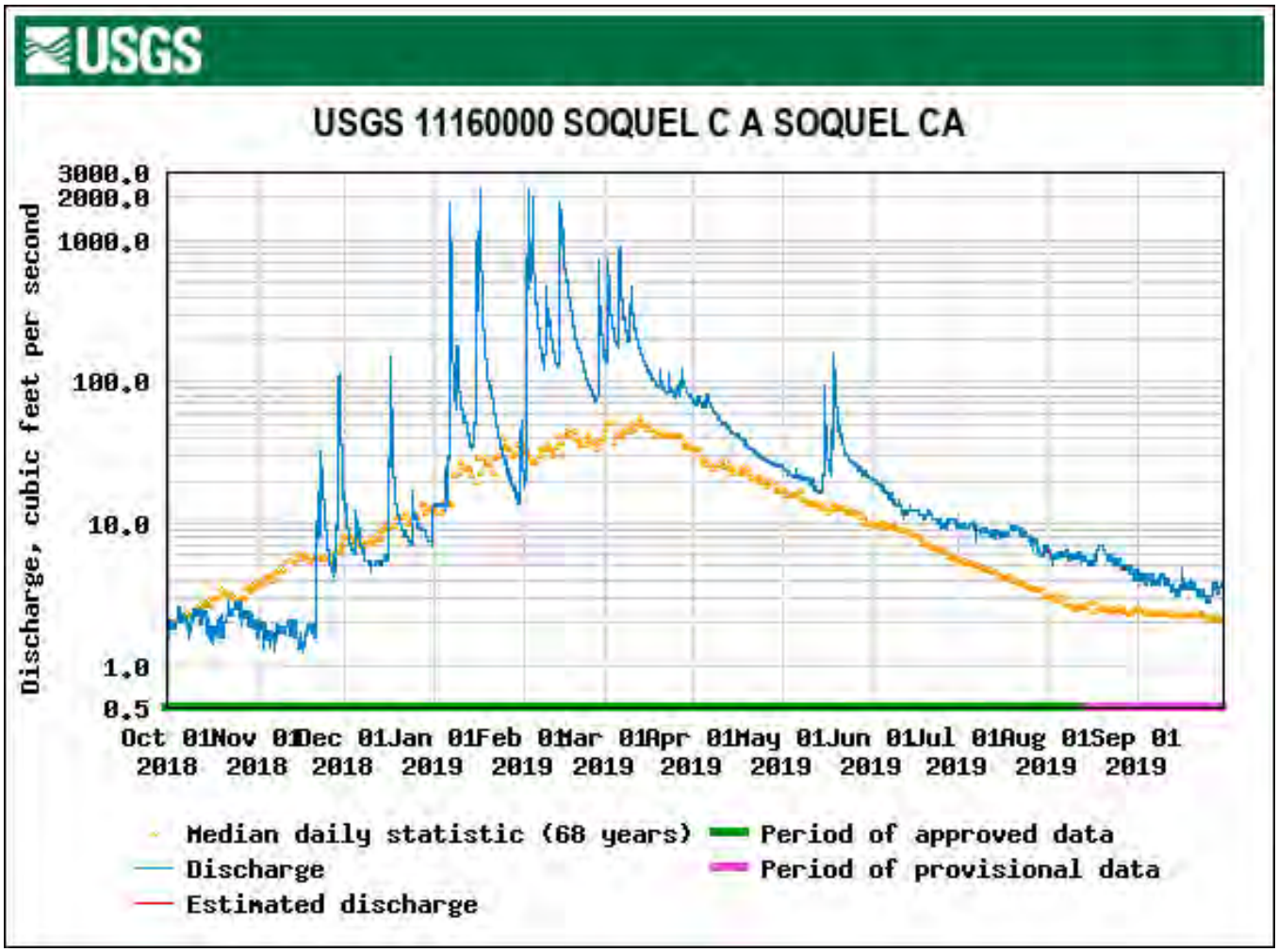


Figure 5. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2019.

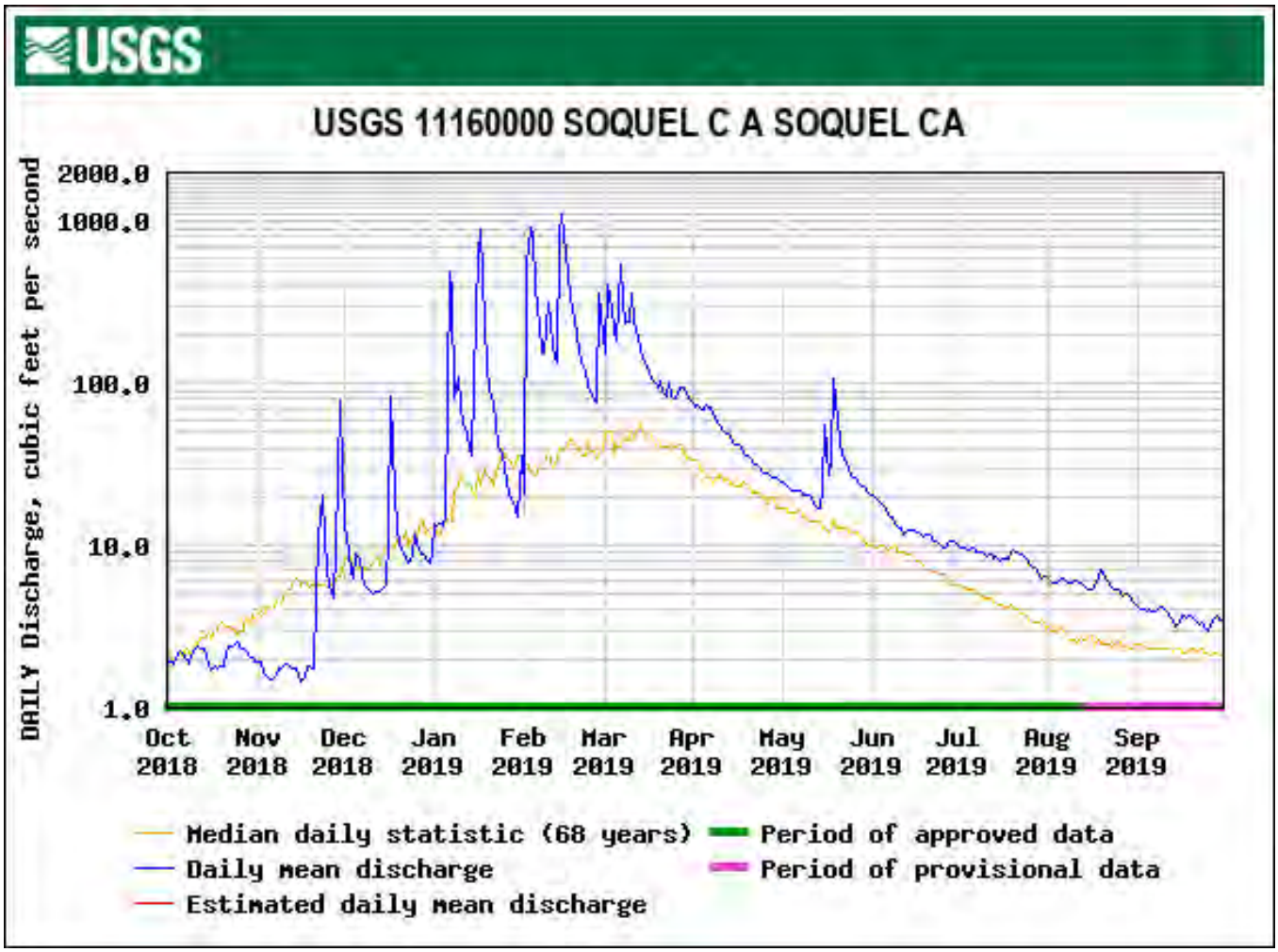


Figure 6. Soquel Creek Streamflow Hydrograph for the USGS Gage in Soquel, CA, 15 May – 9 December 2019.

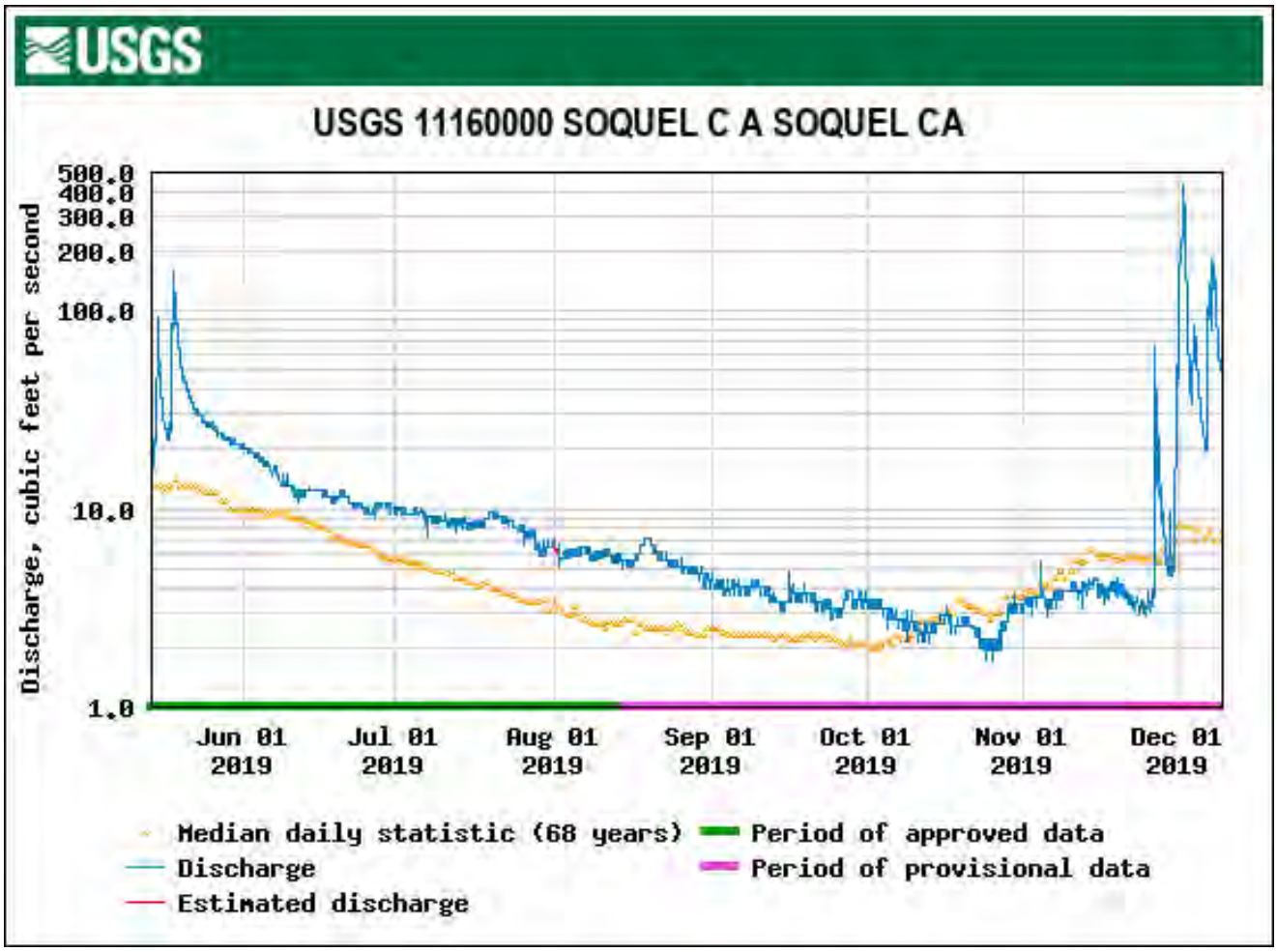


Figure 7. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2018.

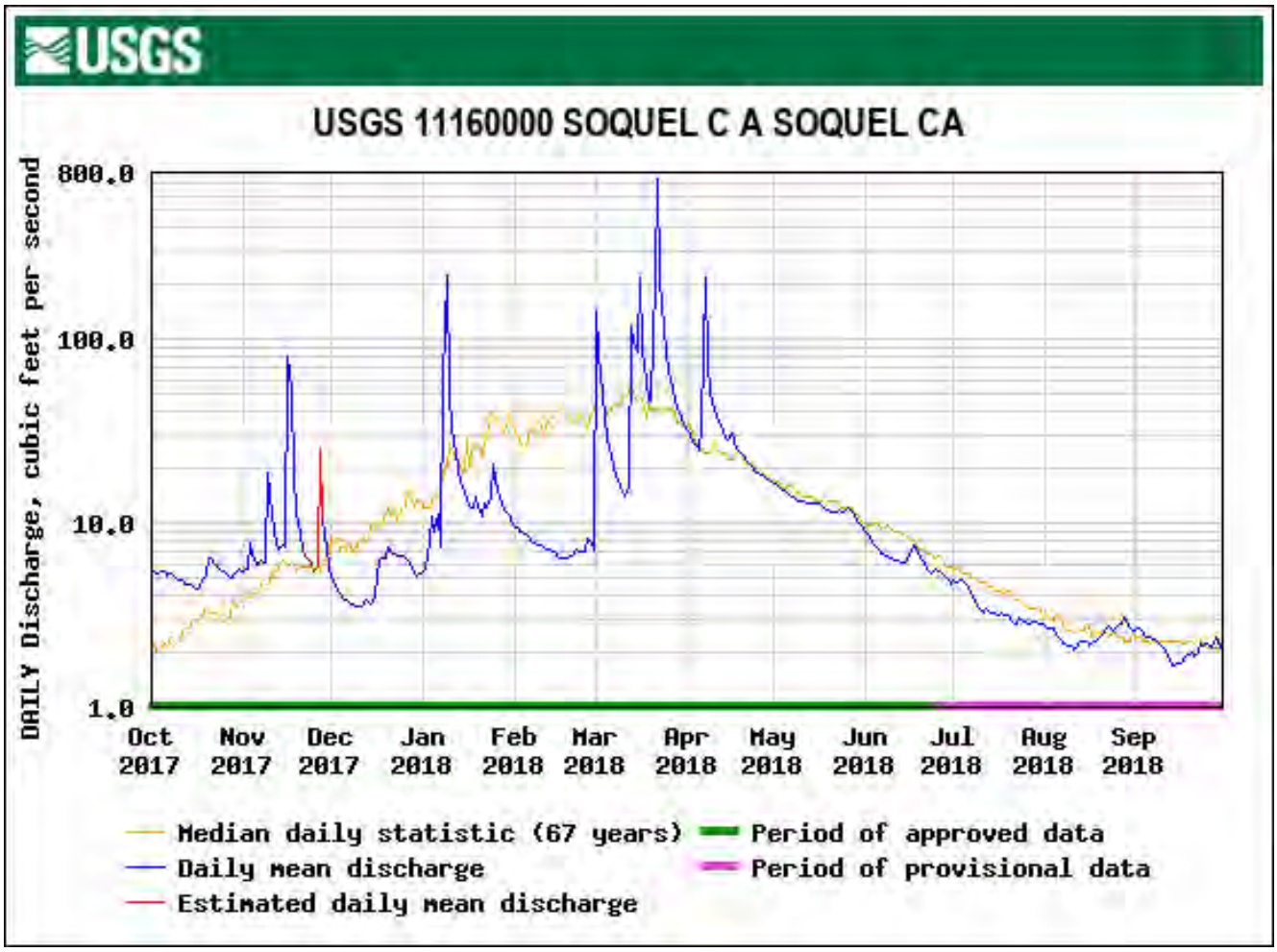


Figure 8. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2018.

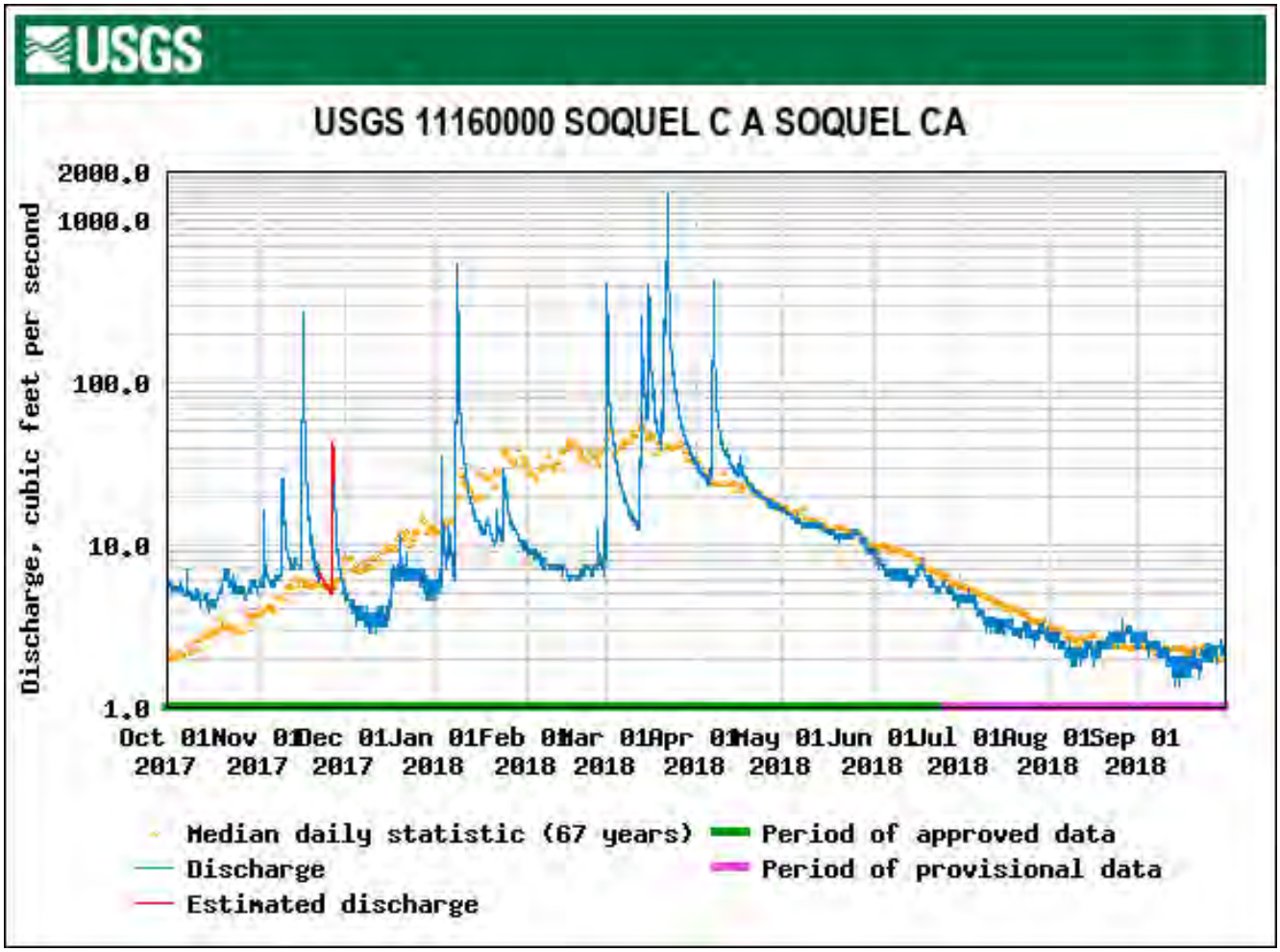


Figure 9. Soquel Creek Streamflow Hydrograph for the USGS Gage in Soquel, CA, 1 June 2017 – 1 December 2018.

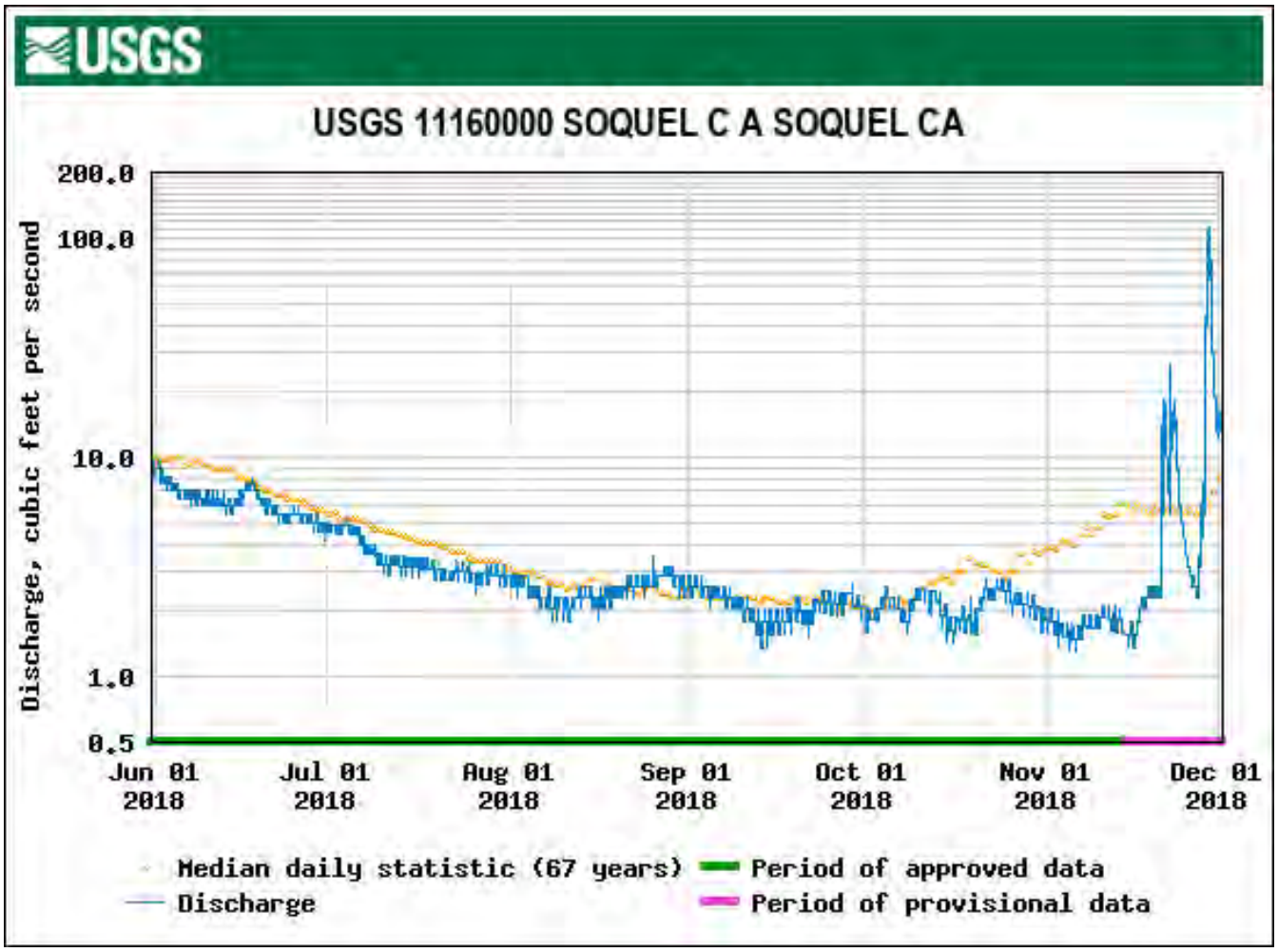


Figure 10. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2017.

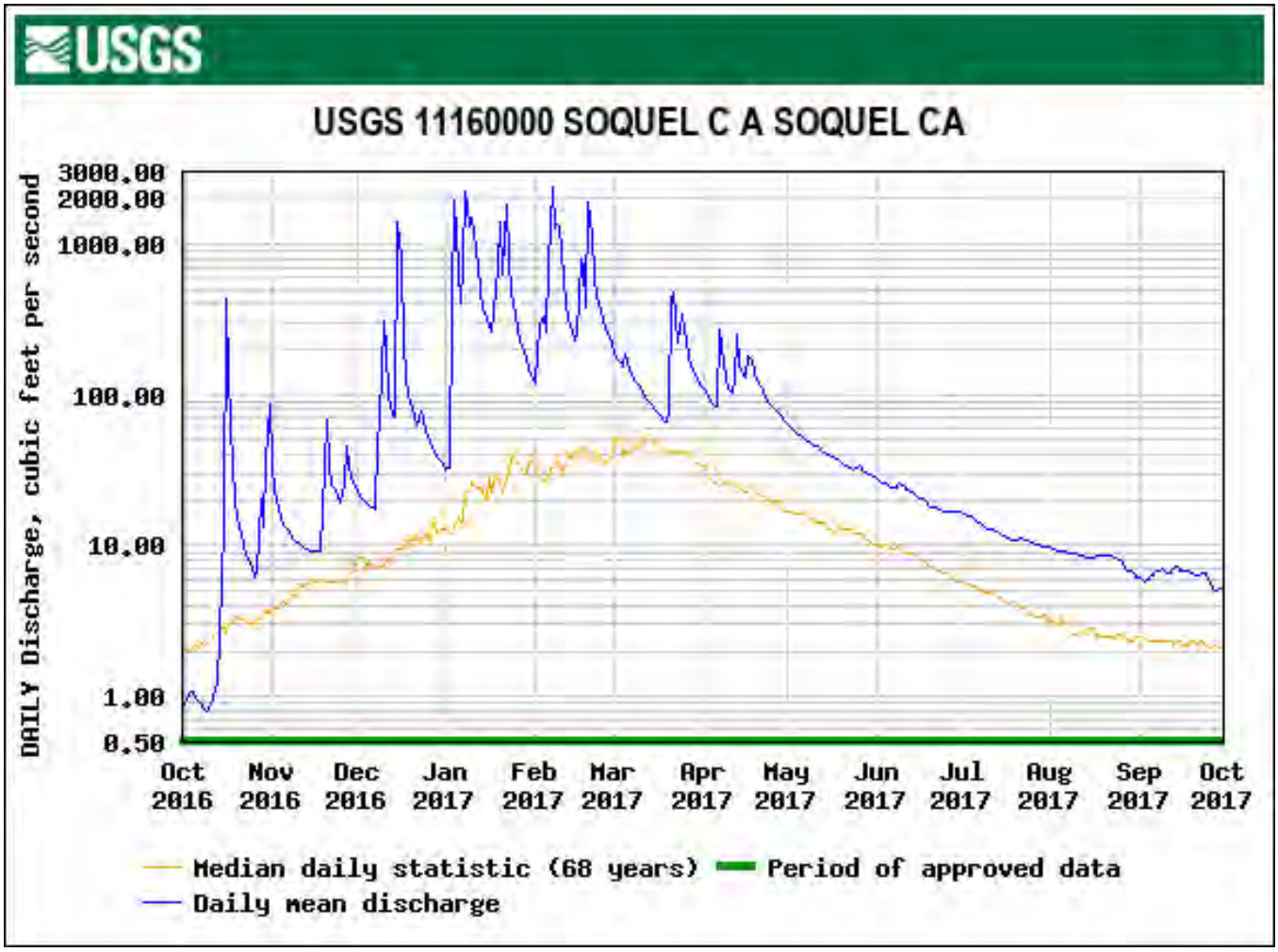


Figure 11. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2017.

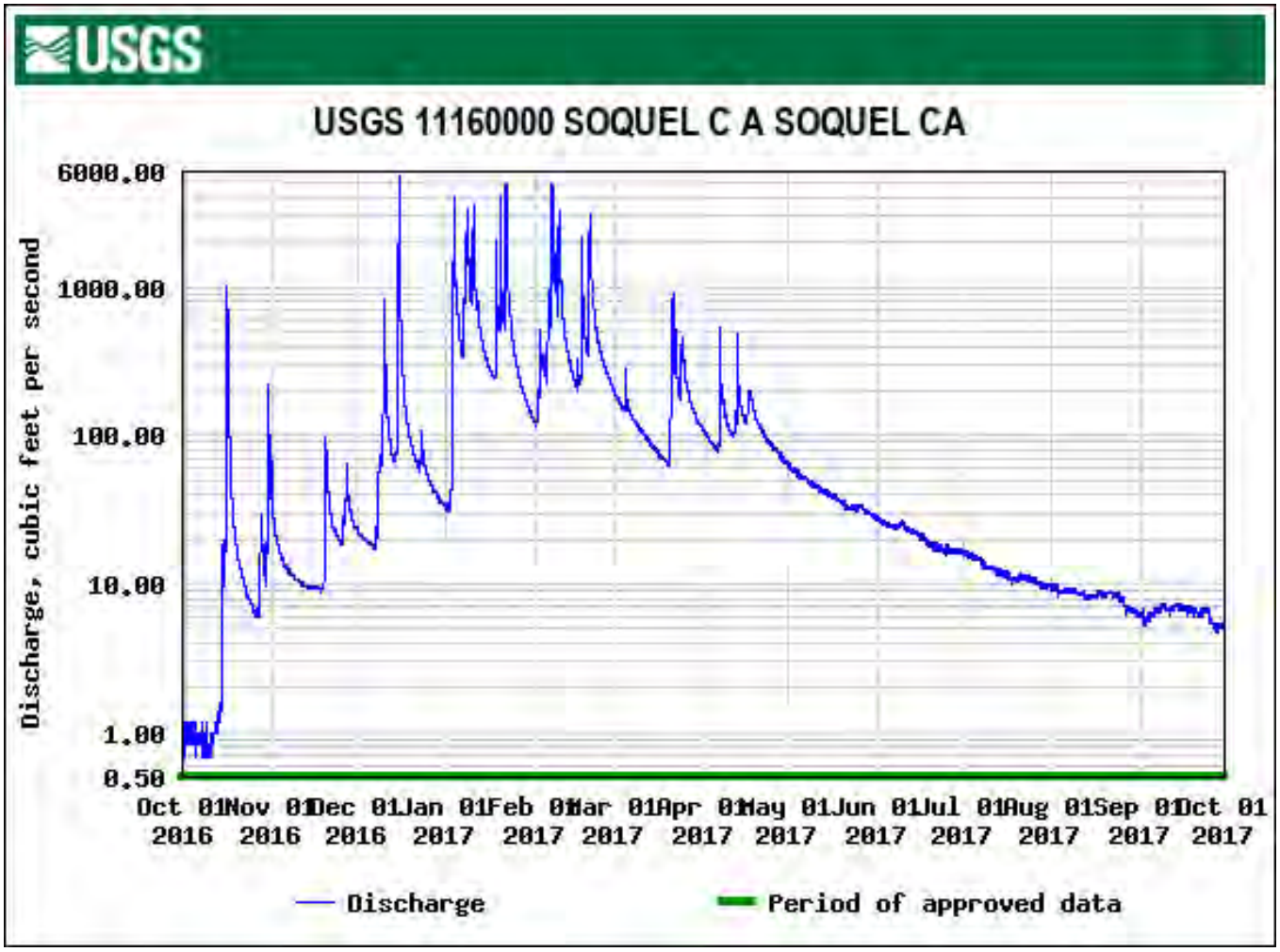


Figure 12. Soquel Creek Streamflow Hydrograph for the USGS Gage in Soquel, CA, 1 June 2017 – 20 November 2017.

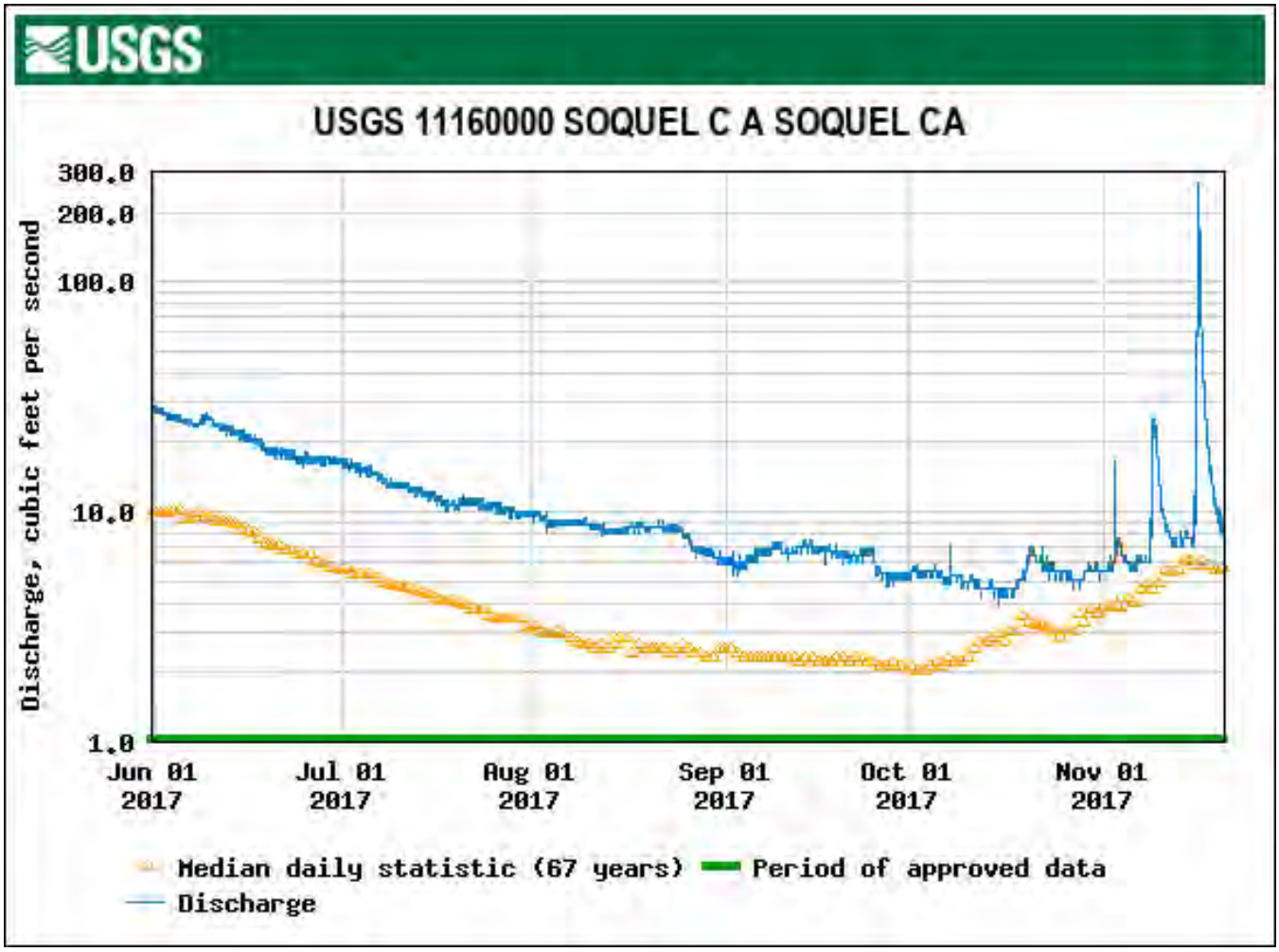


Figure 13. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2016

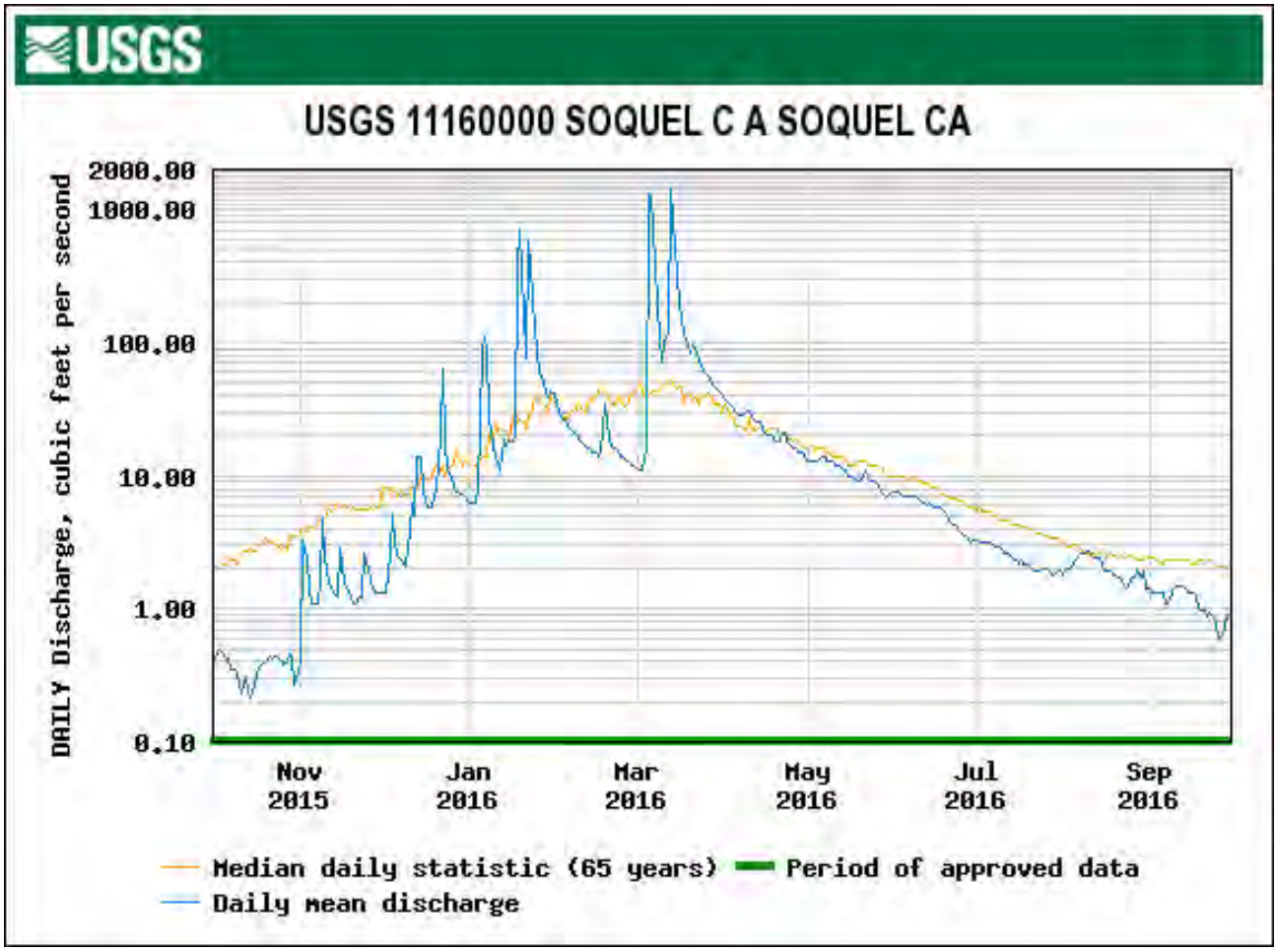


Figure 14. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2016.

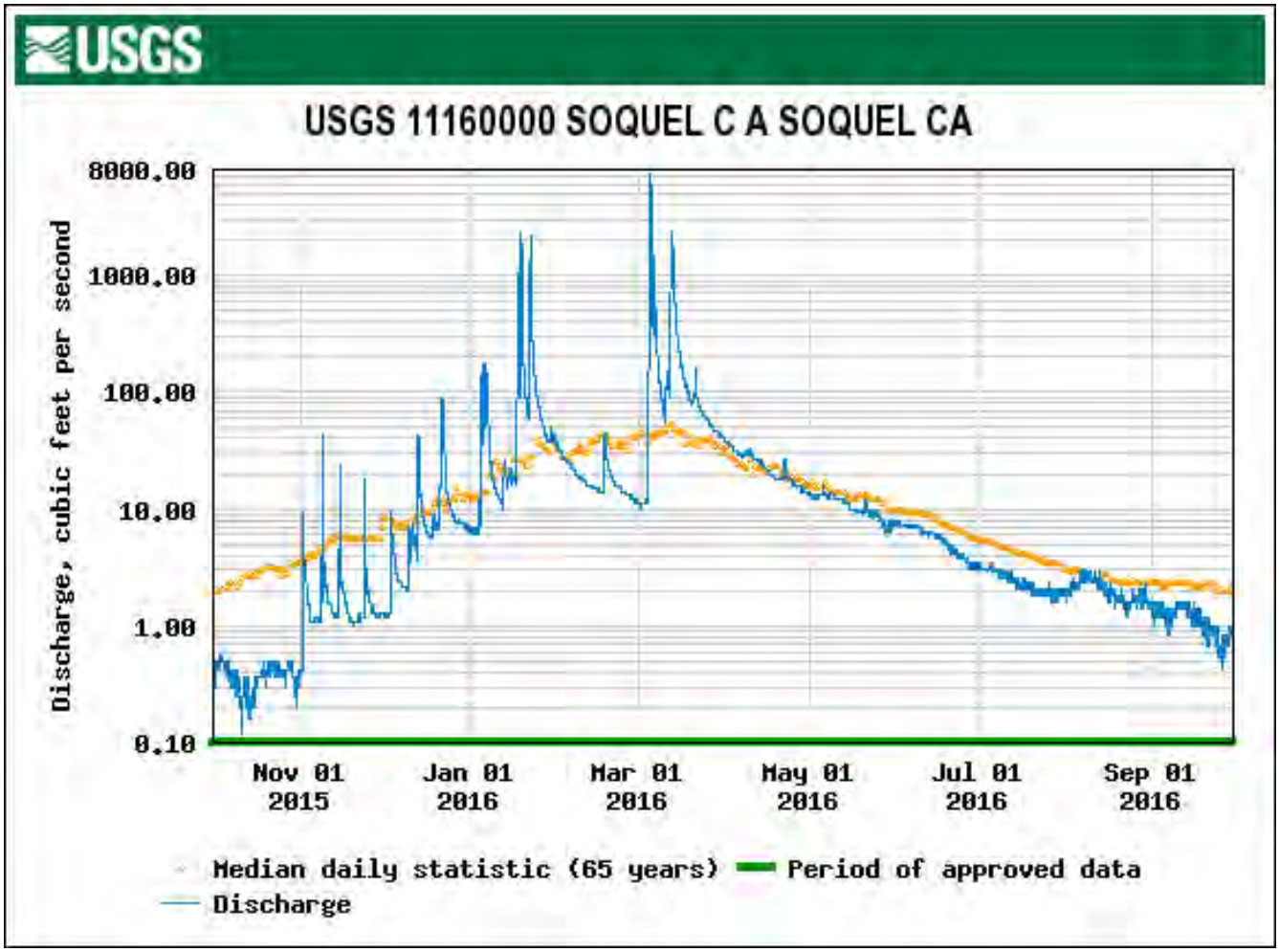


Figure 15. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 15 May 2016 – 11 October 2016.

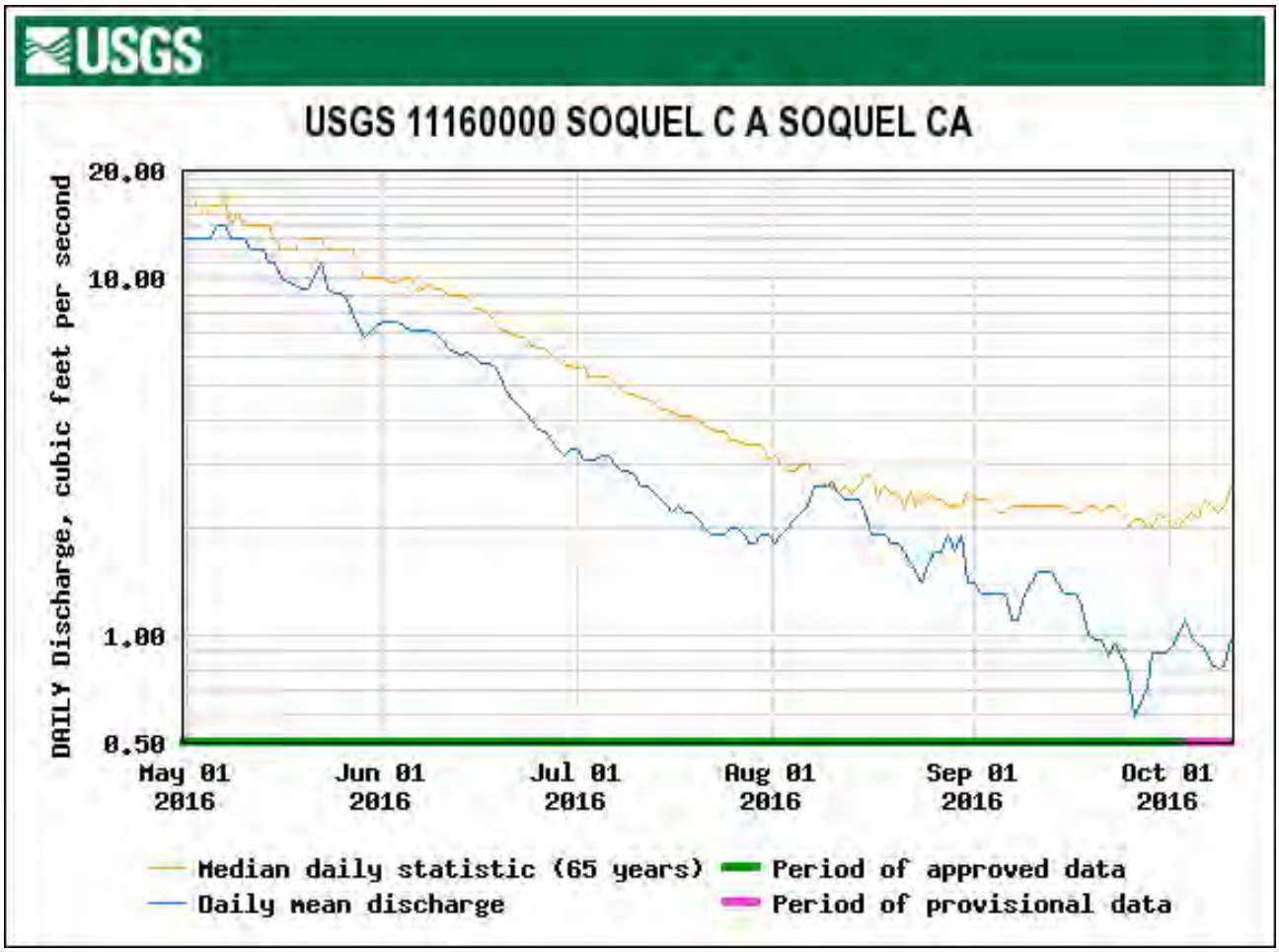


Figure 16. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2015.

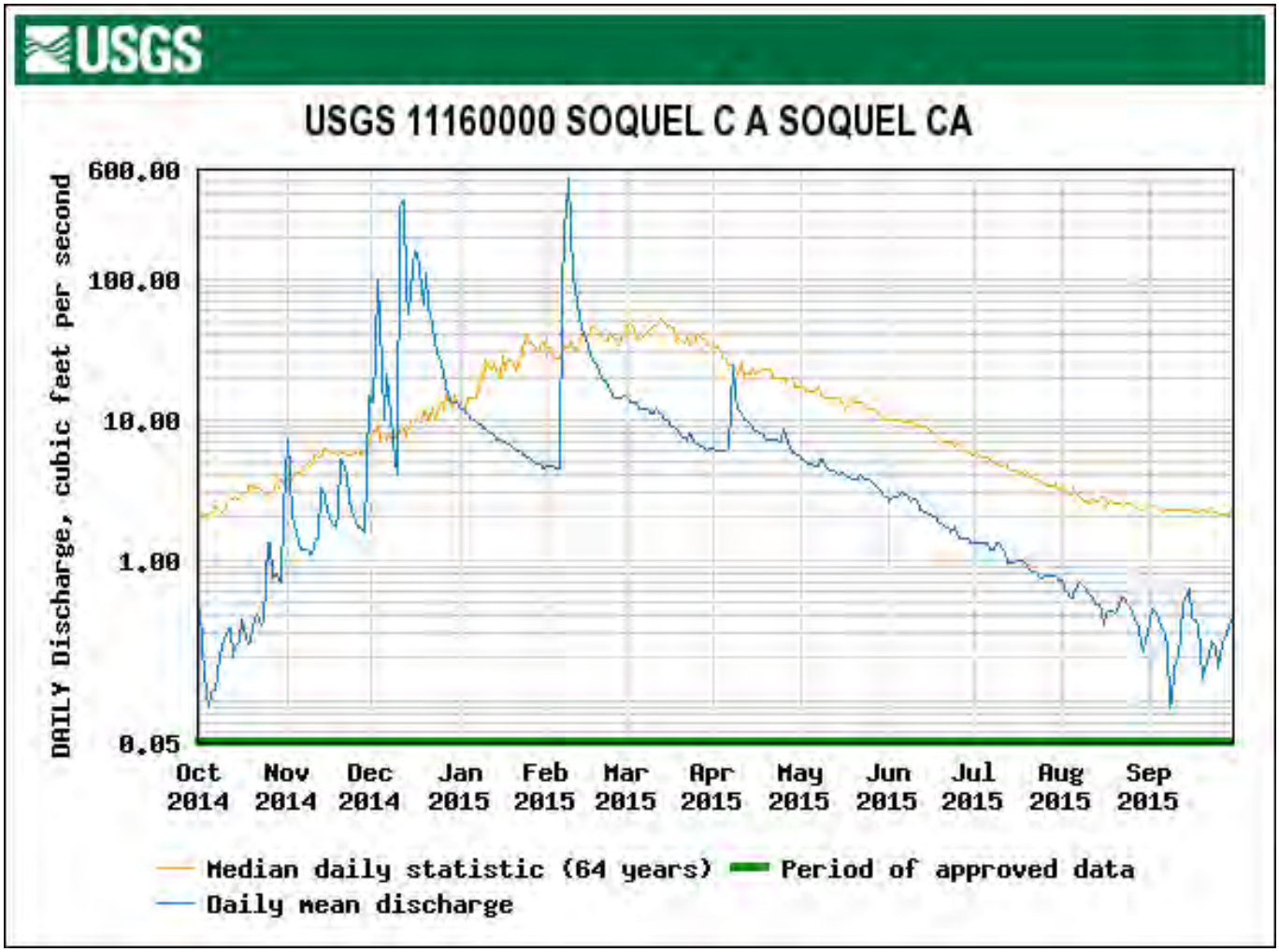


Figure 17. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2015.

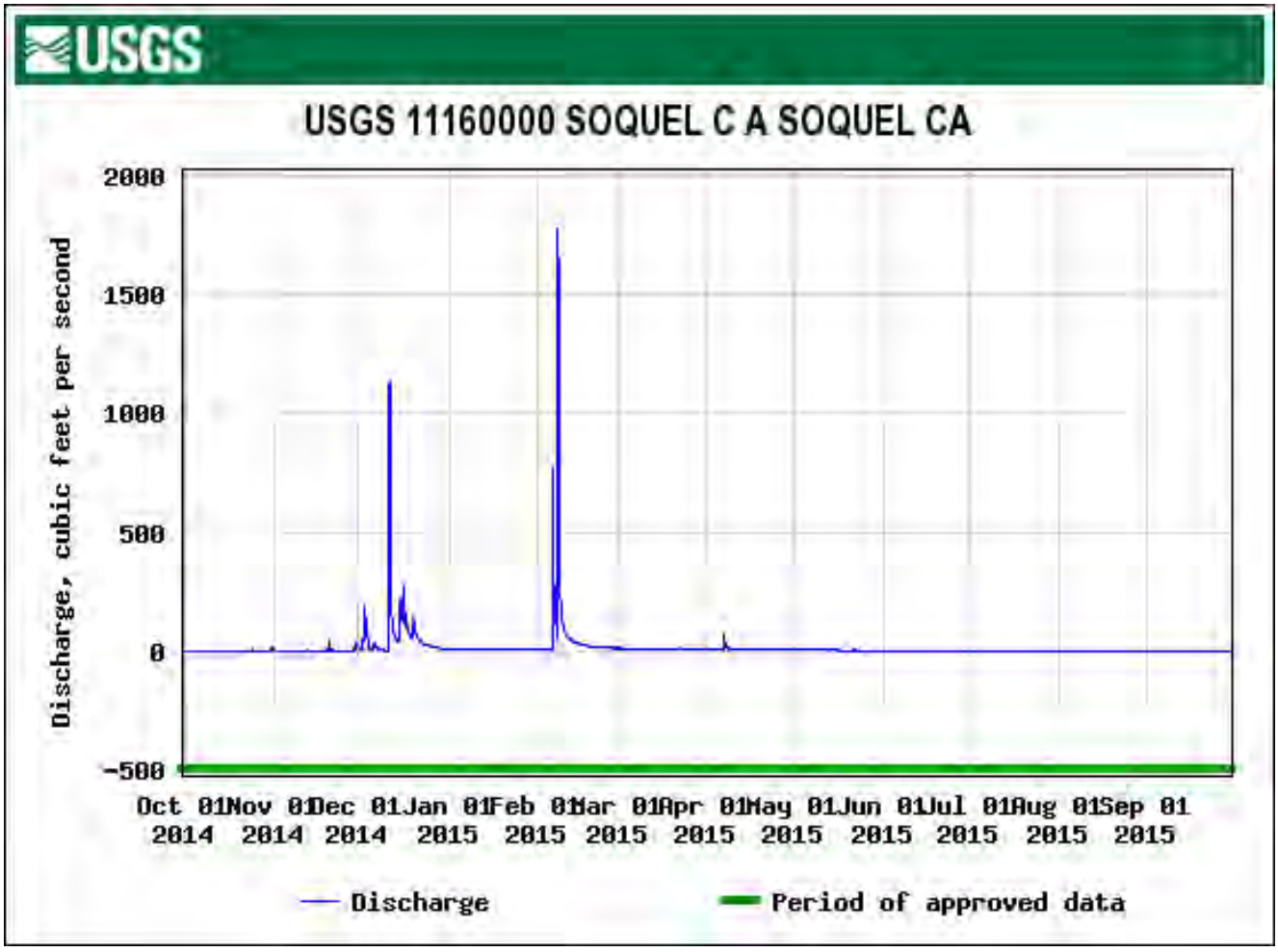


Figure 18. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, 15 May 2015 – 15 November 2015.

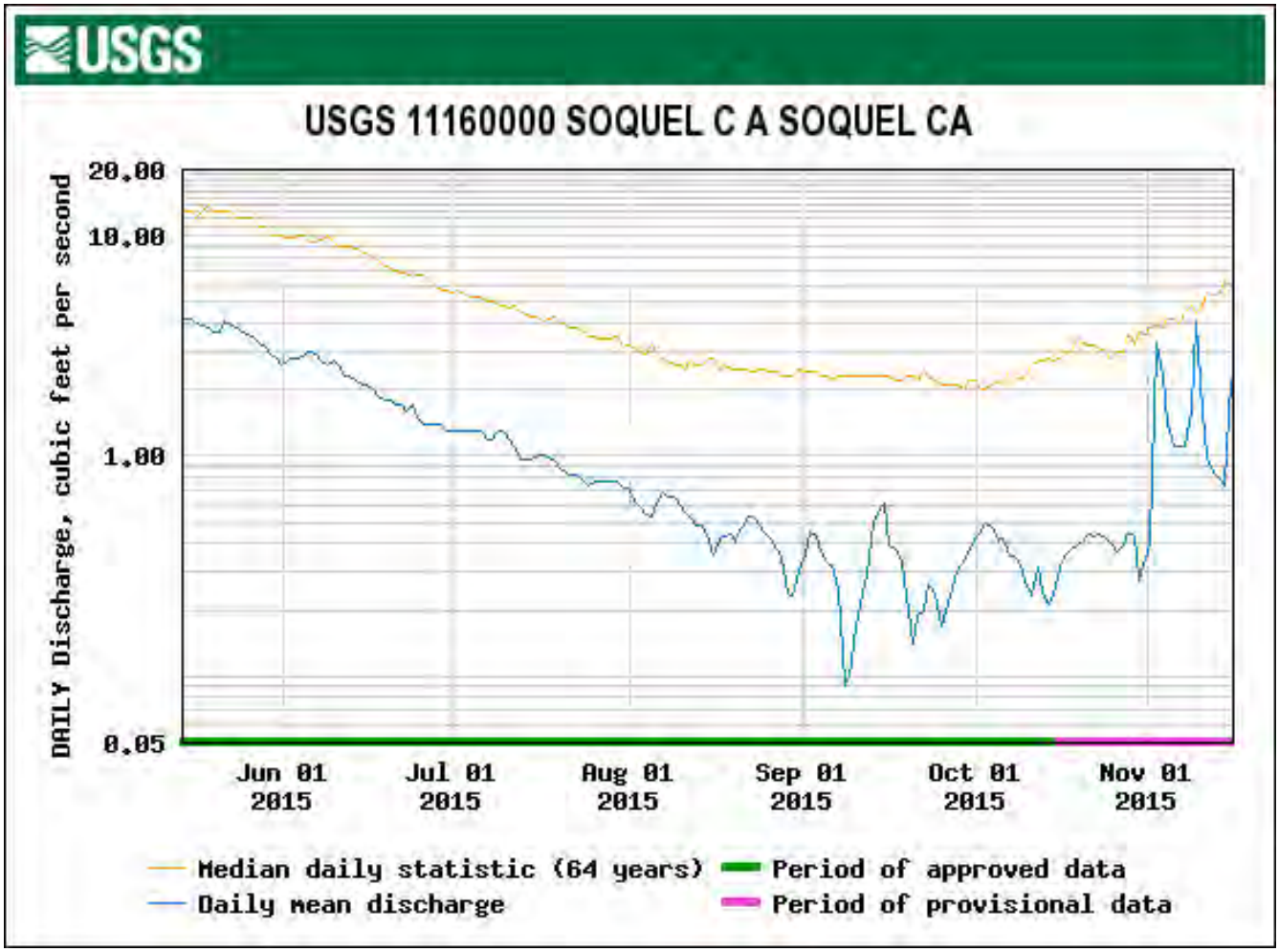


Figure 19. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2014.

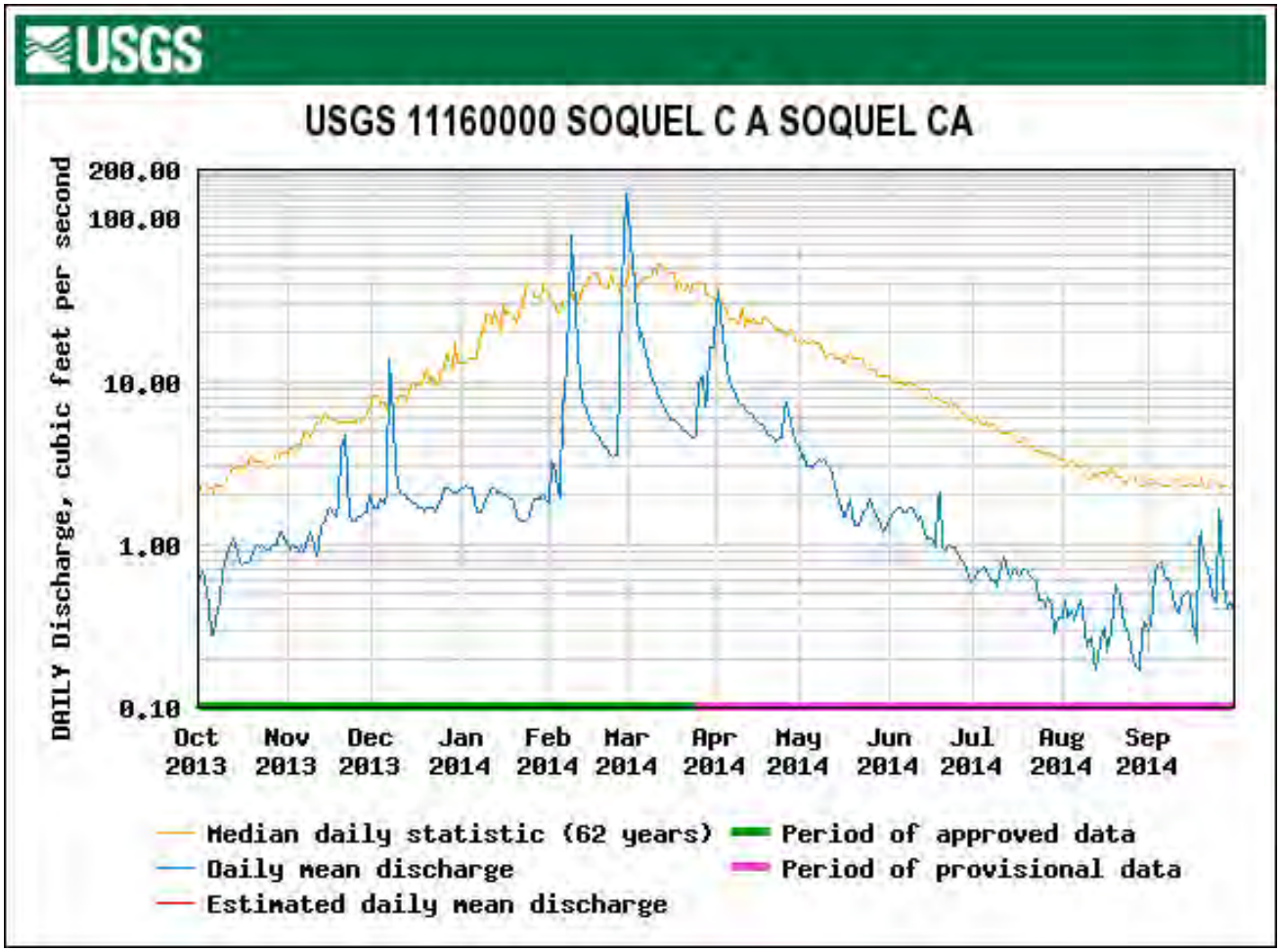


Figure 20. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2014.

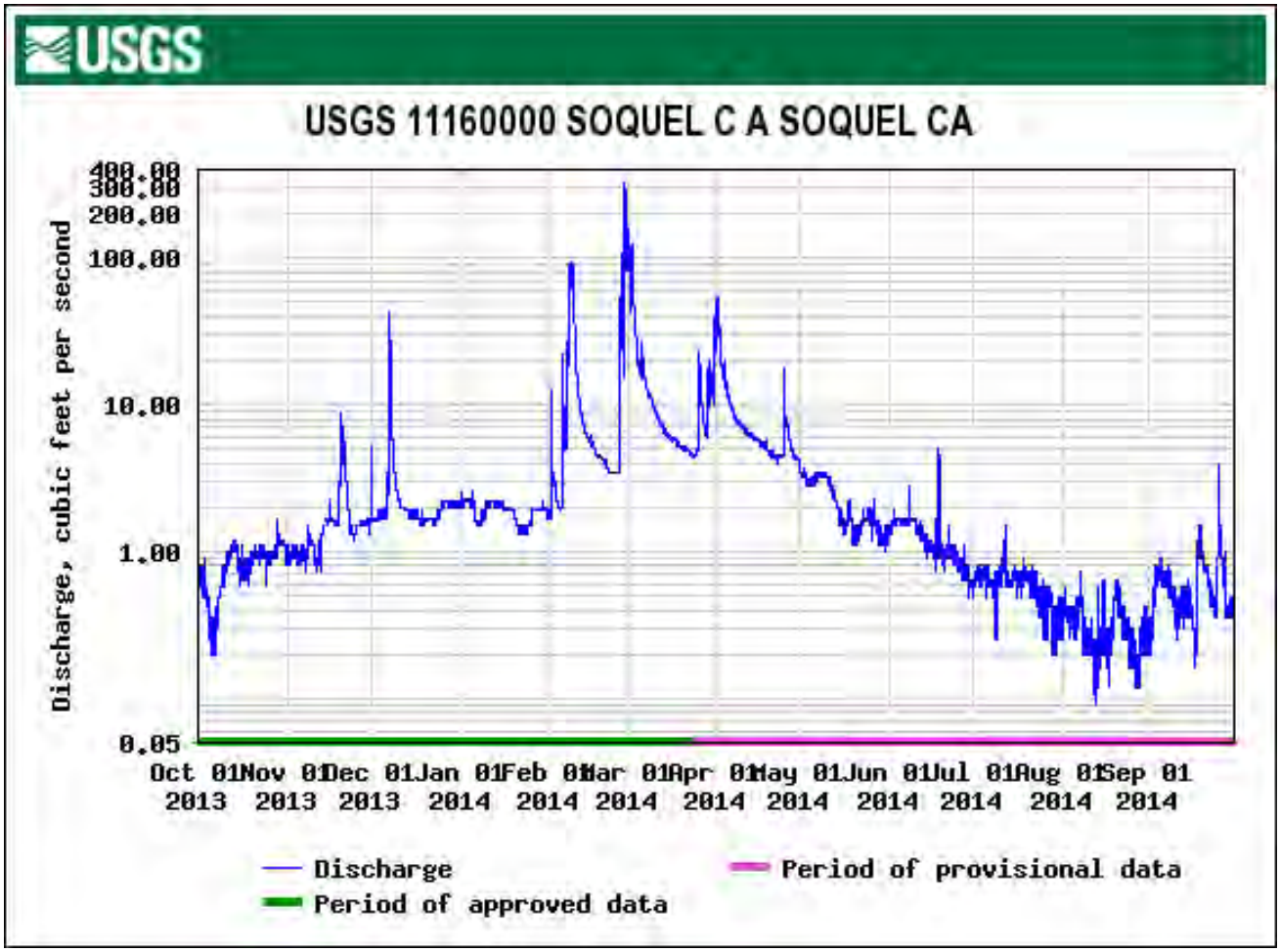


Figure 21. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2013.

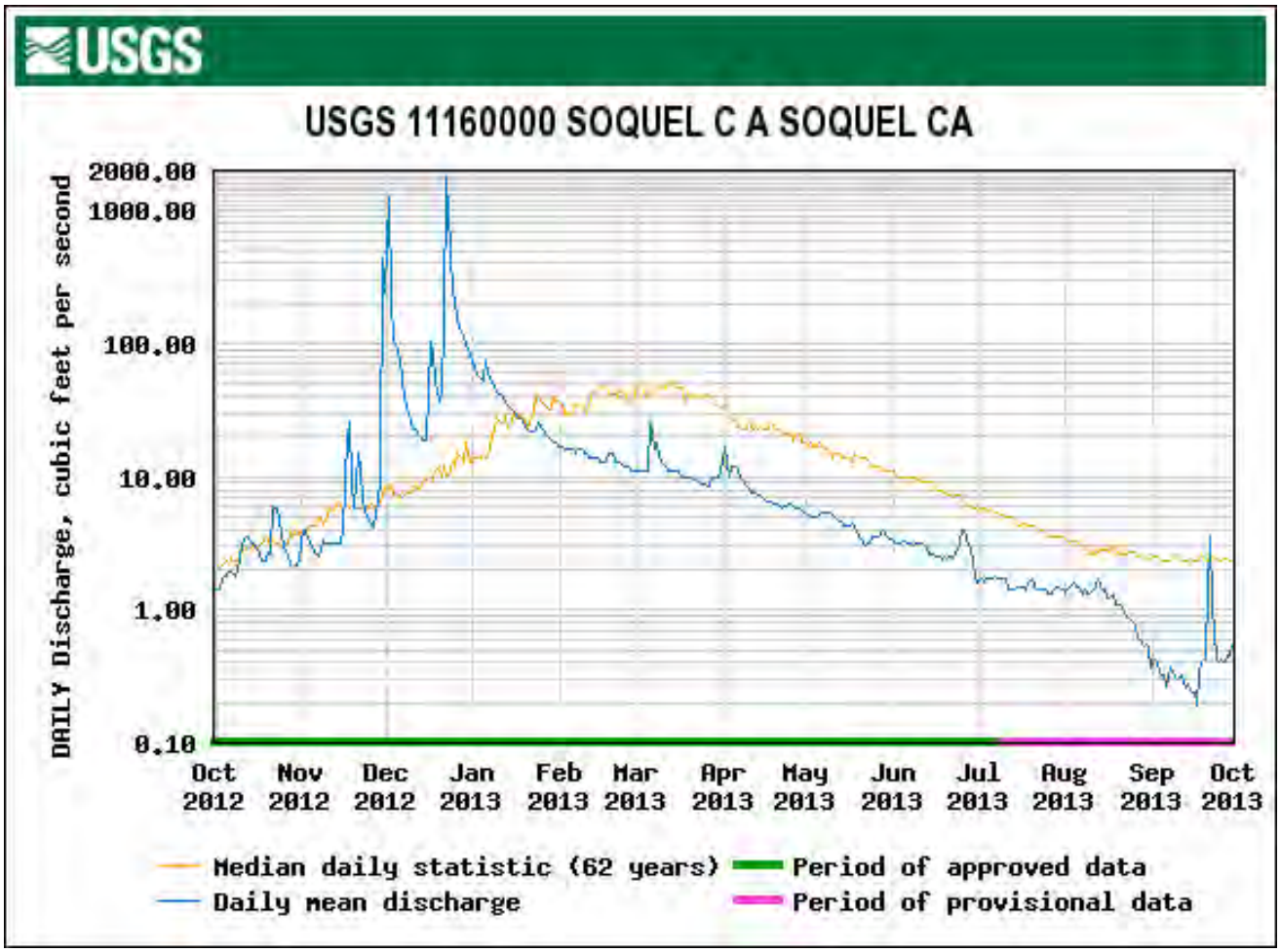


Figure 22. Soquel Creek Actual Streamflow Hydrograph for the USGS Gage in Soquel, CA, October 2012 – May 2013.

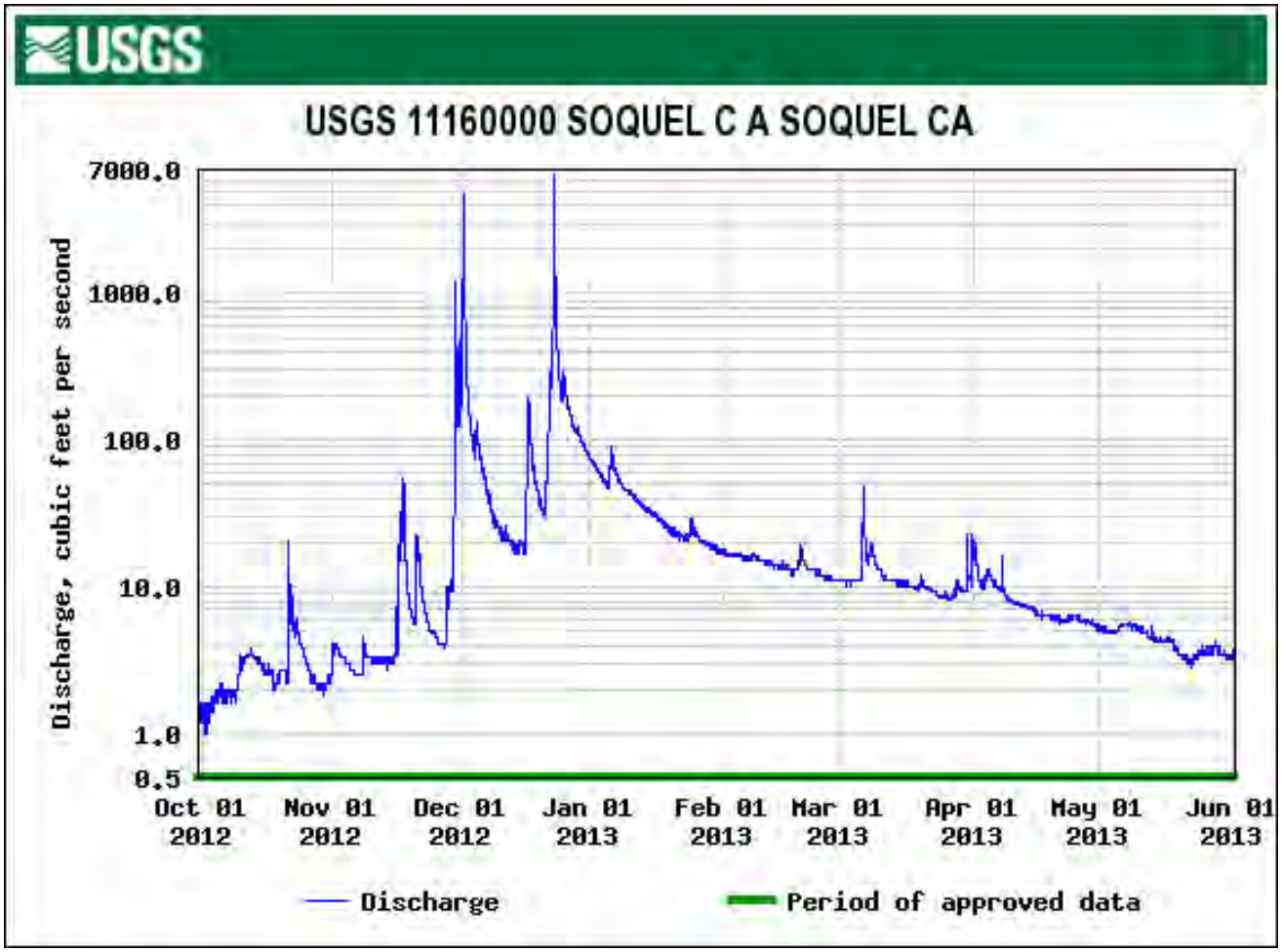


Figure 23. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2012.

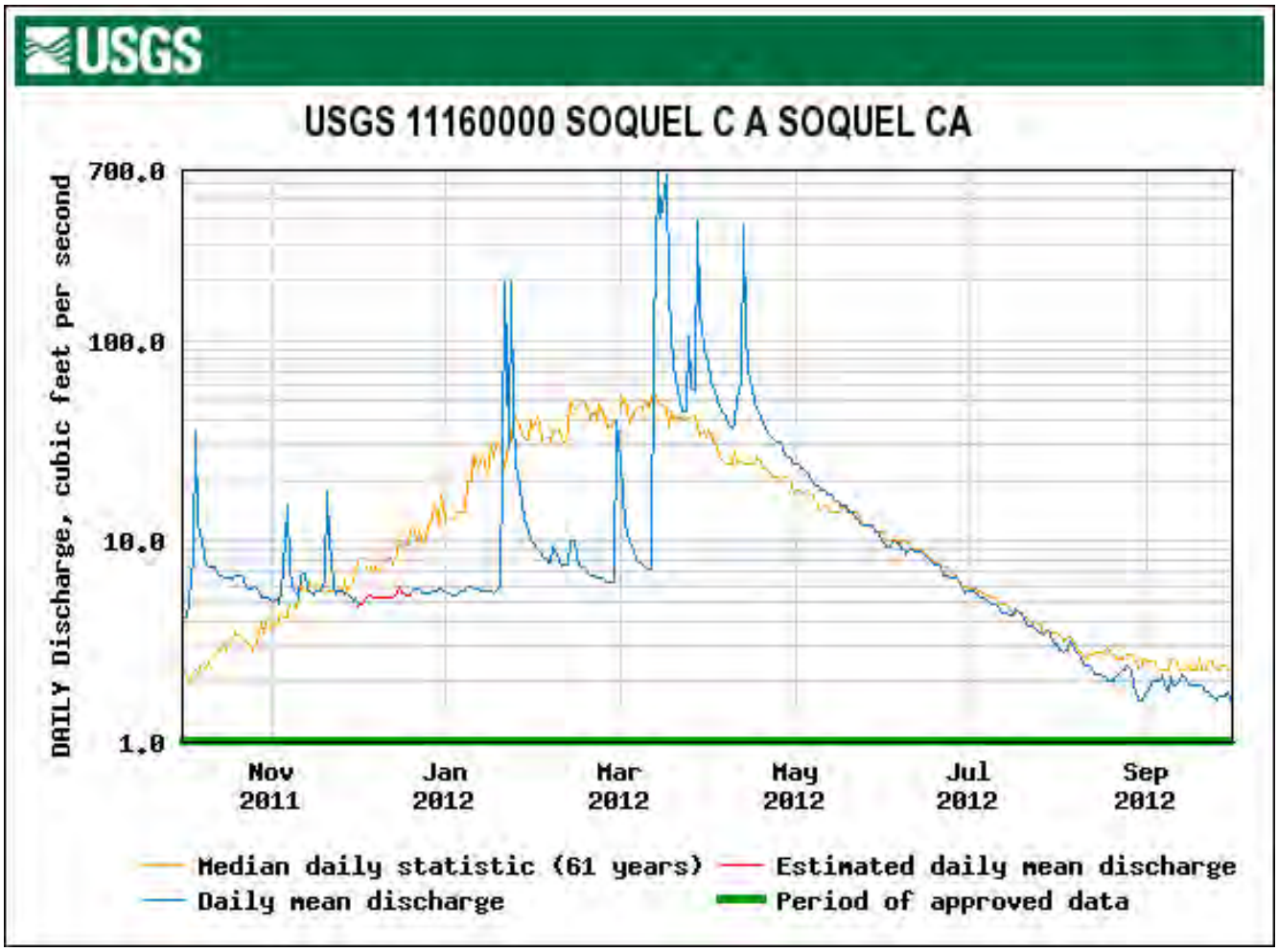


Figure 24. Soquel Creek Actual Measured Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2012.

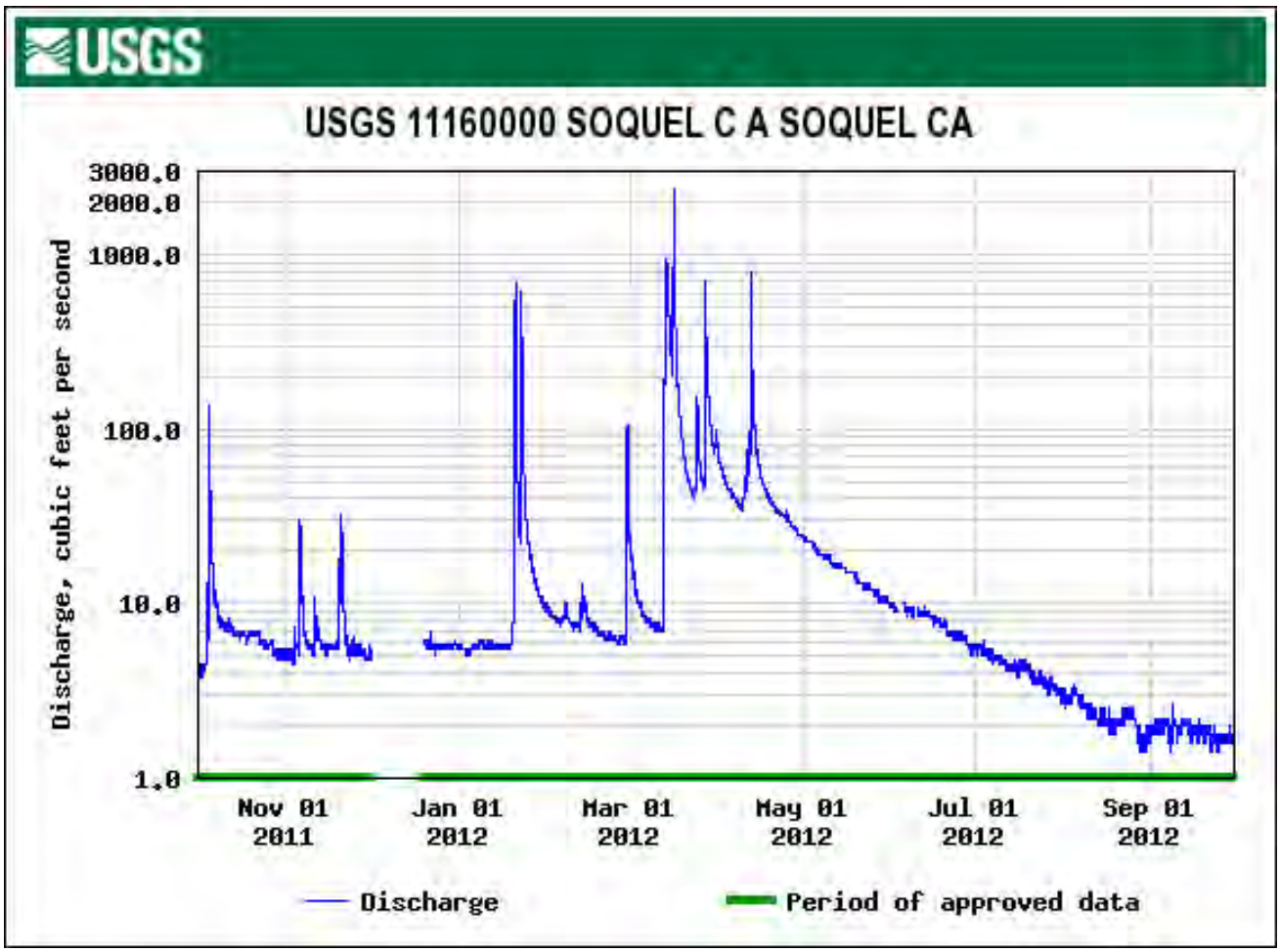


Figure 25. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2011.

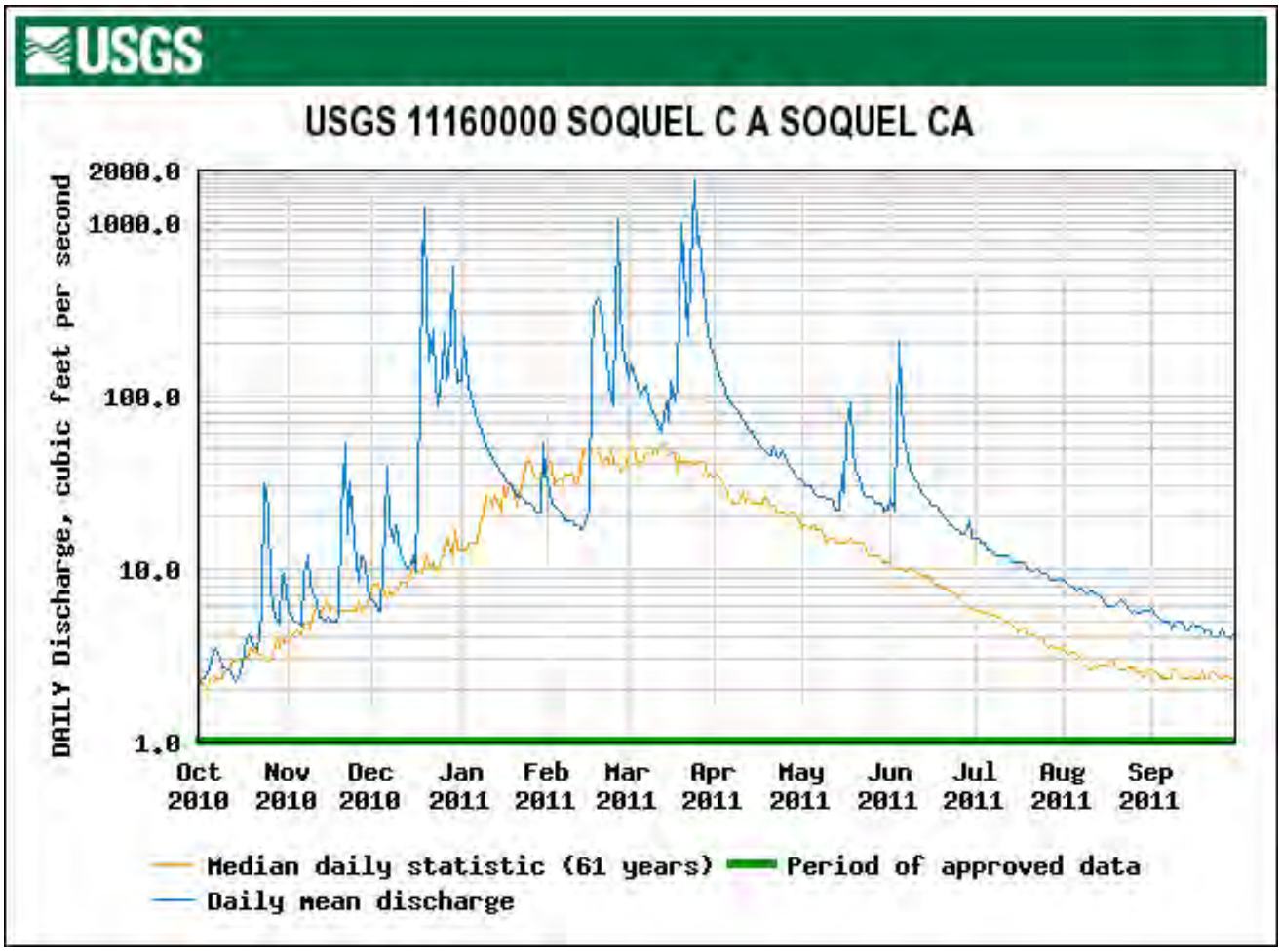


Figure 26. Soquel Creek Actual Measured Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2011.

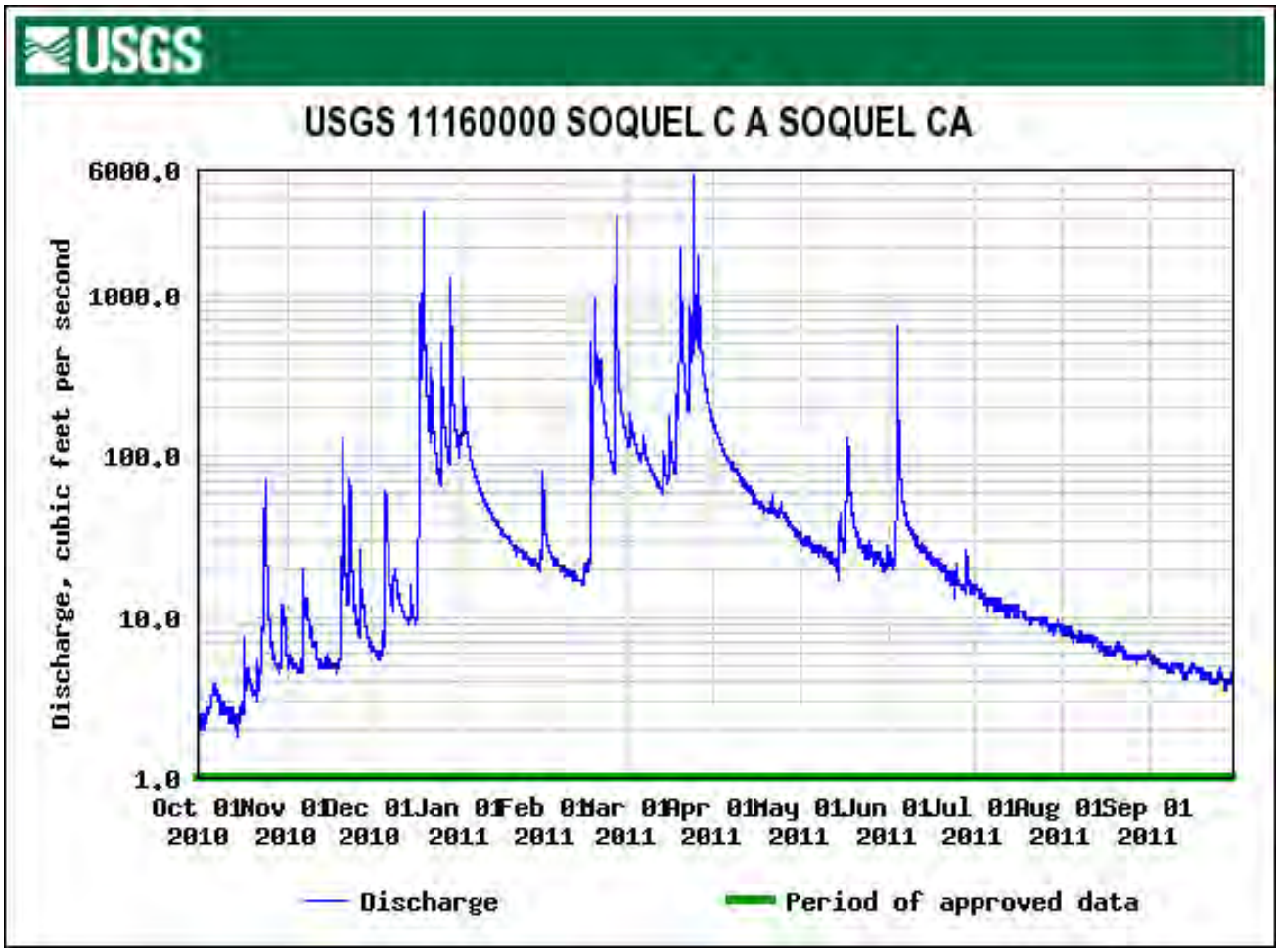


Figure 27. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2010.

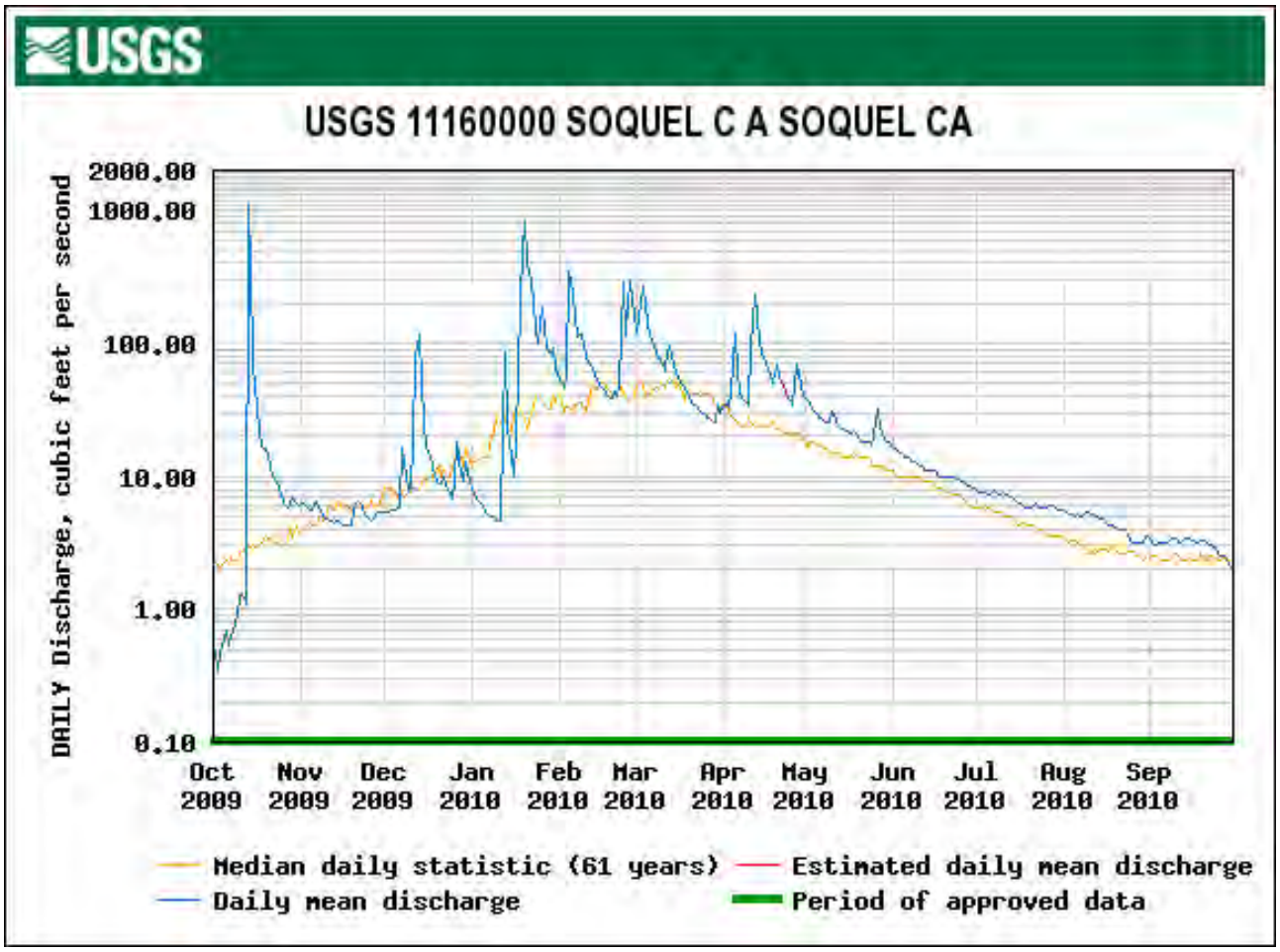


Figure 28. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2009.

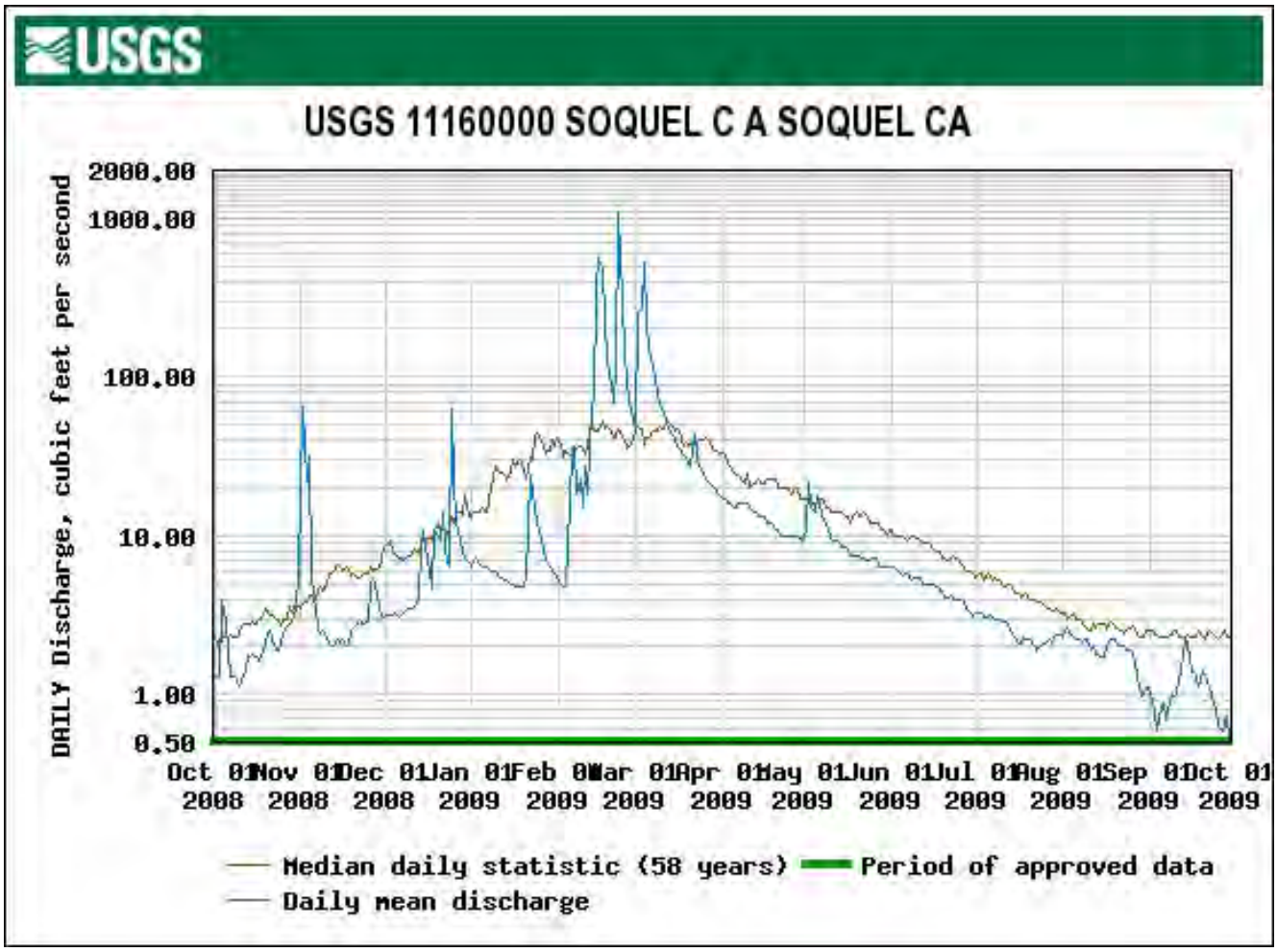


Figure 29. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2008.

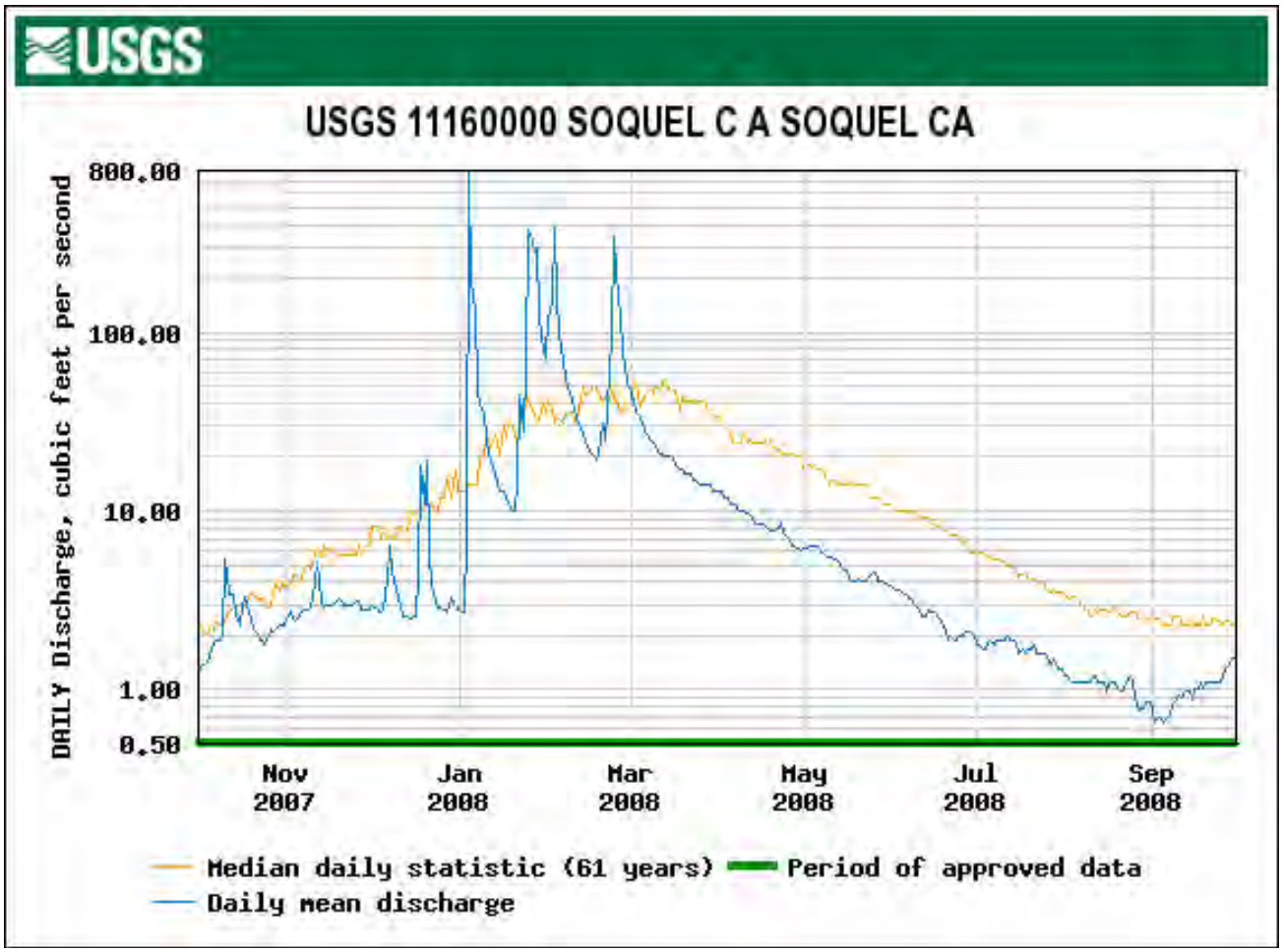


Figure 30. Soquel Creek Mean Daily Streamflow Hydrograph for the USGS Gage in Soquel, CA, Water Year 2007.